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servo drives

Product Manual

Servo drives ARS 2300 SE

Standard Edition

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Translation of the original instructions

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1 General

1.1 Documentation

The purpose of this product manual is to ensure the safe use of the ARS 2300 SE servo drives. It contains safety notes, which must be complied with.

Further information can be found in the following manuals:

- **Product Manual "STO (Safe Torque Off) for the servo drives ARS 2000 SE":** Description of the functional safety technology for the ARS 2000 SE servo drives with the safety function STO.
- **Product Manual "Ethernet Technology Module"**: Description of the implemented Ethernet protocol (UDP).
- **Software Manual "Servo drives ARS 2000":** Description of the device functionality and software functions of the firmware. Description of the Metronix ServoCommander® parameterisation program with instructions concerning the start-up of the ARS 2000 servo drives.
- **CANopen Manual "Servo drives ARS 2000":** Description of the implemented CANopen protocol as per DSP402.

You can find all of these documents on our homepage for download (http://www.metronix.de/).

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

The entire software functionality of the new ARS 2000 SE product range will be implemented in the course of a step-by-step development process.

This version of the product manual contains the functions of the firmware version 4.0.0.1.5.

1.2 Scope of supply

The scope of supply includes:

Table 1: Scope of supply ARS 2300 SE with STO

1x	**Servo drive ARS 2300 SE with STO**			
	Type	ARS 2302 SE	ARS 2305 SE	ARS 2310 SE
	Metronix part number	9200-2302-30	9200-2305-30	9200-2310-30
1x	**Auxiliary equipment**			
	Mating connector PHOENIX Mini-Combicon MC1.5/8-STF-3.81 BK			

OR:

Table 2: Scope of supply ARS 2300 SE without STO

1x	**Servo drive ARS 2300 SE without STO**			
	Type	ARS 2302 SE	ARS 2305 SE	ARS 2310 SE
	Metronix part number	9200-2302-31	9200-2305-31	9200-2310-31

Mating connectors for the power, control, or shaft encoder connections as well as for the shield connection are not included in the standard scope of supply. However, they can be ordered as accessories.

Table 3: Connector set: POWER connector

1x	**Connector set: POWER connector** This connector set includes the mating connectors for the following connections: - Power supply [X9] - Motor connection [X6]			
	Type	ARS 2302 SE	ARS 2305 SE	ARS 2310 SE
	Metronix part number	9200-0230-20		

Table 4: Connector set: DSUB connector

1x	**Connector set: DSUB connector** This connector set includes the mating connectors 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 2302 SE	ARS 2305 SE	ARS 2310 SE
	Metronix part number	9200-0200-00		

Table 5: Connector set: shield connector

1x	**Connector set: shield connector** This connector set includes two shield terminals (SK14)			
	Type	ARS 2302 SE	ARS 2305 SE	ARS 2310 SE
	Metronix part number	9200-0202-00		

2 Safety notes for electrical drives and controllers

2.1 Symbols

Information

Important information and notes.

Caution!

Non-compliance may result in severe damage to property.

DANGER!

Non-compliance may result in **damage to property** and **personal injuries**.

Caution! Hazardous voltage.

This safety note indicates a potential, hazardous 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 commissioning the system,

read the *Safety notes for electrical drives and* controllers as of page 15 and *chapter 8.14 Notes concerning the safe and EMC-compliant* installation as of page 104.

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

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

Only trained and qualified personnel are authorised to work with or on the electrical devices and systems:

TRAINED AND QUALIFIED PERSONNEL

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

- ❖ They have been trained, instructed, and authorised to perform the switching and earthing (grounding) of the devices/systems in line with the applicable safety standards and to label them accordingly as per the job requirements.
- ❖ They have been trained and instructed in line with the applicable safety standards in terms of the maintenance and use of adequate safety equipment.
- ❖ They have completed first aid training.

The following instructions must be read thoroughly prior to the initial operation of the system in order to prevent personal injuries and/or damage to property:

These safety instructions must be complied with at all times.

Do not attempt to install or start the servo drive without having read all of the safety instructions in this document concerning the electrical drives and controllers. These safety instructions and all other user notes must be read prior to performing 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 the servo drive is sold, rented out, or otherwise distributed to third parties, these safety instructions must be included.

Opening the servo drive by the operator is not permissible for safety and warranty reasons.

Professional project planning is a prerequisite for the correct and trouble-free operation of the servo drive!

DANGER!

Improper handling of the servo drive and non-compliance with the warnings as well as improper manipulation of the safety devices may result in damage to property, personal injuries, electric shock or, in extreme cases, in death.

2.3 Hazards resulting from misuse

DANGER!

High electrical voltages and high load currents!

Danger to life or risk of serious personal injury from electric shock!

DANGER!

High electrical voltage caused by incorrect connections!

Danger to life or risk of personal injury from electric shock!

DANGER!

The surfaces of the device housing may be hot!

Risk of injury! Risk of burns!

DANGER!

Dangerous movements!

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

2.4 Safety instructions

2.4.1 General safety instructions

The servo drive has an IP20 protection rating and a pollution degree rating of 2. Ensure that the environment corresponds to this protection rating and pollution degree rating.

Only use manufacturer-approved accessories and spare parts.

The servo drives must be connected to the mains power supply in accordance with the EN standards so that they can be disconnected from the mains power supply by way of suitable disconnectors (e.g. main switches, contactors, circuit breakers).

The servo drive can be protected with a 300 mA AC/DC-sensitive residual-current device of type B.

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

For the switchgear, preventive interference suppression measures should be taken, e.g. in the form of RC circuits or diodes connected to the contactors and relays.

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

The ambient conditions that are specified in the product documentation must be maintained. Safety-critical applications are not allowed, unless specifically approved by the manufacturer.

See *chapter 8.14 Notes concerning the safe and EMC-compliant installation* (page 104) for further information concerning the EMC-compliant installation. The manufacturer of the machine or system is responsible for ensuring compliance with the limits that are specified by the applicable national rules and regulations.

The technical data and the connection and installation conditions for the servo drive are specified in this product manual. Compliance with these specifications is absolutely essential.

DANGER!

The general set-up and safety rules and regulations concerning the work on power installations (e.g. DIN, VDE, EN, IEC, or any other national or international rules and regulations) must be complied with.

Non-compliance may result in death, personal injury, or significant damage to property.

Without any claim to completeness, the following standards, rules, and regulations apply:

VDE 0100	Erection of power installations with nominal voltages up to 1000 V
EN 1037	Safety of machinery - 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

Other standards that are to be complied with 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 function

2.4.2 Safety notes for assembly and maintenance

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

Only personnel who have been trained and qualified for working on or with electrical devices are authorised to operate, maintain, and/or repair the servo drive.

Prevention of accidents, injuries, and/or damage to property:

Vertical axes must be additionally secured against falling down or lowering after the motor has been switched off, for example by way of the following:

- mechanical locking of the vertical axis,
- external braking, catching, or clamping devices, or
- sufficient weight counterbalance of the axis.

The standard motor holding brake that is included in the scope of supply or any other external motor holding brake that is actuated by the servo drive is not suitable for the protection of the operators if used alone!

Disconnect the electrical equipment from the power supply by way of the main switch and secure it so that it cannot be reconnected. Then, wait until the DC bus circuit has discharged prior to any of the following:

- maintenance and repairs
- cleaning
- long downtimes

Prior to performing any maintenance tasks, ensure that the power supply has been turned off and locked and that the DC bus circuit has been discharged.

The external or internal braking resistor carries dangerous DC bus circuit voltages during the operation of the servo drive and up to 5 minutes thereafter. Wait until this time is over 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 on during the operation of the drive, ensure that no drilling chips, metal dust, or installation parts (screws, nuts, cable sections) can fall into the into the servo drive.

Ensure also that the external power supply of the servo drive (24 V) is switched off.

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

Ensure that the AC or DC power supplies are switched off and locked prior to performing any work in the area of the machine. Deactivated output stages or deactivated servo drive enable signals 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 "Safe Stop" safety feature in accordance with EN 954-1 CAT 3 or with the "Safe Torque Off" safety feature in accordance with EN 61800-5-2.

Perform the commissioning with idle motors in order to avoid mechanical damage, e.g. due to an incorrect direction of rotation.

Electronic devices are never fail-safe. It is the user’s responsibility to ensure that the system is brought to a safe state if the electrical device fails.

The servo drive and, in particular, the braking resistor (either external or internal) can exhibit high temperatures that may cause serious burns if touched.

2.4.3 Protection against contact with electrical parts

This section solely applies to devices and drive components with voltages above 50 V. Contact with parts carrying voltage of more than 50 V may be dangerous and cause electric shock. Certain parts will inevitably carry dangerous voltages during the operation of electrical devices.

DANGER!

High electrical voltage!

Danger to life, risk of electric shock, and risk of serious personal injury!

The applicable DIN, VDE, EN, and IEC regulations as well as all of the national and local safety and accident prevention regulations apply to the operation of the device/system. The system manufacturer or operator is responsible for ensuring compliance with these regulations:

Install the respective covers and guards against accidental contact prior to switching the device/system on. Rack-mounted devices must be protected against accidental contact by way of a housing, e.g. a switch cabinet. The national accident prevention regulations must be complied with!

Connect the protective earth conductor (ground conductor) of the electrical system securely to the mains power supply. Due to the integrated line filters, the leakage current exceeds 3.5 mA!

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

Prior to start-up and even for brief measurements or tests, connect the protective earth conductor (ground conductor) of all of the electrical devices in accordance with the circuit diagram or connect it to the earthing system on site. Otherwise, the housing may carry high voltages which can cause electric shock.

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

Prior to accessing electrical parts carrying voltages above 50 V, disconnect the device from the mains power supply or voltage source. Secure it so that it cannot be switched on.

The magnitude of the DC bus circuit voltage must be taken into consideration during the installation process in order to ensure proper insulation and protection. Ensure proper earthing (grounding), conductor rating, and protection against short circuits.

The device includes a rapid discharge circuit for the DC bus circuit in accordance with EN 60204-1. In certain device constellations, however, mostly in the case of parallel connection of several servo drives in the DC bus circuit or in the case of an unconnected braking resistor, this rapid discharge may be rendered ineffective. In these cases, the servo drives may still carry dangerous voltage levels until up to 5 minutes after they have been switched off (residual capacitor charge).

2.4.4 Protection against electric shock by way of protective extra-low voltage (PELV)

All of the connections and terminals with voltages up to 50 V of the servo driver have protective extra-low voltage.They are insulated in accordance with the following standards:

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

DANGER!

High electrical voltage caused by incorrect connections!

Danger to life and risk of injury due to electric shock!

Only devices, electrical components, and wires or cables with protective extra-low voltage (PELV) may be connected to connectors and terminals with voltages from 0 to 50 V.

Connect only those voltages and circuits that are securely isolated from any dangerous voltages. This isolation can be realised by way of isolation transformers, safe optocouplers, or battery operation without mains power.

2.4.5 Protection against dangerous movements

Dangerous movements can be caused by the faulty actuation of the connected motors. Causes may be as follows:

- improper or faulty wiring or cabling
- errors during the operation of the components
- errors of the sensors and transducers
- defective or non-EMC-compliant components
- software errors in superordinate control system

These errors can occur directly after the activation of the device or after some time during the operation.

The monitoring systems in the drive components exclude any malfunction in the connected drives to the greatest possible extent. However, in view of the protection of the operators, particularly in terms of the risk of injuries and/or damage to property, relying solely on this measure is not recommended. Until the built-in monitoring systems become effective, faulty drive movements should always be anticipated.The extent of these faulty drive movements depends on the type of control and on the operating state.

DANGER!

Dangerous movements!

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

For the reasons mentioned above, protection must be ensured by monitoring or by superordinate measures. This must be implemented by the system manufacturer based on the specific system situation and on a hazard and fault analysis. This also includes the safety rules and regulations that apply to the system. Random movements of the machine or other malfunctions may be caused by deactivating, bypassing, or failing to activate the safety devices.

2.4.6 Protection against contact with hot parts

DANGER!

The surfaces of the device housing may be hot!

Risk of injury! Risk of burns!

Do not touch the surfaces of the housing in the vicinity of heat sources! Risk of burns!

Before accessing the devices, let them cool for 10 minutes after they have been switched off.

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

2.4.7 Protection during the handling and installation of the devices

Improper handling and installation of certain parts and components may cause injuries under adverse conditions.

DANGER!

Risk of injury due to improper handling!

Risk of personal injury caused by crushing, shearing, cutting, or impacts!

The following general safety instructions apply:

Comply with the general set-up and safety regulations concerning the handling and installation of the devices.

Use suitable installation and transport devices.

Prevent trapping and crushing by suitable protective measures.

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

Use the lifting devices and tools in a proper manner.

If necessary, use suitable protective equipment (e.g. safety goggles, protective footwear, protective gloves).

Stay out from under suspended loads.

Immediately remove any liquid spills on the floor in order to prevent slipping.

3 Product description

3.1 General

The servo drives of the ARS 2000 SE series (**ARS** servo of the 2nd generation, **S**tandard **E**dition) are intelligent AC servo drives for the control of three-phase, rotatory synchronous motors, torque motors, and linear motors. Due to their extensive parameterisation options, they can be adapted to a variety of different applications.

Communication with a superordinate control system is possible via the integrated CAN interface. The servo drives can be used in a universal manner, since they can be combined with a wide range of encoder systems and motors.

This servo drive standard edition is an alternative to the ARS 2000 FS devices, e.g. for applications that do not require any technology modules.

The parameter sets of both device families are compatible. This means that parameter sets that have been created for the ARS 2000 FS series can be use for the ARS 2000 SE devices and vice versa. Settings concerning components that are not included in the ARS 2000 SE (e.g. servo drive enabling via bus systems) must be adjusted in a suitable manner for the ARS 2000 SE, if required.

The ARS 2000 SE series includes types with single-phase and three-phase supply.

Type key:

ARS 2305 SE (example)

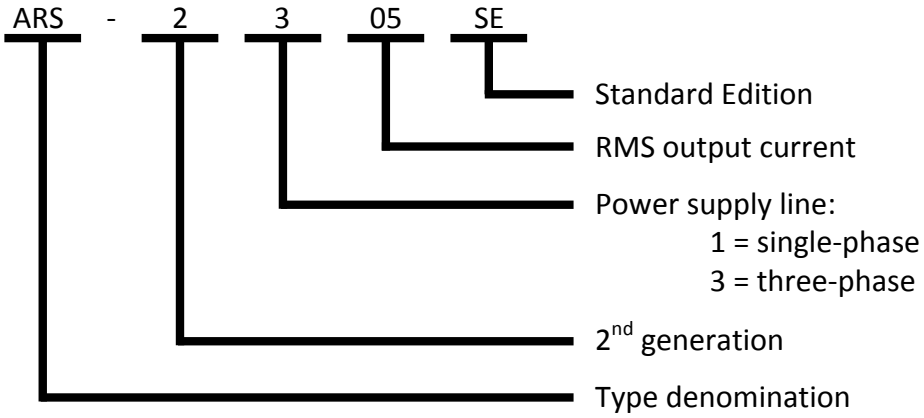


Figure 1: Type key

The single-phase supply types are designed for connection to the 400 VAC mains power supply.

All of the servo drives of the ARS 2000 SE series have the following features:

- Space-saving, compact design, directly cascadable.
- High control quality due to high-quality sensors, far superior to conventional market standards, and above-average processor resources.
- Full integration of all of the components for the controller and power module, including a USB and Ethernet interface for the PC communication, plus a CANopen interface for the integration into automation systems.
- SD card: support of FW downloads (initialisation via boot switches) and the upload and download of parameter sets.
- Integrated universal shaft encoder evaluation for the following encoder types:
  - Resolvers
  - Incremental encoder with/without commutation signals
  - High-resolution Sick-Stegmann incremental encoders, absolute encoders with HIPERFACE®
  - High-resolution Heidenhain incremental encoders, absolute encoders with EnDat
- Compliance with the current CE and EN standards without any additional external measures.
- Device design as per UL standards, cULus-certified.
- Completely closed, EMC-optimised metal housing for mounting on conventional switch cabinet mounting plates. The devices comply with the IP20 degree of protection.
- Integration of all of the required filters, e.g. line filters, motor output filters, filters for the 24 V supply, and filters for the inputs and outputs, into the device in order to ensure compliance with the EC regulations during the operation (industrial environment).
- Integrated braking resistor. External resistors can be connected for higher levels of braking energy.
- Automatic identification of externally connected braking resistors.
- Complete electrical isolation of the controller module and power output stage in accordance with EN 61800-5-1. Electrical isolation of the 24 V potential section with the digital inputs and outputs and the analogue electronic system and electronic control system.
- The device can be used as a torque controller, speed controller, or position controller.
- Integrated positioning control with a wide range of functions as per "CAN in Automation (CiA) DSP402" plus numerous additional application-specific functions.
- Jerk-free or time-optimal positioning, relative or absolute with regard to a reference point.
- Point-to-point positioning (with or without S-ramps).
- Speed- and angle-synchronous operation with an electronic gear unit via the incremental encoder input or fieldbus.
- Extensive modes of operation for synchronisation.
- Numerous homing methods.
- Jogging mode.

- Teach-in mode.
- Short cycle times, 50 µs (20 kHz) in the current control circuit and 100 µs (10 kHz) in the speed control circuit.
- Switchable clock frequency for the power output stage.
- Freely programmable I/Os.
- User-friendly parameterisation with the Metronix ServoCommander® software.
- Menu-guided start-up.
- Automatic motor identification.
- Easy connection to a superordinate control system, e.g. to a PLC via the I/O level or fieldbus.
- High-resolution 16-bit analogue input.
- For the ARS 2000 SE series servo drives with the integrated STO safety function:
  "STO" (Safe Torque Off, corresponds to EN 60204 Stop 0), SIL 3 in accordance with ISO EN 61800-5-2 / PL e in accordance with ISO EN 13849-1.

3.2 Power supply

3.2.1 Three-phase AC power supply

The ARS 2300 SE servo drive fulfils the following requirements:

- Rated voltage 400 VAC.
- Nominal frequency range 50-60 Hz ±10%.
- Surge rating for the potential combination of several servo drives. The ARS 2300 SE servo drive enables a dynamic change in both directions between the motor and generator modes without any dead time.
- No parameterisation by the user required.

3.2.1.1 Switch-on behaviour

- As soon as the ARS 2300 SE servo drive is supplied with mains power, the DC bus circuit is charged (< 1 s) via the braking resistors while the DC bus circuit relay is deactivated.
- After the DC bus circuit has been charged, the relay responds and the DC bus circuit is coupled to the mains power supply without any resistors.

3.2.2 DC bus circuit linking, DC supply

3.2.2.1 DC bus circuit linking

- If they have the same DC bus voltage, it is possible to couple multiple servo drives of the ARS 2300 FS / SE series.

Caution!

Operation with DC bus circuit linking combined with devices of the ARS 2100 FS / SE series is not allowed.

3.2.2.2 DC supply

- Direct DC supply without a mains power connection via the DC bus circuit terminals is possible with voltages ≥ 60 VDC. See *Table 11*.

The digital motor temperature monitoring system requires a DC bus circuit voltage of 230 VDC. Below this voltage, the system will always identify the digital motor temperature sensor as open.

3.2.3 Mains fuse

A slow-blow (B16), single-phase, 16 A automatic circuit breaker must be installed in the mains power supply line.

3.3 Brake chopper

The power output stage has an integrated brake chopper with a braking resistor. If the permissible charging capacity of the DC bus circuit is exceeded during the generator operation, the internal braking resistor can convert the braking energy into heat. The brake chopper is controlled by the software. The internal braking resistor is protected against overloads by the software and hardware.

If the capacity of the internal braking resistors is insufficient in a special application, they can be cut off by removing the jumper between the pins *BR-CH* and *BR-INT* of the [X9] connector. Instead, an external braking resistor must be connected between the pins *BR-CH* and *BR-EXT*. This braking resistor must fulfil certain minimum specifications (see *Table 13, page 36*). The output is protected against a short circuit in the braking resistor or its cable.

Pin *BR-CH* is connected to the positive DC bus circuit potential, which means that it is not protected against earth faults (ground faults), short circuits with regard to the mains voltage, or negative DC bus circuit voltage.

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

3.4 Communication interfaces

The ARS 2000 SE servo drives have several communication interfaces:

- USB interface [X19]: USB
- UDP interface [X18]: Ethernet
- Fieldbus system [X4]: CANopen
- I/O interface [X1]: digital and analogue input and outputs

The Ethernet and USB interface are particularly important for the connection of a PC and for the use of the Metronix ServoCommander® parameterisation tool.

In the case of the present product configuration, the servo drive operates as a slave on the fieldbus.

3.4.1 USB interface [X19]

This interface was mainly intended as a parameterisation interface, but it can also be used for controlling the servo drives.

3.4.2 UDP interface [X18]

The UDP communication enables the connection of the ARS 2000 SE series servo drives to the Ethernet fieldbus system. The communication via the UDP interface [X18] is realised by way of standard cabling.

3.4.3 CAN interface [X4]

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

The specific Metronix CAN protocol of the previous ARS product range is no longer supported by the ARS 2000 SE series.

3.4.4 I/O functions and device control

Ten digital inputs provide the elementary control functions (see *chapter 4.6.5 I/O interface [X1], page 46*):

The ARS 2000 SE series servo drives have a target table in which the positioning targets can be stored and from which they can be retrieved at a later point of time. Four digital inputs are used for the target selection; one input is used as a start input. Please refer to the Software Manual "Servo drives ARS 2000" for further information.

The limit switches are used to limit the range of movement for reasons of safety. During homing, one of the two limit switches can be used as a reference point for positioning control.

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

High-speed sample inputs are available for various time-critical applications (e.g. homing, special applications).

The ARS 2000 SE series servo drives have three analogue inputs for input levels in the range of *+10 V* to *-10 V*. One input is a differential input (16 bits) to guarantee high interference immunity. Two inputs (10 bits) are single-ended inputs. The analogue signals are quantised and digitalised by an analogue-digital converter with a resolution of 16 bits or 10 bits. The analogue signals provide the setpoints (speed or torque) for the control.

In standard applications, the existing digital inputs are already used for basic functions. For further functions, e.g. the teach-in mode, a separate "start homing" input, or a stop input, the analogue inputs AIN 1 and AIN 2 as well as the digital outputs DOUT 2 and DOUT 3, which can also be used as digital inputs, are available.

4 Technical data

4.1 General technical data

Table 6: Technical data: ambient conditions and qualification

Range	Value	
Permissible temperature ranges	Storage temperature:	-25°C to +70°C
	Operating temperature:	0°C to +40°C +40°C to +50°C with power reduction 2.5%/K
Permissible installation altitude	Maximum installation altitude 2000 m above MSL; with a power reduction of 1% per 100 m as of 1000 m above MSL	
Atmospheric humidity	Relative humidity up to 90%, non-condensing	
Type of protection	IP20	
Protection class	I	
Pollution degree	2	
CE conformity Low voltage directive: EMC directive:	2006/95/EC, as proved by the application of the harmonised standard EN 61800-5-1 2004/108/EC, as proved by the application of the harmonised standard EN 61800–3	
EC product type test certificate for the devices with STO:	TÜV 01/205/5245.01/14	
cULus certification	Listed according to UL 508C, C22.2 No. 274-13	

Table 7: Technical data: dimensions and weight

Type	ARS 2302 SE	ARS 2305 SE	ARS 2310 SE
Dimensions including the mounting plate (H * W * D)	334.5 mm * 69 mm * 245.5 mm		
Housing dimensions (H * W * D)	250 mm * 69 mm * 240 mm		
Weight	approx. 3.7 kg		

Table 8: Technical data: cable specifications

Range	ARS 2302 SE	ARS 2305 SE	ARS 2310 SE
Maximum motor cable length for interference emission as per EN 61800-3			
Category C2 Installation in a switch cabinet (see chapter 8.14 Notes concerning the safe and EMC-compliant installation) to be performed by a specialist	$l \leq 50$ m		
Category C3 (industrial environment)	$l \leq 50$ m		
Cable capacity of one phase against shield or between two lines	$C' \leq 200$ pF/m		

Table 9: Technical data: motor temperature monitoring system

Motor temperature monitoring system	Values
Digital sensor	N.C. contact: $R_{cold} < 500\ \Omega$ $R_{hot} > 100\ k\Omega$
Analogue sensor	Silicon temperature sensor, e.g. KTY81, 82 or similar $R_{25} \approx 2000\ \Omega$ $R_{100} \approx 3400\ \Omega$

4.2 Control elements and display elements

On its front panel, the ARS 2300 SE servo drive has three LEDs and one seven-segment display to indicate the operating status.

Table 10: Display elements and RESET button

Element	Function
Seven-segment display	Indication of the operating mode and of an error code in the event of malfunctions
LED 1 (two-colour LED, green/red)	Operational readiness or errors
LED 2 (green)	Servo drive enable signal
LED 3 (yellow)	CAN bus status indication
RESET button	Hardware reset for the processor

4.3 Power supply [X9]

Table 11: Technical data: power data [X9]

Type	ARS 2302 SE	ARS 2305 SE	ARS 2310 SE
Supply voltage	3 x 230 ... 480 VAC [± 10%], 50 ... 60 Hz		
Maximum mains current in continuous operation	2.5 A_{RMS}	5 A_{RMS}	9 A_{RMS}
DC bus circuit voltage (in the case of a supply voltage of 400 VAC)	560 ... 570 VDC		
Alternative DC supply	60 ... 700 VDC		
24 V supply	24 VDC [± 20%], (1 A) *)		

*) plus the current consumption of a holding brake and I/Os (if included

Table 12: Technical data: internal braking resistor [X9]

Type	ARS 2302 SE	ARS 2305 SE	ARS 2310 SE
Braking resistor	68 Ω		
Peak power	8.5 kW		
Continuous power	110 W		
Response threshold	760 V		
Overvoltage detection	800 V		

Table 13: Technical data: external braking resistor [X9]

Type	ARS 2302 SE	ARS 2305 SE	ARS 2310 SE
Braking resistor	≥ 40 Ω		
Continuous power	≤ 5000 W		
Operating voltage	≥ 800 V		

4.4 Motor connector [X6]

Table 14: Technical data: motor connector [X6]

Type	ARS 2302 SE	ARS 2305 SE	ARS 2310 SE
Specifications for operation with 3x 400 VAC [± 10%], 50 Hz			
Nominal output power	1.5 kVA	3.0 kVA	6.0 kVA
Max. output power for 5 s	3.0 kVA	6.0 kVA	12.0 kVA
Nominal output current	2.5 A_{RMS}	5 A_{RMS}	10 A_{RMS}
Max. output current for 5 s	5 A_{RMS} (7.5 A_{RMS} for 2 s)	10 A_{RMS} (15 A_{RMS} for 2 s)	20 A_{RMS}
Max. output current for 0.5 s *)	10.0 A_{RMS}	20.0 A_{RMS} ($f_{el} \geq 20$ Hz)	40.0 A_{RMS} ($f_{el} \geq 20$ Hz)
Current derating from	12.5 kHz	12.5 kHz	5 kHz
Max. clock frequency	16 kHz (programmable via the software)		
Holding brake 24 V	Signal level depending on the switching state, high-side/low-side switch / 2 A max.		
Motor temperature sensor	Normally closed contact, normally open contact, PTC, KTY + 3.3 V/5 mA		
Power loss/efficiency (with regard to the nominal power)**)	Typically 8% / 92%		

*) In the case of lower electrical rotational frequencies (f_{el}), shorter periods apply to the ARS 2310 SE; see the following tables.

**) "As a rating guideline".

4.4.1 Current derating

The ARS 2300 SE series servo drives have a current derating during nominal operation. The rated current and the duration of the maximum permissible peak current of the servo drive depend on several factors.

These factors are:

- Output current level (the higher the output current is, the shorter the permissible time will be)
- Clock frequency of the power output stage (the higher the clock frequency is, the shorter the permissible time will be)
- Electrical rotational frequency of the motor (speed multiplied by the number of pole pairs) (the higher the rotational frequency is, the longer the permissible time will be)

The following applies to the last point (electrical rotational frequency): For the sake of clarity, a distinction is made only between electrical rotational frequencies below 5 Hz and those above 20 Hz. In the case of rotational frequencies between these two values, interpolation is required. This leads to

two tables: the first one applies to motors at a standstill or to slow-running motors (electrical rotational frequency ≤ 5 Hz) and the second one applies to fast-running motors (electrical rotational frequency ≥ 20 Hz).

Note

The heat sink turn-off temperature is 70°C. The servo drive will be switched off when the temperature reaches or exceeds this value. It will not be ready for operation until after a brief cooling period.

Table 15: ARS 2302 SE: rated current values for an ambient temperature ≤ 40°C

Parameter	Values		
Power output stage clock frequency (kHz)	≤ 12.5		
Nominal current (A_{RMS})	2.5		
Max. output current (A_{RMS})	5	7.5	10
Max. permissible time (s)	5	2	0.5
Power output stage clock frequency (kHz)	16		
Nominal current (A_{RMS})	1.9		
Max. output current (A_{RMS})	3.8	5.7	7.6
Max. permissible time (s)	5	2	0.5

Table 16: ARS 2305 SE: rated current values for a blocked or slow-running motor (f_{el} ≤ 5Hz) and for an ambient temperature ≤ 40°C

Parameter	Values		
Power output stage clock frequency (kHz)	≤ 12.5		
Nominal current (A_{RMS})	5		
Max. output current (A_{RMS})	10	15	20
Max. permissible time (s)	5	0.8	0.1
Power output stage clock frequency (kHz)	16		
Nominal current (A_{RMS})	2.5		
Max. output current (A_{RMS})	5	7.5	10
Max. permissible time (s)	5	1.2	0.15

Table 17: ARS 2305 SE: rated current values for a rotating motor (f_{el} ≥ 20 Hz) and for an ambient temperature ≤ 40°C

Parameter	Values		
Power output stage clock frequency (kHz)	≤ 12.5		
Nominal current (A_{RMS})	5		
Max. output current (A_{RMS})	10	15	20
Max. permissible time (s)	5	2	0.5
Power output stage clock frequency (kHz)	16		
Nominal current (A_{RMS})	2.5		
Max. output current (A_{RMS})	5	7.5	10
Max. permissible time (s)	5	2	0.5

Table 18: ARS 2310 SE: rated current values for a blocked or slow-running motor (f_{el}) ≤ 5 Hz and for an ambient temperature ≤ 40°C

Parameter	Values		
Power output stage clock frequency (kHz)	≤ 5		
Nominal current (A_{RMS})	10		
Max. output current (A_{RMS})	20	30	40
Max. permissible time (s)	5	0.1	0.07
Power output stage clock frequency (kHz)	10		
Nominal current (A_{RMS})	7		
Max. output current (A_{RMS})	14	21	28
Max. permissible time (s)	5	0.1	0.06
Power output stage clock frequency (kHz)	16		
Nominal current (A_{RMS})	3.45		
Max. output current (A_{RMS})	6.9	10.35	13.8
Max. permissible time (s)	5	0.2	0.15

Table 19: ARS 2310 SE: rated current values for a rotating motor (f_{el}) ≥ 20 Hz and for an ambient temperature ≤ 40°C

Parameter	**Values**		
Power output stage clock frequency (kHz)	≤ 5		
Nominal current (A_{RMS})	10		
Max. output current (A_{RMS})	20	30	40
Max. permissible time (s)	5	2	0.5
Power output stage clock frequency (kHz)	10		
Nominal current (A_{RMS})	7		
Max. output current (A_{RMS})	14	21	28
Max. permissible time (s)	5	2	0.5
Power output stage clock frequency (kHz)	16		
Nominal current (A_{RMS})	3.45		
Max. output current (A_{RMS})	6.9	10.35	13.8
Max. permissible time (s)	5	2	0.5

4.5 Angle encoder connector [X2A] and [X2B]

The universal shaft encoder interface enables the connection of various types of feedback systems to the ARS 2300 SE series servo drives:

- Resolvers (interface [X2A])
- Encoders (interface [X2B])
  - Incremental encoders with analogue and digital track signals
  - SinCos encoders (single-turn/multi-turn) with HIPERFACE®
  - Multi-turn absolute encoders with EnDat

The encoder type is determined via the Metronix ServoCommander® parameterisation software.

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

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 to [X2B] as the feedback system for the positioning control.

4.5.1 Resolver connector [X2A]

The 9-pin D-SUB connector [X2A] is used to evaluate standard resolvers. Single- and multi-pole resolvers are supported. The number of pole pairs of the resolver must be specified by the user in the "Motor Data" menu of the ServoCommander® parameterisation program so that the ARS 2300 SE can determine the speed correctly. The number of pole pairs of the motor (P_{0motor}) is always an integer multiple of the number of pole pairs of the resolver ($P_{0resolver}$). Incorrect combinations, e.g. $P_{0resolver} = 2$ and $P_{0motor} = 5$, will result in an error message during the motor identification process.

The resolver offset angle, which is automatically determined during the identification process, is a read/write value for service purposes.

Table 20: Technical data: resolver [X2A]

Parameter	Value
Transformation ratio	0.5
Carrier frequency	5 to 10 kHz
Excitation voltage	7 V_{RMS}, short circuit-proof
Excitation impedance (at 10 kHz)	≥ (20 + j20) Ω
Stator impedance	≤ (500 + j1000) Ω

Table 21: Technical data: resolver interface [X2A]

Parameter	Value
Resolution	16 bits
Signal detection delay	< 200 µs
Speed resolution	approx. 4 rpm
Absolute angle detection accuracy	< 5 ´
Max. speed	16,000 rpm

4.5.2 Encoder connector [X2B]

The 15-pin D-SUB connector [X2B] can be used for the feedback of encoder-equipped motors. Possible incremental encoders for the encoder connector can be divided into several groups. If you want to use other types of encoders, please contact your sales partner.

Table 22: Technical data: encoder evaluation [X2B]

Parameter	Value
Parameterisable number of encoder lines	1 - 2^{18} lines/revolution
Angular resolution/interpolation	10 bits/period
Track signals A, B	1 V_{PP} differential; 2.5 V offset
Track signals N	0.2 to 1 V_{PP} differential; 2.5 V offset
Commutation track A1, B1 (option)	1 V_{PP} differential; 2.5 V offset
Track signal input impedance	Differential input 120 Ω
Limit frequency	f_{limit} > 300 kHz (high-resolution track) f_{limit} approx. 10 kHz (commutation track)
Additional communication interface	EnDat (Heidenhain) and HIPERFACE® (Sick-Stegmann)
Supply output	5 V or 12 V; 300 mA max; current-limited Cont sensor lines Setpointprogr

Standard incremental encoders without commutation signals:

This type of encoder is used for low-cost linear motor applications in order to save the costs for the provision of the commutation signals (Hall sensor). With this type of encoder, the ARS 2300 SE series servo drives perform an automatic pole position determination after power-on.

Standard incremental encoders with commutation signals:

This variant uses standard incremental encoders with three additional, binary Hall sensor signals. The line count of the encoder can be parameterised as desired (1 to 16,384 lines/revolution).

There is an additional offset angle for the Hall sensor signals. It is determined during the motor identification process or it can be set via the Metronix ServoCommander® parameterisation software. Normally, the Hall sensor offset angle is zero.

Sick-Stegmann encoders:

Shaft encoders with HIPERFACE® made by Sick-Stegmann are supported in their single-turn and multi-turn variants. The following encoder models can be connected:

- Single-turn SinCos encoders: SCS 60/70, SKS 36, SRS 50/60/64, SEK 34/37/52
- Multi-turn SinCos encoders: SCM 60/70, SKM 36, SRM 50/60/64, SEL 34/37/52
- Single-turn SinCos encoders for hollow shaft drives: SCS-Kit 101, SHS 170, SCK 25/35/40/45/50/53
- Multi-turn SinCos encoders for hollow shaft drives: SCM-Kit 101, SCL 25/35/40/45/50/53

In addition, the following Sick Stegmann encoder systems can be connected and evaluated:

- Absolute, non-contact length measuring system L230 and TTK70 (HIPERFACE®)
- Digital incremental encoder CDD 50

SinCoder® encoders like SNS 50 or SNS 60 are no longer supported.

Heidenhain encoders:

Incremental and absolute encoders by Heidenhain can be evaluated. The following encoder models can be connected:

- Analogue incremental encoders: ROD 400, ERO 1200/1300/1400, ERN 100/400/1100/1300
- Single-turn absolute encoders (EnDat 2.1/2.2): ROC 400, ECI 1100/1300, ECN 100/400/1100/1300
- Multi-turn absolute encoders (EnDat 2.1/2.2): ROQ 400, EQI 1100/1300, EQN 100/400/1100/1300
- Absolute length measuring system (EnDat 2.1/2.2): LC 100/400

Yaskawa encoders:

Digital incremental encoders with index pulse [Σ (sigma 1), Yaskawa OEM protocol] made by Yaskawa are supported.

4.6 Communication interfaces

4.6.1 USB [X19]

Table 23: Technical data: USB [X19]

Communication interface	Values
Function	USB 2.0, Slave–Client, 12 MBaud to 480 MBaud
Connector type	USB-B, no current consumption from the bus (integrated power supply)
Protocol	Metronix-specific (generic device)

4.6.2 Ethernet [X18]

Table 24: Technical data: Ethernet [X18]

Communication interface	Values
Function	Ethernet, 10/100 MBaud (automatic selection)
Connector type	RJ45

4.6.3 CAN bus [X4]

Table 25: Technical data: CAN bus [X4]

Communication interface	Values
CANopen controller	ISO/DIS 11898, full CAN controller, 1 MBaud max.
CANopen protocol	As per DS301 and DSP402

4.6.4 SD/SDHC/MMC card

Table 26: Technical data: SD/SDHC/MMC card

Communication interface	Values
Card type	SD, SDHC, and MMC
File system	FAT12, FAT16, and FAT32

4.6.5 I/O interface [X1]

Table 27: Technical data: digital inputs and outputs [X1]

Digital inputs/outputs	Values	
Signal level	24 V (8 V ... 30 V) active high, compliant with DIN EN 61131-2	
Logic inputs (general) DIN 0 DIN 1 DIN 2 DIN 3	 Bit 0 \ (lsb → least significant bit) Bit 1 \ target selection for positioning Bit 2 / 16 targets selectable from target table Bit 3 / (msb → most significant bit)	
DIN 4	Control input for power stage enable at high signal	
DIN 5	Servo drive enable at high signal, error acknowledgement with falling edge	
DIN 6	Limit switch input 0	
DIN 7	Limit switch input 1	
DIN 8	Control signal for positioning start or Homing switch for homing or saving of positions	
DIN 9	Control signal for positioning start or Homing switch for homing or saving of positions	
Logic outputs (general)	Electrically isolated, 24 V (8 V ... 30 V) active high	
DOUT 0	Ready for operation	24 V, 100 mA max.
DOUT 1	Freely configurable	24 V, 100 mA max.
DOUT 2	Freely configurable, optional use as input DIN 10	24 V, 100 mA max.
DOUT 3	Freely configurable, optional use as input DIN 11	24 V, 100 mA max.
DOUT 4 [X6]	Holding brake	24 V, 2 A max.

Table 28: Technical data: analogue inputs and outputs [X1]

Analogue inputs/outputs	Values	
High-resolution analogue input, AIN 0	± 10 V input range, 16 bits, differential, < 250 µs delay time	
Analogue input, AIN 1	As an option, this input can also be parameterised as a digital input DIN AIN 1 with a switching threshold of 8 V	± 10 V, 10 bits, single ended, < 250 µs delay time
Analogue input, AIN 2	As an option, this input can also be parameterised as a digital input DIN AIN 2 with a switching threshold of 8 V	± 10 V, 10 bits, 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	

4.6.6 Incremental encoder input [X10]

The input supports all standard incremental encoders.

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

As an alternative, the A and B track signals of the device are interpreted as pulse direction signals by the device so that the servo drive can also be controlled by stepper motor control boards.

Table 29: Technical data: incremental encoder input [X10]

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

4.6.7 Incremental encoder output [X11]

The output provides incremental encoder signals that can be processed in superordinate control systems.

The signals are generated based on the angle of rotation of the encoder with a freely programmable line count.

In addition to the track signals A and B, the emulation also provides an index pulse. Once per revolution, this index pulse turns high (for the programmed number of lines) for ¼ of a signal period (as long as the track signals A and B are high).

Table 30: Technical data: incremental encoder output [X11]

Parameter	Value
Number of lines	Programmable 1 - 2^{13} and 2^{14} lines/revolution
Connection level	Differential/RS422 specification
Track signals A, B, N	In accordance with the RS422 specification
Special feature	N track can be deactivated
Output impedance	$R_{out,diff}$ = 66 Ω
Limit frequency	f_{limit} > 1.8 MHz (lines/s)
Edge sequence	Can be limited by way of parameters
Supply output	5 V, 100 mA max.

5 Function overview

5.1 Motors

5.1.1 Synchronous servomotors

In a typical application, permanent-magnet synchronous machines with a sinusoidal EMF are used. The ARS 2300 SE series devices are universal servo drives that can be operated with standard servomotors. The motor specifications are determined and parameterised by an automatic motor identification system.

5.1.2 Linear motors

In addition to rotary applications, ARS 2300 SE servo drives are also suitable for linear drives. In this case, too, permanent-magnet synchronous linear motors are supported. Due to the high signal processing quality, the ARS 2300 SE series is particularly suitable for driving air-core and iron-core synchronous motors with a low motor inductance (2 … 4 mH).

5.2 Functions of the ARS 2300 SE servo drives

5.2.1 Compatibility

For reasons of compatibility, the control structure of the ARS 2300 SE servo drives has more or less the same characteristics, interfaces, and parameters as the previous ARS series.

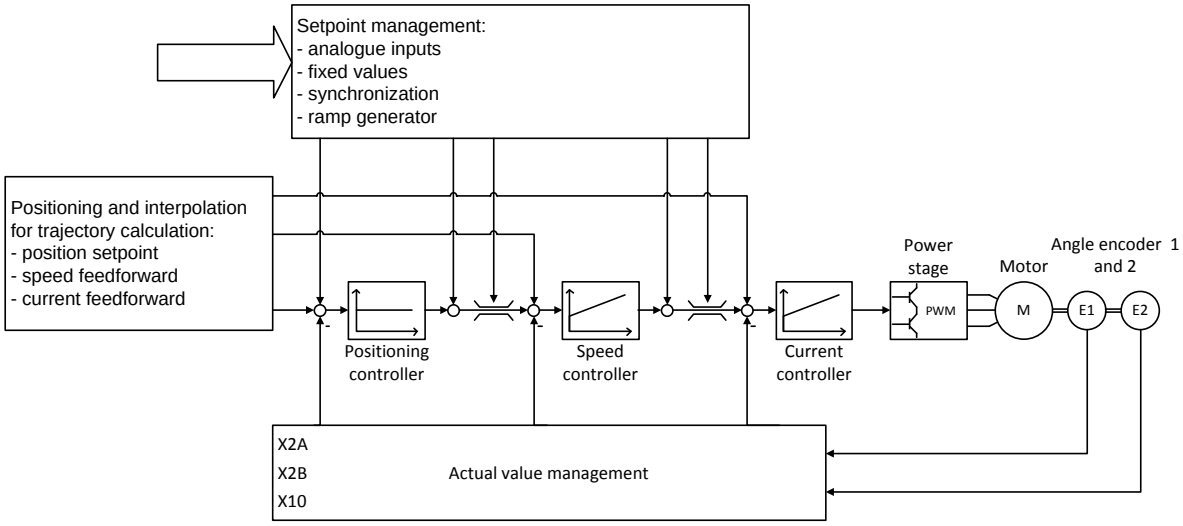


Figure 2: Control structure of the ARS 2300 SE

Figure 2 shows the control structure of the ARS 2300 SE. The current controller, speed controller, and positioning controller are arranged in a cascade. Due to the rotor-oriented control principle, the current can be set separately as active current (i_q) and reactive current (i_d). Therefore, there are two current controllers, both of them PI controllers. However, to provide a better overview, the i_d controller is not included in *Figure 2*.

The basic operating modes are torque control, speed control, and positioning.

Other functions, such as synchronisation, "flying saw", etc., are variants of these basic operating modes. Furthermore, individual functions of these operating modes can be combined, e.g. torque control with speed limitation.

5.2.2 Pulse width modulation (PWM)

The ARS 2300 SE servo drives can vary the clock frequency in the current controller circuit. In most cases, the clock frequency can be set via the Metronix ServoCommander® parameterisation software. In order to minimise switching losses, the clock frequency of the pulse width modulation can be reduced by half compared to the frequency in the current controller circuit.

The ARS 2300 SE servo drives also feature 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® parameterisation software. Sine modulation is the default setting.

If 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 31: Output voltage at the motor terminals in the case of a DC bus circuit voltage (U_{ZK}) of 560 V

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

5.2.3 Setpoint management

The setpoint for the torque and speed control modes can be set via a setpoint management system.

Possible setpoint sources are:

- 3 analogue inputs:
  - AIN 0, AIN 1, and AIN 2
- 3 fixed values:
  - First value: depending on the controller enabling logic:
    - Fixed value 1 or
    - CANopen bus interface
  - Second and third value: fixed values 2 and 3
- SYNC input
- Additional incremental encoder input [X10]

If no setpoint source is activated, the setpoint is zero.

The setpoint management system has a ramp generator with a preceding adder. Via the corresponding selectors, any of the above mentioned setpoint sources can be selected and run through the ramp generator. Additional sources can be selected as setpoints by way of two additional selectors. These, however, cannot be run through the ramp generator. The total setpoint is the sum of all of the values. The ramp can be parameterised as the acceleration or deceleration time depending on the direction.

5.2.4 Torque-controlled mode

In the torque-controlled mode, a certain torque is preset and generated in the motor by the servo drive. 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 operating mode is used if the motor speed is to be kept constant regardless of the acting load. The motor speed exactly follows the speed that is defined by the setpoint management system.

The cycle time of the speed control loop for the ARS 2300 SE servo drive is twice the PWM period, thus typically 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 when subsidiary limits are reached.

In the speed control mode, only the current controller and speed controller are active. If the setpoints are set via analogue setpoint inputs, a "safe zero" can be defined as an option. If the analogue setpoint is within this range, the setpoint is set to zero ("dead zone"). This can suppress interferences or offset drifts. The "dead zone" function can be activated and deactivated as an option and the scope can be set.

The actual speed and position are determined by the encoder system inside the motor, which is also used for commutation. For the actual value feedback for speed control, any encoder interface may be selected (e.g. a reference encoder or a corresponding system at the external incremental encoder input). The actual speed value for the speed controller is then fed back, e.g. via the external incremental encoder input.

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

5.2.6 Torque-limited speed control

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

- Fast updating of the limit value, e.g. in a 200 µs cycle
- Addition of two sources of limitation (e.g. for servo control values)

5.2.7 Synchronisation with external clock signals

The servo drives use sinusoidal constrained current operation. The cycle time is always bound to the PWM frequency. In order to synchronise the device control with external clock signals (e.g. CANopen), the device has a corresponding PLL. Accordingly, the cycle time varies within certain limits to enable the synchronisation with the external clock signal. For the synchronisation with an external clock signal, the user must enter the nominal value of the synchronous cycle time.

5.2.8 Load torque compensation in the case of vertical axes

For vertical axis applications, the holding torque at standstill can be determined and stored. It is then added to the torque control loop and improves the start-up behaviour of the axes when the holding brake is released.

5.2.9 Positioning and position control

In the positioning mode, a superordinate position controller is active in addition to the speed control. It processes the deviations between the actual position and set position and converts them into the corresponding setpoints for the speed controller.

The position controller is a P controller. By default, the cycle time of the position control loop 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 position controller is activated, it receives its setpoints from the positioning control system or from the synchronisation control system. The internal resolution is up to 32 bits per motor revolution (depending on the encoder). This issue is discussed in detail in chapter 5.3.

5.2.10 Synchronisation, electronic gear unit

The ARS 2300 SE servo drives can be used in a master-slave configuration, hereinafter referred to as "synchronisation". The servo drives can be a master or a slave.

If the ARS 2300 SE servo drive is the master, it can provide the slave with its current rotor position via 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]. 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 the communication interfaces or via digital inputs.

Please refer to the Software Manual "Servo drives ARS 2000" for further information.

5.2.11 Brake management

The ARS 2300 SE servo drives can directly actuate a holding brake. The holding brake is operated with programmable delay times. In the positioning mode, an additional automatic braking function can be activated.This automatic braking function switches the power output stage of the ARS 2300 SE servo drives off after a parameterised idle time and engages the brake. This mode of operation is compatible with the functions of the previous ARS and ARS 2000 series.

5.2.12 Contouring control with linear interpolation

The implementation of the "interpolated position mode" enables the specification of position setpoints in a multi-axis application of the servo drive. For this purpose, position setpoints are specified by a superordinate control system in a fixed time pattern (synchronisation interval). If this interval exceeds a position controller 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 feedforward.

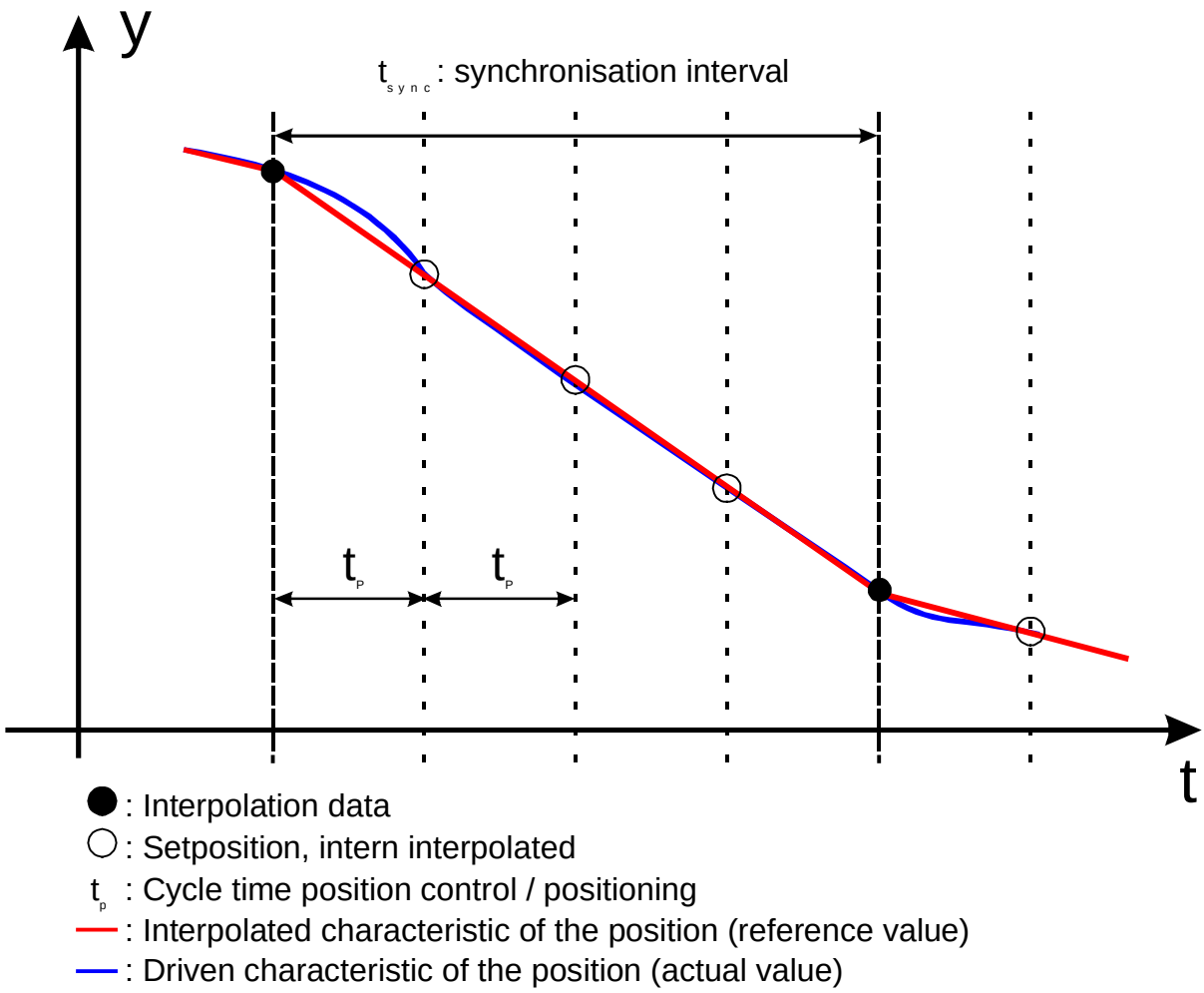


Figure 3: Linear interpolation between two data values

5.2.13 Time-synchronised multi-axis positioning

The implementation of clock synchronisation enables simultaneous movements for multi-axis applications in conjunction with the "interpolated position mode". All of the servo drives of the ARS 2300 SE series, i.e. the entire controller cascade, will be synchronised with the external clock signal. As a result, any pending positioning values in the case of multiple axes will be taken over and executed simultaneously without jitter. The sync message of a CAN bus system, for example, can be used as a clock signal.

As a result, several axes with different path lengths and speeds can reach a target at the same time.

5.2.14 Electronic cam discs

The term "(electronic) cam disc" describes applications in which an input angle or an input position is reproduced as an angle setpoint or as a position setpoint through a function. Typically, these applications are master-slave applications.

The ARS 2300 SE servo drive can realise the following functions via the Metronix ServoCommander® parameterisation software:

- Loading of cam discs with cam switches and axis error compensation from an Excel table
- Display, activation, and online manipulation of cam discs
- Mapping of the trip cams to digital outputs
- Display and activation of the axis error compensation
- Loading and saving of cam discs with cam switches and axis error compensation by way of DCO files
- Display of an active cam disc or axis error compensation in the commands window

Please refer to the Software Manual "Servo drives ARS 2000" for further information.

5.3 Positioning control

5.3.1 Overview

In the positioning mode, a certain position is specified. This position is to be approached by the motor. The current position is determined based on the information that is provided by the internal encoder evaluation. The position deviation is processed in the position controller and passed on to the speed controller.

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

In the case of absolute positioning, a specified target position is directly approached. In the case of relative positioning, the system moves over the parameterised distance.

The positioning control is parameterised via a target table with 256 entries and additional position sets, which are reserved for the communication interfaces (fieldbuses). The setting options for each position set (see below) can be parameterised in a free manner. All that the user has to do for performing the positioning is to select a position set and to issue a start command. Optionally, it is possible to specify the number of the desired position set via the digital inputs. Up to 8 digital inputs can be used for coding the position set number (2^8 options ➔ 256 position sets).

The following settings are possible for the position sets:

- Target position
- Speed of movement
- Final speed
- Acceleration
- Deceleration
- Torque feedforward control
- Remaining distance message
- Additional flags:
  - Relative/relative to last target/absolute
  - Wait for end/interrupt/ignore start
  - Synchronised
  - Rotary axis
  - Option: automatic deceleration if no follow-up positioning is specified
  - Various options for the set-up of path programs

The position sets can be activated via the bus systems or via the Metronix ServoCommander® parameterisation software. 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. As this does not require a fixed zero point, homing is not compulsory. However, it is often useful in order to bring the drive to a defined position.

When several relative positioning sequences are added to one another, e.g. for a trimming unit or a conveyor belt, endless positioning in one direction is possible (chain dimension).

5.3.3 Absolute positioning

In the case of absolute positioning, the target position is a fixed (absolute) position with regard to the zero point or reference point. The position target is approached independently of the current position. In order to perform an absolute positioning process, we recommend referencing (homing) the drive beforehand.

5.3.4 Motion profile generator

In terms of the motion profiles, time-optimal and jerk-limited positioning can be distinguished. 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 speed profile is a curve of third order. Since the acceleration changes steadily, the drive movement is particularly gentle with regard to the mechanical system.

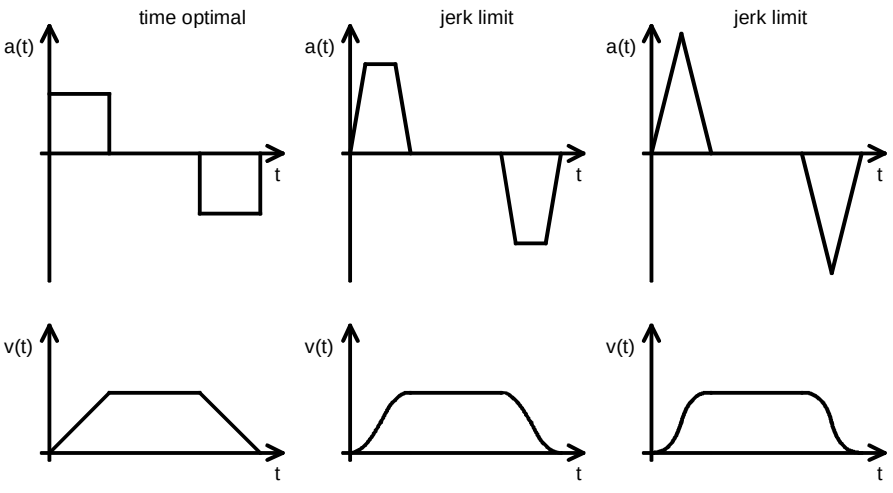


Figure 4: Motion profiles of the ARS 2300 SE servo drive

5.3.5 Homing

Every positioning control requires a defined zero at start-up, which is determined by way of a homing operation. The ARS 2300 SE servo drive can do this homing on its own. It evaluates several inputs, e.g. the limit switch inputs, as the reference signal.

Homing can be started by way of a command via the communication interface or automatically when the servo drive is enabled. Optionally, it is also possible to configure the start via a digital input by way of the Metronix ServoCommander® parameterisation software in order to perform a homing process in a targeted manner regardless of whether the servo drive has been enabled or not. Among other things, the servo drive enable acknowledges error messages (with a falling edge), for example, and can be switched off depending on the application without requiring another homing operation when the servo drive is enabled once again. Since the existing digital inputs are all used in the case of standard applications, the analogue inputs AIN 1 and AIN 2 can optionally be used as digital inputs DIN AIN 1 and DIN AIN 2, and the digital outputs DOUT 2 and DOUT 3 as digital inputs DIN 10 and DIN 11.

For homing, several different methods have been implemented following the DSP 402 CANopen protocol. Most methods usually try to locate a switch at search speed. The subsequent movement depends on the method and type of communication. If a homing process is activated via the fieldbus, there will be no follow-up positioning to the zero position. This can be done optionally during the start process via the servo drive enable signal. A follow-up positioning run is always possible as an option. The default setting is "no follow-up positioning run".

It is possible to parameterise ramps and speed values for the homing run. Homing can also be performed in a time-optimal or jerk-free manner.

5.3.6 Positioning sequences (path program)

Positioning sequences consist of a series of position sets. These are completed one after the other. A position set can become part of a path program. The result is a linked list of positions:

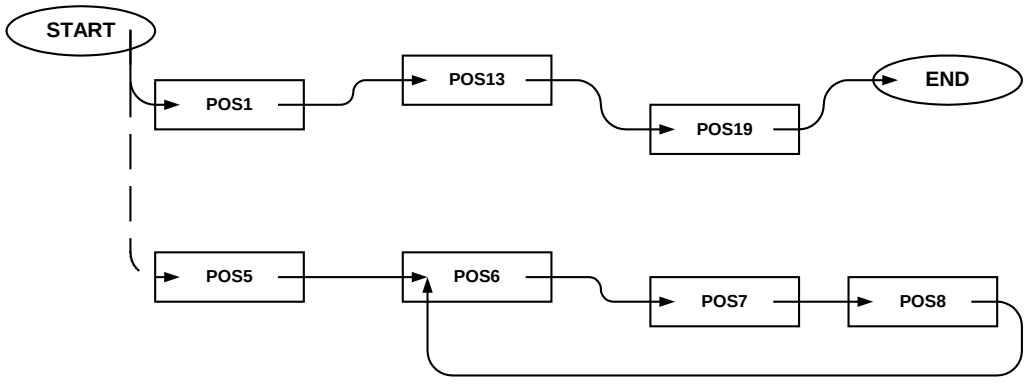


Figure 5: Path program

The user defines the position sequence that is to be performed via the **start position of the path program**. Linear or cyclic sequences are possible.

The start position of a path program can be defined:

- via fieldbus
- via digital inputs

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

Please refer to the Software Manual "Servo drives ARS 2000" for further information.

5.3.7 Optional stop input

The optional stop input can interrupt the running positioning process by setting the specified digital input. When the digital input is reset, the positioning process continues to the original target position.

5.3.8 Jogging mode and teach-in mode

Jogging is the controlled movement of a drive to a specific position. The drive continues to move as long as a specific input signal is active.

The ARS 2300 SE servo drive supports the jogging mode in a positive and negative direction. A separate speed of movement and separate accelerations can be specified for every direction. In addition, it is possible to specify one input for jogging in a positive direction and one input for jogging in a negative direction. (Metronix ServoCommander®: "Parameters/IOs/Digital inputs")

Teach-in mode: The position that is approached in the jogging mode can be saved in a position set by way of the Metronix ServoCommander® parameterisation program.
(Menu: "Parameters/Positioning/Go to destination")

Please refer to the Software Manual "Servo drives ARS 2000" for further information.

6 Functional safety technology

This section provides information on the ARS 2000 SE servo drives with the integrated safety function STO ("Safe Torque Off").

6.1 General

With an increasing degree of automation, the protection of persons against dangerous movements becomes increasingly important. Functional safety describes the necessary measures in the form of electrical or electronic devices for the reduction or elimination of hazards caused by malfunctions. Under normal operating conditions, protective devices prevent access of persons to dangerous areas. In certain operating modes, however, for example during the set-up, persons are required to be present in these dangerous areas. In these situations, the machine operator must be protected by drive- and control-internal measures.

The integrated safety technology provides the control- and drive-specific conditions for the optimal realisation of protective functions. Planning and installation become less labour-intensive. Compared to conventional safety technology, the machine functionality and availability can be increased by the use of integrated safety technology.

In their delivery state, the ARS 2000 SE servo drives with STO are equipped with any integrated functions for safety-related motion monitoring and motion control.

6.2 Description of the integrated safety function STO

Use the "Safe Torque Off" (STO) function if you need to disconnect the motor safely from the energy supply for your application.

The "Safe Torque Off" function switches the driver supply for the power semiconductors off. This prevents the power output stage from providing the voltage that is required by the motor. As a result, the motor cannot start unexpectedly, see *Figure 6*.

Please refer to the Product Manual "STO (Safe Torque Off) for the servo drives ARS 2000 SE" for further information.

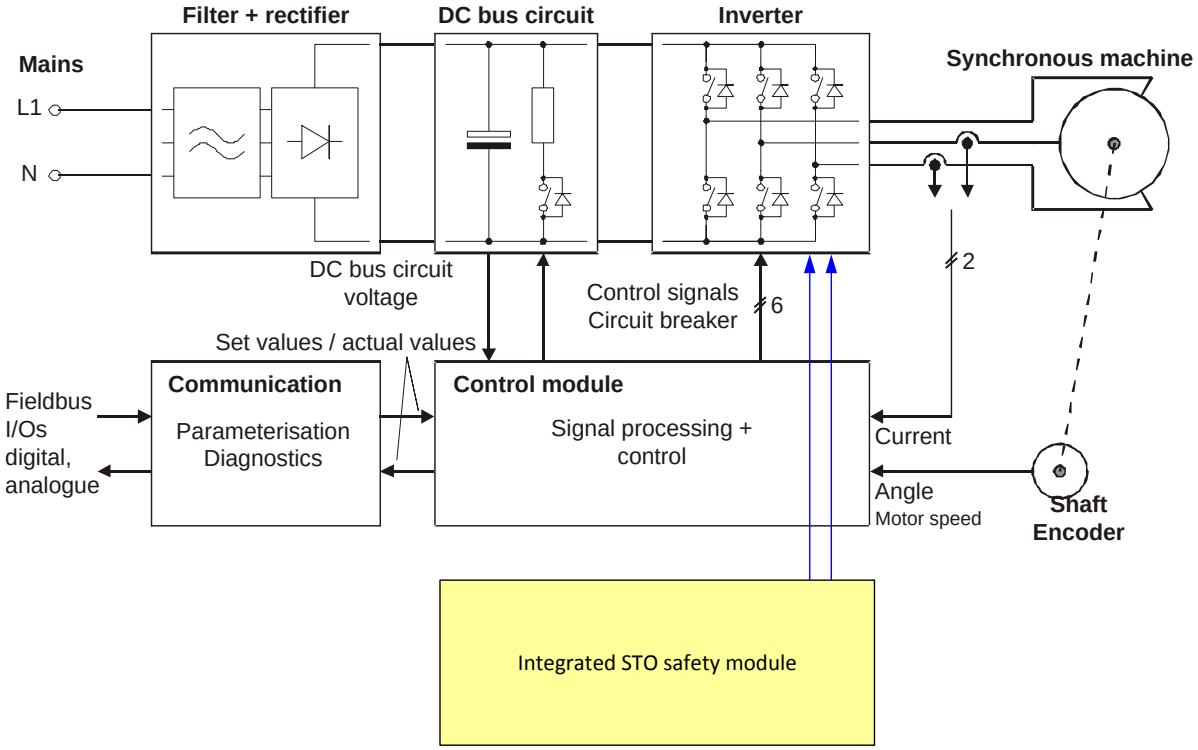


Figure 6: Schematic representation of the integrated safety function STO

7 Mechanical installation

7.1 Important notes

- Only use the ARS 2300 SE servo drives as built-in devices for switch cabinets.
- Vertical mounting position with supply lines [X9] on top.
- Mount it to the control cabinet plate using the fastening tab.
- Installation clearance:
  Keep a minimum distance of 100 mm above and under the device with regard to other components in order to ensure sufficient ventilation.
  For optimal wiring of the motor cable and angle encoder cable under the device, an installation clearance of 150 mm is recommended!
- Mounting clearance:
  The ARS 2300 SE servo drives may be installed directly next to one another on a heat-dissipating back plate, provided that they are installed properly and used as intended. Please note that excessive heat may cause premature ageing of and/or damage to the device. In case the ARS 2300 SE servo drives are subject to high thermal stress, a mounting clearance of 75 mm is recommended (see *Figure 7*).

The device views and connections shown in the following illustrations apply to the servo drives ARS 2302 SE, ARS 2305 SE, and ARS 2310 SE!

7.2 Installation space and mounting clearance

Figure 7: Servo drive ARS 2310 SE with and without STO: installation space and mounting clearance

7.3 Device view

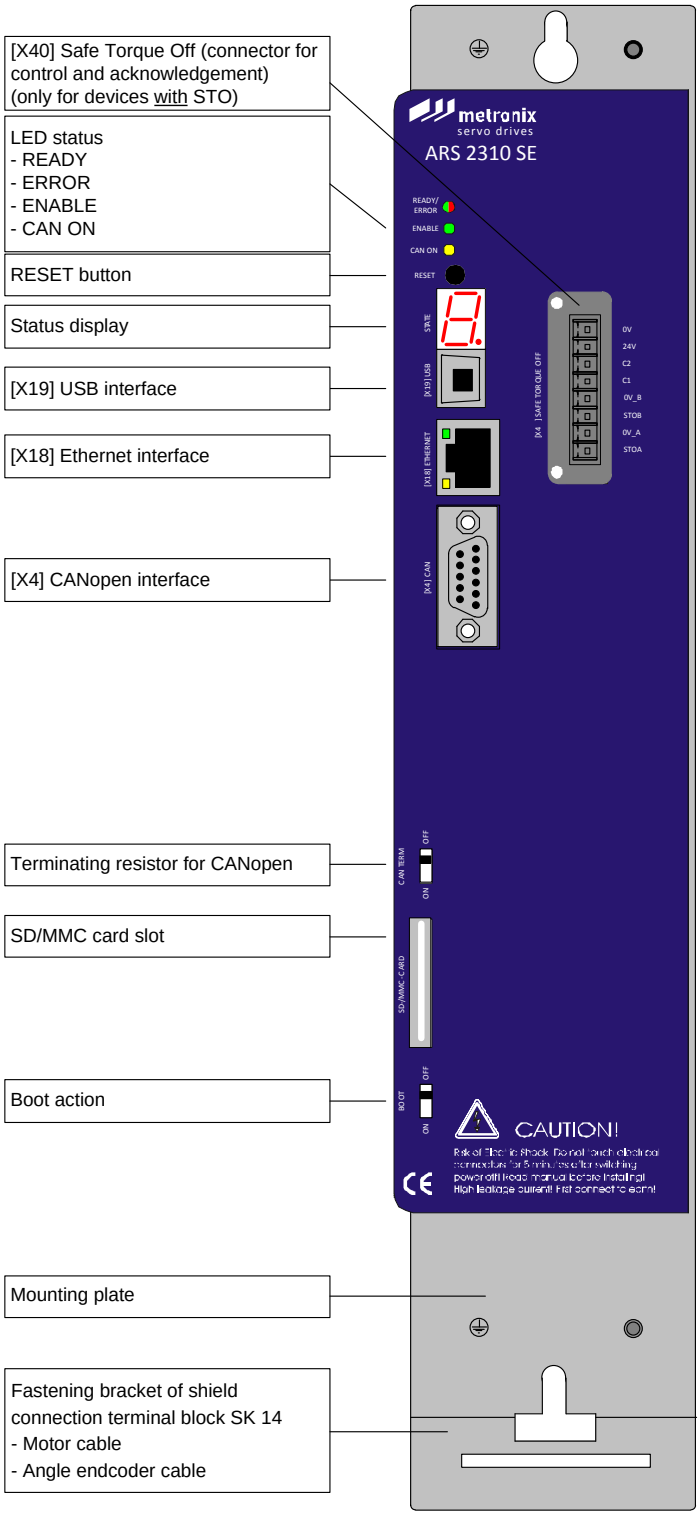


Figure 8: Servo drive ARS 2310 SE: front view

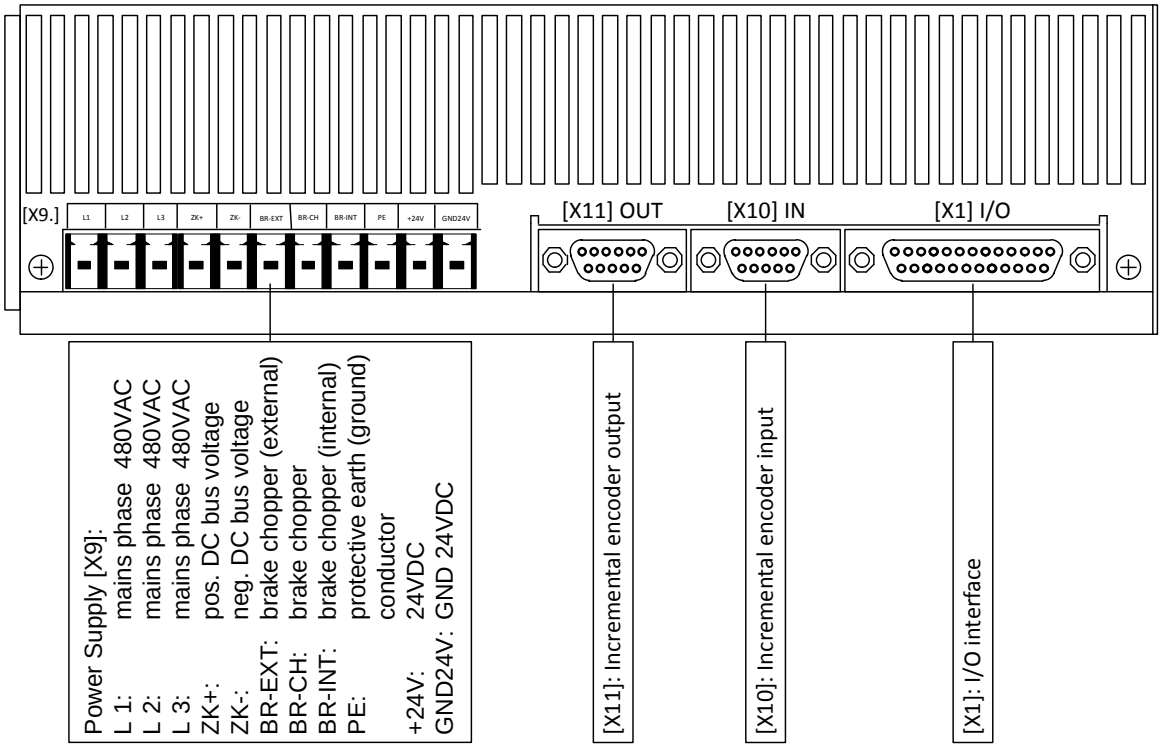


Figure 9: Servo drive ARS 2302 SE: view from above

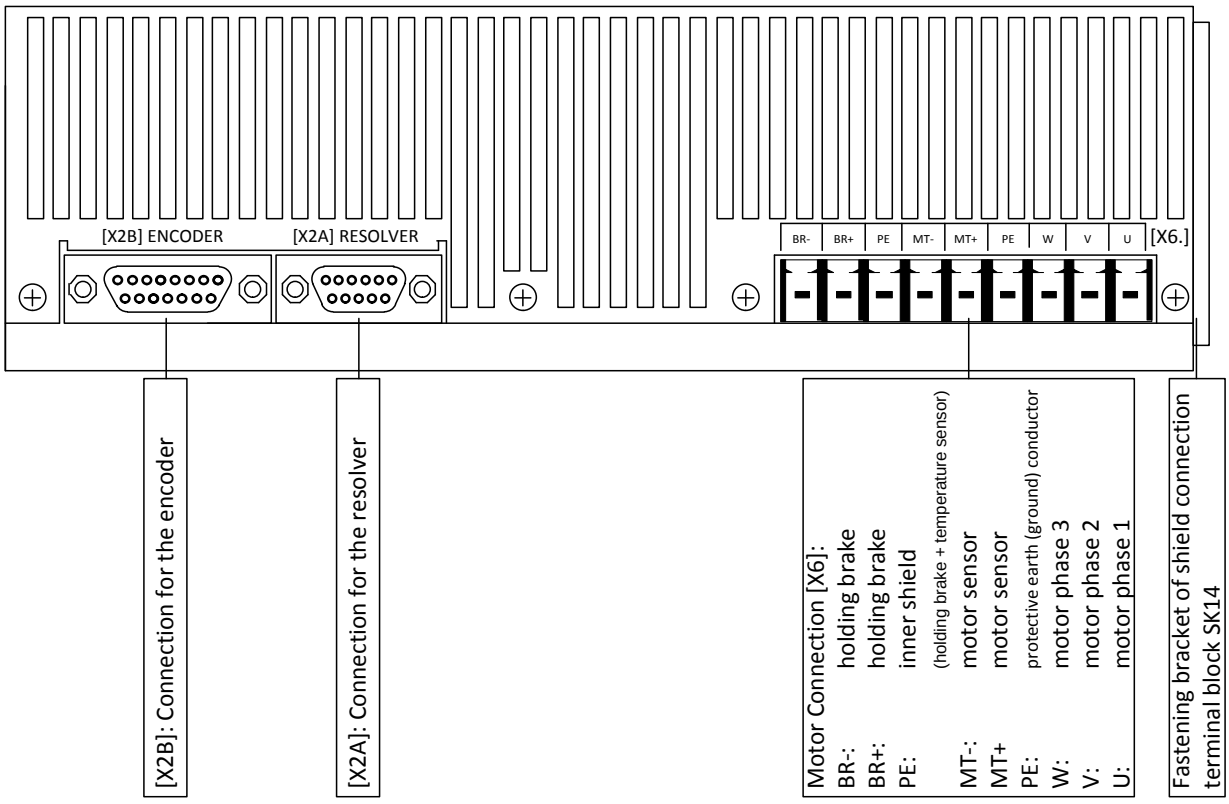


Figure 10: Servo drive ARS 2302 SE: view from below

7.4 Installation

The ARS 2300 SE servo drives have fastening tabs at the top and the bottom. These tabs are used to mount the servo drive vertically to a control cabinet plate. The tabs are part of the heat sink profile. This is why the best possible heat transfer to the control cabinet plate must be ensured. Recommended tightening torque for an M5 screw of property class 5.6: 2.8 Nm.

Please use M5 screws for the mounting of the servo drives ARS 2302 SE, ARS 2305 SE, and ARS 2310 SE.

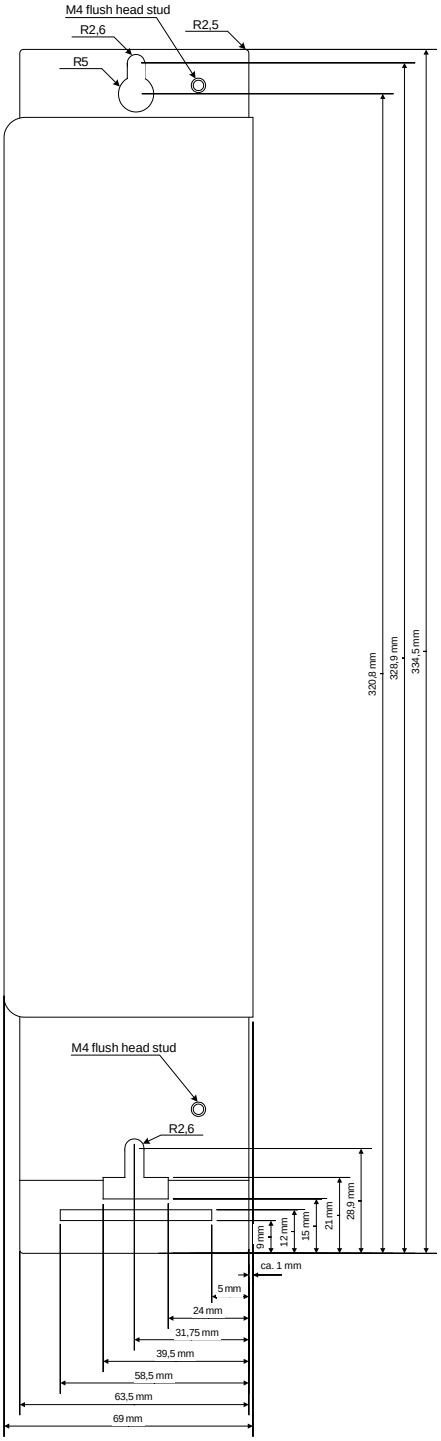


Figure 11: Servo drive ARS 2300 SE: mounting plate

8 Electrical installation

8.1 Connector configuration

The ARS 2300 SE series servo drives are connected to the supply voltage, motor, braking resistor, and holding brake as shown in *Figure 12*.

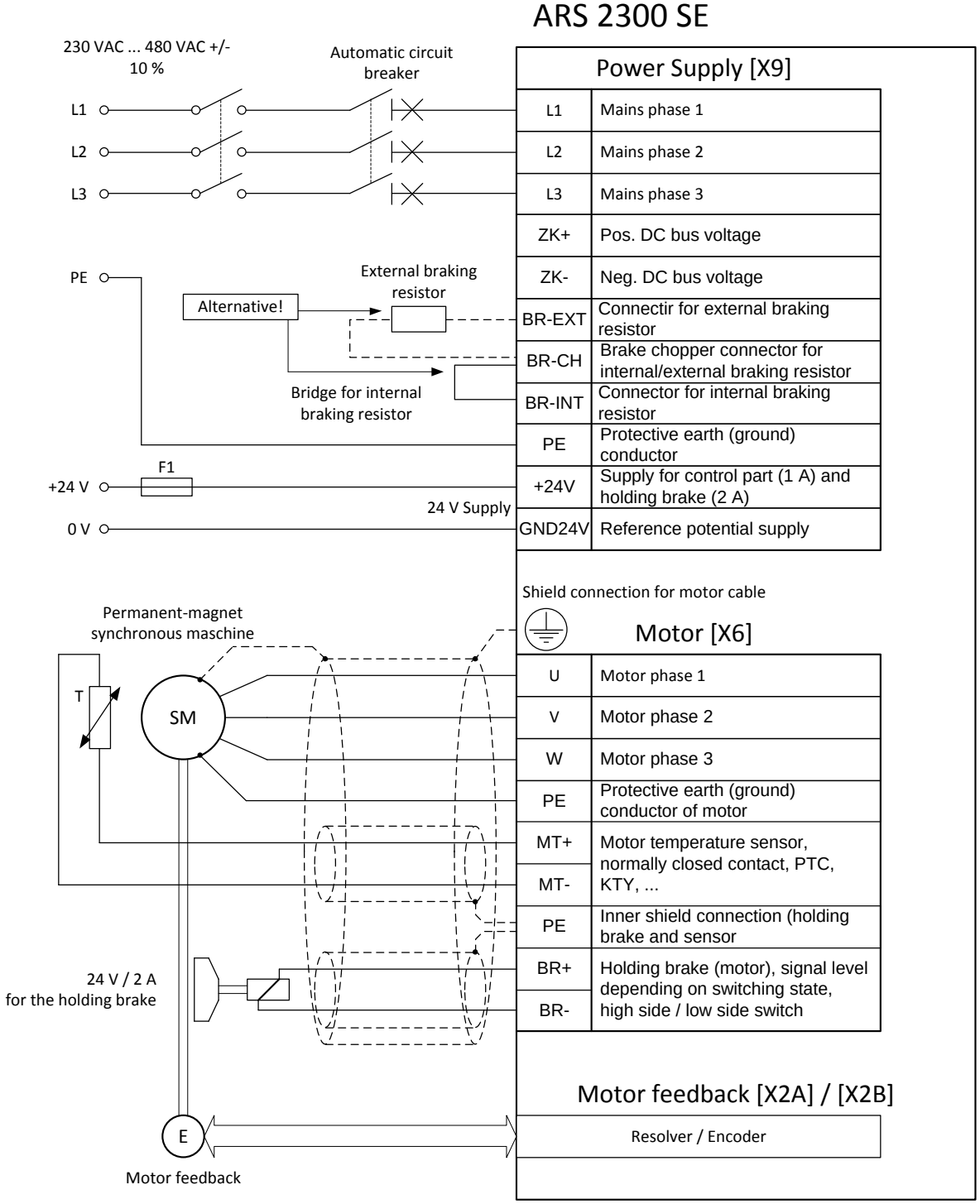


Figure 12: Connection to the power supply [X9] and motor [X6]

The ARS 2300 SE requires a 24V power supply for the electronic system. This power supply must be connected to the terminals +24V and GND24V.

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

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

The connection of the shaft encoder to [X2A] / [X2B] via the D-Sub connector is shown in a schematic manner in *Figure 12*.

The servo drive must be connected to earth (ground) with its PE connector.

As a first step, the servo drive must be completely wired. It is only then that the operating voltages for the DC bus circuit and the electronic supply may be switched on.

Caution!

The servo drive will be damaged in the following cases:

- reverse connection of the operating voltage connections,
- excessive operating voltage, or
- accidental interchanging of the operating voltage and motor connectors!

Caution! Hazardous voltage.

The signals for the temperature sensors "MT-" (PIN 4) and "MT+" (PIN 5) at the motor connector [X6] are not connected to protective extra-low voltage (PELV). (PELV - Protective Extra Low Voltage). These connections are designed for temperature sensors that are not safely separated. The safe separation with regard to the protective extra-low voltage (PELV) is realised inside the ARS 2000 SE.

8.2 ARS 2300 SE – complete system

A complete system with an ARS 2300 SE servo drive is shown in *Figure 13*. The following components are required for the operation of the servo drive:

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

The parameterisation requires a PC with a USB port.

A slow-blow (B16), three-phase, 16A automatic circuit breaker must be installed in the mains power supply line.

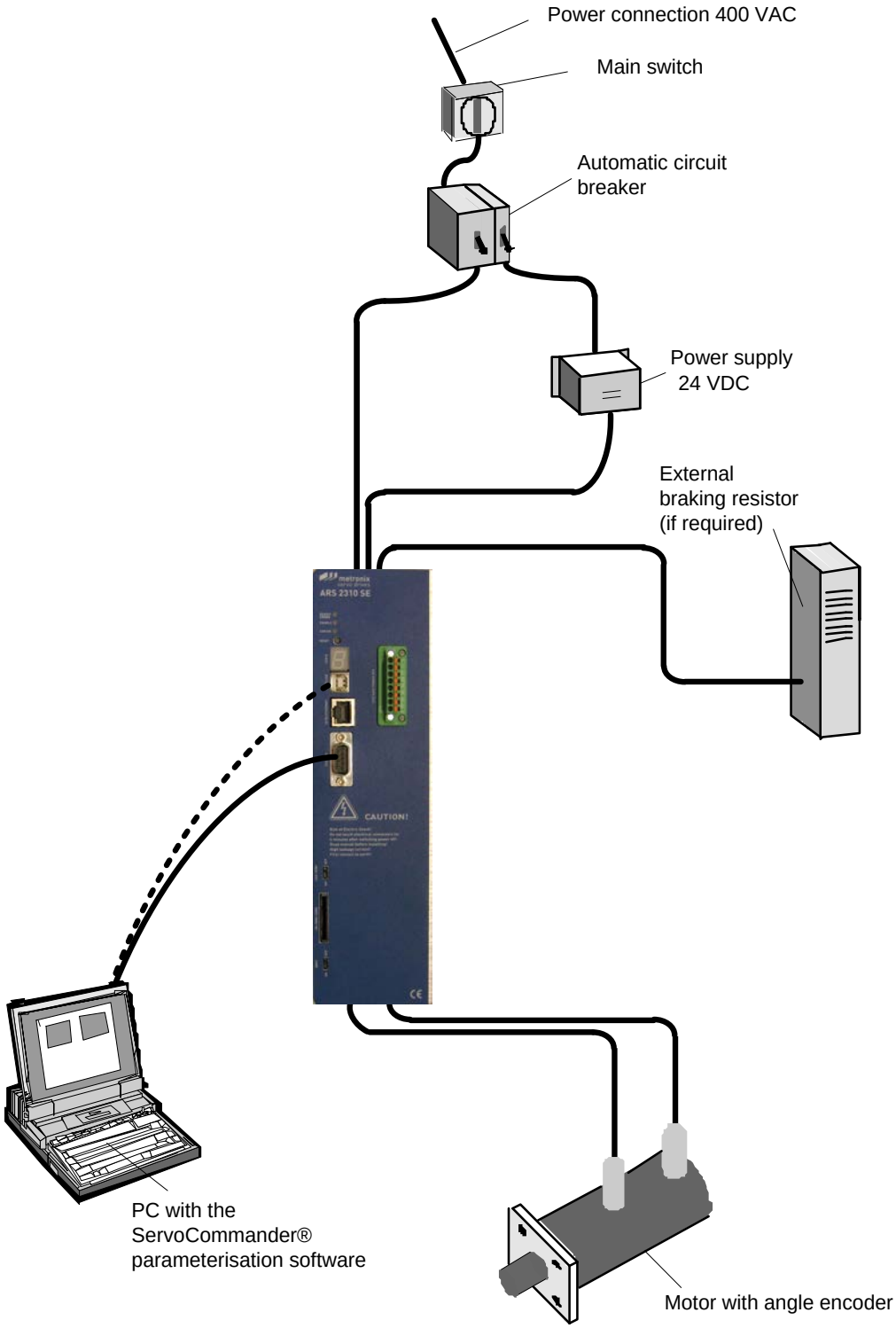


Figure 13: Complete set-up of the ARS 2300 SE (example with STO) with a motor and PC

8.3 Connector: power supply [X9]

The ARS 2300 SE servo drives receive their 24 VDC power supply for the electronic control system via connector [X9].

The mains power supply is a three-phase system. As an alternative to AC power supply or for the purpose of DC bus circuit linking, a direct DC supply for the DC bus circuit is possible.

8.3.1 Configuration on the device [X9]

- PHOENIX Power-COMBICON PC 4/11-G-7.62 BK

8.3.2 Mating connector [X9]

- PHOENIX Power-COMBICON PC5/11-ST1-7.62 BK

8.3.3 Pin assignment [X9]

Table 32: Pin assignment [X9]

Pin no.	Name	Value	Specification
1	L1	230 ... 480 VAC [± 10%], 50 ... 60 Hz	Mains phase 1
2	L2		Mains phase 2
3	L3		Mains phase 3
4	ZK+	< 700 VDC	Pos. DC bus circuit voltage
5	ZK-	GND_ZK	Neg. DC bus circuit voltage
6	BR-EXT	< 800 VDC	Connection of the external braking resistor
8	BR-CH	< 800 VDC	Brake chopper, connection for the internal braking resistor against BR-INT or of the external braking resistor against ZK+
7	BR-INT	< 800 VDC	Connection of the internal braking resistor (bridge to BR-CH when using the internal resistor)
9	PE	PE	Connection of the protective earth (ground) conductor of the mains power supply
10	+24V	24 VDC [± 20%], 1 A *)	Supply voltage for the control module and holding brake
11	GND24V	GND (0 VDC)	Supply voltage reference potential

*) plus the current consumption of a holding brake and I/Os (if included)

8.3.4 Cable type and configuration [X9]

The cable names that are stated refer to cables made by Lapp. They have proved 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 the 400 V supply:

- LAPP KABEL ÖLFLEX CLASSIC 110; 4 x 1.5 mm²

8.3.5 Connection notes [X9]

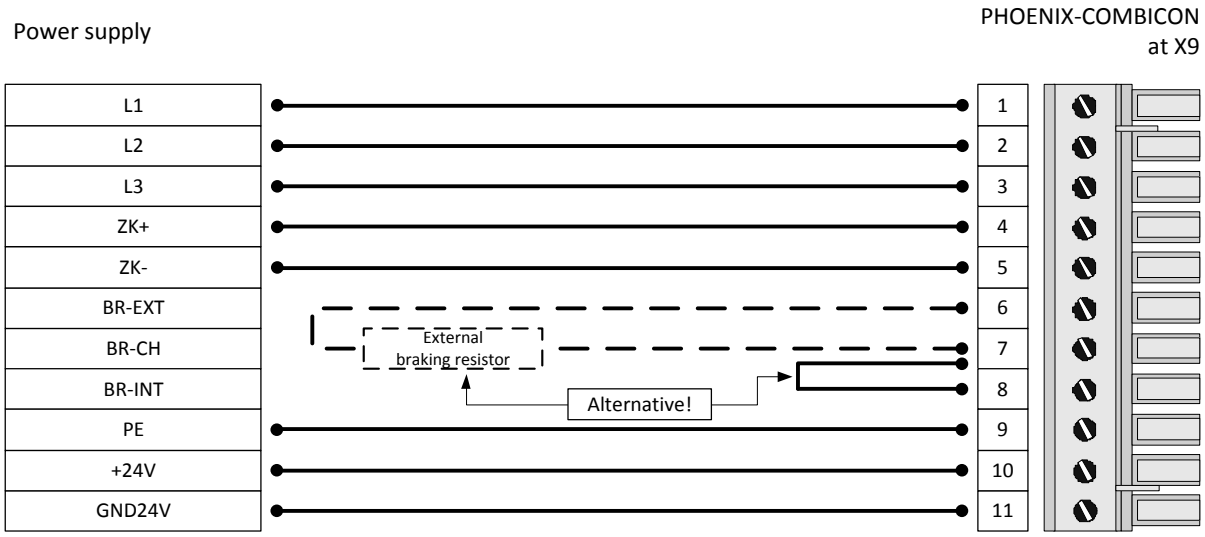


Figure 14: Power supply [X9]

The ARS 2300 SE servo drive has an internal brake chopper and braking resistor. For more braking power, an external braking resistor can be connected to the [X9] pin-and-socket connector.

Table 33: Pin-and-socket connector [X9]: external braking resistor

Pin no.	Name	Value	Specification
6	BR-EXT	< 800 VDC	Connection of the external braking resistor
7	BR-CH	< 800 VDC	Brake chopper connection for the internal braking resistor against BR-INT and for the external braking resistor against BR-EXT
8	BR-INT	< 800 VDC	Connection of the internal braking resistor (bridge to BR-CH when using the internal resistor)

If no external braking resistor is used, a bridge must be connected between pin 7 and pin 8 so that the precharging of the DC bus circuit at mains power "ON" and the rapid discharge of the DC bus circuit are operational!

8.4 Connector: motor [X6]

8.4.1 Configuration on the device [X6]

❖ PHOENIX Power-COMBICON PC 4/9-G-7.62 BK

8.4.2 Mating connector [X6]

❖ PHOENIX Power-COMBICON PC5/9-ST1-7.62 BK

8.4.3 Pin assignment [X6]

Table 34: Pin assignment [X6]

Pin no.	Name	Value	Specification
1	BR-	0 V brake	Holding brake (motor), signal level depending on the switching state, high-side/low-side switch
2	BR+	24 V brake	
3	PE	PE	Inner shield connection (holding brake + temperature sensor)
4	MT-	GND	Motor temperature sensor[1)], normally closed contact, normally open contact, PTC, NTC, KTY
5	MT+	+ 3.3 V/5 mA	
6	PE	PE	Protective earth (ground) conductor of the motor
7	W	0 ... 360 V_{RMS}	Connection of the three motor phases
8	V	0 ... 2.5 A_{RMS} ARS 2302 SE 0 ... 5 A_{RMS} ARS 2305 SE 0 ... 10 A_{RMS} ARS 2310 SE	
9	U	0 ... 1000 Hz	

[1)] Please refer to *chapter 9 Additional requirements to be fulfilled by the servo drives for UL approval*, *page 108.*

In addition, the outer cable shield of the motor cable must be connected to the mounting plate of the servo drive housing over a large contact area with the aid of shield terminal SK14.

8.4.4 Cable type and configuration [X6]

The cable names that are stated refer to cables made by Lapp. They have proved 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.

Caution!

Please comply with the minimum copper cross-section for the cables in accordance with the standard EN 60204-1!

- ARS 2302 SE:
  LAPP KABEL ÖLFLEX SERVO 700 CY; 4 G 1.5 + 2 x (2 x 0.75); ∅ 12.7 mm, with tinned CU overall shielding
- ARS 2305 SE and ARS 2310 SE:
  LAPP KABEL ÖLFLEX SERVO 700 CY; 4 G 2.5 + 2 x (2 x 0.75); ∅ 14.9 mm, with tinned CU overall shielding

For highly flexible applications:

- ARS 2302 SE:
  LAPP KABEL ÖLFLEX SERVO FD 755 P; 4 G 1.5 + 2 x (2 x 0.75) CP; ∅ 14.1 mm, with tinned CU overall shielding for highly flexible use in drag chains
- ARS 2305 SE and ARS 2310 SE:
  LAPP KABEL ÖLFLEX SERVO FD 755 P; 4 G 2.5 + 2 x (2 x 0.75) CP; ∅ 15.1 mm, with tinned CU overall shielding for highly flexible use in drag chains

8.4.5 Connection notes [X6]

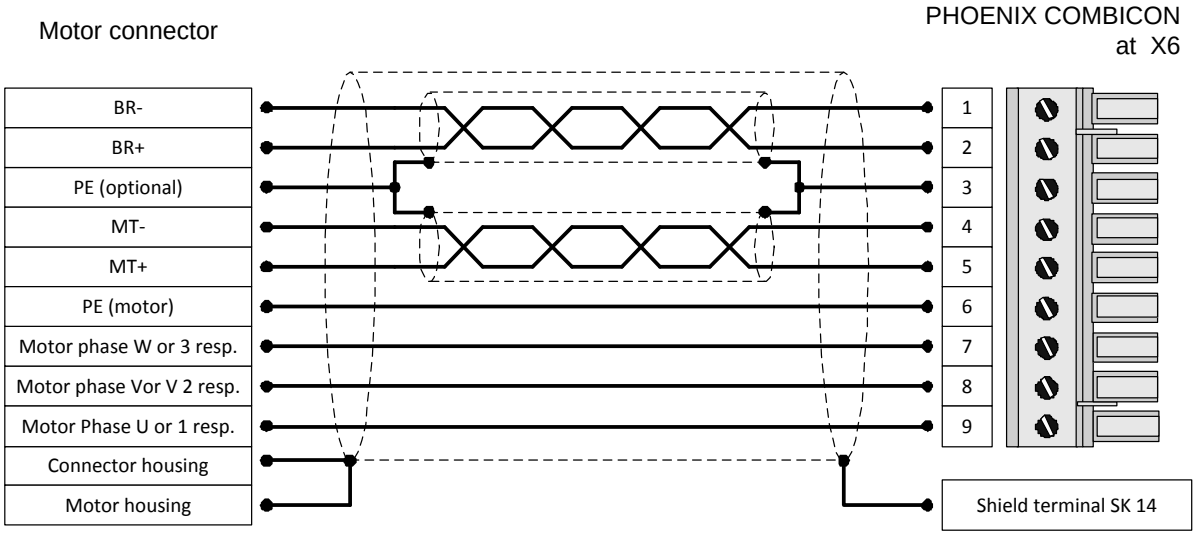


Figure 15: Motor connector [X6]

- ❖ Connect the inner shields to PIN 3. Maximum length: 40 mm.
- ❖ Maximum length of the unshielded cores: 35 mm.
- ❖ Connect the overall shield on the servo drive side over a large contact area by way of shield terminal SK14.
- ❖ Connect the overall shield on the motor side to the connector or motor housing over a large contact area. Maximum length: 40 mm.

The DC bus circuits of several ARS 2300 SE servo drives can be interconnected via the terminals ZK+ and ZK-. Coupling of DC bus circuits is interesting for applications with high braking energy levels or for applications requiring movements to be performed even in the case of a power failure.

Terminals BR+ and BR- can be used to connect a holding brake of the motor. The holding brake is supplied with power via the power supply of the servo drive. Please note the maximum output current that is provided by the servo drive. It may be necessary to connect a relay between the device and the holding brake as shown in *Figure 16*:

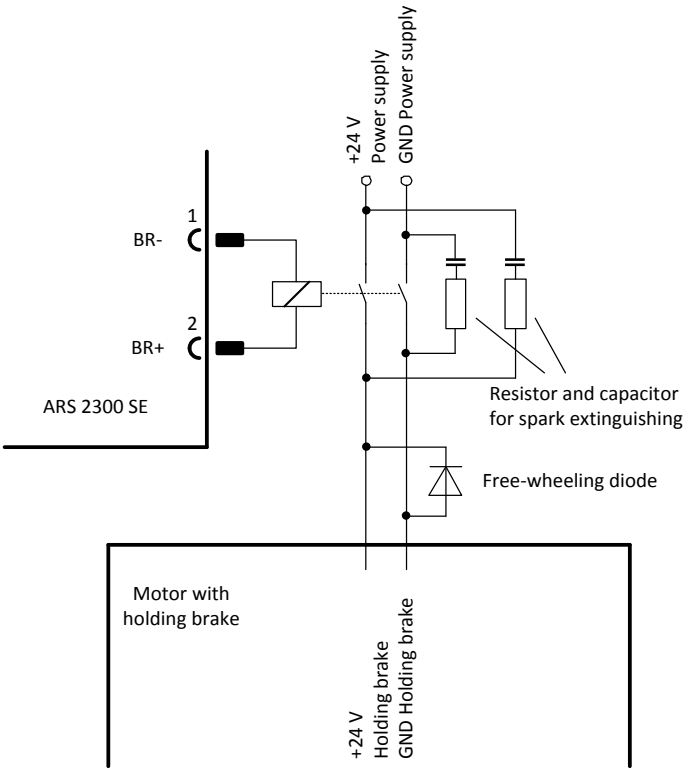


Figure 16: Connecting a locking brake with a high current demand (> 2 A) to the device

Switching of inductive direct current via relays produces strong currents and sparking. For interference suppression, we recommend using integrated RC suppressor elements, for example by Evox RIFA, product name: PMR205AC6470M022 (RC element with 22 Ω in series with 0.47 µF).

8.5 Connector: I/O communication [X1]

The following *Figure 17* shows the operating principle of the digital and analogue inputs and outputs. The ARS 2300 SE servo drive is shown on the right and the control system connection on the left. The cable configuration is also shown.

The servo drive ARS 2300 SE features two potential ranges:

Analogue inputs and outputs:

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

24 V inputs and outputs:

These signals refer to the 24 V supply voltage of the ARS 2300 SE servo drive, which is supplied via [X9]. They are separated from the reference potential of the control module by way of optocouplers.

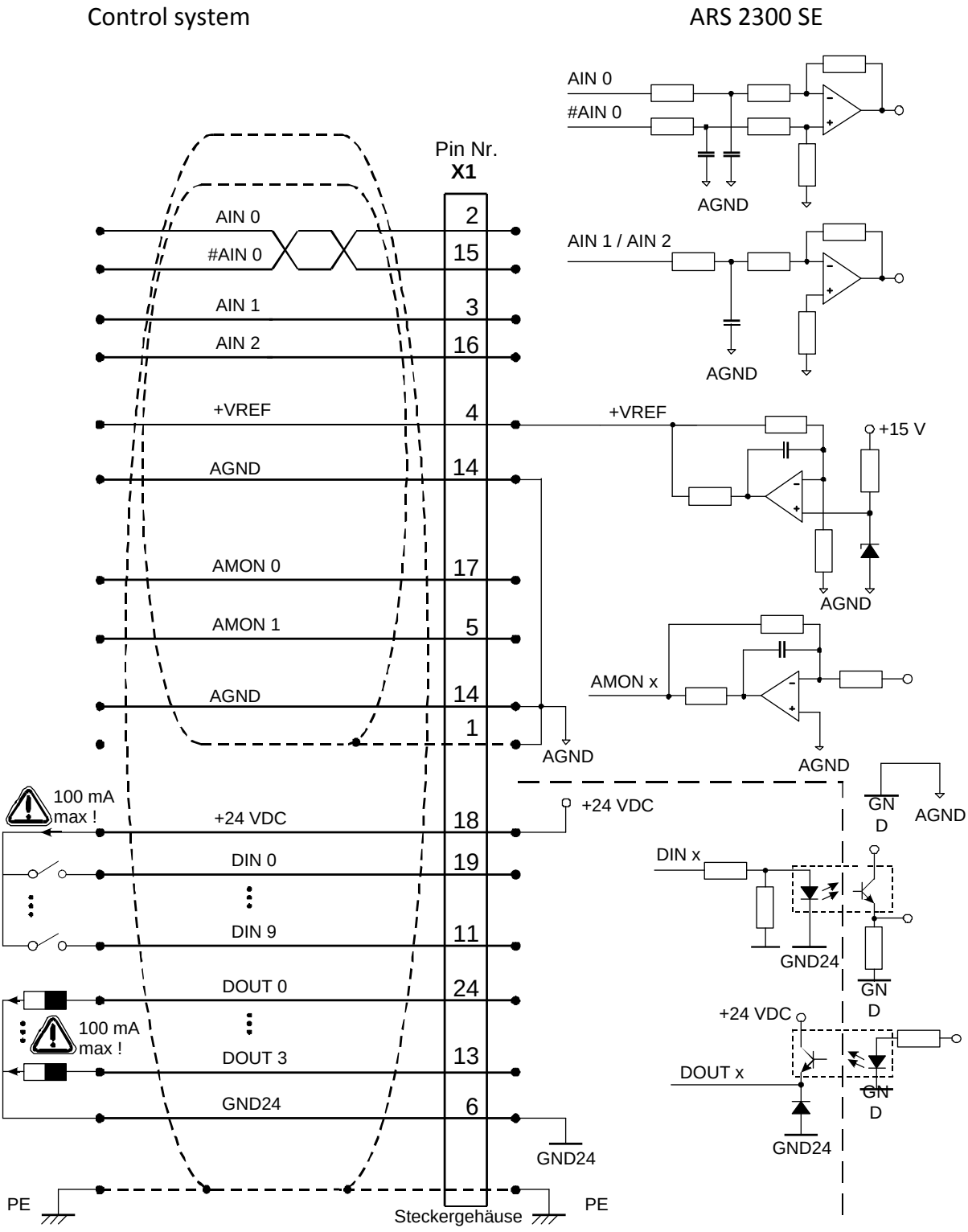


Figure 17: Basic circuit diagram of connector [X1]

The ARS 2300 SE servo drive has one differential (AIN 0) and two single-ended analogue inputs for input voltages in the range of ±10 V. The inputs AIN 0 and #AIN 0 are led to the control system via twisted cables (twisted-pair type).

If the control system is equipped with single-ended outputs, the output is connected to AIN 0 and #AIN 0 is connected to the reference potential of the control system. If the control system is equipped

with differential outputs, they are to be connected 1:1 to the differential inputs of the ARS 2300 SE 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 SE servo drive from being overridden by high "common-mode interference".

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

8.5.1 Configuration on the device [X1]

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

8.5.2 Mating connector [X1]

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

8.5.3 Pin assignment [X1]

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

Pin no.		Name	Value	Specification
1		AGND	0 V	Shield for analogue signals, AGND
	14	AGND	0 V	Reference potential for analogue signals
2		AIN 0	U_{in} = ± 10 V $R_I \geq 30$ kΩ	Setpoint input 0, differential, max. 30 V input voltage
	15	#AIN 0		
3		AIN 1	U_{in} = ± 10 V $R_I \geq 30$ kΩ	Setpoint inputs 1 and 2, single-ended, max. 30 V input voltage
	16	AIN 2		
4		+VREF	+ 10 V	Reference output for the setpoint potentiometer
	17	AMON 0	± 10 V	Analogue monitor output 0
5		AMON 1	± 10 V	Analogue monitor output 1
	18	+24V	24 V/100 mA	Auxiliary voltage for I/Os at X1
6		GND24	Ref. GND	Reference potential for digital I/Os
	19	DIN 0	POS Bit 0	Target selection positioning bit 0
7		DIN 1	POS Bit 1	Target selection positioning bit 1
	20	DIN 2	POS Bit 2	Target selection positioning bit 2
8		DIN 3	POS Bit 3	Target selection positioning bit 3
	21	DIN 4	FG_E	Power output stage enable
9		DIN 5	FG_R	Servo drive enable input
	22	DIN 6	END 0	Limit switch 0 input (locks n < 0)
10		DIN 7	END 1	Limit switch 1 input (locks n > 0)
	23	DIN 8	START	Input for the start of the positioning process
11		DIN 9	SAMP	High-speed input
	24	DOUT 0 / READY	24 V/100 mA	Output for operational readiness
12		DOUT 1	24 V/100 mA	Freely programmable output
	25	DOUT 2	24 V/100 mA	Freely programmable output
13		DOUT 3	24 V/100 mA	Freely programmable output

8.5.4 Cable type and configuration [X1]

The cable names that are stated refer to cables made by Lapp. They have proved 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 (TP); 25 x 0.25 mm²; ∅ 10.7 mm

Figure 17 shows the cable between the ARS 2300 SE servo drive and the control system. The cable that is shown has two cable shields.

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

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

Despite the differential design of the analogue inputs of the ARS 2300 SE servo drive, using unshielded cables for the analogue signals is not recommended, since interferences, e.g. caused by switching contactors, or output power stage interferences of the converters can reach high amplitudes. They inject themselves into the analogue signals and lead to common-mode interferences, which may lead to deviations of the analogue values.

In the case of a limited cable length (l < 2 m, wiring inside the control cabinet), the outer dual-sided PE shield is sufficient for guaranteeing a trouble-free operation.

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

8.5.5 Connection notes [X1]

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

The digital outputs are designed as so-called "high-side switches". This means that the 24 V of the ARS 2300 SE servo drive are actively switched through to the output. Loads such as lamps, relays, etc. are thus switched from the output to GND24. The four outputs DOUT 0 to DOUT 3 can be loaded with a maximum of 100 mA each. The outputs can also be led directly to the 24 V inputs of a PLC.

8.6 Connector: resolver [X2A]

8.6.1 Configuration on the device [X2A]

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

8.6.2 Mating connector [X2A]

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

8.6.3 Pin assignment [X2A]

Table 36: Pin assignment: [X2A]

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

In addition, the outer cable shield must be connected to the housing of the servo drive in a low-impedance manner. For this purpose, the outer cable shield of the angle encoder cable must be connected to the housing of the angle encoder connector.

8.6.4 Cable type and configuration [X2A]

The cable names that are stated refer to cables made by Lapp. They have proved 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 DY) + 2 x (0.5 DY) CY; ∅ 8.5 mm, with tinned CU overall shielding, error during the angle measurement up to approx. 1.5° with a cable length of 50 m
  - ➢ Use 2 x (0.5 DY) 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 overall shielding, error during the angle measurement up to approx 1.5° with a cable length of 50 m
  - ➢ Use 2 x (0.5 D12Y) for the resolver carrier!

8.6.5 Connection notes [X2A]

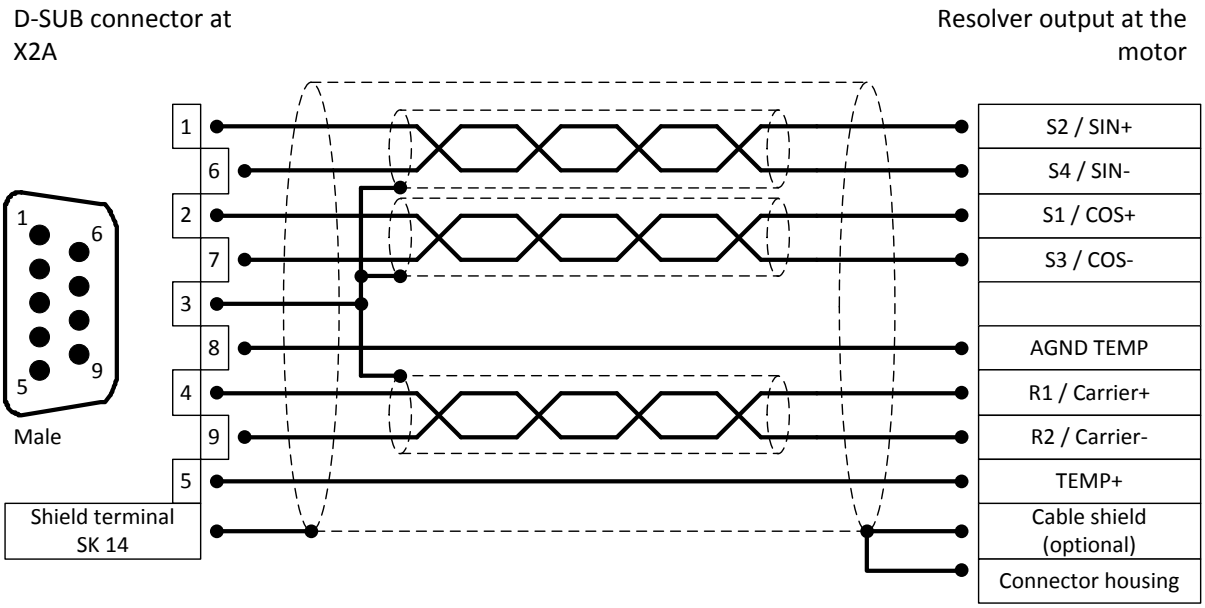


Figure 18: Pin assignment: resolver connector [X2A]

- ❖ The outer shield is always connected to PE (connector housing) on the servo drive side.
- ❖ The three inner shields are connected to PIN 3 of [X2A] on one side of the ARS 2300 SE servo drive.

8.7 Connector: encoder [X2B]

Various types of encoder types can be connected to the 15-pin D-Sub connector. They can be divided into three groups. The universal encoder input [X2B] can be used for one of the encoder types at a time.

- Analogue incremental encoder
- Incremental encoder with a serial interface (e.g. EnDat, HIPERFACE®)
- Digital incremental encoder

8.7.1 Configuration on the device [X2B]

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

8.7.2 Mating connector [X2B]

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

8.7.3 Pin assignment [X2B]

Table 37: Pin assignment: analogue incremental encoder [X2B]

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

[1)] Please refer to *chapter 9 Additional requirements to be fulfilled by the servo drives for UL approval*, *page 108.*

[2)] Heidenhain encoder: A=SIN_Z0; B=COS_Z0; C=SIN_Z1; D=COS_Z1

In addition, the outer cable shield must be connected to the housing of the servo drive in a low-impedance manner. For this purpose, the outer cable shield of the angle encoder cable must be connected to the housing of the angle encoder connector.

Table 38: Pin assignment: incremental encoder with serial interface (e.g. EnDat, HIPERFACE®) [X2B]

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

[1)] Please refer to *chapter 9 Additional requirements to be fulfilled by the servo drives for UL approval*, *page108.*

[2)] Heidenhain encoder: A=SIN_Z0; B=COS_Z0

In addition, the outer cable shield must be connected to the housing of the servo drive in a low-impedance manner. For this purpose, the outer cable shield of the angle encoder cable must be connected to the housing of the angle encoder connector.

Table 39: Pin assignment: digital incremental encoder [X2B]

Pin no.		Name	Value	Specification
1		MT+	+3.3 V / Ri = 2 kΩ	Motor temperature sensor[1)], normally closed contact, PTC, KTY ...
	9	U_SENS+	5 V ... 12 V $R_I \approx 1$ kΩ	Sensor cables for the encoder supply
2		U_SENS-		
	10	US	5 V / 12 V / ± 10% I_{max} = 300 mA	Operating voltage for high-resolution incremental encoders
3		GND	0 V	Reference potential for the encoder supply and motor temperature sensor
	11	N	2 V_{PP} … 5 V_{PP} RI ≈ 120 Ω	Index pulse RS422 (differential) of the digital incremental encoder
4		#N		
	12	H_U	0 V / 5 V RI ≈ 2 kΩ at VCC	Phase U of the Hall sensor for commutation
5		H_V		Phase V of the Hall sensor for commutation
	13	H_W		Phase W of the Hall sensor for commutation
6				
	14	A	2 V_{PP} … 5 V_{PP} RI ≈ 120 Ω	A track signal RS422 (differential) of the digital incremental encoder
7		#A		
	15	B	2 V_{PP} … 5 V_{PP} RI ≈ 120 Ω	B track signal RS422 (differential) of the digital incremental encoder
8		#B		

[1)] Please refer to *chapter 9 Additional requirements to be fulfilled by the servo drives for UL approval*, *page108.*

In addition, the outer cable shield must be connected to the housing of the servo drive in a low-impedance manner. For this purpose, the outer cable shield of the angle encoder cable must be connected to the housing of the angle encoder connector.

8.7.4 Cable type and configuration [X2B]

We recommend using the encoder connecting cables that have been approved for the product in question by the corresponding manufacturer (Heidenhain, Sick-Stegmann, etc.). If the manufacturer does not recommend a particular cable, we recommend configuring the encoder connecting 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.

8.7.5 Connection notes [X2B]

D-SUB connector at X2B

Output of the analogue incremental encoder interface at the motor

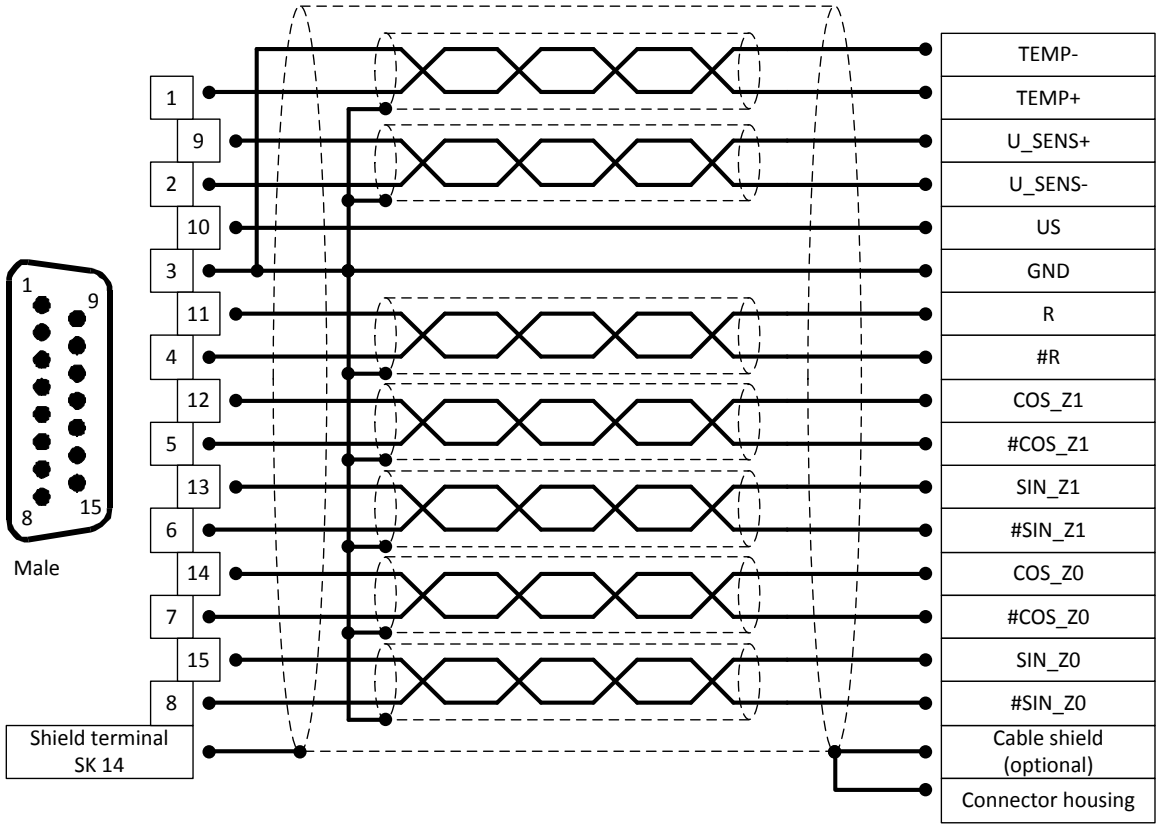


Figure 19: Pin assignment: analogue incremental encoder [X2B]

If an incorrect power supply is activated, the encoder may be destroyed! Ensure that the correct power supply is activated prior to connecting the encoder to [X2B]!

To do so, start the Metronix ServoCommander® parameterisation software and open the menu **Parameters/Device parameters/Angle encoder settings**.

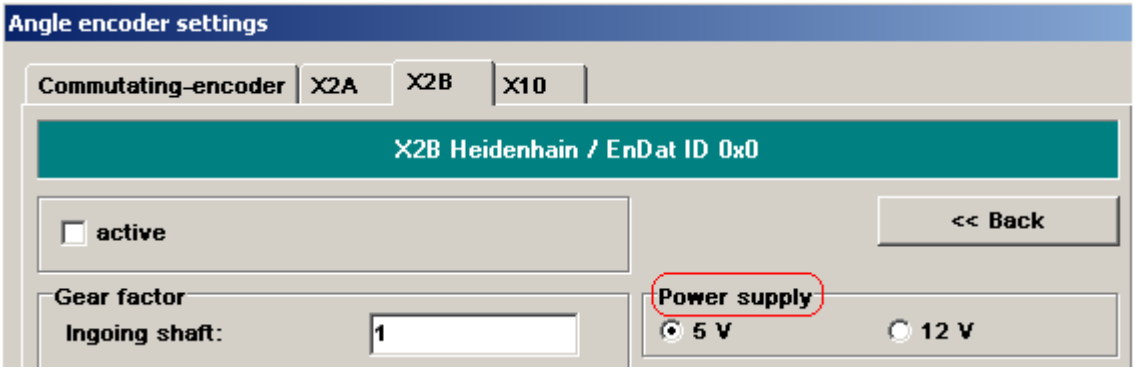


Figure 20: Metronix ServoCommander®: angle encoder settings [X2B]

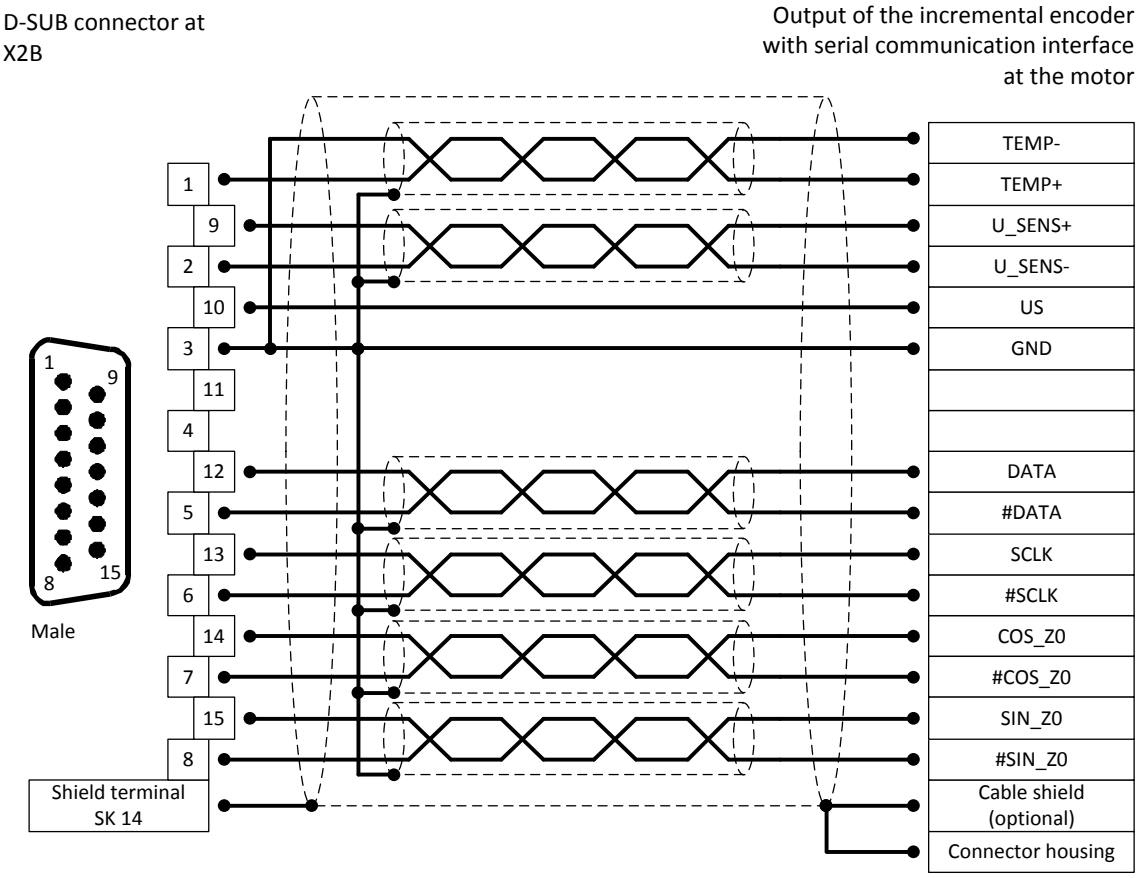


Figure 21: Pin assignment: incremental encoder with a serial interface (e.g. EnDat, HIPERFACE®) [X2B]

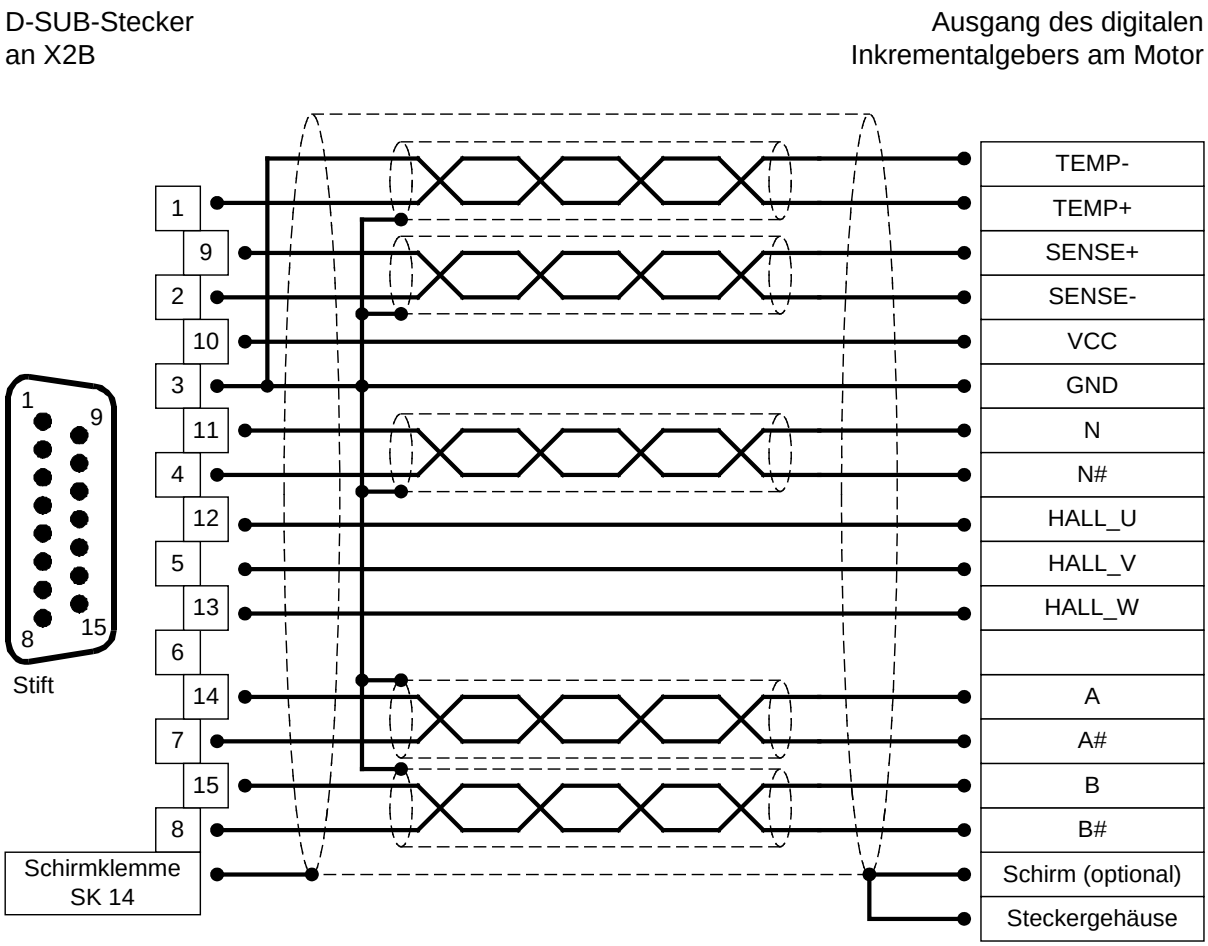


Figure 22: Pin assignment: digital incremental encoder [X2B]

8.8 Connector: incremental encoder input [X10]

8.8.1 Configuration on the device [X10]

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

8.8.2 Mating connector [X10]

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

8.8.3 Pin assignment [X10]

Table 40: Pin assignment: incremental encoder input [X10]

Pin no.		Name	Value	Specification
1		A / CLK	5 V / $R_i \approx 120\ \Omega$	Incremental encoder signal A / stepper motor signal CLK pos. polarity as per RS422
	6	A# / CLK#	5 V / $R_i \approx 120\ \Omega$	Incremental encoder signal A# / stepper motor signal CLK neg. polarity as per RS422
2		B / DIR	5 V / $R_i \approx 120\ \Omega$	Incremental encoder signal B / stepper motor signal DIR pos. polarity as per RS422
	7	B# / DIR#	5 V / $R_i \approx 120\ \Omega$	Incremental encoder signal B# / stepper motor signal DIR neg. polarity as per RS422
3		N	5 V / $R_i \approx 120\ \Omega$	Incremental encoder index pulse N pos. polarity as per RS422
	8	N#	5 V / $R_i \approx 120\ \Omega$	Incremental encoder index pulse N# neg. polarity as per RS422
4		GND		Reference GND for the encoder
	9	GND		Shield for the connecting cable
5		VCC	+ 5 V / ± 5% 100 mA	Auxiliary supply (short-circuit-proof), maximum load 100 mA!

8.8.4 Cable type and configuration [X10]

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

8.8.5 Connection notes [X10]

Input [X10] can be used to process incremental encoder signals as well as pulse direction signals (like the ones generated by the control boards for stepper motors).

The input amplifier at the signal input is designed to process differential signals in accordance with the RS422 interface standard. Processing of other signals and levels (e.g. 5 V single-ended or 24 V_{HTL} of a PLC) may also be possible. Please contact your sales partner.

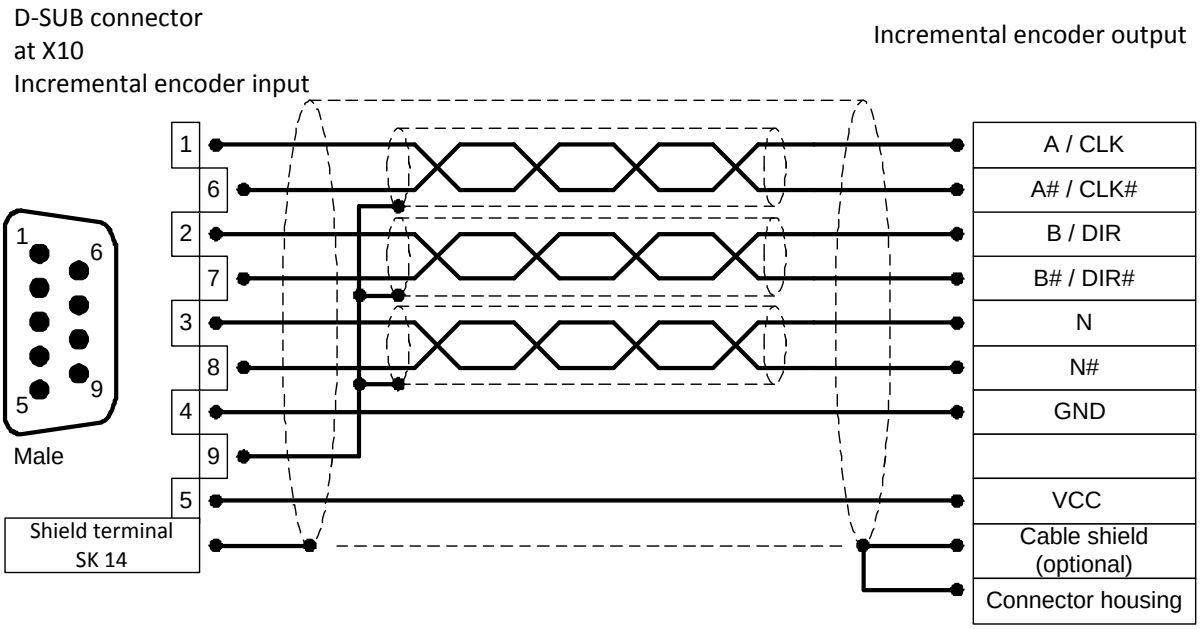


Figure 23: Pin assignment: incremental encoder input [X10]

8.9 Connector: incremental encoder output [X11]

8.9.1 Configuration on the device [X11]

❖ D-SUB connector, 9-pin type, female

8.9.2 Mating connector [X11]

❖ D-SUB connector, 9-pin type, male

❖ Housing for a 9-pin D-SUB connector with locking screws of type 4/40 UNC

8.9.3 Pin assignment [X11]

Table 41: Pin assignment: incremental encoder output [X11]

Pin no.		Name	Value	Specification
1		A	5 V / R_{out} ≈ 66 Ω *)	Incremental encoder signal A
	6	A#	5 V / R_{out} ≈ 66 Ω *)	Incremental encoder signal A#
2		B	5 V / R_{out} ≈ 66 Ω *)	Incremental encoder signal B
	7	B#	5 V / R_{out} ≈ 66 Ω *)	Incremental encoder signal B#
3		N	5 V / R_{out} ≈ 66 Ω *)	Incremental encoder index pulse N
	8	N#	5 V / R_{out} ≈ 66 Ω *)	Incremental encoder index pulse N#
4		GND		Reference GND for the encoder
	9	GND		Shield for the connecting cable
5		VCC	+ 5 V / ± 5% 100 mA	Auxiliary supply (short-circuit-proof), maximum load 100 mA!

*) The value for R_{out} stands for the differential output resistance.

8.9.4 Cable type and configuration [X11]

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

8.9.5 Connection notes [X11]

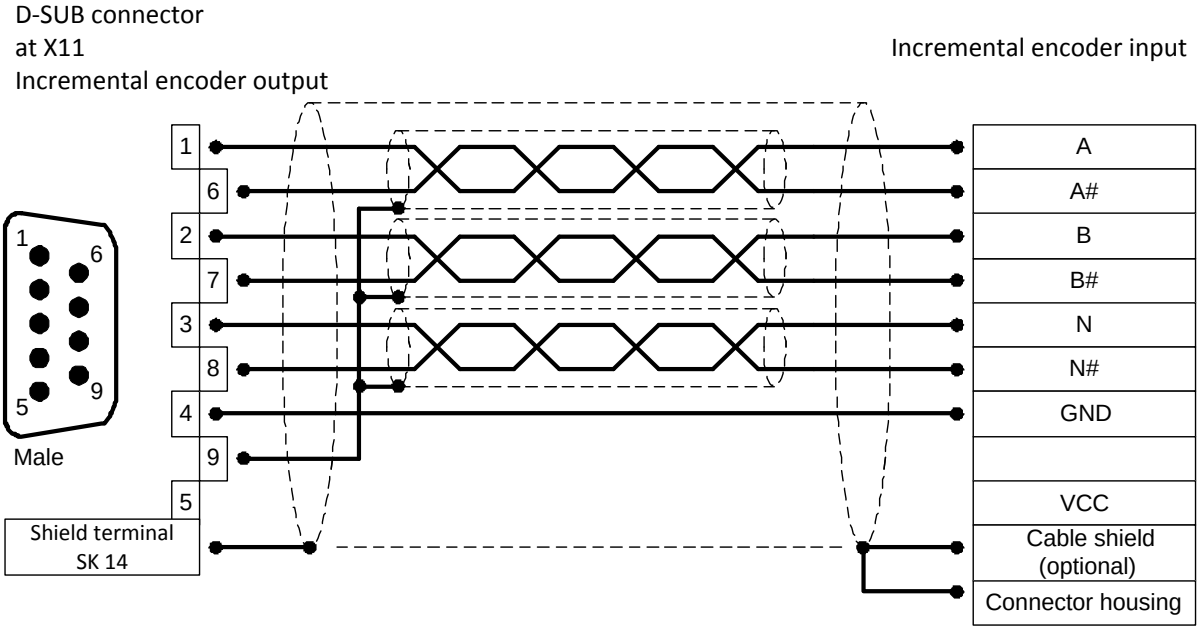


Figure 24: Pin assignment: incremental encoder output [X11]

The output driver at the signal output provides differential signals (5 V) as per the RS422 interface standard.

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

8.10 Connector: CAN bus [X4]

8.10.1 Configuration on the device [X4]

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

8.10.2 Mating connector [X4]

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

8.10.3 Pin assignment [X4]

Table 42: Pin assignment: CAN bus [X4]

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

*) In order to terminate the CAN bus on both ends, an integrated 120 Ohm terminating resistor is provided. It can be activated/deactivated by way of the "CAN TERM switch" on the front panel of the ARS 2300 SE.

8.10.4 Cable type and configuration [X4]

The cable names that are stated refer to cables made by Lapp. They have proved 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 data of the CAN bus cable: 2 pairs of 2 twisted cores, d ≥ 0.22 mm^2, shielded, loop resistance < 0.2 Ω/m, wave impedance 100-120 Ω.

- LAPP KABEL UNITRONIC BUS CAN; 2 x 2 x 0.22; ∅ 7.6 mm, with CU overall shielding

For highly flexible applications:

- LAPP KABEL UNITRONIC BUS CAN FD P; 2 x 2 x 0.25; ∅ 8.4 mm, with CU overall shielding

8.10.5 Connection notes [X4]

Caution!

When cabling the servo drives via the CAN bus, comply with the following information and notes in order to ensure a stable and interference-free system. Improper cabling may cause the CAN bus to malfunction which, in turn, will cause the servo drive to shut down with an error for safety reasons.

The CAN bus provides an easy and fail-safe way of connecting all of the components of a system. However, this requires compliance with the following cabling instructions.

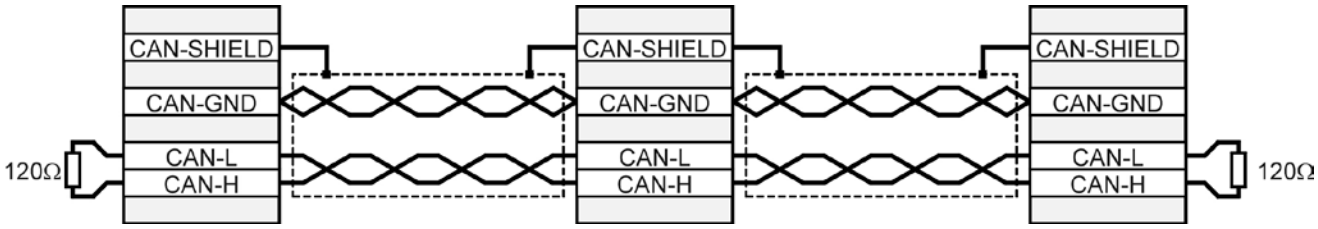


Figure 25: CAN bus cabling example

- 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 25*).
- A terminating resistor of 120 Ω ± 5% must be present on both ends of the CAN bus cable. ARS 2300 SE series servo drives are equipped with an integrated terminating resistor that can be activated/deactivated with the aid of the DIP switch "CAN TERM" that is located on the front panel (see *Figure 8* and *Figure 26*).
- **Shielded** cables with exactly two **twisted** pairs must be used for cabling.
- Use one 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 connected to the CAN shield connectors for all nodes.
- For information about suitable and Metronix-recommended cables, refer to *chapter 8.10.4, Cable type and configuration [X4]*.
- We advise against the use of plug adaptors for cabling the CAN bus. However, if this is necessary, use metal connector housings for connecting the cable shield.
- In order to keep interferences as low as possible ensure that
  - the motor cables are not installed parallel to signal lines
  - the motor cables comply with the Metronix specification
  - the motor cables are properly shielded and earthed (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.

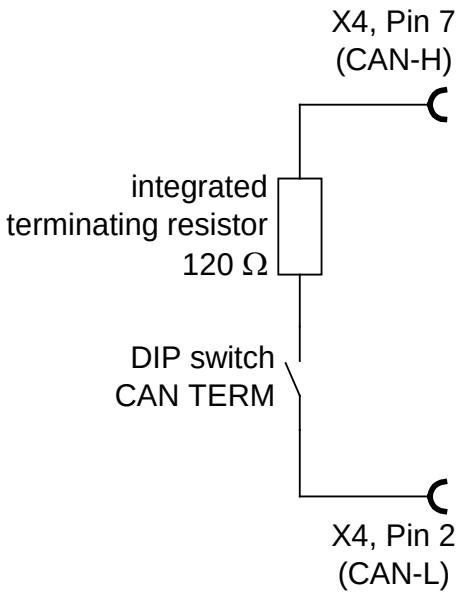


Figure 26: Integrated CAN terminating resistor

8.11 Connector: USB [X19]

8.11.1 Configuration on the device [X19]

❖ USB connector (female), type B

8.11.2 Mating connector [X19]

❖ USB connector (male), type B

8.11.3 Pin assignment USB [X19]

Table 43: Pin assignment: USB interface [X19]

Pin no.		Name	Value	Specification
	1	VCC		+ 5 VDC
2		D-		Data -
3		D+		Data +
	4	GND		GND

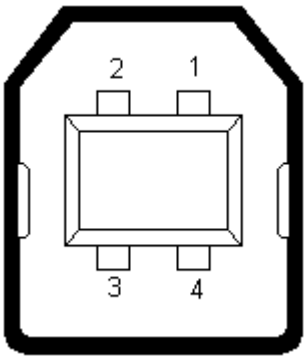


Figure 27: Pin assignment: USB interface [X19], front view

8.11.4 Cable type and configuration [X19]

Interface cable for the USB interface, 4 cores, shielded and twisted.

In order to set up a USB connection, it is mandatory to use a twisted and shielded (4-core) cable since, otherwise, the transmission may be subject to interferences. In addition, it must be ensured that the cable has a wave impedance of 90 Ω.

8.12 Connector [X40]

ARS 2000 SE servo drives with an integrated STO function have a combined interface for control and feedback via the pin-and-socket connector [X40].

Detailed information concerning the pin assignment and use of the STO function can be found in the Product Manual "STO (Safe Torque Off) for the servo drives ARS 2000 SE".

8.13 SD/SDHC/MMC card

8.13.1 Supported card types

- SD
- SDHC
- MMC

8.13.2 Supported functions

- Loading of a parameter set (DCO file)
- Saving of the current parameter set (DCO file)
- Loading of a firmware file

For more information on this subject, please contact the Technical Support.

8.13.3 Supported file systems

- FAT12
- FAT16
- FAT32

8.13.4 File names

Only file and directory names in accordance with the 8.3 standard are supported.

8.3 file and directory names have a maximum of eight characters (letters or numbers) followed by a full stop/period (".") and an extension with a maximum of three characters. In addition, only upper-case letters and numbers are permissible in the file and directory names.

8.13.5 Pin assignment SD/SDHC/MMC card

Table 44: Pin assignment: SD and SDHC card

Pin no.	Name	SD mode	SPI mode
1	DATA3/CS	Data line 3 (bit 3)	Chip select
2	CMD/DI	Command/response	Host to card commands and data
3	Vss1	Supply voltage earth (ground)	Supply voltage earth (ground)
4	Vcc	Supply voltage	Supply voltage
5	CLK	Clock	Clock
6	Vss2	Supply voltage earth (ground)	Supply voltage earth (ground)
7	DAT0/DO	Data line 0 (bit 0)	Card to host data and status
8	DAT1	Data line 1 (bit 1)	Reserved
9	DAT2	Data line 2 (bit 2)	Reserved

Table 45: Pin assignment: MMC card

Pin no.	Name	SD mode	SPI mode
1	RES/CS	Not connected or always "1"	Chip select
2	CMD/DI	Command/response	Host to card commands and data
3	Vss1	Supply voltage earth (ground)	Supply voltage earth (ground)
4	Vcc	Supply voltage	Supply voltage
5	CLK	Clock	Clock
6	Vss2	Supply voltage earth (ground)	Supply voltage earth (ground)
7	DAT/DO	Data 0	Card to host data and status

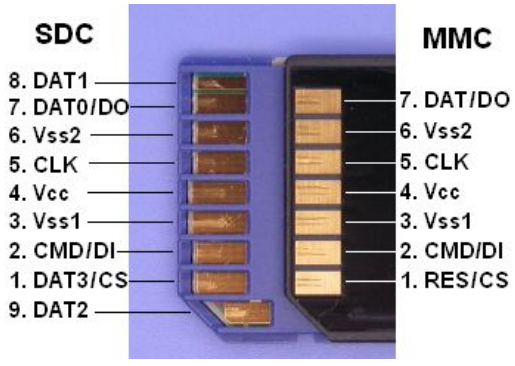


Figure 28: Pin assignment: SD/MMC card

8.13.6 BOOT-DIP switch

During a restart/reset, the BOOT DIP switch is used to determine whether to perform a firmware download from the SD/MMC card or not. The position of the DIP switch is shown in *Figure 8*.

- BOOT DIP switch in position "ON" → firmware download requested
- BOOT DIP switch in position "OFF" → firmware download not requested

If there is no SD/MMC card in the card slot of the servo drive and the BOOT DIP switch is in the position "ON" (firmware download requested), the error 29-0 will be issued after a restart/reset. This error stops any further executions. This means that communication via USB is not possible.

8.14 Notes concerning the safe and EMC-compliant installation

8.14.1 Definitions and terms

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

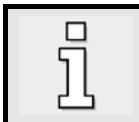
- Sufficient **immunity** of an electrical installation or an electrical device against external electrical, magnetic, or electromagnetic interferences via cables or the environment.
- Sufficiently small **unwanted emission** of electrical, magnetic, or electromagnetic interference from an electrical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

8.14.2 General information on EMC

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

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

In order to increase interference immunity and to decrease interference emissions, the ARS 2300 SE servo drive has integrated output chokes and line filters so that it can be used without additional shielding and filtering devices in most applications.



The ARS 2300 SE series servo drives 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 declaration of conformity in line with the EMC directive 2004/108/EC is available from the manufacturer upon request.

Caution!

In a residential (i.e. non-industrial) environment, this product can cause high-frequency interferences that may require interference suppression measures.

8.14.3 EMC areas: first and second environment

The ARS 2300 SE servo drives fulfil the requirements of the applicable product standard EN 61800-3, provided that the servo drives are properly installed and the connecting lines are properly wired. This standard no longer refers to "classes", but to so-called environments. The first environment includes mains supply networks that supply residential buildings. The second environment includes mains supply networks that exclusively supply industrial buildings.

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

Table 46: EMC requirements: first and second environment

EMC type	Area	Compliance with the EMC requirements
Interference emission	First environment (residential environment), C2	Motor cable length up to 50 m, C‘ ≤ 200 pF/m
	Second environment (industrial environment), C3	
Interference immunity	First environment (residential environment)	Motor cable length up to 50 m, C‘ ≤ 200 pF/m
	Second environment (industrial environment)	

8.14.4 EMC-compliant cabling

The following must be considered for the EMC-compliant set-up of the drive system (see also *chapter* 8 *Electrical installation, page 68*):

- In order to keep the leakage currents and losses in the motor connecting cable as small as possible, the ARS 2300 SE servo drive should be located as close to the motor as possible (see also *chapter 8.14.5 Operation with long motor cables, page 107*).
- The motor cable and angle encoder cable must be shielded.
- The shield of the motor cable is connected to the housing of the ARS 2300 SE servo drive (shield connection terminal). The cable shield must also 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 connector must be connected to the PE connection point of the supply connector [X9].
- The inner PE conductor of the motor cable must be connected to the PE connection point of the 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 (i.e. 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 will inevitably 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 the unshielded cores: 35 mm.
  - Connect the overall shield on the servo drive side to the PE terminal over a large contact area. Maximum length: 40 mm.
  - Connect the overall shield on the motor side to the connector or motor housing over a large contact area. Maximum length: 40 mm.

DANGER!

For safety reasons, all of the PE earth (ground) conductors must be connected prior to the initial operation of the system.

The EN 61800-5-1 regulations concerning protective earthing (grounding) must be complied with during the installation!

8.14.5 Operation with long motor cables

In applications involving long motor cables and/or in the case of unsuitable motor cables with a non-permissible high cable capacity, the filters may be thermally overloaded. To avoid these problems, we strongly recommend the following procedure for applications requiring long motor cables:

- In the case of a cable length of more than 50 m, use only cables with less than 150 pF/m (capacitance per unit length) between the motor phase and shield!
  (Please contact the motor cable supplier, if necessary.)
- In the case of a cable length of more than 50 m, the frequency of the power output stage must be reduced.

8.14.6 ESD protection

Caution!

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

To prevent electrostatic discharge, protective caps are available from specialised suppliers (e.g. Spoerle).

The ARS 2300 SE series servo drives have been designed to provide high interference immunity. For this reason, some function blocks are electrically isolated. Inside the device, the signals are transmitted via optocouplers.

The following isolated areas are distinguished:

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

9 Additional requirements to be fulfilled by the servo drives for UL approval

This chapter provides further information concerning the UL approval of the ARS 2302 SE, ARS 2305 SE, and ARS 2310 SE devices.

9.1 Mains fuse

In case of a required UL certification, the following data for the mains fuse must be complied with:
Listed circuit breaker in accordance with UL 489, rated 480Y/277 VAC, 16 A, SCR 10 kA

9.2 Wiring requirements and environmental conditions

- Use 60/75 or 75°C copper (CU) wires only.
- Tightening torque for the connectors: 0.22...0.25 Nm.
- To be used solely in an environment of pollution degree 2.

9.3 Motor temperature sensor

The servo drive is not equipped with an integrated motor overtemperature sensor system in accordance with UL.

If a UL certification is required, the servo drives may only be used in connection with motors that are equipped with an integrated motor temperature sensor in order to ensure protection against motor overtemperatures. The sensor must be connected to the servo drive and the temperature monitoring system must be activated accordingly via the software.

10 Start-up

10.1 General connection notes

Since the laying of the connecting cables is essential in terms of EMC, compliance with the information given in *chapter 8.14.4 EMC-compliant cabling (page 106)* must be absolutely ensured!

DANGER!

Non-compliance with the instructions in *chapter* 2 *Safety notes for electrical drives and controllers* (as of page *15*) may result in damage to property, personal injury, electric shock or – in extreme cases – in death.

10.2 Tools/material

- Screwdriver for slotted-head screws, size 1
- Angle encoder cable
- Motor cable
- Power supply cable
- ARS 2000 control panel or control system
- Connector set (if required): power and D-Sub connector

10.3 Connecting the motor

- Plug the connector of the motor cable into the corresponding socket of the motor and tighten the connection.
- Plug the PHOENIX connector into the **[X6]** socket of the servo drive.
- Connect the PE line of the motor to the **PE** earthing (grounding) socket.
- Plug the connector of the encoder cable into the encoder output socket of the motor and tighten the connection.
- Plug the D-Sub connector into the socket **[X2A] Resolver** or **[X2B] Encoder** of the servo drive and tighten the locking screws.
- Connect the overall shield of the motor or angle encoder cable over a large contact area with the aid of shield terminal SK14.
- Check all of the connections.

10.4 Connecting the ARS 2300 SE servo drive to the power supply

- ❖ Ensure that the power supply is switched off.
- ❖ Plug the PHOENIX connector into the **[X9]** socket of the servo drive.
- ❖ Connect the PE line of the mains power supply to the **PE** earthing (grounding) socket.
- ❖ Connect the 24 V connections to a suitable power supply unit.
- ❖ Establish the mains power supply connections.
- ❖ Check all of the connections.

10.5 Connecting the PC (USB interface)

- ❖ Plug the plug A of the USB interface cable into the socket for the USB interface of the PC.
- ❖ Plug the plug A of the USB interface cable into the **[X19] USB** socket of the ARS 2300 SE servo drive.
- ❖ Check all of the connections.

You can now communicate with the servo drive via the Metronix ServoCommander® parameterisation program. Please refer to the Software Manual "Servo drives ARS 2000" for further information.

10.6 Operability check

1. Ensure that the controller enable switch is turned off.
2. Switch on the power supply of all of the devices. The READY LED on the front panel of the servo drive should now light green.

If the READY LED does not light green but red, there is a malfunction. If the seven-segment display indicates a number sequence, this is an error message. The underlying cause of the error must be eliminated. In this case, please continue with *chapter 11.2 Error messages (page 114)*. If the device displays nothing, follow these steps:

1. Switch the power supply off.
2. Wait 5 minutes so that the DC bus circuit can discharge.
3. Check all of the connecting cables.
4. Check whether the 24 V power supply operates correctly.
5. Switch the power supply back on.

11 Service functions and error messages

11.1 Protection and service functions

11.1.1 Overview

The ARS 2300 SE servo drive has an extensive sensor system that monitors the controller unit, power output stage, motor, and the communication with the outside world. Errors that occur will be stored in the internal error memory. Most errors will cause the controller unit to shut down the servo drive and the power output stage. The servo drive can only be switched on again after the error memory has been erased by an acknowledgement and after the error has been eliminated or ceased to exist.

Operational safety is ensured by an extensive sensor system and numerous monitoring functions:

- Measurement of the motor temperature
- Measurement of the power unit temperature
- Detection of earth (ground) faults (PE)
- Detection of connections between two motor phases
- Detection of overvoltage in the DC bus circuit
- Detection of errors concerning the internal voltage supply
- Breakdown of the supply voltage

If the 24 V DC supply voltage fails, there will be approximately 20 ms left to save the parameters, for example, and to shut down the control system in a defined manner.

11.1.2 Phase and mains power failure detection

In three-phase operation, the ARS 2300 SE servo drives detect the failure of one phase (phase failure detection) or of several phases (mains power failure detection) of the mains power supply of the device.

11.1.3 Overcurrent and short-circuit monitoring

The overcurrent and short-circuit monitoring system 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 circuit 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.

11.1.4 Overvoltage monitoring of the DC bus circuit

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

11.1.5 Temperature monitoring of the heat sink

The heat sink temperature of the power output stage is measured with a linear temperature sensor. The temperature limit varies from device type to device type.

11.1.6 Monitoring of the motor

The ARS 2300 SE servo drives have the following protective functions to monitor the motor and the connected shaft encoder:

Monitoring of the shaft encoder: An error of the shaft encoder leads to the shut-down of the power output stage. In the case of a resolver, the track signal is monitored, for example. In the case of incremental encoders, the commutation signals are checked. Other "intelligent" encoders have other error detection features.

Measurement and monitoring of the motor temperature: The ARS 2300 SE series servo drives have a digital and analogue input for measuring and monitoring the motor temperature. Thanks to the analogue signal detection method, also non-linear sensors are supported.
The following temperature sensors can be selected:

- At [X2A], [X2B] and [X6]: Input for PTCs, NTCs, normally closed contacts, normally open contacts and analog sensors, type KTY.

11.1.7 I²t monitoring

The ARS 2300 SE servo drives have 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.

11.1.8 Power monitoring of the brake chopper

The operating software includes a power monitoring system for the internal braking resistor.

When the "I²t brake chopper" power monitoring value reaches 100%, the power of the internal braking resistor will be reduced to nominal power.

11.1.9 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 end user uses the ARS 2300 SE servo drive once again, it must be parameterised. The Metronix ServoCommander® parameterisation software checks the start-up status and requests the user to parameterise the servo drive. At the same time, the device displays an "A" on the seven-segment display to indicate that it is ready but not parameterised.

11.1.10 Rapid discharge of the DC bus circuit

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

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

11.1.11 Operating hours counter

The implemented operating hours counter is rated for a minimum of 200,000 hours of operation. The operating hours counter is displayed in the Metronix ServoCommander® parameterisation software.

11.2 Operating mode and error messages

11.2.1 Operating mode and error indication

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

Table 47: Operating mode and error indication

Indication	Meaning
 	In the speed control mode, the outer segments "rotate". The indication depends on the current position or speed of the rotor. If the servo drive is enabled, the centre segment is active in addition.
	The ARS 2000 SE servo drive must be parameterised (seven-segment display = "A")
	In the torque control mode, the two segments on the left are active (seven-segment display = "I").
P xxx	Positioning ("xxx" stands for the position number). The numbers are successively displayed.
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 displayed.
E xxy	Error message with index “xx” and subindex “y”. The numbers are successively displayed.
-xxy-	Warning message with the index "xx" and subindex "y". A warning will be displayed at least twice on the seven-segment-display. The numbers are successively displayed.
	Option "STO" (Safe Torque Off) active for the ARS 2000 SE series with STO. (seven-segment display = "H", blinking with a frequency of 2 Hz)

11.2.2 Error messages

If an error occurs, the ARS 2000 SE servo drive will display an error message cyclically by way of its seven-segment display. The error message is comprised of an "E" (for error), a main index (xx), and a subindex (y), for example **E 0 1 0**.

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

Table 48 Error messages provides an overview of the various messages and corresponding measures.

Error messages with the main index 00 are no runtime errors. The include information. In general, no measures by the user are required. They appear only in the error buffer and are not displayed on the seven-segment display.

The following table contains all error messages than can arise in ARS 2000 devices. Depending on the type not every error applies to every device.

Table 48: Error messages

Error message		**Meaning of the error message**	**Measures**
Main index	**Sub index**		
00	0	Invalid error	Information: Only for connected service module. An invalid (corrupted) entry in the error buffer has been marked by this error number. The system time entry is set to 0. No measures required.
	1	Invalid error detected and corrected	Information: Only for connected service module. An invalid (corrupted) error entry has been detected in the permanent event memory and corrected.
	2	Error cleared	Information: The active errors have been acknowledged. No measures required.
	4	Serial number/device type changed (module change)	Information: Only for connected service module. An exchangeable error buffer has been plugged into another device. No measures required.
	7	Log add-on: Permanent event memory and FSM module	Information: Entry in permanent event memory. “An additional record was found.” No measures required.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	8	Servo drive switched on	Information: Entry in permanent event memory. No measures required.
	9	Servo drive safety parameters revised	Information: Entry in permanent event memory. No measures required.
	11	FSM: Module change (previous type): Permanent event memory and FSM module	Information: Entry in permanent event memory. No measures required.
	12	FSM: Module change (current type): Permanent event memory and FSM module	Information: Entry in permanent event memory. No measures required.
	21	Log entry from the FSM-MOV: Permanent event memory and FSM module	Information: Entry in permanent event memory. No measures required.
01	0	Stack overflow	Incorrect firmware? If necessary, reload the standard firmware. Contact the Technical Support.
02	0	Undervoltage of the DC bus circuit	Error priority set too high? Check the power supply. Check (measure) the DC bus circuit voltage. Check the response threshold of the DC bus circuit monitoring system.
03	0	Motor overtemperature (analogue)	Motor too hot? Check the parameterization (current controller, current limits). Suitable sensor? Sensor defective? Check the parameterization of the sensor or the characteristic curve of the sensor. If the error occurs also when the sensor is bypassed, return the device to our sales partner.
	1	Motor overtemperature (digital)	
	2	Motor Overtemperature (analogue): wire break	Check the connecting cables of the temperature sensor (broken wire). Check the parameterisation of wire break detection system (threshold value).

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	3	Motor overtemperature (analogue): short circuit	Check the connecting cables of the temperature sensor (short circuit). Check the parameterisation of the short-circuit monitoring system (threshold value).
04	0	Power module overtemperature	Plausible temperature indication? Check the installation conditions. Fan filter mats dirty? Device fan defective?
	1	DC bus circuit overtemperature	
05	0	Failure of internal voltage 1	Disconnect the device from the entire periphery and check whether the error is still present after a reset. If the error is still present, return the device to your sales partner.
	1	Failure of internal voltage 2	
	2	Driver supply failure	
	3	Undervoltage of the digital I/Os	Check the outputs for short circuits or specific load. If necessary, contact the Technical Support.
	4	Overcurrent of the digital I/Os	
	5	Technology module supply voltage failure	Technology module defective? Replace the technology module. If necessary, contact the Technical Support.
	6	X10, X11 and RS232 supply voltage failure	Check the pin assignment of the connected peripheral equipment. Check the connected peripheral equipment for short-circuits.
	7	Safety module internal voltage failure	Safety module defective? Replace the safety module. If the error persists, please send the servo drive to our sales partner.
	8	Failure of internal voltage 15 V	Please return the device to our sales partner.
	9	Faulty encoder supply	
06	0	Short circuit in the power output stage	Motor defective? Short circuit in the cable? Power output stage defective?

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	1	Brake chopper overcurrent	Check the external braking resistor for short circuits. Check whether the resistance value is too small. Check the brake chopper output of the device.
07	0	Overvoltage in the DC bus circuit	Check the connection to the braking resistor (internal/external). External braking resistor overloaded? Check the rating.
08	0	Resolver angle encoder error	See items 08-2 .. 08-8.
	1	Sense of rotation of the serial and incremental position evaluation systems not identical	A and B track mixed up? Check / correct the connection of the tracks.
	2	Incremental encoder Z0 track signals error	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	Incremental encoder Z1 track signals error	
	4	Digital incremental encoder track signals error	
	5	Incremental encoder Hall generator signals error	
	6	Angle encoder communication error	
	7	Incorrect signal amplitude of the incremental track	
	8	Internal angle encoder error	The internal monitoring system of the angle encoder at [X2B] has detected an error. Communication error? If necessary, contact the Technical Support.
	9	Encoder at [X2B] not supported	Please contact the Technical Support.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
09	0	Old encoder parameter set (type ARS)	Save the data in the encoder EEPROM (reformatting).
	1	Encoder parameter set cannot be decoded	Angle encoder defective? Check the configuration of the angle encoder interface. The encoder signals are disturbed. Check the installation for compliance with the EMC recommendations.
	2	Unknown encoder parameter set version	Save the data into the encoder again.
	3	Corrupted data structure in encoder parameter set	If necessary, re-determine the data and save it in the encoder again.
	4	EEPROM data: faulty customer-specific configuration	Motor repaired: Perform a homing run and save the data in the angle encoder. Then, save to the basic device. Motor replaced: Parameterise the basic device, perform a homing run, save the data in the angle encoder, and then save to the basic device.
	5	Read/Write Error EEPROM parameter set	Please contact the Technical Support.
	7	Write protected EEPROM of the angle encoder	Please contact the Technical Support.
	9	Insufficient capacity of the angle encoder EEPROM	
10	0	Overspeed (motor overspeed protection)	Check the offset angle. Check the parameterisation of the limit value.
11	0	Homing: error during the start	Controller not enabled.
	1	Error during a homing run	The homing run has been interrupted, for example because the controller enabling has been cancelled.
	2	Homing: no valid index pulse	The required index pulse is not provided.
	3	Homing: timeout	The maximum time that has been parameterised for homing has been reached before the homing run could be completed. Check the parameterisation of the time.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	4	Homing: wrong/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: I²t/following error	Unsuitable parameterisation of the acceleration ramps. An invalid stop has been reached, for example because no reference switch has been installed. Check the connection of a reference switch. If necessary, contact the Technical Support.
	6	Homing: end of search distance reached	The maximum distance for the homing run has been covered, but the reference point or the target of the homing run have not been reached.
	7	Homing: Encoder difference control	The deviation fluctuates, e.g. due to gear slackness. If necessary, increase the shut-down threshold. Check actual-value encoder connection.
12	0	CAN: two nodes with the same ID	Check the configuration of the devices that are 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 earthed (grounded), all signals connected?). Replace the device. If the error has been successfully eliminated by replacing the device, return the replaced device to your sales partner.
	2	CAN: CAN communication error during the transmission	Check the cabling (compliance with the cable specification, cable break, maximum cable length exceeded, correct terminating resistors, cable shield earthed (grounded), all signals connected?). Check the start sequence of the application. Replace the device. If the error has been successfully eliminated by replacing the device, return the replaced device to your sales partner.
	3	CAN: CAN communication error during the reception	

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	4	CAN: node Guarding	Align the cycle time of the remote frames with the PLC or failure of the PLC. Signals disturbed?
	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	CAN bus timeout	Check the CAN parameterisation.
14	0	Insufficient power supply for the identification	Check the power supply. Check the motor resistor.
	1	Current controller identification: insufficient measurement cycle	The automatic parameter identification process delivers a time constant beyond the value range that can be parameterised. The parameters must be optimised manually.
	2	Power output stage could not be enabled	The power output stage has not been enabled. Check the connection of DIN 4.
	3	Power output stage prematurely disabled	The power output stage has been disabled during a running identification process (e.g. via DIN 4).
	4	Selected resolver type not supported by the identification system	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	Index pulse not found	The index pulse could not be found after the maximum permissible 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.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	7	Identification not possible	Check the DC bus circuit voltage. Check the wiring of the motor/encoder system. Motor blocked (holding brake not released)?
	8	Invalid number of pole pairs	The calculated number of pole pairs is beyond the parameterisation range. Check the data sheet of the motor. If necessary, contact the Technical Support.
15	0	Division by 0	Please contact the Technical Support.
	1	Out of range error	
	2	Mathematical underflow	
16	0	Incorrect program execution	Please contact the Technical Support.
	1	Illegal interrupt	
	2	Initialization error	
	3	Unexpected state	
17	0	Max. following error exceeded	Increase the error window. The parameterisation of the acceleration is too high.
	1	Encoder difference monitoring	External angle encoder not connected or defective? The deviation fluctuates, e.g. due to gear slackness. If necessary, increase the shut-down threshold.
	2	Current jerk control	Please contact the Technical Support.
18	0	Analogue motor temperature warning threshold	Motor too hot? Check the parameterisation (current controller, current limits). Suitable sensor? Sensor defective? Check the parameterisation of the sensor or the characteristic curve of the sensor. If the error occurs also when the sensor is bypassed, return the device to our sales partner.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
21	0	Error 1 current measurement U	Please contact the Technical Support.
	1	Error 2 current measurement V	
	2	Error 2 current measurement U	
	3	Error 1 current measurement V	
22	0	PROFIBUS: incorrect initialization	Technology module defective? Replace the technology module. If necessary, 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.
	4	PROFIBUS: error in value range	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). If necessary, contact the Technical Support.
23	0	No consumable record	Position save and restore failed, homing required.
	1	Record with invalid checksum	
	2	Flash content inconsistent	
25	0	Invalid device type	Please return the device 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 functionality restricted!	Please return the device to our sales partner.
	4	Invalid power module type	Check the firmware version. If necessary, request an update from the Technical Support.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	5	Incompatibility firmware / hardware. The firmware is not suitable for the device.	Check the firmware version. If necessary, request an update from the Technical Support.
26	0	No user parameter set	Load the default parameter set.
	1	Checksum error	If the error is still present, return the device to our sales partner.
	2	Flash: write error	Please return the device to our sales partner.
	3	Flash: delete error	
	4	Flash: error in the internal flash	Reload the firmware. If necessary, contact the Technical Support.
	5	No calibration data	
	6	No user position data set	Save and reset. Load the default parameter set. If the error occurs again, contact the Technical Support.
	7	Error in data tables (CAM)	Load the default parameter set and perform a start-up procedure. If necessary, reload the parameter set. If necessary, contact the Technical Support.
27	0	Following error warning threshold	Check the parameterisation of the following error. Motor blocked?
28	0	No operating hours counter	Acknowledge the error. If the error occurs again, contact the Technical Support.
	1	Operating hours counter: write error	
	2	Operating hours counter corrected	
	3	Operating hours counter converted	
29	0	No SD card	Please contact the Technical Support
	1	SD card: initialisation error	
	2	SD card: data error	
	3	SD card: write error	
	4	SD card: firmware download error	

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
30	0	Internal conversion error	Please contact the Technical Support.
31	0	Motor I^2t	Motor blocked? Check the power rating of the drive.
	1	Servo drive I^2t	Check the power rating of the drive package.
	2	PFC I^2t	Check the power rating of the drive. Select operation without PFC?
	3	Braking resistor I^2t	Braking resistor overloaded. Use external braking resistor?
	4	I^2t active power overload	Reduce the active power of the drive.
32	0	DC bus circuit charging time exceeded	Bridge for the internal brake resistor installed? Check the connection of the external braking resistor. If necessary, contact the Technical Support.
	1	Undervoltage for active PFC	Check whether the power supply complies with the nominal data.
	5	Brake chopper overload The DC bus circuit could not be discharged.	Check the ON/OFF cycles.
	6	DC bus circuit discharge time exceeded	Bridge for the internal brake resistor installed? Check the connection of the external braking resistor. If necessary, contact the Technical Support.
	7	No power supply for the controller enable signal	No DC bus circuit voltage? Check the power supply. If necessary, contact the Technical Support.
	8	Power supply failure during the controller enabling process	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.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
34	0	No synchronisation via the field bus	Failure of synchronization messages from master?
	1	Field bus synchronisation error	Failure of synchronization messages from master? Insufficient synchronisation interval?
35	0	Overspeed protection of the linear motor	The encoder signals are disturbed. Check the installation for compliance with EMC recommendations.
	5	Error during the determination of the commutation position	The selected method is not suitable for the motor. Please contact the Technical Support.
36	0	Parameter limited	Check the user parameter set.
	1	Parameter not accepted	
37	0	Sercos: received data disturbed	Check the sercos wiring (clean the optical waveguide, for example). Check the luminous power settings. Check the baud rate.
	1	Sercos: optical waveguide loop interrupted	Check the sercos wiring (optical waveguide) for breaks. Check the connections.
	2	Sercos: double MST failure	Check the sercos wiring (optical waveguide). Check the control system (are all of the MSTs being transmitted?)
	3	Sercos: illegal phase specification in the MST info	Check the program in the Sercos master.
	4	Sercos: double MDT failure	Check the sercos wiring (optical waveguide). 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 the IDN S-0-0032 to S-0-0035.
	6	Sercos: T3 invalid	Increase the baud rate. Shift the point of time T3 manually.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
38	0	sercos prog.: SERCON initialisation error	Technology module defective? Replace the technology module. If necessary, contact the Technical Support.
	1	Sercos: no technology module present	Technology module plugged in correctly? Technology module defective? Replace the technology module. If necessary, contact the Technical Support.
	2	Sercos: defective technology 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: faulty weighting parameters	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 during the conversion	Check the weighting settings. If necessary, contact the Technical Support.
	9	Sercos: SERCON 410b mode active	Technology module defective? Replace the technology module.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
39	0	Sercos: List S-0-0370: invalid configuration of the MDT Data container	Please contact the Technical Support.
	1	Sercos: List S-0-0371: invalid configuration of the AT-Data container	
	2	Sercos: error in the cyclic channel MDT	
	3	Sercos: error in the cyclic channel AT	
	4	Sercos: error in the cyclic data container MDT	
	5	Sercos: error in the cyclic data container 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 beyond the negative SW limit switch	The start of a positioning run has been suppressed, since the target is located beyond the respective software limit switch. Check the target data. Check the positioning range.
	3	Target position beyond the positive SW limit switch	
41	0	Path program: synchronisation error	Check the parameterization. If necessary, contact the Technical Support.
42	0	Positioning: no follow-up position: stop	The positioning target cannot be reached with the current positioning options or boundary conditions. Check the positioning parameters.
	1	Positioning: reversal of rotation not permissible: stop	
	2	Positioning: reversal of rotation not permissible after a stop	

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	3	Positioning start rejected: incorrect operating mode	The change of the mode of operation could not be performed by the position set.
	4	Positioning start rejected: homing required	Reset the optional parameterisation “homing required”. Perform a new homing run.
	5	Rotary axis: direction of rotation not permissible	In accordance with the selected mode, the calculated direction of rotation of the rotary axis is not permissible. Check the selected mode.
	9	Error during the start of the positioning run	Check the speed and acceleration parameters.
43	0	Limit switches: negative setpoint blocked	The drive has left the intended motion range. Technical defect in the system? Check the limit switches.
	1	Limit switches: positive setpoint blocked	
	2	Limit switches: positioning suppressed	
44	0	Error in the cam disc tables	Check whether the index has been assigned correctly. Check whether there are cam discs present in the device.
	1	Cam disc: general homing error	Ensure that the drive has been homed prior to the activation of the cam disc. Delete the “homing required” option. Ensure that a cam disc cannot be started during a homing run.
47	0	Timeout (set-up mode)	Check the processing of the request by the PLC. Speed threshold too low or timeout too small?
48	0	Drive not referenced	Switch to positioning and perform a homing run.
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.

Error message		Meaning of the error message	Measures	
Main index	Sub index			
51	0	No or unknown FSM module or faulty driver supply	Cause:	Internal voltage error of the safety module or of the fieldbus activation module.
			Action:	Module presumably defective. If possible, replace with another module.
			Cause:	No safety module detected or unknown module type.
			Action:	❖ Install safety or fieldbus activation module appropriate for the firmware and hardware. ❖ Load firmware appropriate for the safety or fieldbus activation module, see type designation on the module.
	2	FSM: different module type	Cause:	Type or revision of the module does not fit the project planning.
			Action:	❖ Check whether correct module type and correct version are being used. ❖ With module replacement: Module type not yet configured. Accept currently integrated safety or fieldbus activation module.
	3	FSM: different module version	Cause:	Type or revision of the module is not supported.
			Action:	❖ Install safety or fieldbus activation module appropriate for the firmware and hardware. ❖ If only a module with a more recent version is available: Load firmware that is appropriate for the module, see type designation on the module.
			Cause:	The module type is correct but the module version is not supported by the basic device.
			Action:	❖ Check module version; if possible use module of same version after replacement. Install suitable safety or fieldbus activation module for the firmware and hardware. ❖ If only a module with a more recent version is available: Load firmware that is appropriate for the module, see type designation on the module.

Error message		Meaning of the error message	Measures	
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	4	FSM: Fault in SSIO communication	Cause:	Error in the internal communication connection between the basic device and the safety module.
			Action:	❖ Identify interfering radiators in the environment of the servo drive. ❖ Replace module or basic device. ❖ Please contact the Technical Support.
	5	FSM: Fault in FSM break control	Cause:	Internal hardware error (brake activation control signals) of the safety module or fieldbus activation module.
			Action:	Module presumably defective. If possible, replace with another module.
			Cause:	Error in brake driver circuit section in the basic device.
			Action:	Basic device presumably defective. If possible, replace with another basic device.
	6	FSM: Non-identical module serial number	Cause:	Serial number of currently connected safety module is different from the stored serial number.
			Action:	Error only occurs after replacement of the FSM 2.0 MOV. ❖ With module replacement: Module not yet configured. Accept currently integrated FSM 2.0 MOV. ❖ Check parameterisation of the FSM 2.0 – MOV with regard to the application as modules have been replaced.
52	1	Safety function: Discrepancy time overrun	Cause:	Control ports STO-A and STO-B are not actuated simultaneously.
			Action:	Check discrepancy time.
			Cause:	Control ports STO-A and STO-B are not wired in the same way.
			Action:	Check circuitry of the inputs.

Error message		Meaning of the error message	Measures	
Main index	Sub index			
			Cause:	Upper and lower switch supply voltage not simultaneously activated (discrepancy time exceeded) – Error in control / external circuitry of safety module. – Error in safety module.
			Action:	❖ Check circuitry of the safety module – are the inputs STO-A and STO-B switched off on two channels and simultaneously? ❖ Replace safety module if you suspect it is faulty.
	2	Safety function: Failure of driver supply with active PWM activation	Cause:	Failure of driver supply voltage with active PWM.
			Action:	The safe status was requested with power output stage enabled. Check integration into the safety-orientated interface.
	3	FSM: Rotational speed limits in basic device overlap	Cause:	Basic device reports error if the currently requested direction of movement is not possible because the safety module has blocked the setpoint value in this direction. Error may occur in connection with the SSFx safe speed functions if an asymmetrical speed window is used where one limit is set to zero. In this case, the error occurs when the basic device moves in the blocked direction in the Positioning mode.
			Action:	Check application and change if necessary.

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Main index	**Sub index**			
53	0	USF0: Safety condition violated	Cause:	Violation of monitored speed limits of the SSF0 in operation / when USF0 / SSF0 requested.
			Action:	Check when the violation of the safety condition occurs: a) During dynamic braking to safe rotational speed. b) After the drive has reached the safe speed. ❖ With a) Check of braking ramp – record measuring data - can the drive follow the ramp? ❖ Change parameters for the slowdown ramp or start time / delay times for monitoring. With b) Check how far the current speed is from the monitored limit speed; increase distance if necessary (parameter in safety module) or correct speed specified by controller.
	1	USF1: Safety condition violated	Cause:	Violation of monitored speed limits of the SSF1 in operation / when USF1 / SSF1 requested.
			Action:	See USF0, error 53-0.
	2	USF2: Safety condition violated	Cause:	Violation of monitored speed limits of the SSF2 in operation / when USF2 / SSF2 requested.
			Action:	See USF0, error 53-0.
	3	USF3: Safety condition violated	Cause:	Violation of monitored speed limits of the SSF3 in operation / when USF3 / SSF3 requested.
			Action:	See USF0, error 53-0.

Error message		Meaning of the error message	Measures	
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54	0	SBC: Safety Condition Violated	Cause:	Brake should engage; no feedback received within the expected time.
			Action:	❖ Check how the feedback signal is configured – was the correct input selected for the feedback signal? ❖ Does the feedback signal have the correct polarity? ❖ Check whether the feedback signal is actually switching. ❖ Is the parameterised time delay for the analysis of the feedback signal appropriate to the brake used (measure switching time if necessary)?
	2	SS2: Safety Condition Violated	Cause:	Actual speed outside permitted limits for too long.
			Action:	Check when the violation of the safety condition occurs: a) During dynamic braking to zero. b) After the drive has reached zero speed. ❖ With a) Check of braking ramp – record measuring data - can the drive follow the ramp? Change parameters for the slowdown ramp or start time / delay times for monitoring. ❖ With a) If the option “Trigger basic device quick stop” is activated: Check of the basic device’s quick stop ramp. ❖ With b) Check whether the drive continues to oscillate after reaching the zero speed or remains at idle and stable – increase monitoring tolerance time if necessary. ❖ With b) If the actual speed value is very noisy at rest. Check and if necessary adjust expert parameters for speed recording and detection of idling

Error message		Meaning of the error message	Measures	
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	3	SOS: Safety Condition Violated	Cause:	– Angle encoder analysis reports “Motor running” (actual speed exceeds limit). – Drive has rotated out of its position since reaching the safe state.
			Action:	❖ Check the position tolerance for the SOS monitoring and increase if necessary, if this is permissible. ❖ If the actual speed value is very noisy when at rest: Check and if necessary adjust expert parameters for speed recording and detection of idling.
	4	SS1: Safety Condition Violated	Cause:	Actual speed is outside of permitted limits for too long.
			Action:	Check when the violation of the safety condition occurs: a) During dynamic braking to zero. b) After the drive has reached zero speed. ❖ With a) Check of braking ramp – record measuring data - can the drive follow the ramp? Change parameters for the slowdown ramp or start time / delay times for monitoring. ❖ With a) If the option “Trigger basic device quick stop” is activated: Check of the basic device’s quick stop ramp. ❖ With b) Check whether the drive continues to oscillate after reaching the zero speed or remains at idle and stable – increase monitoring tolerance time if necessary. ❖ With b) If the actual speed value is very noisy when at rest: Check and if necessary adjust expert parameters for speed recording and detection of standstill.

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
	5	STO: Safety Condition Violated	Cause:	Internal hardware error (voltage error) of the safety module.
			Action:	Module presumably defective. If possible, replace with another module.
			Cause:	Error in driver circuit section in the basic device.
			Action:	Basic device presumably defective. If possible, replace with another basic device.
			Cause:	No feedback received from basic device to indicate that output stage was switched off.
			Action:	Check whether the error can be acknowledged and whether it occurs again upon a new STO request – if yes: Basic device is presumably faulty. If possible, replace with another basic device.
	6	SBC: Brake not vented for > 24 hrs	Cause:	Error occurs when SBC is requested and the brake has not been opened by the basic device in the last 24 hours.
			Action:	❖ If the brake is actuated via the brake driver in the basic device [X6]: The brake must be energised at least once within 24 hours before the SBC request because the circuit breaker check can only be performed when the brake is switched on (energised). ❖ Only if brake control takes place via DOUT4x and an external brake controller: Deactivate 24 hr monitoring in the SBC parameters if the external brake controller allows this.

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	7	SOS: SOS requested > 24 hrs	Cause:	If SOS is requested for more than 24 hours, the error is triggered.
			Action:	Terminate SOS and move axle at least once during this time.
55	0	No actual rotational speed / position value available or idle > 24 hrs	Cause:	– Subsequent error when a position encoder fails. – Safety function SSF, SS1, SS2 or SOS requested and actual rotational speed value is not valid.
			Action:	Check the function of the position encoder(s) (see following error).
	1	SINCOS encoder [X2B] - Tracking signal error	Cause:	– Vector length $\sin^2+\cos^2$ is outside the permissible range. – The amplitude of one of the two signals is outside the permissible range. – Offset between analogue and digital signal is greater than 1 quadrant.
			Action:	Error may occur with SIN/COS and Hiperface encoders. ❖ Check the position encoder. ❖ Check the connection wiring (broken wire, short between two signals or signal / screening). ❖ Check the supply voltage for the position encoder. ❖ Check the motor cable / screening on motor and drive side – EMC malfunctions may trigger the error.
	2	SINCOS encoder [X2B] - Standstill > 24 hrs	Cause:	Input signals of the SinCos encoder have not changed by a minimum amount for 24 hours (when safety function is requested).
			Action:	Terminate SS2 or SOS and move axle at least once during this time.

Error message		Meaning of the error message	Measures	
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	3	Resolver [X2A] - Signal error	Cause:	– Vector length $\sin^2+\cos^2$ is outside the permissible range. – The amplitude of one of the two signals is outside the permissible range. – Input signal is static (same values to right and left of maximum).
			Action:	❖ Check the resolver. ❖ Check the connection wiring (broken wire, short between two signals or signal / screening). ❖ Check for a failure of the primary radiator signal ❖ Check the motor and encoder cable / screening on motor and drive side. EMC malfunctions can trigger the error.
	7	Other encoder [X2B] - Faulty angle information	Cause:	– “Angle faulty” message is sent from basic device when status lasts for longer than the allowed time. – Encoder at X2B is analysed by the basic device. – Encoder is faulty.
			Action:	❖ Check the position encoder at X2B. ❖ Check the connection wiring (broken wire, short between two signals or signal / screening). ❖ Check the supply voltage for the ENDAT encoder. ❖ Check the motor cable / screening on motor and drive side – EMC malfunctions may trigger the error.

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
	8	Impermissible acceleration detected	Cause:	– Error in connected position encoder. – EMC malfunctions affecting the position encoder. – Impermissibly high acceleration rates in the movement profiles. – Acceleration limit parameterised too low. – Angle jump after reference movement in the position data transmitted from the basic device to the safety module.
			Action:	❖ Check the connected position encoder: If further error messages occur in conjunction with the encoders, then eliminate their cause first. ❖ Check the motor and encoder cable / screening on motor and drive side. EMC malfunctions can trigger the error. ❖ Check the setpoint specifications / Movement profiles of the controller: Do they contain impermissibly high temperatures above the limit value for acceleration monitoring (P06.07)? ❖ Check whether the limit value for acceleration monitoring was parameterised correctly - the limit value (P06.07) should be at least 30% ... 50% above the maximum acceleration actually occurring. ❖ In case of an angle jump in the position data transmitted from the basic device - Acknowledge error once.

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
56	8	Rotational speed / angle difference, encoder 1 - 2	Cause:	– Rotational speed difference between encoder 1 and 2 of one µC outside the permissible range for longer than the allowed time. – Angle difference between encoder 1 and 2 of one µC outside the permissible range for longer than the allowed time.
			Action:	❖ Problem may occur if two position encoders are used in the system and they are not “rigidly coupled”. ❖ Check for elasticity or looseness, improve mechanical system. ❖ Adjust the expert parameters for the position comparison if this is acceptable from an application point of view.
	9	Error, cross-comparison of encoder analysis	Cause:	Cross-comparison between µC1 and µC2 has detected an angle difference or rotational speed difference or difference in capture times for the position encoders.
			Action:	Timing disrupted. If the error occurs again after a reset, the safety module is presumably faulty.

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
57	0	Error, I/O self test (internal/external)	Cause:	– Internal error of digital inputs DIN40 ... DIN43 (detected via internal test signals). – Error at brake output at X6 (signalling, detected by test pulses). – Internal error of brake output (detected via internal test signals). – Internal error of digital outputs DOUT40 – DOUT42 (detected via internal test signals).
			Action:	❖ Check the connection wiring for the digital outputs DOUT40 ... DOUT42 (short circuit, cross circuit, etc.). ❖ Check the connection wiring for the brake (short circuit, cross circuit, etc.). ❖ Brake connection: The error may occur with long motor cables if: 1. The brake output X6 was configured for the brake (this is the case with factory settings!) and 2. A motor without a holding brake is used and the brake connection lines in the motor cable are terminated at X6. In this case: Disconnect the brake connection lines at X6. ❖ If there is no error in the connection wiring, there may be an internal error in the module (check by swapping the module).

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
	1	Digital inputs - Signal level error	Cause:	❖ Exceeding / violation of discrepancy time with multi-channel inputs (DIN40 ... DIN43, two-handed control device, mode selector switch).
			Action:	❖ Check the external active and passive sensors – do they switch on two channels and simultaneously (within the parameterised discrepancy time). ❖ Two-handed control device: Check how the device is operated by the user – are both pushbuttons pressed within the discrepancy time? Give training if necessary. ❖ Check the set discrepancy times – are they sufficient?
	2	Digital inputs - Test pulse error	Cause:	One or more inputs (DIN40 ... DIN49) were configured for the analysis of the test pulses of the outputs (DOUT40 ... DOUT42). The test pulses from DOUTx do not arrive at DIN4x.
			Action:	❖ Check the wiring (shorts after 0 V, 24 V, cross circuits). ❖ Check the assignment – correct output selected / configured for test pulse?
	6	Electronics temperature too high	Cause:	The safety module's temperature monitor has been triggered; the temperature of µC1 or µC2 was below -20° or above +75°C.
			Action:	❖ Check the operating conditions (ambient temperature, control cabinet temperature, installation situation in the control cabinet). ❖ If the servo drive is experiencing high thermal load (high control cabinet temperature, high power consumption / output to motor, large number of occupied slots), a servo drive of the next higher output level should be used.

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
58	0	FSM: Plausibility check of parameters	Cause:	The plausibility check in the safety module produced errors, e.g. an invalid angle encoder configuration; the error is triggered when a validation code is requested by the SafetyTool and when parameters are backed up in the safety module.
			Action:	Note instructions for SafetyTool for complete validation; check parameterisation.
	1	General error, parameterisation	Cause:	Parameter session active for > 8 hrs. The safety module has thus terminated the parameterisation session. The error message is saved in the permanent event memory.
			Action:	Terminate parameterisation session within 8 hrs. If necessary, start a new parameterisation session and continue.
	4	Buffer, internal communication	Cause:	– Communication connection faulty. – Timeout / data error / incorrect sequence (packet counter) in data transmission between the basic device and safety module. – Too much data traffic, new requests are being sent to safety module before old ones have been responded to.
			Action:	❖ Check communication interfaces, wiring, screening, etc. ❖ Check whether other devices have read access to the servo drive and safety module during a parameterisation session - this may overload the communication connection. ❖ Check whether the firmware versions of the safety module and basic device and the versions of the Metronix ServoCommander® and SafetyTool are compatible.

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
	5	Communication module - basic device	Cause:	– Packet counter error during transmission µC1 ←→ µC2 – Checksum error during transmission µC1 ←→ µC2.
			Action:	❖ Internal malfunction in the servo drive. ❖ Check whether the firmware versions of the safety module and basic device and the versions of the Metronix ServoCommander® and SafetyTool are compatible.

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
	6	Error in cross-comparison for processors 1 - 2	Cause:	Timeout during cross-comparison (no data) or cross-comparison faulty (data for µC1 and µC2 are different). – Error in cross-comparison for digital I/O. – Error in cross-comparison for analogue input. – Error in cross-comparison for internal operating voltage measurement (5 V, 3.3 V, 24 V) and reference voltage (2.5 V). – Error in cross-comparison for SIN/COS angle encoder analogue values. – Error in cross-comparison for programme sequence monitoring. – Error in cross-comparison for interrupt counter. – Error in cross-comparison for input map. – Error in cross-comparison for violation of safety conditions. – Error in cross-comparison for temperature measurement.
			Action:	This is an internal error in the module that should not occur during operation. ❖ Check the operating conditions (temperature, air humidity, condensation). ❖ Check the EMC wiring as specified and screening design; are there any external interference sources? ❖ Safety module may be faulty – is error eliminated after replacing the module? ❖ Check whether new firmware for the servo drive or a new version of the safety module is available from the manufacturer.

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
59	1	FSM: Fail-safe mode supply/safe pulse inhibitor	Cause:	Internal error in module in failsafe supply circuit section or in the driver supply for the upper and lower switches.
			Action:	Module faulty, replace.
	2	FSM: Logic failure / intermediate circuit	Cause:	– Reference voltage 2.5 V outside tolerance. – Logic supply overvoltage +24 V detected.
			Action:	Module faulty, replace.
	3	FSM: Error internal power supply	Cause:	Voltage (internal 3.3 V, 5 V, ADU reference) outside the permissible range.
			Action:	Module faulty, replace.
	4	FSM: Error management, too many errors	Cause:	Too many errors have occurred simultaneously.
			Action:	❖ Clarify: What is the status of the installed safety module - does it contain a valid parameter set? ❖ Read out and analyse the permanent event memory of the basic device via Metronix ServoCommander® ❖ Eliminate error causes step by step. ❖ Install safety module with “delivery status” and perform commissioning of basic device. ❖ If this is not available: Set factory settings in the safety module, then copy data from the basic device and perform complete validation. Check whether the error occurs again.
	5	FSM: Log file - write error	Please contact the Technical Support.	
	6	FSM: Parameter set - save error	Please contact the Technical Support.	

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
	7	FSM: Flash checksum error	Cause:	– Voltage interruption / power off while parameters were being saved. – Flash memory in safety module corrupted (e.g. by extreme malfunctions).
			Action:	Check whether the error recurs after a reset. If it does: ❖ Parameterise the module again and validate the parameter set again. If error persists: ❖ Module faulty, replace.
	8	FSM: Internal monitoring, processor 1 - 2	Cause:	– Serious internal error in the safety module: Error detected while dynamising internal signals. – Disrupted programme sequence, stack error or OP code test failed, processor exception / interrupt.
			Action:	Check whether the error recurs after a reset. If it does: ❖ Module faulty, replace.
	9	FSM: Structure error, invalid software state	Cause:	Triggering of internal programme sequence monitoring.
			Action:	❖ Check the firmware version of the basic device and the version of the safety module – update available? ❖ Safety module faulty; replace.
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. Check the RPDO configuration of the servo drive and of the control system.	
	4	EtherCAT: invalid TPDO length		

Error message		Meaning of the error message	Measures
Main index	Sub index		
	5	EtherCAT: faulty cyclic data transfer	Check the EtherCAT wiring. Check the configuration of the master.
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: duplicated MAC ID	Change the MAC ID.
	1	DeviceNet: bus power lost	Check the DeviceNet wiring.
	2	DeviceNet: overflow of receive buffer	Reduce the number of messages per time unit during the transmission.
	3	DeviceNet: overflow of transmit buffer	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 overflow	Please contact the Technical Support.
65	0	DeviceNet: no module	Technology module defective? Replace the technology module.
	1	DeviceNet: I/O connection timeout	Please contact the Technical Support.

Error message		Meaning of the error message	Measures
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72	0	Profinet: Initialization error	Replace the Profinet module.
	1	Profinet: Bus error	No communication possible, e.g. because the bus cable is disconnected. Check the cabling and restart the Profinet communication.
	3	Profinet: Invalid IP configuration	IP address, subnet mask or gateway address are not valid or not permissible. Change IP configuration.
	4	Profinet: Invalid device name	According to the Profinet standard, the Profinet device name is not permissible. Change device name.
	5	Profinet: Technology module defect	Replace the Profinet module.
	6	Profinet: Invalid / not supported indication	A Profinet feature has been used that is not supported by the module. If necessary, contact the Technical Support.
78	0	NRT frame send error	Reduce bus traffic, for example by using less devices in a line.
80	0	IRQ: current controller overflow	Please contact the Technical Support.
	1	IRQ: speed controller overflow	
	2	IRQ: position controller overflow	
	3	IRQ: interpolator overflow	
81	4	IRQ: low-level overflow	Please contact the Technical Support.
	5	IRQ: MDC overflow	
82	0	Sequence control: general	For information only, no measures required.
	1	CO write access started multiple times	Please contact the Technical Support.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
83	0	Invalid technology module or Technology module: (slot/combination)	Load the correct firmware. Check the slot. If necessary, contact the Technical Support.
	1	Technology module not supported	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.
	4	Technology module: MC2000 watchdog	
84	0	State change of the sequence control	Detailed information concerning internal processes. No measures required. If necessary, select the option “Entry into buffer” in the error management.
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	SD-ADU synchronisation error after start	
	5	SD-ADU not synchronous	
	6	IRQ 0 (current controller): trigger error	
	7	CAN controller not available	
	8	Device parameters checksum error	
	9	DEBUG-Firmware loaded	

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
91	0	Internal initialisation error	Please contact the Technical Support.
	1	Memory error	
	2	Controller/power stage code read error	
	3	Internal software initialization error	
92	0	Error during firmware download	Incorrect firmware? Load the correct firmware. If necessary, contact the Technical Support.
	1	Error during Bootloader Update	Please contact the Technical Support.