KUHNKE

Product Manual



Servo Positioning Controller ARS 2300 FS

designed for Functional Safety

+

Translation of the original instructions

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TABLE OF CONTENTS:

1 GENERAL 16

1.1 Documentation 16

1.2 Scope of supply 17

2 SAFETY NOTES FOR ELECTRICAL DRIVES AND CONTROLLERS 18

2.1 Symbols 18

2.2 General notes 19

2.3 Hazards resulting from misuse 21

2.4 Safety instructions 22

2.4.1 General safety instructions 22

2.4.2 Safety notes for assembly and maintenance 24

2.4.3 Protection against contact with electrical parts 26

2.4.4 Protection against electric shock by way of protective extra-low voltage (PELV) 27

2.4.5 Protection against dangerous movements 27

2.4.6 Protection against contact with hot parts 28

2.4.7 Protection during the handling and installation of the devices 29

3 PRODUCT DESCRIPTION 30

3.1 General 30

3.2 Power supply 33

3.2.1 Three-phase AC power supply 33

3.2.1.1 Switch-on behaviour: 33

3.2.2 DC bus circuit linking, DC supply 33

3.2.2.1 DC bus circuit linking 33

3.2.2.2 DC supply 33

3.2.3 Mains fuse 33

3.3 Brake chopper 34

3.4 Communication interfaces 34

3.4.1 Serial interface [X5] 35

3.4.2 USB interface [X19] 35

3.4.3 UDP interface [X18] 35

3.4.4 CAN interface [X4] 35

3.4.5 Technology module: Profibus 36

3.4.6 Technology module: Sercos II 36

3.4.7 Technology module: EtherCAT 36

3.4.8 I/O functions and device control 37

4 TECHNICAL DATA 38

4.1 General technical data 38

4.2 Control elements and display elements 39

4.3 Power supply [X9] 40

4.4 Motor connector [X6] 41

4.4.1 Current derating 42

4.5 Angle encoder connector [X2A] and [X2B] 46

4.5.1 Resolver connector [X2A] 47

4.5.2 Encoder connector [X2B] 48

4.6 Communication interfaces 50

4.6.1 RS232 [X5] 50

4.6.2 USB [X19] 50

4.6.3 Ethernet [X18] 51

4.6.4 CAN bus [X4] 51

4.6.5 SD/MMC card 51

4.6.6 I/O interface [X1] 52

4.6.7 Incremental encoder input [X10] 53

4.6.8 Incremental encoder output [X11] 54

5 FUNCTION OVERVIEW 55

5.1 Motors 55

5.1.1 Synchronous servomotors 55

5.1.2 Linear motors 55

5.2 Functions of the ARS 2300 FS servo positioning controller 56

5.2.1 Compatibility 56

5.2.2 Pulse width modulation (PWM) 56

5.2.3 Setpoint management 57

5.2.4 Torque-controlled mode 58

5.2.5 Speed-controlled mode 58

5.2.6 Torque-limited speed control 58

5.2.7 Synchronisation with external clock signals 58

5.2.8 Load torque compensation in the case of vertical axes 59

5.2.9 Positioning and position control 59

5.2.10 Synchronisation, electronic gear unit 60

5.2.11 Brake management 60

5.3 Positioning control 61

5.3.1 Overview 61

5.3.2 Relative positioning 62

5.3.3 Absolute positioning 62
5.3.4 Motion profile generator 62
5.3.5 Homing 63
5.3.6 Positioning sequences 63
5.3.7 Optional stop input 64
5.3.8 Contouring control with linear interpolation 64
5.3.9 Time-synchronised multi-axis positioning 65

6 FUNCTIONAL SAFETY TECHNOLOGY 66

6.1 General 66
6.1.1 DIP switch 67
6.1.2 Assignment of the DIP switch 68
6.2 Integrated safety technology (schematic representation) 70
6.3 Module variants 71
6.3.1 FBA module 71
6.3.2 FSM 2.0 – STO (Safe Torque Off) 72
6.3.3 FSM 2.0 – MOV 72

7 MECHANICAL INSTALLATION 73

7.1 Important notes 73
7.2 Device view 75
7.3 Installation 77

8 ELECTRICAL INSTALLATION 78

8.1 Connector configuration 78
8.2 ARS 2300 FS – complete system 79
8.3 Connector: power supply [X9] 81
8.3.1 Configuration on the device [X9] 81
8.3.2 Mating connector [X9] 81
8.3.3 Pin assignment [X9] 82
8.3.4 Cable type and configuration [X9] 82
8.3.5 Connection notes [X9] 83
8.4 Connector: motor [X6] 84
8.4.1 Configuration on the device [X6] 84
8.4.2 Mating connector [X6] 84
8.4.3 Pin assignment [X6] 84
8.4.4 Cable type and configuration [X6] 85
8.4.5 Connection notes [X6] 85
8.5 Connector: I/O communication [X1] 87

8.5.1 Configuration on the device [X1] 89
8.5.2 Mating connector [X1] 89
8.5.3 Pin assignment [X1] 90
8.5.4 Cable type and configuration [X1] 91
8.5.5 Connection notes [X1] 91
8.6 Connector: resolver [X2A] 92
8.6.1 Configuration on the device [X2A] 92
8.6.2 Mating connector [X2A] 92
8.6.3 Pin assignment [X2A] 92
8.6.4 Cable type and configuration [X2A] 93
8.6.5 Connection notes [X2A] 93
8.7 Connector: encoder [X2B] 94
8.7.1 Configuration on the device [X2B] 94
8.7.2 Mating connector [X2B] 94
8.7.3 Pin assignment [X2B] 95
8.7.4 Cable type and configuration [X2B] 97
8.7.5 Connection notes [X2B] 98
8.8 Connector: incremental encoder input [X10] 100
8.8.1 Configuration on the device [X10] 100
8.8.2 Mating connector [X10] 100
8.8.3 Pin assignment [X10] 100
8.8.4 Cable type and configuration [X10] 101
8.8.5 Connection notes [X10] 101
8.9 Connector: incremental encoder output [X11] 102
8.9.1 Configuration on the device [X11] 102
8.9.2 Mating connector [X11] 102
8.9.3 Pin assignment [X11] 102
8.9.4 Cable type and configuration [X11] 103
8.9.5 Connection notes [X11] 103
8.10 Connector: CAN bus [X4] 104
8.10.1 Configuration on the device [X4] 104
8.10.2 Mating connector [X4] 104
8.10.3 Pin assignment [X4] 104
8.10.4 Cable type and configuration [X4] 105
8.10.5 Connection notes [X4] 105
8.11 Connector: RS232/COM [X5] 107
8.11.1 Configuration on the device [X5] 107
8.11.2 Mating connector [X5] 107

8.11.3 Pin assignment [X5] 107
8.11.4 Cable type and configuration [X5] 108
8.11.5 Connection notes [X5] 108
8.12 Connector: USB [X19] 109
8.12.1 Configuration on the device [X19] 109
8.12.2 Mating connector [X19] 109
8.12.3 USB [X19] 109
8.12.4 Cable type and configuration [X19] 109
8.13 SD/MMC card 110
8.13.1 Supported card types 110
8.13.2 Supported functions 110
8.13.3 Supported file systems 110
8.13.4 File names 110
8.13.5 Pin assignment SD/MMC card 111
8.13.6 BOOT-DIP switch 112
8.14 Notes concerning the safe and EMC-compliant installation 113
8.14.1 Definitions and terms 113
8.14.2 General information on EMC 113
8.14.3 EMC areas: first and second environment 114
8.14.4 EMC-compliant cabling 114
8.14.5 Operation with long motor cables 115
8.14.6 ESD protection 116

9 ADDITIONAL REQUIREMENTS TO BE FULFILLED BY THE SERVO POSITIONING CONTROLLERS FOR UL APPROVAL 117

9.1 Mains fuse 117
9.2 Wiring requirements and environmental conditions 117
9.3 Motor temperature sensor 117

10 START-UP 118

10.1 General connection notes 118
10.2 Tools/material 118
10.3 Connecting the motor 118
10.4 Connecting the ARS 2300 FS servo positioning controller to the power supply 119
10.5 Connecting the PC (serial interface) 119
10.6 Connecting the PC (USB interface, alternative) 119
10.7 Operability check 119

11 SERVICE FUNCTIONS AND ERROR MESSAGES....120
11.1 Protection and service functions....120
11.1.1 Overview....120
11.1.2 Phase and mains power failure detection....120
11.1.3 Overcurrent and short-circuit monitoring....121
11.1.4 Overvoltage monitoring of the DC bus circuit....121
11.1.5 Temperature monitoring of the heat sink....121
11.1.6 Monitoring of the motor....121
11.1.7 I²t monitoring....121
11.1.8 Power monitoring of the brake chopper....122
11.1.9 Start-up status....122
11.1.10 Rapid discharge of the DC bus circuit....122
11.1.11 Operating hours counter....122
11.2 Operating mode and error messages....123
11.2.1 Operating mode and error indication....123
11.2.2 Error messages....124
12 TECHNOLOGY MODULES....161
12.1 EA88 interface (terminal extensions)....161
12.1.1 Product description....161
12.1.2 Technical data....161
12.1.2.1 General data....161
12.1.2.2 Digital inputs....162
12.1.2.3 Digital outputs....162
12.1.3 Pin assignment and cable specifications....163
12.1.3.1 Power supply....163
12.1.3.2 Pin assignments....163
12.1.3.3 Mating connectors....164
12.1.3.4 Connection notes....164
12.2 PROFIBUS-DP interface....165
12.2.1 Product description....165
12.2.2 Technical data....165
12.2.3 Pin assignment and cable specifications....167
12.2.3.1 Pin assignment....167
12.2.3.2 Mating connector....167
12.2.3.3 Cable type and configuration....167
12.2.4 Termination and bus terminating resistors....168
12.3 Sercos II module....169
12.3.1 Product description....169

12.3.2 Technical data....170
12.3.3 Optical waveguide specification....171
12.4 EtherCAT....172
12.4.1 Product description....172
12.4.2 Characteristics of the EtherCAT technology module....172
12.4.3 Technical data....173
12.4.4 Display elements....174
12.4.5 EtherCAT interface....174
12.5 MC 2000 "Drive-In" 4-axis motion coordinator....175
12.5.1 Product description....175
12.5.2 Features....176
12.5.2.1 Compact....176
12.5.2.2 Fast....177
12.5.2.3 Easy....177
12.5.3 Technical data....178
12.6 General installation notes for technology modules....179

TABLE OF FIGURES:

Figure 1: Type key 30

Figure 2: Control structure of the ARS 2300 FS 56

Figure 3: Motion profiles of the ARS 2300 FS servo positioning controller 62

Figure 4: Path program 63

Figure 5: Linear interpolation between two data values 65

Figure 6: Schematic representation of the integrated safety technology (MOV) 70

Figure 7: FBA module: front view 71

Figure 8: Servo positioning controller ARS 2300 FS: installation space 74

Figure 9: Servo positioning controller ARS 2310 FS: front view 75

Figure 10: Servo positioning controller ARS 2302 FS: view from above 76

Figure 11: Servo positioning controller ARS 2302 FS: view from below 76

Figure 12: Servo positioning controllers ARS 2300 FS: mounting plate 77

Figure 13: Connection to the power supply and motor 78

Figure 14: Complete set-up of the ARS 2300 FS with a motor and PC 80

Figure 15: Power supply [X9] 83

Figure 16: Motor connector [X6] 85

Figure 17: Connecting a holding brake with a high current demand (> 2 A) to the device 86

Figure 18: Basic circuit diagram of connector [X1] 88

Figure 19: Pin assignment: resolver connector [X2A] 93

Figure 20: Pin assignment: analogue incremental encoder – option [X2B] 98

Figure 21: Pin assignment: incremental encoder with a serial interface (e.g. EnDat, HIPERFACE) – option [X2B] 98

Figure 22: Pin assignment: digital incremental encoder - option [X2B] 99

Figure 23: Pin assignment [X10]: incremental encoder input 101

Figure 24: Pin assignment [X11]: incremental encoder output 103

Figure 25: CAN bus cabling example 105

Figure 26: Integrated CAN terminating resistor 106

Figure 27: Pin assignment RS232 null modem cable [X5] 108

Figure 28: Pin assignment USB interface [X19], front view 109

Figure 29: Pin assignment: SD/MMC card 111

Figure 30: EA88: position of the pin-and-socket connectors [X21] and [X22] on the front plate 164

Figure 31: PROFIBUS-DP interface: front view 166

Figure 32: PROFIBUS-DP interface: connection with external terminating resistors 168
Figure 33: Sercos II module: front view 170
Figure 34: EtherCAT module: front view 173
Figure 35: MC 2000 4-axis motion coordinator 176
Figure 36: MC 2000 4-axis motion coordinator as a complete assembly 176
Figure 37: Servo positioning controller with an integrated MC 2000 technology module (example) 179

Table of Tables:

Table 1: Scope of supply 17

Table 2: Connector set: POWER connector 17

Table 3: Connector set: DSUB connector....17

Table 4: Connector set: shield connector 17

Table 5: Technical data: ambient conditions and qualification 38

Table 6: Technical data: dimensions and weight....38

Table 7: Technical data: cable specifications 39

Table 8: Technical data: motor temperature monitoring system 39

Table 9: Display elements and RESET button 39

Table 10: Technical data: power data [X9] 40

Table 11: Technical data: internal braking resistor [X9] 40

Table 12: Technical data: external braking resistor [X9] 40

Table 13: Technical data: motor connector [X6]....41

Table 14: ARS 2302 FS: rated current values for an ambient temperature ≤ 40°C 42

Table 15: ARS 2305 FS: rated current values for a blocked or slow-running motor (f_{el}) ≤ 5Hz and for an ambient temperature ≤ 40°C 43

Table 16: ARS 2305 FS: rated current values for a rotating motor (f_{el}) ≥ 20 Hz and for an ambient temperature ≤ 40°C....43

Table 17: ARS 2310 FS: rated current values for a blocked or slow-running motor (f_{el}) ≤ 5 Hz and for an ambient temperature ≤ 40°C 44

Table 18: ARS 2310 FS: rated current values for a rotating motor (f_{el}) ≥ 20 Hz and for an ambient temperature ≤ 40°C....45

Table 19: Technical data: resolver [X2A]....47

Table 20: Technical data: resolver interface [X2A]....47

Table 21: Technical data: encoder evaluation [X2B] 48

Table 22: Technical data: RS232 [X5] 50

Table 23: Technical data: USB [X19]....50

Table 24: Technical data: Ethernet [X18] 51

Table 25: Technical data: CAN bus [X4]....51

Table 26: Technical data: SD/MMC card....51

Table 27: Technical data: digital inputs and outputs [X1] 52

Table 28: Technical data: analogue inputs and outputs [X1]....53

Table 29: Technical data: incremental encoder input [X10] 53

Table 30: Technical data: incremental encoder output [X11] 54
Table 31: Output voltage at the motor terminals in the case of a DC bus circuit voltage (U_{ZK}) of 560 V 57
Table 32: Overview of the DIP switch functionality 67
Table 33: Fieldbus-specific assignment of the DIP switches 69
Table 34: Pin assignment [X9] 82
Table 35: Pin-and-socket connector [X9]: external braking resistor 83
Table 36: Pin assignment [X6] 84
Table 37: Pin assignment: I/O communication [X1] 90
Table 38: Pin assignment [X2A] 92
Table 39: Pin assignment: analogue incremental encoder – option [X2B] 95
Table 40: Pin assignment: incremental encoder with a serial interface (e.g. EnDat, HIPERFACE) – option [X2B] 96
Table 41: Pin assignment: digital incremental encoder – option [X2B] 97
Table 42: Pin assignment [X10]: incremental encoder input 100
Table 43: Pin assignment [X11]: incremental encoder output 102
Table 44: Pin assignment CAN bus [X4] 104
Table 45: Pin assignment RS232 interface [X5] 107
Table 46: Pin assignment USB interface [X19] 109
Table 47: Pin assignment: SD card 111
Table 48: Pin assignment: MMC card 111
Table 49: EMC requirements: first and second environment 114
Table 50: Operating mode and error indication 123
Table 51: Error messages 125
Table 52: Technical data: EA88 interface 161
Table 53: Digital inputs: EA88 interface [X21] 162
Table 54: Digital outputs: EA88 interface [X22] 162
Table 55: EA88: connector [X21] for 8 digital inputs 163
Table 56: EA88: connector [X22] for 8 digital outputs 163
Table 57: Technical data: PROFIBUS-DP interface: ambient conditions, dimensions, and weight 165
Table 58: Technical data: PROFIBUS-DP interface: interfaces and communication 166
Table 59: Pin assignment: PROFIBUS-DP interface 167
Table 60: Technical data: Sercos II module: ambient conditions, dimensions, and weight 170

Table 61: Technical data: EtherCAT module: ambient conditions, dimensions, and weight.....173

Table 62: Display elements.....174

Table 63: Signal level and differential voltage 174

Table 64: Technical data: MC 2000 4-axis motion coordinator 178

1 General

1.1 Documentation

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

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

- **Product Manual "Servo Positioning Controller ARS 2100 FS":** Description of the technical data and device functionality plus notes concerning the installation and operation of ARS 2102 FS, ARS 2105 FS, and ARS 2108 FS servo positioning controllers.
- **Product Manual "MC 2000":** Description of the technical data and device functionality as well as notes on the installation and operation of the Motion Coordinator MC 2000 (German version).
- **Product Manual "FSM 2.0 - STO":** Description of the technical data and device functionality plus notes on the installation and operation of the FSM 2.0 – STO.
- **Product Manual "FSM 2.0 - MOV":** Description of the technical data and device functionality plus notes on the installation and operation of the FSM 2.0 – MOV (German version).
- **PROFIBUS Manual "Servo Positioning Controller ARS 2000":** Description of the implemented PROFIBUS-DP protocol.
- **CANopen Manual "Servo Positioning Controller ARS 2000":** Description of the implemented CANopen protocol as per DSP402.
- **ETHERNET Manual "Servo Positioning Controller ARS 2000"**: Description of the implemented Ethernet protocol (UDP).
- **EtherCAT Manual "Servo Positioning Controller ARS 2000"**: Description of the implemented EtherCAT protocol (CoE) (German version).
- **Sercos Manual "Servo Positioning Controller ARS 2000":** Description of the implemented Sercos functionality.

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

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

The entire software functionality of the new ARS 2000 FS 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 4.1.0.1.2.

1.2 Scope of supply

The scope of supply includes:

Table 1: Scope of supply

1x	Servo positioning controller ARS 2300 FS			
	Type	ARS 2302 FS	ARS 2305 FS	ARS 2310 FS
	Kuhnke part number	9200-2302-20	9200-2305-20	9200-2310-20

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

Table 2: 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 FS	ARS 2305 FS	ARS 2310 FS
	Kuhnke part number	9200-0230-00		

Table 3: 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 FS	ARS 2305 FS	ARS 2310 FS
	Kuhnke part number	9200-0200-00		

Table 4: Connector set: shield connector

1x	**Connector set: shield connector** This connector set includes two shield terminals (SK14)			
	Type	ARS 2302 FS	ARS 2305 FS	ARS 2310 FS
	Kuhnke 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, Kuhnke will not assume any liability.



Prior to commissioning the system, read the *Safety notes for electrical drives and controllers* as of page 18 and *chapter 8.14 (Notes concerning the safe and EMC-compliant installation*, page 113).

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 positioning controller 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 positioning controller 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 positioning controller.



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



If the servo positioning controller is sold, rented out, or otherwise distributed to third parties, these safety instructions must be included.



Opening the servo positioning controller 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 positioning controller!



DANGER!

Improper handling of the servo positioning controller 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 positioning controller 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 positioning controllers 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 positioning controller 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 113) 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 positioning controller 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 positioning controller.

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 drive controller 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 positioning controller 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 positioning controller.



Ensure also that the external power supply of the controller (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 controller supply.



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 controller 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. In the ARS 2300 FS, these safety features can be realised, for example, by way of an FSM 2.0 - STO module.



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 positioning controller 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 positioning controllers 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 positioning controllers 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 positioning controller 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 positioning controllers of the ARS 2000 FS series (**ARS** servo of the 2nd generation for **F**unctional **S**afety) are intelligent AC servo inverters with extensive parameterisation and extension options. Due to their high level of flexibility, they can be adapted to numerous areas of application.

These servo positioning controllers are designed for the integration of so-called FSM modules (**F**unctional **S**afety **M**odules). Thanks to their integrated safety features, external monitoring devices can be omitted for numerous applications.

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

Type key:

ARS 2302 FS (example)

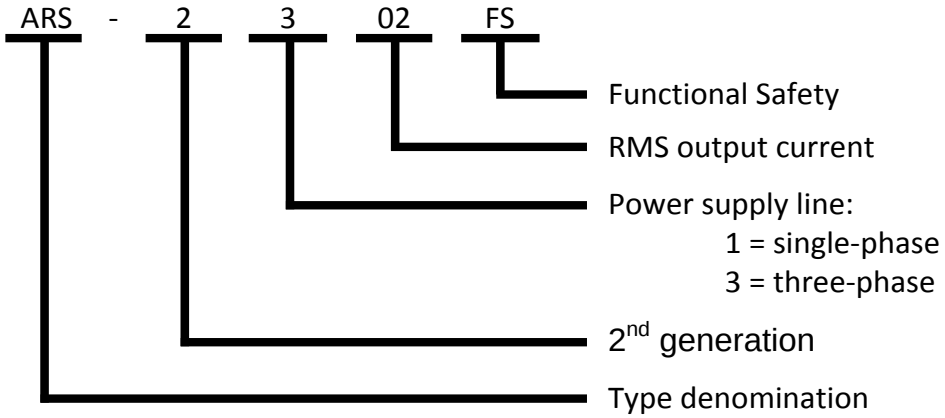


Figure 1: Type key

All of the servo positioning controllers of the ARS 2000 FS series devices 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, Ethernet, and RS232 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 encoders 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 have an 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 EMC regulations during the operation (1st environment with limited availability in accordance with EN 61800-3).
- 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 and without smooth position transitions.
- 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 Kuhnke 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.
- Technology slots for extensions, e.g. an I/O extension module or Profibus interface.
  Note: Depending on the current consumption, only one technology module with an additional fieldbus interface may be used.
- "STO" option (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.

3.2 Power supply

3.2.1 Three-phase AC power supply

The ARS 2300 FS servo positioning controller fulfils the following requirements:

- Nominal frequency range 50-60 Hz ±10%.
- Surge rating for the potential combination with servo inverters. The ARS 2300 FS servo positioning controller 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 FS servo positioning controller 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

- It is possible to link multiple ARS 2300 FS servo positioning controllers if their nominal DC bus circuit voltage is identical.



Caution!

Operation with DC bus circuit linking combined with devices of the ARS 2100 FS 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.



The digital motor temperature monitoring system (at socket [X6]) 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), three-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 12, page 40*). 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 FS servo positioning controller has several communication interfaces. The basic device itself is equipped with many of these interfaces.

The following communication interfaces are included in the basic device:

- Serial interface [X5]: RS232/RS485
- USB interface [X19]: USB
- UDP interface [X18]: Ethernet
- Fieldbus system [X4]: CANopen
- I/O interface [X1]: digital and analogue input and outputs

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

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

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

3.4.1 Serial interface [X5]

The RS232 protocol is mainly used as a parameterisation interface, but it also enables the control of the ARS 2000 FS servo positioning controller.

3.4.2 USB interface [X19]

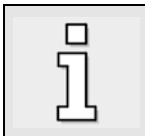
This interface was also mainly intended as a parameterisation interface, but it can also be used for controlling the ARS 2000 FS servo positioning controller.

3.4.3 UDP interface [X18]

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

3.4.4 CAN interface [X4]

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



The specific Kuhnke CAN protocol of the previous ARS product range is no longer supported by the ARS 2000 FS series. The ARS 2000 FS servo positioning controller supports the CANopen protocol as per DS301 with the DSP402 application profile.

3.4.5 Technology module: Profibus

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

In addition, it is also possible to integrate the device into a control system by I/O mapping via PROFIBUS. From a control point of view, this option offers the same functionality as a standard PLC coupling via parallel wiring with regard to the digital I/Os of the device.

A special Kuhnke telegram can be used to access nearly all of the device-specific functions, exceeding the functionality defined by PROFIDRIVE.



The Kuhnke PROFIBUS profile of the previous ARS series is no longer supported by the ARS 2000 FS series.

3.4.6 Technology module: Sercos II

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

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

3.4.7 Technology module: EtherCAT

The EtherCAT interface enables the connection of the ARS 2000 FS servo positioning controller to the EtherCAT fieldbus system. The communication via the EtherCAT interface (IEEE-802.3u) is realised with the aid of EtherCAT standard cabling.

3.4.8 I/O functions and device control

Ten digital inputs provide the elementary control functions (see *chapter 4.6.6 I/O interface [*X1*], page 52*):

The ARS 2000 FS has a target table in which the positioning targets can be stored and from where they can be retrieved at a later point of time. At least four digital inputs are used for the target selection; one input is used as a start input.

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 controller on the software side.

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

The ARS 2000 FS servo positioning controller has 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. Alternatively, the EA88 interface can be used as an extension of the digital inputs.

4 Technical data

4.1 General technical data

Table 5: Technical data: ambient conditions and qualification

Range	Values
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
cULus certification	Listed as per UL 508C, C22.2 No. 274-13

Table 6: Technical data: dimensions and weight

Type	ARS 2302 FS	ARS 2305 FS	ARS 2310 FS
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 7: Technical data: cable specifications

Range	ARS 2302 FS	ARS 2305 FS	ARS 2310 FS
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 8: 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 FS servo positioning controller has three LEDs and one seven-segment display to indicate the operating status.

Table 9: 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)	Controller enable signal
LED 3 (yellow)	CAN bus status indication
RESET button	Hardware reset for the processor

4.3 Power supply [X9]

Table 10: Technical data: power data [X9]

Type	ARS 2302 FS	ARS 2305 FS	ARS 2310 FS
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 11: Technical data: internal braking resistor [X9]

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

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

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

4.4 Motor connector [X6]

Table 13: Technical data: motor connector [X6]

Type	ARS 2302 FS	ARS 2305 FS	ARS 2310 FS
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
Clock frequency	4 … 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 2305 FS and ARS 2310 FS; see the following tables.

**) "As a rating guideline".

4.4.1 Current derating

In deviation from the technical motor data, the ARS 2300 FS servo positioning controllers have current derating during nominal operation. The rated current and the duration of the maximum permissible peak current of the servo positioning controller 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 positioning controller 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 14: ARS 2302 FS: 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 15: ARS 2305 FS: 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 16: ARS 2305 FS: 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 17: ARS 2310 FS: 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 18: ARS 2310 FS: 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 FS servo positioning controller:

- 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 can be defined via the Kuhnke ServoCommander® parameterisation software.

The feedback signal is made available to any subsequent drives 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 FS 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 19: 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 20: 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 21: 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 120Ω
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 Control via sensor lines Setpoint programmable via SW

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 FS servo positioning controller must 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 Kuhnke ServoCommander® parameterisation software. Normally, the Hall sensor offset angle is zero.

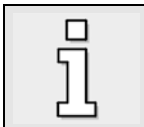
Sick-Stegmann encoders:

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 37/52
- Multi-turn SinCos encoders: SCM 60/70, SKM 36, SRM 50/60/64, SEL 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:

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

4.6 Communication interfaces

4.6.1 RS232 [X5]

Table 22: Technical data: RS232 [X5]

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

4.6.2 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	Kuhnke-specific (generic device)

4.6.3 Ethernet [X18]

Table 24: Technical data: Ethernet [X18]

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

4.6.4 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

4.6.5 SD/MMC card

Table 26: Technical data: SD/MMC card

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

4.6.6 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	Controller 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	
DIN 9	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, 9-bit resolution, f_{limit} > 1 kHz	

4.6.7 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 controller 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.

4.6.8 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 FS servo positioning controller is a universal servo drive controller 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 FS servo positioning controllers 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 FS 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 FS servo positioning controller

5.2.1 Compatibility

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

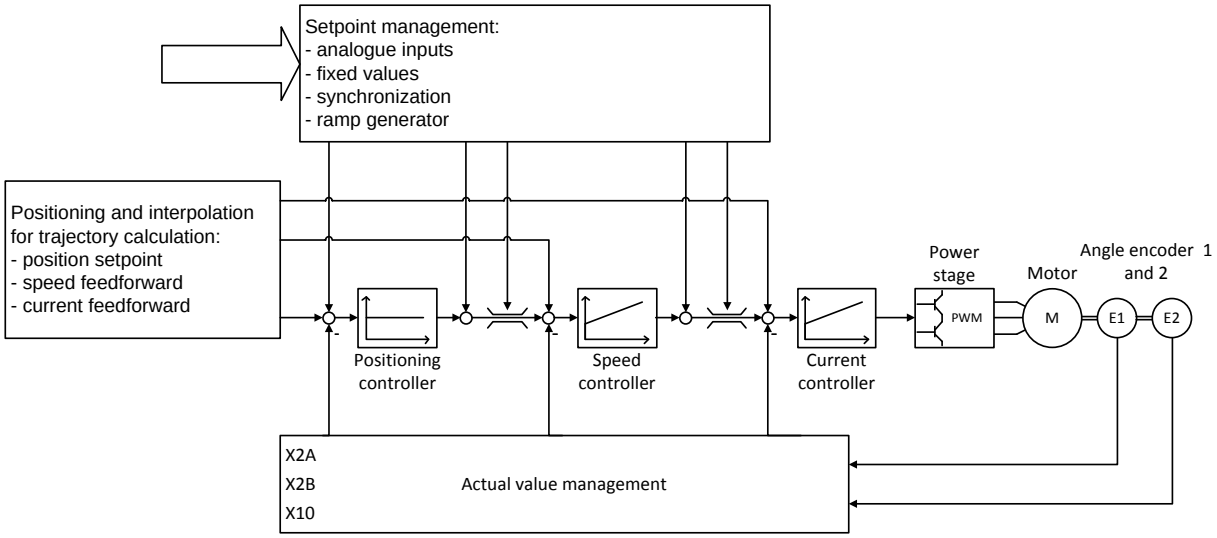


Figure 2: Control structure of the ARS 2300 FS

Figure 2 shows the control structure of the ARS 2300 FS. 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 FS servo positioning controller can vary the clock frequency in the current controller circuit. In most cases, the clock frequency can be set via the Kuhnke 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 FS servo positioning controller also features a sine modulation or alternatively a sine modulation with third harmonic. This increases the effective converter output voltage. The type of modulation can be selected via the Kuhnke ServoCommander® parameterisation software. Sine modulation is the default setting.

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
    - RS232 interface or
    - CANopen bus interface or
    - PROFIBUS-DP interface or
    - Sercos interface
  - Second and third value: fixed values 2 and 3
- Process controller
- 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 positioning controller. 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 FS servo positioning controller 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, the current controller and and the 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 and the width 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 FS servo positioning controllers 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 controllers 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. Sercos, CANopen, EtherCAT), 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).

5.2.10 Synchronisation, electronic gear unit

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

If the ARS 2300 FS servo positioning controller 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.

The ARS 2300 FS servo positioning controller can calculate the speed forward control independently. All of the inputs can be activated/deactivated. As an option, the internal encoder can be shut off if another input is selected as the actual value encoder. This applies also to the speed control mode. The external inputs can be weighted with gear factors. The inputs can be used individually or simultaneously.

5.2.11 Brake management

The ARS 2300 FS servo positioning controller 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 FS servo positioning controller off after a parameterised idle time and engages the brake. This mode of operation is compatible with the functions of the previous ARS series.

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 range of 2^{32} full revolutions enables any number of relative positioning movements in one direction.

The positioning control is parameterised by way of a target table. The target table includes entries for the parameterisation of a target via a communication interface and also target positions that can be retrieved via the digital inputs. For each entry, the positioning method, motion profile, acceleration and deceleration times, and maximum speed can be defined. All of the targets can be pre-parameterised. All that the user has to do for performing the positioning is to select the desired entry and to issue a start command. It also possible to change the target parameters online via the communication interface.

The ARS 2300 FS servo positioning controller can store at total of 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 addressed via the bus systems or via the Kuhnke 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 this case, 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. In the case of absolute positioning, the target position is a fixed (absolute) position with regard to the zero point or reference point.

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 of third order. Since the acceleration changes steadily, the drive movement is particularly gentle with regard to the mechanical system.

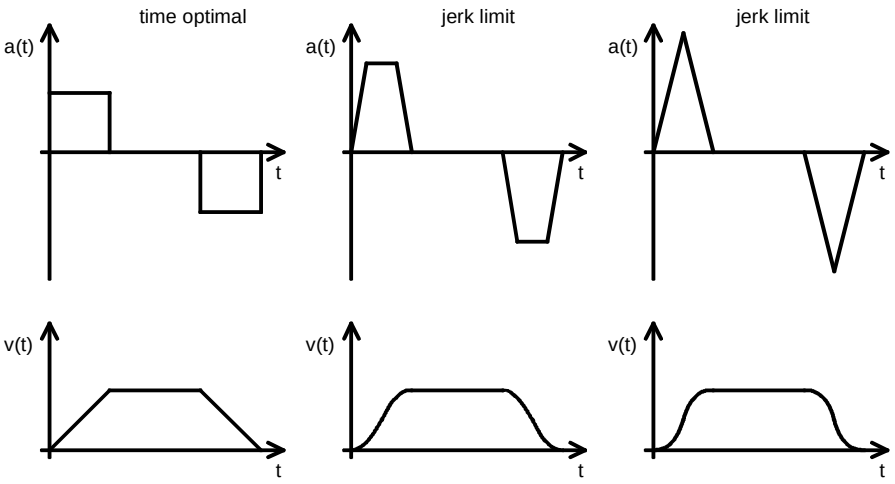


Figure 3: **Motion profiles of the ARS 2300 FS servo positioning controller**

5.3.5 Homing

Every positioning control requires a defined zero at start-up, which is determined by way of a homing operation. The servo positioning controller ARS 2300 FS 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 controller is enabled. Optionally, it is also possible to configure the start via a digital input by way of the Kuhnke ServoCommander® parameterisation software in order to perform a homing process in a targeted manner regardless of whether the controller has been enabled or not. Among other things, the controller 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 controller 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 controller enable or RS232. 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

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:

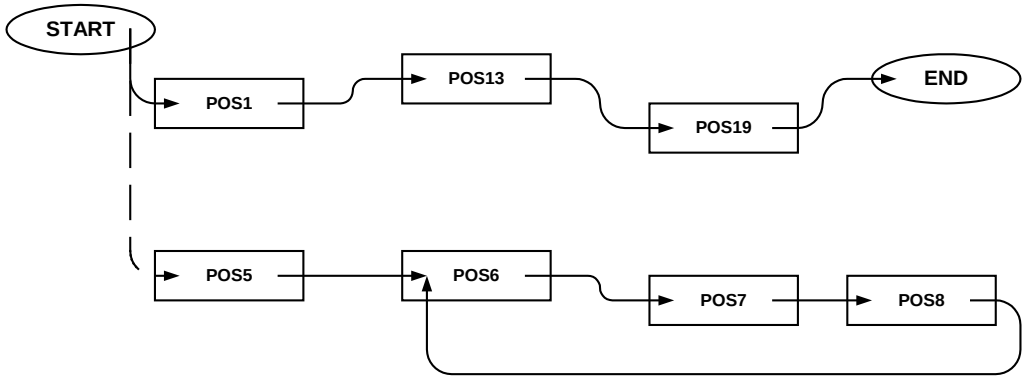


Figure 4: Path program

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.

For further information, please refer to the software manual "Servo Positioning Controller ARS 2000 FS".

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 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 controller. 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 controller autonomously interpolates the data values between two set position values, as shown in the following illustration. The servo positioning controller also calculates a corresponding speed feedforward.

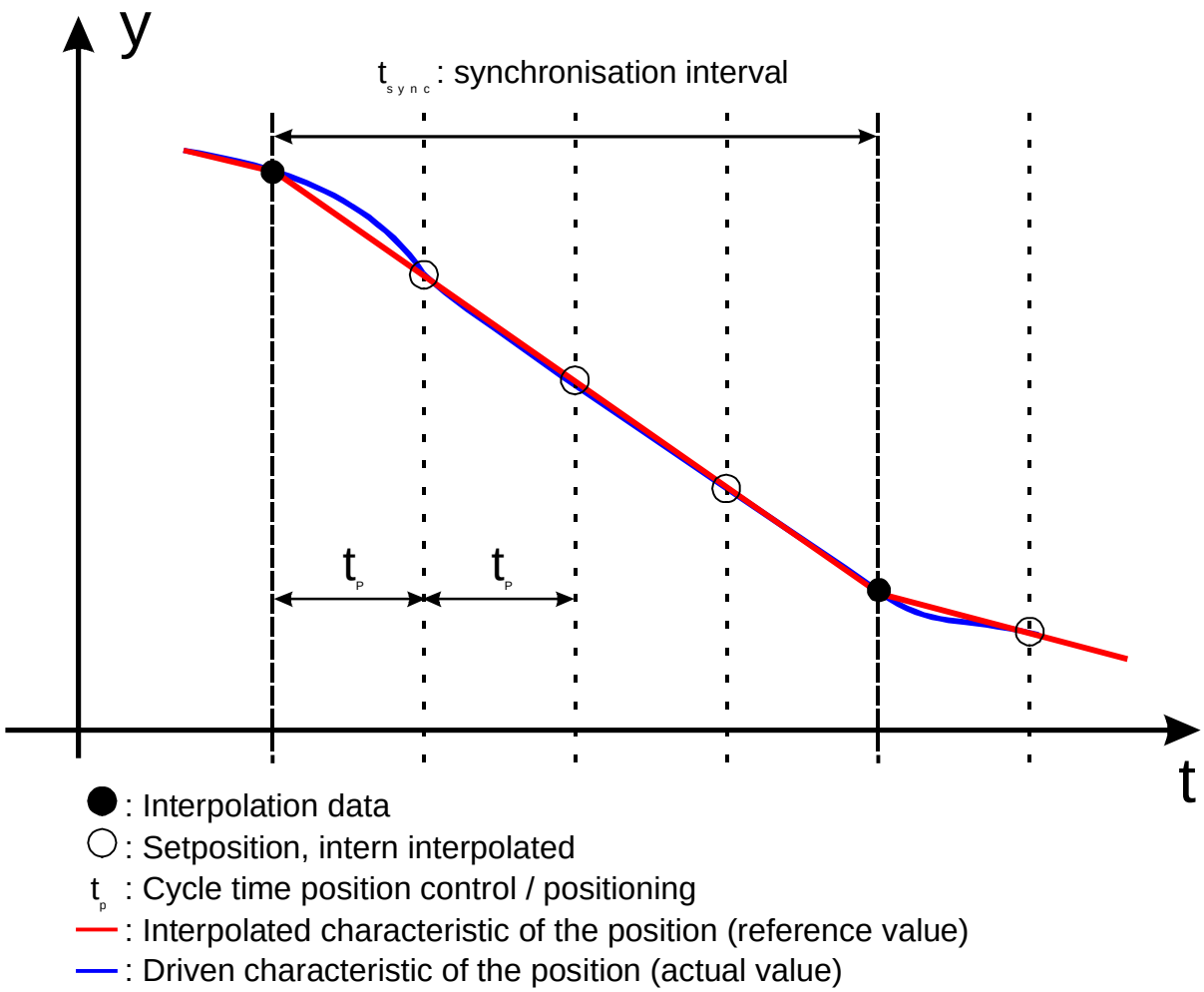


Figure 5: Linear interpolation between two data values

5.3.9 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 positioning controllers of the ARS 2300 FS 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 or the EtherCAT "DC" (**D**istributed **C**lock), 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.

6 Functional safety technology

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 FS servo positioning controllers are not equipped with any integrated functions for safety-related motion monitoring and motion control. However, they have an extension slot for a safety module.

As a standard, the ARS 2000 FS servo positioning controllers come supplied with the module FSM 2.0 – FBA (**F**ield**b**us **A**ctivation Module) integrated in the extension slot for safety modules. You can remove this module and replace it with a functional safety module.

If the safety modules of the FSM 2.0 series (**F**unctional **S**afety **M**odule) are used, external monitoring devices are no longer required for numerous applications. The wiring of the entire system is simplified and the number of components as well as the costs of the system solution can be reduced.

The design of the safety modules ensures that they can be simply plugged into the basic device from the outside. As a result, the servo positioning controllers can be quickly adapted to the specific safety requirements of the overall system. Retrofitting of these modules (or the later use of a different safety module), thereby, becomes possible. The module is supplied with power via the power supply of the basic device.

6.1.1 DIP switch

The FBA module (**F**ield**b**us **A**ctivation Module) and all of the integrated functional safety modules (FSM 2.0) are equipped with a DIP switch (8 poles). Under certain conditions, substantial parts of the parameters of the fieldbus communication can be configured with the aid of this DIP switch. Depending on the fieldbus that is used, it is possible, for example, to adjust the fieldbus node number, baud rate, etc. This DIP switch does not have a safety-relevant function.

The following applies in order to achieve downward compatibility with the previous ARS 2000 devices:

- If all of the switches on the module are set to zero (factory setting), the fieldbus communication parameters of the parameter data set of the basic device will be used.



The position of the DIP switch is read in only once after a reset. Modifications of the switch positions during the operation, therefore, do not affect the current operation.

Table 32: Overview of the DIP switch functionality

Technology module (type)	Functionality of the DIP switch		
	Communication on/off	**Baud rate**	**Station address setting**
-- (CAN, in the basic device)	✓	✓	✓
Profibus	✓	-- (via the master)	✓
Sercos (without DIP switches)	✓	✓	✓
Sercos (with DIP switches)	--	--	--
EtherCAT	--[1)]	--	--

[1)] The control of EtherCAT via the DIP switches is not planned. If the EtherCAT fieldbus technology module is used, the bus will be switched on automatically.

6.1.2 Assignment of the DIP switch

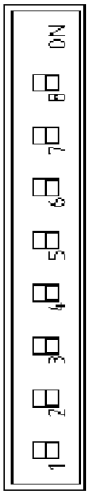
The firmware of the ARS 2000 FS servo positioning controllers distinguishes itself by the universal support of various types of fieldbuses. Since every fieldbus requires a specific hardware, the fieldbus is selected based on the fieldbus module that is plugged into one of the technology slots. Depending on the identified technology module, the individual switches have an influence on the activation and, where applicable, also on the configuration of this specific fieldbus. If the system does not find any fieldbus technology module, the switch settings affect the fieldbus CAN whose interface is integrated into the basic device. This means that if, for example, a Profibus module is installed, then the switch positions cannot be used to activate the CAN communication.

The assignment of the individual switch positions to a specific function depends on the fieldbus that is used. As far as this is possible, the function of a switch is the same for all of the fieldbuses such as, for example, switch 8 for activating/deactivating the communication. The functions are listed in *Table 33*.

The following general rules apply to the communication parameterisation of the technology modules that are listed in *Table 33*:

- Switch position = 0:
  The activation of the communication, baud rate, and fieldbus address will be taken from the parameter data set or – depending on the parameterisation – optionally also by an addition of digital inputs.
- Switch position <> 0:
  The configuration of the communication parameters via the DIP switch takes precedence over the corresponding settings in the parameter data set:
  - Activation of the communication via DIP switch
  - Selection of the baud rate (if it can be adjusted) via DIP switch
  - Setting of the fieldbus address via DIP switch (addition to the basic node number taken from the parameter data set)
- If the communication is deactivated via the DIP switch, it is optionally possible to reactivate or deactivate it via the Kuhnke ServoCommander® parameterisation software.
- The fieldbus address that is set via the DIP switch is checked internally for validity and, if necessary, it is limited.
- Fieldbus-specific functions (for example CAN: check for double node numbers) are configured via the settings in the parameter data set.
- If no fieldbus technology module is connected, the DIP switch is used for the configuration of the CAN hardware that is integrated in the basic device.
  The control of operating parameters for the RS485 communication that is also supported in the basic device is not possible in favour of the parameterisation of the CAN interface.

Table 33: Fieldbus-specific assignment of the DIP switches

DIP switch		Functionally of the DIP switch (fieldbus specific with technology module)			
		CAN (in the basic device)	**PROFIBUS**	**Sercos (without DIP switch)**	**EtherCAT**
	8	Communication: 1: On 0: Off	Communication: 1: On 0: Off	Communication: 1: On 0: Off	Communication: 1: On 0: Off [1)]
	7	Baudrate: 11: 1 MBaud 10: 500 kBaud 01: 250 KBaud 00: 125 kBaud	Slave address respectively address offset [2)]: 0 .. 127 valid range: 3 .. 125	Baudrate: 11: 16 MBaud 10: 8 MBaud 01: 4 MBaud 00: 2 MBaud	No function[1)]
	6				
	5	Node address respectively address offset [2)]: 1 ... 31		Drive address respectively address offset [2)]: 1 ... 31	
	4				
	3				
	2				
	1				

1 If all DIP switches == 0: automatic start-up of EtherCAT is activated ➔ EtherCAT is switched on.
If at least one of the DIP switches 1 to 7 <> 0 and DIP switch 8 == 0: no automatic start-up of EtherCAT ➔ EtherCAT is switched off.

2) If necessary, the addresses will be added as an offset of a predefined base address of the corresponding bus system. The base address can be predefined in the Kuhnke ServoCommander® and can then be saved in the parameter set of the ARS 2000 FS.

The activation of a fieldbus via the DIP switch takes precedence over the activation of the fieldbus based on the parameter data set.

In order to be nonetheless able to change settings and test different configurations during the operation, the fieldbus menu of the Kuhnke ServoCommander® can be used.

After a reset, however, the setting of the DIP switches will be checked and used.

Example:

- DIP switch position <> 0 and DIP8 = ON
  ➔ fieldbus always activated, can be changed via Kuhnke ServoCommander®.
- DIP switch position <> 0 and DIP8 = OFF
  ➔ fieldbus always off, can be changed via Kuhnke ServoCommander®.
- DIP switch position = 0
  ➔ fieldbus configuration based on the parameter set. Can be changed and saved via Kuhnke ServoCommander® (downward-compatible).

6.2 Integrated safety technology (schematic representation)

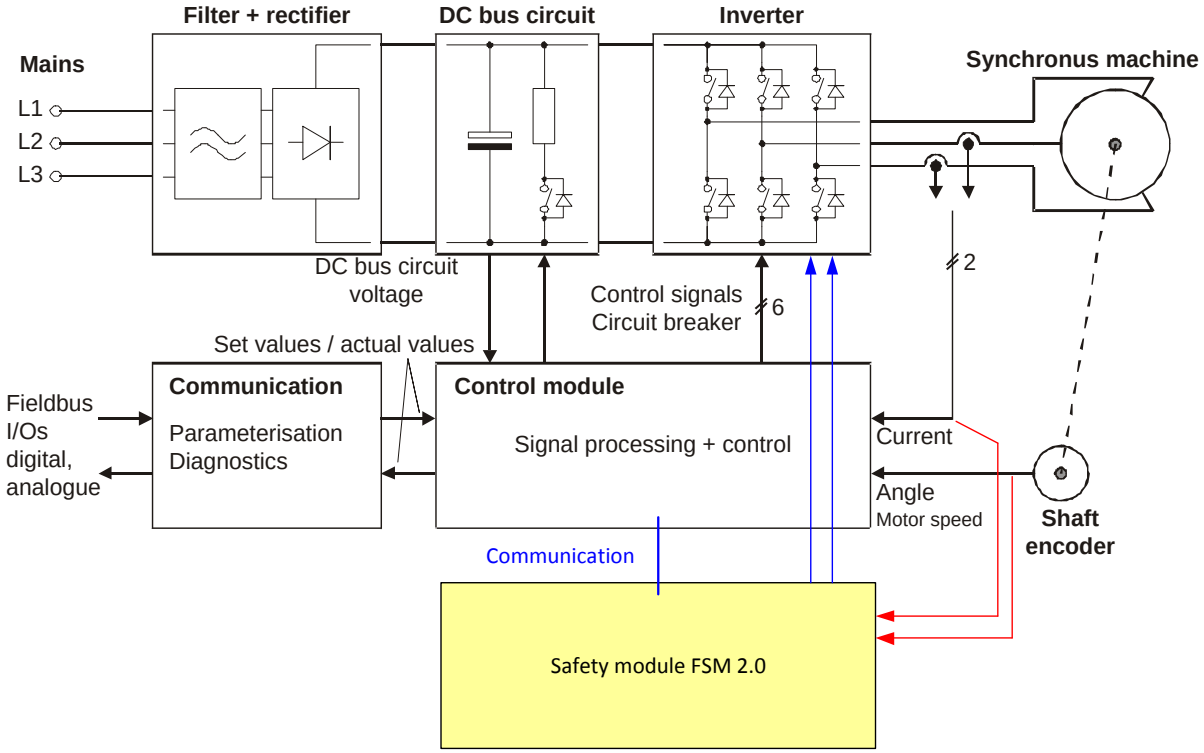


Figure 6: Schematic representation of the integrated safety technology (MOV)

6.3 Module variants

6.3.1 FBA module

As a standard, the basic device comes supplied with a so-called "FBA module" (**F**ield**b**us **A**ctivation module). It has a DIP switch (8 poles) on its front panel. Under certain conditions, substantial parts of the parameters of the fieldbus communication can be configured with the aid of this DIP switch. Depending on the fieldbus that is used, it is possible, for example, to adjust the fieldbus node number, baud rate, etc. This means, for example, that a servo positioning controller that is supplied in its original state (i.e. without a parameterisation or fieldbus data settings) can be installed and used in a system.

In addition, the FBA module is required for enabling the driver power supply for the power output stage.



Figure 7: FBA module: front view

6.3.2 FSM 2.0 – STO (Safe Torque Off)

Please refer to the original instructions "FSM 2.0 – STO" for further information.

6.3.3 FSM 2.0 – MOV

Module for the safety functions SLS, SOS, SBC, etc.

Please refer to the original instructions "FSM 2.0 – MOV" for further information.

7 Mechanical installation

7.1 Important notes

- Only use the ARS 2300 FS servo positioning controller as a built-in device 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!
- ARS 2300 FS servo positioning controllers 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 FS servo positioning controllers are subject to high thermal stress, a mounting clearance of 75 mm is recommended!



The connections shown in the following illustrations apply to the servo positioning controllers ARS 2302 FS, ARS 2305 FS, and ARS 2310 FS!



Figure 8: Servo positioning controller ARS 2300 FS: installation space

7.2 Device view

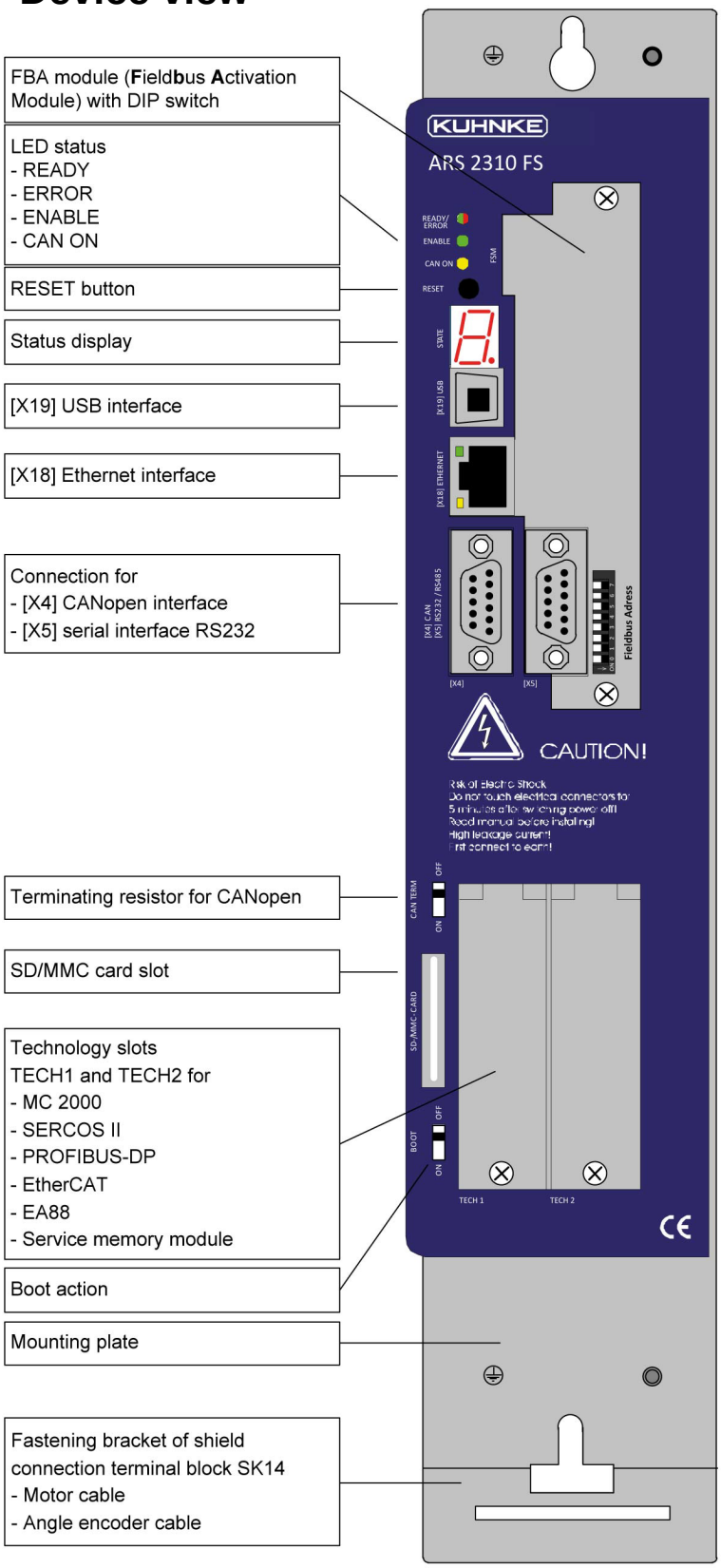


Figure 9: Servo positioning controller ARS 2310 FS: front view

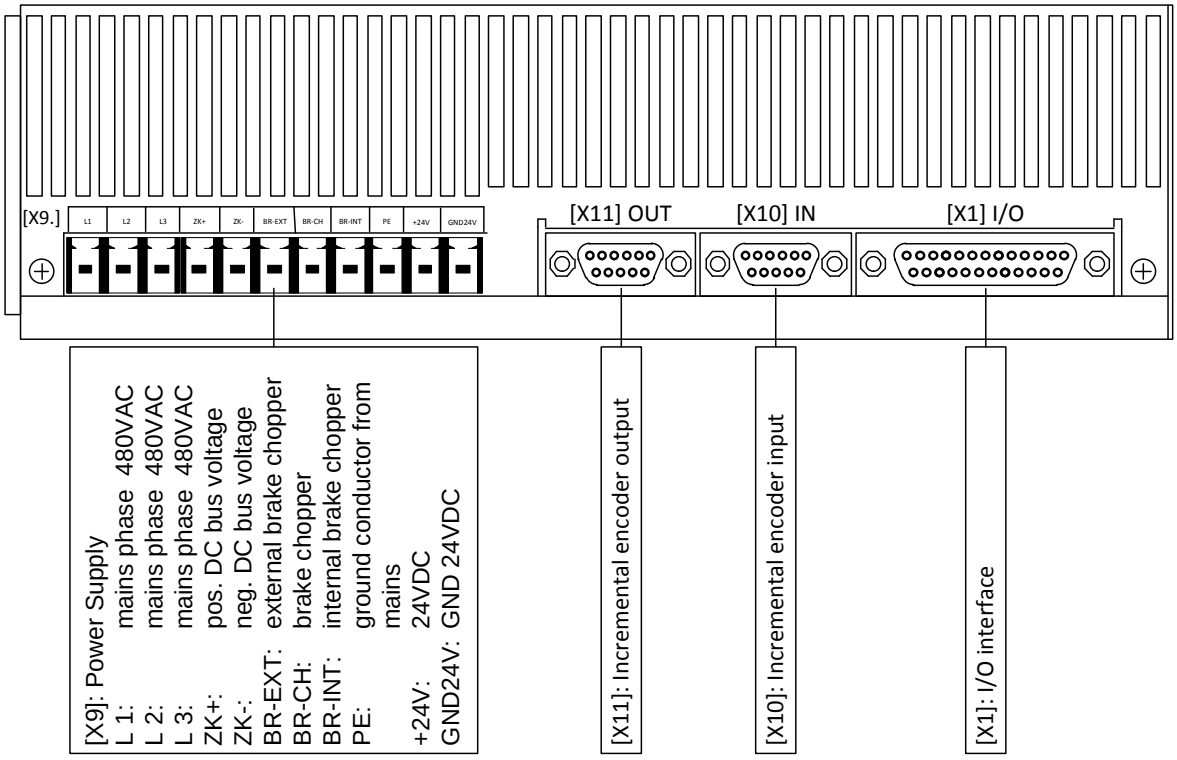


Figure 10: Servo positioning controller ARS 2302 FS: view from above

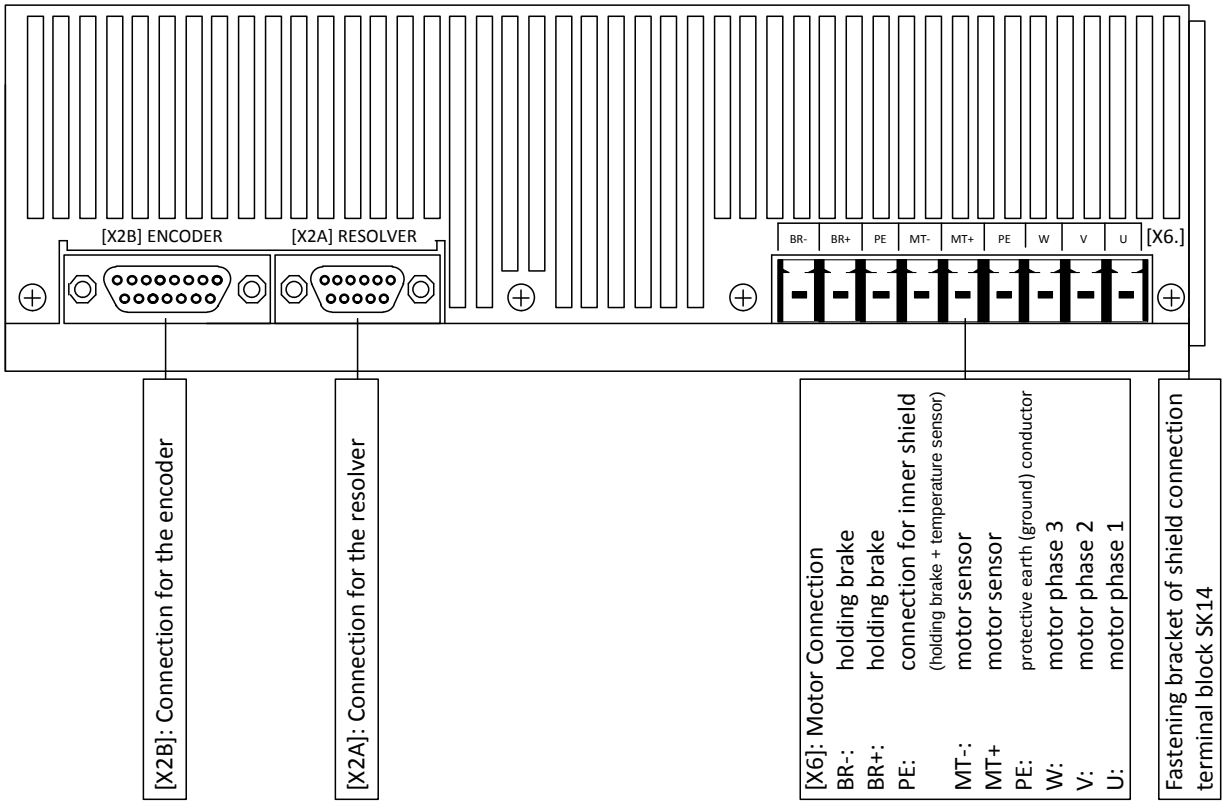


Figure 11: Servo positioning controller ARS 2302 FS: view from below

7.3 Installation

The servo positioning controller ARS 2300 FS has fastening tabs at the top and bottom. These tabs are used to mount the servo positioning controller 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 positioning controllers ARS 2302 FS, ARS 2305 FS, and ARS 2310 FS.

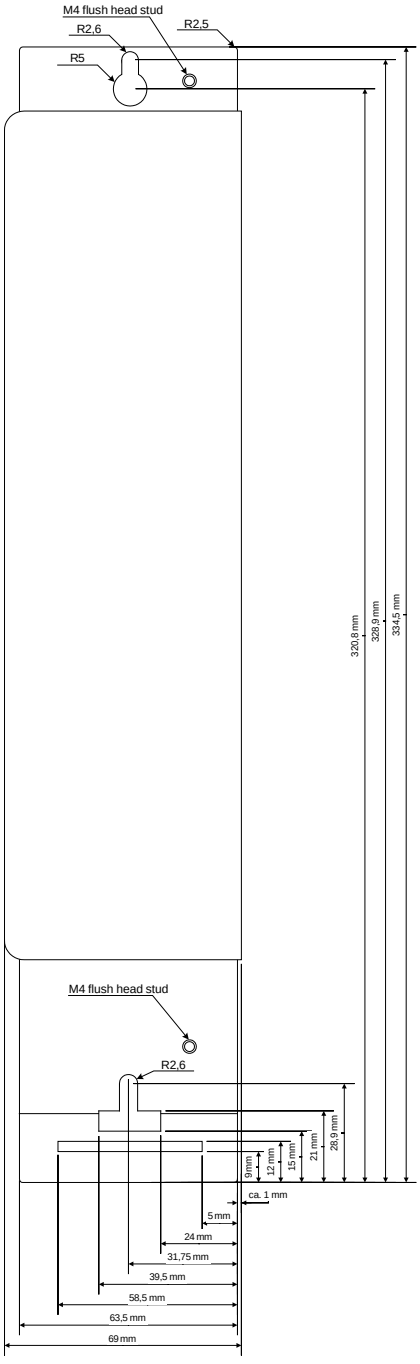


Figure 12: Servo positioning controllers ARS 2300 FS: mounting plate

8 Electrical installation

8.1 Connector configuration

The ARS 2300 FS servo positioning controller is connected to the power supply, motor, braking resistor, and holding brake as shown in *Figure 13*.

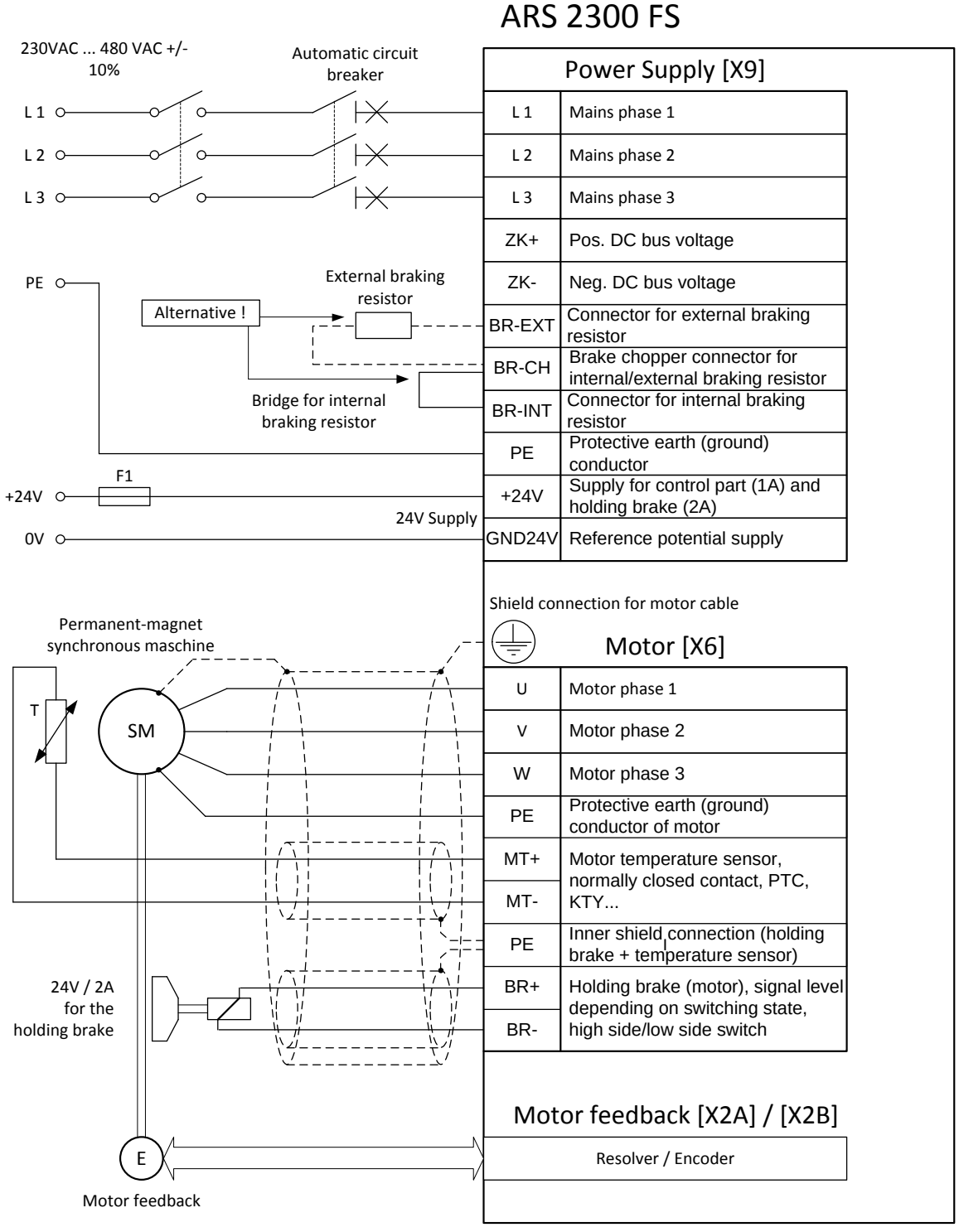


Figure 13: Connection to the power supply and motor

The ARS 2300 FS 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 13*.

The ARS 2300 FS servo positioning controller must be connected to earth (ground) with its PE connector.

As a first step, the ARS 2300 FS servo positioning controller 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. In the case of reverse connection of the operating voltage connectors, excessive operating voltage, or accidental interchanging of the operating voltage and motor connectors, the ARS 2300 FS servo positioning controller will be damaged.

8.2 ARS 2300 FS – complete system

The complete ARS 2300 FS servo positioning controller system is shown in *Figure 14*. The following components are required for the operation of the servo positioning controller:

- 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 2302 FS, ARS 2305 FS, or ARS 2310 FS servo positioning controller
- Motor with motor cable
- Mains power cable

The parameterisation requires a PC with a serial port or USB port.

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

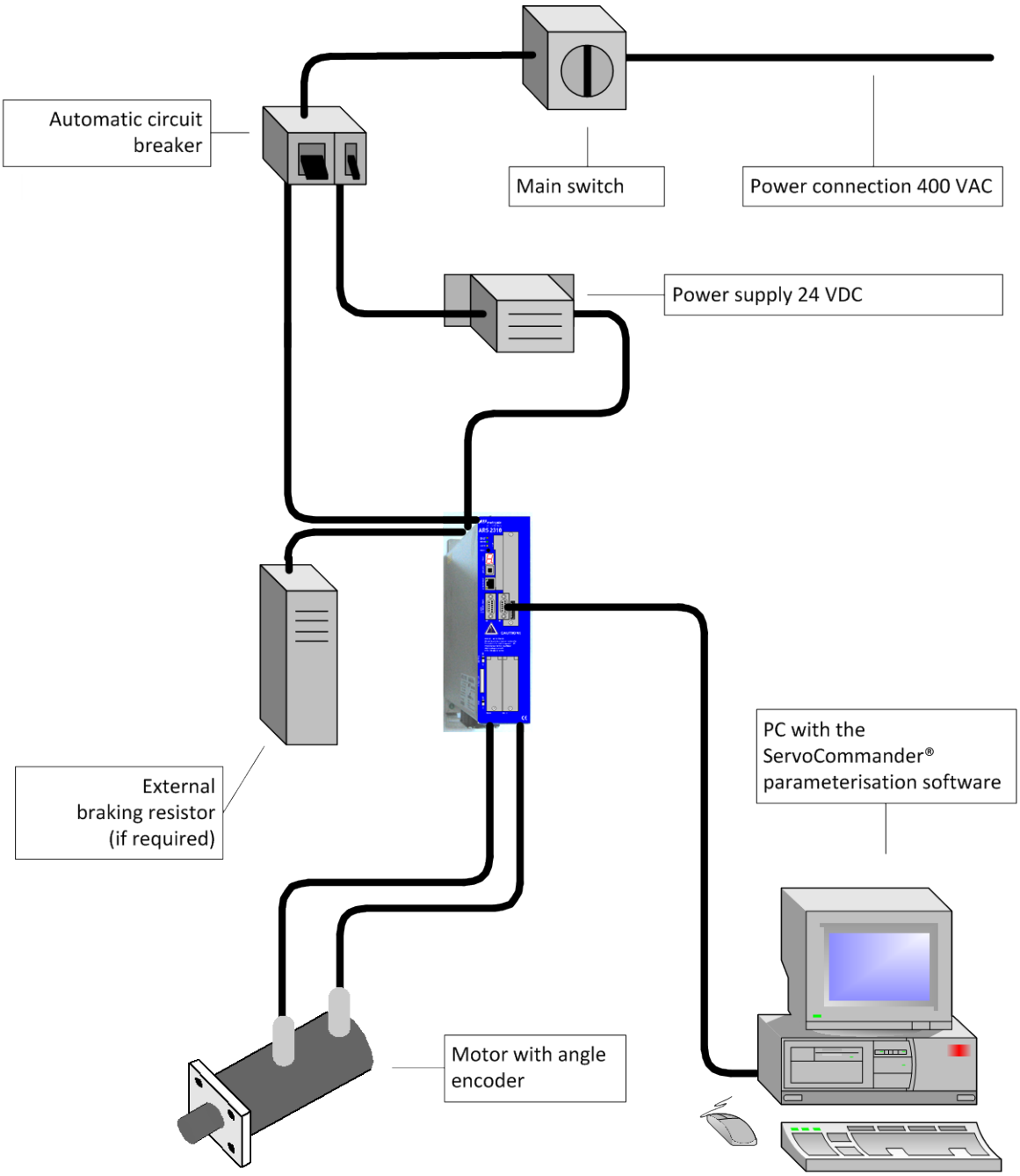


Figure 14: Complete set-up of the ARS 2300 FS with a motor and PC

8.3 Connector: power supply [X9]

The ARS 2300 FS servo positioning controller receives its 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 34: 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	+24 V	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]

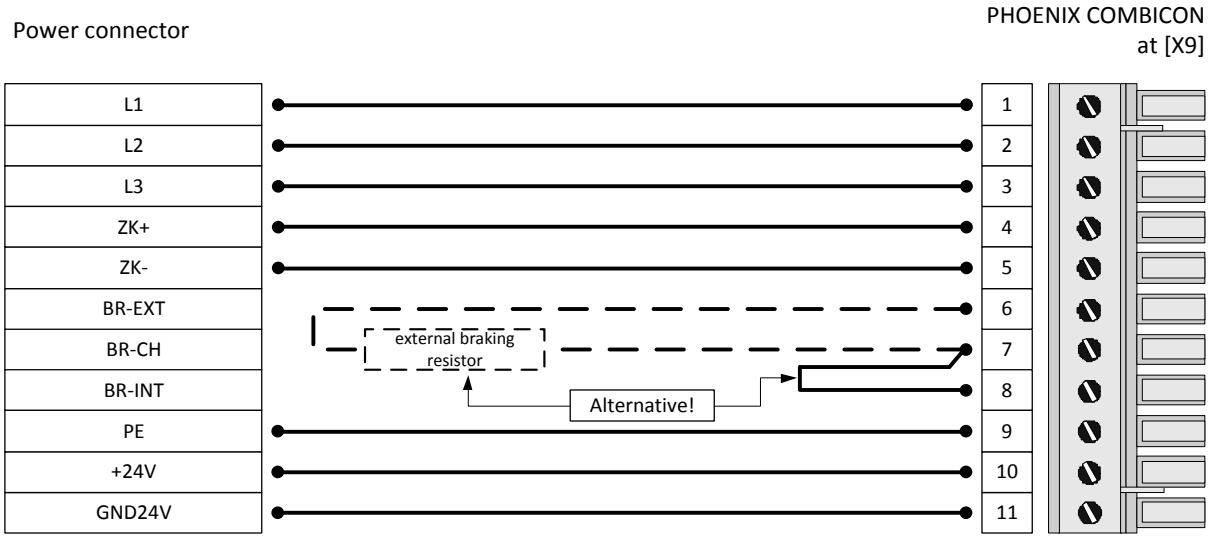


Figure 15: Power supply [X9]

The ARS 2300 FS servo positioning controller 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 35: 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]

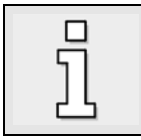
❖ PHOENIX Power-COMBICON PC 4 HV/9-ST-7.62 BK

8.4.3 Pin assignment [X6]

Table 36: 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 FS 0 ... 5 A_{RMS} ARS 2305 FS 0 ... 10 A_{RMS} ARS 2310 FS	
9	U	0 ... 1000 Hz	

[1)] Please refer to *chapter 9 Additional requirements to be fulfilled by the servo positioning controllers for UL approval*, *page 117.*



In addition, the outer cable shield of the motor cable must be connected to the mounting plate of the controller 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 FS
  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 2310 FS
  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 FS
  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 2310 FS
  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]

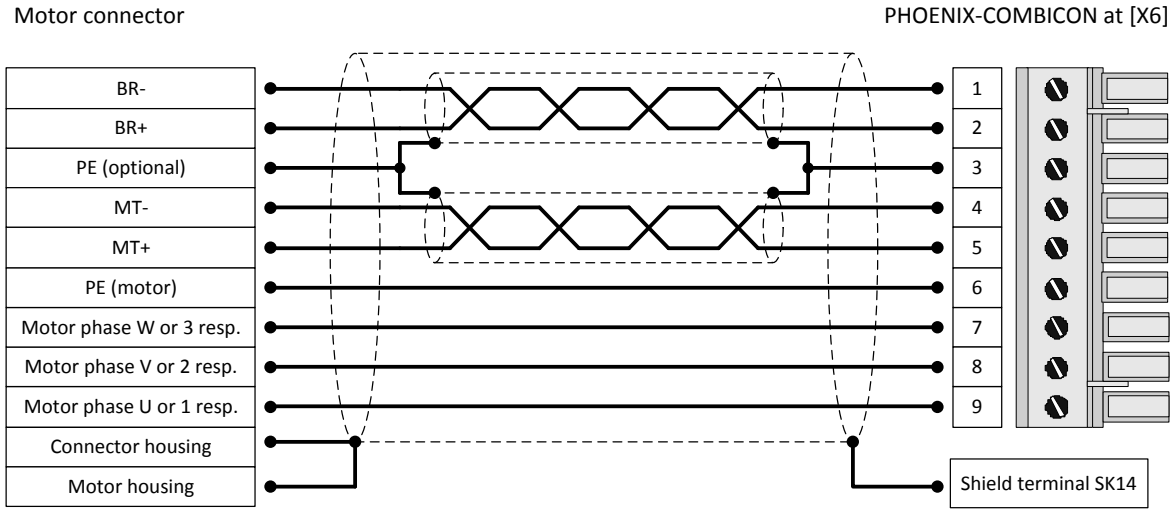


Figure 16: Motor connector [X6]

- ❖ 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 controller 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 FS servo positioning controllers 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. Further information can be found in Application Note 67.

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 positioning controller. Please note the maximum output current that is provided by the ARS 2300 FS servo positioning controller. It may be necessary to connect a relay between the device and the holding brake as shown in *Figure 17*:

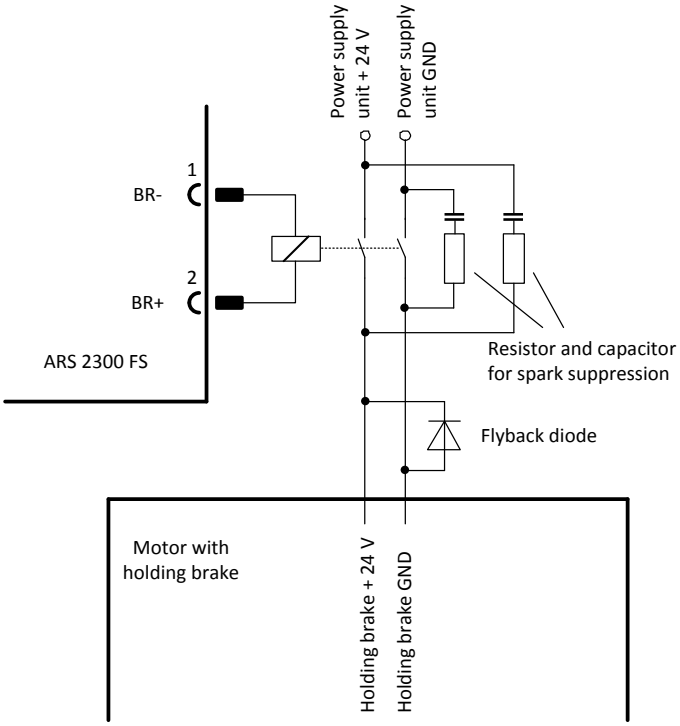


Figure 17: Connecting a holding brake with a high current demand (> 2 A) to the device

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 18* shows the operating principle of the digital and analogue inputs and outputs. The servo positioning controller ARS 2300 FS is shown on the right and the control system connection on the left. The cable configuration is also shown.

The servo positioning controller ARS 2300 FS 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 positioning controller. 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 FS servo positioning controller, which is supplied via [X9]. They are separated from the reference potential of the control module by way of optocouplers.

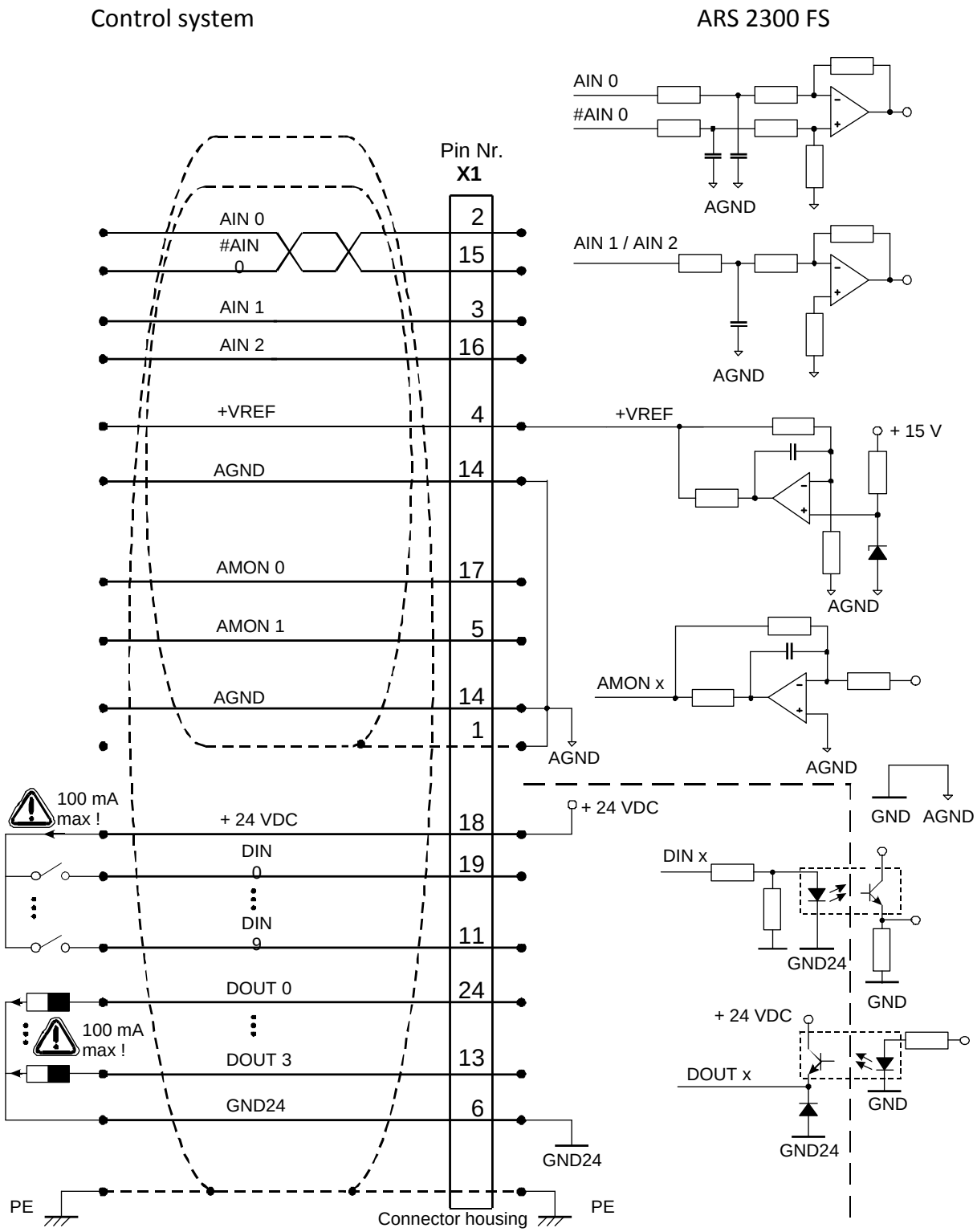


Figure 18: Basic circuit diagram of connector [X1]

The ARS 2300 FS servo positioning controller 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 FS servo positioning controller.

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 FS servo positioning controller 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 FS servo positioning controller 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 37: 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	Controller 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 18 shows the cable between the ARS 2300 FS servo positioning controller 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 FS servo positioning controller, 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 FS servo positioning controller, Kuhnke recommends using shielded control cables.

Despite the differential design of the analogue inputs of the ARS 2300 FS servo positioning controller, 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 FS servo positioning controller. 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 FS servo positioning controller. Pins 1 and 14 are directly connected to each other inside the controller.

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 FS servo positioning controller 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 FS servo positioning controller 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

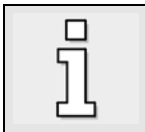
8.6.2 Mating connector [X2A]

- 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 38: Pin assignment [X2A]

Pin no.		Name	Value	Specification
1		S2	3.5 V_{RMS} / 5-10 kHz R_i > 5 kΩ	SINE track signal, differential
	6	S4		
2		S1	3.5 V_{RMS} / 5-10 kHz R_i > 5 kΩ	COSINE track signal, differential
	7	S3		
3		AGND	0 V	Shield for signal pairs (inner shield)
	8	MT-	GND	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	
5		MT+	+ 3.3 V / Ri = 2 kΩ	Motor temperature sensor, normally closed contact, PTC, KTY…



In addition, the outer cable shield of the angle encoder cable must be connected to the mounting plate of the controller over a large contact area with the aid of shield terminal SK14.

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]

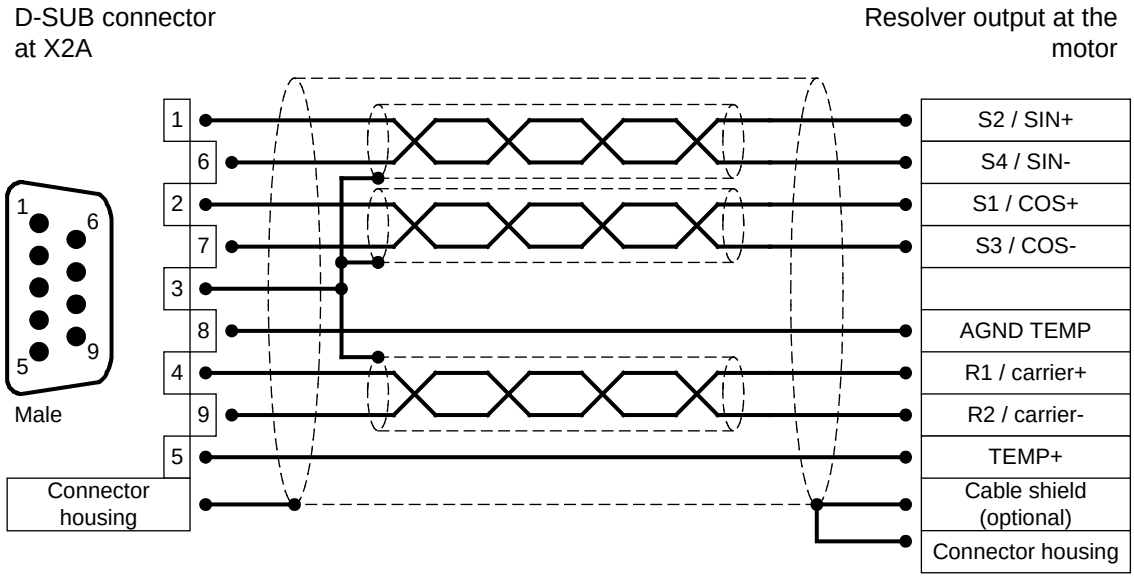


Figure 19: Pin assignment: resolver connector [X2A]

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

8.7 Connector: encoder [X2B]

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 39: Pin assignment: analogue incremental encoder – option [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 positioning controllers for UL approval*, *page 117.*

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



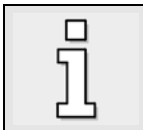
In addition, the outer cable shield of the angle encoder cable must be connected to the mounting plate of the controller over a large contact area with the aid of shield terminal SK14.

Table 40: Pin assignment: incremental encoder with a serial interface (e.g. EnDat, HIPERFACE) – option [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 positioning controllers for UL approval*, *page 117.*

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



In addition, the outer cable shield of the angle encoder cable must be connected to the mounting plate of the controller over a large contact area with the aid of shield terminal SK14.

Table 41: Pin assignment: digital incremental encoder – option [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 on 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 positioning controllers for UL approval*, *page 117.*

In addition, the outer cable shield of the angle encoder cable must be connected to the mounting plate of the controller over a large contact area with the aid of shield terminal SK14.

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]

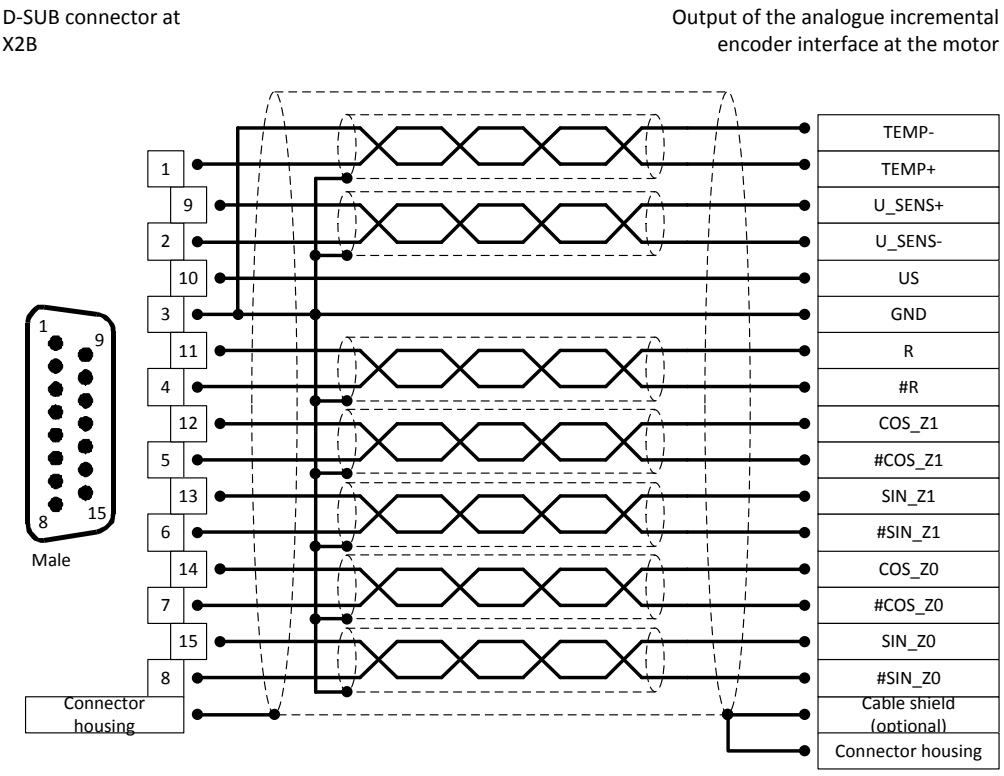


Figure 20: Pin assignment: analogue incremental encoder – option [X2B]

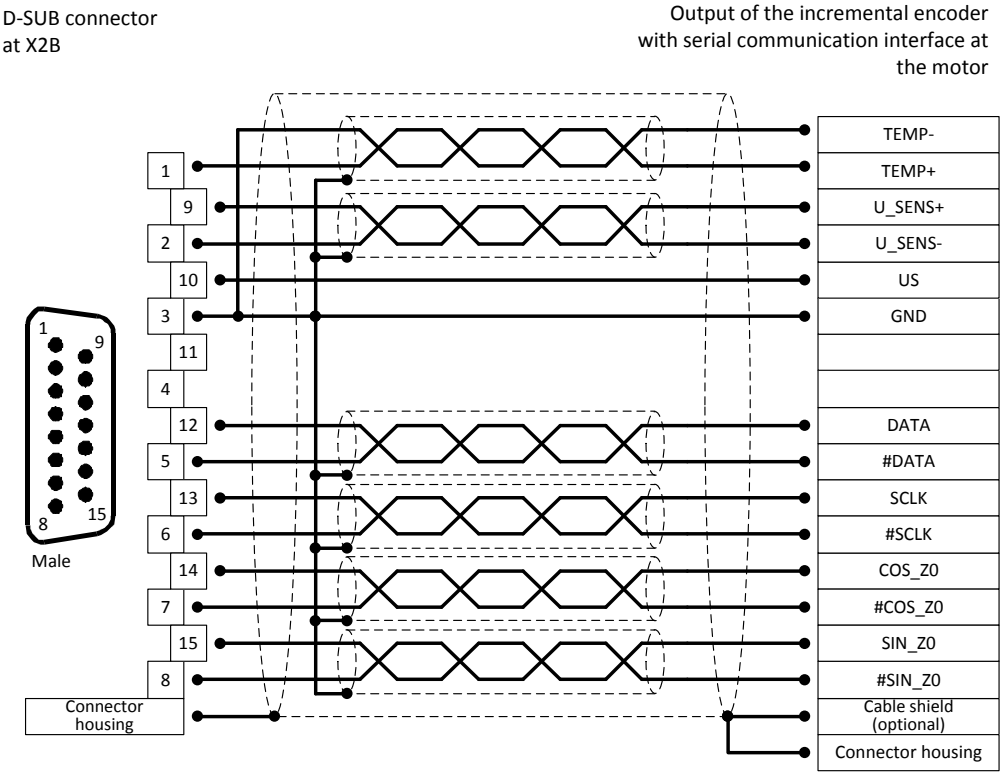


Figure 21: Pin assignment: incremental encoder with a serial interface (e.g. EnDat, HIPERFACE) – option [X2B]

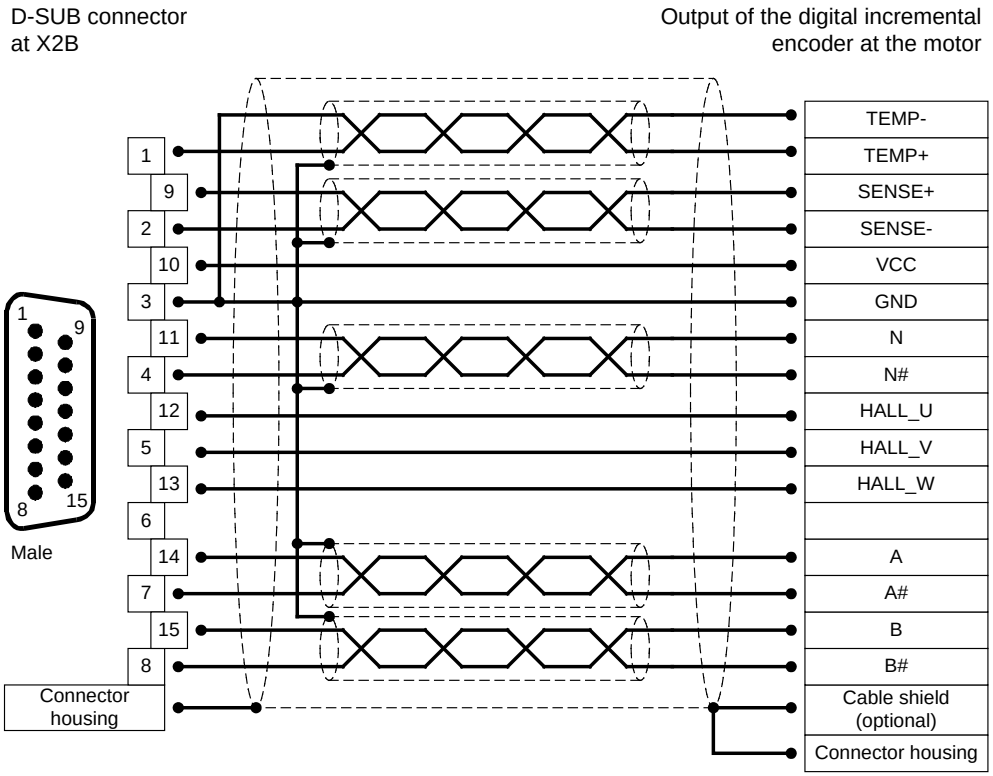


Figure 22: Pin assignment: digital incremental encoder - option [X2B]

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 42: Pin assignment [X10]: incremental encoder input

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 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 and 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.

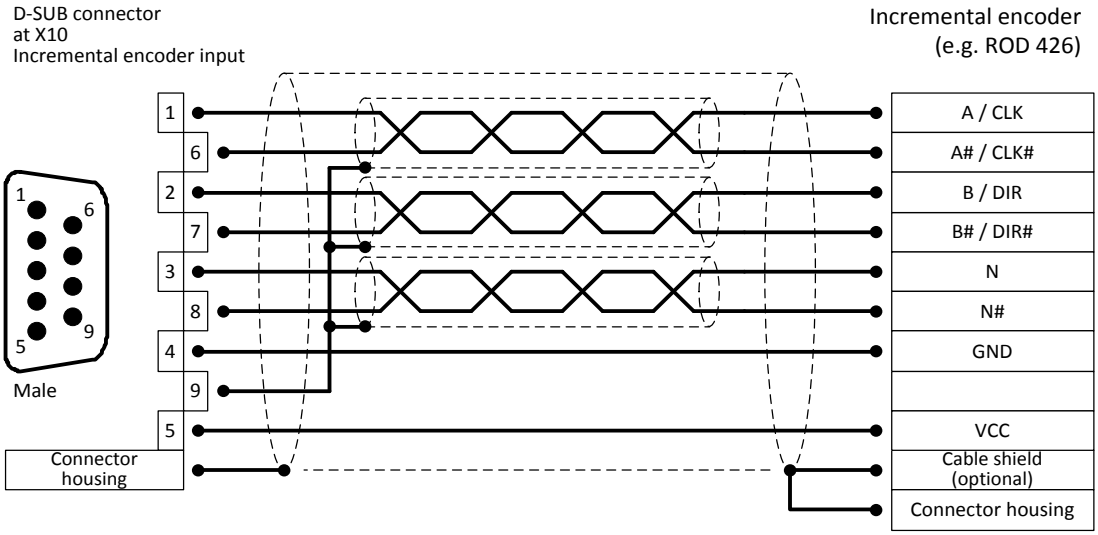


Figure 23: Pin assignment [X10]: incremental encoder input

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 43: Pin assignment [X11]: incremental encoder output

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 incremental encoder signals are twisted in pairs and the individual pairs are shielded.

8.9.5 Connection notes [X11]

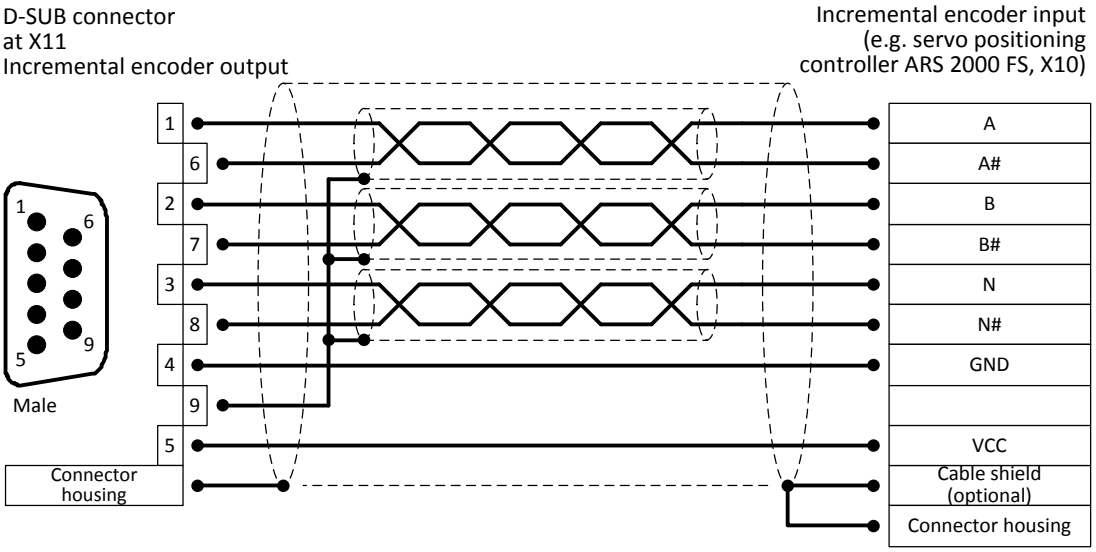


Figure 24: Pin assignment [X11]: incremental encoder output

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

Up to 32 additional servo positioning controllers 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 44: 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 controller
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

*) An external terminating resistor of 120 Ω is required on both ends of the bus. If the bus ends are not formed by ARS 2300 FS servo positioning controllers with integrated terminating resistors, we recommend using metal film resistors with a 1% tolerance of type 0207, e.g. made by BCC, part no.: 232215621201.

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 positioning controllers 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 controller 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.

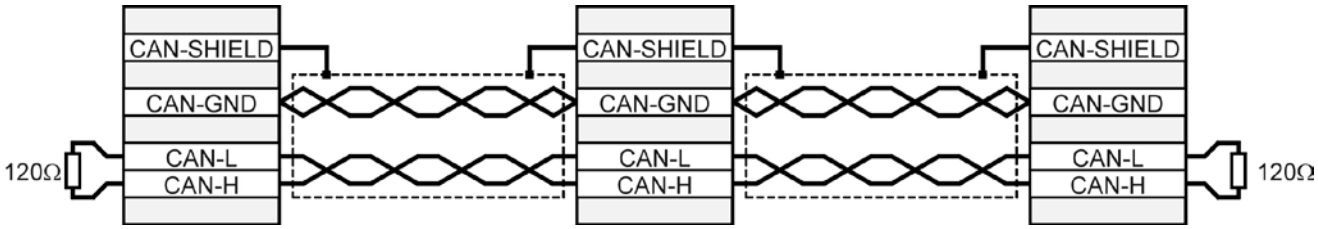


Figure 25: CAN bus cabling example

- The individual nodes of the network are always connected in line so that the CAN cable is looped through from controller to controller (see *Figure 25)*.
- A terminating resistor of 120 Ω ± 5% must be present on both ends of the CAN bus cable. The ARS 2300 FS servo positioning controller is equipped with an integrated terminating resistor that can be activated/deactivated via the DIP switch "CAN TERM" on the front panel (see *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 Kuhnke-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 theKuhnke 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.

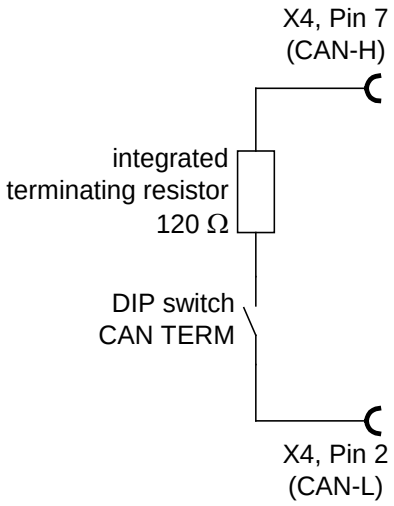


Figure 26: Integrated CAN terminating resistor

8.11 Connector: RS232/COM [X5]

8.11.1 Configuration on the device [X5]

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

8.11.2 Mating connector [X5]

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

8.11.3 Pin assignment [X5]

Table 45: Pin assignment RS232 interface [X5]

Pin no.		Name	Value	Specification
1				Not used
	6			Not used
2		RxD	10 V / R_I > 2 kΩ	Reception line, RS232 specification
	7	-	-	Not used
3		TxD	10 V / R_{out} < 2 kΩ	Transmission line, RS232 specification
	8			Not used
4		+RS485		Reserved for optional RS485 use
	9	-RS485		Reserved for optional RS485 use
5		GND	0 V	Interface GND, electrically coupled with GND of the digital module

8.11.4 Cable type and configuration [X5]

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

8.11.5 Connection notes [X5]

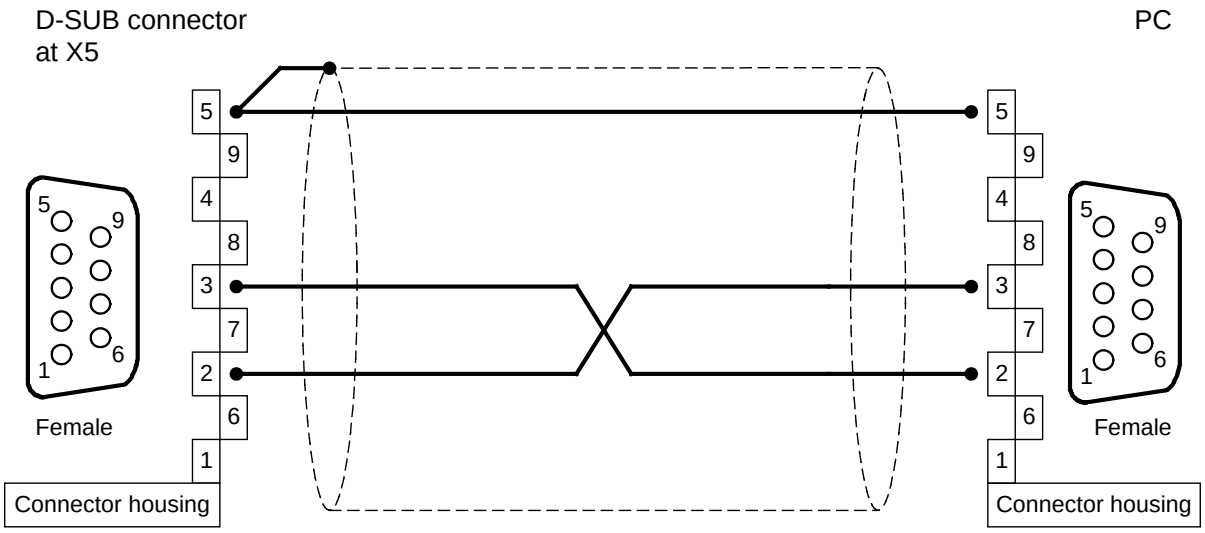


Figure 27: Pin assignment RS232 null modem cable [X5]

8.12 Connector: USB [X19]

8.12.1 Configuration on the device [X19]

❖ USB connector (female), type B

8.12.2 Mating connector [X19]

❖ USB connector (male), type B

8.12.3 USB [X19]

Table 46: Pin assignment USB interface [X19]

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

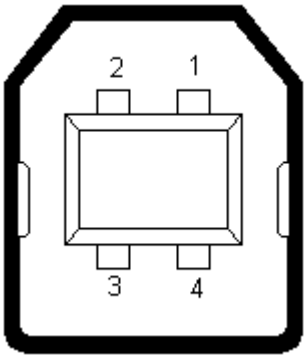


Figure 28: Pin assignment USB interface [X19], front view

8.12.4 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.

8.13 SD/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

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/MMC card

Table 47: Pin assignment: SD 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 48: 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

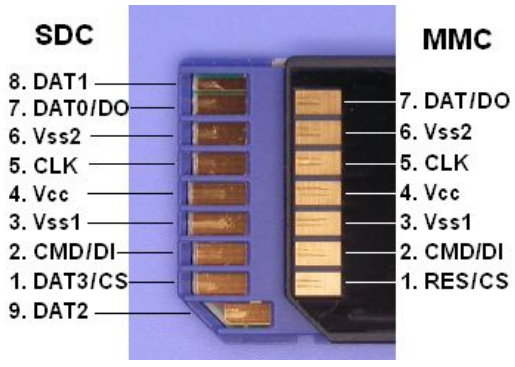


Figure 29: Pin assignment: SD/MMC card

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.

- 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 positioning controller 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 the serial interface (RS232) or 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 positioning controller always depend on the overall drive concept consisting of the following components:

- Power supply
- Servo positioning controller
- 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 FS servo positioning controller 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 FS servo positioning controllers 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 FS servo positioning controllers fulfil the requirements of the applicable product standard EN 61800-3, provided that the servo positioning controllers 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 FS servo positioning controllers without external filter measures:

Table 49: EMC requirements: first and second environment

EMC type	Area	Compliance with the EMC requirements
Interference emission	First environment (residential environment)	Motor cable length up to 50 m, C‘ ≤ 200 pF/m
	Second environment (industrial environment)	
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 78*):

- In order to keep the leakage currents and losses in the motor connecting cable as small as possible, the ARS 2300 FS servo positioning controller should be located as close to the motor as possible (see also *chapter 8.14.5 Operation with long motor cables, page 115*).
- The motor cable and angle encoder cable must be shielded.
- The shield of the motor cable must be connected to the housing of the ARS 2300 FS servo positioning controller (shield connection terminals). The cable shield must also be connected to the associated servo positioning controller so that the leakage currents can flow back into the controller 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 controller 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 the system due due to ESD (electrostatic discharge).



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

The ARS 2300 FS servo positioning controller has 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 output stage 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 positioning controllers for UL approval

This chapter provides further information concerning the UL approval of the ARS 2302 FS, ARS 2305 FS, and ARS 2310 FS 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 positioning controller is not equipped with an integrated motor overtemperature sensor system in accordance with UL.

If a UL certification is required, the servo positioning controllers 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 positioning controller 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 the previous *chapter 8.14.4 EMC-compliant cabling (page 114)* must be absolutely ensured!



DANGER!

Non-compliance with the instructions in *chapter 2 Safety notes for electrical drives and controllers (as of page 18)* 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
- Serial interface cable
- Angle encoder cable
- Motor cable
- Power supply cable
- Controller enabling cable
- 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 positioning controller.
- 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 positioning controller 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 FS servo positioning controller to the power supply

- ❖ Ensure that the power supply is switched off.
- ❖ Plug the PHOENIX connector into the **[X9]** socket of the servo positioning controller.
- ❖ 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 (serial interface)

- ❖ Plug the D-Sub connector of the serial interface cable into the socket for the serial interface of the PC and tighten the locking screws.
- ❖ Plug the D-Sub connector of the serial interface cable into the socket **[X5] RS232/COM** of the ARS 2300 FS servo positioning controller and tighten the locking screws.
- ❖ Check all of the connections.

10.6 Connecting the PC (USB interface, alternative)

- ❖ 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 FS servo positioning controller.
- ❖ Check all of the connections.

10.7 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 positioning controller 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 123)*. If the device displays nothing, follow these steps:

3. Switch the power supply off.
4. Wait 5 minutes so that the DC bus circuit can discharge.
5. Check all of the connecting cables.
6. Check whether the 24 V power supply operates correctly.
7. 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 FS servo positioning controller 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 positioning controller and the power output stage. The servo positioning controller 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 mains power/phase failure
- 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 FS servo positioning controller detects 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 to device.

11.1.6 Monitoring of the motor

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

11.1.8 Power monitoring of the brake chopper

The firmware includes an "I²t brake chopper" 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 positioning controllers, which are sent to Kuhnke for service, will be equipped with a different firmware and different parameters for testing purposes.

Before the end user uses the ARS 2300 FS servo positioning controller once again, it must be parameterised. The Kuhnke ServoCommander® parameterisation software checks the start-up status and requests the user to parameterise the servo positioning controller. 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

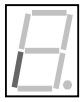
The implemented operating hours counter is rated for a minimum of 200,000 hours of operation. The operating hours counter is displayed in the Kuhnke ServoCommander® parameterisation software.

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 50: 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. If the controller is enabled, the centre segment is active in addition.
	The ARS 2000 FS servo positioning controller 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 the 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 FS series. (seven-segment display = "H", blinking with a frequency of 2 Hz)

11.2.2 Error messages

If an error occurs, the ARS 2000 FS servo positioning controller 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 51 Error messages provides an overview of the various messages and corresponding measures.

Error messages with the main index 00 are no runtime errors. They 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.

Table 51: 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.
	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.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
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).
	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.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	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 positioning controller 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?
	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	

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	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.
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.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
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.
	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.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	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	
	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.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	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.
	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.

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
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.
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	

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	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.
	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	

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
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	
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 positioning controller 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.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	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.
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?)

Error message		Meaning of the error message	Measures
Main index	**Sub index**		
	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.
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	
Main index	**Sub index**			
	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.

Error message		Meaning of the error message	Measures	
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	
Main index	**Sub index**			
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	
Main index	**Sub index**			
	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.

Error message		Meaning of the error message	Measures	
Main index	**Sub index**			
	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	
Main index	**Sub index**			
	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 Kuhnke 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 Kuhnke 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 viaKuhnke 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 positioning controller 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 positioning controller 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
Main index	**Sub index**		
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.

12 Technology modules

12.1 EA88 interface (terminal extensions)

12.1.1 Product description

The EA88 interface can be used in technology slot TECH 1 or TECH 2 of the ARS 2000 FS servo positioning controller to extend the already existing digital I/Os. Up to two EA88 interfaces can be supported simultaneously.

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

The EA88 interface has the following characteristics:

- Digital 24 V inputs
- Digital 24 V outputs that can be activated separately and loaded with 100 mA each
- MicroCombicon pin-and-socket connectors made by PHOENIX
- Pin-and-socket connectors via male multipoint connector in accordance with EN 60603-1
- Inputs and outputs isolated by way of optocouplers
- Inputs and outputs protected against short circuits and overload

12.1.2 Technical data

12.1.2.1 General data

Table 52: Technical data: EA88 interface

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

12.1.2.2 Digital inputs

8 digital 24 V inputs, protected against inverse polarity and short circuits.

Table 53: Digital inputs: EA88 interface [X21]

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

12.1.2.3 Digital outputs

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

Table 54: Digital outputs: EA88 interface [X22]

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

Parameter	Values
Loads	R > 220 Ω; L at random; C < 10 nF
Switching delay as of port pin	< 100 µs

12.1.3 Pin assignment and cable specifications

12.1.3.1 Power supply

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

12.1.3.2 Pin assignments

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

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

Table 55: EA88: connector [X21] for 8 digital inputs

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

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

Table 56: EA88: connector [X22] for 8 digital outputs

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

The following *Figure 30* shows the position of the connectors and their numbering:

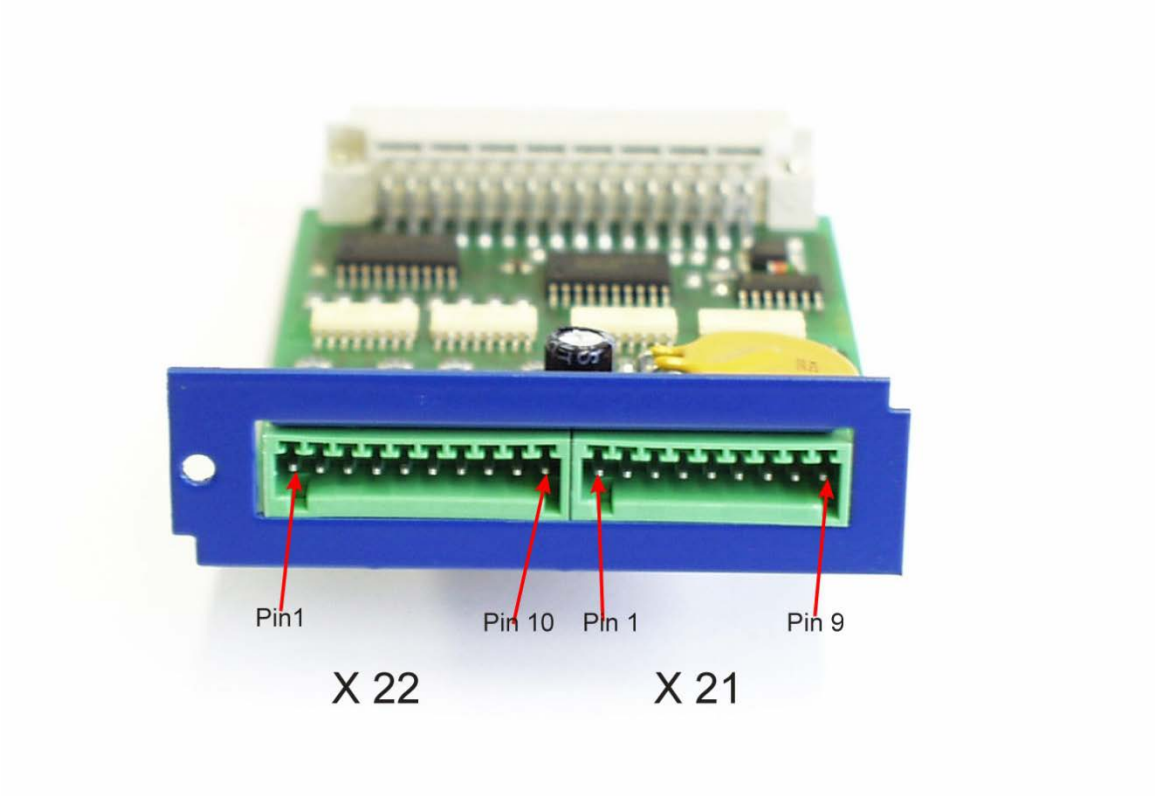


Figure 30: EA88: position of the pin-and-socket connectors [X21] and [X22] on the front plate

12.1.3.3 Mating connectors

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

12.1.3.4 Connection notes

The MicroCombicon mating connectors made by PHOENIX regarding [X21] (FK-MC 0.5/9-ST-2.5) and [X22] (FK-MC 0.5/10-ST-2.5) are supplied together with the EA88 interface technology module. The cables are connected in the form of crimp connections. To do so, strip the cable over a length of approximately 8 mm. Then, insert it into the corresponding opening and press down the orange crimp lock using a suitable screwdriver, the tip of a ball-pen or similar. Release the lock in order to secure the cable in place. The maximum permissible wire cross-section (wire gauge) is 0.5 mm^2 or AWG20.

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

As the lines GND24V and +24Vext. must transfer the entire current of all of the connected outputs, their cross-section must be sized accordingly (recommended: AWG20).

12.2 PROFIBUS-DP interface

12.2.1 Product description

The PROFIBUS-DP interface provides an additional fieldbus connection. All of the functions and parameters can be addressed directly, for example from a Simatic S7 control system. The interface is plugged into the technology slot TECH 2 of the ARS 2000 FS servo positioning controller.



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

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

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

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

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

12.2.2 Technical data

Table 57: Technical data: PROFIBUS-DP interface: ambient conditions, dimensions, and weight

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

Table 58: Technical data: PROFIBUS-DP interface: interfaces and communication

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

The following elements can be found on the front plate of the PROFIBUS-DP interface (see *Figure 31*):

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



Figure 31: PROFIBUS-DP interface: front view

12.2.3 Pin assignment and cable specifications

12.2.3.1 Pin assignment

❖ 9-pin DSUB connector, female

Table 59: Pin assignment: PROFIBUS-DP interface

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

[1)] Can be used for external bus termination or to supply the transmitters/receivers of an external optical waveguide module.

[2)] The signal is optional. It is used for directional control in the case of an external optical waveguide module.

12.2.3.2 Mating connector

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

12.2.3.3 Cable type and configuration

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

For highly flexible applications:

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

12.2.4 Termination and bus terminating resistors

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

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

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

The external connection can also be set up discretely (see *Figure 32*). The 5 V power supply that is required for the externally connected terminating resistors is supplied at the PROFIBUS connector of the PROFIBUS-DP interface (see the pin assignment in *Table 59*).

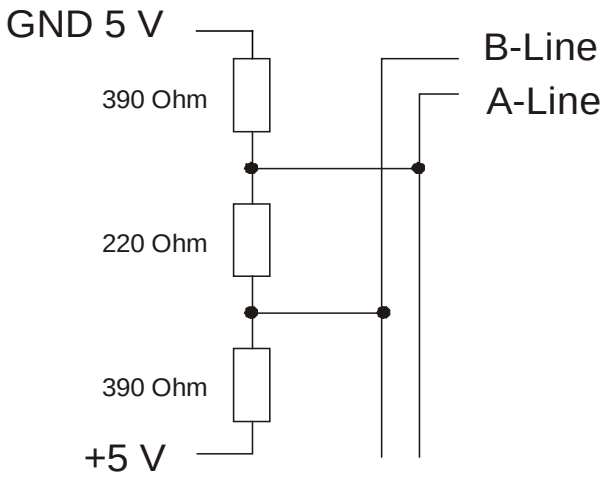
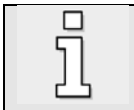


Figure 32: PROFIBUS-DP interface: connection with external terminating resistors

12.3 Sercos II module

12.3.1 Product description

The Sercos II module is used to connect the ARS 2000 FS servo positioning controller to a Sercos-compatible CNC control. The communication on the Sercos II bus uses a ring-shaped optical waveguide with transmission rates of up to 16 Mbaud. If six servo positioning controllers are connected to one bus, setpoints and actual values (position, speed, and torque values) can be exchanged with the CNC control every 500 µs.



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

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

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

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

A special feature of the Sercos II bus is the synchronisation of all the devices connected to the bus. If several ARS 2000 FS servo positioning controllers are connected, the internal controllers and power output stages of the servo positioning controllers operate in a phase-locked manner.

The Sercos II bus address can be optionally set via the 8-pole DIP switch. After a reboot/restart, the servo positioning controller checks whether a bus address has been set via these switches (all switches in position OFF → no bus address set). If no bus address has been set via the 8-pole DIP switch, the servo positioning controller uses the bus address that has been set via the Kuhnke ServoCommander® (menu: Parameters/Field bus/ Sercos…).

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

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

12.3.2 Technical data

Table 60: Technical data: Sercos II module: ambient conditions, dimensions, and weight

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

The following elements can be found on the front plate of the Sercos II module (see *Figure 33*):

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

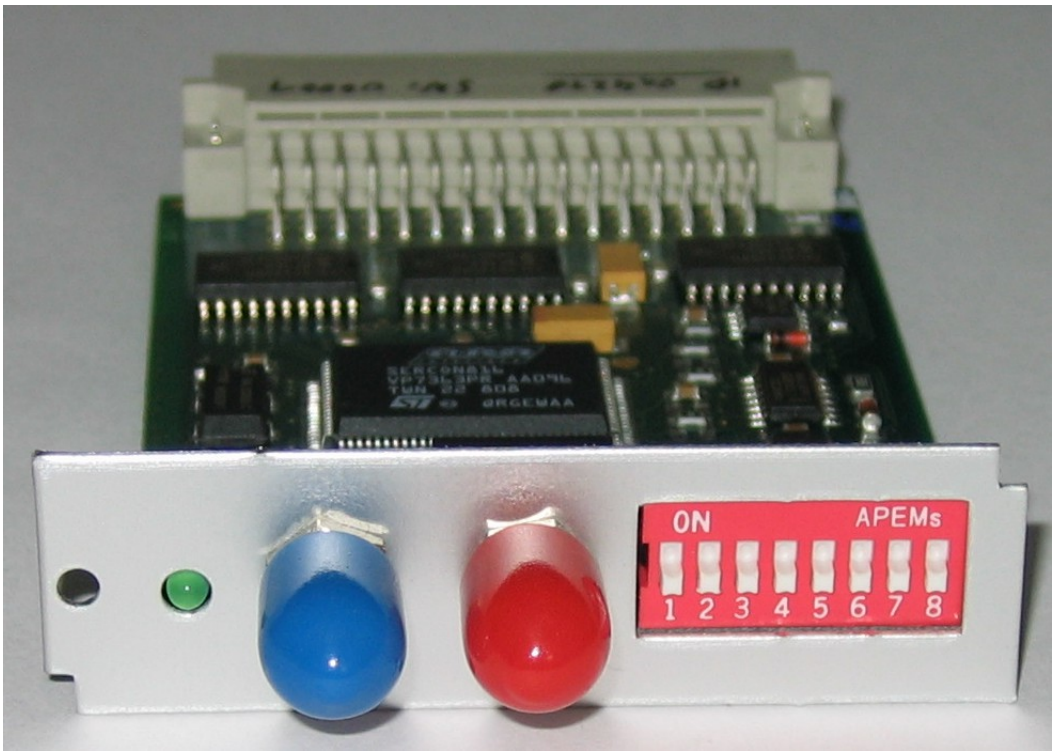


Figure 33: Sercos II module: front view

12.3.3 Optical waveguide specification

Further information concerning the type and set-up of suitable optical waveguides can be found in the standard Sercos literature, for example:

http://www.sercos.org/

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

Germany

12.4 EtherCAT

12.4.1 Product description

The EtherCAT technology module enables the connection of the ARS 2000 FS servo positioning controller to the EtherCAT fieldbus system. The communication via the EtherCAT interface (IEEE-802.3u) is realised with the aid of standard EtherCAT cabling.



In the case of the ARS 2000 FS servo positioning controller, the CoE protocol (CANopen over EtherCAT) with the FPGA ESC20 made by Beckhoff is supported.



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

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

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

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

12.4.2 Characteristics of the EtherCAT technology module

The EtherCAT technology module has the following characteristics:

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



Figure 34: EtherCAT module: front view

12.4.3 Technical data

Table 61: Technical data: EtherCAT module: ambient conditions, dimensions, and weight

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

12.4.4 Display elements

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

Table 62: Display elements

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

12.4.5 EtherCAT interface

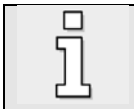
Table 63: Signal level and differential voltage

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

12.5 MC 2000 "Drive-In" 4-axis motion coordinator

12.5.1 Product description

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



The motion coordinator MC 2000 technology module is supported solely in the **TECH 2** technology slot.

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

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

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

With the MC 2000, complex motion control can be realised fast and easily, for example:

- electronic cam discs and gears
- joint axes
- point-to-point positioning
- several types of interpolation (interpolation, circular interpolation, helical interpolation)

Simply insert the MC 2000 module into the servo positioning controller. As the master, it can control up to three additional ARS 2000 servo axes via CANopen DSP 402. In addition, an external encoder can be connected directly to the ARS 2000. It can then be evaluated as an additional axis by the MC 2000. All of the available standard I/Os in the ARS 2000 can be used for this purpose.

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

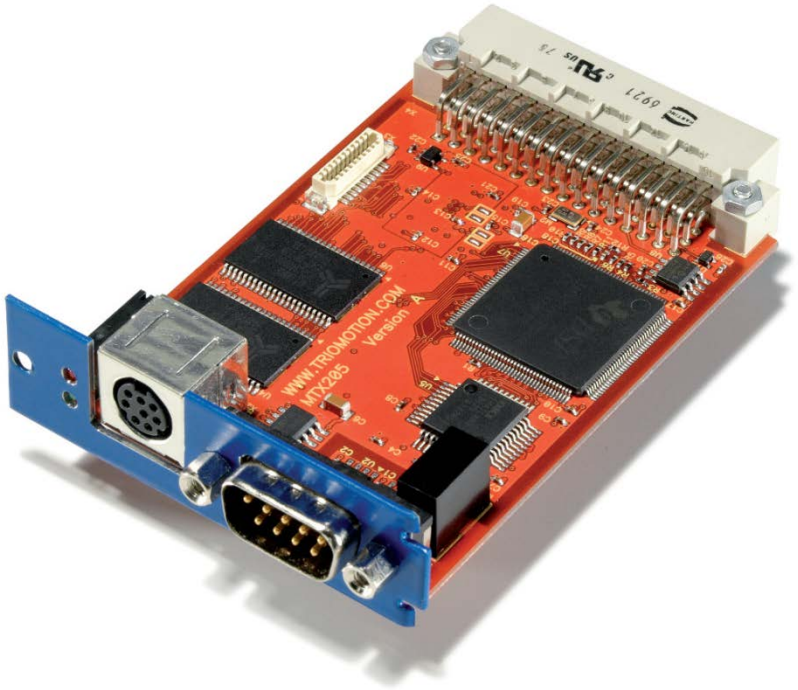


Figure 35: MC 2000 4-axis motion coordinator

12.5.2 Features

12.5.2.1 Compact

- Plug-in module directly integrated in the servo positioning controller
- Controls up to 4 real servo axes
- Easy wiring via the CAN bus

Figure 36: MC 2000 4-axis motion coordinator as a complete assembly

12.5.2.2 Fast

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

12.5.2.3 Easy

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

12.5.3 Technical data

Table 64: Technical data: MC 2000 4-axis motion coordinator

Dimensions (L x W x H)	92 x 65 x 19 mm
Temperature range	0°C to 50°C
Current consumption	350 mA / 3.3 VDC and 150 mA / 5 VDC max. (internally via servo positioning controller)
Max. number of axes	8 (4x servo drives, 1x encoder, 3x virtual)
Additional encoder input	Bi-directional connection (via servo positioning controller –X10)
Servo cycle time	1 ms
Built-in digital inputs	6x 24 VDC (via servo positioning controller)
Built-in digital outputs	3x 24 VDC (via servo positioning controller)
Built-in analogue inputs	3x ±10 VDC via servo positioning controller (1x 16 bit differential and 2x 10 bit single ended)
Built-in analogue outputs	2 x ±10 VDC, 9 bit (via servo positioning controller)
Input function	Forward limit / reverse limit / datum / F hold
Serial ports	1x RS232 (programming) + 1x RS485 (e.g. HMI)
CAN ports	2x CAN interfaces (1x remote drive max. 1 MBaud and 1x remote CAN I/O max. 500 kBaud via servo positioning controller)
Extension module	EA88 IO extension module (via servo positioning controller)
User memory	512 kBytes
Table memory	32,000 values
Multi-tasking	2 fast tasks + 5 normal tasks
EMC compliance	EN 61800-3
CANopen protocol	CiA Draft Standard Proposal 402
Order number	9200-0008-00
RS232 cable for MC 2000	9200-0008-10

12.6 General installation notes for technology modules



DANGER!

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



DANGER!

Prior to installing a technology module, the servo positioning controller must be disconnected from any current-carrying conductors. After the operating voltage has been disconnected, wait for 5 minutes so that the capacitors in the servo positioning controller can be completely discharged.



Caution!

Ensure that ESD protection measures are applied when handling technology modules.

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

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