metronix
servo drives

Product Manual

Servo drives ARS 2320, ARS 2340, ARS 2320W, ARS 2360W

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Translation of the original instructions

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1 General

1.1 Documentation

This product manual serves the purpose of a safe use of the ARS 2300 series servo drives. It contains safety notes, which must be complied with.

Further information can be found in the following manuals of the ARS 2000 product range:

- **Software Manual "Servo drive ARS 2000":** Description of the device functionality and the software functions of the firmware including the RS232 communication. Description of the Metronix ServoCommander™ parameterisation program with instructions concerning the start-up of ARS 2000 servo drives.
- **Product Manual "Servo drive ARS 2100":** Description of the technical specifications and the device functionality as well as notes on the installation and the operation of the servo drive ARS 2100.
- **Product Manual "Servo drives ARS 2302, ARS 2305 and ARS 2310":** Description of the technical data and the device functionality as well as notes concerning the installation and operation of ARS 2302, 2305 and 2310 servo drives.
- **Product Manual "Motion Coordinator MC 2000":** Description of the technical data and the device functionality as well as notes on the installation and the operation of the Motion Coordinator MC 2000 (German version).
- **CANopen Manual "Servo drive ARS 2000":** Description of the implemented CANopen **protocol** as per DSP402.
- **ETHERNET Manual "Servo drive ARS 2000":** Description of the implemented Ethernet **protocol** (UDP).
- **PROFIBUS Manual "Servo drive ARS 2000":** Description of the implemented PROFIBUS-DP **protocol**.
- **sercos Manual "Servo drive ARS 2000":** Description of the implemented sercos **functionality**.
- **EtherCAT Manual "Servo drive ARS 2000"**: Description of the implemented EtherCAT **protocol** (CoE) (German version).

You can find all these documents on our homepage at the download area (http://www.metronix.de).

Certificates and declarations of conformity for the products described in this manual can be found at http://www.metronix.de.

1.2 Scope of supply

The scope of supply includes:

Table 1: Scope of supply

1x	Servo drive ARS 2300				
	Type	ARS 2320	ARS 2320 W	ARS 2340	ARS 2360 W
	Metronix order number	9200-2320-00	9200-2320-10	9200-2340-00	9200-2360-10

Counter plugs for power, controller or shaft encoder connections, as well as for shield connection are not included in the standard scope of supply. They can, however, be ordered as accessories.

Table 2: Connector set: POWER connector

1x	**Connector set: POWER-Connector** This plug set contains the counter plugs for the following connections: - Supply [X9] - Motor connection [X6] - motor temperature sensor and holding brake [X6A]				
	Type	ARS 2320	ARS 2320 W	ARS 2340	ARS 2360 W
	Metronix order number	9003-0280-01		9003-0280-02	

Table 3: Connector set: DSUB connector

1x	**Connector set: DSUB connector** This connector set includes the counter plugs for the following connections: - I/O interface [X1] - Angle encoder connection [X2A] - Angle encoder connection [X2B] - CAN fieldbus interface [X4] - Incremental encoder input [X10] - Incremental encoder output [X11]				
	Type	ARS 2320	ARS 2320 W	ARS 2340	ARS 2360 W
	Metronix order number	9200-0200-00			

Table 4: Connector set: Shield connector

1x	**Connector set: Shield connector** This connector set includes one shield terminal (SK-20D)				
	Type	ARS 2320	ARS 2320 W	ARS 2340	ARS 2360 W
	Metronix order number	9200-0203-00			

2 Safety notes for electrical drives and controllers

2.1 Used symbols

Information

Important information and notes.

Caution!

Nonobservance may result in severe property damages.

DANGER!

Nonobservance may result in **property damages** and in **personal injuries**.

Caution! Dangerous voltages.

The safety note indicates a possible perilous voltage.

2.2 General notes

In case of damage resulting from non-compliance with the safety notes in this manual, Metronix Meßgeräte und Elektronik GmbH will not assume any liability.

Prior to the initial use you must read the *Safety notes for electrical drives and controllers* starting on *page 18* and *chapter 8.15 Notes concerning safe and EMC-compliant installation* starting on *page 127*.

If the documentation in the language at hand is not understood accurately, please contact and inform your supplier.

Sound and safe operation of the servo drive requires proper and professional transportation, storage, mechanical installation, and project planning – with a consideration of the risks as well as the protective and emergency measures – plus the proper and professional electrical installation, operation, and maintenance of the devices.

Only trained and qualified personnel is authorised to handle electrical devices and systems:

TRAINED AND QUALIFIED PERSONNEL

in the sense of this product manual or the safety notes on the product itself are persons who are sufficiently familiar with the project, the setup, assembly, commissioning and operation of the product as well as all warnings and precautions as per the instructions in this manual and who are sufficiently qualified in their field of expertise:

- Education and instruction concerning the standards and accident prevention regulations for the application, or authorisation to switch devices/systems on and off and to ground them as per the standards of safety engineering and to efficiently label them as per the job demands.
- Education and instruction as per the standards of safety engineering regarding the maintenance and use of adequate safety equipment.
- First aid training.

The following notes must be read prior to the initial operation of the system to prevent personal injuries and/or property damages:

These safety notes must be complied with at all times.

Do not try to install or commission the servo drive before carefully reading all safety notes for electrical drives and controllers contained in this document. These safety instructions and all other user notes must be read prior to any work with the servo drive.

In case you do not have any user notes for the servo drive, please contact your sales representative. Immediately demand these documents to be sent to the person responsible for the safe operation of the servo drive.

If you sell, rent and/or otherwise make this device available to others, these safety notes must also be included.

The user must not open the servo drive for safety and warranty reasons.

Professional control process design is a prerequisite for sound functioning of the servo drive!

DANGER!

Inappropriate handling of the servo drive and non-compliance with the warnings as well as inappropriate intervention in the safety features may result in property damage, personal injuries, electric shock or in extreme cases even death.

2.3 Danger resulting from misuse

DANGER!

High electrical voltages and high load currents!

Danger to life or serious personal injury from electrical shock!

DANGER!

High electrical voltage caused by wrong connections!

Danger to life or serious personal injury from electrical shock!

DANGER!

Surfaces of device housing may be hot!

Risk of injury! Risk of burning!

DANGER!

Dangerous movements!

Danger to life, serious personal injury or property damage due to unintentional movements of the motors!

2.4 Safety notes

2.4.1 General safety notes

The servo drive corresponds to IP20 degree of protection as well as pollution degree 2. Make sure that the environment corresponds to this degree of protection and pollution degree.

Only use replacement parts and accessories approved by the manufacturer.

The devices must be connected to the mains supply as per EN regulations, so that they can be cut off the mains supply by means of corresponding separation devices (for example main switch, contactor, power switch).

The servo drive may be protected using an AC/DC sensitive 300 mA fault current protection switch, type B (RCD = Residual Current protective Device).

Gold contacts or contacts with a high contact pressure should be used to switch the control contacts.

Preventive interference rejection measures should be taken for control panels, such as connecting contactors and relays using RC elements or diodes.

The safety rules and regulations of the country in which the device will be operated must be complied with.

The environment conditions defined in the product documentation must be kept. Safety-critical applications are not allowed, unless specifically approved by the manufacturer.

For notes on installation corresponding to EMC, please refer to *chapter 8.15 Notes concerning safe and EMC-compliant installation (page 127)*. The compliance with the limits required by national regulations is the responsibility of the manufacturer of the machine or system.

The technical data and the connection and installation conditions for the servo drive are to be found in this product manual and must be met.

DANGER!

The general setup and safety regulations for work on power installations (for example DIN, VDE, EN, IEC or other national and international regulations) must be complied with.

Non-compliance may result in death, personal injury or serious property damages.

Without claiming completeness, the following regulations and others apply:

VDE 0100	Erection of power installations with nominal voltages up to 1000 V
EN 1037	Safety of maschinery - Prevention of unexpected start-up
EN 60204-1	Safety of machinery - Electrical equipment of machines Part 1: General requirements
EN 61800-3	Adjustable speed electrical power drive systems Part 3: EMC requirements and specific test methods
EN 61800-5-1	Adjustable speed electrical power drive systems Part 5-1: Safety requirements - Electrical, thermal and energy
EN 61800-5-2	Adjustable speed electrical power drive systems Part 5-2: Safety requirements - Functional
EN ISO 12100	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN ISO 13849-1	Safety of machinery - Safety-related parts of control systems Part 1: General principles for design
EN ISO 13849-2	Safety of machinery - Safety-related parts of control systems Part 2: Validation

More standards to be respected by the user:

EN 574	Safety of machinery - Two-hand control devices
EN 1088	Safety of machinery - Interlocking devices associated with guards
EN ISO 13850	Safety of machinery - Emergency stop

2.4.2 Safety notes for assembly and maintenance

The appropriate DIN, VDE, EN and IEC regulations as well as all national and local safety regulations and rules for the prevention of accidents apply for the assembly and maintenance of the system. The plant engineer or the operator is responsible for compliance with these regulations:

The servo drive must only be operated, maintained and/or repaired by personnel trained and qualified for working on or with electrical devices.

Prevention of accidents, injuries and/or damages:

Additionally secure vertical axes against falling down or lowering after the motor has been switched off, for example by means of:

- Mechanical locking of the vertical axle,
- External braking, catching or clamping devices or
- Sufficient balancing of the axle

The motor holding brake supplied by default or an external motor holding brake driven by the servo drive alone is not suitable for personal protection!

Keep the electrical equipment voltage-free using the main switch and protect it from being switched on again until the DC bus circuit is discharged, in the case of:

- Maintenance and repair work
- Cleaning
- long machine shutdowns

Prior to carrying out maintenance work make sure that the power supply has been turned off, locked and the DC bus circuit is discharged.

The external or internal brake resistor carries dangerous DC bus voltages during operation of the servo drive and up to 5 minutes thereafter. Contact may result in death or serious personal injury. Wait for this time prior to performing any work on the affected connections. Measure the voltages for your own protection. Contact with these high DC bus circuit voltages may result in death or serious personal injury.

Be careful during the assembly. During the assembly and also later during operation of the drive, make sure to prevent drill chips, metal dust or assembly parts (screws, nuts, cable sections) from falling into the device.

Also make sure that the external power supply of the servo drive (24 V) is switched off.

The DC bus circuit or the mains supply must always be switched off prior to switching off the 24 V servo drive supply.

Carry out work in the machine area only, if AC and/or DC supplies are switched off. Switched off output stages or servo drive enablings are no suitable means of locking. In the case of a malfunction the drive may accidentally be put into action.

This does not apply to drives with the special “Safe Torque-Off (STO)” features, see *chapter* 6 *Functional safety technology*.

Initial operation must be carried out with idle motors, to prevent mechanical damages for example due to the wrong direction of rotation.

Electronic devices are never fail-safe. It is the user’s responsibility, in the case an electrical device fails, to make sure the system is transferred into a secure state.

The servo drive and in particular the brake resistor, externally or internally, can assume high temperatures, which may cause serious burns.

2.4.3 Protection against contact with electrical parts

This section only concerns devices and drive components carrying voltages exceeding 50 V. Contact with parts carrying voltages of more than 50 V can be dangerous for people and may cause electrical shock. During operation of electrical devices some parts of these devices will inevitably carry dangerous voltages.

DANGER!

High electrical voltage!

Danger to life, danger due to electrical shock or serious personal injury!

The appropriate DIN, VDE, EN and IEC regulations as well as all national and local safety regulations and rules for the prevention of accidents apply for the assembly and maintenance of the system. The plant engineer or the operator is responsible for compliance with these regulations:

Before switching on the device, install the appropriate covers and protections against accidental contact. Rack-mounted devices must be protected against accidental contact by means of a housing, for example a switch cabinet. The national regulations for safety/accident prevention must be complied with!

Always connect the ground conductor of the electrical equipment and devices securely to the mains supply. Due to the integrated line filter the leakage current exceeds 3.5 mA!

Comply with the minimum copper cross-section for the ground conductor over its entire length (see for example EN 60800-5-1).

Prior to the initial operation, even for short measuring or testing purposes, always connect the ground conductor of all electrical devices as per the terminal diagram or connect it to the ground wire. Otherwise the housing may carry high voltages which can cause electrical shock.

Do not touch electrical connections of the components when switched on.

Prior to accessing electrical parts carrying voltages exceeding 50 Volts, disconnect the device from the mains or power supply. Protect it from being switched on again.

For the installation the amount of DC bus voltage must be considered, particularly regarding insulation and protective measures. Ensure proper grounding, wire dimensioning and corresponding short-circuit protection.

The device comprises a rapid discharge circuit for the DC bus as per EN 60204-1. In certain device constellations, however, mostly in the case of parallel connection of several servo drives in the DC bus or in the case of an unconnected brake resistor, this rapid discharge may be rendered ineffective. The servo drives can carry voltage until up to 5 minutes after being switched off (residual capacitor charge).

2.4.4 Protection against electrical shock by means of protective extra-low voltage (PELV)

All connections and terminals with voltages of up to 50 Volts at the servo drive are protective extra-low voltage, which are designed safe from contact in correspondence with the following standards:

- International: IEC 60364-4-41
- European countries within the EU: EN 61800-5-1

DANGER!

High electrical voltages due to wrong connections!

Danger to life, risk of injury due to electrical shock!

Only devices and electrical components and wires with a protective extra low voltage (PELV) may be connected to connectors and terminals with voltages between 0 to 50 Volts.

Only connect voltages and circuits with protection against dangerous voltages. Such protection may be achieved by means of isolation transformers, safe optocouplers or battery operation.

The signals for the digital temperature sensor “-MTdig” (PIN 2) and “+MTdig” (PIN 1) at the motor connector [X6A] are not connected to Protective Extra Low Voltage (PELV).
These connections are designed for temperature sensors that are not safely separated.
The safe separation from Protective Extra Low Voltage (PELV) is performed within the ARS 2000.

2.4.5 Protection against dangerous movements

Dangerous movements can be caused by faulty control of connected motors, for different reasons:

- Improper or faulty wiring or cabling
- Error in handling of components
- Error in sensor or transducer
- Defective or non-EMC-compliant components
- Software error in superordinated control system

These errors can occur directly after switching on the device or after an indeterminate time of operation.

The monitors in the drive components for the most part rule out malfunctions in the connected drives. In view of personal protection, particularly the danger of personal injury and/or property damage, this may not be relied on exclusively. Until the built-in monitors come into effect, faulty drive movements must be taken into account; their magnitude depends on the type of control and on the operating state.

DANGER!

Dangerous movements!

Danger to life, risk of injury, serious personal injuries or property damage!

For the reasons mentioned above, personal protection must be ensured by means of monitoring or superordinated measures on the device. These are installed in accordance with the specific data of the system and a danger and error analysis by the manufacturer. The safety regulations applying to the system are also taken into consideration. Random movements or other malfunctions may be caused by switching the safety installations off, by bypassing them or by not activating them.

2.4.6 Protection against contact with hot parts

DANGER!

Housing surfaces may be hot!

Risk of injury! Risk of burning!

Do not touch housing surfaces in the vicinity of heat sources! Danger of burning!

Before accessing devices let them cool down for 10 minutes after switching them off.

Touching hot parts of the equipment such as the housing, which contain heat sinks and resistors, may cause burns!

2.4.7 Protection during handling and assembly

Handling and assembly of certain parts and components in an unsuitable manner may under adverse conditions cause injuries.

DANGER!

Risk of injury due to improper handling!

Personal injury due to pinching, shearing, cutting, crushing!

The following general safety notes apply:

Comply with the general setup and safety regulations on handling and assembly.

Use suitable assembly and transportation devices.

Prevent incarcerations and contusions by means of suitable protective measures.

Use suitable tools only. If specified, use special tools.

Use lifting devices and tools appropriately.

If necessary, use suitable protective equipment (for example goggles, protective footwear, protective gloves).

Do not stand underneath hanging loads.

Remove leaking liquids on the floor immediately to prevent slipping.

3 Product description

3.1 General

The servo drive ARS 2300 (ARS servo 2nd generation) series devices are intelligent AC servo drives with substantial parameterisation possibilities and extension options. They are flexible and can be easily adapted to a number of different applications.

ARS 2300 servo drives include types with three-phase power supply.

Type key:

Example using the ARS 2320:

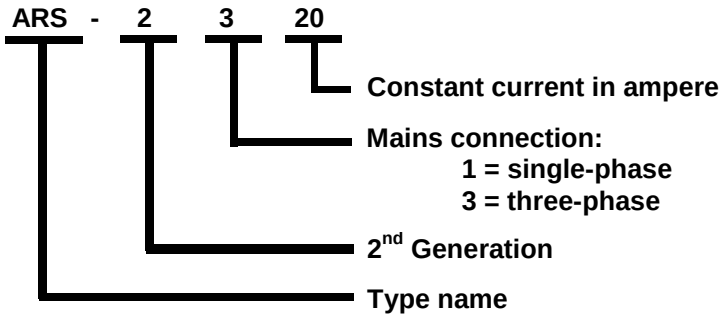


Figure 1: Type key

For the water cooled power stages, a “W” is added to the type key:

W = water cooling

Types available:

ARS 2320W und ARS 2360W

All servo drive ARS 2000 series devices have the following features:

- Space-saving compact design, directly cascadable
- High quality of control due to extremely high-quality sensor technology, far superior to conventional market standards, and better than average computer resources
- Full integration of all components for the controller and power unit, including an RS232 interface for PC communication and a CANopen interface for integration in automation systems.
- Integrated universal encoder evaluation for the following encoders:
  - Resolver
  - Incremental encoder with/without commutation signals
  - High-resolution Stegmann incremental encoders, absolute encoders with HIPERFACE®
  - High-resolution Heidenhain incremental encoders, absolute encoders with EnDat
- Compliance with current European regulations and associated standards without any additional external measures
- Device design as per UL standards
- Completely closed, EMC-optimized metal housing for mounting to conventional control cabinet plates. All devices comply with the IP20 degree of protection
- Integration of all filters to fulfil the EMC regulations (industrial) inside the device, for example line filter, motor output filter, filter for 24 V-supply as well as inputs and outputs
- Integrated brake resistor. External resistors can be connected for higher braking energies
- Complete galvanic separation of controller unit and power output stage as per EN 61800-5-1. Galvanic separation of the 24 V potential area with the digital inputs and outputs, analogue electronics and the control electronics
- Operation as speed controller, torque controller or positioning controller
- Integrated positioning control with wide range of functions as per CAN in Automation (CiA) DSP402 and numerous additional application-specific functions
- Jerk limit or time-optimal positioning relative or absolute to a point of reference
- Point-to-point positioning (with or without S-ramps)
- Speed and angle synchronisation with electronic gear system via incremental encoder input or fieldbus
- Extensive modes of operation for synchronisation
- Various methods for homing
- Jogging
- Teach-in mode
- Short cycle times, resulting in cut-off frequencies of approximately 2 kHz in current control circuit, and approximately 500 Hz in speed control circuit
- Switchable clock frequency for the power output stage
- Freely programmable I/O‘s

- User-friendly parameterisation with the Metronix ServoCommander™ software
- Menu-driven first set up
- Automatic motor identification
- Easy coupling to host controller, for example to a PLC via I/O level or fieldbus
- High-resolution 16-bit analogue input
- Technology slots for extensions such as I/O extension module or PROFIBUS interface.
  Note: Depending on the current consumption, only one technology module with an additional fieldbus interface may be used
- Integrated safety function “Safe Torque-Off (STO)” in accordance with DIN EN ISO 13849-1, Category 3 Performance Level d

3.2 Power supply

3.2.1 Three-phase AC power supply

The ARS 2300 servo drive fulfils the following requirements:

- Nominal frequency range 50-60Hz ± 10%
- Electrical impulse load capacity for possible combination of several servo drives. The servo drive ARS 2300 allows dynamic conversion in both directions between motor and generator operation without dead times
- No parameterisation by user necessary

3.2.1.1 Behaviour during switch-on, behaviour during normal operation and control characteristics

- As soon as the servo drive ARS 2300 is supplied with the input voltage, the DC bus is charged(< 1 s) using the brake resistor as a precharging resistor, the DC bus relay deactivated.
- After precharging of the DC bus the relay is energized and the DC bus is coupled hard to the mains power without the precharging resistor.

3.2.2 DC bus coupling, DC supply

3.2.2.1 DC bus coupling

- It is possible to couple multiple ARS 2300 servo drives when they have the same DC bus voltage.

3.2.2.2 DC-supply:

- The direct DC supply is supported for a supply with voltages ≥ 60 VDC by the DC-bus connection instead of the connection to the mains

The digital motor temperature measurement system requires a DC bus voltage of 230 VDC minimum. Below this voltage, the system will always identify the digital motor temperature sensor as open. In this case you must either use the analogue temperature sensing (if the temperature sensor is safely separated, see *chapter 8.6.11*) or disable the temperature sensing at all.

3.2.3 Mains fuse

Install a three-phase automatic circuit breaker into the mains supply line:

- For servo drive type ARS 2320, ARS 2320W: 32 A, slow-blow type (B32)
- For servo drive type ARS 2340, ARS 2360W: 50 A, slow-blow type (B50)

3.3 Brake chopper

The power output stage comprises a brake chopper with a braking resistor. If the admissible charging capacity of the DC bus is exceeded during regenerative power supply, the internal braking resistor can convert the braking energy into heat. The brake chopper is controlled by the software. The internal brake resistor is overload-protected by means of software and hardware.

If in a special application the capacity of the internal braking resistor is not sufficient, the resistor can be switched off by removing the jumper between pins *BR-CH* and *BR-INT* of connector [X9]. Instead, an external braking resistor has to be connected between pins *BR-CH* and *BR-EXT*. The values of this braking resistor must not be below certain predefined minimum values (see *Table 12, page 41*). The output is protected against a short-circuit in the braking resistor or in its feed line.

Pin *BR-CH* is connected to the positive DC bus potential and therefore not protected against ground fault or shorts to mains power or negative DC bus voltage.

Internal and external braking resistors cannot be used simultaneously. External braking resistors are not automatically overload-protected by the device.

3.4 Communication interfaces

The servo drive ARS 2300 has several communication interfaces. The basic device itself is already equipped with many of these interfaces.

The following communication interfaces are included in the basic device:

- Serial interface [X5]: RS232/RS485
- Fieldbus system [X4]: CANopen
- I/O interface [X1]: Digital and analogue In- and outputs

The serial interface is particularly important for the connection of a PC and for the use of the Metronix ServoCommander™ parameterisation tool.

The fieldbus systems PROFIBUS-DP, sercos and EtherCAT are extension options that can be implemented in the form of plug-in modules. If required, customer-specific fieldbus protocols can also be realised.

In any case, the servo drive of this design always works as a slave to the fieldbus.

3.4.1 Serial interface [X5]

The RS232 protocol is mainly intended to be a parameterisation interface, but also allows the control of the servo drive.

3.4.2 CAN interface [X4]

The CANopen protocol as per DS301 with application profile DSP402 is implemented.

The specific Metronix CAN protocol of the previous ARS devices is no longer supported by the ARS 2300 series.

3.4.3 Technology module: PROFIBUS

Support of PROFIBUS communication as per DP-V0. For drive technology applications the functions as per PROFIDRIVE Version 3.0 are available. The features include functions as per Application Class 1 (speed and torque control) as well as per Application Class 3 (point-to-point positioning).

It is also possible to include the device into control systems via an I/O mapping via PROFIBUS. From a control point of view, this option offers the same functionality as a conventional PLC coupling via parallel wiring with the device's digital I/Os.

Via a special Metronix telegram it is also possible to access all device-specific functions, exceeding the functionality defined by PROFIDRIVE.

The Metronix PROFIBUS-profile of the previous ARS series is no longer supported by the ARS 2300 series.

3.4.4 Technology module: sercos II

The sercos II interface is a slave fieldbus module that enables the use of the ARS 2000 servo drives in numerically-controlled, highly dynamic drive applications, for example in machine tools. The sercos II interface enables the position, speed, or torque control in accordance with the functionality of the compliance classes A and B.

The connected module is automatically identified. Since the data exchange between the CNC system and the servo drive is realised via optical fibre cables, mutual interference can be avoided. The drive address is set, and the bus is activated, via the Metronix ServoCommander™ parameterisation tool. The transmission rate can be set to a value between 2 and 16 Mbit/s.

3.4.5 Technology module: EtherCAT

The EtherCAT interface enables the connection of the ARS 2000 servo drive to the EtherCAT fieldbus system. The communication via the EtherCAT interface (IEEE-802.3u) is realised with the aid of EtherCAT standard cabling. It is possible between an ARS 2300 (firmware version 3.5.0.1.8 or higher) and the Metronix ServoCommander™ parameterisation software (version 2.8.0.2.1 or higher).

3.4.6 I/O functions and device control

Ten digital inputs provide the elementary control functions (see *chapter 4.8.3 I/O interface [X1], page 52*):

The ARS 2300 comprises a target table, in which the positioning targets are stored and from which they can later be retrieved. At least four digital inputs serve the purpose of target selection; one input is used as a start input.

The limit switches serve the safety limitation of the motion space. During a homing one of the two limit switches may serve as a reference point for the positioning control.

Two inputs are used for the power stage enabling on the hardware side as well as for the servo drive enabling on the software side.

High-speed sample inputs are available for different time-critical applications (for example homing, special applications).

The servo drive ARS 2300 has three analogue inputs for input levels in the range of *+10V* to *-10V*. One input is designed as a differential input (16 bit), to guarantee high interference immunity. Two inputs (10 bit) are single-ended. The analogue signals are quantized and digitalized by an analogue-digital converter at a resolution of 16 bit or 10 bit. The analogue signals provide the set points (speed or torque) for the control.

In common applications the existing digital inputs are already used for basic functions. For the use of further functions such as teach-in mode, separate “start homing” input or stop input, the analogue inputs AIN 1, AIN 2 as well as the digital outputs DOUT 2 and DOUT 3, which are also usable as digital inputs, can optionally also be used. Alternatively the I/O extension module EA88 can be inserted.

4 Technical data

4.1 General Technical data

Table 5: Technical data: Ambient conditions and qualification

Range	Values
Admissible temperature ranges	Storage temperature: -25°C to +70°C
	Operating temperature: 0°C to +40°C +40°C to +50°C at reduced power 2,5% /K
Admissible installation height	Mounting height maximum 2000 m above msl, above 1000 m above msl with power reduction 1% per 100 m
Humidity	Relative humidity up to 90 %, not bedewing
Protection degree	IP20
Protection class	I
Pollution degree	2
CE conformity Low-voltage directive: EMC directive:	 2006/95/EC verified by application of the harmonised standard EN 61800-5-1 2004/108/EC verified by application of the harmonised standard EN 61800–3

Table 6: Technical data: Dimensions and weight

Type	ARS 2320	ARS 2320W	ARS 2340	ARS 2360W
Dimensions of the servo drive (height*width*depth) (without counter plug, shield screw and screw heads	approx. 330 mm x 89 mm x 242 mm	approx. 330 mm x 89 mm x 170 mm	approx. 330 mm x 164 mm x 242 mm	approx. 330 mm x 164 mm x 170 mm
Dimensions of the mounting plate (height*width*depth)	approx. 369 mm x 80 mm x 2 mm	approx. 369 mm x 80 mm x 10 mm	approx. 369 mm x 160 mm x 2 mm	approx. 369 mm x 160 mm x 10 mm
Weight	approx. 8 kg	approx. 5,5 kg	approx. 13,5 kg	approx. 9 kg

Table 7: Technical data: Cable specifications

Range	**ARS 2320 and ARS 2320W**	**ARS 2340 and ARS 2360W**
Maximum motor cable length for interference emission as per EN 61800-3		
Category C2 Switch cabinet assembly (see *chapter 8.15 Notes concerning safe and EMC-compliant installation*)	$l \leq 15$ m	
Category C3 (industrial area)	$l \leq 50$ m	
Cable capacity of a phase against shield or between two lines	$C' \leq 200$ pF/m	

Table 8: Technical data: Motor temperature monitoring

Motor temperature monitoring	**Values**
Digital Sensor at [X6A]	Normally closed contact: $R_{cold} < 500\ \Omega$ $R_{hot} > 100\ k\Omega$
Analogue Sensor at [X2A] or [X2B]	Silicon temperature sensor, for example KTY81, 82 or similar $R_{25} \approx 2000\ \Omega$ $R_{100} \approx 3400\ \Omega$

4.2 Operating and display elements

On the front the servo drive ARS 2300 has two LEDs and one seven-segment display to indicate the operating status.

Table 9: Display elements and RESET button

Element	**Function**
Seven segment display	Display of operating mode and a coded error number in the case of a malfunction
LED1	Operational state
LED2	Status display CAN bus
RESET-Button	Hardware reset for processor

4.3 Supply [X9]

Table 10: Technical data: Performance data [X9]

Type	**ARS 2320 und ARS 2320W**	**ARS 2340 und ARS 2360W**
Supply voltage	3 x 230 ... 480 VAC [+/- 10%], 50...60Hz	
Alternative DC supply	60 ... 700 VDC	

Table 11: Technical data: Internal braking resistor [X9] or [X9A]

Type	**ARS 2320 and ARS 2320W Connector [X9]**	**ARS 2340 and ARS 2360W Connector [X9A]**
Internal braking resistor	47 Ω	23,5 Ω
Pulse power	12 kW	23 kW
Continuous power	> 110 W	> 220 W
Response threshold	760 V	

Table 12: Technical data: External braking resistor [X9] or [X9A]

Type	**ARS 2320 and ARS 2320W Connector [X9]**	**ARS 2340 and ARS 2360W Connector [X9A]**
External braking resistor	$30\Omega \leq R_{external} \leq 100\ \Omega$	$18\Omega \leq R_{external} \leq 75\ \Omega$
Continuous power	≤ 5 kW	≤ 10 kW
Operating voltage	≥ 800 V	

4.4 Motor connection [X6]

Table 13: Technical data: Motor connection [X6]

Type	ARS 2320	ARS 2320W	ARS 2340	ARS 2360W
Data for use at 3x 400 VAC [± 10%], 50 Hz with an output stage clock frequency of 5 kHz or 7,5 kHz for the devices ARS 2320W and ARS 2360W				
Output power	12 kVA	12 kVA	20 kVA	25 kVA
Max. output power for 3 s	25 kVA	25 kVA	50 kVA	60 kVA
Output current	20 A_{eff}	20 A_{eff}	40 A_{eff}	60 A_{eff}
Max. output current for 3 s	41 A_{eff}	50 A_{eff}	70 A_{eff}	120 A_{eff}
Clock frequency	max. 12,5 kHz			
Power loss @ nominal operating conditions and f_{PWM} = 5kHz or 7,5 kHz for the devices ARS 2320W or ARS 2360W	approximately 220 W	approximately 250 W	approximately 550 W	approximately 750 W
Max. mains current in continuous operation [1)]	20 A_{eff}	20 A_{eff}	40 A_{eff}	40 A_{eff}

1) for a cos φ in the motor circuit of 0,7

4.4.1 Current derating

Other than stated in the technical motor data, the ARS 2320, ARS 2340, ARS 2320W and ARS 2360W servo drives have current derating in nominal operating conditions.

The following formula can be used to calculate the output current of the output stage as a function of the output stage frequency (f_{PWM}) for values > 5 kHz or > 7,5 kHz:

$$\text{ARS 2320:} \quad I(f_{PWM}) = -\frac{6\ \text{A}}{10\ \text{kHZ}} \times f_{PWM} + 23{,}00\ \text{A}$$

(current derating in nominal operation of 5 kHz and above)

$$\text{ARS 2340:} \quad I(f_{PWM}) = -\frac{13\ \text{A}}{10\ \text{kHZ}} \times f_{PWM} + 46{,}50\ \text{A}$$

(current derating in nominal operation as of 5 kHz)

$$\text{ARS 2320W:} \quad I(f_{PWM}) = 20\ \text{A}$$

(no current derating in nominal operation)

$$\text{ARS 2360W:} \quad I(f_{PWM}) = -2\ \frac{\text{A}}{\text{kHZ}} \times f_{PWM} + 75\ \text{A}$$

(current derating in nominal operation as of 7,5 kHz)

The following derating graph shows the admissible rated current as a function of the adjusted pulse frequency:

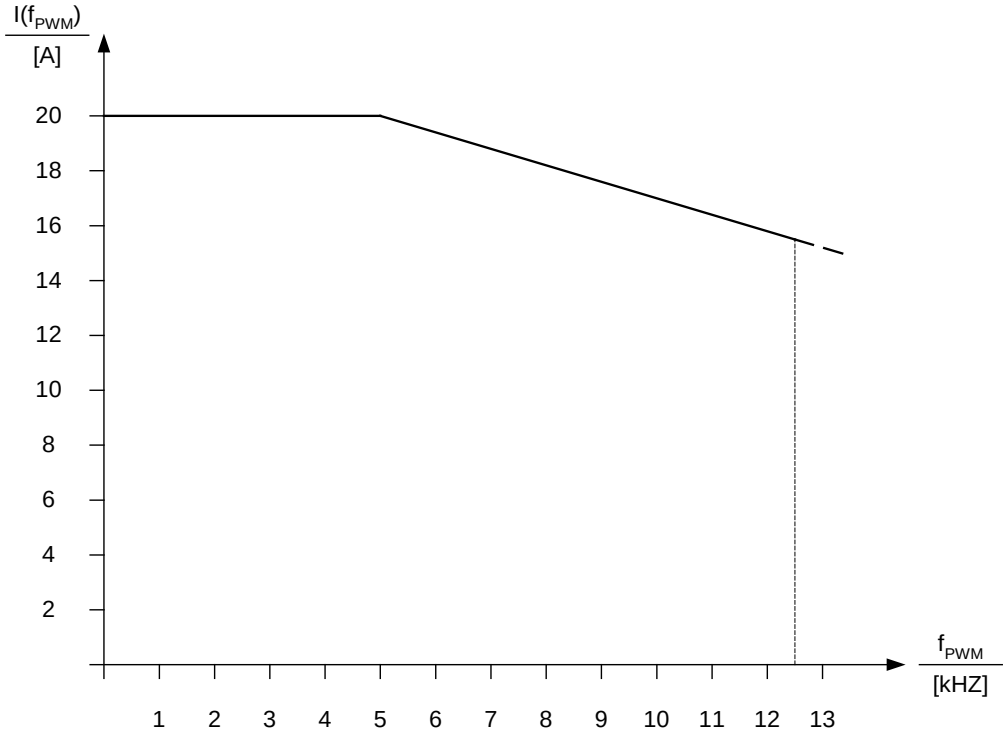


Figure 2: ARS 2320: Current derating diagram

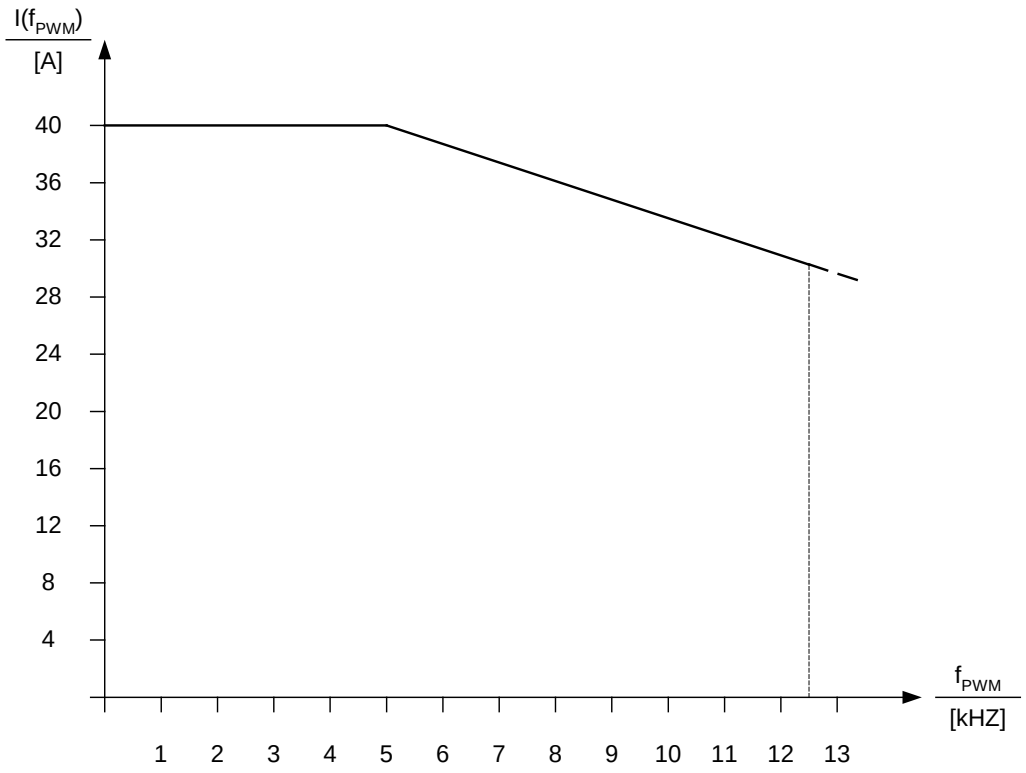


Figure 3: ARS 2340: Current derating diagram

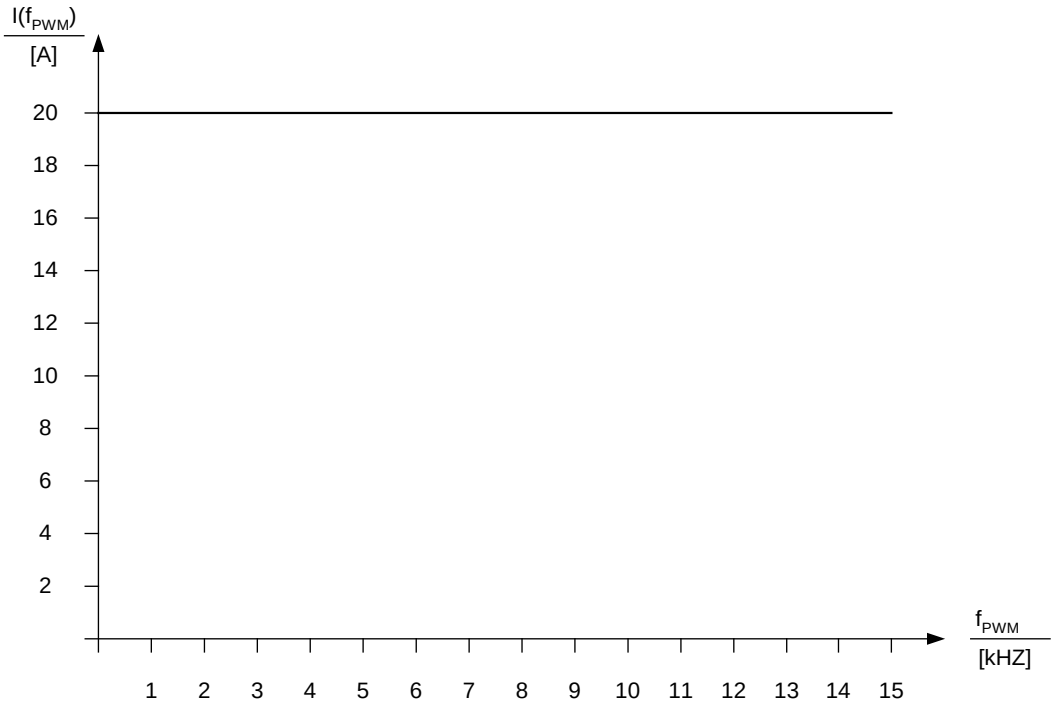


Figure 4: ARS 2320W: no current derating as a function of the pulse frequency (f_{PWM})

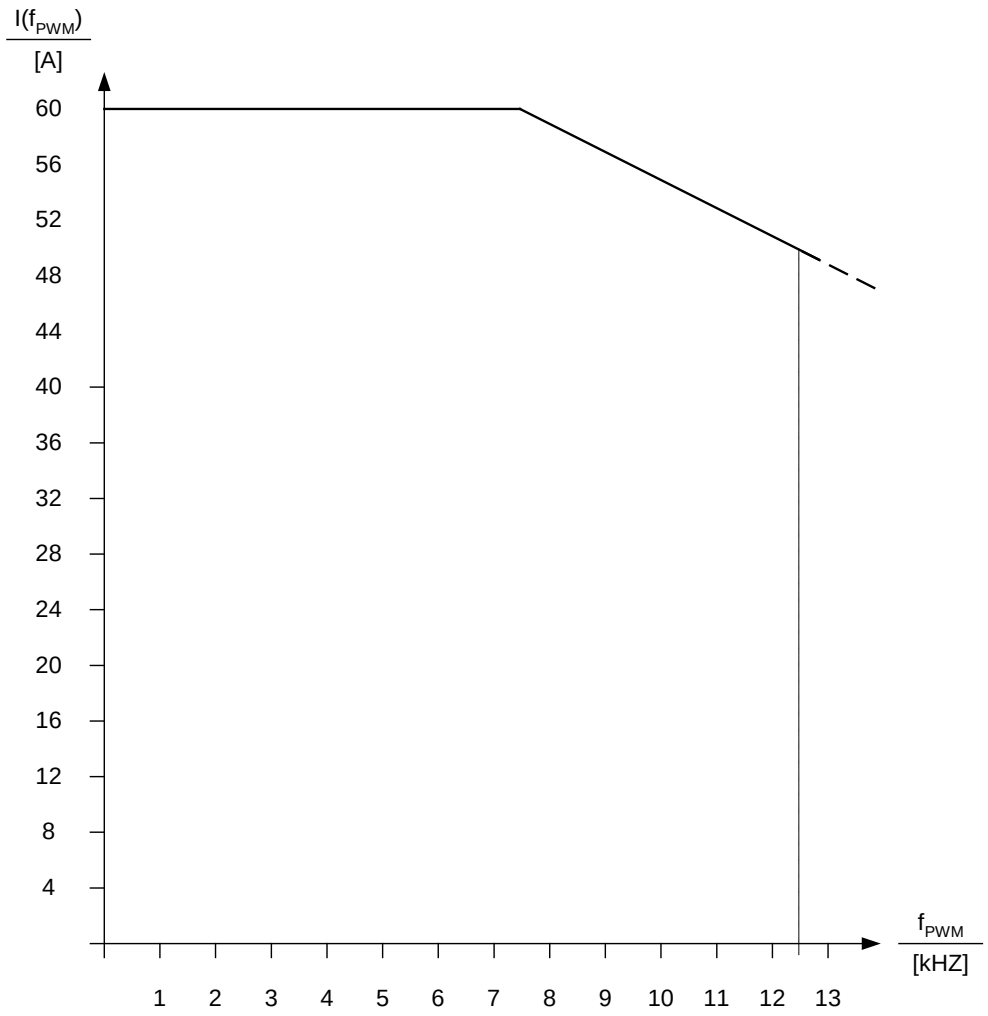


Figure 5: ARS 2360W: Current derating diagram

4.4.2 I^2xt derating for ARS 2320W and ARS 2360W

For these two servo drives it is necessary to calculate a derating for the duration of the maximum current as a function of the pulse frequency (f_{PWM}) and the electrical rotational frequency in the firmware. The following figure shows the 4 essential set points.

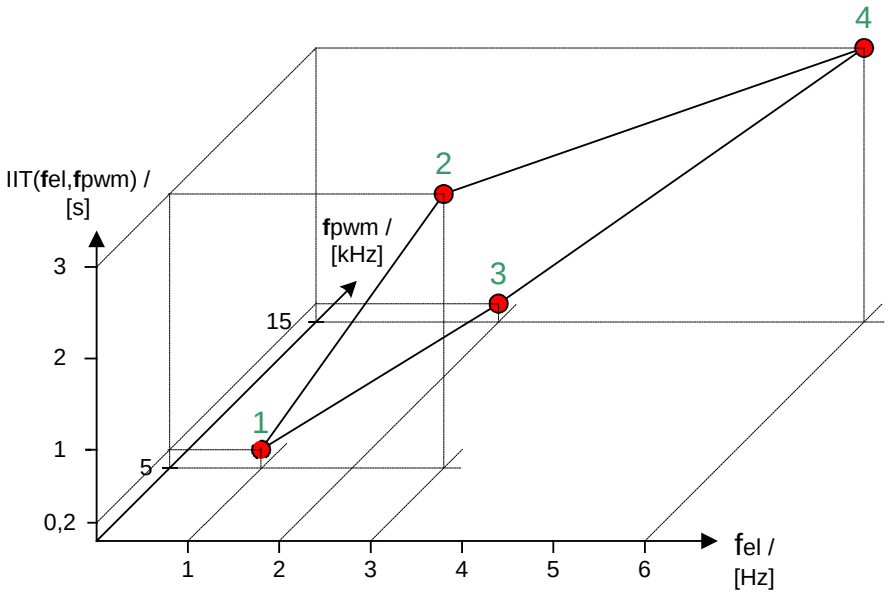


Figure 6: ARS 23xxW: I^2xt derating diagram

Table 14: I^2xt – times (set points 1 to 4)

Set points*	**1**	**2**	**3**	**4**
f_{el} / Hz	up to 1 Hz	as of 3 Hz	up to 2 Hz	as of 6 Hz
F_{PWM} / kHz	5	5	15	15
I_{max} / A (ARS 2320W)	50	50	45	45
I_{max} / A (ARS 2360W)	120	120	90	90
I^2xt / s	0,2	3	0,2	3

* Linearization between the single set points.

4.5 Water cooling system

Table 15: Requirements for the water cooling system

Type	ARS 2320W, ARS 2360W
Coolant temperature (initial cycle)	< 30°C
Rate of flow	> 8 l /min
Tightening torque for the M6 screws for fastening the device on the water cooling system	9 –10 Nm
Mounting side evenness of the water cooling system	<= 25 µm @ 100mm
Mounting side roughness of the water cooling system	<= 10 µm

For more information concerning the water cooling system, please refer to *chapter 7.5*.

4.6 Safe Torque Off (STO) and 24V supply [X3]

The servo drives ARS 2320, ARS 2320W, ARS 2340 and ARS 2360W receive their 24VDC power supply for the electronic control system through connector [X3].

For the safety function “Safe Torque Off (STO)” please refer to *chapter* 6 *Functional safety technology, page 66.*

Table 16: Technical data: 24VDC supply [X3]

Type	ARS 2320, ARS 2340, ARS 2320W, ARS 2360W
24V supply	24 VDC [± 20%] (0,8 A) *)

*) Plus current consumption of a potentially existing holding brake and I/Os

4.7 Motor feedback connection [X2A] and [X2B]

Different feedback systems can be connected to the servo drive ARS 2300 via the universal encoder interface:

- Resolver (interface [X2A])
- Encoder (interface [X2B])
  - Incremental encoders with analogue and digital track signals
  - SinCos encoder (single-turn/multi-turn) with HIPERFACE®
  - Multiturn absolute encoder with EnDat

The encoder type is determined in the Metronix ServoCommander™ parameterisation software.

The feedback signal is available via the incremental encoder output [X11] for master-slave applications.

It is possible to evaluate two shaft encoder systems in parallel. Typically, the resolver for the current control is connected to [X2A], and for example an absolute encoder is connected to [X2B] as a feedback system for the positioning control.

4.7.1 Resolver connection [X2A]

The 9-pin D-SUB connection [X2A] is used to evaluate standard resolvers. Single- and multi-polepair resolvers are supported. The user can state the number of pairs of poles of the servo motor in the “Motor Data” menu of the Metronix ServoCommander™ parameterization program so that the ARS 2300 determines the speed correctly. However, the number of pairs of poles can also be identified automatically. The number of pairs of poles of the motor (P_{0Motor}) is always an integer multiple of the number of pairs of poles of the resolver ($P_{0Resolver}$). Wrong combinations lead to an error message during motor identification.

The resolver offset angle, which is determined automatically during the identification, is readable and writeable for service purposes.

Table 17: Technical data: Resolver [X2A]

Parameter	Values
Transformation ratio	0,5
Carrier frequency	5 bis 10 kHz
Excitation voltage	7 V_{RMS}, short circuit-proof
Impedance excitation (at 10kHz)	≥ (20 + j20)Ω
Impedance stator	≤ (500 + j1000)Ω

Table 18: Technical data: Resolver interface [X2A]

Parameter	Values
Resolution	16 Bit
Delay time signal detection	< 200 µs
Speed resolution	approximately 4 min^{-1}
Absolute accuracy of angle detection	< 5´
Max. rotational speed	16.000 min^{-1}

4.7.2 Encoder connection [X2B]

At the 15-pole D-Sub connection [X2B], motors with encoder can be fed back. The possible incremental encoders for the encoder connection are divided into several groups. If you want to use other types of encoders, please contact your sales representative.

Standard incremental encoders without commutation signals:

This type of encoder is used with low-cost linear motor applications, to save the costs for the provision of the commutation signals (hall sensor). With this type of encoder the servo drive ARS 2300 must carry out an automatic pole position determination after power-on.

Standard incremental encoders with commutation signals:

These are standard incremental encoders with three binary hall sensor signals. The number of lines of the encoder can be freely parameterized (1 – 16384 lines/rotation).

There is an additional offset angle for the hall sensor signals. It is determined during motor identification or can be set via the parameterisation software Metronix ServoCommander™. In general, the hall sensor offset angle is zero.

Stegmann encoders:

Single-turn and multi-turn shaft encoders with HIPERFACE® made by Stegmann are supported. The following series of encoders can be connected:

- Singleturn SinCos encoders: SCS 60, SCS 70, SKS 36, SR 50, SR 60
- Multiturn SinCos encoders: SRM 50, SRM 60, SKM36, SCM 60, SCM 70
- SinCos Hollow shaft encoders: SCS-Kit 101, SCM-Kit 101, SHS 170

SinCoder® encoders like SNS 50 or SNS 60 are not supported.

Heidenhain encoders:

Incremental and absolute encoders by Heidenhain are evaluated. The following series of encoders can be connected:

- Heidenhain ERN1085, ERN 1387, ECN1313, RCN220, RCN 723, RON786, ERO1285, etc.
- Rotary encoders with an EnDat interface.

Table 19: Technical data: Encoder evaluation [X2B]

Parameter	Values
Parameteriszable number of encoder lines	1 – 2^{18} lines/revolution
Angular resolution / interpolation	10 bits / period
Trace signals A, B	1 V_{SS} differential
Trace signals N	0,2 to 1 V_{SS} differential
Commutation track A1, B1 (optional)	1 V_{SS} differential
Trace signal input impedance	Differential input 120 Ω
Limit frequency	f_{limit} > 300 kHz (high-resolution track) f_{limit} approximately 10 kHz (commutation track)
Additional communication interface	EnDat (Heidenhain) and HIPERFACE® (Stegmann)
Supply output	5 V or 12 V, 300 mA max., current-limited Control through sensor lines Set point can be changed through SW

4.8 Communication interfaces

4.8.1 RS232 [X5]

Table 20: Technical data: RS232 [X5]

Communication interface	Values
RS232	As per RS232 specification, 9600 Baud to 115.2 kBaud

4.8.2 CAN-Bus [X4]

Table 21: Technical data: CAN bus [X4]

Communication interface	Values
CANopen controller	ISO/DIS 11898, full CAN controller, max. 1Mbaud
CANopen protocol	as per DS301 and DS402

4.8.3 I/O interface [X1]

Table 22: Technical data: Digital inputs and outputs [X1]

Digital inputs/outputs	Values	
Signal level	24V (8V...30V) active high, conforming with DIN EN 61131-2	
Logic inputs general DIN0 DIN1 DIN2 DIN3	 Bit 0 \ Bit 1, \ Target selection for positioning Bit 2, / 16 targets selectable from target table Bit 3 /	
DIN4	Control input power stage (enable at High)	
DIN5	Servo drive enable at high signal, acknowledge error with falling edge	
DIN6	Limit switch input 0	
DIN7	Limit switch input 1	
DIN8	Control signal Start positioning or Homing switch for homing or saving of positions	
DIN9	Control signal Start positioning or Homing switch for homing or saving of positions	
Logic outputs general	Galvanically separated, 24V (8V...30V) active high	
DOUT0	Operational state	24 V, max. 100 mA
DOUT1	Freely configurable	24 V, max. 100 mA
DOUT2	Freely configurable, optional use as input DIN 10	24 V, max. 100 mA
DOUT3	Freely configurable, optional use as input DIN 11	24 V, max. 100 mA
DOUT4 [X6]	Holding brake	24 V, max. 2 A

Table 23: Technical data: Analogue inputs and outputs [X1]

Analogue inputs/outputs	Values	
High-resolution analogue input, AIN 0	± 10 V input range, 16 Bit, differentially, < 250 µs delay time	
Analogue input, AIN 1	Optionally, this input can also be parameterized as digital input DIN AIN 1 with a switching threshold at 8 V	± 10 V, 10 Bit, single ended, < 250 µs delay time
Analogue input, AIN 2	Optionally, this input can also be parameterized as digital input DIN AIN 2 with a switching threshold at 8 V	± 10 V, 10 Bit, single ended, < 250 µs delay time
Analogue outputs, AOUT 0 and AOUT 1	± 10 V output range, 10 mA, 9 bit resolution, f_{Limit} > 1 kHz	

4.8.4 Incremental encoder input [X10]

The input supports all common incremental encoders.

For example encoders corresponding to the industry standard ROD426 by Heidenhain or encoders with single-ended TTL outputs as well as open collector outputs.

Alternatively, the A and B encoder signals are interpreted by the device as pulse-direction signals, so that the servo drive can also be driven by stepping motor control boards.

Table 24: Technical data: Incremental encoder input [X10]

Parameter	Values
Parameterisable line count	$1 – 2^{28}$ lines/revolution
Trace signals: A, #A, B, #B, N, #N	In accordance with RS422 specification
Max. input frequency	1000 kHz
Pulse direction interface: CLK, #CLK, DIR, #DIR, RESET, #RESET	In accordance with RS422 specification
Supply output	5 V, max. 100 mA

4.8.5 Incremental encoder output [X11]

The output provides incremental encoder signals for processing in superimposed controls.

The signals are generated from the encoder's angle of rotation with a freely programmable number of lines.

Besides the encoder signals A and B, the emulation also provides a reset pulse, which goes to high once per rotation (for the programmed number of lines), for the duration of a ¼ signal period (as long as the encoder signals A and B are high).

Table 25: Technical data: Incremental encoder output [X11]

Parameter	Values
Number of lines	Programmable 1 – 2^{14} lines/revolution
Connection level	Differential / RS422 specification
Encoder signals A, B, N	As per RS422 specification
speciality	N-Trace disconnectable
Output impedance	$R_{a,diff}$ = 66 Ω
Limit frequency	f_{Limit} > 1,8 MHz (lines/s)
Edge sequence	Can be limited by parameters
Output supply	5 V, max. 100 mA

5 Function overview

5.1 Motors

5.1.1 Synchronous servo motors

Typically, permanently excited synchronous motors with sinusoidal EMF are used. The servo drive ARS 2300 is a universal servo drive, which can be operated with standard servo motors. The motor specifications are determined and parameterized by means of an automatic motor identification.

5.1.2 Linear motors

Besides rotary applications, the servo drives ARS 2300 are also suitable for linear drives. Here also, permanently excited synchronous linear motors are supported. Due to the high signal processing quality, the ARS 2000 series is particularly suitable for driving air-core and iron-core synchronous motors with low motor inductances (2 … 4 mH).

5.2 Functions of the servo drive ARS 2300

5.2.1 Compatibility

For compatibility reasons, from the user's point of view, the control structure of the ARS 2300 has mostly the same characteristics, interfaces and parameters as the previous ARS family.

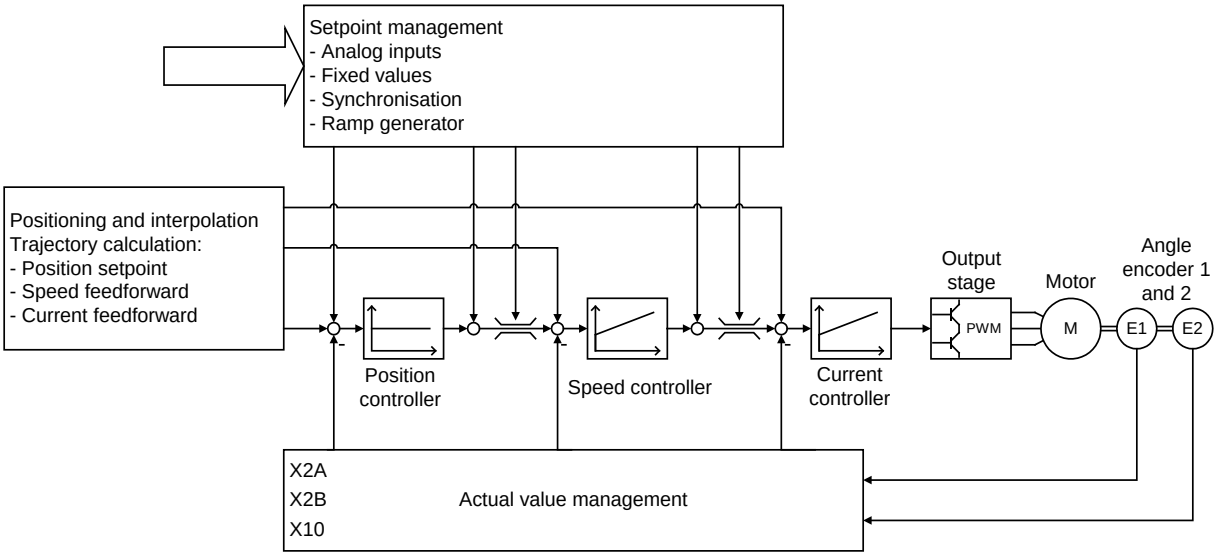


Figure 7: Control scheme of the ARS 2300

Figure 7 shows the basic control structure of the ARS 2300. Current controller, speed controller and positioning controller are arranged in a cascade. Due to the rotor-oriented control principle the current can be set separated in active current (i_q) and reactive current (i_d). Therefore there are two current controllers, both of them PI controllers. To provide a better overview, however, the i_d controller does not appear in *Figure 7.*

The provided basic modes of operation are torque control, speed control and positioning.

Functions such as synchronisation, "flying saw" and so on are variants of these basic modes of operation. Furthermore, individual functions of these modes of operation can be combined with each other, for example torque control with speed limitation.

5.2.2 Pulse width modulation (PWM)

The servo drive ARS 2300 is able to vary the clock frequency in the current controller circuit. In most cases the settings can be made using the parameterisation software Metronix ServoCommander™. In order to minimize switching losses, the clock of the pulse width modulation can be cut in half as compared to the frequency in the current controller circuit.

The servo drive ARS 2300 also features a sine modulation or alternatively a sine modulation with third harmonic. This increases the effective converter output voltage. The type of modulation can be selected via the Metronix ServoCommander™. The default setting is sine modulation.

If the sine modulation with third harmonic is used, the controllable upper motor speed limit increases due to the higher control reserve of the PWM output stage.

Table 26: Output voltage at the motor terminals at U_{ZK} = 560V

Converter output voltage	Output voltage at the motor terminals
$U_{A,(sin)}$	$U_{LL,motor}$ = approx. 320 V_{eff}
$U_{A,(sin+sin3x)}$	$U_{LL,motor}$ = approx. 360 V_{eff}

5.2.3 Set point management

For speed controlled and torque controlled modes of operation, the set point can be set via a set point management.

The following set point sources can be selected:

- 3 analogue inputs:
  - AIN 0, AIN 1 and AIN 2
- 3 fixed values:
  - 1st value: setting depending on controller enabling logic:
    - fixed value 1 or
    - RS232 interface or
    - CANopen bus interface or
    - PROFIBUS-DP interface or
    - sercos interface
  - 2nd and 3rd value: setting of fixed values 2 and 3
- Process controller
- SYNC input
- Additional incremental encoder input [X10]

If no set point source is activated, the set point is zero.

The set point management has a ramp generator with a preceding adder. Any of the above-mentioned set point sources can be selected via the corresponding selectors and run through the ramp generator. Additional sources can be selected as set points using two more selectors. These, however, cannot be run through the ramp generator. The total set point is then a summation of all values. The acceleration and deceleration times of the ramp are directionally parameterisable.

5.2.4 Torque-controlled mode

In torque control mode a certain set point torque is set, which the servo drive generates in the motor. In this case only the current controller is activated, since the torque is proportional to the motor current.

5.2.5 Speed-controlled mode

This mode of operation is used, if the motor speed is to be kept constant regardless of the acting load. The motor speed exactly follows the speed set by the set point management.

The cycle time of the speed control loop for the servo drive ARS 2300 is twice the PWM period duration, thus typically typ. 208,4 µs. However, it can also be set as an integer multiple of the current controller cycle time.

The speed controller is a PI controller with an internal resolution of 12 bits per rpm. In order to eliminate wind-up effects, the integrator function is stopped upon reaching subsidiary limitations.

In speed control mode only the current controller and the speed controller are active. In the case of setting via analogue set point inputs it is optionally possible to define a “safe zero”. If the analogue set point is within this range, the set point is then set to zero (“dead zone”). This can suppress interferences or offset drifts. The function of a dead zone can be activated and deactivated and the width can be set.

The set points of the speed as well as the actual position are generally determined from the encoder system inside the motor, which is also used for commutation. For the actual value feedback to the speed control any encoder interface may be selected (for example reference encoder or corresponding system at external incremental encoder input). The actual speed value for the speed controller is then fed back for example via the external incremental encoder input.

The set point for the speed can also be set internally or can be derived from the data of an external encoder system (speed synchronisation via [X10] for speed controller).

5.2.6 Torque-limited speed control

The servo drives ARS 2300 support torque-limited speed-controlled operation with the following features:

- ❖ Fast updating of the limit value, for example in 200 µs cycle
- ❖ Addition of two sources of limitation (for example for servo control values)

5.2.7 Synchronization with external clock sources

The servo drives operate with sinusoidal constrained current. The cycle time is always linked with the PWM frequency. In order to synchronize the device control system with external clock sources (for example sercos, PROFIBUS MC), the device is equipped with a corresponding PLL. In these cases, the cycle time is variable within certain limits in order to allow synchronization with the external clock signal. For synchronization with external clock sources, the user has to indicate the nominal synchronous cycle time.

5.2.8 Load torque compensation for vertical axes

For vertical axes applications it is possible to detect and store the holding torque during standstill. It is then added to the torque control loop and improves the start-up behaviour of the axes after releasing the holding brake.

5.2.9 Positioning and position control

In positioning mode a superordinated positioning controller is active in addition to the speed control, which processes deviation of the actual position from the set position and converts it into the corresponding set points for the speed controller.

The position controller is a P-controller. By default, the cycle time of the position control circuit is twice the speed controller cycle time. However, it can also be set as an integer multiple of the speed controller cycle time.

When the positioning controller is activated, it receives its set points from the positioning or from the synchronisation controller. The internal resolution is up to 32 bits per motor revolution (depending on the encoder used).

5.2.10 Synchronisation, electronic gearing

The servo drive ARS 2300 allows master-slave operation, which in the following will be called synchronisation. The servo drive can serve as master or slave.

If the servo drive ARS 2300 is the master, it can provide the slave with its current rotor position at the incremental encoder output [X11].

With this information the slave can determine the current position and/or speed of the master via the incremental encoder input [X10]. Of course it is also possible to derive this information needed for the slave via an external encoder [X2B].

The synchronisation can be activated or deactivated via communication interfaces or via digital inputs.

The speed feed forward can be calculated by the servo drive ARS 2300 itself. All inputs can be activated/deactivated. The internal encoder can optionally be shut off, if another input is selected as actual-value encoder. This also applies to speed control mode. The external inputs can be weighed with transmission factors. The different inputs can be used individually or simultaneously.

5.2.11 Brake management

The servo drive ARS 2300 can directly actuate a holding brake. The holding brake is operated with programmable delay times. In positioning mode an additional automatic braking function can be activated, which shuts down the power stage of ARS 2300 after a parameterized idle time and which lets the brake fall in. This mode of operation is compatible with the functions of the previous ARS product range.

5.3 Positioning control

5.3.1 Overview

In positioning mode a certain position is set, which is to be approached by the motor. The current position is derived from the information provided by the internal encoder evaluation. The position deviation is processed in the position controller and is passed on to the speed controller.

The integrated positioning control allows jerk-limited or time-optimal positioning relative or absolute to a point of reference. It provides the position controller and - to improve the dynamics - the speed controller also, with the set points.

In the case of absolute positioning a set target position is directly approached. In the case of relative positioning a parameterized route is run. The positioning space of 2^{32} full revolutions allows any number of relative positioning in one direction.

The positioning control is parameterized via a target table. The target table includes entries for the parameterisation of a target via a communication interface and also target positions, which can be retrieved via the digital inputs. For each entry it is possible to set the positioning method, the driving profile, the acceleration and the deceleration times as well as the maximum speed. All targets can be pre-parameterized. The only thing to do for positioning is then to select an entry and start the action. It is also possible to change the target parameters online via the communication interface.

The servo drive ARS 2300 provides 256 configurable positioning sets.

The following settings are possible for all positioning sets:

- Target position
- Driving speed
- Final speed
- Acceleration
- Deceleration
- Torque feed forward
- Remaining distance trigger
- Additional flags, these are:
  - Relative / relative to last target / absolute
  - Wait for end / interrupt / ignore start
  - Synchronized
  - Rotary axis
  - Option: automatic deceleration in case of missing following positioning
  - Different options on the setup of path programs

The positioning sets can be activated via all bus systems or via the parameterisation software Metronix ServoCommander™. The positioning process can be controlled via digital inputs.

5.3.2 Relative positioning

In the case of relative positioning, the target position is added to the current position. Since no fixed zero is required, referencing is not compulsory. It does, however, make sense in many cases, in order to bring the drive to a defined position.

Adding of relative positioning allows for example endless positioning in one direction for a trimming unit or a conveyor belt (incremental dimension).

5.3.3 Absolute positioning

The target position is approached independent of the current position. In order to execute an absolute positioning we recommend prior referencing of the drive. In the case of absolute positioning the target position is a fixed (absolute) position referred to the zero or reference point.

5.3.4 Driving profile generator

Driving profiles are categorized in time-optimal and jerk-limited positioning. In the case of time-optimal positioning the maximum set acceleration is used for starting and braking. The drive approaches the target in the shortest time possible, the velocity profile is trapezoidal, and the acceleration profile is block-shaped.

In the case of jerk-limited positioning the acceleration profile is trapezoidal and the velocity profile is therefore of third order. Since the acceleration changes continuously, the drive is extremely gentle on the mechanics.

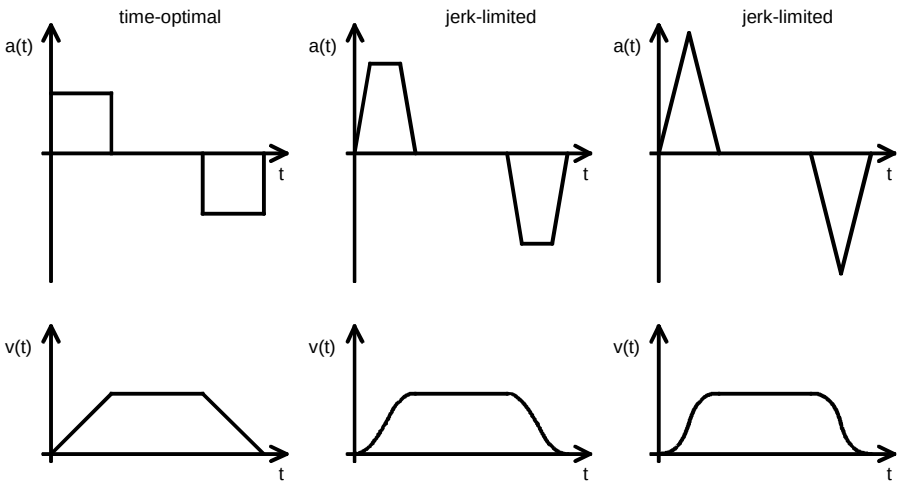


Figure 8: ARS 2300 servo drive driving profiles

5.3.5 Homing

Every positioning control requires a defined zero at start-up, which is determined by means of a homing. The servo drive ARS 2300 can do this homing on its own. As reference signals it evaluates different inputs, for example the end switch inputs.

A homing can be started by means of a command via the communication interface or automatically with the servo drive enabling. Optionally a start via a digital input can be programmed using the parameterisation program Metronix ServoCommander™, to carry out a specific homing independent of the servo drive enabling. The servo drive enabling acknowledges (with falling edge) for example error messages and can be switched off depending on the application, without requiring another homing with a new enabling. Since the existing digital inputs are used in standard applications, the use of the analogue inputs AIN 1, AIN 2 as digital inputs DIN AIN 1 and DIN AIN 2 as well as the digital outputs DOUT 2 and DOUT 3 as digital inputs DIN 10 and DIN 11 are optionally available.

Several methods as per the CANopen manual and following DSP 402 are implemented for the homing. Most methods first search for a switch at search velocity. The further movement depends on the method of communication. If a homing is activated via the fieldbus, there is generally no following positioning to zero. This is done optionally during the start via the servo drive enabling or RS232. A following positioning is always an option. The default setting is “no following positioning”.

Ramps and velocities are parameterisable for the homing. The homing can also be time-optimal and jerk-limited.

5.3.6 Positioning sequences

Positioning sequences consist of a series of positioning sets. These are run consecutively. A positioning set can be made part of a path program by means of its path program options, thus generating a linked list of positions:

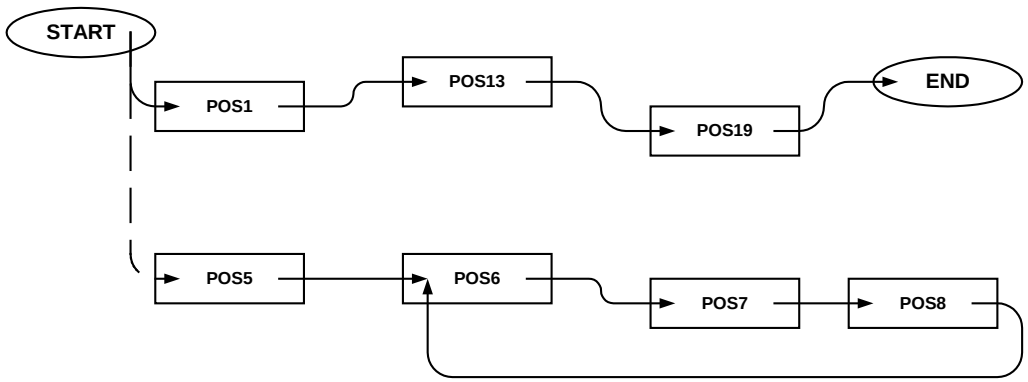


Figure 9: Path program

Via the **start position of the path program** the user determines which position series to run. In principle, linear or cyclic series are possible.

The start position of a path program can be determined:

- via fieldbus
- via digital inputs

The number of positions in the corresponding positioning sequence is only limited by the number of totally available positions. Every user-defined positioning set (0 to 255) can be used in the path program.

For further information, please refer to the software manual “Servo drive ARS 2000”.

5.3.7 Optional stop input

The optional stop input can interrupt the ongoing positioning by setting the selected digital input. Resetting the digital input will resume positioning to the original target position.

5.3.8 Contouring control with linear interpolation

The implementation of the Interpolated Position Mode allows setting position values in a multi-axis application of the servo drive. For that purpose set position values are provided by a superordinated control at a fixed time pattern (synchronisation interval). If this interval exceeds a position control cycle, the servo drive autonomously interpolates the data values between two set position values, as shown in the following illustration. The servo drive also calculates a corresponding speed feed forward.

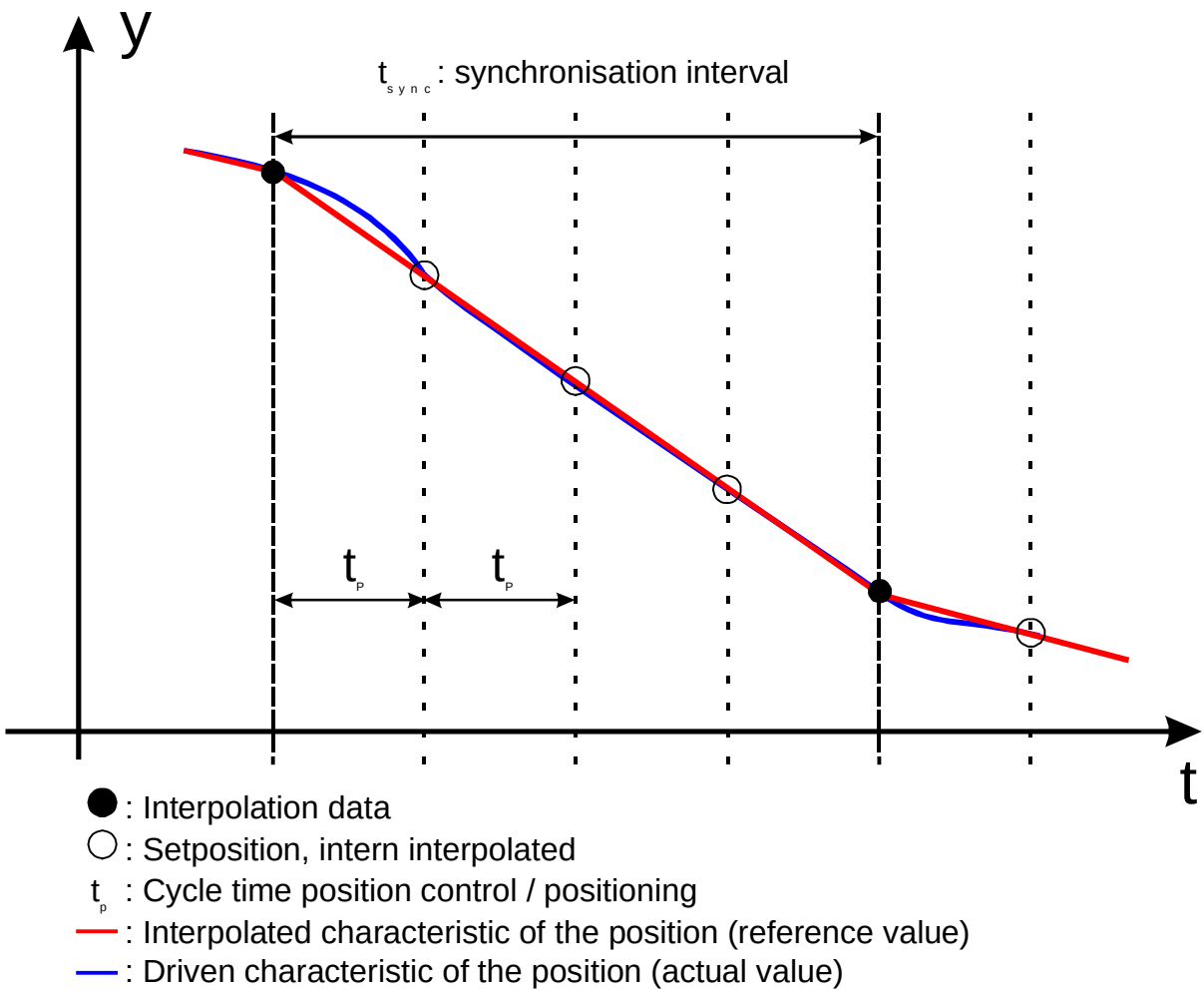


Figure 10: Linear interpolation between two data values

5.3.9 Time-synchronized multi-axis positioning

The implementation of the clock synchronisation allows simultaneous movements for multi-axis applications in conjunction with “interpolated positioning mode”. All servo drives of the ARS 2300 family, that is the entire controller cascade, will be synchronized to the external clock signal. Pending positioning values in the case of multiple axes are then taken over and executed simultaneously without jitter. The sync message of a CAN bus system or the EtherCAT “DC” (**D**istributed **C**lock) can for example be used as a clock signal.

That way it is for example possible to send several axes with different path lengths and velocities to the destination at the same time.

6 Functional safety technology

6.1 General, intended use

The ARS 2000 servo drives support the safety function “unexpected start-up” and “switch to powerless” as required by standard EN ISO 13849-1, Category 3 Performance Level d.

Statistical Data:

- Channel 1, switch off the PWM signal via X1: MTTFd = 714,81 years
- Channel 2, switch off the power supply via X3: MTTFd = 304,7 years
- PFH value: PFH = 8,63 • 10^{-8} /h

According to the standard mentioned above, the MTTFd values are limited to 100 years.

Notes:

- The characteristic values are valid only at use as agreed after product manual
- These are calculated values which represent the probabilities of failure. They do not guarantee any particular product lifecycle
- According to EN ISO 13849-1: 2008-12, section “C.5 MTTFd data of electrical components” can be accepted that only 50% of the failures lead to dangerous failures

The standstill of the machine has to be initiated and ensured by the control system of the machine. This applies particularly to vertical axes without self-locking mechanism or weight compensation. Generally, for vertical axes further safety precautions have to be taken.

In accordance with a danger analysis / risk assessment following the machinery directives 2006/42/EG and the appropriate standardize respectively, the machine manufacturer has to plan the safety system for the entire machine whilst taking into account all components integrated. Among these are also electric drives. The requirement at controls, that is the Performance Level which can be selected results from the risk height.

The “Safe Torque-Off (STO)” function will not cause an electrical isolation. It therefore provides no protection against electric shock. It is thus impossible to achieve an EMERGENCY OFF installation in the normative sense by using the “Safe Torque-Off (STO)” function, because in order to do so, the entire system would have to be shut down via the power switch (main switch or power contactor).

There are three stop categories for an EMERGENCY STOP as per EN 60204-1 which can be used depending on a risk analysis (see *Table 27*).

Table 27: Stop categories

Stop category 0	Uncontrolled stop. Standstill by immediate disconnection from power.	EMERGENCY OFF or EMERGENCY STOP
Stop category 1	Controlled stop. Power is disconnected when the machine has come to a standstill.	EMERGENCY STOP
Stop category 2	Controlled stop. Power is not disconnected when the machine is at a standstill.	not suitable for EMERGENCY OFF or EMERGENCY STOP

6.2 Integrated “Safe torque-Off (STO)” function

DANGER!

The “Safe Torque-Off” function does **not** protect against electrical shock. It only offers protection against dangerous rotary motion!

6.2.1 General / description of “Safe Torque-Off” function

The “Safe Torque-Off” (STO) function, in former times “safe stop”, safely interrupts the power supply to the drive. The drive may not generate any torque and therefore no dangerous rotary motion. In the case of hanging loads additional measures must be taken to safely prevent sagging (for example a mechanical holding brake). In “Safe Torque-Off” (STO) mode, the standstill position does not have to be monitored.

There are basically three suitable measures to bring about a “Safe Torque-Off” (STO):

- contactor between mains and drive system (power contactor)
- contactor between power module and drive motor (motor contactor)
- safe pulse inhibitor (inhibiting of pulses from power semiconductor, integrated into ARS 2300)

The use of the integrated solution (safe pulse inhibitor) offers several advantages:

- less external components, for example contactors
- less wiring and space needed in switch cabinet
- lower cost

Another advantage is the availability of the system. With the integrated solution the intermediate circuit of the servo drive can remain charged. As a consequence, there are no significant waiting times for a system restart.

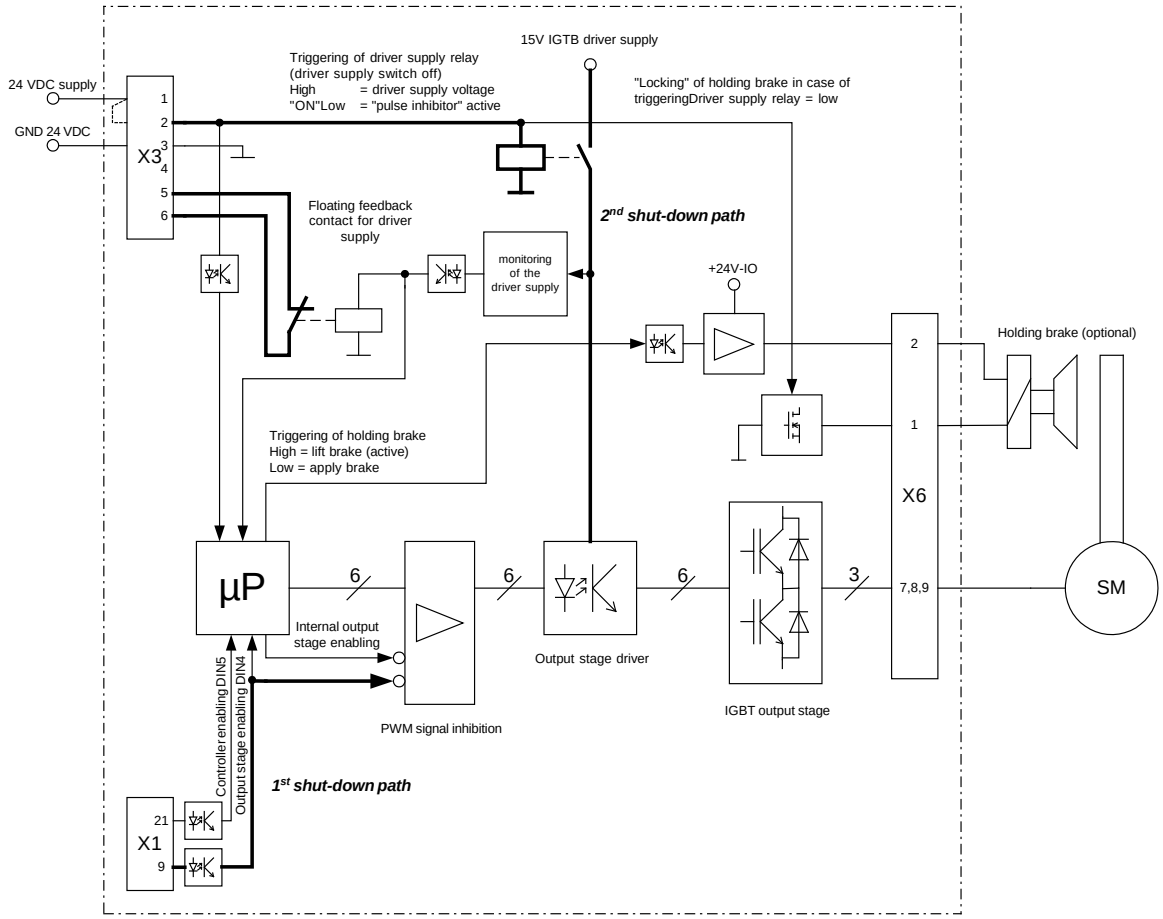


Figure 11: Block diagram "STO" as per EN ISO 13849-1, Category 3 Performance Level d

DANGER!

If the "STO" function is not needed, pins 1 and 2 at [X3] must be bridged..

A "Safe Torque-Off" (STO) as per EN ISO 13849-1, Category 3 Performance Level d, requires two channels, that is a restart must be safely prevented via two ways, completely independent of each other. These two ways of interruption, the power supply to the drive and the safe pulse inhibitor, are called shut-down paths.

1st Shut-down path:

Output stage enabling via [X1] (inhibition of PWM signals; die IGBT drivers will no longer be addressed with modulation patterns).

2nd Shut-down path:

Interruption of power supply to the six output stage IGTBs via [X3] by means of a relay (relays will cut the power supply to the IGBT optocoupler drivers to prevent PWM signals from getting to the IGBTs.).

Between the triggering of the output stage supply relay and the monitoring of the driver supply a plausibility test will be performed in the µP. This will detect errors in the pulse inhibitor and will also suppress the error message E-05-2 ("Driver voltage fault") occurring during normal operation.

3. Floating feedback contact:

The integrated circuit for the “Safe Torque-Off (STO)” function also has a floating feedback contact ([X3] pins 5 and 6) for the existence of the driver supply. This contact is designed as a normally closed contact. It, for example, has to be connected to the superordinated control. At regular intervals (for example PLC cycle or with each “Safe Torque-Off (STO)” request), the PLC has to perform a plausibility check between the triggering of the driver supply relay and the feedback contact (contact open = driver supply available).

In the case of an error during the plausibility check, further operation must be prevented, for example by eliminating the controller enabling (servo drive enabling) or by shutting down the power contactor.

6.2.2 Holding brake activation

In the case of activation of the “Safe Torque-Off” function, the holding brake is switched currentless (brake applied); (see *Figure 11: Block diagram “STO” as per EN ISO 13849-1, Category 3 Performance Level d*).

1st Channel:

During operation the holding brake is controlled with the DIN5 (controller enabling) (see timing diagram below). The first shut-down path “output stage enabling” acts on the brake driver via the µP and switches the holding brake currentless (brake applied).

2nd Channel:

The second shut-down path “triggering of driver supply relay” directly acts on s MOSFET which deactivates the holding brake (brake applied).

DANGER!

The user is responsible for the dimensioning and the safe functioning of the holding brake. The functioning of the brake must be checked and ensured by means of a suitable brake test.

6.2.3 Mode of operation / timing:

The following timing diagram shows how the “Safe Torque-Off (STO)” function works in connection with the controller enabling and the holding brake:

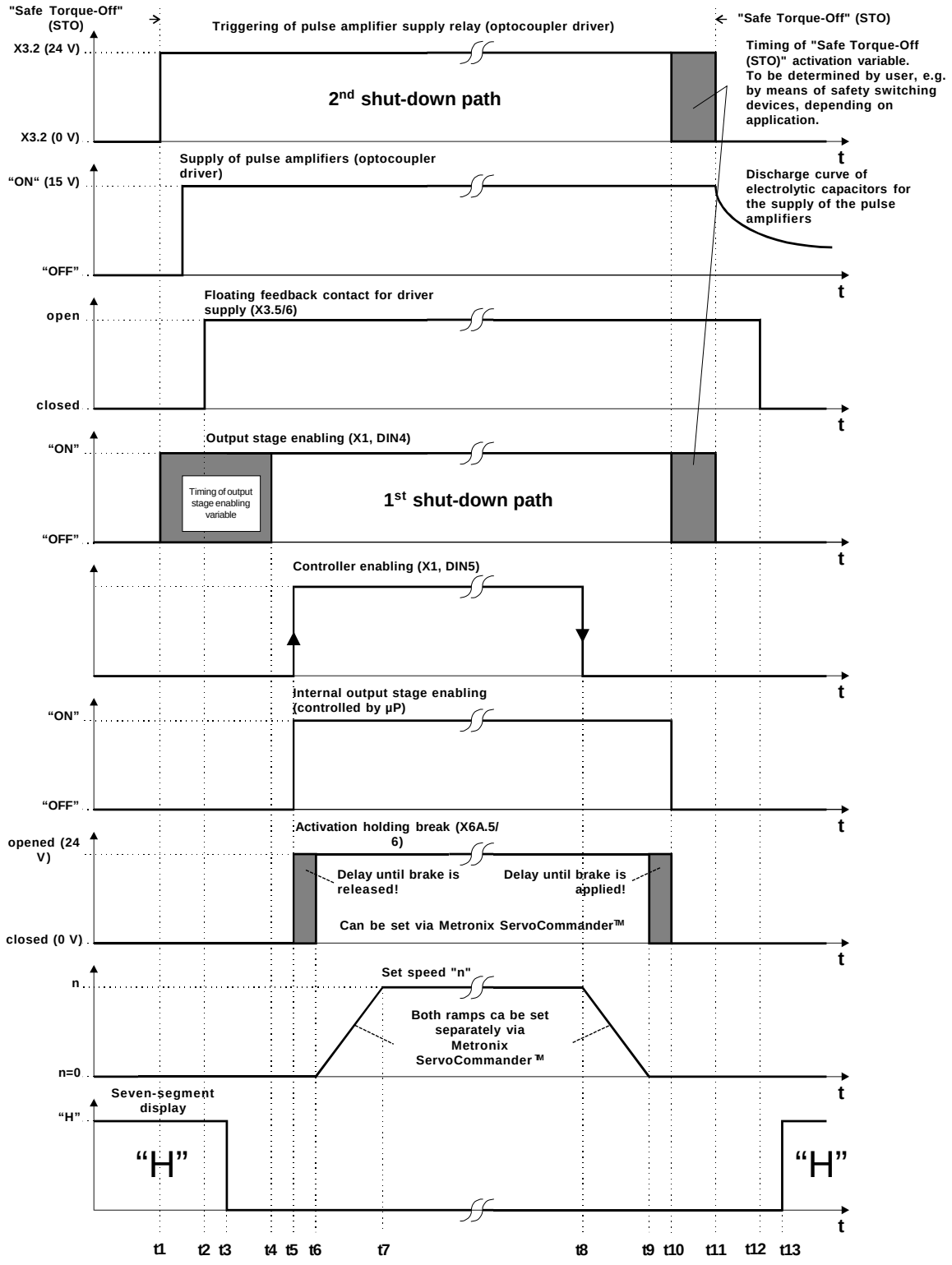


Figure 12: Timing of “Safe Torque-Off” (STO) as per EN ISO 13849-1, Category 3 Performance Level d

Description of the timing diagram:

This timing diagram has been generated using as an example the speed control under consideration of the controller enabling DIN 5 at [X1]. For applications with field buses the controller enabling is also controlled by the respective field bus. Depending on the application, the mode of operation can be parameterized via Metronix ServoCommander™.

Note:
In contrast to the functional operation, the "Safe Torque-Off (STO)" state is marked in BOLD!

Initial state:

- The 24V supply is switched on and the intermediate circuit has been charged.
- **The servo drive is in "Safe Torque-Off (STO)" mode. This status is indicated by a flashing "H" on the 7-segment display.**

In order to reactivate the output stage of the servo drive and thus to operate the connected motor, the following steps must be followed:

1. The triggering of the relay that switches the supply voltage of the output stage drivers (2nd shut-off path) happens at the time t1 via [X3] with 24V between pins 2 and 3.
2. The driver supply is charged.
3. The floating feedback contact ([X3] pins 5 and 6) for the plausibility check between the triggering of the driver supply relay and the availability of the driver supply is opened no later than 20ms after t1 (t2-t1).
4. Approx. 10ms after the opening of the feedback contact the "H" will disappear from the display at the time t3.
5. The time for the output stage enabling ([X1], DIN4) can for the most part be freely selected (t4-t1): The enabling may be at the same time as the triggering of the driver relay, but must happen approx. 10µs (t5-t4) prior to the rising edge of the controller enabling ([X1], DIN5), depending on the application.
6. With the rising edge of the controller enabling at the time t5 the release of the holding brake of the motor (if available) will be initiated and the output stage will be internally enabled. Releasing the brake is only possible if the triggering of the relay that switches the driver supply is pending, since this will trigger a MOSFET, which is located in the circuit of the holding brake. The parameterization program Metronix ServoCommander™ can be used to set a delay (t6-t5). That way the drive will remain at "0" speed for the time set and only after this time has run out at t6, the drive will start approaching the set speed. This delay is set so that the existing holding brake is safely released before the rotary motion starts. For motors without holding brake this time can be set to 0.
7. At the time t7 the drive will have reached the set speed. The necessary ramp settings can be parameterized via Metronix ServoCommander™.

The following steps show how to get a rotating drive to a “Safe Torque-Off (STO)” state:

1. Before activating the “Safe Torque-Off” (that is driver supply relay “OFF” and output stage enabling “OFF”; both shut-down paths inhibit the PWM signals) the drive should be stopped by deactivating the controller enabling. Depending on the application, the brake ramp (t9-t8) can be set via Metronix ServoCommander™ (“Quick stop deceleration”).

DANGER!

Activation of the “Safe Torque-Off (STO)” function during operation will cause the drive to run down. If the drive has a holding brake it will be activated. It is therefore very important to make sure that the motor brake can actually stop the motion of the drive.

2. After 0 speed has been reached, the drive will be controlled to this set value for a parameterisable drop-out delay time (t10-t9). This parameterisable time is the delay, after which the holding brake of the motor is applied. This time depends on the holding brake and must be set by the user. For applications without holding brake this time can be set to 0.
3. After this time has run out, the internal output stage enabling will be switched off by the µP (t10).

The holding brake will definitely be activated as soon as the “brake ramp time + set drop-out delay time” has run out, even if it the drive has not yet been able to stop!

4. **As of t10 the “Safe Torque-Off” can be activated (simultaneous deactivation of triggering of driver supply relay and output stage enabling). The time (t11-t10) depends on the application and must be set by the user.**
5. **With the withdrawal of the trigger signal for the relay that switches off the driver supply (t11) the capacitors in this voltage branch will be discharged. Approx. 80ms (t12-t11) after the withdrawal of the trigger signal for the relay that switches off the driver supply, the feedback contact ([X3], pins 5 and 6) will be closed.**
6. **At the time t13 the letter “H” will be shown on the 7-segment display of the servo drive for the visualization of the “Safe Torque-Off (STO)” function. This will happen at least 30ms after the closing of the floating feedback contact (t13-12).**

6.2.4 Application examples

6.2.4.1 Emergency stop circuit:

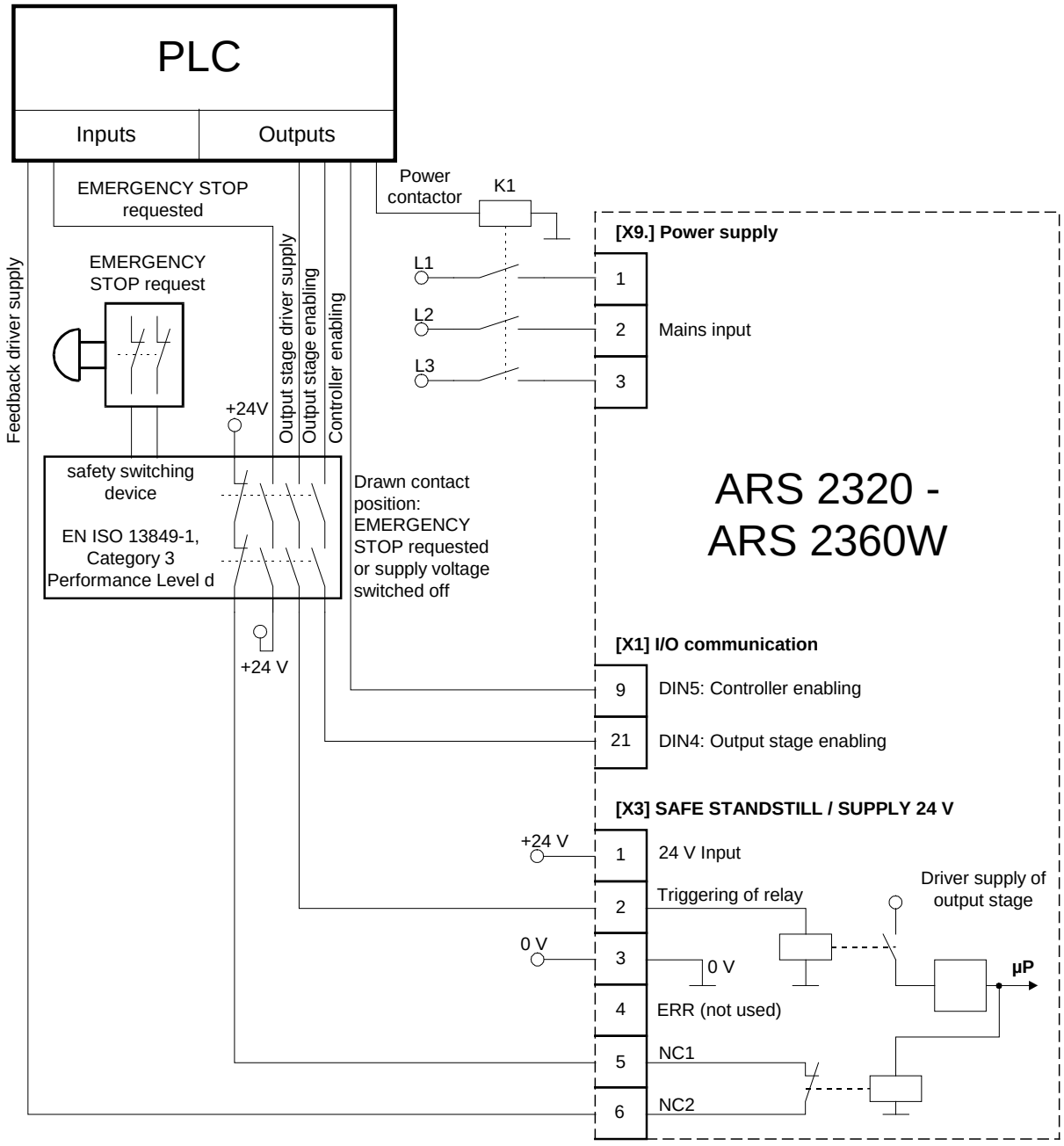


Figure 13: Emergency-off circuit in accordance with EN ISO 13849-1, Category 3 Performance Level d, and stop category 0 in accordance with 60204-1.

Mode of operation:

The EMERGENCY STOP request inhibits the output stage enabling and the triggering of the relay for the driver supply of the IGBT output stage via the EMERGENCY STOP contactor. The drive coasts down and at the same time the holding brake of the motor, if available, is activated.

The servo drive is in “Safe Torque-Off (STO)” mode.

The EMERGENCY STOP contactor has been approved as per EN ISO 13849-1, Category 3 Performance Level d.

A superordinate control monitors the “EMERGENCY STOP request” and “driver supply feedback” signals and checks them for plausibility. In the case of an error the power contactor will be shut down.

The DC bus voltage remains present and can be used by the drive immediately after deactivation of the EMERGENCY-STOP switching device and after the enabling of the controller.

The connection of the motor and the optional holding brake are not shown here, please refer to *chapter* 8 *Electrical installation.*

DANGER!

The brake of the motor has to be designed such that it can stop the movement of the drive.

6.2.4.2 Safety door monitoring

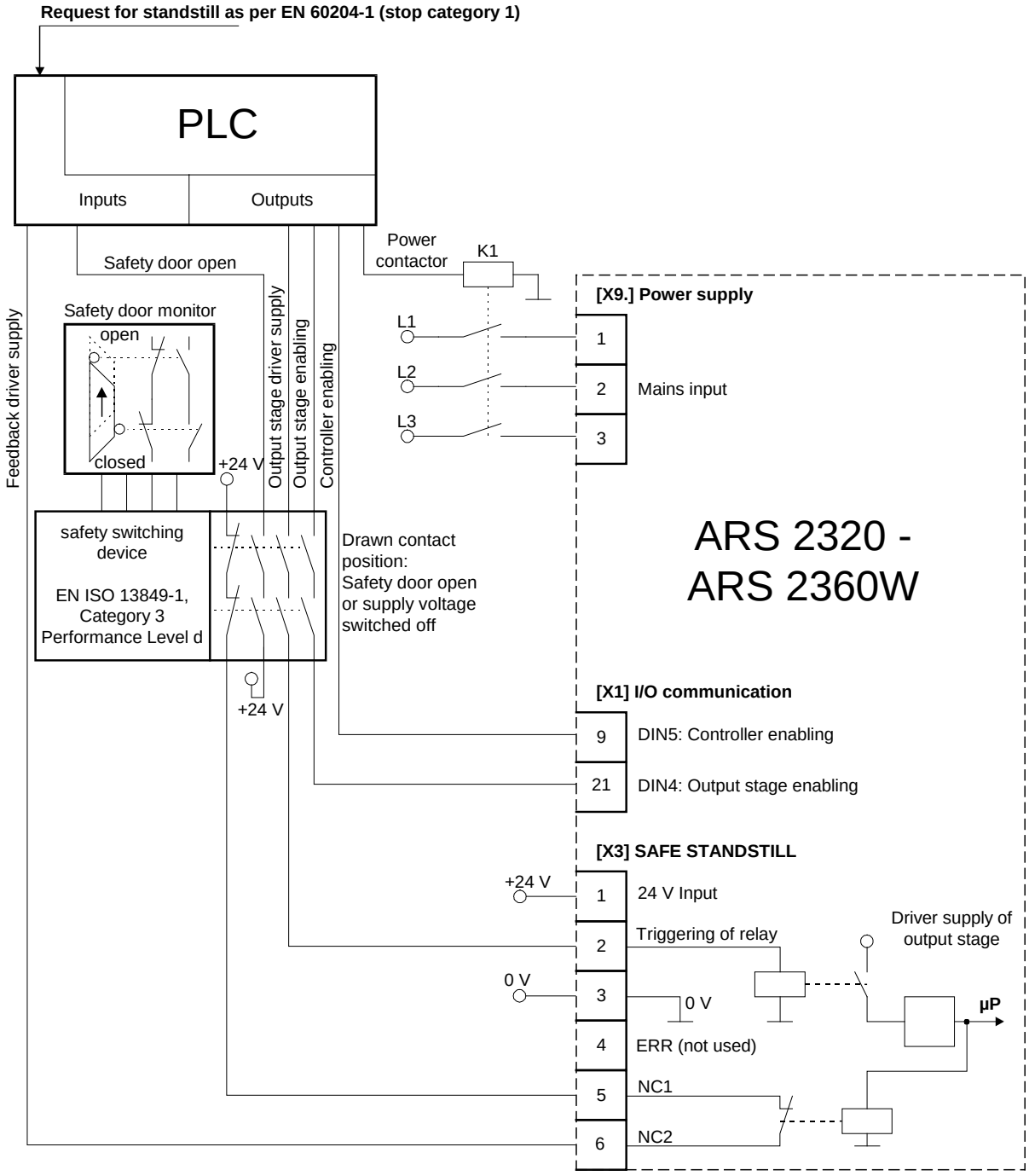


Figure 14: Safety door monitoring in accordance with EN ISO 13849-1, Category 3 Performance Level d, and stop category 1 in accordance with 60204-1.

Mode of operation:

The request to stop the drive will set the controller enabling to low.

The drive will approach 0 speed using the set deceleration ramp (parameterisable via Metronix ServoCommander™). After the ramp time (including drop-out delay time of holding brake, if available) has run out, the triggering of the driver supply relay and the controller enabling will be cancelled by the superordinate control.

A superordinate control monitors the “safety door open”, “output stage driver supply output” and the “driver supply feedback” signals and checks them for plausibility. In the case of an error the power contactor will be shut down.

The opening of the safety door will also interrupt the output stage enabling and the triggering of the driver supply relay. The servo drive is in “Safe Torque-Off (STO)” mode and protected against restart.

The safety door switching device has been approved as per EN ISO 13849-1, Category 3 Performance Level d.

The DC bus voltage remains present and can be used by the drive immediately after the safety door has been closed.

If the safety door is opened without a request for a standstill, the motor coasts down as per EN 60204-1 stop category 0 and at the same time the holding brake of the motor will be applied, if available. The drive is in “Safe Torque-Off (STO)” mode and protected against restart.

It is also possible to use a door position switch, which keeps the safety door closed until the drive has come to a complete standstill or the “feedback driver supply” signal indicates the safe mode and the plausibility check have been successfully completed. However, the “Safe Torque-Off” mode offering protection against restarting is only activated with the opening of the safety door (nor shown).

Another possible application is the use of a safety door switching device with delayed contacts. The opening of the safety door has a direct impact on the controller enabling, whose falling edge causes a controlled stopping at a set deceleration ramp. The signals “output stage enabling” and output stage driver supply” are then switched off with a delay via the safety module. The drop-out delay time must be matched to the deceleration ramp time (not shown).

DANGER!

The brake of the motor has to be designed such that it can stop the movement of the drive.

7 Mechanical Installation

7.1 Important notes

- Use the ARS 2320 and ARS 2340 servo drives exclusively for control cabinet installation.
- Vertical installation position with the fan down and the technology slots TECH1 and TECH2 up.
- Fasten the servo drive to the control cabinet plate using the mounting plate.
- Installation spaces:
  Keep a minimum distance of 100 mm underneath and above the servo drive to other components to ensure sufficient ventilation.
- The ARS 2320 and ARS 2340 servo drives may be installed adjacently in one switch cabinet without a gap, proper usage and installation on a heat-dissipating rear panel provided. Please note that excessive heating may cause premature aging and/or damaging of the servo drive. The case of high thermal stress of the servo drives, the following installation distances (dimension A in the following illustrations) are recommended:
  - ARS 2320: 95 mm (see *Figure 15*)
  - ARS 2340: 95 mm (see *Figure 16*)
- For the devices ARS 2320W und ARS 2360W, the water cooling system is the limiting factor. Two examples for water cooling systems are listed in *chapter 7.5*.

7.2 Installation space

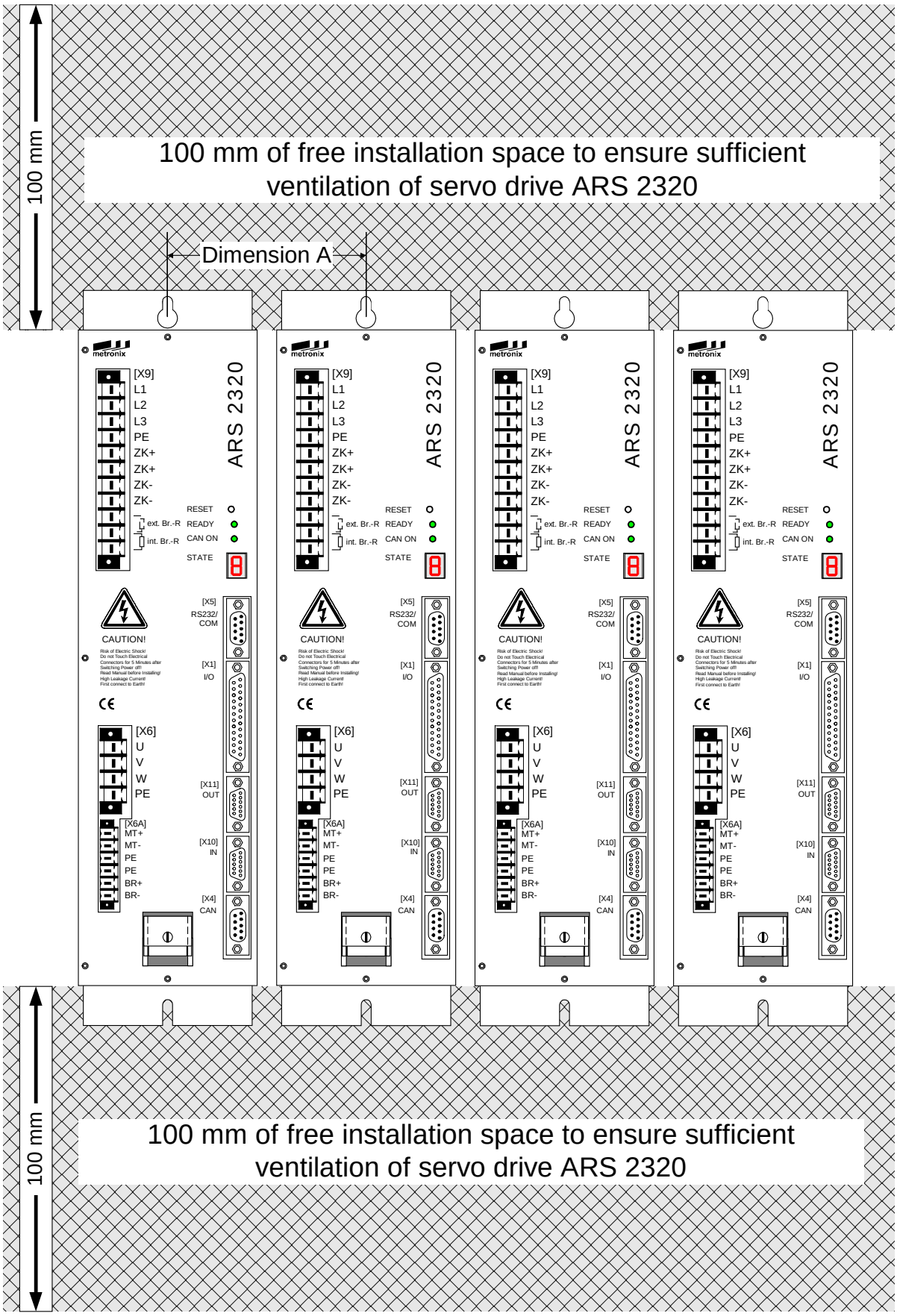


Figure 15: Servo drive ARS 2320: Installation space

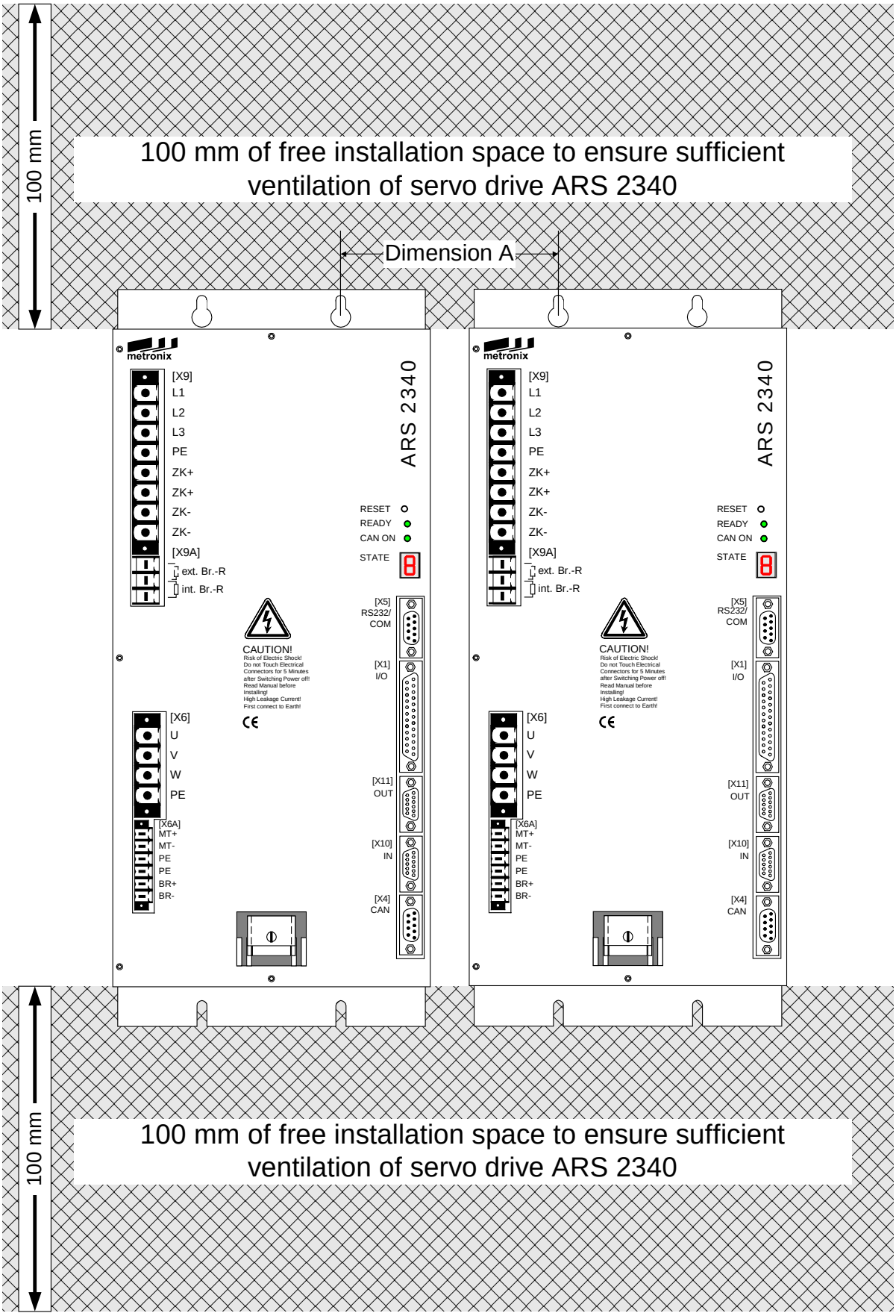


Figure 16: Servo drive ARS 2340: Installation space

7.3 Device views

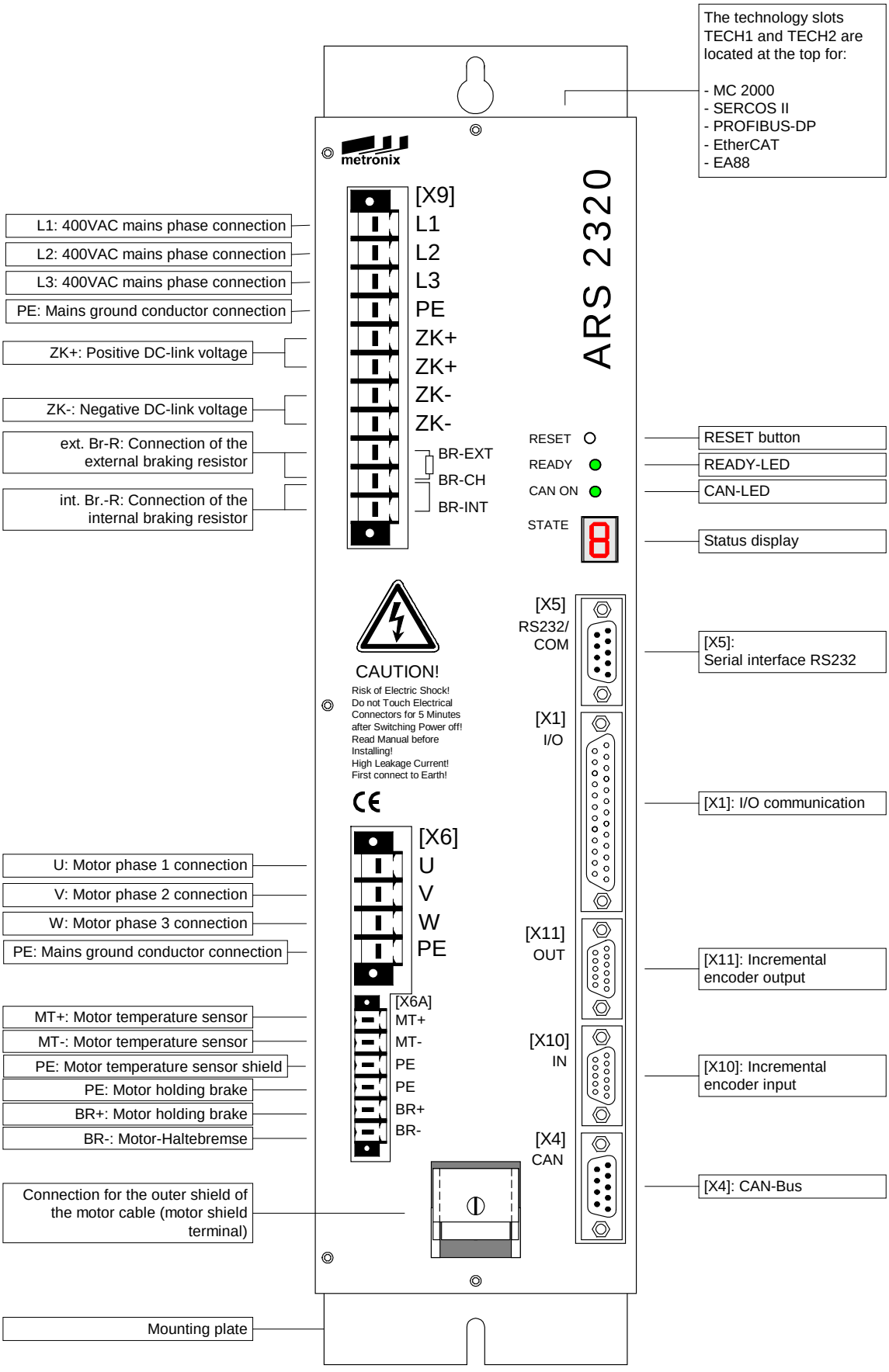


Figure 17: Servo drives ARS 2320 and ARS 2320W: Front view

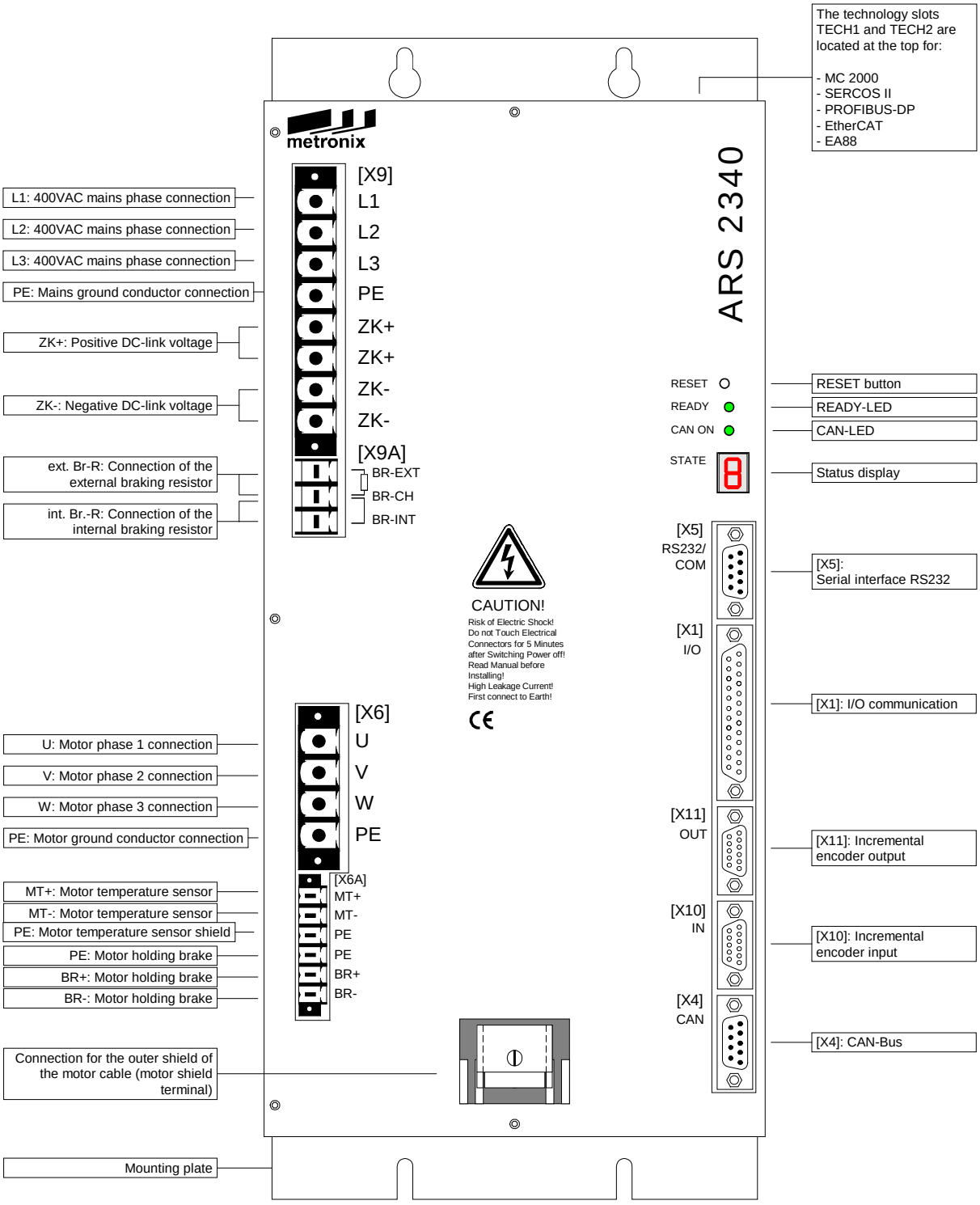


Figure 18: Servo drives ARS 2340 and ARS 2360W: Front view

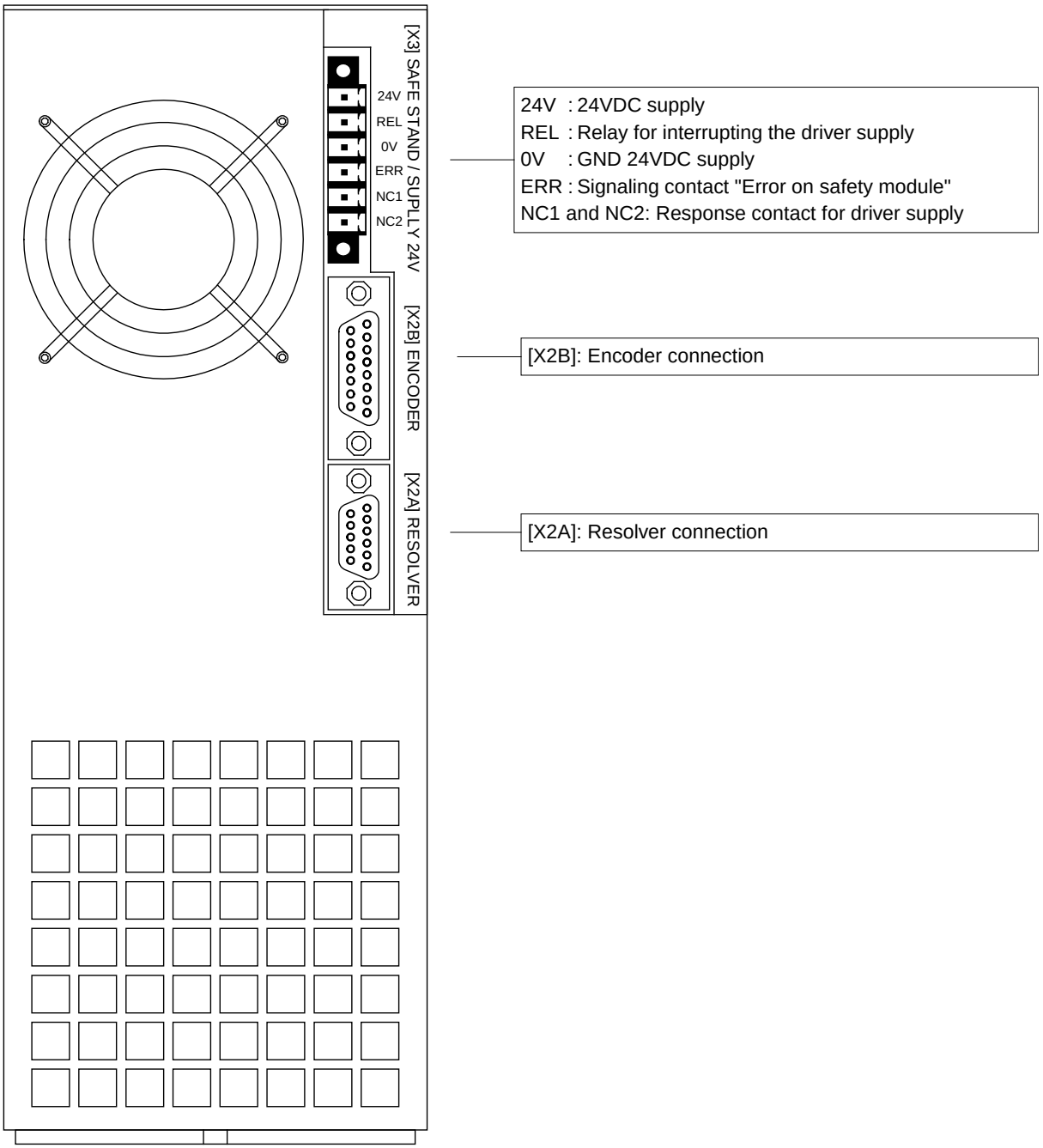


Figure 19: Servo drives ARS 2320 and ARS 2320W: Bottom view

Note:

The depth gauge of the water cooled devices is approximately 70 mm shorter.

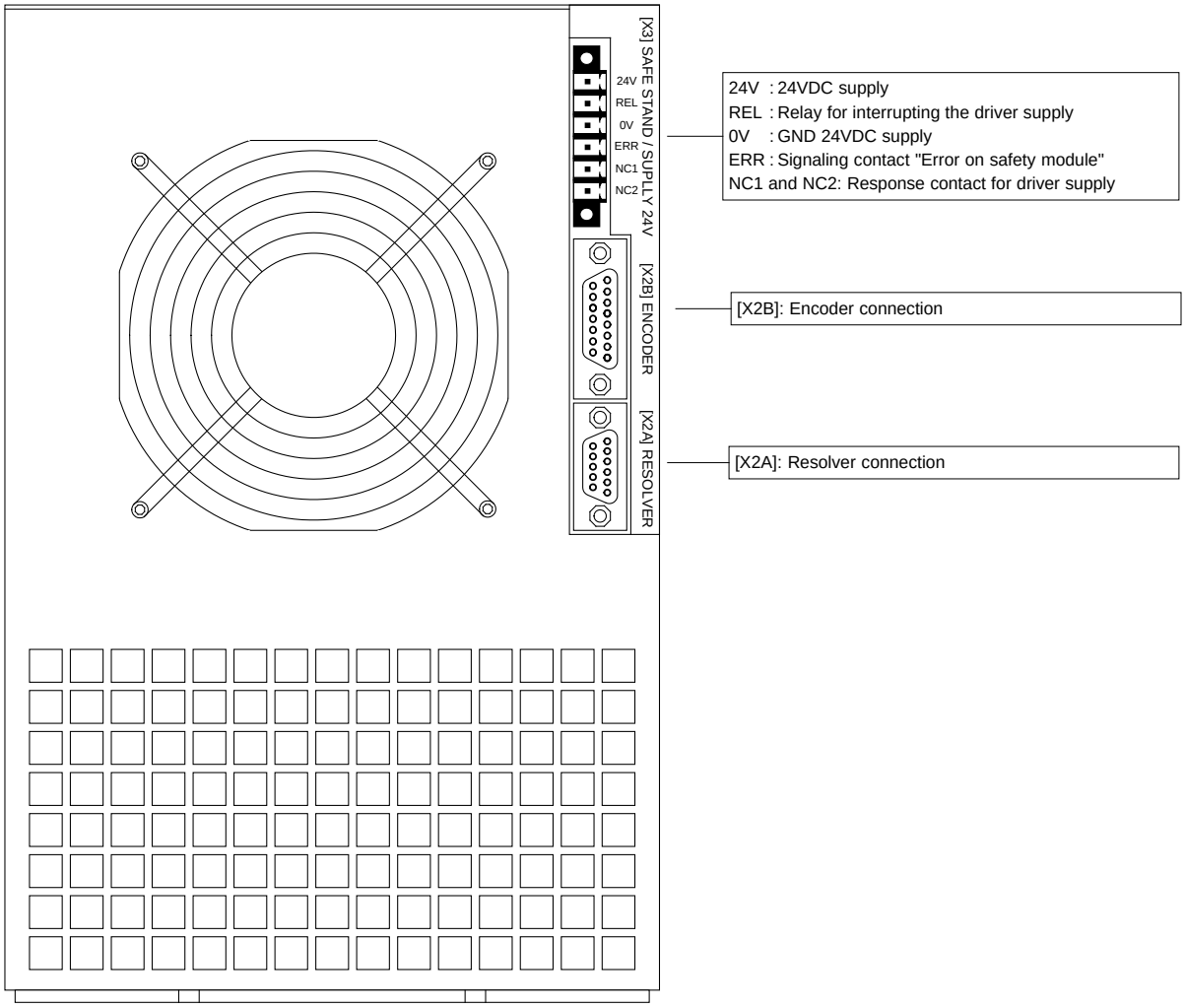


Figure 20: Servo drives ARS 2340 and ARS 2360W: Bottom view

Note:

The depth gauge of the water cooled devices is approximately 70 mm shorter.

7.4 Installation

The ARS 2300 servo drive has fastening straps at the top and at the bottom. Using these straps, the servo drive has to be installed perpendicularly on a control cabinet mounting plate. The fastening straps are part of the heat sink profile. This is why the best possible heat transfer to the control cabinet plate has to be ensured.

Please use M6 screws for the mounting of the servo drives ARS 2320, ARS 2340, ARS 2320W, and ARS 2360W.

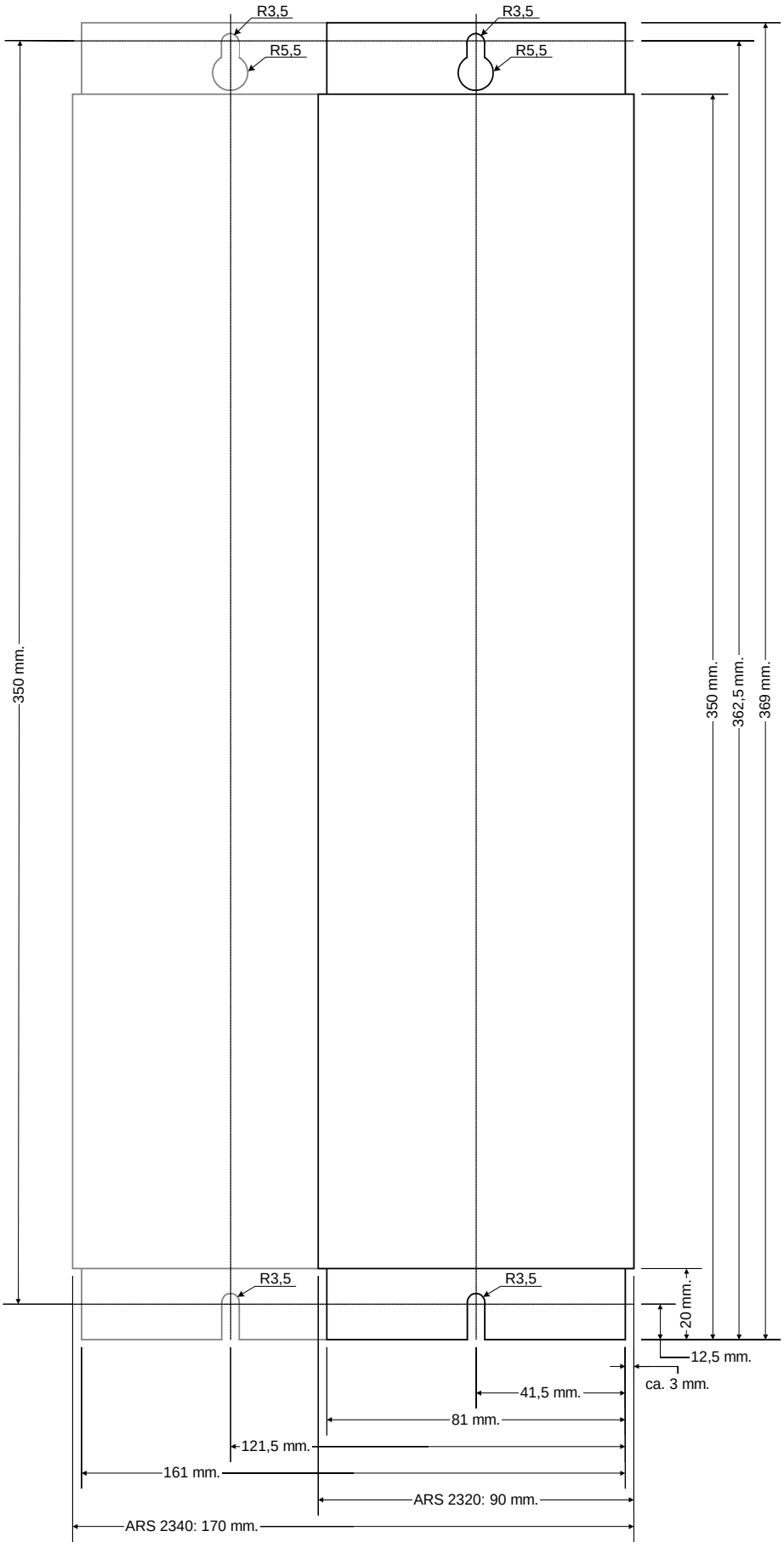


Figure 21: Servo drives ARS 2320 and ARS 2340: Drilling pattern on the mounting plate

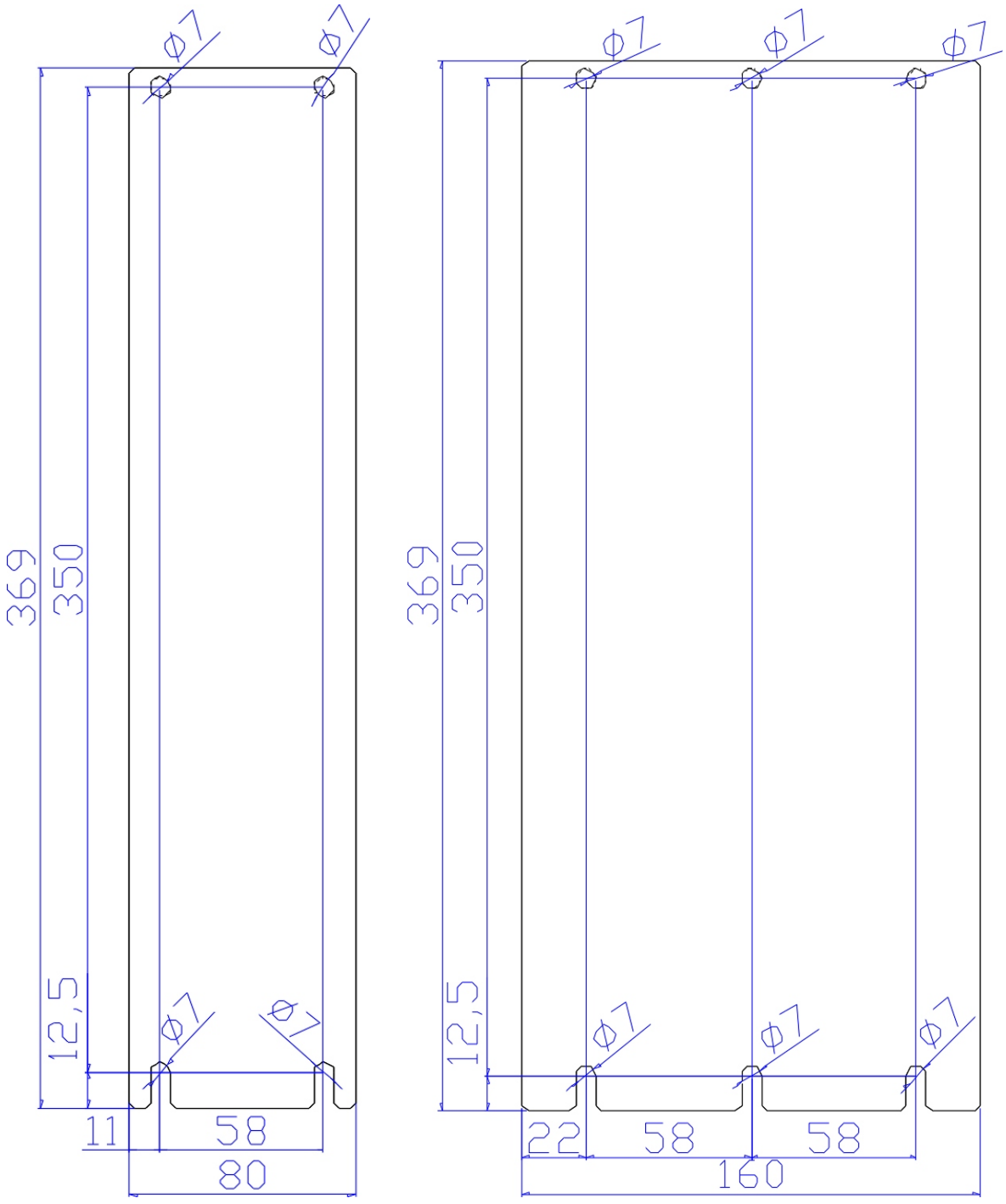


Figure 22: Servo drives ARS 2320W and ARS 2360W: Drilling pattern on the water cooling system

7.5 Water cooling system

The technical data and the requirements for the cooling circuit are shown in *chapter 4.5., Table 15* on *page 47.*

The following examples for water cooling systems can be obtained from the manufacturers specified below. The water cooling systems have been specifically designed for the ARS 2360W.

For the ARS 2320W, a customer specific solution is available, too.

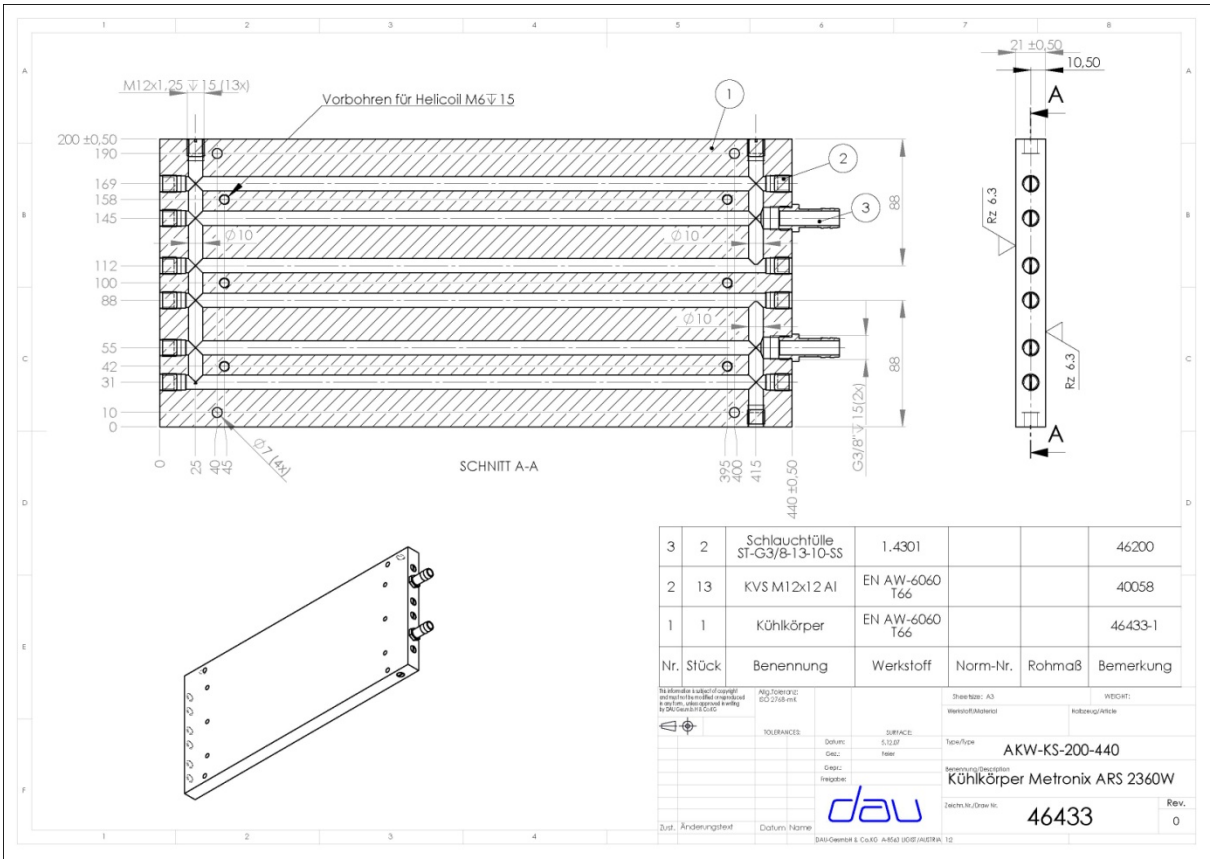


Figure 23: Water cooling system – example by the manufacturer Dau

Address:

DAU Ges.m.b.H & Co.KG

Dietenberg 38

A-8563 Ligist / Austria

Tel.: +43 (0)31 43 23 51-0

Fax: +43 (0)31 43 23 51-14

Mobile: +43 676 6060022

www.dau-at.com

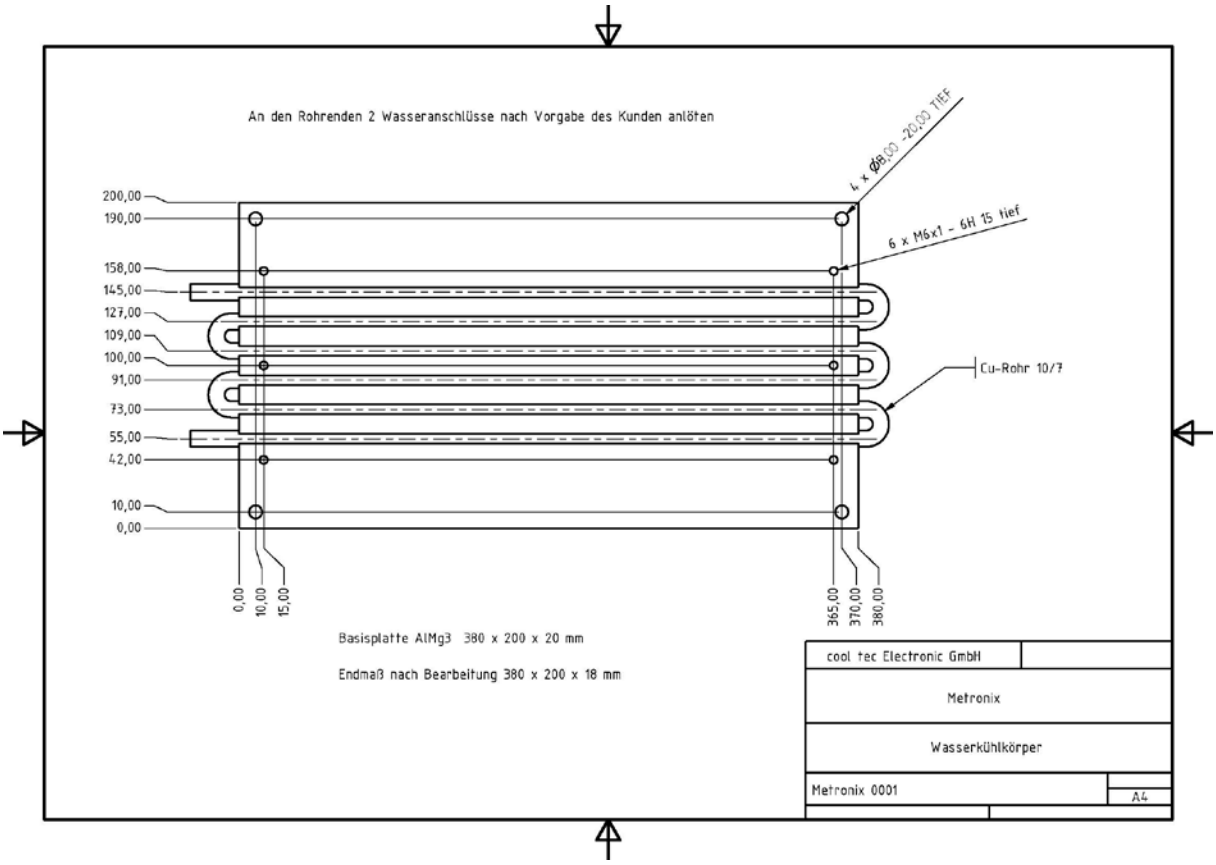


Figure 24: Water cooling system – example by the manufacturer Cooltec

Address:

cool tec Electronic GmbH

Ilmenauer Straße 4

D-98701 Großbreitenbach

international freecall: 00800 02 66 58 32

international freefax: 00800 02 66 53 29

www.cooltec.de

8 Electrical installation

8.1 Connector configuration

The ARS 2300 servo drive is connected to the supply voltage, the motor, the external braking resistor and the holding brake as shown in *Figure 25* and *Figure 21*.

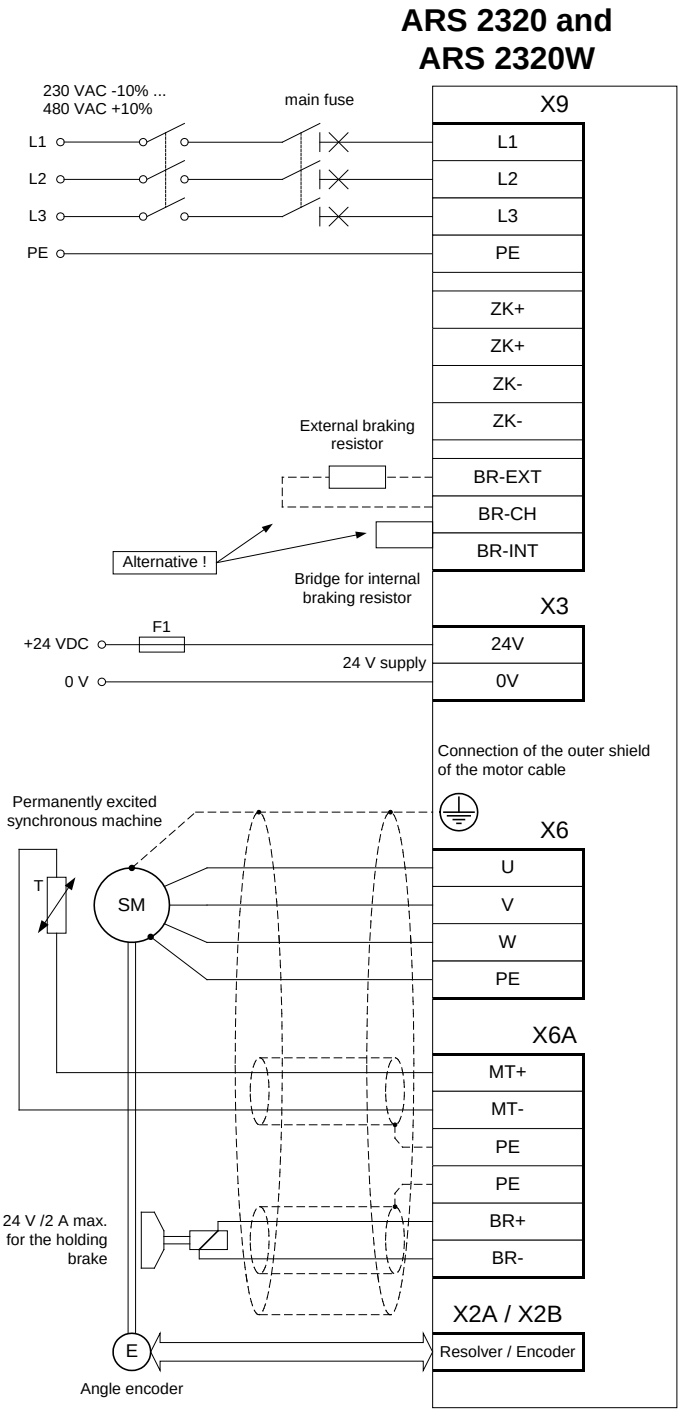


Figure 25: Servo drives ARS 2320 and ARS 2320W: Connection to the supply voltage and to the motor

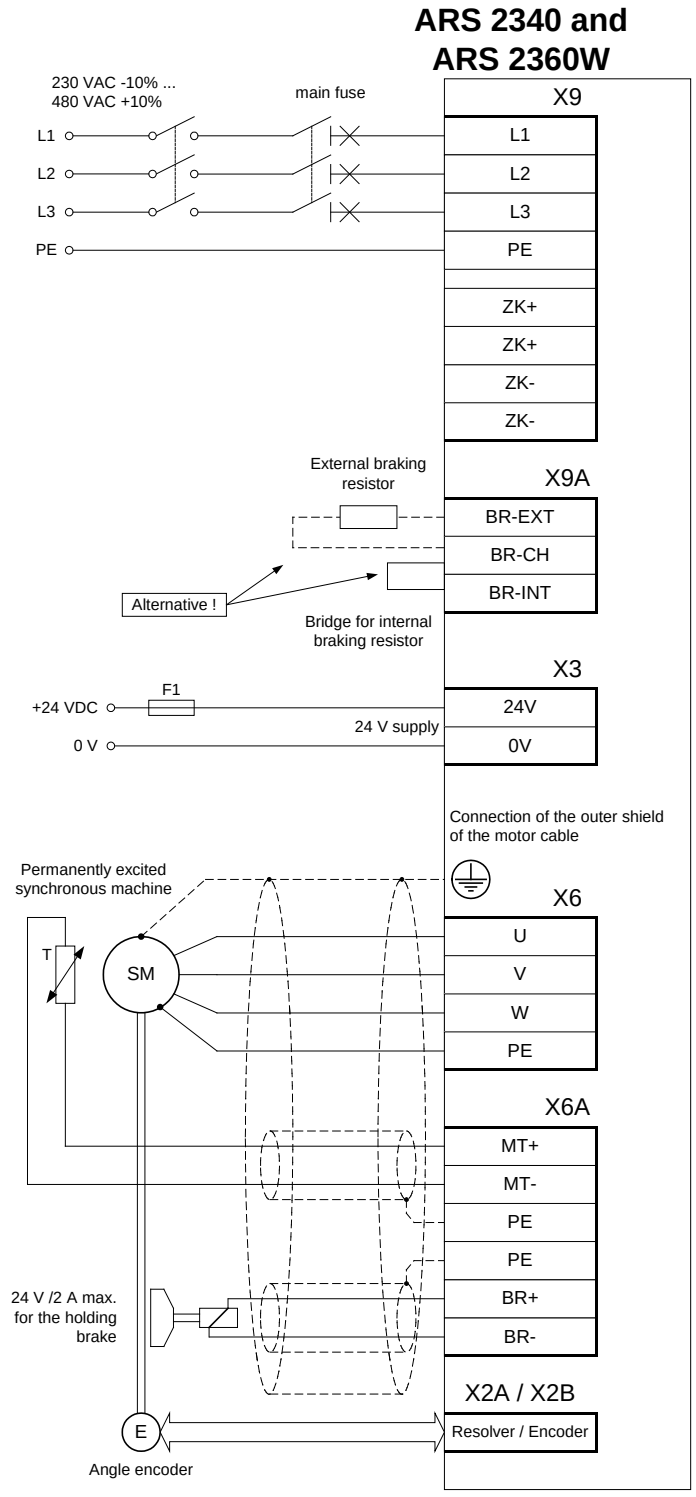


Figure 26: Servo drives ARS 2340 and ARS 2360W: Connection to the supply voltage and to the motor

Operation of the ARS 2300 servo drive requires a 24V voltage source for supplying the electronic system. This voltage source has to be connected to terminals 24V and 0V.

The power output stage is connected either to terminals L1, L2 and L3 for AC supply or to terminals ZK+ and ZK- for DC supply.

The motor is connected to terminals U, V, W. The motor temperature switch (PTC or normally closed contact) is connected to terminals MT+ and MT-, if the switch is integrated in one cable together with the motor phases. If an analogue temperature sensor (for example KTY81) is used in the motor, it is connected to [X2A] or [X2B] through the encoder cable.

The connection of the rotary encoder to [X2A] / [X2B] via the D-Sub connector is roughly shown in *Figure 25*.

The ARS 2300 servo drive must be connected to ground with its PE connector.

The ARS 2300 servo drive must be completely wired before the operating voltages for the DC bus and the electronic system can be switched on. In the case of inverted wiring of the operating voltage connections, an excessive operating voltage or a mix-up of operating voltage and motor connections, the ARS 2300 servo drive will be damaged.

8.2 ARS 2300 complete system

The complete ARS 2300 servo drive system is shown in *Figure 27*. The following components are required for using the servo drive:

- Mains main switch
- Fault-current circuit breaker, type B (RCD), AC/DC sensitive 300mA (if required by an application)
- Automatic circuit breaker
- ARS 2300 servo drive
- Motor with motor cable
- Mains cable

A PC with a serial connecting cable is required for parameterization.

Install a three-phase automatic circuit breaker into the mains supply line:

- For the servo drives type ARS 2320, ARS 2320W: 32 A, slow-to-blow type (B32)
- For the servo drives ARS 2340, ARS 2360W: 50 A, slow-to-blow type (B50)

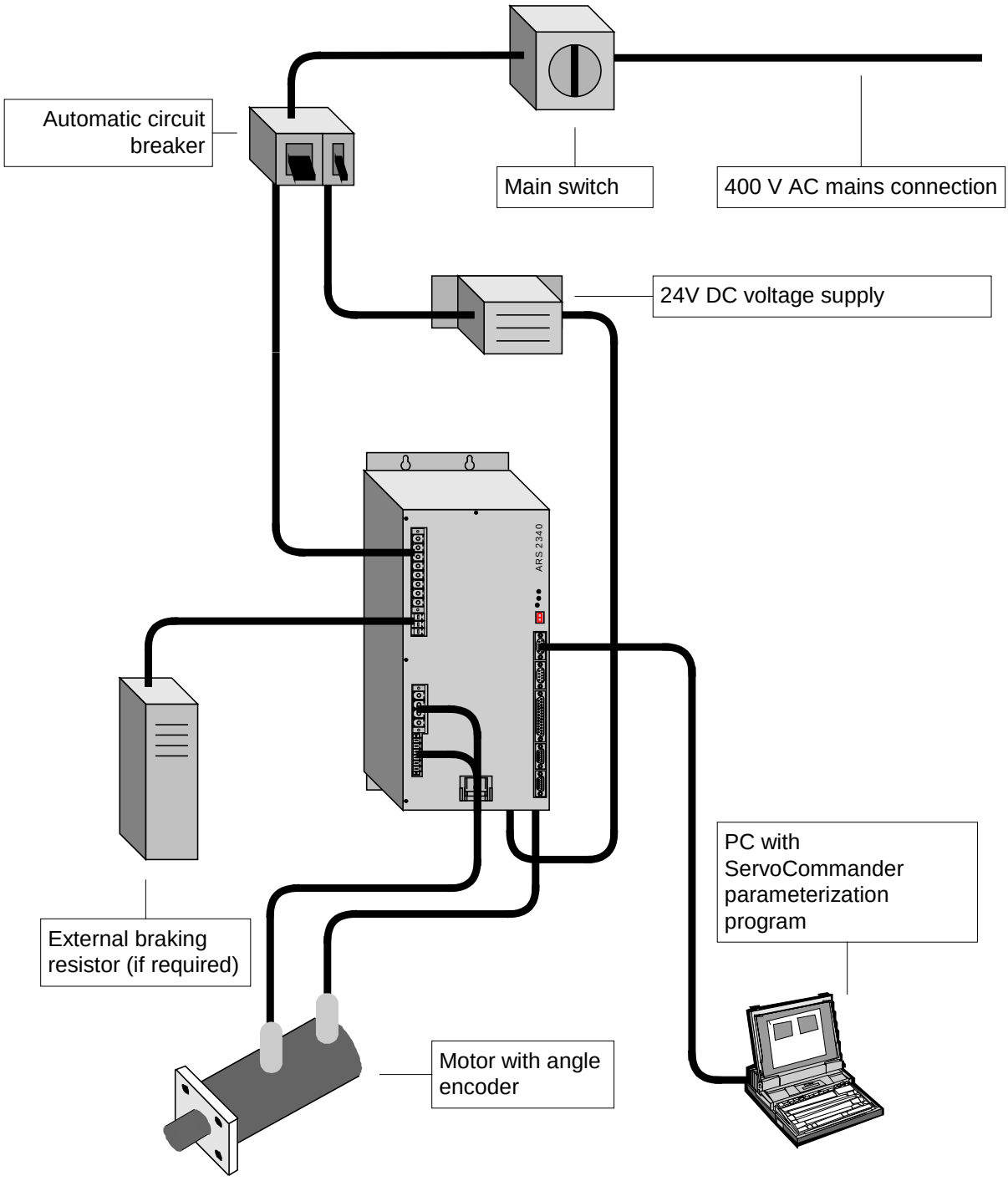


Figure 27: Complete set-up of the ARS 2300 with motor and PC

8.3 Connection at the ARS 2320 and ARS 2320W servo drives: Power supply and braking resistor [X9]

The ARS 2320 and ARS 2320W servo drives are supplied with three-phase mains power through connector [X9]. As an alternative to AC power supply or as a DC bus, direct DC power supply for the DC bus is possible via connector [X9].

The ARS 2320 and ARS 2320W servo drives receive their 24VDC power supply for the electronic control system through connector [X3]. See *chapter 8.5 Connection: Safe Torque Off (STO) and 24V supply [X3], page 99*.

8.3.1 Configuration at the ARS 2320 and ARS 2320W servo drives [X9]

❖ PHOENIX Power-Combicon, 11-pin type, PC 4/11-G-7.62

8.3.2 Counter plug [X9] at the ARS 2320 and ARS 2320W

❖ PHOENIX Power-Combicon 11-pin type, PC 5/11-STF1-7.62

8.3.3 Pin assignment [X9] at the ARS 2320 and 2320W

Table 28: Pin assignment at the ARS 2320 and ARS 2320W: Supply[X9]

Pin no.	Name	Values	Specification
1	L1	3 x 230 VAC -10% to 3 x 480 VAC +10%	Mains supply phase L1
2	L2		Mains supply phase L2
3	L3		Mains supply phase L2
4	PE	-	Connection of mains ground conductor
5	ZK+	< 700 VDC	Alternative supply: Positive DC bus voltage
6			
7	ZK-	< 700 VDC	Alternative supply: Negative DC bus voltage
8			

8.3.4 Connection: External braking resistor [X9] at the ARS 2320 and ARS 2320W

The ARS 2320 and ARS 2320W servo drives have an internal brake chopper with braking resistor.

For more braking power, an external braking resistor can be connected to pin-and-socket connector [X9].

Table 29: Pin assignment at the ARS 2320 and ARS 2320W: External braking resistor [X9]

Pin no.	Name	Values	Specification
9	BR-EXT	< 800 VDC	External braking resistor
10	BR-CH	< 800 VDC	Brake chopper connection for external braking resistor against BR-EXT Brake chopper connection for internal braking resistor against BR-INT
11	BR-INT	< 800 VDC	Internal braking resistor

If no external braking resistor is used, a bridge has to be installed between PIN10 and PIN11, so that the DC bus precharge, when the mains power supply is “ON”, and the DC bus rapid discharge can function properly!

8.3.5 Type and configuration of cable [X9] at the ARS 2320 and ARS 2320W

The cable names given refer to cables made by Lapp. They have proven to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

For 400 VAC supply:

- LAPP KABEL ÖLFLEX-CLASSIC 110; 4 x 4 mm²

8.3.6 Connection notes concerning [X9] at the ARS 2320 and ARS 2320W

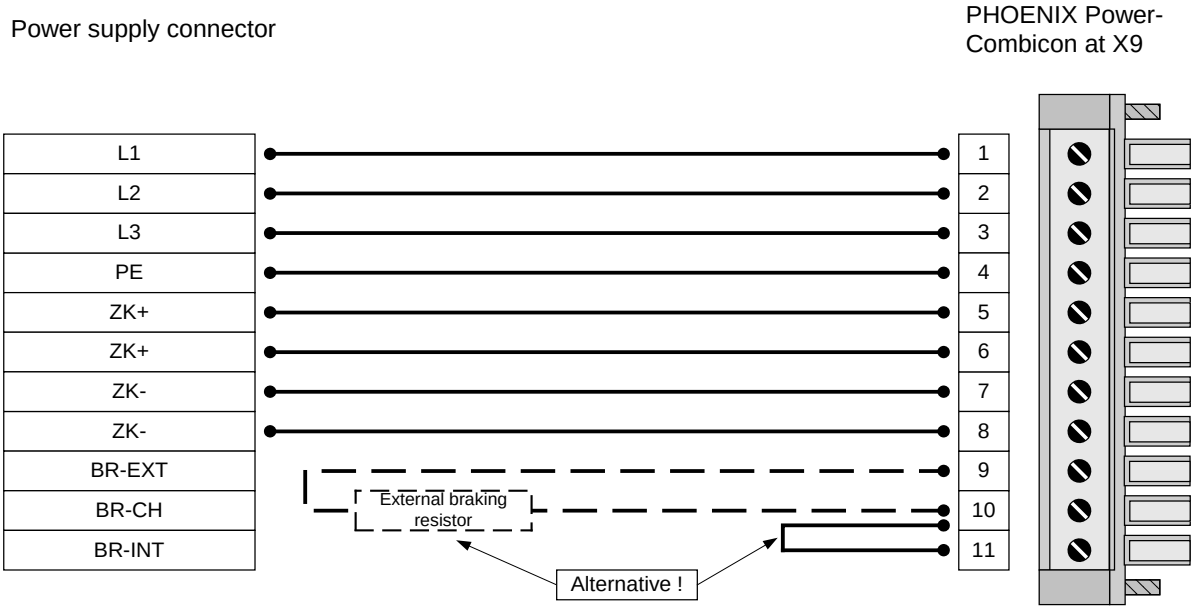


Figure 28: Pin assignment at the ARS 2320 and ARS 2320W: Supply and braking resistor [X9]

8.4 Connection at the ARS 2340 and ARS 2360W servo drives: Power supply [X9] and braking resistor [X9A]

The ARS 2340 and ARS 2360W servo drives are supplied with three-phase mains power through connector [X9]. As an alternative to AC power supply or as a DC bus, direct DC power supply for the DC bus is possible via connector [X9].

The ARS 2340 and ARS 2360W servo drives receive their 24VDC power supply for the electronic control system through connector [X3]. (See *chapter 8.5 Connection: Safe Torque Off (STO) and 24V supply [X3], page 99*.)

8.4.1 Configuration at the ARS 2340 and ARS 2360W servo drives [X9]

❖ PHOENIX Power-Combicon 8-pin type, PC 6-16/8-GF-10.16

8.4.2 Counter plug [X9] at the ARS 2340 and ARS 2360W

❖ PHOENIX Power-Combicon 8-pin type, PC 16/8-STF-10.16

8.4.3 Pin assignment [X9] at the ARS 2340 and ARS 2360W

Table 30: Pin assignment at the ARS 2340 and ARS 2360W: Supply [X9]

Pin no.	Name	Values	Specification
1	L1	3 x 230 VAC -10% to 3 x 480 VAC +10%	Supply: Mains phase L1
2	L2		Supply: Mains phase L2
3	L3		Supply: Mains phase L2
4	PE	-	Connection of mains ground conductor
5	ZK+	< 700 VDC	Alternative supply: Positive DC bus voltage
6			
7	ZK-	< 700 VDC	Alternative supply: Negative DC bus voltage
8			

8.4.4 Type and configuration of cable [X9] at the ARS 2340 and ARS 2360W

The cable names given refer to cables made by Lapp. They have proven to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

For 400 VAC supply:

- ARS 2340 LAPP KABEL ÖLFLEX-CLASSIC 110; 4 x 6 mm²
- ARS 2360W LAPP KABEL ÖLFLEX-CLASSIC 110; 4 x 10 mm²

8.4.5 Connection notes concerning [X9] at the ARS 2340 and ARS 2360W

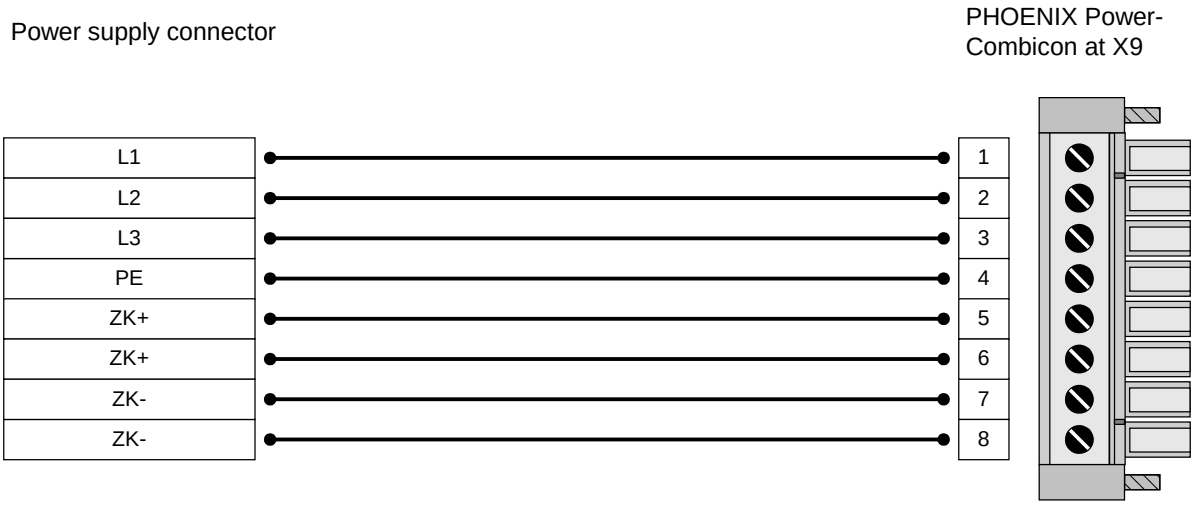


Figure 29: Pin assignment at the ARS 2340 and ARS 2360W: Supply [X9]

8.4.6 Connection: External braking resistor [X9A] at the ARS 2340 and ARS 2360W

The ARS 2340 and ARS 2360W servo drives have an internal brake chopper with braking resistor.

For more braking power, an external braking resistor can be connected to pin-and-socket connector [X9A].

8.4.7 Configuration [X9A] at the ARS 2340 and ARS 2360W

- PHOENIX Power-Combicon 3-pin type, PC 4/3-G-7.62

8.4.8 Counter plug [X9A] at the ARS 2340 and ARS 2360W

❖ PHOENIX Power-Combicon 3-pin type, PC 5/3-ST1-7.62

8.4.9 Pin assignment [X9A] at the ARS 2340 and ARS 2360W

Table 31: Pin assignment at the ARS 2340 and ARS 2360W: Braking resistor [X9A]

Pin no.	Name	Values	Specification
1	BR-EXT	< 800 VDC	External braking resistor
2	BR-CH	< 800 VDC	Brake chopper connection for external braking resistor against ext. Br.-R Brake chopper connection for internal braking resistor against int. Br.-R
3	BR-INT	< 800 VDC	Internal braking resistor

If no external braking resistor is used, a bridge has to be installed between PIN2 and PIN3, so that the DC bus precharge, when the mains power supply is “ON”, and the DC bus rapid discharge can function properly!

8.4.10 Connection notes concerning [X9A] at the ARS 2340 and ARS 2360W

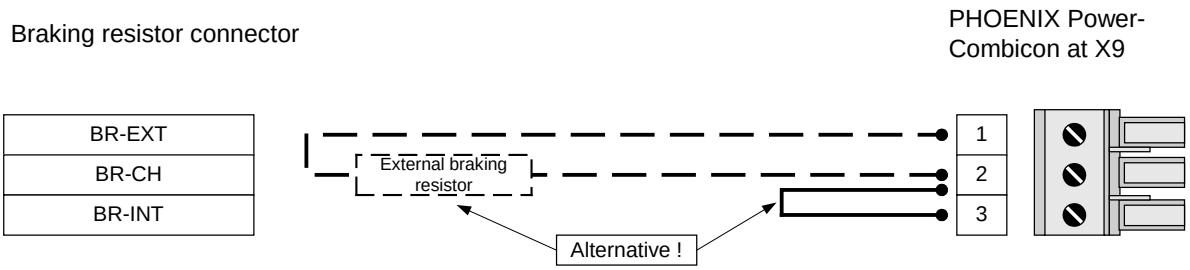


Figure 30: Pin assignment at the ARS 2340 and ARS 2360W: Braking resistor [X9A]

8.5 Connection: Safe Torque Off (STO) and 24V supply [X3]

The servo drives ARS 2320, ARS 2320W, ARS 2340 and ARS 2360W receive their 24VDC power supply for the electronic control system through connector [X3].

For the description of the safety function “Safe Torque-Off (STO)” see *chapter 6.2 Integrated “Safe torque-Off (STO)” function*.

8.5.1 Configuration on the device [X3]

❖ PHOENIX Mini-Combicon MC 1,5/6-STF-3,81

8.5.2 Counter plug [X3]

❖ PHOENIX Mini-Combicon MC 1,5/6-GF-3,81

8.5.3 Pin assignment [X3]

Table 32: Pin assignment: [X3]

Pin no.	Name	Values	Specification
1	24V	24VDC / 2.8 A	24VDC supply for control section (0.8A) and holding brake (2A) (Without safety measures in accordance with Category 3 Performance Level d: Bridge pin 1 and 2)
2	REL	0VDC / 24VDC	Setting and resetting of the relay for interrupting the driver supply
3	0V	GND 24 VDC	Reference potential for the 24VDC supply and the PLC
4	ERR	0V / 24VDC	Signalling contact “Error on safety module”
5	NC1	250VAC max. switching voltage	Floating response contact of driver supply, normally closed contact
6	NC2		

8.5.4 Cable type and configuration: 24VDC power supply [X3]

The cable names given refer to cables made by Lapp. They have proven to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

For 24 VAC power supply:

- ❖ LAPP KABEL ÖLFLEX-CLASSIC 110; 2 x 1 mm²

8.5.5 Connection notes [X3]

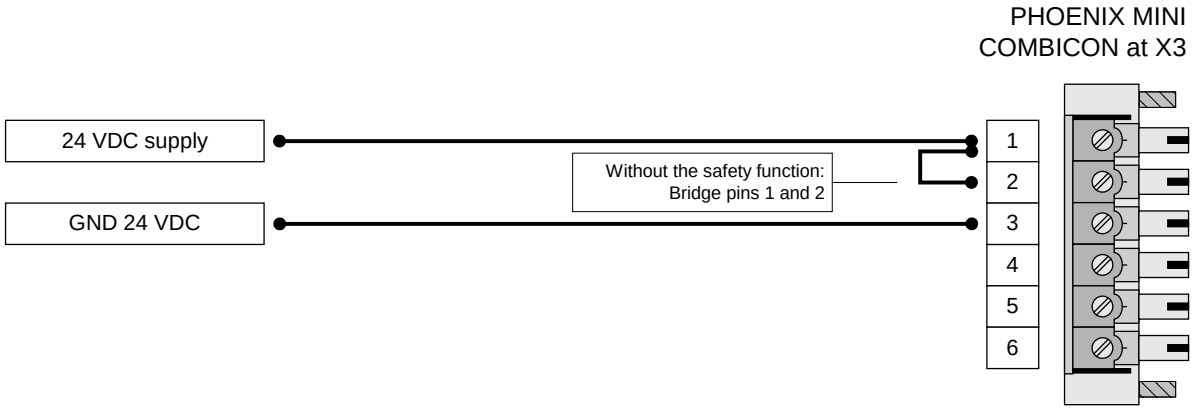


Figure 31: Pin assignment: 24VDC power supply [X3]

8.6 Connection: Motor [X6] and [X6A]

8.6.1 Configuration [X6] at the ARS 2320 and ARS 2320W

❖ PHOENIX Power-Combicon 4-pin type, PC 4/4-G-7.62

8.6.2 Counter plug [X6] at the ARS 2320 and ARS 2320W

❖ PHOENIX Power-Combicon 4-pin type, PC 5/4-STF1-7.62

8.6.3 Configuration [X6] at the ARS 2340 and ARS 2360W

❖ PHOENIX Power-Combicon-Plus 4-pin type, PC 6-16/4-GF-10.16

8.6.4 Counter plug [X6] at the ARS 2340 and ARS 2360W

❖ PHOENIX Power-Combicon 4-pin type, PC 16/4-STF-10.16

8.6.5 Configuration device side [X6A]

❖ PHOENIX Mini-Combicon 6-pin type, MC 1,5/ 6-GF-3.81

8.6.6 Counter plug [X6A]

❖ PHOENIX Mini-Combicon 6-pin type, MC 1,5/ 6-STF-3.81

8.6.7 Pin assignment [X6]

Table 33: Pin assignment: Motor [X6]

Pin no.	Name	Values	Specification
1	U	0...360 V_{eff} 0..20 A_{eff} (ARS 2320 and ARS 2320W) 0..40 A_{eff} (ARS 2340) 0..60 A_{eff} (ARS 2360W) 0...1000 Hz	Connection of the three motor phases (with 3rd harmonic)
2	V		
3	W		
4	PE	-	Connection of motor PE line

Additionally, the outer cable shield of the motor cable has to be connected flat to the mounting plate of the servo drive housing using shield terminal SK-20D.

Table 34: Motor temperature monitoring system and holding brake [X6A]

Pin no.	Name	Values	Specification
1	MT+	+5 V / 5 mA	Motor temperature sensor: Normally closed contact, normally open contact, PTC
2	MT-	GND	
3	PE	-	Shield of motor temperature monitoring system
4	PE	-	Shield of motor holding brake
5	BR+	24 V brake, 2A max.	Holding brake (motor), signal level depending on switching state, high-side / low-side switch
6	BR-	0 V brake	

8.6.8 Type and configuration of cable [X6] and [X6A] at the ARS 2320 and ARS 2320W

The cable names given refer to cables made by Lapp. They have proven to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

- LAPP KABEL ÖLFLEX-SERVO 700 CY; 4 G 4 + (2 x 0,75 + 2 x 1,0); ∅ 16.6 mm,
  with tinned CU shielding

For highly flexible applications:

- LAPP KABEL ÖLFLEX-SERVO-FD 750 P; 4 G 4 + (2 x 0,75 StD) + (2 x 1,0 StD) CP;
  ∅ 16.9 mm,
  with tinned CU shielding
  for highly flexible use in drag chains

8.6.9 Type and configuration of cable [X6] and [X6A] at the ARS 2340

The cable names given refer to cables made by Lapp. They have proven to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

- LAPP KABEL ÖLFLEX-SERVO 700 CY; 4 G 6 + (2 x 0,75 + 2 x 1,0); ∅ 17.7 mm,
  with tinned CU shielding

For highly flexible applications:

- LAPP KABEL ÖLFLEX-SERVO-FD 750 P; 4 G 6 + (2 x 0,75 StD) + (2 x 1,0 StD) CP; ∅ 18.9 mm,
  with tinned CU shielding
  for highly flexible use in drag chains

8.6.10 Type and configuration of cable [X6] and [X6A] at the ARS 2360W

The cable names given refer to cables made by Lapp. They have proven to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

- LAPP KABEL ÖLFLEX-SERVO 700 CY; 4 G 10 + (2 x 0,75 + 2 x 1,0); ∅ 21.6 mm,
  with tinned CU shielding

For highly flexible applications:

- LAPP KABEL ÖLFLEX-SERVO-FD 750 P; 4 G 10 + (2 x 0,75 Std) + (2 x 1,0 Std) CP; ∅ 18.9 mm,
  with tinned CU shielding
  for highly flexible use in drag chains

Recommendation:

For motor output currents of > 55 A_{eff} a 16 mm^2 cable has to be used. For example LAPP KABEL ÖLFLEX-SERVO 700 CY; 4 G 16 + (2 x 2 x 1); ∅ 24.5 mm,
with tinned CU shielding.

When using a 16 mm^2 cable it may be necessary to use the bigger shield terminal SK 35 or SK 35-D manufactured by Phoenix Contact or to connect the cable shield with a cable tie or another cable clamp flat to the servo drive.

8.6.11 Connection notes concerning [X6] and [X6A]

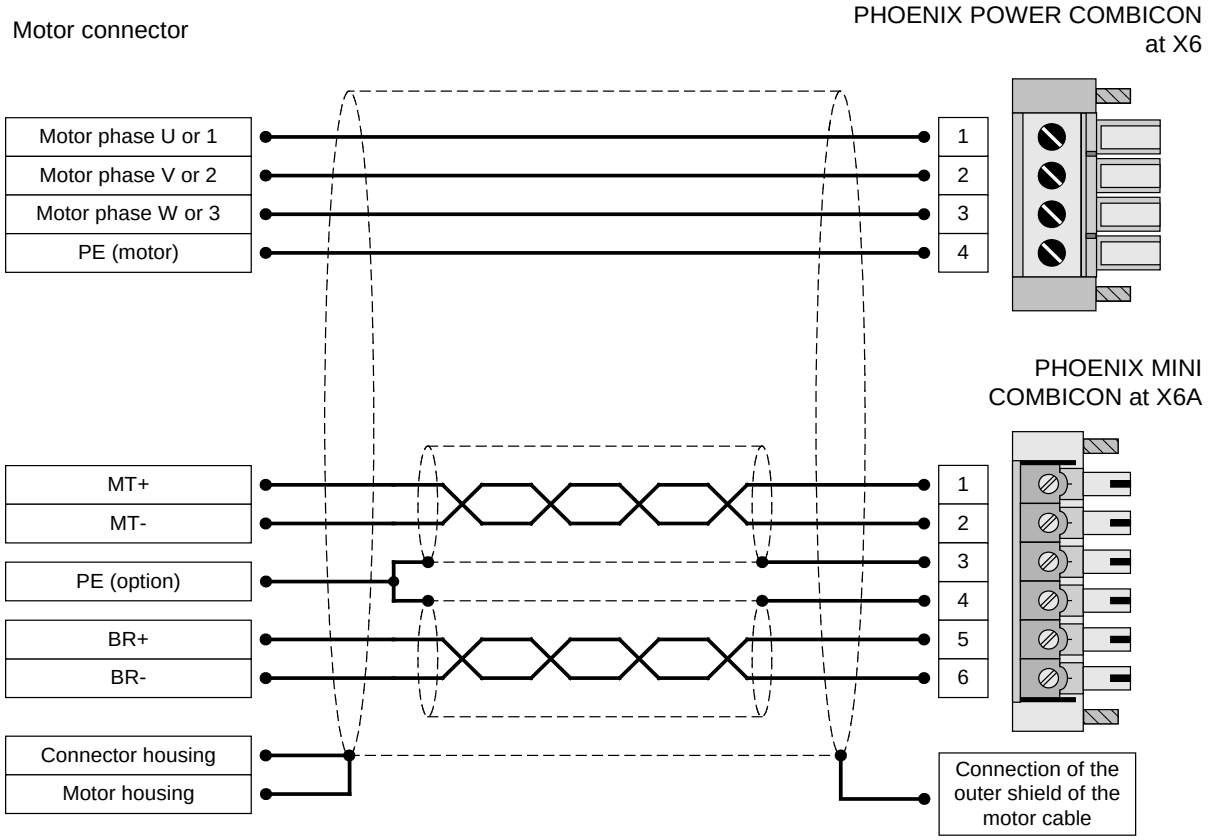


Figure 32: Pin assignment: Motor [X6] and [X6A]

- ❖ Connect the inner shields to PIN 3. Maximum length: 40 mm.
- ❖ Maximum length of unshielded cores: 35 mm.
- ❖ Connect the shield on the servo drive flat to shield terminal SK-20-D.
- ❖ Connect the shield on the motor side flat to the connector or motor housing. Maximum length: 40 mm.

The signals for the digital temperature sensor “-MTdig” (PIN 2) and “+MTdig” (PIN 1) at the motor connector [X6A] are not connected to Protective Extra Low Voltage (PELV). These connections are designed for temperature sensors that are not safely separated. The safe separation from Protective Extra Low Voltage (PELV) is performed within the ARS 2000.

Via terminals ZK+ and ZK- the DC buses of several servo drives ARS 2300 can be interconnected. The coupling of the DC bus is interesting for applications with high brake energies or if movements have to be carried out even in the case of power failure.

A holding brake can be connected to the terminals BR+ and BR- of the motor. The holding brake is fed by the servo drive’s power supply. Note the maximum output current provided by the servo drive

ARS 2300. A relay may have to be placed between the device and the holding brake as shown in *Figure 32*.

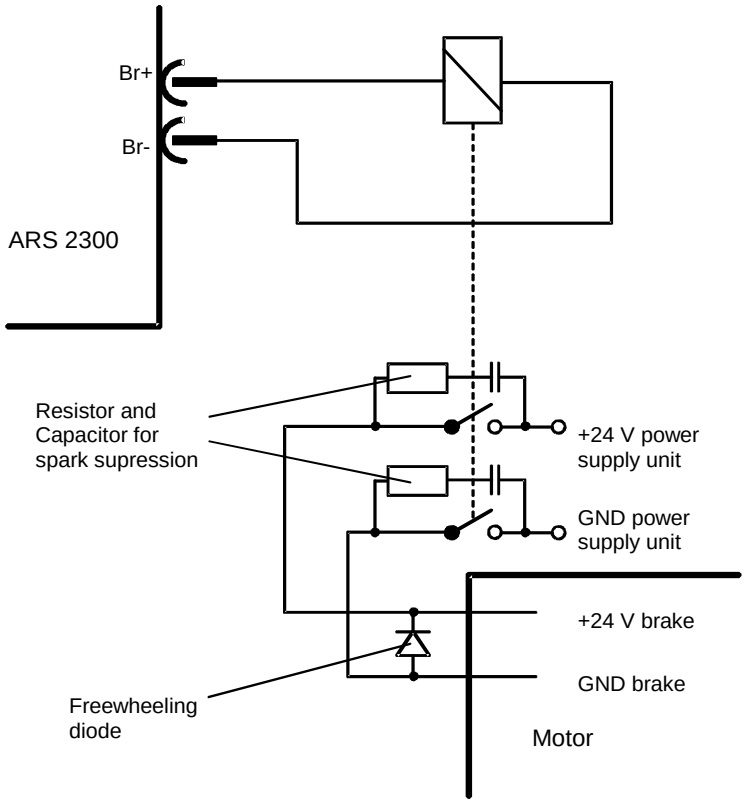


Figure 33: Connecting a holding brake with high current demand (> 2A) to the device

The switching of inductive direct current via relay produces strong currents and sparking. For interference suppression, we recommend integrated RC suppressor elements, for example made by Evox RIFA, type: PMR205AC6470M022 (RC element with 22Ω in series with 0.47uF).

8.7 Connection: I/O communication [X1]

The following *Figure 34* shows the basic function of the digital and analogue inputs and outputs. The ARS 2300 servo drive is shown on the right-hand side, the control connection on the left-hand side. The cable configuration is also shown.

The ARS 2300 servo drive has two potential ranges:

Analogue inputs and outputs:

All analogue inputs and outputs refer to AGND. AGND is internally connected to GND, the reference potential for the control section with µC and AD converters in the servo drive. This potential range is electrically isolated from the 24V range and from the DC bus.

24V inputs and outputs:

These signals refer to the 24V supply voltage of the ARS 2300 servo drive which is supplied via [X3]. They are separated from the reference potential of the control section by means of optocouplers.

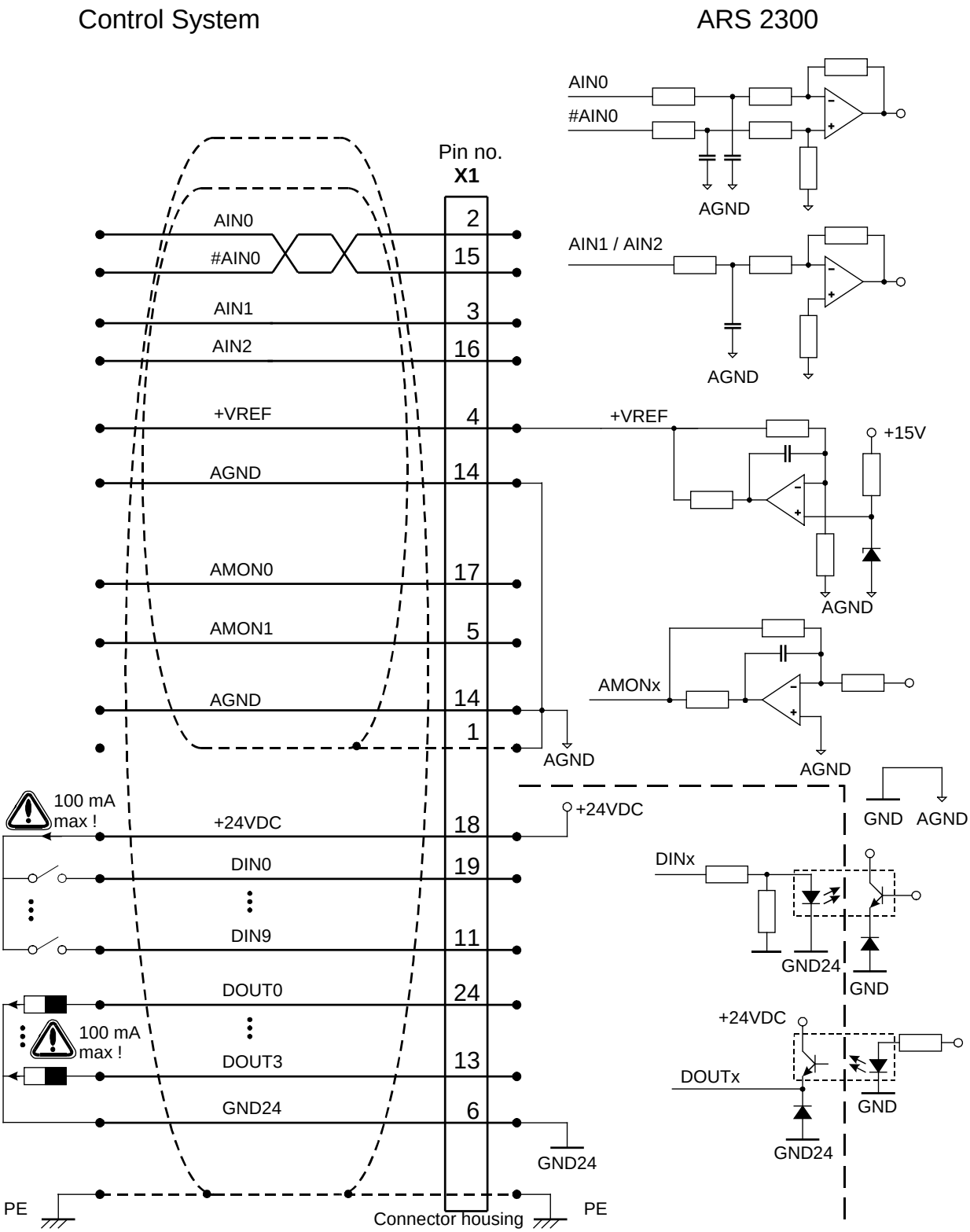


Figure 34: Basic circuit diagram of connection [X1]

The ARS 2300 servo drive has one differential analogue input (AIN0) and two single-ended analogue inputs designed for input voltages in the range of ± 10V. Inputs AIN0 and #AIN0 are led to the control system via twisted cables (twisted-pair type). If the control system has single-ended outputs, the output is connected to AIN0 and #AIN0 is connected to the reference potential of the control system. If the control system has differential outputs, they have to be connected 1:1 to the differential inputs of the ARS 2300 servo drive.

The reference potential AGND is connected to the reference potential of the control system. This is necessary in order to prevent the differential input of the ARS 2300 servo drive from being overridden by high “common-mode interferences”.

There are two analogue monitor outputs with output voltages in the range of ± 10V and one output for a reference voltage of +10V. These outputs can be led to the superimposed control system, the reference AGND must be carried along. If the control system has differential inputs, the “+” input of the control system is connected to the output of the ARS 2300 servo drive and the “-“ input of the control system to AGND.

8.7.1 Configuration on the device [X1]

- D-SUB connector, 25-pin type, female

8.7.2 Counter plug [X1]

- D-SUB connector, 25-pin type, male
- Housing for 25-pin D-SUB connector with bolting screws of type 4/40 UNC

8.7.3 Pin assignment [X1]

Table 35: Pin assignment: I/O communication [X1]

Pin no.		Name	Values	Specification
1		AGND	-	Shield for analogue signals
	14	AGND	-	Reference potential for analogue signals
2		AIN0	U_{In} = ±10V R_I ≥30kΩ	Set point input 0, differential, 30V input voltage max.
	15	#AIN0		
3		AIN1	U_{In} = ±10V R_I ≥30kΩ	Set point inputs 1 and 2, single-ended, 30V input voltage max.
	16	AIN2		
4		+VREF	+10V	Reference output for set point potentiometer
	17	AMON0	±10V	Analogue monitor output 0
5		AMON1	±10V	Analogue monitor output 1
	18	+24V	24VDC / 100mA	24VDC supply, led out
6		GND24	-	Reference potential for digital inputs/outputs
	19	DIN0	POS Bit0	Positioning target selection bit0
7		DIN1	POS Bit1	Positioning target selection bit1
	20	DIN2	POS Bit2	Positioning target selection bit2
8		DIN3	POS Bit3	Positioning target selection bit3
	21	DIN4	FG_E	Output stage enabling
9		DIN5	FG_R	Input for servo drive enabling
	22	DIN6	END0	Input of limit switch 0 (blocks n < 0)
10		DIN7	END1	Input of limit switch 1 (blocks n > 0)
	23	DIN8	START	Input for start of positioning process
11		DIN9	SAMP	High-speed input
	24	DOUT0 / BEREIT	24VDC / 100mA	Output for readiness for operation
12		DOUT1	24VDC / 100mA	Freely programmable output
	25	DOUT2	24VDC / 100mA	Freely programmable output
13		DOUT3	24VDC / 100mA	Freely programmable output

8.7.4 Cable type and configuration [X1]

The cable names given refer to cables made by Lapp. They have proven to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

- LAPP KABEL UNITRONIC-LiYCY; 25 x 0.25 mm²

Figure 34 shows the cable between the ARS 2300 servo drive and the control system. The cable shown has two cable shields.

The outer cable shield is connected to PE on both sides. Inside the ARS 2300 servo drive, the connector housing of the D-Sub connector is connected to PE. If metal D-Sub connector housings are used, the cable shield is simply squeezed underneath the strain relief.

Often an unshielded cable is sufficient for 24V signals. In environments with high interferences or in the case of long cables (l > 2m) between the control system and the ARS 2300 servo drive, Metronix recommends the use of shielded control cables.

Although the analogue inputs of the ARS 2300 servo drive are differential, using unshielded cables for the analogue signals is not recommended as interferences, for example caused by switching contacts, or output stage interferences of the converters can reach high amplitudes. They couple themselves into the analogue signals and cause common-mode interferences which may lead to deviations of the analogue measured values.

In the case of limited cable lengths (l < 2m, wiring inside the control cabinet), the outer dual-sided PE shield is enough to guarantee trouble-free operation.

For optimal interference suppression of the analogue signals, the cores for the analogue signals have to be shielded together and separated from other cores. At the ARS 2300 servo drive, the inner cable shield is connected on one side to AGND (pin 1 or 14). It can be connected on both sides in order to establish a connection between the reference potentials of the control system and the ARS 2300 servo drive. Pins 1 and 14 are directly connected to each other inside the servo drive.

8.7.5 Connection notes [X1]

The digital inputs are rated for control voltages of 24V. The high signal level already ensures a high level of interference immunity of these inputs. The ARS 2300 servo drive provides an auxiliary voltage of 24V which may be loaded with 100 mA maximum. As a result, the inputs can be activated directly via switches. Activation via the 24V outputs of a PLC is of course also possible.

The digital outputs are so-called “high-side switches”. This means that the 24V of the ARS 2300 servo drive are actively switched through to the output. Loads such as lamps, relays, etc. thus must be connected between the output and GND24. The four outputs DOUT0 to DOUT3 can be loaded with a maximum of 100mA each. The outputs can also be led directly to 24V inputs of a PLC.

8.8 Connection: Safe Torque Off (STO) [X3]

For the description of the safety function “Safe Torque-Off (STO)”, please refer to *chapter 6.2 Integrated “Safe torque-Off (STO)” function*.

8.8.1 Configuration on the device [X3]

❖ PHOENIX Mini-Combicon MC 1,5/6-STF-3,81

8.8.2 Counter plug [X3]

❖ PHOENIX Mini-Combicon MC 1,5/ 6-GF-3,81

8.8.3 Pin assignment [X3]

Table 36: Pin assignment: [X3]

Pin No	Name	Values	Specification
1	24V	24VDC	24VDC supply led out (Without the safety function: Bridge pin 1 and 2)
2	REL	0V / 24VDC	Setting and resetting of the relay for interrupting the driver supply
3	0V	0V	Reference potential for the PLC
4	ERR	0V / 24VDC	Signalling contact “Error on safety module”
5	NC1	250VAC max. switching voltage	Floating response contact of driver supply; normally closed contact
6	NC2		

8.8.4 Connection notes [X3]

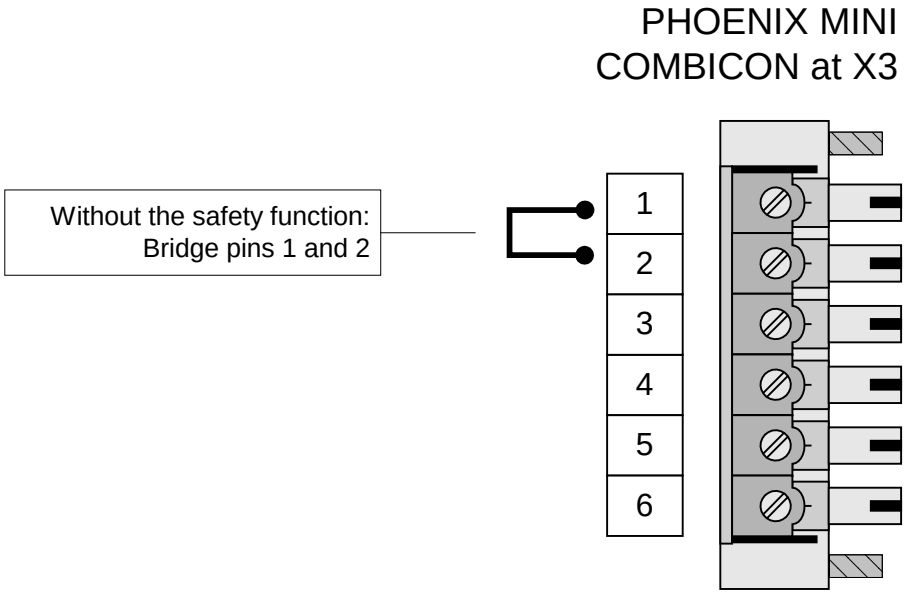


Figure 35: Connection notes [X3]: Without safety function

8.9 Connection: Resolver [X2A]

8.9.1 Configuration on the device [X2A]

- 1 D-SUB connector, 9-pin type, female

8.9.2 Counter plug [X2A]

- D-SUB connector, 9-pin type, male
- Housing for 9-pin D-SUB connector with bolting screws of type 4/40 UNC

8.9.3 Pin assignment [X2A]

Table 37: Pin assignment: [X2A]

Pin no.		Name	Values	Specification
1		S2	$3.5V_{eff}$ /5-10kHz	SINE trace signal, differential
	6	S4	$R_i > 5k\Omega$	
2		S1	$3.5V_{eff}$ /5-10kHz	COSINE trace signal, differential
	7	S3	$R_i > 5k\Omega$	
3		AGND	0V	Shield for signal pairs (inner shield)
	8	MT-	GND	Temperature sensor reference potential
4		R1	$7V_{eff}$ /5-10kHz $I_A \leq 150mA_{eff}$	Carrier signal for resolver
	9	R2	GND	
5		MT+	+3.3V / R_i=2kΩ	Motor temperature sensor, normally closed contact, PTC, KTY

In addition, a low-impedance connection of the outer cable shield to the housing of the servo drive has to be established. Therefore, the outer cable shield of the angle encoder cable must be connected to the housing of the angle encoder connector.

8.9.4 Cable type and configuration [X2A]

The cable names given refer to cables made by Lapp. They have proven to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

- LAPP KABEL ÖLFLEX-SERVO 720 CY; 3 x (2 x 0,14 CY) + 2 x (0,5 CY) CY; ∅ 8.5 mm, with tinned CU shielding
  Error during angle detection up to about 1.5° at a cable length of 50 m
  - Use 2 x (0.5 CY) for the resolver carrier!

For highly flexible applications:

- LAPP KABEL ÖLFLEX-SERVO-FD 770 CP; 3 x (2 x 0,14 D12Y) + 2 x (0,5 D12Y) CP; ∅ 8.3 mm, with tinned CU shielding
  Error during angle detection up to about 1.5° at a cable length of 50 m
  - Use 2 x (0.5 D12Y) for the resolver carrier!

8.9.5 Connection notes [X2A]

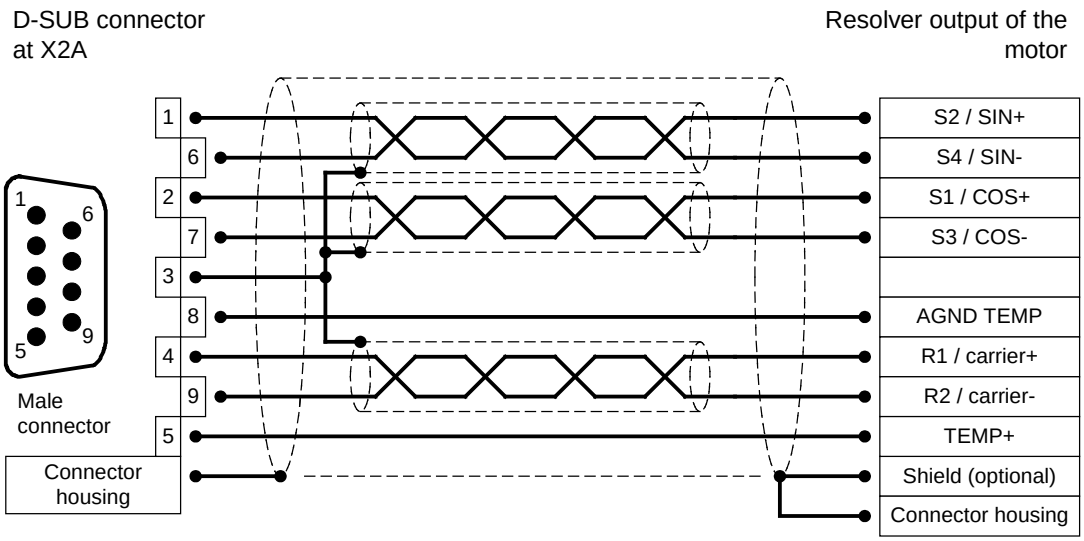


Figure 36: Pin assignment: Resolver connection [X2A]

- The outer shield is always connected to PE (connector housing) on the servo drive.
- The three inner shields are connected on one side to PIN3 of X2A of the ARS 2300 servo drive.

8.10 Connection: Encoder [X2B]

8.10.1 Configuration on the device [X2B]

- D-SUB connector, 15-pin type, female

8.10.2 Counter plug [X2B]

- D-SUB connector, 15-pin type, male
- Housing for 15-pin D-SUB connector with bolting screws of type 4/40 UNC

8.10.3 Pin assignment [X2B]

Table 38: Pin assignment: Analogue incremental encoder - optional [X2B]

Pin no.		Name	Values	Specification
1		MT+	+3.3V / Ri=2kΩ	Motor temperature sensor, normally closed contact, PTC, KTY
	9	U_SENS+	5V...12V $R_I \approx 1k\Omega$	Sensor lines for encoder supply
2		U_SENS-		
	10	US	5V / 12V/ ±10% I_{max} = 300mA	Operating voltage for high-resolution incremental encoders
3		GND	0V	Reference potential for encoder supply and motor temperature sensor
	11	R	$0.2V_{SS}$.. $0.8V_{SS}$ $R_I \approx 120\Omega$	Reset pulse trace signal (differential) of high-resolution incremental encoder
4		#R		
	12	COS_Z1 *)	$1V_{SS}$±10% $R_I \approx 120\Omega$	COSINE commutation signal (differential) of high-resolution incremental encoder
5		#COS_Z1 *)		
	13	SIN_Z1 *)	$1V_{SS}$±10% $R_I \approx 120\Omega$	SINE commutation signal (differential) of high-resolution incremental encoder
6		#SIN_Z1 *)		
	14	COS_Z0 *)	$1V_{SS}$±10% $R_I \approx 120\Omega$	COSINE trace signal (differential) of high-resolution incremental encoder
7		#COS_Z0 *)		
	15	SIN_Z0 *)	$1V_{SS}$±10% $R_I \approx 120\Omega$	SINE trace signal (differential) of high-resolution incremental encoder
8		#SIN_Z0 *)		

*) Heidenhain encoder: A=SIN_Z0; B=COS_Z0; C=SIN_Z1; D=COS_Z1

Table 39: Pin assignment: Incremental encoder with serial interface (for example EnDat, HIPERFACE®) - optional [X2B]

Pin no.		Name	Values	Specification
1		MT+	+3.3V / Ri=2kΩ	Motor temperature sensor, normally closed contact, PTC, KTY
	9	U_SENS+	5V...12V / $R_I \approx 1k\Omega$	Sensor lines for encoder supply
2		U_SENS-		
	10	US	5V / 12V/ ±10% I_{max} = 300mA	Operating voltage for high-resolution incremental encoders
3		GND	0V	Reference potential for encoder supply and motor temperature sensor
	11			
4				
	12	DATA	$5V_{SS}$ $R_I \approx 120\Omega$	Bi-directional RS485 data line (differential) (EnDat/HIPERFACE®
5		#DATA		
	13	SCLK	$5V_{SS}$ $R_I \approx 120\Omega$	Clock output RS485 (differential) (EnDat)
6		#SCLK		
	14	COS_Z0 *)	$1V_{SS}$±10% $R_I \approx 120\Omega$	COSINE trace signal (differential) of high-resolution incremental encoder
7		#COS_Z0 *)		
	15	SIN_Z0 *)	$1V_{SS}$±10% $R_I \approx 120\Omega$	SINE trace signal (differential) of high-resolution incremental encoder
8		#SIN_Z0 *)		

*) Heidenhain encoder: A=SIN_Z0; B=COS_Z0

Table 40: Pin assignment: Digital incremental encoder - optional [X2B]

Pin no.		Name	Values	Specification
1		MT+	+3.3V / Ri=2kΩ	Motor temperature sensor, normally closed contact, PTC, KTY
	9	U_SENS+	5V...12V / $R_I \approx 1k\Omega$	Sensor lines for encoder supply
2		U_SENS-		
	10	US	5V..12V/ ±10% I_{max} = 300mA	Operating voltage for high-resolution incremental encoders
3		GND	0V	Reference potential for encoder supply and motor temperature sensor
	11	N	$2V_{SS}$.. $5V_{SS}$ $R_I \approx 120\Omega$	Reset pulse RS422 (differential) from digital incremental encoder
4		#N		
	12	H_U	0V / 5V $R_I \approx 2k\Omega$ an VCC	Hall sensor phase U for commutation
5		H_V		Hall sensor phase V for commutation
	13	H_W		Hall sensor phase W for commutation
6				
	14	A	$2V_{SS}$.. $5V_{SS}$ $R_I \approx 120\Omega$	A trace signal RS422 (differential) from digital incremental encoder
7		#A		
	15	B	$2V_{SS}$.. $5V_{SS}$ $R_I \approx 120\Omega$	B trace signal RS422 (differential) from digital incremental encoder
8		#B		

In addition, a low-impedance connection of the outer cable shield to the housing of the servo drive has to be established. Therefore, the outer cable shield of the angle encoder cable must be connected to the housing of the angle encoder connector.

8.10.4 Cable type and configuration [X2B]

We recommend using the encoder connection cables authorized by the manufacturers (Heidenhain, Stegmann, etc.) for their various products. If the manufacturer does not recommend a particular cable, we recommend setting up the encoder connection cables as described below.

For the angle encoder supply US and GND, we recommend

- a minimum cross-section of 0.25 mm² for an angle encoder cable length up to 25 m, and
- a minimum cross-section of 0.5 mm² for an angle encoder cable length up to 50 m.

8.10.5 Connection notes [X2B]

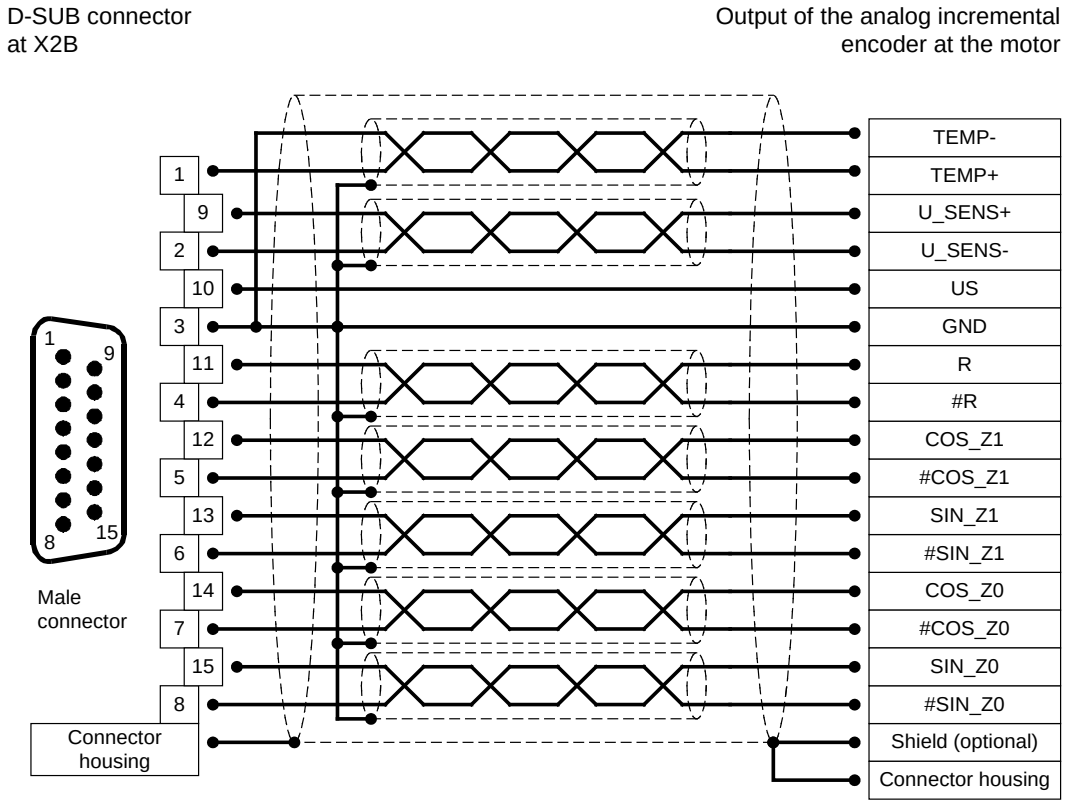


Figure 37: Pin assignment: Analogue incremental encoder - optional [X2B]

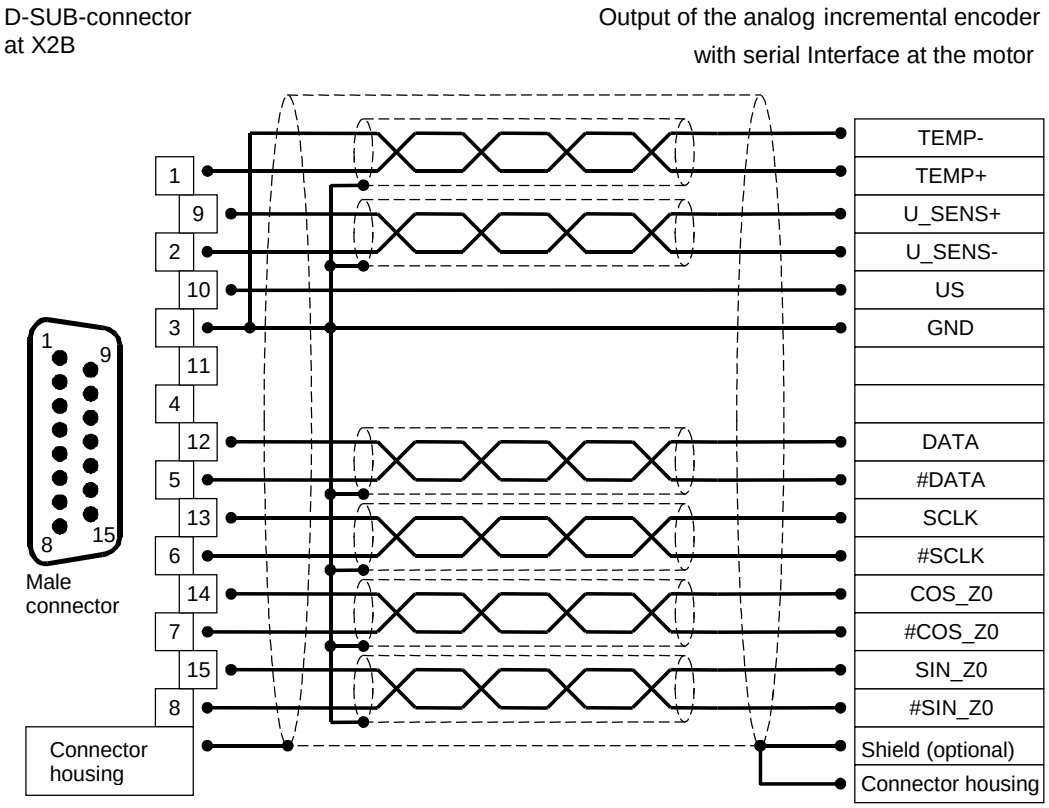


Figure 38: Pin assignment: Incremental encoder with serial interface (for example EnDat, HIPERFACE®) - optional [X2B]

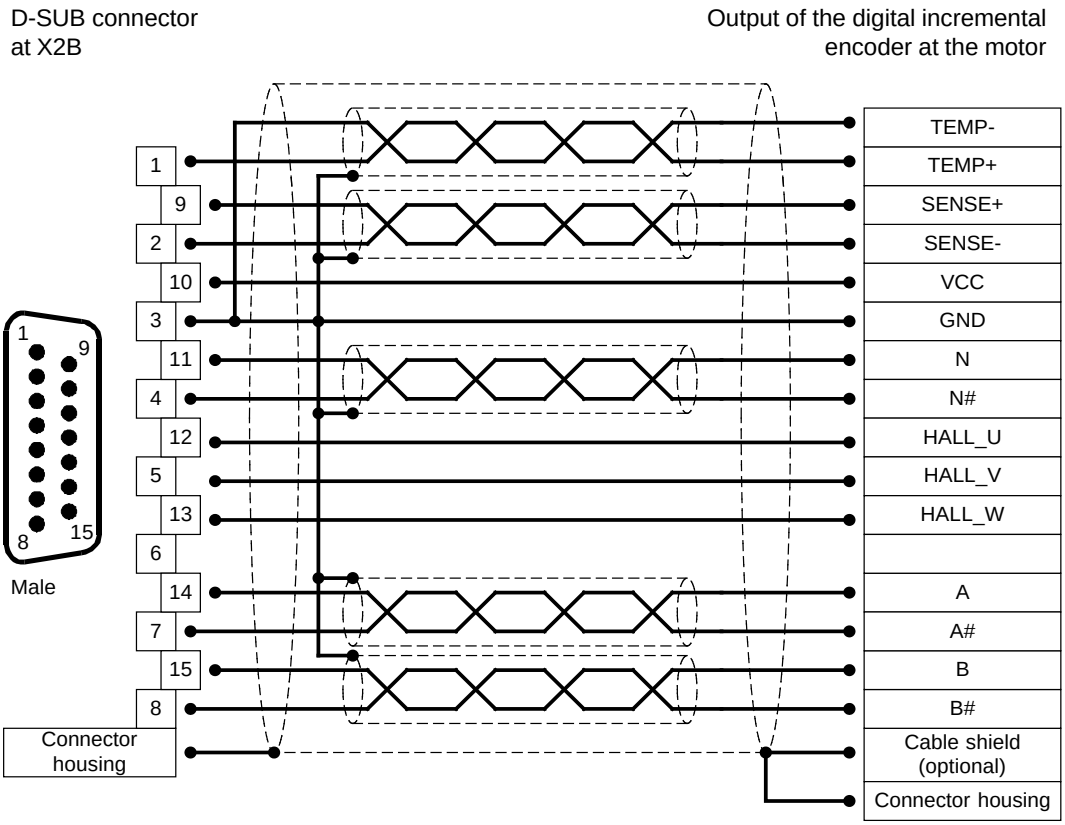


Figure 39: Pin assignment: Digital incremental encoder - optional [X2B]

8.11 Connection: Incremental encoder input [X10]

8.11.1 Configuration on the device [X10]

- D-SUB connector, 9-pin type, female

8.11.2 Counter plug [X10]

- D-SUB connector, 9-pin type, male
- Housing for 9-pin D-SUB connector with bolting screws of type 4/40 UNC

8.11.3 Pin assignment [X10]

Table 41: Pin assignment: Incremental encoder input [X10]

Pin no.		Name	Values	Specification
1		A / CLK	5V / $R_I \approx 120\Omega$	Incremental encoder signal A / Stepper motor signal CLK Positive polarity in accordance with RS422
	6	A# / CLK#	5V / $R_I \approx 120\Omega$	Incremental encoder signal A# / Stepper motor signal CLK Negative polarity in accordance with RS422
2		B / DIR	5V / $R_I \approx 120\Omega$	Incremental encoder signal B / Stepper motor signal DIR Positive polarity in accordance with RS422
	7	B# / DIR#	5V / $R_I \approx 120\Omega$	Incremental encoder signal B# / Stepper motor signal DIR Negative polarity in accordance with RS422
3		N	5V / $R_I \approx 120\Omega$	Incremental encoder reset pulse N Positive polarity in accordance with RS422
	8	N#	5V / $R_I \approx 120\Omega$	Incremental encoder reset pulse N# Negative polarity in accordance with RS422
4		GND	-	Reference GND for the encoder
	9	GND	-	Shield for the connecting cable
5		VCC	+5V±5% 100mA	Auxiliary supply(short circuit-proof), can be loaded with 100mA maximum

8.11.4 Cable type and configuration [X10]

We recommend using encoder connection cables in which the incremental encoder signals are twisted in pairs and the individual pairs are shielded.

8.11.5 Connection notes [X10]

Input [X10] can be used to process incremental encoder signals and pulse direction signals like the ones generated by control cards for stepper motors.

The input amplifier at the signal input is designed to process differential signals in accordance with the RS422 interface standard. It may also be possible to process other signals and levels (for example 5V single-ended or $24V_{HTL}$ from a PLC). Please contact your distributor.

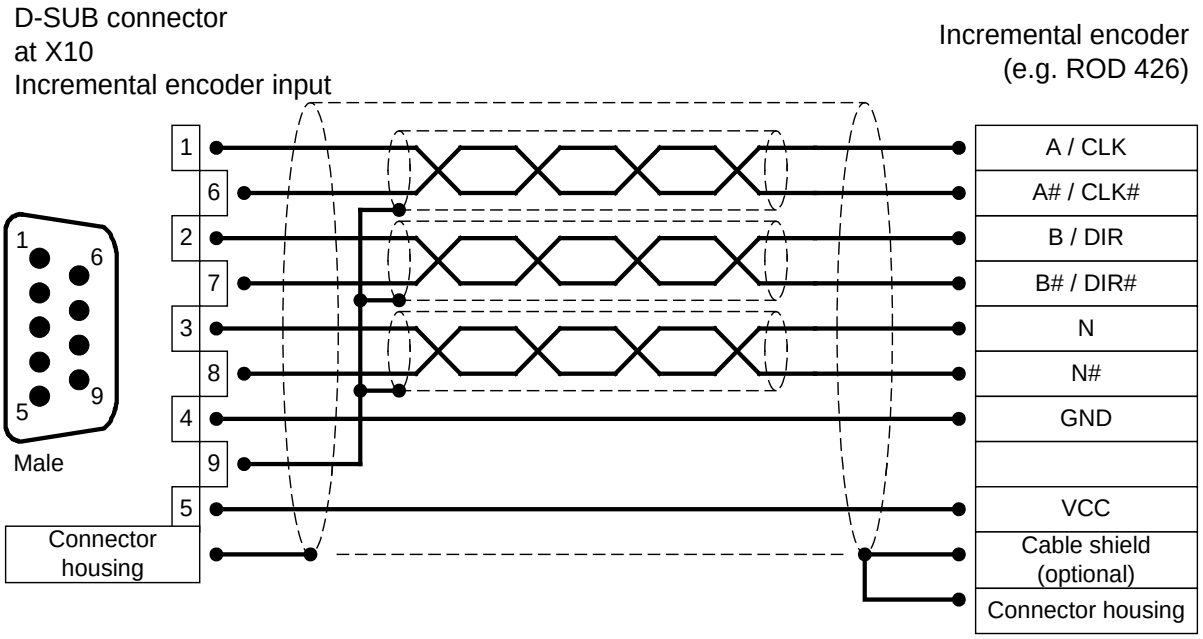


Figure 40: Pin assignment: Input of the incremental encoder [X10]

8.12 Connection: Incremental encoder output [X11]

8.12.1 Configuration on the device [X11]

- D-SUB connector, 9-pin type, female

8.12.2 Counter plug [X11]

- D-SUB connector, 9-pin type, male
- Housing for 9-pin D-SUB connector with bolting screws of type 4/40 UNC

8.12.3 Pin assignment [X11]

Table 42: Pin assignment: Incremental encoder output [X11]

Pin no.		Name	Values	Specification
1		A	5V / $R_A \approx 66\Omega$ *)	Incremental encoder signal A
	6	A#	5V / $R_A \approx 66\Omega$ *)	Incremental encoder signal A#
2		B	5V / $R_A \approx 66\Omega$ *)	Incremental encoder signal B
	7	B#	5V / $R_A \approx 66\Omega$ *)	Incremental encoder signal B#
3		N	5V / $R_A \approx 66\Omega$ *)	Incremental encoder reset pulse N
	8	N#	5V / $R_A \approx 66\Omega$ *)	Incremental encoder reset pulse N#
4		GND	-	Reference GND for the encoder
	9	GND	-	Shield for the connecting cable
5		VCC	+5V ±5% 100mA	Auxiliary supply, can be loaded with 100mA maximum, but short-circuit-proof !

*) The value for R_A stands for the differential output resistance.

8.12.4 Cable type and configuration [X11]

We recommend using encoder connection cables in which the incremental encoder signals are twisted in pairs and the individual pairs are shielded.

8.12.5 Connection notes [X11]

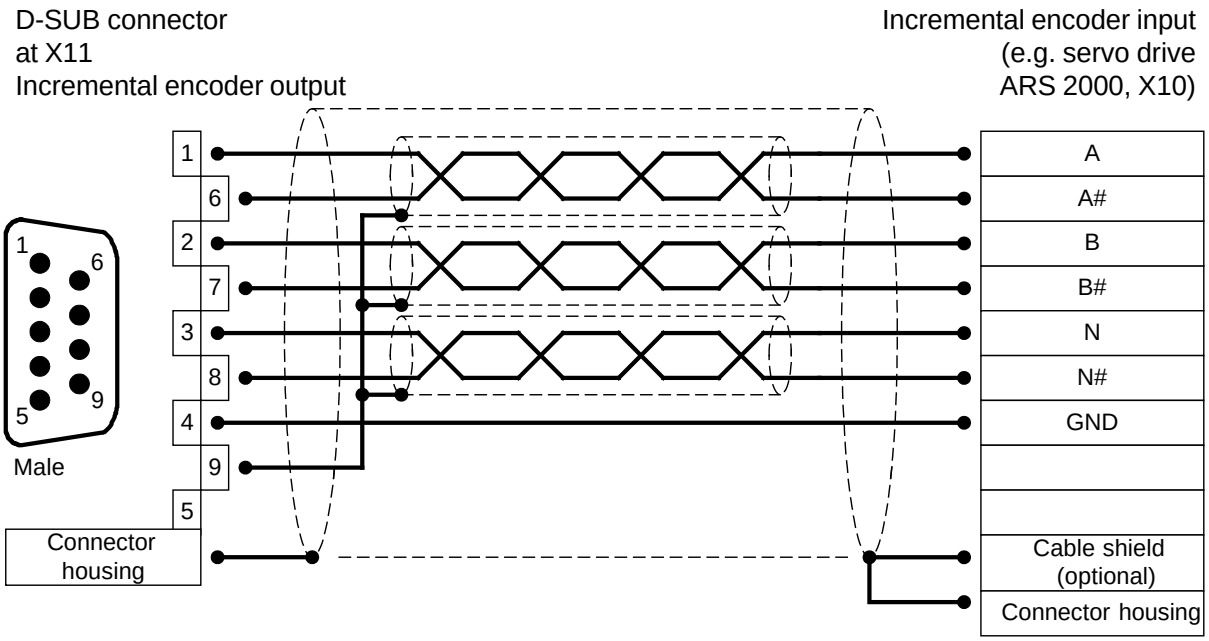


Figure 41: Pin assignment: Incremental encoder output [X11]

The output driver at the signal output supplies differential signals (5V) in accordance with the RS422 interface standard.

Up to 32 additional servo drives can be controlled by one device.

8.13 Connection: CAN bus [X4]

8.13.1 Configuration on the device [X4]

- D-SUB connector, 9-pin type, male

8.13.2 Counter plug [X4]

- D-SUB connector, 9-pin type, female
- Housing for 9-pin D-SUB connector with bolting screws of type 4/40 UNC

8.13.3 Pin assignment [X4]

Table 43: Pin assignment: CAN bus [X4]

Pin no.		Name	Values	Specification
1		-	-	Not used
	6	GND	0V	CAN-GND, galvanically connected to GND in the servo drive
2		CANL	*)	CAN low signal line
	7	CANH	*)	CAN high signal line
3		GND	0V	See pin no. 6
	8	-	-	Not used
4		-	-	Not used
	9	-	-	Not used
5		Schirm	PE	Connection for cable shield

*) An external terminating resistor of 120Ω is required on both bus ends. We recommend using metal film resistors with a 5% tolerance of type 0207, for example made by BCC, part no.: 232215621201.

8.13.4 Cable type and configuration [X4]

The cable names given refer to cables made by Lapp. They have proven to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

Technical specification of the CAN bus cable: 2 pairs of 2 twisted cores, d ≥ 0.22 mm^2, shielded, loop resistance < 0.2 Ω/m, characteristic impedance 100-120 Ω.

- LAPP KABEL UNITRONIC BUS CAN; 2 x 2 x 0,22; ∅ 7.6 mm, with Cu shielding

For highly flexible applications:

- LAPP KABEL UNITRONIC BUS-FD P CAN UL/CSA; 2 x 2 x 0,25; ∅ 8.4 mm, with Cu shielding

8.13.5 Connection notes [X4]

Caution!

When cabling the servo drive via the CAN bus, make sure to observe the following information and notes in order to set up a stable and interference-free system. Improper cabling may cause the CAN bus to malfunction which in turn can cause the servo drive to shut down with an error due to safety reasons.

The CAN bus provides an easy and fail-safe way of interconnecting all components of a system. This requires, however, compliance with the following notes on cabling.

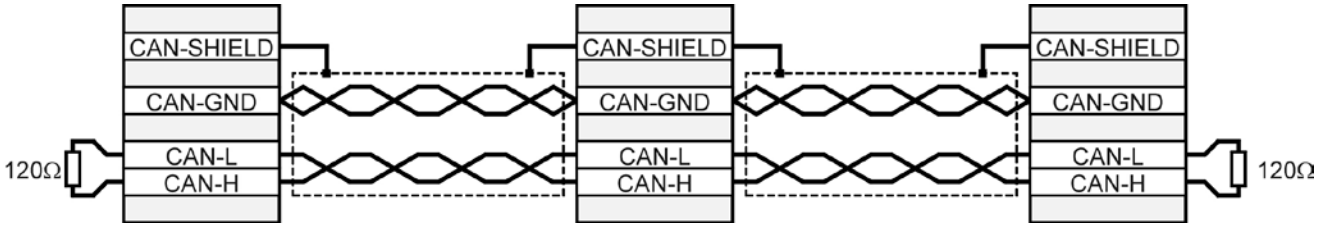


Figure 42: CAN bus cabling example

- The individual nodes of the network are always connected in line so that the CAN cable is looped through from servo drive to servo drive (see *Figure 42*).
- A terminating resistor of 120Ω/-5% has to be present on both ends of the CAN bus cable. CAN boards or PLCs often come supplied with such a terminating resistor which has to be taken into consideration accordingly.
- **Shielded** cables with exactly two **twisted** pairs must be used for cabling.
- Use a twisted pair to connect CAN-H and CAN-L.
- The cores of the other pair are used **jointly** for CAN-GND.
- The shield of the cable is led to the CAN shield connections for all nodes.
- For suitable cables and cables recommended by Metronix please refer to *chapter 8.13.4 Cable type and configuration [X4]*.
- We advise against the use of plug adapters for cabling the CAN bus. Should this be necessary nonetheless, make sure to use metal connector housings to connect the cable shield.
- In order to keep interferences as low as possible, make sure that
  - motor cables are not laid parallel to signal lines.
  - motor cables comply with Metronix specifications.
  - motor cables are properly shielded and grounded.
- For further information on interference-free CAN bus cabling, please refer to the Controller Area Network protocol specification, version 2.0, by Robert Bosch GmbH, 1991.

8.14 Connection: RS232/COM [X5]

8.14.1 Configuration on the device [X5]

- D-SUB connector, 9-pin type, male

8.14.2 Counter plug [X5]

- D-SUB connector, 9-pin type, female
- Housing for 9-pin D-SUB connector with bolting screws of type 4/40 UNC

8.14.3 Pin assignment [X5]

Table 44: Pin assignment: RS232 interface [X5]

Pin no.		Name	Values	Specification
1		-	-	Not used
	6	-	-	Not used
2		RxD	10 V / R_I > 2kΩ	Reception line, RS232 specification
	7	-	-	Not used
3		TxD	10 V / R_A < 2kΩ	Transmission line, RS232 specification
	8	-	-	Not used
4		+RS485	-	reserved for optional RS485 use
	9	-RS485	-	reserved for optional RS485 use t
5		GND	0V	Interface GND, galvanically connected to GND of the digital section

8.14.4 Cable type and configuration [X5]

Interface cable for serial interface (null modem), 3 cores.

8.14.5 Connection notes [X5]

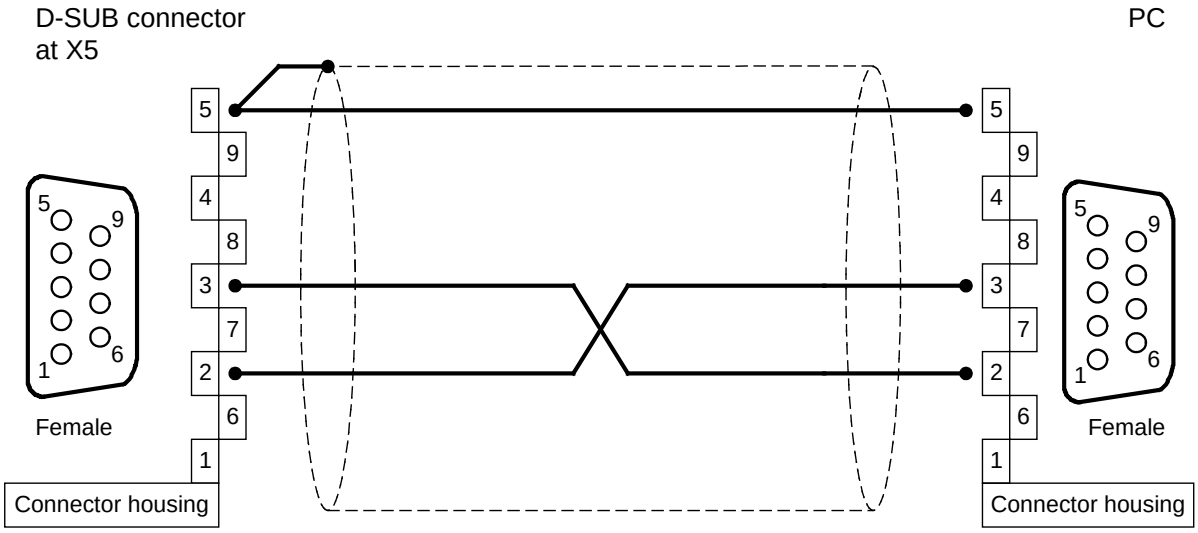


Figure 43: Pin assignment: RS232 null modem cable [X5]

8.15 Notes concerning safe and EMC-compliant installation

8.15.1 Definitions and terminology

Electromagnetic compatibility (EMC) or electromagnetic interference (EMI) includes the following requirements:

- Sufficient **immunity** of an electrical installation or an electrical device against external electrical, magnetic or electromagnetic interferences via cables or the environment.
- Sufficiently small **unwanted emission** of electrical, magnetic or electromagnetic interference of an electrical installation or an electrical device to other devices in the vicinity via cables or through the environment.

8.15.2 General information concerning EMC

The interference emission and interference immunity of a device always depend on the overall drive concept consisting of the following components:

- Power supply
- Servo drive
- Motor
- Electromechanical system
- Configuration and type of wiring
- Superimposed control system

In order to increase interference immunity and to decrease interference emissions the servo drive ARS 2300 already comprises output chokes and mains filters, so that it can be operated without additional shielding and filtering devices in most applications.

The servo drives ARS 2300 are certified as per the product standard EN 61800-3 for electrical drive systems.

In most cases no external filtering is required (see below).

The conformity certificate for EMC directive 2004/108/EC is available from the manufacturer.

Caution!

This product can cause high-frequency interference in residential areas, which could require measures for radio interference suppression.

8.15.3 EMC areas: first and second environment

Proper installation and wiring of all connecting cables provided, the ARS 2300 servo drives fulfil the requirements of product standard EN 61800-3. This standard no longer refers to “classes”, but to so-called environments. The first environment includes mains supply networks supplying residential buildings. The second environment includes mains supply networks exclusively supplying industrial buildings.

The following applies to the ARS 2300 servo drives without external filter measures:

Table 45: EMC requirements: First and second environment

EMC type	Environment	Compliance with EMC requirements
Interference emission	First environment (domestic environment), C2	Motor cable length up to 15m if C' ≤ 200 pF
	Second environment (industrial environment), C3	Motor cable length up to 50m if C' ≤ 200 pF
Interference immunity	First environment (domestic environment)	Independent of motor cable length
	Second environment (industrial environment)	

8.15.4 EMC-compliant cabling

The following information has to be complied with for an EMC-compliant set-up of the drive system (see also *chapter* 8 *Electrical installation, page 89*):

- In order to keep leakage currents and losses in the motor connecting cable as small as possible, the ARS 2300 servo drive should be located as close to the motor as possible (see also *chapter 8.15.5 Operation with long motor cables, page 130*).
- The motor cable and the angle encoder cable have to be shielded.
- The shield of the motor cable has to be connected to the housing of the ARS 2300 servo drive (shield connection terminals). The cable shield also has to be connected to the associated servo drive so that the leakage currents can flow back into the servo drive causing the leakage.
- The mains-end PE connection has to be connected to the PE connection point of supply connector [X9].
- The inner PE conductor of the motor cable has to be connected to the PE connection point of motor connector [X6].
- The signal lines must be as far away from the power cables as possible. They should not be laid in parallel. If intersections cannot be avoided, they should be perpendicular (that is at a 90° angle) if possible.
- Unshielded signal and control lines should not be used. If their use is inevitable, they should at least be twisted.

- ❖ Even shielded cables have short unshielded ends (unless shielded connector housings are used). In general, the following applies:
  - ➢ Connect the inner shields to the associated pins of the connectors. Maximum length: 40 mm.
  - ➢ Maximum length of unshielded cores: 35 mm.
- ❖ The following applies to the motor cable:
  - ➢ Strip the motor cable as shown in *Figure 44*:

1. Strip 30 mm of the insulation of the motor cable 240 mm away from the end of the cable.
2. Strip 140 mm of the insulation of the motor cable at the end of the cable.
3. Remove 140 mm of the outer motor cable shield of the insulated cable.
4. Shorten the cables for the motor phases and the protective ground conductor of the motor to 90 mm.
   - ➢ Connect the outer stripped motor cable shield (30 mm long) on the servo drive flat to the motor shield terminal.
   - ➢ Connect the motor temperature sensor, the holding brake and the inner shields to connector [X6A].
   - ➢ Connect the motor phase and the protective ground conductor of the motor to connector [X6].
   - ➢ Connect the shield on the motor side flat to the connector or motor housing. Maximum length: 40 mm.

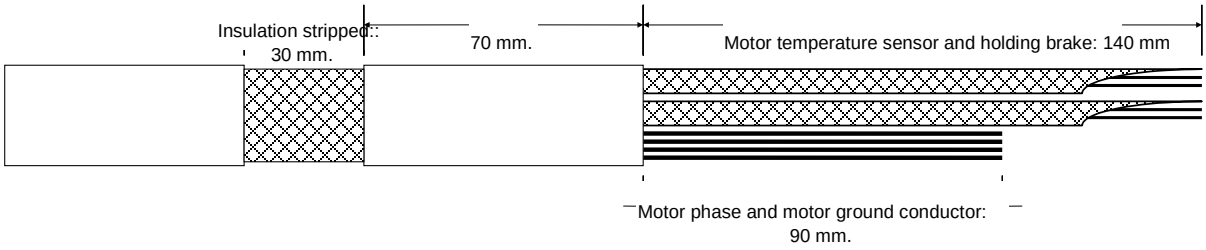


Figure 44: Motor cable: Lengths of shields and cables

DANGER!

For reasons of safety, all PE ground connectors must be connected prior to start-up.

The regulations of EN 61800-5-1 concerning protective grounding must be complied with during installation!

8.15.5 Operation with long motor cables

If certain applications require long motor cables and/or if incorrect motor cables with inadmissibly high cable capacities are used, the filters may be thermally overloaded. To avoid these problems, we recommend the following for applications requiring long motor cables:

- As of a cable length of more than 50 m, only use cables with less than 150 pF/m (capacitance per unit length) between the motor phase and the shield!
  (Please contact your motor cable supplier if necessary)

8.15.6 ESD protection

Caution!

Unused D-Sub connectors may cause damage to the device or other components of the system due to ESD (electrostatic discharge).

To prevent such discharge, protective caps are available from specialized suppliers (for example Spoerle).

The ARS 2300 servo drive has been designed to provide high interference immunity. For this reason, some function blocks are electrically isolated. Inside the device, signals are transmitted using optocouplers.

The following isolated areas can be distinguished:

- Power module with DC bus and mains input
- Electronic control system with a system processing the analogue signals
- 24VDC supply and digital inputs and outputs

9 Initial operation

9.1 General notes on connection

Since the laying of the connecting cables is very important for EMC, make sure to comply with the information given in *chapter 8.15.4 EMC-compliant cabling (page 128)*!

DANGER !

Non-compliance with the information given in *chapter 2 Safety notes for electrical drives and controllers (page 18)* may result in property damage, injury, electric shock and in extreme cases in death.

9.2 Tools / material

- Screwdriver for slotted-head screws, size 1
- Serial interface cable
- Rotary angle encoder cable
- Motor cable
- Power supply cable
- Operator panel ARS 2000 or control

9.3 Connecting the motor

- Plug the connector of the motor cable into the matching socket of the motor and tighten it.
- Plug the PHOENIX connector into socket **[X6]** of the servo drive and make sure that the PE line of the motor is connected to **PE** of the motor connector **[X6] PIN 4**.
- Plug the connector of the encoder cable into the encoder output socket of the motor and tighten it.
- Plug the D-Sub connector into socket **[X2A] Resolver** or **[X2B] Encoder** of the servo drive and tighten the bolting screws.
- Apply the shield of the motor over a large contact area.
- Check all connections again.

9.4 Connecting the ARS 2300 servo drive to the power supply

- ❖ Make sure that the power supply has been switched off.
- ❖ Plug the PHOENIX connector into socket **[X6]** of the servo drive and make sure that the PE line of the motor is connected to **PE** of the motor connector **[X6] PIN 4**.
- ❖ Plug the PHOENIX connector into socket **[X3]** of the servo drive.
- ❖ Connect the 24VDC connectors to a suitable power supply unit (via connector [X3]).
- ❖ Make the mains supply connections.
- ❖ Check all connections again.

9.5 Connecting the PC (serial interface)

- ❖ Plug the D-Sub connector of the serial interface cable into the socket for the serial interface of the PC and fasten the bolting screws.
- ❖ Plug the D-Sub connector of the serial interface cable into the socket **[X5] RS232/COM** of the servo drive ARS 2300 and fasten the bolting screws.
- ❖ Check all connections again.

9.6 Checking operability

1. Make sure that the controller enabling switch is turned off.
2. Switch on the power supply of all devices. The READY LED on the front panel of the servo drive should light up.

If the READY LED does not light green, there is a malfunction. If the seven-segment display indicates a number sequence, this number sequence is an error message. You have to eliminate the cause of this error message. In this case, please continue with *chapter 10.2 Operating mode and error messages (page 136).* If no display lights up on the device, proceed as follows:

3. Switch off the power supply.
4. Wait for 5 minutes so that the DC bus can discharge.
5. Check all connecting cables.
6. Check whether the 24VDC power supply operates correctly.
7. Switch on the power supply.

10 Service functions and error messages

10.1 Protection and service functions

10.1.1 Overview

The ARS 2300 servo drive has an extensive sensor system monitoring the operation of the controller unit, power output stage, motor and communication with the outside world. Any occurring errors are stored in an internal error memory. Most errors will cause the controller unit to shut down the servo drive and the power output stage. They can only be switched on again after the error memory has been deleted by acknowledging the error and after the error has been eliminated or ceased to exist.

An extensive sensor system and numerous monitoring functions ensure operational safety:

- Motor temperature measurement and monitoring
- Power module temperature measurement
- Detection of ground faults (PE)
- Detection of connections between two motor phases
- Detection of supply phase failure
- Detection of supply mains failure
- Detection of overvoltage in the DC bus
- Detection of errors concerning the internal voltage supply
- Breakdown of the supply voltage

If the 24 V DC supply voltage fails, approx. 20 ms remain to save parameters and shut down the control properly for example.

10.1.2 Phase and mains failure detection

In three-phase operation, the ARS 2300 servo drive detects failure of one phase (phase failure detection) or of several phases (mains failure detection) of the mains supply of the device.

10.1.3 Overcurrent and short-circuit monitoring

The overcurrent and short-circuit monitoring system responds as soon as the current in the DC bus exceeds three times the maximum current of the servo drive. It detects short-circuits between two motor phases and short-circuits at the motor output terminals against the positive and negative reference potential of the DC bus and against PE. If the error monitoring system detects an overcurrent, the power output stage will be shut down immediately to guarantee resistance against short-circuits.

10.1.4 Overvoltage monitoring of the DC bus

The overvoltage monitoring system of the DC bus responds as soon as the DC bus voltage exceeds the operating voltage range. As a result, the power output stage will be shut down.

10.1.5 Temperature monitoring of the heat sink

The heat sink temperature of the power output stage is measured using a linear temperature sensor. The temperature limit varies from device to device. About 5°C below the limit, a temperature warning is issued.

10.1.6 Motor monitoring

The ARS 2300 servo drive has the following protective functions to monitor the motor and the connected rotary encoder.

Monitoring of the rotary encoder: An error in the rotary encoder shuts down the power output stage. In the case of resolvers, the trace signal is measured, for example. In the case of incremental encoders, the commutation signals are checked. Other “intelligent” encoders have other means of error detection.

Motor temperature measurement and monitoring: The ARS 2300 servo drive has one digital and one analogue input for detecting and monitoring the motor temperature. Due to the analogue signal detection, also non-linear sensors are supported. The following inputs for temperature sensors can be selected.

- At [X6A]: Digital input for PTCs, normally closed contacts and normally open contacts.
- At [X2A] and [X2B]: Normally closed contacts and analogue sensors of the KTY range. Other sensors (NTC, PTC) require corresponding software adaptations.

10.1.7 I²t monitoring

The ARS 2300 servo drive has an I²t monitoring system to limit the average power loss in the power output stage and in the motor. Since the power loss in the electronic power system and in the motor increases in a square manner with the current in the worst case, the squared current value is taken as the measure for the power loss.

10.1.8 Power monitoring of the internal brake chopper

The firmware includes an “I²t brake chopper” power monitoring system for the internal braking resistor.

When the “I²t brake chopper” power monitoring system reaches a value of 100%, the power of the internal braking resistor is reset to nominal power.

10.1.9 Start-up status

Servo drives, which are sent to Metronix for service, will be equipped with a different firmware and different parameters for testing purposes.

Before the ARS 2300 servo drive is re-used for the first time at the end user, it has to be re-parameterized. The Metronix ServoCommander™ parameterization software inquires the start-up status and asks the user to parameterize the servo drive. At the same time, the device displays an “A” on the seven-segment display to indicate that it is ready for operation but not parameterized.

10.1.10 Operating hours meter

An operating hours meter is implemented, which has been designed for at least 200 000 operating hours. The operating hours meter is displayed in the parameterisation software Metronix ServoCommander™.

10.1.11 Rapid discharge of the DC bus

If the system detects a failure of the mains supply, the DC bus is rapidly discharged within the safety period in accordance with EN 60204-1.

Delayed activation of the brake chopper according to power classes in the case of parallel operation and mains supply failure ensures that the main energy during rapid discharge of the DC bus is taken over through the braking resistors of the higher power classes.

10.2 Operating mode and error messages

10.2.1 Operating mode and error display

The system supports a seven-segment display. The following table describes the display and the meaning of the symbols shown:

Table 46: Operating mode and error display

Display	Meaning
 	In the operation mode speed control the outer bars “rotate”, depending on the actual speed resp. the actual position of the rotor. If the drive is enabled, the center bar of the seven-segment display is on, too.
	The servo drive ARS 2000 still has to be parameterised (seven-segment display = “A”).
	Operating mode torque control, the two bars on the left hand of the display are on (seven-segment display = “I”).
P xxx	Positioning, “xxx” stands for the position number. The numbers are successively indicated.
PH x	Homing (“x” stands for the currently active phase of the homing run). 0 : Search phase 1 : Crawling phase 2 : Positioning to zero position The numbers are successively indicated.
E xxy	Error message with index “xx” and subindex “y”. The numbers are successively indicated.
-xxy-	Warning message with Index “xx” and subindex “y”. A warning is displayed at least twice on the seven-segment-display. The numbers are successively indicated.
	Option “Safe Torque-Off (STO)” active for the ARS 2000 devices. (seven-segment display = “H”, blinking with a frequency of 2Hz)

10.2.2 Error messages

If an error occurs, the servo drive ARS 2300 will cyclically show an error message in its seven-segment display. The error message is comprised of an E (for Error), a main index (xx) and a sub index (y), for example: **E 0 1 0**.

Warnings have the same code numbers as error messages. As a distinguishing feature, warnings have a centre bar before and after the number, for example **- 1 7 0 -**.

The following *Table 47: Error messages* summarizes the meaning of the messages and the corresponding measures.

The error messages with the main index 00 do not reflect run time errors. They contain information and in general there are no measures required by the user. They occur in the error buffer only but will not be shown on the 7-segment display.

Table 47: Error messages

Error message		**Meaning of the error message**	**Measures**
Main index	**Sub index**		
00	0	Invalid error	Information: An invalid (corrupted) entry in the error buffer is marked by this error number. No measures required
	1	Invalid error detected and corrected	Information: An invalid (corrupted) error entry was detected and corrected. The Debug information stores the initially found error number. No measures required
	2	Error cleared	Information: The active errors have been cleared. No measures required
	4	Serial number/device type changed (change of modules)	Information: A flexible error buffer (service memory module) has been plugged into another device. No measures required
01	0	Stack overflow	Incorrect firmware? If necessary, reload the standard firmware again. Contact the Technical Support
02	0	Undervoltage of DC-bus	Error reaction set too high? Check power supply. Check (measure) the intermediate circuit voltage Check threshold limit of the DC bus Monitoring

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
03	0	Overtemperature analogue motor	Motor too hot? Check the parameterization (current controller, current limitation). Suitable sensor? Sensor defective? Check the parameterization of the sensor or the sensor characteristic curve. Error also occurs if sensor is bypassed: device defective. Please, send the servo drive to our sales partner.
	1	Overtemperature digital motor	
	2	Overtemperature motor analogue: Wire break	Check cables of temperature sensor (broken wire). Check the parameterization of wire break monitoring (threshold value).
	3	Overtemperature motor analogue: Short circuit	Check cables of temperature sensor (short circuit). Check the parameterization of short circuit monitoring (threshold value).
04	0	Overtemperature of the power stage	Plausible temperature display? Check the installation conditions, filter mats of fan dirty? Device fan defective?
	1	Overtemperature in the DC-bus	
05	0	Internal undervoltage supply 1	Disconnect the device from the entire periphery and check whether the error persists after a reset. If the error persists, please send the servo drive to our sales partner.
	1	Internal undervoltage supply 2	
	2	Driver voltage failure	
	3	Undervoltage dig. I/O	Check the outputs for short-circuits or specific load. If necessary, contact the Technical Support.
	4	Overcurrent dig. I/O	
06	0	Short circuit in the power stage	Motor defective? Short-circuit in cable? Power stage defective?
	1	Overcurrent brake chopper	Check the external brake resistor: Short circuit or resistance value too low? Check braking chopper output of the device.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
07	0	Overvoltage in the DC-bus	Check connection to braking resistor (internal / external). External braking resistor overloaded? Check rating.
08	0	Angle encoder error resolver	See measures 08-2 .. 08-8.
	1	Sense of rotation of the serial and incremental position evaluation is not identical	A and B-track are mixed up? Correct (check) the connection of the tracks.
	2	Error of track signals Z0 Incremental encoder	Angle encoder connected? Angle encoder cable defective? Angle encoder defective? Check the configuration of the angle encoder interface. The encoder signals are disturbed: check the installation for compliance with EMC recommendations
	3	Error of track signals Z1 Incremental encoder	
	4	Error of track signals of digital incremental encoder	
	5	Error of Hall signals incremental encoder	
	6	Communication error encoder	
	7	Signal amplitude incremental track erroneous	
	8	Internal encoder error	Internal monitoring of the angle encoder at [X2B] has identified an error. Communication error? Check the encoder type, contact the Technical Support if necessary.
	9	Encoder at X2B not supported	Please contact the Technical Support
09	0	Old encoder parameter set (type ARS)	Save data into the encoder EEPROM (new format)
	1	Encoder parameter set cannot be decoded	Encoder defect? Check encoder interface configuration. The encoder signals are disturbed. Check the installation for compliance with EMC recommendations
	2	Unknown encoder parameter set version	Save the data into the encoder again.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	3	Corrupted data structure in encoder parameter set	If necessary, determine the data once more and save it into the encoder again.
	4	EEPROM data: Erroneous customer specific configuration	Motor repaired: perform a homing run and save to the angle encoder, and then save to the basic device. Motor replaced: parameterise the basic device, perform a homing run, save to the angle encoder and then save to the basic device.
	7	Write protected EEPROM angle encoder	Please contact the Technical Support.
	9	EEPROM angle encoder too small	
10	0	Overspeed (motor overspeed protection)	Encoder offset angle correct? Overspeed protection limit too small?
11	0	Error at start of homing run	No servo drive enabling.
	1	Error during homing run	Homing has been interrupted for example by disabling the servo drive.
	2	Homing run: No valid index pulse	The required index pulse is missing.
	3	Homing run: timeout	The maximum time parameterized for homing has been consummated before the homing run has been completed. Please check the time parameterisation.
	4	Homing run : Wrong or invalid limit switch	The associated limit switch is not connected. Limit switches mixed up? Move the limit switch so that it is not located in the area of the index pulse.
	5	Homing run: I^2t / following error	Unsuitable parameterisation of acceleration ramps. Invalid stop reached, for example because no homing switch is connected. Check the connection of a home switch. Contact the Technical Support.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	6	Homing run: End of homing distance	The maximum homing distance has been travelled but the reference point or the destination of the homing run have not been reached.
12	0	CAN: Two nodes with the same ID	Check the configuration of the devices connected to the CAN bus.
	1	CAN: Communication error / bus OFF	Check the cabling (compliance with the cable specification, cable break, maximum cable length exceeded, correct terminating resistors, cable shield grounded, all signals applied?). Replace the device. If the error could be eliminated by replacing the device, please send the replaced device to our sales partner.
	2	CAN: Communication error on send	Check the cabling (compliance with the cable specification, cable break, maximum cable length exceeded, correct terminating resistors, cable shield grounded, all signals applied?). Check the start sequence of the application. Replace the device. If the error could be eliminated by replacing the device, please send the replaced device to our sales partner.
	3	CAN: Communication error on receive	
	4	CAN: Node Guarding	Equalize the cycle time of the remote frames with the PLC resp. failure of the PLC. Signals interfered?
	5	CAN: RPDO too short	Check the configuration.
	9	CAN: Protocol error	Check the command syntax of the control (record the data traffic). Please contact the Technical Support.
13	0	Timeout CAN-Bus	Check CAN parameterisation.
14	0	Insufficient supply for identification	Check the power supply. Check the motor resistor.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	1	Identification current controller: Measurement cycle insufficient	The automatic parameter identification process delivers a time constant beyond the parameterisation value range. The parameters must be optimized manually.
	2	Power stage could not be enabled	The power stage has not been enabled, check the connection of DIN 4.
	3	Power stage prematurely disabled	The power stage has been disabled while the identification process was running (for example via DIN 4).
	4	Identification does not support selected resolver	The identification cannot be performed with the present angle encoder settings. Check the configuration of the angle encoder. If necessary, contact the Technical Support.
	5	No index pulse detected	The index pulse could not be found after the maximum number of electrical rotations. Check the index pulse signal. Check the angle encoder settings.
	6	Invalid hall signals	Check the connection. Check the data sheet as to whether the encoder provides 3 Hall signals with 120° or 60° segments. If necessary, contact the Technical Support.
	7	Identification not possible	Check the DC bus circuit voltage. Check the wiring of the motor/encoder system. Motor blocked (for example holding brake not released)?
	8	Invalid number of pole pairs	The number of pole pairs calculated is beyond the parameterisation range. Check the motor data sheet. If necessary, contact the Technical Support
15	0	Division by zero	Please contact the Technical Support.
	1	Out of range error	
	2	Mathematical underflow	
16	0	Erroneous program execution	Please contact the Technical Support.
	1	Illegal interrupt	

Error message		Meaning of the error message	Measures
Main index	Sub index		
	2	Initialization error	
	3	Unexpected state	
17	0	Max. following error exceeded	Increase error window. Acceleration parameterization too large.
	1	Encoder difference control	Check the connection of the encoders. Check the parameterized gear.
18	0	Warning level analogue motor temperature	Motor too hot? Check the parameterization (current controller, current limitation). Suitable sensor? Sensor defective? Check the parameterisation of the sensor and sensor characteristic. Error also occurs if sensor is bypassed: device defective. Please, send the servo drive to our sales partner.
21	0	Error 1 current measurement V	Please contact the Technical Support.
	1	Error 2 current measurement U	
	2	Error 2 current measurement V	
	3	Error 1 current measurement V	
22	0	PROFIBUS: Wrong initialization	Technology module defective? Replace the technology module. Contact the Technical Support
	1	PROFIBUS: reserved	Please contact the Technical Support.
	2	PROFIBUS: Communication error	Check the slave address. Check the bus terminators. Check the cabling.
	3	PROFIBUS: Invalid slave address	Incorrect slave address. Please select another slave address.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	4	PROFIBUS: Range overflow	Mathematical error during the conversion of physical units. The value range of the data and of the physical units do not match (fieldbus display units). Contact the Technical Support.
25	0	Invalid device type	Please send the servo drive to our sales partner.
	1	Device type not supported	
	2	HW revision not supported	Check the firmware version. If necessary, request an update from the Technical Support.
	3	Device function restricted	Please send the servo drive to our sales partner.
26	0	No user parameter set	Load the default parameter set. If the error continues to occur, contact the Technical Support.
	1	Checksum error	
	2	Flash: Error during write-operation	Please send the servo drive to our sales partner
	3	Flash: Error during erase-operation	
	4	Flash: Error in internal flash	Re-load the firmware. If the error continues to occur, contact the Technical Support
	5	No calibration data	
	6	Missing user position data sets	Simply perform save & reset. Load the default parameter set. If the error continues to occur, contact the Technical Support.
	7	Faulty data tables (CAM)	Load the default parameter set and commission the servo drive. If necessary, reload parameter set. If the error continues, contact the Technical Support.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
27	0	Following error warning level	Check the parameterisation of the following error. Motor blocked?
28	0	Hours-run meter missing	Acknowledge the error. If the error occurs again, contact the Technical Support.
	1	Hours-run meter: write error	
	2	Hours-run meter corrected	
	3	Hours-run meter converted	
30	0	Internal calculation error	Please contact the Technical Support.
31	0	I^2t motor	Motor blocked? Check the power rating of the drive.
	1	I^2t servo drive	Check the power rating of the drive package.
	2	I^2t-PFC	Check the power rating of the drive package. Select operation without PFC?
	3	I^2t-Break resistor	Braking resistor overloaded. Use external braking resistor?
	4	I^2t real power overload	Reduce the real power of the drive.
32	0	Loading period DC-bus exceeded	Bridge for the internal brake resistor installed? Check the connection of the external brake resistor. If necessary, contact the Technical Support.
	1	Undervoltage for active PFC	Check whether the power supply complies with the nominal data.
	5	Braking chopper overload. Intermediate circuit couldn't be discharged.	Check the ON/OFF cycles.
	6	Discharge period DC-bus exceeded	Bridge for the internal brake resistor installed? Check the connection of the external brake resistor. If necessary, contact the Technical Support.
	7	Failure of power supply for servo drive enable	No intermediate circuit voltage? Check the power supply. If necessary, contact the Technical Support.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	8	Supply power breakdown at servo drive enable	Check the power supply.
	9	Phase failure	
33	0	Following error encoder emulation	Check the settings of the incremental encoder emulation (number of lines). If necessary, contact the Technical Support.
34	0	No synchronisation via field bus	Failure of synchronization messages from master?
	1	Field bus synchronisation error	Failure of synchronization messages from master? Parameterization of synchronization interval too small?
35	0	Speed protection of Linear motor	The encoder signals are disturbed. Check the installation for compliance with EMC recommendations.
	5	Error during the determination of the commutation position	For this motor an improper method has been chosen. Please contact the Technical Support.
36	0	Parameter limited	Check user parameter set.
	1	Parameter not accepted	
37	0	sercos: Excessive distortion	Check the sercos wiring (for example clean the optical fibre). Check settings for the luminous power. Check the baud rate.
	1	sercos: Ring not closed	Check the sercos wiring (optical fibre) for breaks. Check the connections.
	2	sercos: MST missing twice	Check the sercos wiring (optical fibre). Check the control system (are all of the MSTs being transmitted?)
	3	sercos: Illegal phase requested by master	Check the program in the sercos master

Error message		Meaning of the error message	Measures
Main index	Sub index		
	4	sercos: MDT missing twice	Check the sercos wiring (optical fibre). Check the control system (are all of the MDTs being transmitted?)
	5	sercos: Unknown operation mode selected	Check the settings for the operating modes in IDN S-0-0032 to S-0-0035
	6	sercos: T3 invalid	Increase the baud rate. Shift the point of time T3 manually.
38	0	sercos: SERCON Status event	Technology module defective? Replace the technology module. If necessary, contact the Technical Support.
	1	sercos: No module	Technology module plugged-in correctly? Technology module defective? Replace the technology module. If necessary, contact the Technical Support.
	2	sercos: Defective module	Replace the technology module. If necessary, contact the Technical Support.
	3	sercos: S-0-0127: Invalid data in S-0-0021	Check the configuration (cyclic data for MDT and AT). Time slot calculation by the master.
	4	sercos: S-0-0127: Illegal IDNs in AT or MDT	Check the configuration (cyclic data transfer).
	5	sercos: S-0-0128: invalid data in S-0-0022	Check the weighting settings. Check the operating mode settings. Check the internal/external angle encoder settings.
	6	sercos: S-0-0128: Invalid scaling	Check the weighting settings.
	7	sercos: Invalid IDN in S-0-0026 / S-0-0027	Check the configuration of the signal status and signal control word (S-0-0026 / S-0-0027).
	8	sercos: Error at conversion	Check the weighting settings. If necessary, contact the Technical Support.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	9	sercos: SERCON 410b mode activated	Technology module defective? Replace the technology module.
39	0	sercos: List S-0-0370: Invalid configuration MDT-Data container	Please contact the Technical Support.
	1	sercos: List S-0-0371: Invalid configuration AT-Data container	
	2	sercos: Cyclic channel fault MDT	
	3	sercos: Cyclic channel fault AT	
	4	sercos: Cyclic data container fault MDT	
	5	sercos: Cyclic data container fault AT	
40	0	Negative SW limit switch reached	Check the negative range limit.
	1	Positive SW limit switch reached	Check the positive range limit.
	2	Target position behind the negative SW limit switch	The start of a positioning run was suppressed as the target lies beyond the respective software limit switch. Check the target data. Check the positioning range.
	3	Target position behind the positive SW limit switch	
41	0	Course program: Synchronization error	Check the parameterization. If necessary, contact the Technical Support.
42	0	Positioning: Missing following position: Stop	The positioning target cannot be reached with the current positioning options or the current boundary conditions. Check the positioning parameters.
	1	Positioning: Reversing the direction not allowed: Stop	
	2	Positioning: Reversing the direction after stop not allowed	

Error message		Meaning of the error message	Measures
Main index	Sub index		
	3	Start positioning rejected: wrong mode of operation	The change of the mode of operation could not be performed by the position set.
	4	Start positioning discarded: homing required	Reset the optional parameterisation “homing required”. Perform a new homing run.
	5	Rotary axis: direction of rotation is not allowed	According to the selected mode of the rotary axis the calculated direction of rotation is not allowed. Check the selected mode.
	9	Error at positioning start	Check speed parameters and acceleration
43	0	Limit switch: Negative set point inhibited	The drive has left the intended motion range. Technical defect in the system? Check the limit switches.
	1	Limit switch: Positive set point inhibited	
	2	Limit switch: Positioning suppressed	
44	0	CAM table error	Check whether the index has been assigned correctly. Check whether there are cam plates present in the device.
	1	CAM: drive not referenced	Ensure that the drive has been homed prior to the activation of the cam plate. Delete the “homing necessary” option. Ensure that a cam plate cannot be started during a homing run.
45	0	Supply voltage cannot be switched off	Please contact the Technical Support.
	1	Supply voltage cannot be switched on	
	2	Supply voltage has been activated	
47	0	Error set-up mode: timeout expired	Check the processing of the request by the PLC. Speed threshold too low or timeout too small?

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
50	0	CAN: Too many synchronous PDOs	Deactivate the PDOs or increase the SYNC interval. The maximum number of PDOs must not be greater than the factor tp between the position controller and IPO (menu: Parameters/Controller parameters/Cycle times)
	1	SDO error occurred	Please contact the Technical Support.
60	0	Ethernet user-specific (1)	Please contact the Technical Support.
61	0	Ethernet user-specific (2)	Please contact the Technical Support.
62	0	EtherCAT: General bus error	No EtherCAT bus available. Check the cabling.
	1	EtherCAT: Initialization error	Replace the technology module. If necessary, contact the Technical Support.
	2	EtherCAT: Protocol error	Wrong protocol (no CAN over EtherCAT)? Check the EtherCAT wiring.
	3	EtherCAT: Invalid RPDO length	Check the protocol.
	4	EtherCAT: Invalid TPDO length	Check the RPDO configuration of the servo drive and of the control system.
	5	EtherCAT: Erroneous cyclic communication	Check the EtherCAT wiring. Check the configuration of the master system.
63	0	EtherCAT: Defective module	Technology module defective? Replace the technology module.
	1	EtherCAT: Invalid data	Check the protocol. Check the EtherCAT wiring.
	2	EtherCAT: TPDO data has not been read	Reduce the cycle time (EtherCAT bus).
	3	EtherCAT: No distributed clocks active	Check whether the master supports the “distributed clocks” feature. If necessary, contact the Technical Support.
	4	Missing SYNC message in IPO cycle	Check the cycle times of the servo drive and of the control system.
64	0	DeviceNet: Duplicate MAC ID	Change the MAC ID.
	1	DeviceNet: Bus power lost	Check the DeviceNet wiring.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	2	DeviceNet: RX queue overrun	Reduce the number of messages per time unit during the transmission.
	3	DeviceNet: TX queue overrun	Reduce the number of message per time unit that are to be transmitted.
	4	DeviceNet: IO send error	Please contact the Technical Support.
	5	DeviceNet: Bus Off	Check the DeviceNet wiring.
	6	DeviceNet: CAN controller overrun	Please contact the Technical Support.
65	0	DeviceNet active, but no module	Technology module defective? Replace the technology module.
	1	Timeout I/O connection	Please contact the Technical Support.
80	0	IRQ: Time overflow current control	Please contact the Technical Support.
	1	IRQ: Time overflow speed control	
	2	IRQ: Time overflow position control	
	3	IRQ: Time overflow interpolator	
81	4	IRQ: Time overflow low-level	Please contact the Technical Support.
	5	IRQ: Time overflow MDC	
82	0	Sequence control: General	Normally just information. No measures required.
83	0	Invalid technology module or Technology module: (slot/combination)	Load the correct firmware. Please check the slot. If necessary, contact the Technical Support.
	1	Technology module not supported	Incorrect firmware? Load the correct firmware. If necessary, contact the Technical Support.
	2	Technology module: HW revision not supported	
	3	Service memory module: write error	Please contact the Technical Support.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	4	Technology module: MC2000 watchdog	
90	0	Missing hardware component (SRAM)	Please contact the Technical Support.
	1	Missing hardware component (FLASH)	
	2	Error during booting of FPGA	
	3	Error during start of SD-ADUs	
	4	Synchronisation error SD-ADU after start	
	5	SD-ADU not in synchronism	
	6	IRQ 0 (current controller): Trigger error	
	7	CAN controller not available	
	8	Checksum Error in Device Parameters	
	9	DEBUG-Firmware loaded	
91	0	Internal initialisation error	Please contact the Technical Support.

11 Technology modules

11.1 EA88 interface (terminal extension)

11.1.1 Product description

The EA88 interface can be used in technology slot TECH 1 or TECH 2 of the ARS 2300 servo drive to extend the already existing digital IOs. Up to two EA88 interfaces can be supported simultaneously.

This technology module can be used to actuate up to 8 digital 24V outputs independently. In addition, 8 digital 24V inputs are available.

The EA88 interface has the following characteristics:

- Digital 24V inputs
- Digital 24V outputs which can be activated separately and loaded with 100 mA each
- MicroCombicon pin-and-socket connectors made by PHOENIX
- Pin-and-socket connectors via male multipoint connector in accordance with EN 60603-2
- The inputs and outputs are floating due to the optocouplers
- The inputs and outputs are protected against short circuits and overload

11.1.2 Technical data

11.1.2.1 General data

Table 48: Technical data: EA88 interface

Range	Values
Storage temperature range	-25 °C to +75°C
Operating temperature range / deratings	0°C to 50°C
Atmospheric humidity	0..90%, non-condensing
Altitude	Up to 2000 m above msl
External dimensions (LxWxH):	87mm x 65mm x 19mm; suitable for technology slot TECH 1 and/or TECH 2
Weight:	approx. 50g

11.1.2.2 Digital inputs

8 digital inputs 24V, protected against inverse polarity and short-circuit-proof.

Table 49: Digital inputs: EA88 interface [X21]

Parameter	Values
Input	High level switches the input
Nominal voltage	24 VDC
Voltage range	-30 V...30 V
“High” detection at	U_{In} > 8 V
“Low” detection at	U_{In} < 2 V
Hysteresis	>1V
Input impedance	≥ 4.7 kΩ
Inverse polarity protection	Up to -30V
Switching delay up to port pin (low-high transition)	< 100 µs

11.1.2.3 Digital outputs

8 digital outputs 24V, protected against inverse polarity and short-circuit-proof, protection against thermal overload.

Table 50: Digital outputs: EA88 interface [X22]

Parameter	Values
Switch type	High-side switch
Nominal voltage	24 VDC
Voltage range	18 V...30 V
Output current (nominal)	$I_{L,nominal}$ = 100 mA
Voltage loss at $I_{L,nominal}$	≤ 1 V
Residual current with switch in OFF position	< 100 µA
Protection against short-circuit / overcurrent	> 500mA (approx. value)
Temperature protection	Shut-down if the temperature is too high, T_J > 150°
Supply	Protection in the case of inductive loads and voltage supply via the output, also if the supply is turned off
Loads	R > 220 Ω; L at random; C < 10nF
Switching delay as of port pin	< 100 µs

11.1.3 Pin assignment and cable specifications

11.1.3.1 Power supply

- The admissible input voltage range during operation is 15VDC….32VDC.
- The digital outputs of the EA88 technology module are supplied with voltage exclusively by an external 24VDC power supply. The nominal input voltage for the I/O supply is 24VDC.
- If digital inputs are used, the reference potential GND24V of the 24VDC supply also has to be connected to the EA88 interface technology module.

11.1.3.2 Pin assignments

The following elements can be found on the front plate of the EA88 interface:

- Connector [X21] for 8 digital inputs:
  PHOENIX Contact MicroCombicon MC 0.5/9-G-2.5 (9-pin type)

Table 51: EA88: Connector [X21] for 8 digital inputs

Pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Signal	GND 24V	In 1	In 2	In 3	In 4	In 5	In 6	In 7	In 8

- Connector [X22] for 8 digital outputs:
  PHOENIX Contact MicroCombicon MC 0.5/10-G-2.5 (10-pin type)

Table 52: EA88: Connector [X22] for 8 digital outputs

Pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Signal	GND 24V	Out 1	Out 2	Out 3	Out 4	Out 5	Out 6	Out 7	Out 8	+24VDC external

The following *Figure 45* shows the position of the connectors and their numbering:

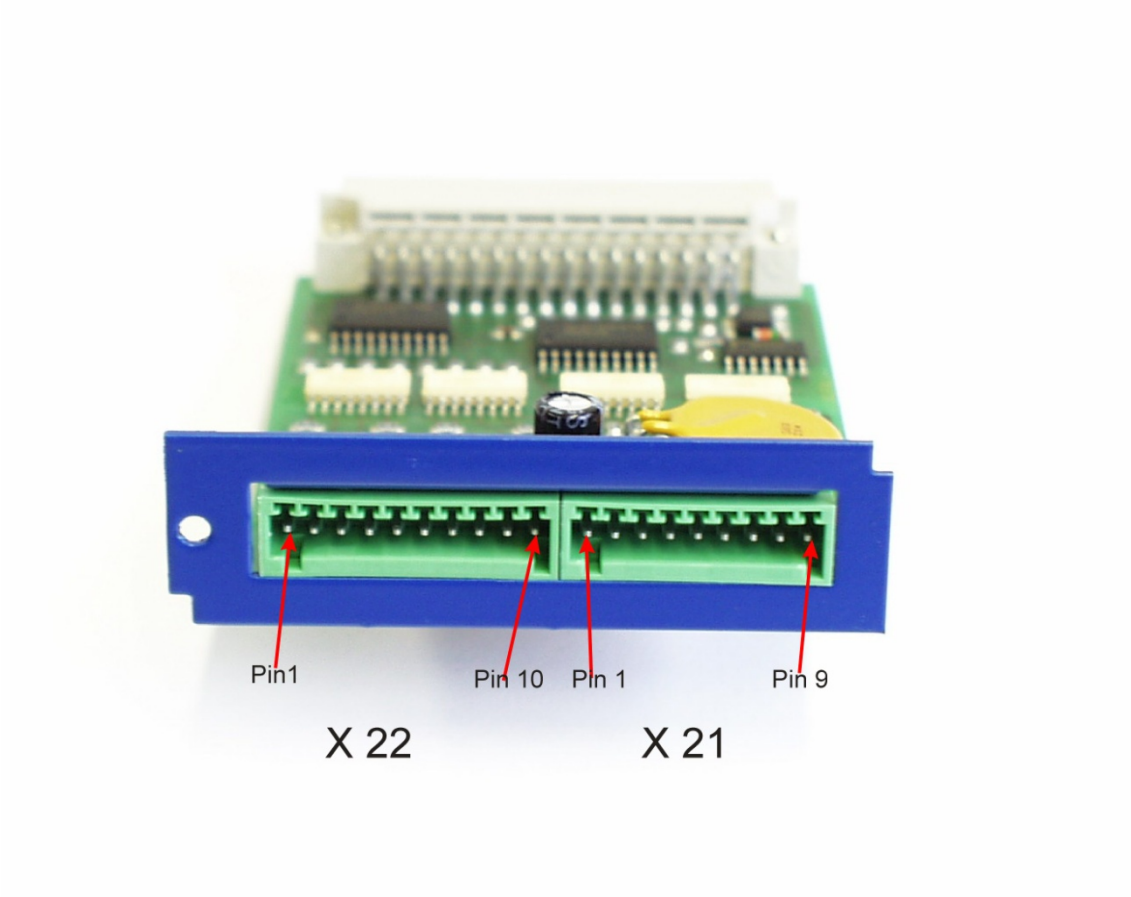


Figure 45: E88: Position of the pin-and-socket connectors [X21] and [X22] at the front plate

11.1.3.3 Counter plug

- Connector [X21] for 8 digital inputs: PHOENIX Contact MicroCombicon FK-MC 0.5/9-ST-2.5
- Connector [X22] for 8 digital outputs: PHOENIX Contact MicroCombicon FK-MC 0.5/10-ST-2.5

11.1.3.4 Connection notes

The MicroCombicon counter plugs made by PHOENIX Contact regarding [X21] (FK-MC 0.5/9-ST-2.5) and [X22] (FK-MC 0.5/10-ST-2.5) are supplied together with the EA88 interface technology module. The cables are connected in the form of crimp connections. To do so, first strip the cable at a length of about 8 mm. Then insert it into the desired opening by pressing down the orange crimp lock using a suitable screwdriver, the tip of a ball-pen or something similar. Release the lock to fix the cable in place. The maximum admissible wire cross-section (wire gauge) is 0.5 mm^2 or AWG20.

If the EA88 interface is also used to control digital outputs, an additional external 24V supply voltage has to be connected to [X22], pin 10.

As the lines GND24V and +24Vext. have to transfer the entire current of all outputs connected, their cross-section has to be sized accordingly (recommended: AWG 20).

11.2 PROFIBUS-DP interface

11.2.1 Product description

The PROFIBUS-DP interface provides an additional field bus connection. All functions and parameters can be addressed directly, for example from a Simatic S7 control system. The interface is plugged into the technology slot TECH 2 of the ARS 2300 servo drive.

The PROFIBUS-DP interface is supported solely in the **TECH 2** technology slot.

In addition to the PROFIBUS-DP interface, the TECH 1 technology slot can also be used for the I/O extension module EA88.

Additional technology modules will not be supported if the PROFIBUS-DP interface is used.

If your specific requirements are more complex, please contact your sales partner in order to find a solution for your particular application.

As a special feature, S7 function blocks have been developed for the servo drives. Using these function blocks, the servo drives can be controlled directly by the PLC program and the users can integrate their systems easily and clearly into the Simatic S7 environment.

11.2.2 Technical data

Table 53: Technical data: PROFIBUS-DP interface: Ambient conditions, dimensions and weight

Range	Values
Storage temperature range	-25 °C to +75°C
Operating temperature range / deratings	0°C to 50°C
Atmospheric humidity	0..90%, non-condensing
Altitude	Up to 2000 m above msl
External dimensions (LxWxH):	approx. 92 x 65 x 19mm suitable for the technology slot TECH 2
Weight:	approx. 50g

Table 54: Technical data: PROFIBUS-DP interface: Interfaces and communication

Communication interface	PROFIBUS module
Controller	PROFIBUS controller VPC3+, 12 Mbaud max.
Protocol	PROFIBUS-DP, 32-byte telegrams with operating-mode-depending configuration
Interface	Floating, D-SUB 9-pin, integrated bus terminating resistors (can be activated by DIP switches)
Special functions	Support of diagnosis data, RTS signal led out, fail-safe mode, sync/freeze

The following elements can be found on the front plate of the PROFIBUS-DP interface (see *Figure 46*:

- a green LED to indicate readiness for operation
- a 9-pin female DSUB connector
- two DIP switches for activating the terminating resistors

Figure 46: PROFIBUS-DP interface: Front view

11.2.3 Pin assignments and cable specifications

11.2.3.1 Pin assignment

❖ 9-pin DSUB connector, female

Table 55: Pin assignment: PROFIBUS-DP interface

Pin no.		Denomination	Values	Specification
1		Shield	-	Cable shield
	6	+5V	+5 V	+5V output (floating)[1)]
2		-	-	Not used
	7	-	-	Not used
3		RxD / TxD-P		B-line transmission / reception data
	8	RxD / TxD-N		A-line transmission / reception data
4		RTS / LWL		Request to Send [2)]
	9	-	-	Not used
5		GND5V	0 V	Reference potential GND 5V [1)]

[1)] Can be used for external bus termination or to supply the transmitter/receiver of an external optical waveguide transmission.

[2)] The signal is optional. It is used to identify the direction of an external optical waveguide connection.

11.2.3.2 Counter plug

❖ 9-pin DSUB connector, for example Erbic MAX PROFIBUS IDC Switch, made by ERNI

11.2.3.3 Cable type and configuration

The cable names given refer to cables made by Lapp. They have proven to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

❖ LAPP KABEL UNITRONIC BUS L2/FIP FC; 1 x 2 x 0.64; ∅ 7.8 mm,
with tinned total CU shielding for quick-connect applications with IDC connectors

For highly flexible applications:

❖ LAPP KABEL UNITRONIC BUS FD P L2/FIP; 1 x 2 x 0.64; ∅ 8 mm,
with tinned total CU shielding for highly flexible use in drag chains

11.2.4 Termination and bus terminating resistors

Every bus segment of a PROFIBUS network has to be equipped with bus terminating resistors to minimise line reflections and to adjust a defined rest potential on the line. The bus termination has to be provided at the **beginning** and at the **end of every bus segment**.

Most PROFIBUS connectors come supplied with integrated terminating resistors. For bus connections with connectors without integrated terminating resistors, the PROFIBUS-DP interface has its own terminating resistors. They can be activated with the help of the **two DIP switches** on the module (switch set to ON).

To ensure safe operation of the network, **only one bus termination may be used at a time**.

The external connection can also be set up discretely (see *Figure 47*). The power supply of 5 V required for the externally connected terminating resistors is supplied at the PROFIBUS connector of the PROFIBUS-DP interface (see pin assignment in *Table 55*).

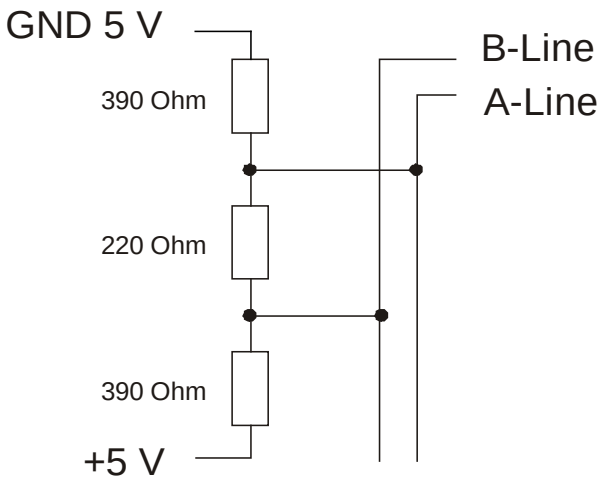
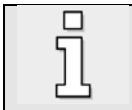


Figure 47: PROFIBUS-DP interface: Connection with external terminating resistors

11.3 sercos II module

11.3.1 Product description

The sercos II module is used to connect the ARS 2300 servo drive to a sercos-compatible CNC control. The communication on the sercos II bus uses a ring-shaped optical fibre link with transmission rates of up to 16 Mbaud. If six servo drives are connected to one bus, set points and actual values (position, speed and torque values) can be exchanged with the CNC control every 500 µs.



The sercos II module is supported solely in the **TECH 2** technology slot.

In addition to the sercos II module, the TECH 1 technology slot can also be used for the I/O extension module EA88.

Additional technology modules will not be supported if the sercos II module is used.

If your specific requirements are more complex, please contact your sales partner in order to find a solution for your particular application.

A special feature of the sercos II bus is the synchronisation of all the devices connected to the bus. If several ARS 2300 servo drives are connected, the internal controller and output stages of the servo drives operate in a phase-locked manner.

Via the 8-pole DIP switch the sercos II bus address can optionally be set. When restarted, the servo drive checks whether there has been set a bus address via these switches (all switches in position OFF → no bus address set). If no bus address has been set via the 8-pole DIP switches, the servo drive uses the bus address set via the Metronix ServoCommander™ (menu: Parameters/Field bus/ sercos…).

Example for setting the bus address via the 8-pole DIP switch: Switches 1, 4 and 8 are active (in position ON). From this the (decimal) bus address 137 (89h) is derived.

Switch 1: 2^0 → 1
Switch 4: 2^3 → 8
Switch 8: 2^7 → 128
Sum: 1 + 8 + 128 = 137

11.3.2 Technical data

Table 56: Technical data: sercos II module: Ambient conditions, dimensions and weight

Range	Values
Storage temperature range	-25 °C to +75°C
Operating temperature range / deratings	0°C to 50°C
Atmospheric humidity	0..90%, non-condensing
Altitude	up to 2000 m above msl
External dimensions (LxWxH):	approx. 92 x 65 x 19mm suitable for technology slot TECH 2
Weight	approx. 50g

The following elements can be found on the front plate of the sercos II module (see *Figure 48*):

- a green LED to indicate that the bus is ready for operation
- a connection for the optical waveguide receiver / type HFD 7000-402 (metal connection)
  → Connection directly underneath the 8-pole DIP switch
- a connection for the optical waveguide transmitter / type HFD 7000-210 (plastic connection)
  → Connection directly above the LED
- 8-pole DIP switch to set the fieldbus address

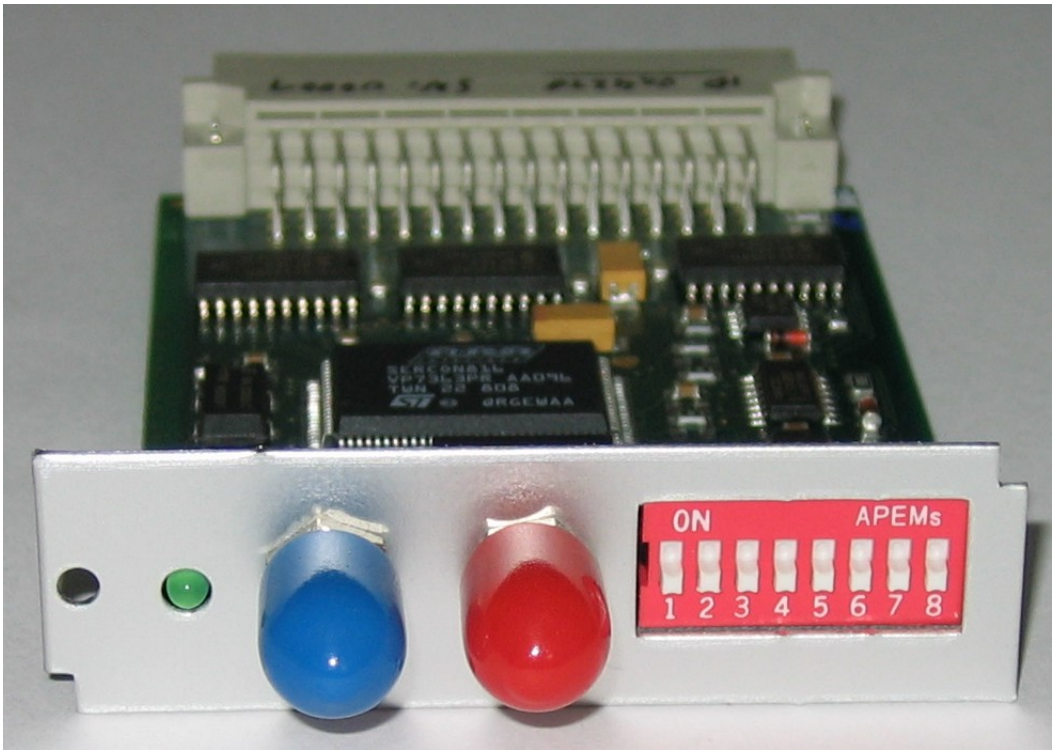


Figure 48: sercos II module: Front view

11.3.3 Optical waveguide specification

More information concerning the type and setup of suitable optical waveguides can be found in the standard sercos literature, for example:

http://www.sercos.org/

Interests Group sercos interface e.V.
Landhausstrasse 20, 70190 Stuttgart

Germany

11.4 EtherCAT

11.4.1 Product description

The EtherCAT technology module enables the connection of the ARS 2300 servo drive to the EtherCAT fieldbus system. The communication via the EtherCAT interface (IEEE-802.3u) is realised with the aid of standard EtherCAT cabling.

In the case of the ARS 2300 Metronix supports the CoE protocol (CANopen over EtherCAT) with the FPGA ESC20 made by Beckhoff.

The EtherCAT technology module is supported solely in the **TECH 2** technology slot.

In addition to the EtherCAT technology module, the TECH 1 technology slot can also be used for the I/O extension module EA88.

Additional technology modules will not be supported if the EtherCAT technology module is used.

If your specific requirements are more complex, please contact your sales partner in order to find a solution for your particular application.

11.4.2 Characteristics of the EtherCAT technology module

The EtherCAT technology module has the following characteristics:

- It can be fully mechanically integrated in the Metronix servo drives of the ARS 2000 series
- EtherCAT corresponding to IEEE-802.3u (100Base-TX) with 100 Mbps (full duplex)
- Star and line topology
- Connector: RJ45
- Electrically isolated EtherCAT interface
- Communication cycle: 1ms
- 127 slaves max.
- EtherCAT slave implementation based on FPGA ESC20 by Beckhoff
- Support of the “Distributed Clocks” feature for synchronised set value transfer
- LED display for indicating readiness and link-detect

Figure 49: EtherCAT module: Front view

11.4.3 Technical data

Table 57: Technical data: EtherCAT module: Ambient conditions, dimensions and weight

Range	Values
Storage temperature range	-25°C to +75°C
Operating temperature range	0°C to 50°C
Atmospheric humidity	0..90%, non-condensing
Altitude	up to 2000 m above msl
External dimensions (LxWxH):	approx. 92 x 65 x 19 mm
Weight:	approx. 55 g
Slot	Technology slot TECH 2

11.4.4 Display elements

The front panel of the EtherCAT technology module is equipped with two LEDs for indicating the operating states.

Table 58: Display elements EtherCAT module

Element	Function
LED 1 Two-colour-LED (green/red)	Run (green), link/activity EtherCAT port 1 (red), EtherCAT active (yellow)
LED 2 (red)	Link/activity EtherCAT port 2

11.4.5 EtherCAT interface

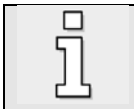
Table 59: Signal level and differential voltage EtherCAT module

Signal level	0 ... 2.5 VDC
Differential voltage	1.9 ... 2.1 VDC

11.5 MC 2000 “Drive-In” 4-Axis Motion Coordinator

11.5.1 Product description

The technology module MC 2000 motion coordinator can control up to four servo axes of the ARS 2000 and ARS 2000 FS servo drive series in a multi-axis-coordinated way.



The Motion Coordinator MC 2000 technology module is supported solely in the **TECH 2** technology slot.

In addition to the MC 2000 module, the TECH 1 technology slot can also be used for the I/O extension module EA88.

Additional technology modules will not be supported if the MC 2000 module is used.

If your specific requirements are more complex, please contact your sales partner in order to find a solution for your particular application.

With the MC 2000 complex motion control can be realised fast and easy, for example.

- Electronic cam drives and gears
- Joint axes
- Point-to-point positioning
- Several types of interpolation (Interpolation, Circular Interpolation, Helical Interpolation).

Simply insert the MC 2000 module into the servo drive. As the MC 2000 master, it can control up to three additional ARS 2300 servo drive slaves via CANopen DSP402. In addition, an external encoder can be connected directly to the ARS 2300. This external encoder can then be evaluated as an additional axis by the MC 2000. All of the available standard I/Os in the ARS 2300 can be used for this purpose.

In addition, the ARS 2000 can be expanded by using the I/O module EA88. A second CAN-interface is available for connecting external CAN I/Os via the master.

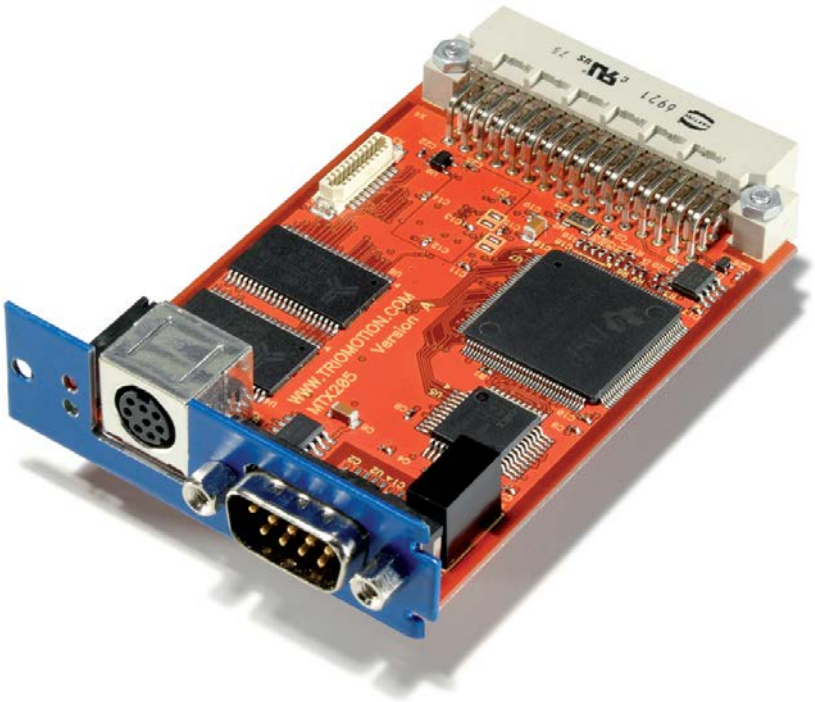


Figure 50: MC 2000 4-Axis Motion Coordinator

11.5.2 Features

11.5.2.1 Compact

- ❖ Plug-in module that is directly integrated in the servo drive
- ❖ Controls up to 4 real servo axes
- ❖ Easy wiring via CAN-bus

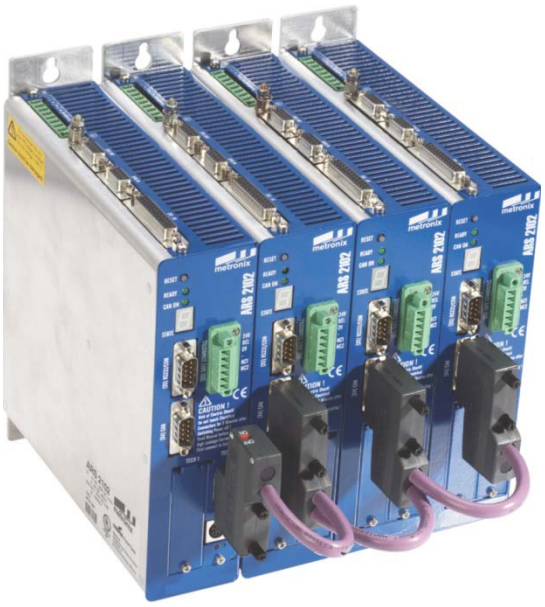


Figure 51: MC 2000 4-Axis Motion Coordinator maximum capacity

11.5.2.2 Fast

- 1 ms cycle time with up to 4 servo axes
- Short start up time with the Trio Motion BASIC software with numerous predefined commands
- High-speed sample input for fast measuring and interpretation of actual values

11.5.2.3 Easy

- Application programming with the proven Trio Motion software “Motion Perfect”
- Program generation of complex motion sequences like camming, gearing and interpolated multi axis movements
- Minimal external wiring thanks to the integration of the MC 2000 into a servo drive (technology slot TECH 2)

11.5.3 Technical data

Table 60: Technical data: MC 2000 4-Axis Motion Coordinator

Size (LxWxH)	92 x 65 x 19 mm
Temperature range	0° C to 50° C
Current consumption	Max. 350 mA / 3,3 VDC and 150 mA / 5 VDC (internally via servo drive)
Max. number of axes	8 (4x servo drives, 1x encoder, 3x virtual)
Additional encoder input	Bi-directional connection (via servo drive –X10)
Servo cycle time	1 ms
Built-in digital inputs	6x 24 VDC (via servo drive)
Built-in digital outputs	3x 24 VDC (via servo drive)
Built-in analogue inputs	3x ±10 VDC via servo drive (1x 16 Bit differential and 2x 10 Bit single ended)
Built-in analogue outputs	2 x ±10 VDC, 9 bit (via servo drive)
Input function	Forward limit / reverse limit / datum / F hold
Serial ports	1x RS232 (programming) + 1x RS485 (for example HMI)
CAN ports	2x CAN interfaces (1x remote drive max. 1 Mbaud and 1x remote CAN I/O max. 500 kBaud via servo drive)
Extension module	EA88 IO extension module (via servo drive)
User memory	512 kBytes
Table memory	32,000 values
Multi-tasking	2 fast tasks + 5 normal tasks
EMC Compliance	EN 61800-3
CANopen protocol	CiA Draft Standard Proposal 402
Order number	9200-0008-00
RS232 cable for MC 2000	9200-0008-10

11.6 General installation notes for technology modules

DANGER!

Non-observance of the instructions that are stated in *chapter* 2 *Safety notes for electrical drives and controllers (page 18)* may lead to property damage, injuries, electric shock, or – in extreme cases – even death.

DANGER!

Prior to installing technology modules, the servo drive has to be disconnected from any current-carrying conductors. After the operating voltage has been disconnected, wait for 5 minutes so that the capacities in the servo drive can be completely discharged.

Caution!

Make sure that ESD protection measures are taken when handling technology modules.

To insert a technology module into the ARS 2300 servo drive, please proceed as follows:

1. Remove the cover of the technology slot (TECH 1 or TECH 2) of the servo drive with a suitable Phillips screwdriver.
2. Push the technology module into the open technology slot so that the lateral guides hold the board.
3. Push the technology module into the slot until it reaches the stop.
4. Screw the technology module to the housing of the servo drive with the Phillips screw.
5. Ensure that the front plate of the technology module has conducting contact with the housing of the servo drive (PE).