

DIAS-Drive 335-23

Instruction Manual

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Translation of the Original Instructions

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DIAS-Drive 335-23

The manual describes the servo amplifier of the DIAS-Drive series. Additional information on the safety functions and the existing inputs and outputs in the installed VAC 013 interface module can be found in the corresponding chapter.

Individual chapters:

- Technical Data of the servo amplifier
- Assembly and Installation
- Interface description
- Setup of the servo amplifier
- Accessories
- Transport, storage, maintenance, disposal



Abbreviations used in this manual

Abbreviation	Definition
AWG	American Wire Gauge (American cable coding)
BGND	Mass for the 24V auxiliary and braking supply
CE	Communauté Européenne
CLOCK	Clock signal
EMC	Electromagnetic Compatibility
EN	European Norm
IGBT	Insulated Gate Bipolar Transistor
LED	Light Emitting Diode
PELV	protected Extra Low Voltage
RES	Resolver
R _{int.}	Internal regen resistor connection
R _{tr}	Brake chopper connection
V AC	Alternating Current
V DC	Direct current

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1 General

1.1 Symbols Used

The following symbols are used in the operator documentation for warning and danger messages, as well as informational notes:

DANGER



Danger indicates that death or serious injury **will occur**, if the specified measures are not taken.

⇒ To avoid death or serious injuries, observe all guidelines.

Danger indique une situation dangereuse qui, faute de prendre les mesures adéquates, **entraînera** des blessures graves, voire mortelles.

⇒ Respectez toutes les consignes pour éviter des blessures graves, voire mortelles.

WARNING



Warning indicates that death or serious injury **can** occur, if the specified measures are not taken.

⇒ To avoid death or serious injuries, observe all guidelines.

Avertissement d'une situation dangereuse qui, faute de prendre les mesures adéquates, **entraînera** des blessures graves, voire mortelles.

⇒ Respectez toutes les consignes pour éviter des blessures graves, voire mortelles.

CAUTION



Caution indicates that moderate to slight injury **can** occur, if the specified measures are not taken.

⇒ To avoid moderate to slight injuries, observe all guidelines.

Attention indique une situation dangereuse qui, faute de prendre les mesures adéquates, **peut** entraîner des blessures assez graves ou légères.

⇒ Respectez toutes les consignes pour éviter des blessures graves, voire mortelles.



INFORMATION

Provides important information on the product, handling or relevant sections of the documentation, which require attention.



Hot surfaces



Warning of dangerous electrical voltage



Danger for ESD-sensitive components.

Les signes de danger pour les composants sensibles aux décharges électrostatiques.

1.2 Safety Guidelines



The safety instructions must be read before installation and initial start-up of the servo amplifier. Improper handling of the servo amplifier can lead to personal injury or material damage. Compliance with the technical data and connection specifications (nameplate and documentation) mandatory.

Only qualified personnel may perform tasks such as transportation, assembly, initial startup and maintenance. Qualified personnel are those who are familiar with the transport, assembly, installation, setup and operation of the product, and have the appropriate qualifications for their task.

The machine manufacturer must perform a safety analysis for the entire machine. With the appropriate measures, the manufacturer ensures that no injuries or damage can be caused by unexpected movements.

Improper operation of the servo amplifier or failure to follow the following guidelines and improper handling of the safety equipment can result in damage to the machine, personnel injury, electrical shock or in extreme cases, death.

Annotations



Danger! **Shock current**

After disconnecting the servo amplifier from the voltage supply, a wait-time of at least 5 minutes is required before current conducting components of the amplifier (e.g. clamps) can be touched or connectors removed. After turning off the voltage supply, the internal capacitors can have dangerous voltage levels for up to 5 minutes. For safety purposes, measure the voltage in the intermediate circuit and wait until the voltage is below 40 V.

The electrical connectors of the servo amplifier can never be removed while voltage is applied. The danger of electrical arcing exists, which could cause personal injury as well as damage to the contacts.

When using a ground fault interrupter in the circuit, a Type B FI-switch must be used. If an FI switch of Type A is used, a DC ground fault could cause it to malfunction.

Failure to follow these instructions can lead to death, serious injury or damage to the machine.



Warning **General**

The use of the servo amplifier is defined by EN61800-3. In living areas, this product can cause EMC interference problems. In such a case, the user must take additional filtering measures.

The servo amplifier contains electrostatic-sensitive components, which can be damaged by improper handling. Before touching the servo amplifier, the user must discharge their body by touching a grounded object with a conductive surface. Contact with highly insulated material (synthetic fiber, plastic foil etc.) must be avoided. The servo amplifier must be placed on a conductive surface.

Opening the device is not allowed. During operation, keep all covers and control cabinet doors closed. The danger of severe damage to health or material, as well as death exists.

During operation, servo amplifiers – according to their protection type – may have bare, voltage-carrying components. Control and power connections may be live, even if the motor is not turning.

The ground conductor for protection of the DIAS drive in a fixed installation should be a minimum of 10 mm² (8 AWG) Cu or 16 mm² (5 AWG) Al.

If the servo amplifier is connected via a plug-in connection according to IEC 60309, a small cross-section of the protective ground conductor, but at least 2.5 mm² (AWG 13) CU, is permissible if it is part of a multi-core connection. In this case, suitable strain relief must be provided.

The +24 V auxiliary power supply and the power supply for the +24V-BR holding brake supply must be galvanically separated as protective extra-low voltage (PELV) according to EN 60950.

Failure to follow the above safety measures can lead to severe injuries and machine damage.

**Caution! Hot surface**

During operation, the heat sink of the servo amplifier can reach temperatures of over 80° C (176° F). The heat sink temperature should be checked before handling and it may be necessary to wait until it has fallen below 40 °C (104 °F).

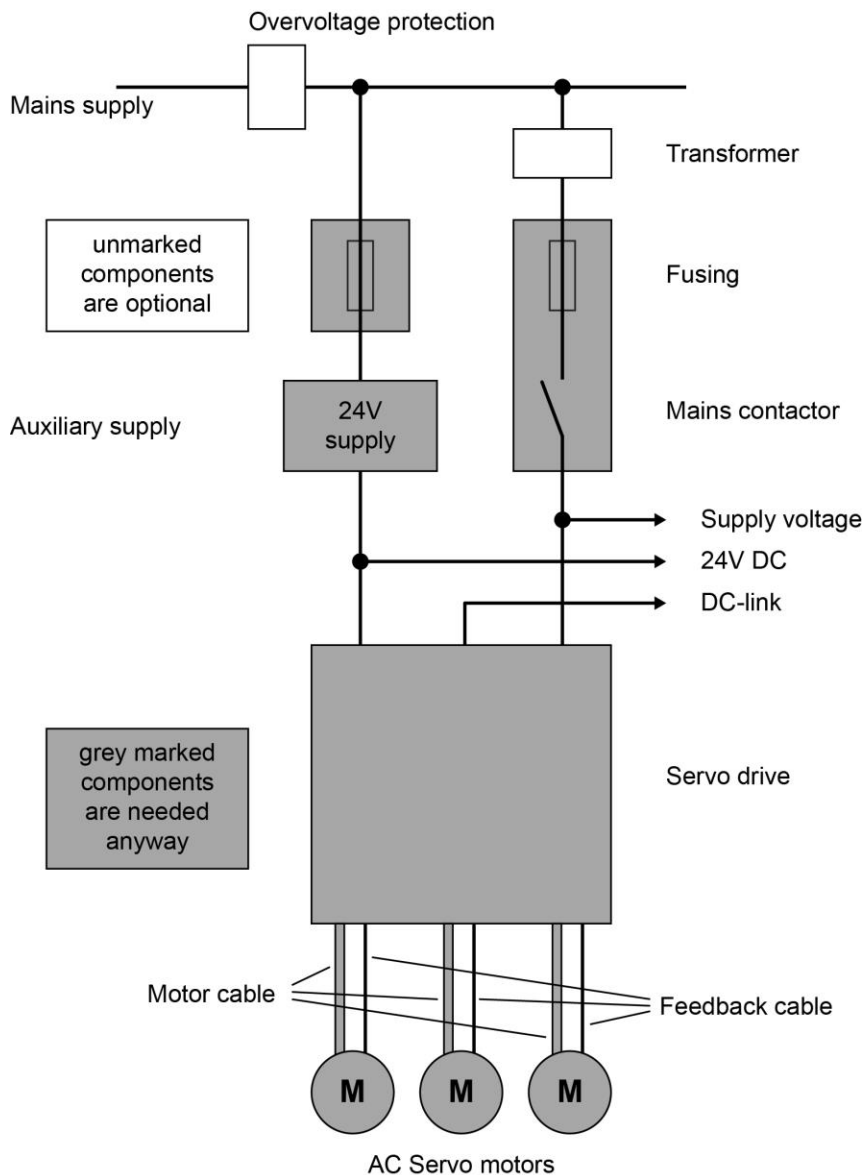
Failure to follow the above safety measures can lead to severe injuries.

**Caution! Electromagnetic Fields (EMF)****Risk of death!**

Due to the electromagnetic fields generated during operation of the servo amplifier, people with pacemakers or implants are particularly at risk if they are in the immediate vicinity of the device.

Caution must therefore be taken to ensure that such persons maintain the necessary safety distance of at least 2 m.

1.3 Servo Amplifier Components



1.4 European Guidelines and Norms

Servo amplifiers are components designed for installation in electrical systems/machines for industrial use. During the installation into machines/systems, the servo amplifier should not be operated until it has been determined that the machine/system meets the requirements of the EG-machine guideline 2006/42/EG and the Electromagnetic Compatibility (EMC) directive 2014/30/EU.



Note: The machine manufacturer must perform a safety analysis for the entire machine. With the appropriate measures, the manufacturer ensures that no injuries or damage can be caused by unexpected movements.

CE – Conformity

With the delivery of servo amplifiers within the European community, compliance with the Electromagnetic Compatibility (EMC) directive 2014/30/EU and Low voltage directive 2014/35/EU is mandatory.

The harmonized standard EN 61800-5-1 (Electrical Power Amplifier Systems with Adjustable Speed - part 5-1: Requirements for the Safety of Electrical, Thermal and Energetic Demands) was included with the Low voltage directive 2014/35/EU for this servo amplifier.

The harmonized standard EN 61800-3 (Electrical Power Amplifier systems with Adjustable Speed - Part 3: EMI Product Norm including Special Test Processes) was included with the Electromagnetic Compatibility (EMC) directive 2014/30/EU for this servo amplifier.

To meet the EMC conditions for the installation, the documentation contains detailed information on:

- Shielding
- Ground connection
- Control cabinet wiring
- Filters (as required)

The servo amplifier from the DIAS-Drive series was tested with the system components and the corresponding configuration defined in this document. Any change in the configuration and installation described in this document requires new measurements to ensure the standards are met.

1.5 Designated Use

The servo amplifier from SIGMATEK GmbH & Co KG was designed and produced with state of the art technology. The product was tested for reliability before delivery, especially in terms of fail-safe conditions. It is an installed component for electrical systems and can only be operated as an integral part. Before installation, the following conditions for designated use must be met:

- Each user of the product must read and understand the safety instructions for designated and non-designated use.
- The machine manufacture must perform a safety analysis of the machine in order to ensure that no injuries or damage is caused to personnel and equipment by unexpected movements.
- The servo amplifier must be operated under the assembly and installation conditions described in this document. The environmental conditions (temperature, protection class, humidity, voltage supply, EMC and mounting position) must be observed in particular.
- The amplifier can only be operated in a control cabinet with **minimum IP54**.
- The Servo amplifier must be operated in the original condition without any mechanical or electrical changes.
- Mechanically or electrically defective or faulty servo amplifiers may be not installed or operated.
- The servo amplifier is provided for the control of synchronous servo, linear and torque motors, as well as frequency, torque, speed or position control of asynchronous motors.
- The specified rated voltage of the motor must be at least as high as the power supply voltage of the servo amplifier (230 V, 400 V or 480 V).
- Only motors with star circuit may be used.
- This product can lead to EMC disruptions in living areas. In such a case, the user must take additional filtering measures.

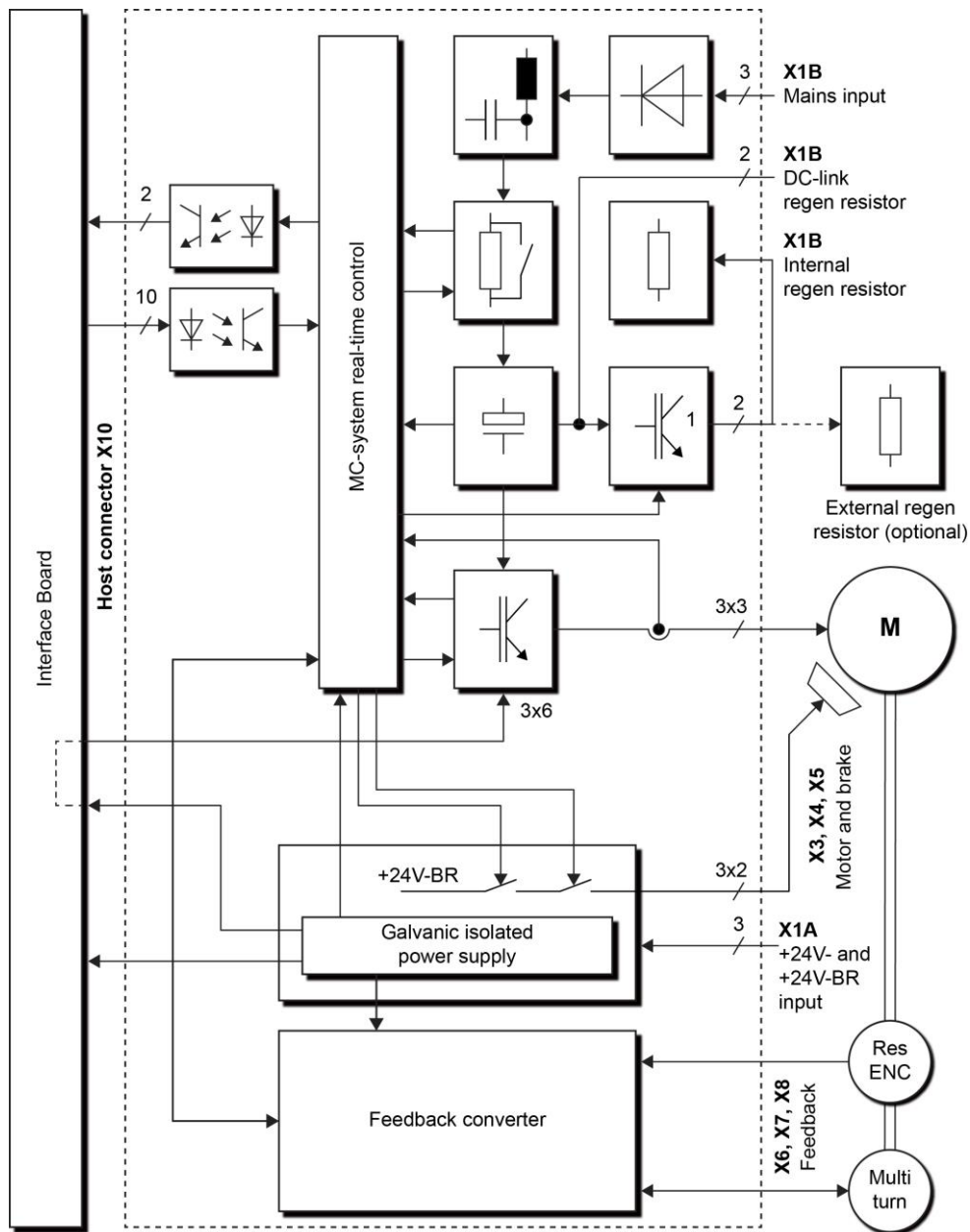
1.6 Non-designated Use

If a servo amplifier is operated according to the environmental conditions described in this document, it is "designated use".

- Single-phase operation is not authorized as standard use, but is allowed for initial startup and demonstration purposes.
- Because of saline and therewith, conductive contamination, the servo amplifier cannot be used on ships (sea operation) or in offshore applications.
- The servo amplifier cannot be operated under any environmental conditions other than those described in this documentation (meaning without a control cabinet, incorrect assembly etc.)

Particular caution is required in production facilities, in which conductive material such as carbon fiber, graphite, and cast iron or similar material is used. In such cases, the control cabinet must be hermetically sealed (no forced ventilation with fan filters) or placed outside of the contaminated area. Especially during the initial start-up, the danger posed by open control cabinet doors is extremely high. Contaminated servo amplifiers may no longer be used.

1.7 Block Diagram



1.7.1 Hardware

- The main supply is connected to a rectifier, input filter and a charging circuit, which reduces the load current for the power-up moment.
- IGBT – Power output stage with separate current measurement (short circuit protected).
- Short circuit proof brake chopper with internal brake resistor. For insufficient power, the internal resistor can be disconnected and replaced by an external one.
- DC link for connection to additional amplifiers.
- Auxiliary voltage for the internal supply.
- Separate voltage supply for the holding brake.
- Evaluation from the resolver, EnDAT and Hiperface sensors.
- Micro controller system with communication to the interface

1.7.2 DIAS-Drive Concept

- 1 and 3-axis amplifiers to reduce machine costs. 3-axis amplifiers have advantages reducing components
- Auto-range function to optimize the resolution of the actual current value of 10 A axes, in various configurations.
- Two different mounting options.
 - On a mounting place in the control cabinet
 - Through-hole technology
- Broad input voltage range from $3 \times 230 \text{ VAC}_{-10\%} \dots 3 \times 480 \text{ VAC}_{+10\%}$ supplied from TN-supply or TT-supply with grounded neutral point, with a maximum current of symmetrical $5000 \text{ A}_{\text{RMS}}$.
- TT supplies without grounded neutral lines require additional measures.
- Charging circuit for limiting the maximum load current at the power-up moment.
- Fuse installed by user (phase failure is monitored by the amplifier)
- 1-phase operation is possible, e.g. for initial start-up
- 24 V auxiliary supply, galvanically isolated for independent power.
- Separate 24 Volt connection to power the holding brakes.
- Noise filter for the main, 24 V auxiliary and holding brake supplies, class A (industrial use)
- Housing with connection for the cable shielding
- Protective functions against:
 - Under or over voltage in the DC-link circuit.
 - Several short circuit conditions
 - Phase error in the main supply
 - Brake resistance over heating
 - Over temperature (heat sink, ambient and motor)
- The overload protection is provided internally by the drive. The load current is limited to 100 % of peak output current. For the thermal protection of the motor the I^2T regulation is used.



Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Manufacturer Instructions, National Electrical Code and any additional local codes.

1.7.3 Software Functions

- Modified space vector modulation (SVM) technique to reduce the power stage losses
- Field oriented current controller (update time 62.5 μ s)
- Feedback evaluation and speed controller (update time 62.5 μ s)
- Spline interpolation and position controller (update time 62.5 μ s)
- Full synchronisation up to the output stage to the control frequency with cycle times of 250 μ s, 500 μ s and 1 ms to 8 ms
- The servo amplifier has a volatile data storage medium. After power-up, the parameters are loaded into the servo amplifier via the host
- Starting with FW version 1.82, the electrical rotary field frequency is limited to 599 Hz. The error bit 18 is set when the frequency is above 599 Hz for more than one second. The amplifier then changes to error status. The cause could be a high rotation speed with motors that have a high number of poles.

1.8 Technical Data

	DIM	DIAS-Drive SDD335-23
Rated values		
Rated input voltage (symmetrical opposite to earth) max. 5000 rms (L1, L2, L3)	V _{AC}	3 x 230 V _{-10%} – 480 V ^{10%} , 45 – 65 Hz
Max. peak current at power-up moment (limited by the charging circuit)	A	2.5
Rated power in S1 mode	kVA	14
Rated DC-link voltage	V _{DC}	290 – 680
Over voltage protection – limit for the intermediate circuit	V _{DC}	450 – 900
Additional supply voltage +24 V	V _{DC}	22 – 30
Power from the additional +24 V	W	35
Holding brake supply +24 V-BR	V _{DC}	25 – 27
Max. holding brake current per axis	A _{DC}	2
Holding brake voltage drop with a load +24 V-BR	V _{DC}	Max. 1 (at 3 x 2 A Holding brake current)
Max. switching energy of the holding brake	mJ	100
Rated current for axis 1 (rms +/- 3 %)	A _{rms}	10
Max. standstill current for axis 1 starting from 500 ms	A _{rms}	7
Rated current for axis 2 (rms +/- 3 %)	A _{rms}	10
Max. standstill current for axis 2 starting from 500 ms	A _{rms}	7
Rated current for axis 3 (rms +/- 3 %)	A _{rms}	15
Max. standstill current for axis 3 starting from 500 ms	A _{rms}	10.5
Max. continuous sum current of all axes (heat sink)	A _{rms}	20
Peak output current axis 1 for a max 5 s (rms +/- 3 %)	A _{rms}	20
Peak output current axis 2 for a max 5 s (rms +/- 3 %)	A _{rms}	30
Peak output current axis 3 for a max 5 s (rms +/- 3 %)	A _{rms}	35
The loss in the power output stage (add the average current of the 3 axis and multiply by the factor) without brake unit losses	W / A _{rms}	10
Output frequency of the power output stage	kHz	8
Maximum output current for 8 V feedback systems at X6, X7, X8	mA	250
Minimum output current for 8 V feedback systems at X6, X7, X8	mA	0
Maximum output current for 5 V feedback systems at X6, X7, X8	mA	250
Minimum output current for 5 V feedback systems at X6, X7, X8	mA	50
Maximum residual current	mA	15
PWM frequency	kHz	8
Regulator frequency	kHz	16

Brake Unit		
Capacitance of the intermediate circuit voltage	μF	700
External regen resistor	Ω	25
Internal regen resistor	Ω	25
Rated power of the internal regen resistor	W	200
G-VMAINS = 230 (rated supply voltage = 230 V)		
Start-up limit	V_{DC}	420
Switch-off level	V_{DC}	400
Over voltage protection	V_{DC}	450
Max. rated power of the external regen resistor	W	750
Peak internal regen resistor power (max. 1 s)	kW	6.5
G-VMAINS = 400 (rated supply voltage = 400 V)		
Start-up limit	V_{DC}	730
Switch-off level	V_{DC}	690
Over voltage protection	V_{DC}	800
Max. rated power of the external regen resistor	W	1200
Peak internal regen resistor power (max. 1 s)	kW	21
G-VMAINS = 480 (rated supply voltage = 480 V)		
Start-up limit	V_{DC}	850
Switch-off level	V_{DC}	810
Over voltage protection	V_{DC}	900
Max. rated power of the external regen resistor	W	1500
Peak internal regen resistor power (max. 1 s)	kW	27
Internal fuse		
24 V auxiliary supply voltage (+24 V to BGND)	-	Electronic fuse
Holding brake supply 24 V-BR (+24 V-BR to BGND)	-	Electronic fuse
Regen resistor	-	Electronic protection
Resolver specification		
Exciter frequency f_{err}	kHz	8
Exciter voltage U_{Ref}	U_{eff}	4
Number of poles m	-	2, 4, 6 ... 32
Resolver voltage $U_{\text{sin/cos, max}}$	U_{eff}	2.2
Connector types		
Internal auxiliary power supply (X1A)	-	Combicon 5, 3-pole, 2.5 mm ²
Power Supply (X1B)	-	Power Combicon 7.62, 8-pole, 4 mm ²
Feedback (X6, X7, X8)	-	Sub-D 25-pole (female)
Motor (X3, X4, X5)	-	Power Combicon 7.62, 6-pole, 4 mm ²
Dimensions		
Height with/without connector plugs	mm	472 / 378
Width	mm	158
Depth	mm	240
Weight	kg	10

General	
Article number	09-501-351-23
Standard	UL 508C, E336350

1.9 Environmental Conditions, Ventilation and Mounting

Storage conditions	⇒ page 49
Transport conditions	⇒ page 49
Environmental temperatures in operation	0 ... +45 °C (32 ... 113 °F) at rated data +45 ... 55 °C (113 ... 131 °F) with power reduction by 2.5 % / K
Air humidity in operation	Relative humidity 85 %, no condensation
Installation altitude above sea level	0-2000 m without derating > 2000 m with derating of the maximum environmental temperature by 0.5 °C per 100 m
Pollution degree	2
Overvoltage category	III
Servo amplifier protection class	IP 20
Mounting position	⇒ page 26
Ventilation	Forced ventilation by controlled internal fan

1.10 Auxiliary Supply Voltage

The power supply mounted in the switchgear cabinet and used for the +24 V auxiliary supply voltage and holding brake supply (+24V-BR), must output a galvanically isolated protected extra-low voltage (PELV) according to EN60950. Due to the start current at the power-up moment, the rated current must be at least 5 A.

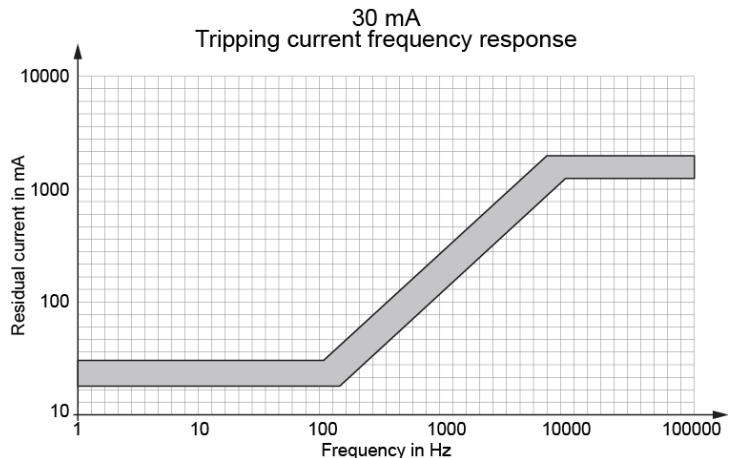
2 Installation

2.1 Important Instructions



- When using a ground fault interrupter in the circuit, a Type B FI-switch must be used. If an FI switch of Type A is used, a DC ground fault could cause it to malfunction. High-frequency leakage currents occur, which must be taken into consideration when selecting the FI (e.g. Schrack ID-B 4/XX/XX-B).

Trigger diagram:

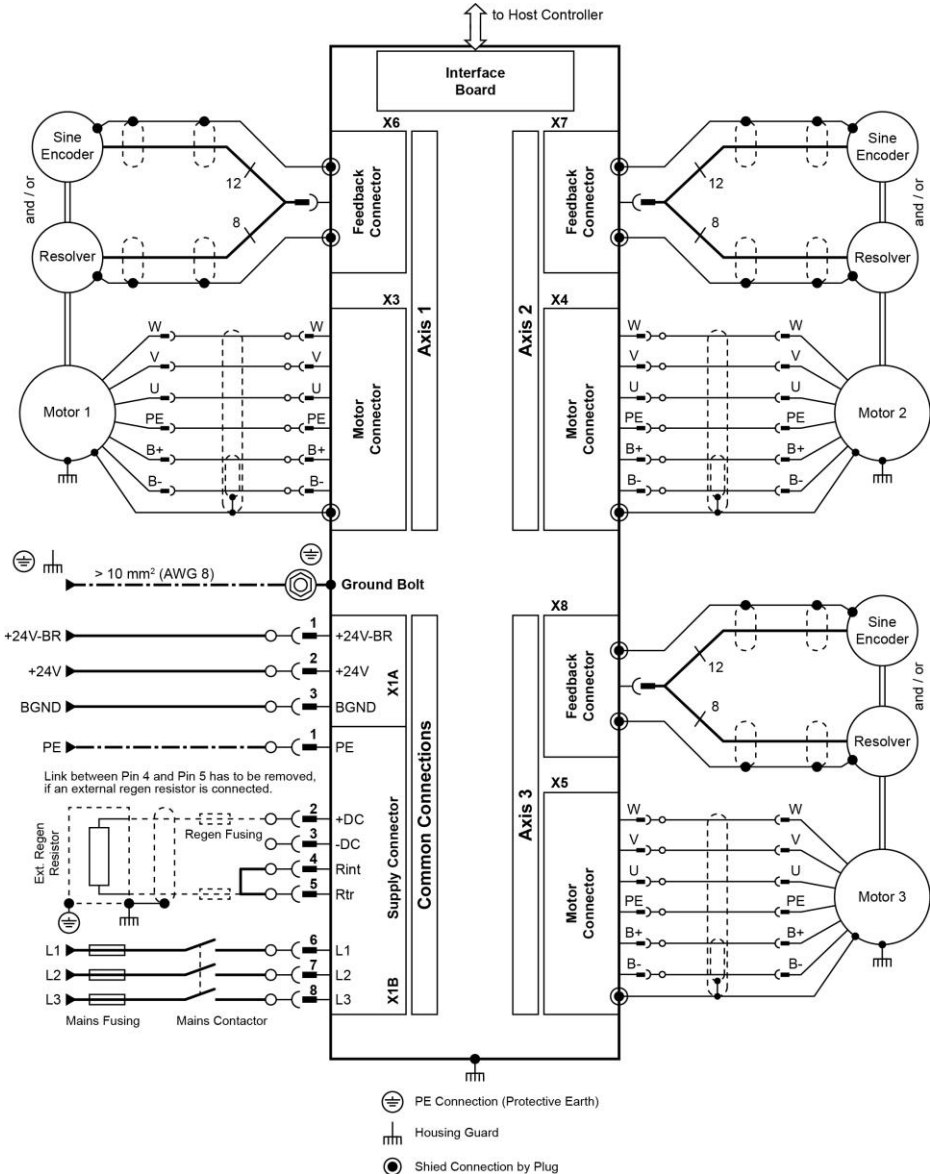


- The servo amplifier and motor must be grounded according to the guidelines. Uncoated mounting plates must be used in the control cabinet.
- The DIAS-Drive must be connected to ground via the grounding terminal using a wire with a cross section of at least 10 mm² (8 AWG).
- The main voltage supply for the DIAS-Drive requires a fixed connection. If the servo amplifier is mounted with a connector terminal to a moving machine part, the ground connection must have a cross section of at least 10 mm² (8 AWG) to avoid the high residual current (> 3.5 mA).
- Before installation, the servo amplifier must be mechanically tested. If damage from transportation is determined, for example, the amplifier cannot be used. Electronic components cannot be handled.

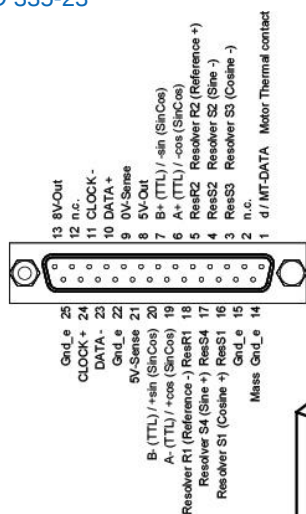
- The rated voltage and current of the servo motor and servo amplifier must match. The electrical connection must correspond to the schematic on page 24.
- The main supply can under no circumstances exceed the rated values for the servo amplifier. **“Voltage Supply Options”** on page 31 should be noted.
- The external fuse for the main supply, the +24 V auxiliary and holding brake supply must meet the specifications for **“External fusing”** on page 30.
- The motor and control cable should be routed with a minimum clearance of 100 mm. This improves the effect of noise in the control cable, which is caused by the high noise generation of the motor cable. A shielded motor and feedback cable must be used, by which the shielding on both cable ends is applied.
- As described on page 26, the correct mounting position is vertical.
- The ventilation in the control cabinet must provide sufficient cool and filtered air. Information on the **“Environmental conditions, ventilation and mounting”** can be found on page 21.
- **Any subsequent changes to a servo amplifier will render the warranty void**, with exception of the parameter settings.
- During the initial start-up of the servo amplifier, the peak current must be tested. small motors can be damaged quickly, especially if the servo amplifier settings are too high (e.g. a 1 A motor with a 10 A amplifier without being limited to 1 A).
- **Note:** The mass symbol  found in all schematic plans means that the electric connection between the indicated device and the mounting panel in your control cabinet must be made over the largest possible surface. This connection should enable the dissipation of HF noise and should not be confused with the PE symbol . (Protective measure according to EN 60204)
- Storage time:
 - < 1 year:** no limitations
 - ≥ 1 year:** The intermediate circuit capacitors of the servo amplifier must be reformed before the initial startup. In addition, all electrical connections must be removed and the servo amplifier supplied with 230 V AC, single phase at terminals L1 / L2 for 30 minutes.

2.2 Construction of the Control Cabinet

2.2.1 Wiring Diagram and Pin Assignment



2.2.1.1 SDD 335-23

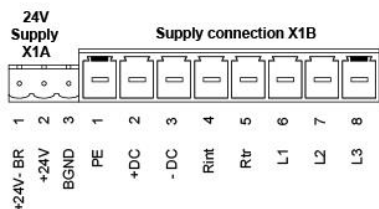
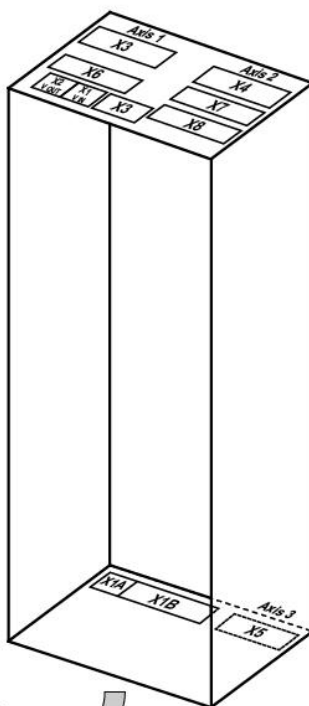
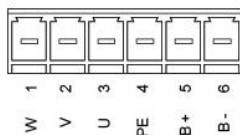


Feedback connection

Axis 1: X6 (Top view)
Axis 2: X7 (Top view)
Axis 3: X8 (Top view)

Motor connection

Axis 1: X3 (Top view)
Axis 2: X4 (Top view)
Axis 3: X5 (Bottom view)

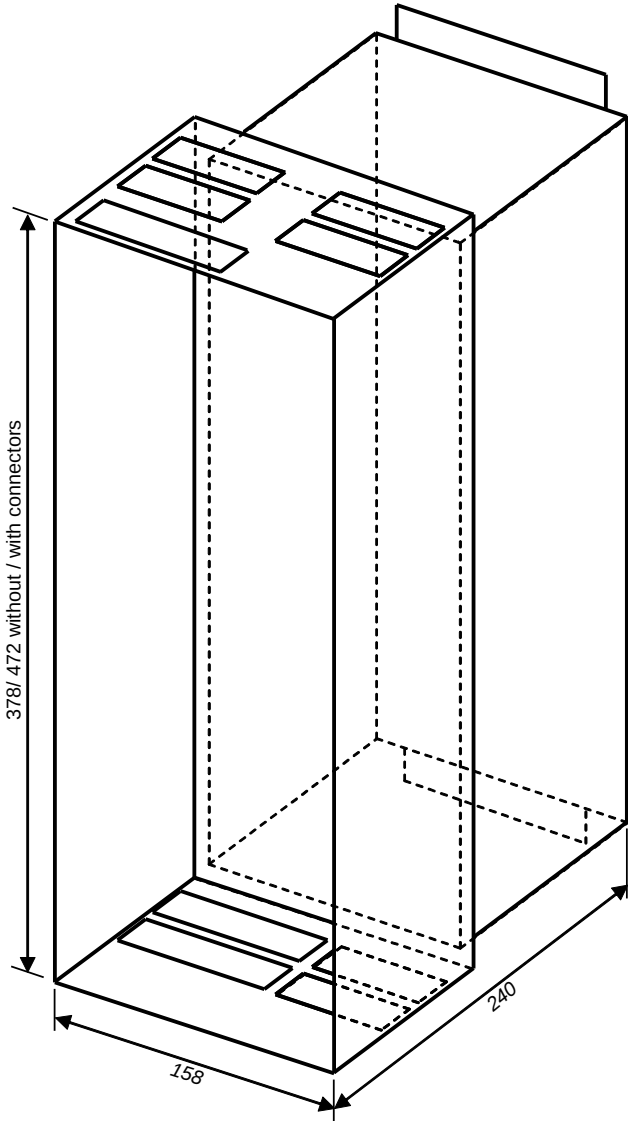


Supply connection X1B

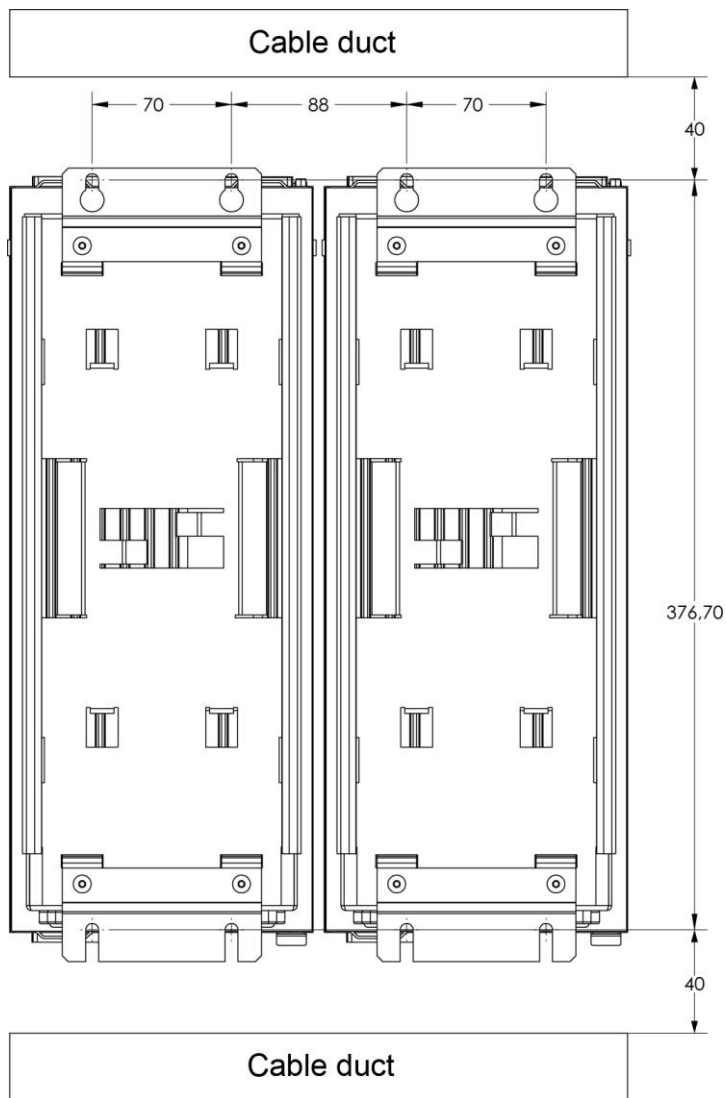


Drive type Cable	Axis 1		Axis 2		Axis 3	
	Motor	Feedback	Motor	Feedback	Motor	Feedback
SDD335-23	X3	X6	X4	X7	X5	X8

2.2.2 Mechanical Construction and Mounting



The drawing shows the servo amplifier dimensions.

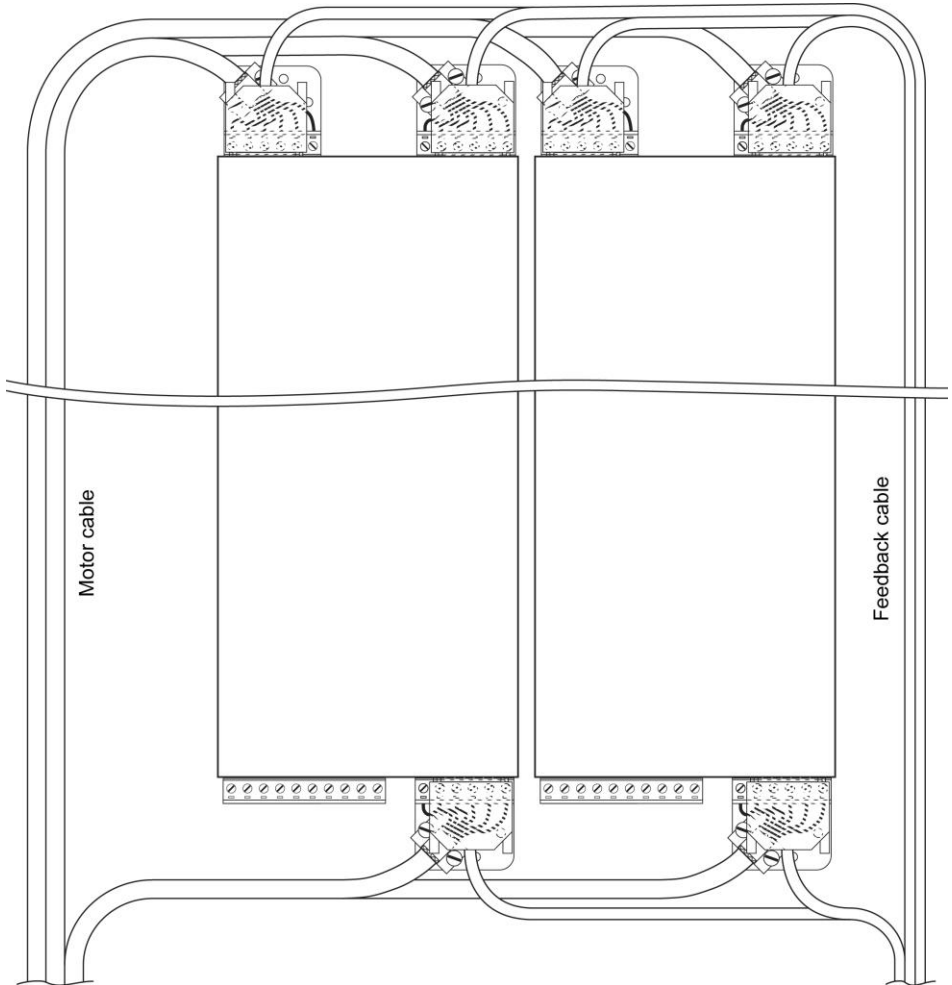


The cable channels below and above the servo amplifier must have the specified distances. This will ensure the sufficient air reaches the heat sink.

Material: 4 x M5 socket head screws to DIN 912

Tool required: 4 mm Allen key

2.2.3 Laying the Motor and Control Cables



Note:

The motor and control cable must absolutely be kept separate. The voltage connection to X1B should also be laid mainly in the cable channels on the left side of the control cabinet.

2.2.4 Connector Models

All connections to the servo amplifier are connector plugs (except: grounding bolt). With this method, the cable connection is simplified and the amplifier can be more easily exchanged. Additionally, it also provides the possibility to manufacture pre-assembled cable sets for large machine quantities.

The following is the technical data for the applicable connectors:

Connector	Type	Wire size	Max. screw torque
X1A	Phoenix MSTB 2,5 HC/3-ST	1-2.5 mm ² (14-18 AWG)	0.3 Nm (2.25 inch lb)
X1B	Phoenix PC5/8-ST2-7,62	1-4 mm ² (12-18 AWG)	1.3 Nm (12 inch lb)
X3, X4, X5	Phoenix PC5/6-ST2-7,62	1-2.5 mm ² (14-18 AWG)	1.3 Nm (12 inch lb)
X6, X7, X8	D-Sub 25 with metal housing	0.25-0.5 mm ² (21-24 AWG)	solder or crimp
Ground bolt	M5	10 mm ² (8 AWG)	3.5 Nm (31 inch lb)

2.2.5 Cable Types

According to EN 60204 (for AWG: table 310-16 of the NEC 60 °C or 75 °C column), is recommended:

Signal		Cable rating
Alternating current	Maximum 4 mm ² (12 AWG)	600 V 105 °C (221 °F)
DC-link voltage	Maximum 4 mm ² (12 AWG)	1000 V 105 °C (221 °F)
Regen resistor	2.5 mm ² (14 AWG)	1000 V 105 °C (221 °F)
Motor cable	Maximum 2.5 mm ² (14 AWG), shielded, max. 25 m, cable capacitance <150 pF/m	600 V 105 °C (221 °F)
Holding brake	Min. 0.75 mm ² (18 AWG), component of the motor cable, shielded separately, note voltage loss	600 V 105 °C (221 °F)
Resolver with thermo contact	4x2x0.25 mm ² (24 AWG), twisted pairs, shielded, max. 25 m, cable capacitance <120 pF/m	
EnDAT [®] signal encoder	7x2x0.25 mm ² (24 AWG), twisted pairs, shielded, max. 25 m, cable capacitance <120 pF/m	
+24 V and +24 V-BR input	Maximum 2.5 mm ² (14 AWG) (check voltage drop)	

Note: Use 60/75 °C Copper conductors only!

2.2.6 External Fusing

The AC-mains and 24 V fuses are designed according to the customer requirements for the circuit.

Signal	Fuses, time delay
AC mains input (L1-L3) Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 528 volts maximum when protected by RK5 class fuses rated 20 A	The size of the fuse depends on the average power consumption of the connected amplifier. Max. 20 A with 4 mm ² (12 AWG) (FRS-25) wires
24 V DC input (24 V, 24 V-BR to BGnd)	16 A slow-blow at 2.5 mm ² (14 AWG) for the control
External regen resistor	10 A time delayed, 1200 V (e.g. SIBA 10 022 01, 3-pin-D-Fuse-Link) or FRS-10

UL Requirement:

Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 528 volts maximum when protected by RK5 class fuses rated 20A.

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Manufacturer Instructions, National Electrical Code and any additional local codes.

2.2.7 Voltage Supply Options



The main voltage supply for the DIAS-Drive requires a fixed connection. If the servo amplifier is mounted on a moveable machine part with connector plug, the ground connection has to have a minimum wire size of greater than 10 mm² (8 AWG) because of the high leakage current of the servo amplifier (> 3.5 mA).



When using a ground fault interrupter in the circuit, a Type B FI switch must be used. If an FI switch of Type A is used, a DC ground fault could cause it to malfunction.

Main voltage supply (grounded)

The servo amplifier can be connected directly to a voltage supply with a grounded neutral point without galvanic isolation.

Main voltage supply (non-grounded)

If the servo amplifier is operated in a non-grounded system (IT grid), the danger of over voltage or damage exists. The following measures can be taken to provide protection against over voltage:

- Use of a galvanically insulating transformer with a grounded neutral point on the secondary side. This offers the highest protection.
- Installation of over voltage protection in the voltage supply of the control cabinet.

The servo amplifier is tested according to EN 61800-3 as follows:

- Periodic over voltage between phase conductors (L1, L2, L3) and the amplifier housing cannot exceed 1000 V (amplitude).
- According to EN61800, the peak voltages (< 50 µs) between the phase conductors cannot exceed 1000 V. Peak voltages (< 50 µs) between the phase conductors and the housing cannot exceed 2000 V..



Note: Non-grounded mains supplies always require additional surge protection in the mains input.

High voltage supply

If the input supply voltage exceeds the specified maximum value, a suitable transformer is required to reduce it.

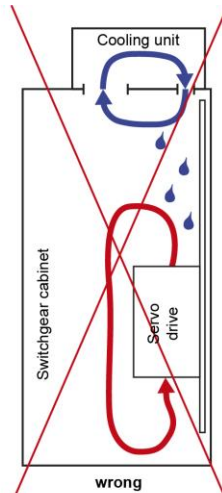
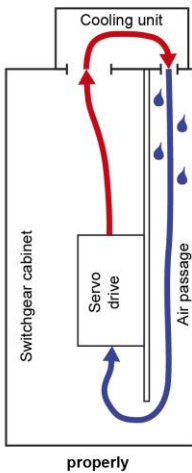
2.2.8 Usage of Cooling Devices

The servo amplifier functions up to an ambient temperature of 45 °C (55 °C with reduced power). Under some circumstances, a cooling device is required.

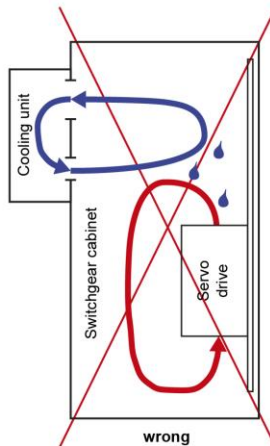
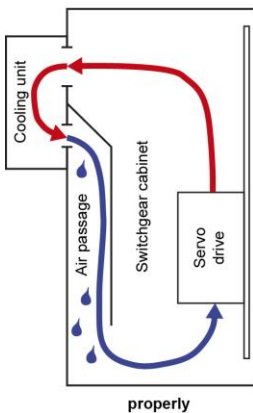


Note: A cooling device always produces condensation water. Important points must therefore be observed:

- Cooling units must be mounted in such a way that no condensation water can drip into the control cabinet.
- Cooling units must be mounted so that condensation water is not distributed over electrical or electronic components.



Cooling device mounted in the top of the control cabinet



Cooling device mounted in the cabinet door

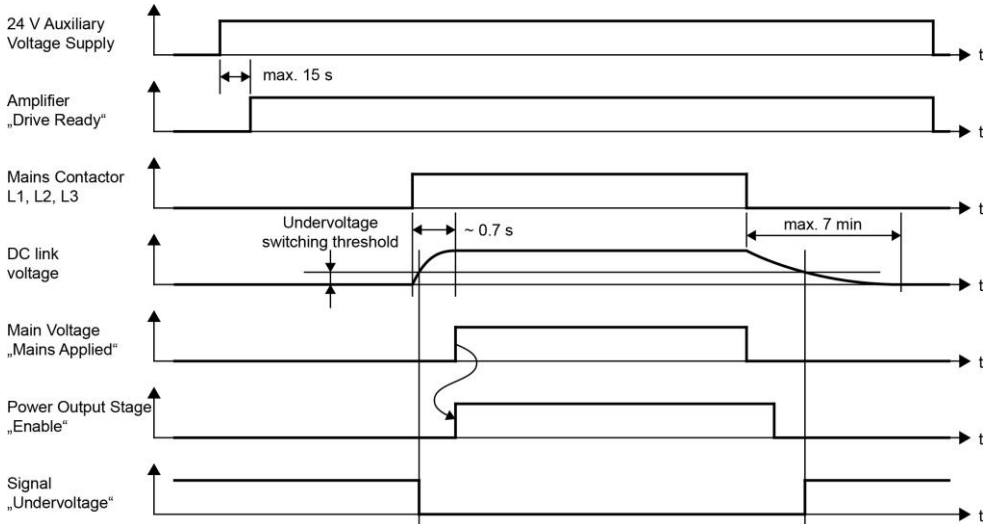
Condensation water can also be avoided as follows

- The switch point of the temperature regulator should be just below the building temperature.
- In damp environments, the proper seals should be used in the control cabinet.

If electronic components are colder than the air in the control cabinet, condensation water can accumulate; especially when the cabinet door is opened during servicing.

2.2.9 Turn on/off Response of the Servo Amplifier

The turn on/off response of the servo amplifier is shown below.



Five seconds after turning on the 24 V auxiliary supply (start time of the micro controller), the "Drive ready" signal is set to high.

The above image shows when the 24 V auxiliary supply activates the system through turning on the main switch and the main supply is engaged later. This, however, is not absolutely necessary. The main supply can also be activated with the 24 V auxiliary supply at the same time.

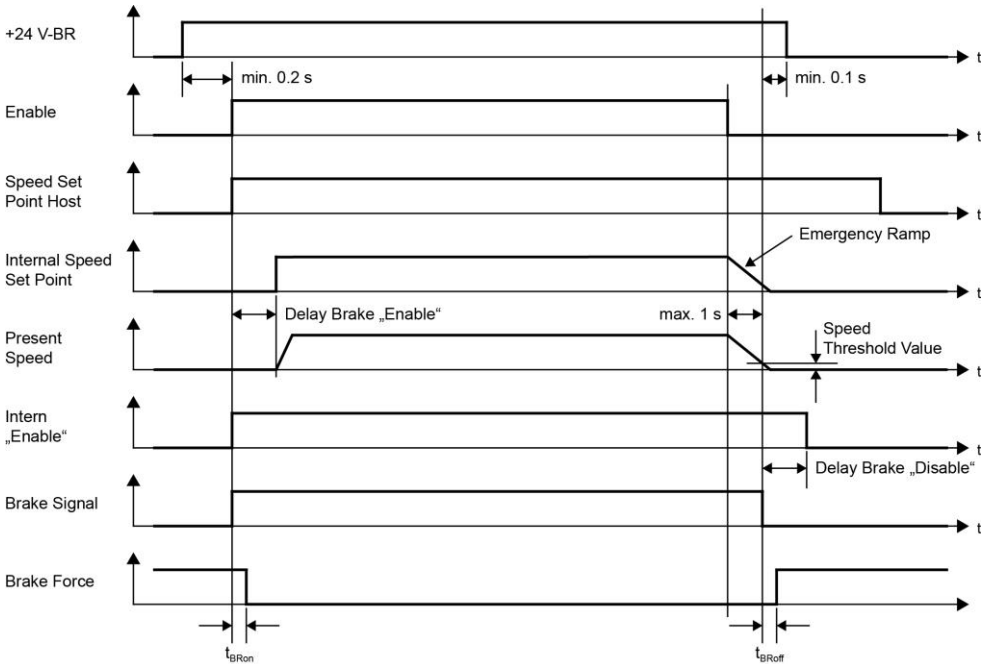
Since the servo amplifier has a volatile memory, received parameters must be stored in the host controller. The advantage here is in the automatic download of program data when an amplifier is changed.

If the main supply is turned on, the capacitors in the intermediate circuit are loaded. Approximately 0.7 seconds are needed.

If the main supply is turned off, the current of intermediate circuit is maintained and can be used for controlled braking of the motor. If the motor is slowed, the energy is returned to the intermediate circuit.

If the motor is stopped, the "enable" signal can be removed. After 5 minutes, the intermediate circuit is discharged.

2.2.10 Holding Brake Control



The figure above shows the holding brake function.

A standard holding brake with 24 volts DC and a maximum of 2 Amps can be used on the servo amplifier.



The circuit has a high level of functional safety, but **no personnel safety**.

3 Connections

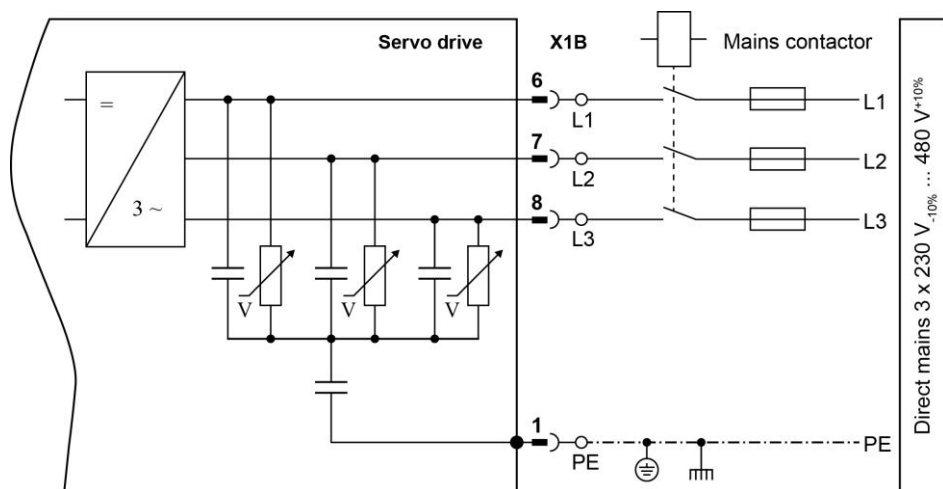
3.1 Main Power supply (X1B)

The connection to the main supply voltage is designed for voltages from 230 V AC to 480 V AC. When using a non-earthed supply, over voltage protection must be built into the main power supply of the control cabinet.



Note: If within a group of amplifiers, the intermediate circuit is bridged, the input voltage in this group must also be bridged.

3-phase connection:



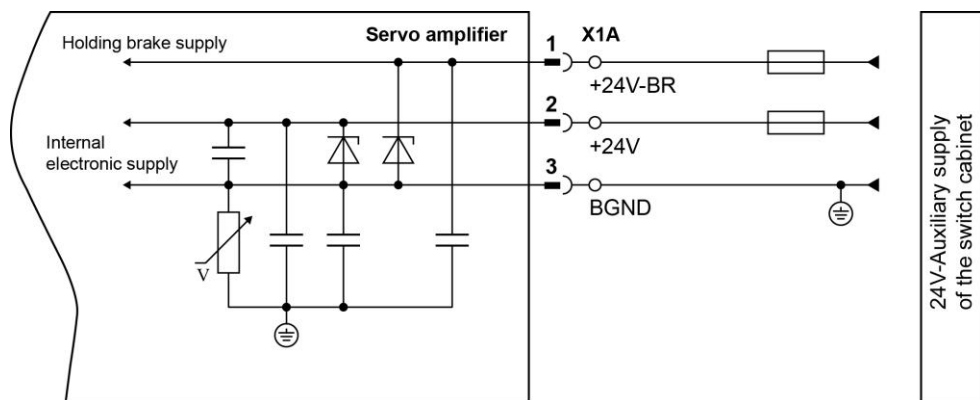
3.2 24 V Auxiliary supply – Holding Brake supply (X1A)

If a 24 V supply is used in the control cabinet to power the relays, coils or other devices, it can also be used for the servo amplifier (the maximum current of the supply must be taken into consideration).

To deactivate the stop brake independently from the 24 V auxiliary voltage, the amplifier has an additional input +24 V-BR.



Note: The mass of the 24 V power supply must be connected to ground near the supply.



3.3 DC-link (X1B)

To bridge the DC-link voltage with other servo amplifiers, the X1B/2 (+DC) and 3 (-DC) connectors can be used.

The intermediate circuit power can be distributed to different servo amplifiers with this method.



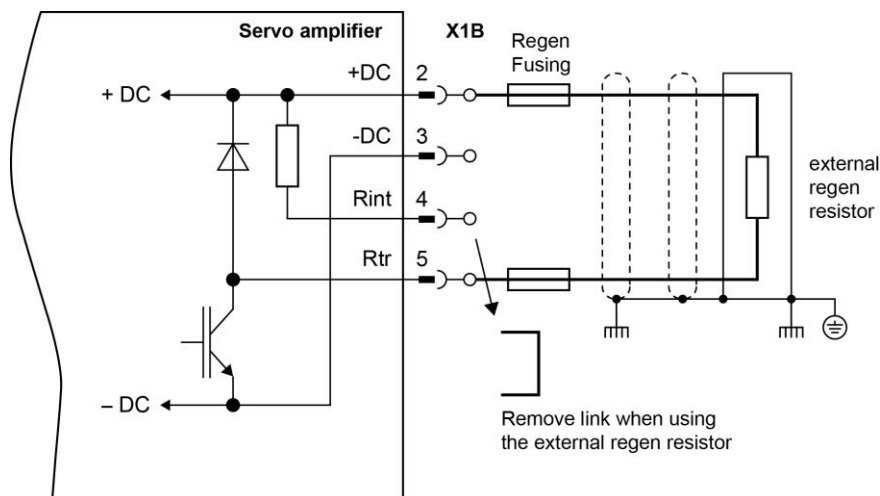
Note: If the intermediate circuit is bridged within a group of amplifiers, the main power supply in this group must also be bridged.

3.4 External Regen Resistor (X1B)

If the power of the internal brake resistor is insufficient, an external resistor can be added. Here, the connection to R_{int} (terminal 4 of X1B) and R_{tr} (terminal 5 of X1B) must be removed. The external resistor is connected to terminal 2 and 5 of X1B. The fuse on both connections of the external brake resistor is mandatory. 1000 VDC fuses with slow trigger characteristics must be used.



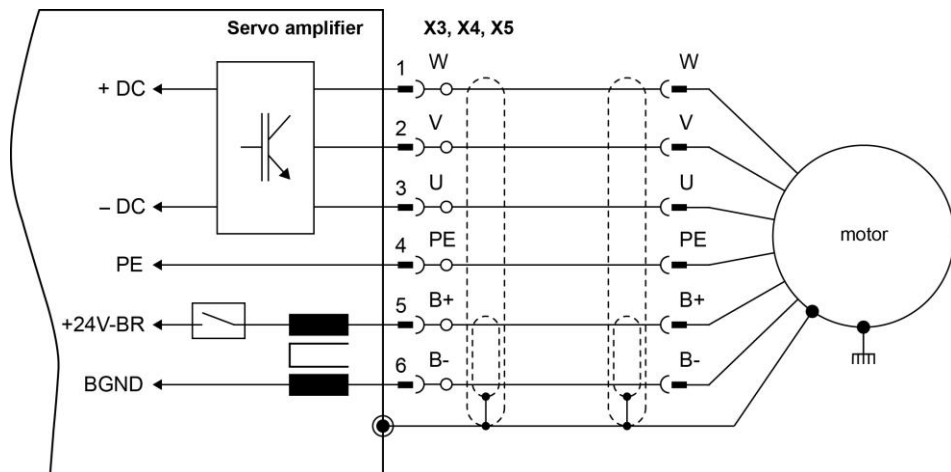
Note: The brake resistor fuse does not protect the resistor, rather the connected cable in the event of a short circuit. The amplifier has electronic protection for the brake resistor.



3.5 Motor Connection (X3, X4, X5)

3.5.1 Standard configuration

The cable length for the motor is limited to 25 m. If a longer cable is used, additional suppression coils in the motor output are required.

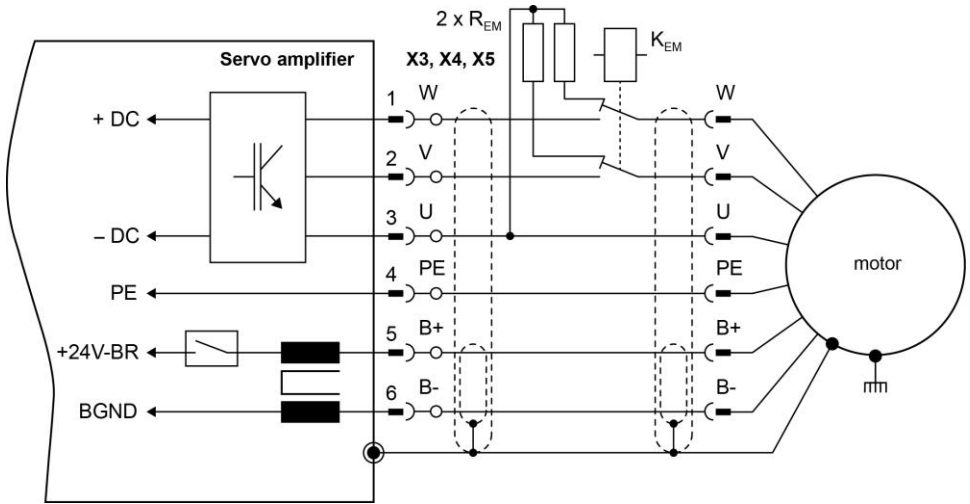


3.5.2 Classic Emergency Stop Functions (Stop Category 0)

The cable length for the motor is limited to 25 m. If a longer cable is used, additional suppression coils in the motor output are required.



Note: The K_{EM} coil must be turned on before the amplifier is enabled and can be turned off after at least 1 ms after the amplifier is disabled.



The resistance value and the power of the R_{EM} resistor are calculated using the following formulas:

$$R_{EM} [\Omega] = \frac{\max SPEED \cdot K_{Erms}}{I_{\max} \cdot 0.8} \quad P_{EM} [W] = \frac{(I_{\max} \cdot 0.8)^2 \cdot R_{EM}}{10}$$

maxSPEED

$I_{\max}$

K_{Erms}

maximum revolutions [rpm]

maximum motor current allowed [A]

voltage constant of the motor [V*min]

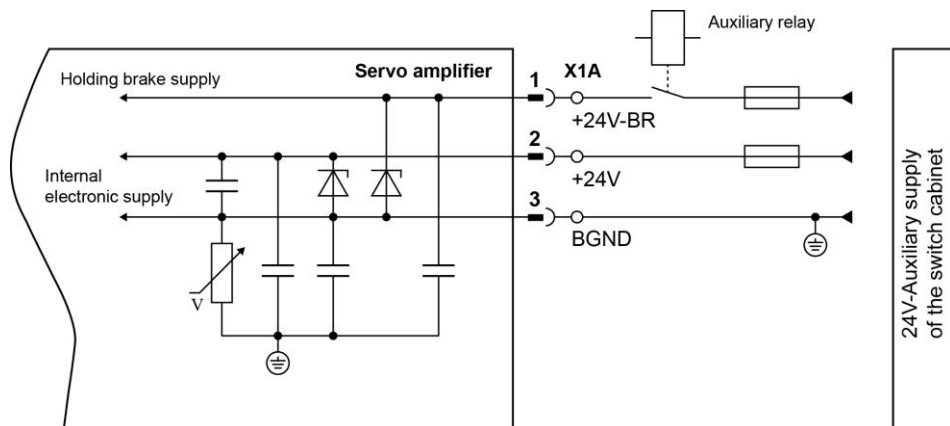
3.5.3 Personnel-Safe Holding Brake Control

The servo amplifier has a high reliability in the brake control.

If a personnel-safe holding brake control is required, an additional safety contact in the +24V-BR voltage path in keeping with the safety standards is needed.



Despite this, the danger of injury and/or damage to the machine still exists with a mechanical defect in the holding brake.



3.6 Feedback (X6, X7, X8)

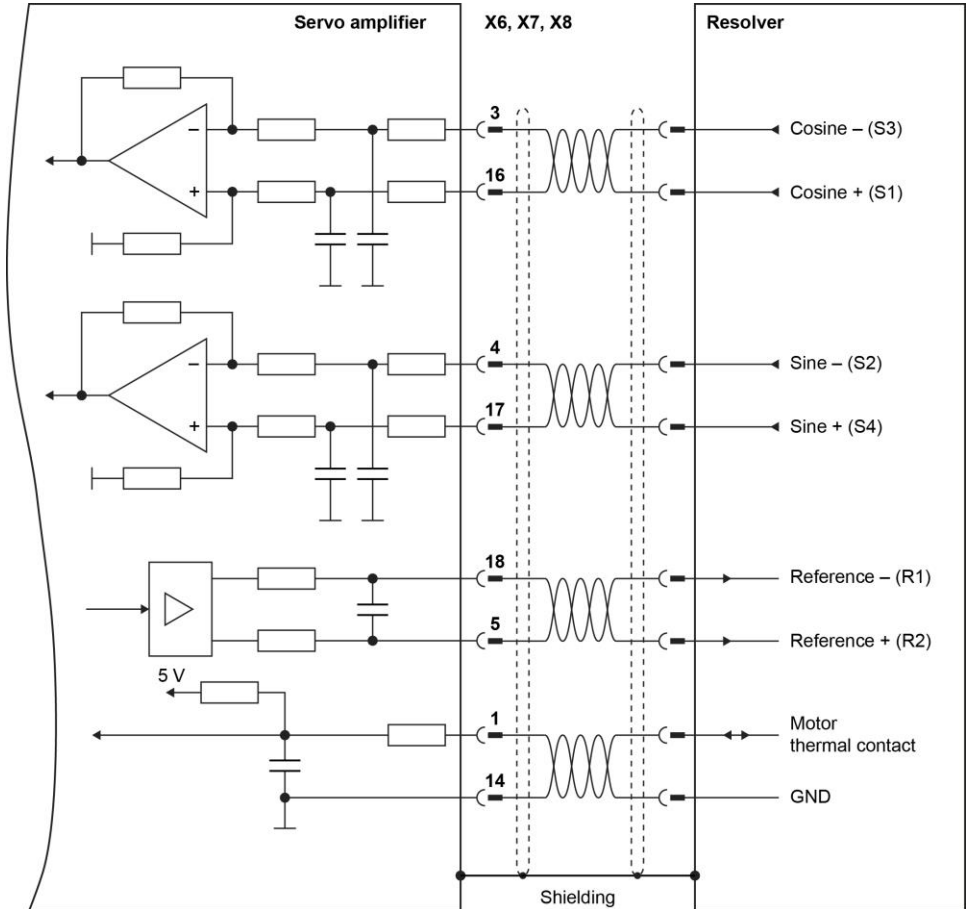
The servo amplifier has various feedback inputs for different feedback devices.

- Resolver Feedback with thermo contact
- EnDAT[®] encoder (single and multi-turn)
- Hiperface[®] encoder (single and multi-turn)
- Sin/Cos & TTL Encoder

For EnDAT, Hiperface, Sin/Cos and TTL encoder systems, the current maximum number of feedback signals of 8192 per mechanical turn is supported (M-RPULSE).

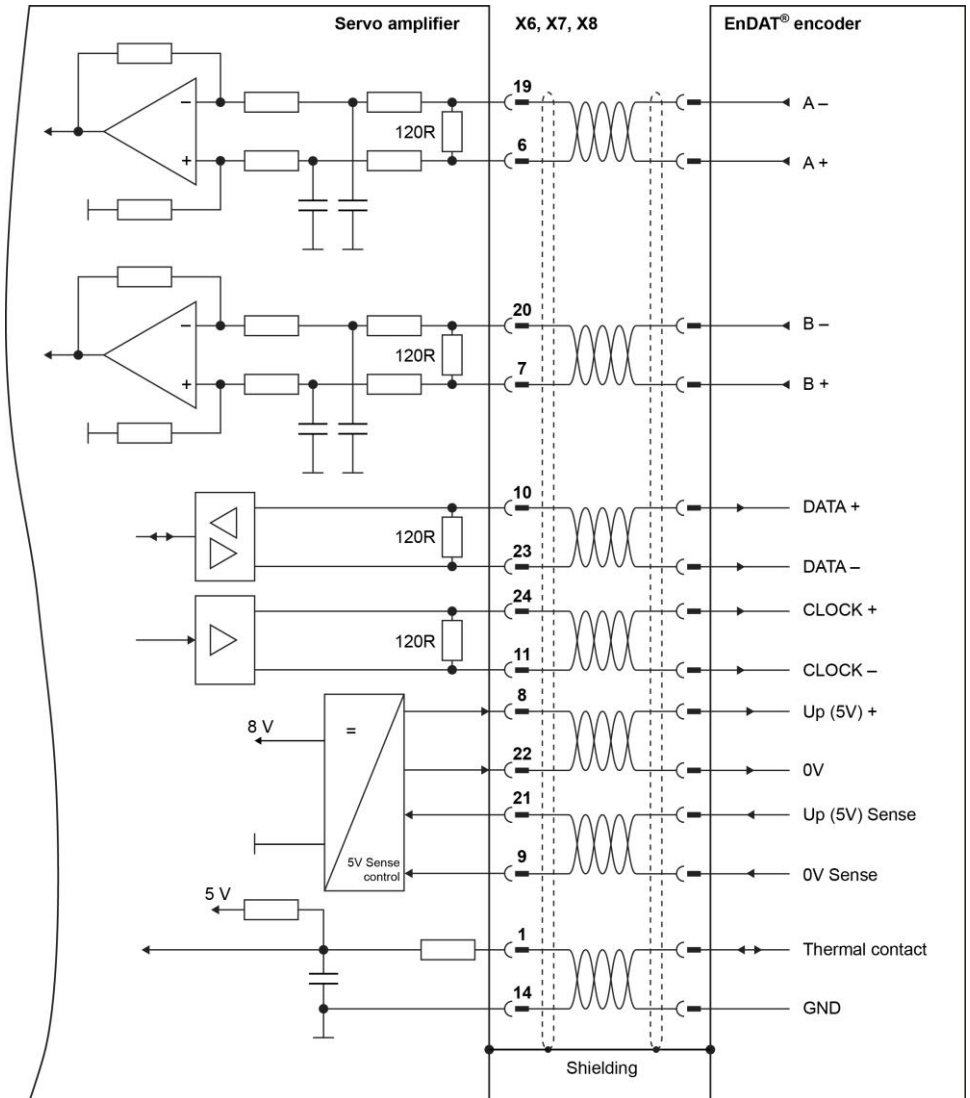
3.6.1 Resolver Feedback

A resolver is used as the standard feedback. The servo amplifier supports the analysis of single-speed (2-pin) and multi-speed resolvers (up to 32 pins). The maximum cable length is 50 m. If a thermo contact is used, the signal is also wired into the resolver cable.



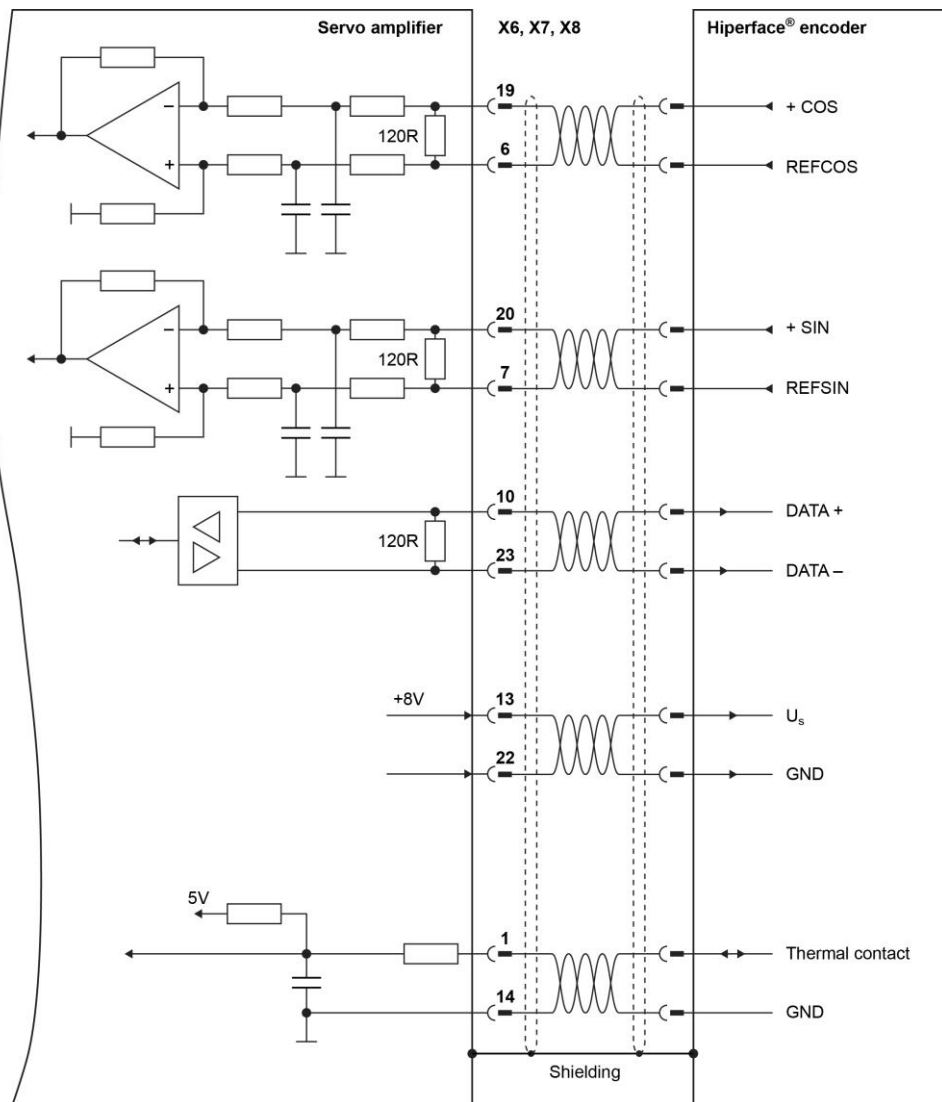
3.6.2 EnDAT® Signal Encoder

The EnDAT® encoder is a high-resolution feedback system for motors. The cable length is limited to 25 m. If a thermo contact is used, the signal is transmitted through the feedback cable.



3.6.3 Hiperface® Signal Encoder

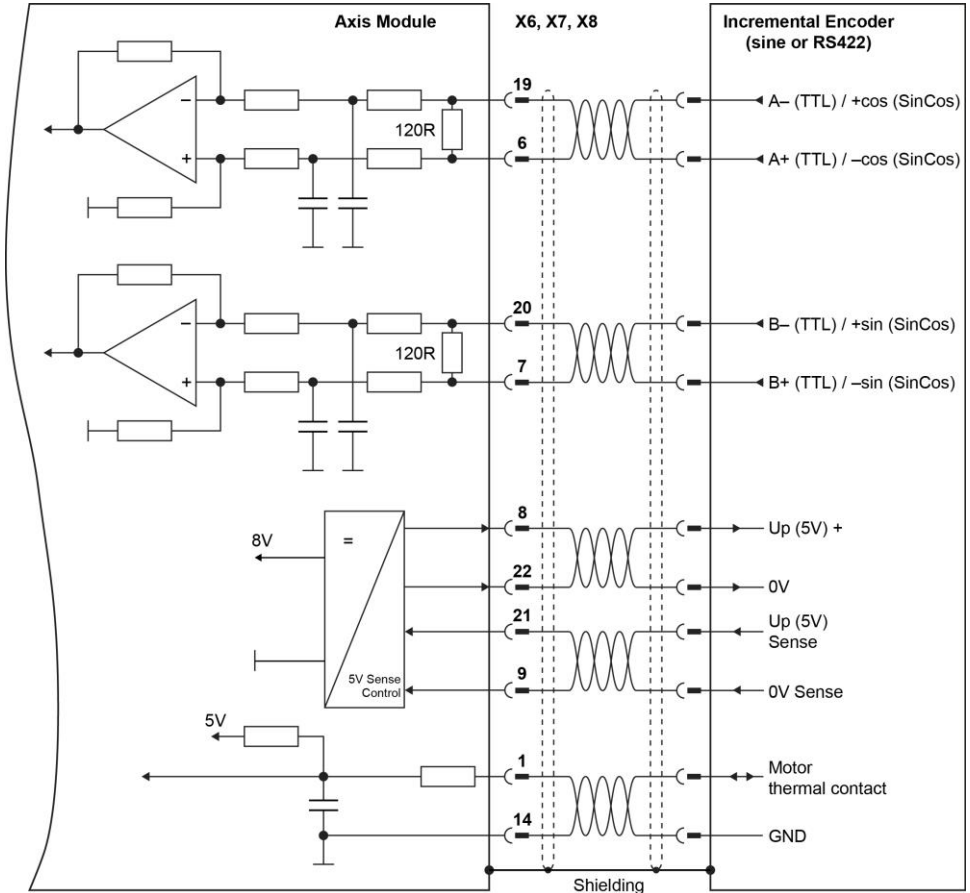
The signal encoder with a Hiperface® interface is a high-resolution feedback system for motors. The cable length is limited to 25 m.



3.6.4 Sine/Cosine & TTL Encoder Feedback

A sine encoder is a high-resolution feedback system, used with linear or torque servomotors. The maximum cable length is 10 m. If a thermo contact is used, the signal is wired into the resolver cable.

The upper frequency limit for TTL encoders is 100 kHz. The reference signal is not evaluated in the amplifier.



4 Maintenance

The servo amplifier is maintenance-free.



Note: Opening the housing invalidates the warranty.

Dirt on the housing can be removed with isopropyl alcohol or similar products.

- Contamination in the device must be removed by the manufacturer.
- Dirty fan grates can be cleaned with a dry brush.
- Spraying or submersion is not allowed.

4.1 Replace and Repair

Repair: Repair of the servo amplifier must be performed by the manufacturer.

Replace: If a servo amplifier must be replaced, the following checklist must be observed (no special mounting tools are required):

Turn off the control cabinet supply and remove the servo amplifier fuses.

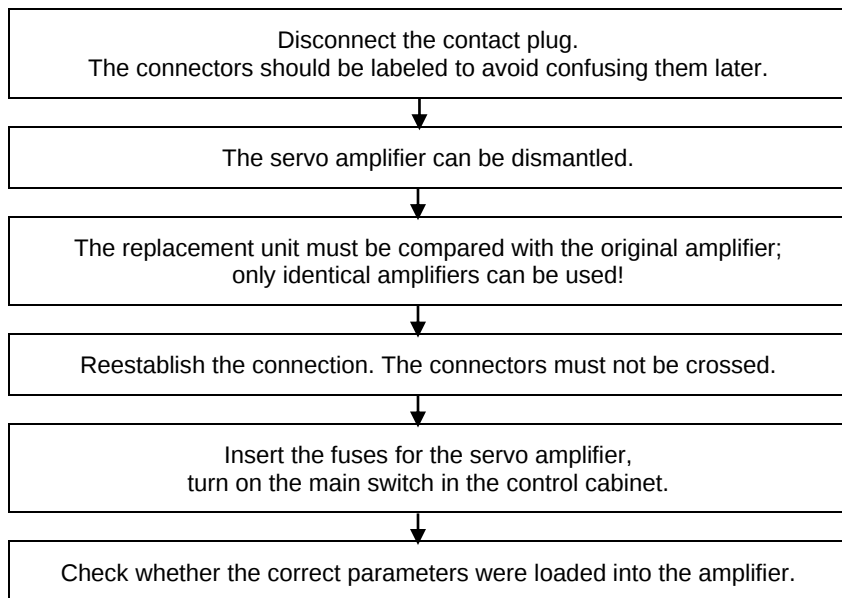


After disconnecting the servo amplifier from the main voltage supply, a wait-time of 5 minutes is required before current-conducting components in the amplifier (e.g. contacts) can be touched or connectors removed. Capacitors can contain dangerous voltages for up to 5 minutes after the supply voltage is removed. It is necessary to wait until the DC-link voltage is below 40 V.



During operation, the heat sink of the servo amplifier can reach temperatures of over 80 °C (176 °F). The heat sink temperature should be checked before handling and it may be necessary to wait until it is below 40 °C (104 °F).





5 Appendix

5.1 Transport, Storage and Disposal

Transport:

- For transport, the original recyclable packaging from the manufacturer must be used.
- During transport dropping should be avoided.
- The storage temperature must be between -25 and $+70$ °C (-13 ... 158 °F), max. change 20 K/h.
- The maximum humidity is 95% , non-condensing
- The servo amplifier contains electrostatic-sensitive components, which can be damaged by improper handling. Before touching the servo amplifier, the user must discharge their body by touching a grounded object with a conductive surface. Contact with highly insulated material (synthetic fibre, plastic foil etc.) must be avoided. The servo amplifier must be placed on a conductive surface.
- If the packaging is damaged, the amplifier must be visually inspected for damage. If damaged, the transport company and the manufacturer must be informed. The amplifier should not be installed and operated if damaged.

Packaging:

- Recyclable cardboard with liner
- Dimensions: 500 mm x 300 mm x 400 mm (width, height, depth)
- Labelling: nameplate on the outer side of the box

Storage:

- Only the original recyclable packaging from the manufacturer can be used
- The servo amplifier contains electrostatic-sensitive components, which can be damaged by improper handling. Before touching the servo amplifier, the user must discharge their body by touching a grounded object with a conductive surface. Contact with highly insulated material (synthetic fibre, plastic foil etc.) must be avoided. The servo amplifier must be placed on a conductive surface.

- A maximum of 6 servo amplifiers can be stacked on top of one another.
- The storage temperature must be between -25 and $+70$ °C (-13 ... 158 °F), max. change 20 K/h.
- The maximum humidity 95 %, non-condensing.
- Storage time:
 - < 1 year:** without limitations
 - ≥ 1 year:** The intermediate circuit capacitors of the servo amplifier must be reformed before the initial startup. In addition, all electrical connections must be removed and the servo amplifier supplied with 230 V AC, single phase at terminals L1 / L2 for 30 min.

Disposal:

- The servo amplifier can be disassembled by removing the screws in its main components (heat sink, steel housing, circuit boards).
- Disposal should be carried out by certified companies.

5.2 Correcting Errors

Errors and warnings are displayed via LED and over the bus system. On page 53 under “Status Register”, the various errors that can occur are described.

5.2.1 LED Display

The DIAS-Drive has two LED's, which display the status of the amplifier.

LED		Description
Green	Red	
On	On	Controller in boot mode (Firmware damaged or not available)
1 Hz flashing	Off	Ready to start
8 Hz flashing	Off	Output current is limited by the I2T value (one or more axes)
On	Off	Operation
On	1 Hz flashing	Warning
Off	On	Error

5.2.2 Amplifier Malfunctions

Malfunction of the drive	Possible Causes	Solution
When the motor is turning in the clockwise direction (observe the motor shaft), I-FPOS decreases	Resolver not functioning correctly Resolver connected incorrectly	Check resolver Connect the resolver according to the wiring diagram (see page 42 et seq.)
Motor does not rotate Motor current has reached limit, however, without torque	Motor is not connected correctly	Check connections on motor terminal board U, V, W
The motor "spins through" The motor torque is too low or different in the directions	<i>M-ROFF</i> is not set to the right value Motor and/or feedback is connected incorrectly	Check the <i>M-ROFF</i> parameter Check the motor and feedback connection
Motor stops at certain positions	The setting of <i>M-POL</i> and/or <i>M-RPOL</i> is incorrect The motor cable has a wire break The motor cable is not connected to all wires	Check the <i>M-POL</i> and <i>M-RPOL</i> parameters corresponding to the motor data. Replace motor cable (especially for drag chains) Check motor cable connections
The motor oscillates	Control gain too high Shielding of the feedback cable has a defect	Reduce <i>V-KP</i> and/or <i>P-KV</i> Check the feedback cable and exchange it if needed (especially with drag chains)

5.2.3 Status Register

With **I-STATUS**, the status of the DIAS-Drive can be read. All error and status information is contained in a 32-bit variable. The amplifier function can be changed by setting the appropriate bits via using the **G-MASKE1**, **G-MASKE2**, **G-MASKW** and **G-MASKD** commands.

According to the mask settings the amplifier detects errors, warnings or does not respond. The individual bits have different values and limitations in the mask assignment.

Bit	Error	Cause	Solution
0	Single-phase operation	The main supply voltage is single phase only	Check the amplifier fuse Check electrical connection
1	Error in the main voltage supply	Amplifier is "enabled" without the applied main voltage supply	check fuses in the mains supply check electrical supply Amplifier is enabled before the DC-link voltage is loaded
2	reserved		
3	DC over voltage	Internal / External regen resistor not connected Internal regen resistor defective External regen resistor defective	connect regen resistor replace amplifier replace external regen resistor
4	DC under voltage	The main voltage supply for the enabled amplifier is too low	disable amplifier before the DC-link voltage crosses the under-voltage threshold set by G-VBUSM
5	reserved		
6	Holding brake error	No holding brake connected with parameter M-BRAKE = 1 Short circuit in holding brake cables Short circuit in the holding brake	Use motor with holding brake Check holding brake cable Change M-BRAKE parameter to 0 as long as a motor without brakes is used. Check connector and motor cable Check holding brake
7	Brake switch error	Defective internal stop brake switch No holding brake connected in parameters M-BRAKE = 1	Replace amplifier Use motor with holding brake Change M-BRAKE parameter to 0 as long as a motor without brakes is used. Check connector and motor cable Check holding brake
8	reserved		

9	Motor temperature	Motor temperature switch is triggered Break in feedback cable or connectors	Check cause (Motor under-dimensioned; poor environmental conditions) Check feedback cable and connector, exchange if necessary
10	Environmental temperature	Internal temperature too high	improve ventilation in the cabinet and check mounting position according to this manual
11	Heat sink temperature	Heat sink temperature too high	Improve ventilation in the cabinet and check mounting position according to this manual
12	Feedback error	Feedback cable broken feedback device defective Bad feedback connection	Check feedback cable and replace if necessary Replace feedback device Check feedback connection
13	Commutation error	Incorrect motor phase position Wrong wiring of motor or feedback cable	Check M-ROFF Check motor connection
14	Motor over speed	Incorrect motor phase position Incorrect motor connection or wrong feedback cable Over shoot (greater than $1.2 * V-NMAX$)	Check M-ROFF Check motor connection Check feedback cable Optimize control loop
15	Drag error	P-PEMAX lag window too small	Increase P-PEMAX and/or optimize control loops
16	Trajectory error	The speed setting, which was calculated using the change in the position setting by the host, is higher than 10000 r/min^{-1}	Check P-PSCALE and P-SSCALE parameters and the reference value of the controller
17	Host communication	No new preset values were transmitted for two successive cycles Internal communication error with the interface	Synchronization is not engaged; check A-CTIME and the cycle time of the control Check A-STIME Communication disrupted, check see also I-DError
18	Amplifier error E2 (I-DError)	Various internal errors	see also I-DError Contact manufacturer

19	Amplifier Error E1 (I-DError)	Various internal errors	see also I-DError Contact manufacturer
		Power output error: Motor cable has a ground fault Motor has a ground fault Output stage defective	Check motor cable, replace if necessary replace motor Replace amplifier
		Ballast circuit error regen resistor cable has ground fault regen resistor has ground fault regen output stage is defective	replace regen resistor cable replace regen resistor Replace amplifier
20	"Enable locked" error	The amplifier is "enabled" via the software when one of safety inputs still has a "low" signal.	Enable amplifier only if ENABLE and EN-BRAKE are "high".
21	Driver voltage error	The amplifier is "enabled" via the software when LOCK still has a "low" signal.	Enable the amplifier only if the LOCK signal is "high".
22	DC over voltage and regen resistor limit reached.	Regen resistor power is insufficient. Brake resistance power has been reached and the resistor was deactivated.	An external regen resistor must be used to adjust the value of G-MBAL .
23	Brake supply voltage error	Holding brake supply 24 V-BR missing. Holding brake switch is defective	If the motor has a holding brake, the amplifier can only be "enabled" when 24 V-BR is applied to the brake. Replace amplifier
24	reserved		
25	I2T Error	I-I2T exceeds the warning value A-I2TERR	Increase A-I2TERR
26	Motor temperature warning	I-TEMPM exceeds the warning value A-TEMPMW	Increase A-TEMPMW
27	Motor parameter error	M parameters were not found in the encoder when using motors with an EnDAT® or HIPERFACE® encoder	M parameters were not loaded into the encoder Encoder defective Defective signal lines or connectors, faulty wiring or broken cables
28	Multi-turn error	When using an EnDAT® or HIPERFACE® multi-turn encoder, an error has occurred at the extension at > 4096 turns	Motor with multi-turn encoder was replaced Encoder defect

29	Total power limit reached	The power of all axes has exceeded the maximum load.	Reduce the load Drive is insufficiently dimensioned
30	reserved		
31	reserved		

6 DIAS Drive 300 Accessories

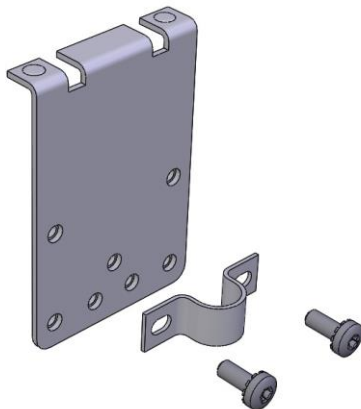
6.1 Shielding Plate with Strain Relief

(Article number: 09-501-101-Z1)

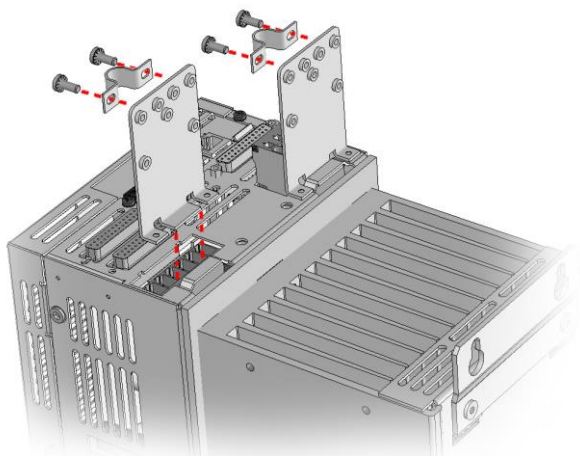
The shielding plate with strain relief is used to secure the DIAS Drive cables.

Included in delivery are:

- 1 pcs. Strain relief
(mounting on the upper side of the DIAS Drive)
- 2 pcs. Allen screws
Type M5



6.1.1 Mounting Instructions



Remove the appropriate connector. Insert the strain relief into the slots provided. The reconnected plug holds the strain relief in position.

Run the cable through the clamps and secure it to the strain relief using the two screws.

6.2 Mounting Set

(Article number: 09-501-101-Z2)

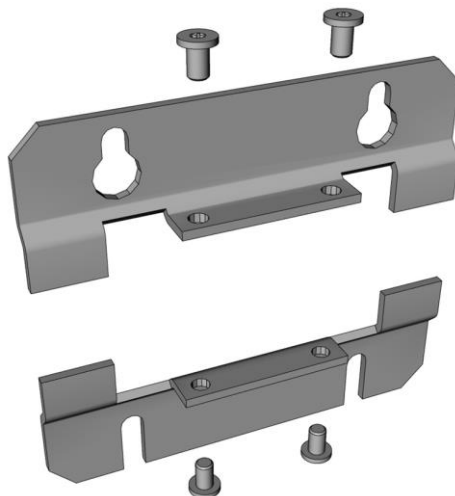
The fixing (mounting) set serves for mounting the DIAS-Drive in the switchgear cabinet. By doing so, the amplifier's fan block is located outside of the switchgear cabinet (better ventilation). An appropriate recess in the switchgear cabinet must be provided.

Included in delivery are:

2 pcs. Mounting Bracket

(mounting on the upper or
lower side of the DIAS Drive)

4 pcs. Allen screws
Type M5



6.2.1 Mounting Instructions

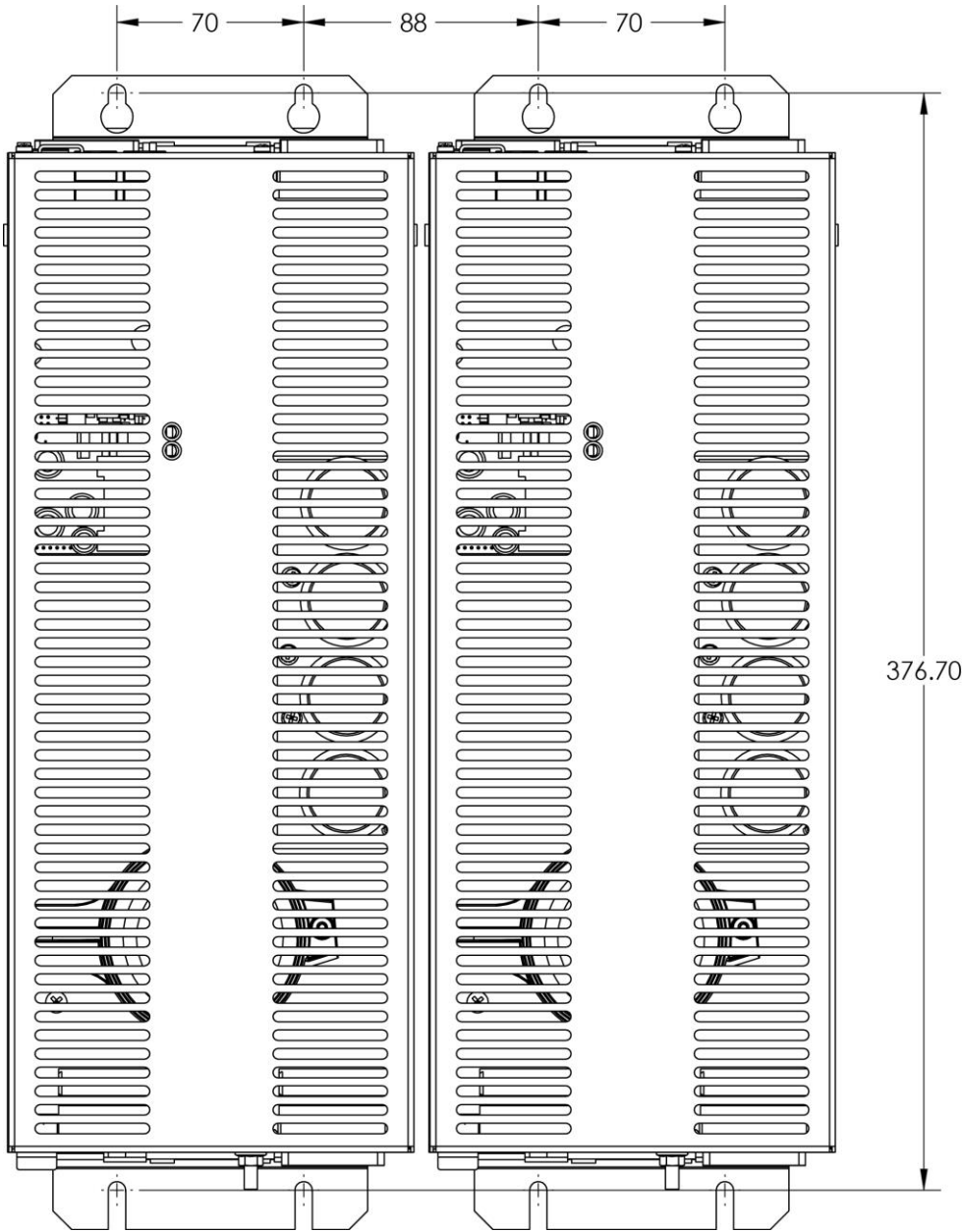
Mounting on the **upper side** of the amplifier.

Place the mounting bracket in the provided slots and secure it with both screws.

Mounting on the **lower side** of the amplifier.

Place the mounting bracket in the provided slots and secure it with both screws.

6.2.2 Dimensions incl. Mounting Set



7 VARAN Interface for the DIAS Drive 3xx (VAC 013)



This VARAN interface module is used for communication between a DIAS drive and control over the VARAN bus. It is integrated into the DIAS Drive.

It contains the safety functions SS1 (Safe Stop 1) (stop category 1 according to EN60204) for safely shutting down the amplifier and the "safe restart" STO (Safe Torque Off).

In addition, it contains the interface for digital inputs that can be used as a fast position-latch input.

Through the VARAN-Out port, the VARAN bus can be configured in a linear structure.

7.1 Introduction

7.1.1 Target Group/Purpose of this Operating Manual

This operating manual contains all information required for operating the product.

This operating manual is intended for:

- Project planners
- Technicians
- Commissioning engineers
- Machine operators
- Maintenance/test technicians

General knowledge of automation technology is required.

Further help and training information, as well as the appropriate accessories can be found on our website www.sigmatek-automation.com

Our support team is happily available to answer your questions.
Please see our website for our hotline number and business hours.

7.1.2 Important Reference Documentation

- Safety System Manual

This and additional documents can be downloaded from our website or obtained through support.

7.1.3 Contents of Delivery

VAC 013

7.2 Basic Safety Guidelines

7.2.1 Disclaimer



The contents of this operating manual were prepared with the greatest care. However, deviations cannot be ruled out. This operating manual is regularly checked and required corrections are included in the subsequent versions. The machine manufacturer is responsible for the proper assembly, as well as device configuration. The machine operator is responsible for safe handling, as well as proper operation.

The current operating manual can be found on our website. If necessary, contact our support.

Subject to technical changes, which improve the performance of the devices. The following operating manual is purely a product description. It does not guarantee properties under the warranty.

Please thoroughly read the corresponding documentation and this operating manual before handling a product.

SIGMATEK GmbH & Co KG is not liable for damages caused through non-compliance with these instructions or applicable regulations.

7.2.2 General Safety Guidelines

The safety guidelines in the other sections of this operating manual must be observed. These instructions are visually emphasized by symbols.



According to EU Guidelines, the operating instructions are a component of a product.

This operating manual must therefore be accessible in the vicinity of the machine since it contains important instructions.

This operating manual should be included in the sale, rental or transfer of the product, or its online availability indicated.

Maintain this operating manual in readable condition and keep it accessible for reference.

Regarding the requirements for Safety and health connected to the use of machines, the manufacturer must perform a risk assessment in accordance with machine guidelines 2006/42/EG before introducing a machine to the market.

Before commissioning this product, check that conformance with the provisions of the 2006/42/EG guidelines is correct. As long as the machine with which the product should be used does not comply with the guideline, operating this product is prohibited.

Operate the unit with devices and accessories approved by SIGMATEK only.

CAUTION



Handle the device with care and do not drop or let fall.

Prevent foreign bodies and fluids from entering the device.

The device must not be opened, otherwise it could be damaged!

The module complies with EN 61131-2.

In combination with a machine, the machine builder must comply with EN 60204-1 standards.

For your own safety and that of others, compliance with the environmental conditions is essential.

The control cabinet must be connected to ground correctly.

To perform maintenance or repairs, disconnect the system from the power supply.

7.2.3 Designated Use

The Safety functions implemented in the Safety modules are designed for use with safety applications in a PLC control and meet the required conditions for safe operation in compliance with SIL 3 according to EN 62061 and in compliance with PL e. Cat. 4 in accordance with EN ISO 13849-1.

CAUTION



The instructions contained in this operating manual must be followed.

For error-free operation, proper transport and storage are essential.

Installation, mounting, programming, initial start-up, operation, maintenance and decommissioning can only be performed by qualified personnel.

Qualified personnel in this context are people, who have completed training or have trained under supervision of qualified personnel and have been authorized to operate and maintain safety-related equipment, systems and facilities in compliance with the strict guidelines and standards of safety technology.

For your own safety and that of others, the safety modules should be used for their designated purpose only.

Correct EMC installation is also included under designated use.

Non-designated use consists of:

- any changes made to the module or the use of damaged modules.
- use of the module inconsistent with the technical margins described in this manual or the specification's defined in the technical data.

7.3 Norms and Guidelines

7.3.1 Residual Risks

CAUTION



According to the EU guideline 2006/42/EG (machine guideline), the machine manufacturer must perform a risk assessment, which includes the possible residual risks posed by the product. These include:

- unwanted movements of driven machine components
- unwanted temperatures, emissions of gas, particles, smell and light.
- dangerous contact voltages
- the effects of electrical, magnetic and electromagnetic fields produced during operation (for example, on pacemakers and implants)
- possible effects of information technology devices (cell/smart phones etc.)
- release of non-environmentally compatible substances and emissions

7.3.2 Safety of the Machine or Equipment

Be sure to observe the safety guidelines, otherwise all warranty claims will be lost.



Observe all on-site rules and regulations for accident prevention and occupational safety.

7.3.3 Guidelines

The product was constructed in compliance with the following European Union guidelines and tested for conformity:

7.3.3.1 Functional Safety Standards

EN 62061

SIL 3

EN ISO 13849-1/-2

PL e / CAT 4

7.3.3.2 EU Declaration of Conformity



EU Declaration of Conformity

The VAC 013 conforms to the following European guidelines:

- 2006/42/EGMachine Guideline
- 2014/30/EU “Electromagnetic Compatibility” (EMC guideline)
- 2011/65/EU “Restricted use of certain hazardous substances in electrical and electronic equipment” (RoHS Guideline)

The EU Conformity Declarations are provided on the SIGMATEK website. See Products/Downloads or use the search function and the keyword “EU Declaration of Conformity”.

7.4 Technical Data

7.4.1 General

Interfaces	1 x VARAN In (RJ45) (maximum cable length:100 m) 1x VARAN Out (RJ45) (maximum cable length:100 m) 1 x DIAS-Drive interface (26-pin blade terminal) 4 fast digital inputs 2 safety inputs for the SSI (SAFE Stop 1) and STO (SAFE Torque Off) safety functions. 1 relay outputs for indicating the Safety function status
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7.4.2 Electrical Requirements

Supply voltage	+5 V DC (Provided by the DIAS-Drive)	
Current consumption	Typically 400 mA	Maximum 500 mA
Supply voltage		

7.4.3 Input Specifications

Number	Digital inputs (D-IN1 to D-IN4)	Safety inputs (ENABLE_L and ENABLE_H)
Input voltage	typically +24, maximal +30 V	Differential Voltage between ENABLE_H (+) and ENABLE_L (-) typically 24 V, maximal 30 V
Signal level	Low: $\leq +5$ V, High: $\geq +15$ V	-
Switching threshold	Typically +9 V	Differential voltage between ENABLE_H and ENABLE_L. Low < +6 V, High > +14 V
Input current	10 mA at +24 V	
Input delay	Typically 0.1 ms	Turn-on circa 20 ms, Turn-off 0.5 to 1 s



The 4 digital inputs are type 1 according to EN 61131-2.

7.4.4 Relay Specifications

Number of relays	1x Relay output (contacts S3, S4)
Relay types	1 x normally open
Power supply	+24 V DC
Switching time	<10 ms
Switching range	Max. 30 V DC/ min. 100 µA, max. 0.5 A
Switching power	Max. 42 V AC/ min. 100 µA, max. 0.5 A

USA and Canada:

The supply must be limited to:

- a) max. 5 A at voltages from 0-20 V (0-28.3 Vp) or
- b) 100 VA at voltages from 20-30 V (28.3-42.4 Vp).

The limiting component (e.g. transformer, power supply or fuse) must be certified by an NRTL (Nationally Recognized Testing Laboratory).

7.4.5 Safety Conformity

Safety integration level according to IEC EN 62061	SIL 3	
Performance level according to EN ISO 13849-1	PLe	
Diagnostic coverage according to EN ISO 13849	DC [%]	99
Probability of failure per hour	PFH _D [10 ⁻⁹]	0.29
Average time until a dangerous error occurs	MTTF _{Dsymmetrized} [Years]	8694
Service life [years]	20	

7.4.6 Miscellaneous

Article number	16-059-013 16-059-013-L
Hardware version	1.x-3.x
Standard	UL certified as part of diverse drives. Not ul certified as a single product.
Approvals	CE, TÜV-Austria EG Type Tested

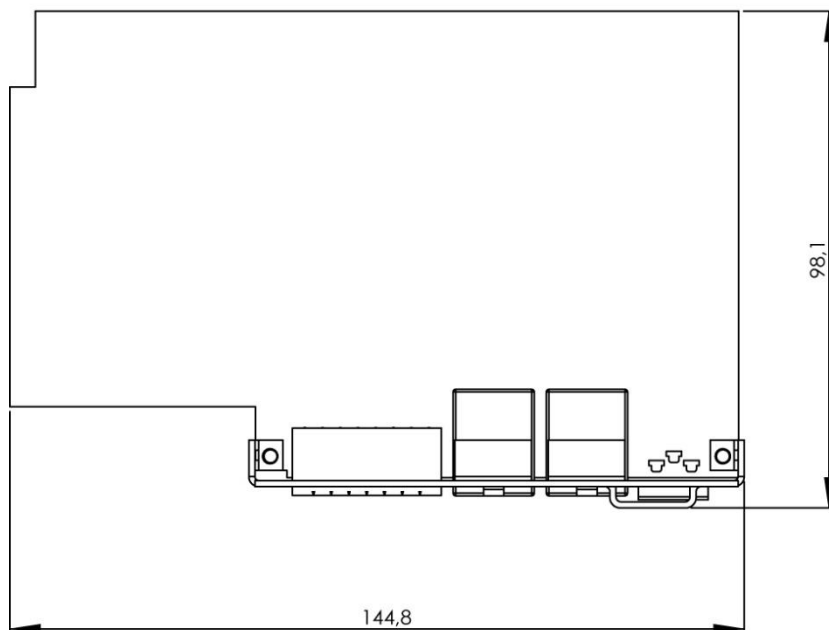
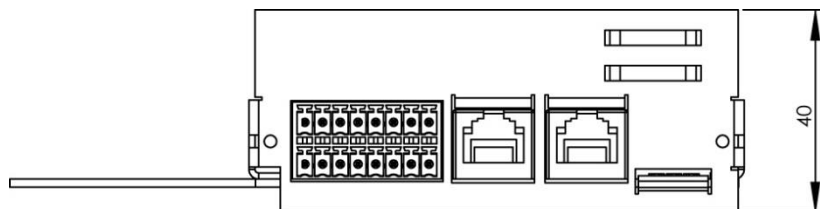
7.4.7 Environmental Conditions

Storage temperature	-20 - +85 °C	
Environmental temperature	0 ... +60 °C	
Humidity	0-95 %, non-condensing	
Altitude	up to 2000 m above NN	
EMC stability	Tested in the DIAS Drive according to EN61800-3	
Vibration resistance	EN 60068-2-6	Frequency 5-150 Hz Acceleration: 1 g Amplitude: 0,075 mm (0,15 mm pp)
Shock resistance	EN 60068-2-27	150 m/s ² (15 G)
Protection type	EN 60529	IP20
Pollution degree	2	



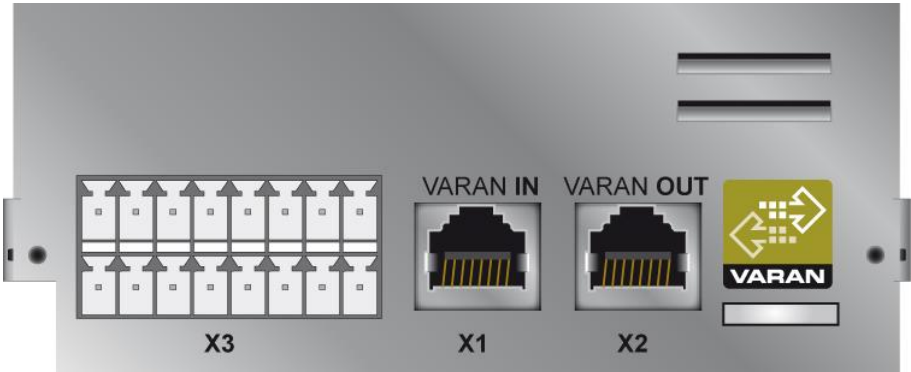
In a domestic environment this product may cause high frequency interference in which case interference suppression measures may be required.

7.5 Mechanical Dimensions

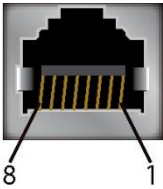


Integrated in DIAS-Drive SDD 3xx

7.5.1 Connector Layout

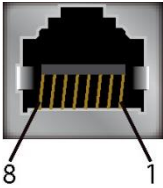


X1: VARAN In



Pin	Function
1	TX/RX+
2	TX/RX-
3	RX/TX+
4 - 5	-
6	RX/TX-
7 - 8	-

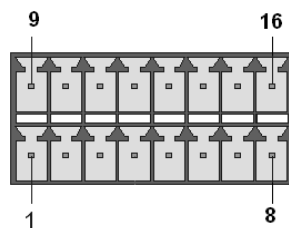
X2: VARAN Out



Pin	Function
1	TX/RX+
2	TX/RX-
3	RX/TX+
4 - 5	-
6	RX/TX-
7 - 8	-

More information on the VARAN bus can be found in the VARAN bus specifications!

X3: IO



Pin	Function
1	ENABLE_L
2	ENABLE_H
3	reserved
4	reserved
5	not used
6	not used
7	S3
8	S4
9	reserved
10	reserved
11	reserved
12	Ext. GND
13	D-IN 1
14	D-IN 2
15	D-IN 3
16	D-IN 4

Applicable Connectors

X3: 2x 8-pin Phoenix plug with spring terminal FMC1, 5/8-ST-3.5

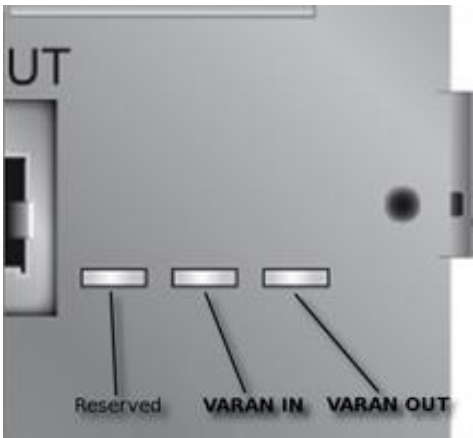
Use a rigid or flexible cable with a cross-section of 0.25 to 1.5 mm².

When using a flexible connection cable, a wire end ferrule should be used according to the following specifications of the connector:

- Conductor cross-section flexible with ferrule without plastic sleeve 0.25 mm² ... 1.5 mm²
- Conductor cross-section flexible with ferrule with plastic sleeve 0.25 mm² ... 0.75 mm²
- Stripping length 10 mm

For the stress relief, it is important to ensure that the minimum bend radius (eight times the cable diameter) of the cable is not exceeded!

7.5.2 Status Displays



LED	LED color	Definition	
VARAN IN	green	LINK	Lights when the connection between the two PHYs is established
	yellow	ACTIVE	Lights when data is exchanged over the VARAN bus.
VARAN OUT	green	LINK	Lights when the connection between the two PHYs is established
	yellow	ACTIVE	Lights when data is exchanged over the VARAN bus.

7.6 Additional Safety Information

The safety module "Safe Restart Lock" is an integral component of the DIAS Drive 3xx and is already installed with delivery; it meets the conditions required for safe operation according to SIL 3 in compliance with IEC 62061 and according to PL e in compliance with EN 13849-1.



Safety modules can only be powered by supplies that meet the requirements for SELV/PELV in compliance with EN60204.

Installation, mounting, programming, initial start-up, operation, maintenance and discarding of safety modules **can only be performed by qualified personnel**.

Qualified personnel in this context are people who have completed training or have trained under supervision of qualified personnel and have been authorized to operate and maintain safety-related equipment, systems and facilities in compliance with the strict guidelines and standards of safety technology.

For your own safety and the safety of others, use Safety modules for their designated purpose only.

Correct EMC installation is also included under designated use.

Non-designated use consists of

- Any changes made to the Safety modules or the use of damaged Safety modules
- The use of Safety modules inconsistent with the technical margins described in these operating instructions.
- The use of Safety modules inconsistent with the technical data described in these operating instructions (see the "Technical data" sections of the respective production).

In addition, the warnings in the other sections of these instructions must also be observed. These instructions are visibly emphasized by symbols.

- Only qualified personnel are authorized to install the "safe restart" STO (Safe Torque off) and set the parameters.
- All control devices (switches, relays, PLC, etc.) and the control cabinet must meet the requirements for EN 13849. This consists of:
 - – Door switches, etc. with at least IP54 protection.
 - – Control classes with at least IP54 protection.
- The proper cables and end-sleeves must be used
- All cables that affect safety (i.e. control cables for the ENABLE_L and ENABLE_H inputs) must be laid in a conduit outside of the control cabinet.
Short or crossed circuits in the signal lines must be avoided! See EN ISO 13849
- The terminal connections X3/Pin 2, Pin 4, Pin 10 and Pin 12 are labeled as "reserved" and cannot be laid externally!
- When using the SS1 (Safe Stop 1) safety function, the typical turn-off delay is 0.5 seconds. Subsequent actions that require the STO (Safe Torque Off) function (i.e. manual access to the machine), can only be released after 1 second.
- If external forces influence axes that are used with the STO safety function (e.g. hanging load), additional measures must be taken (such as an electromagnetic double-surface spring brake, instead of a permanent magnet brake).

Failure to follow the above safety measures can lead to severe injuries.

The main power supply for the servo amplifier must be disconnected using the main switch for the following instances:



- Cleaning, maintenance or repairs
- Extended still-stand periods

Failure to follow the above safety measures can lead to severe injuries.

7.7 Additional Information

7.7.1 "Safe Restart" STO (Safe Torque Off)

The DIAS Drive, in combination with the optional VARAN interface, supports the safety functions SS1 (Safe Stop 1) and STO (Safe Torque Off) and meets the requirements for Category 4 Performance Level "e" according to EN ISO 13849-1 and SIL3 according to EN 62061.

For his purpose, the servo amplifier has two safe inputs ENABLE_L and ENABLE_H.

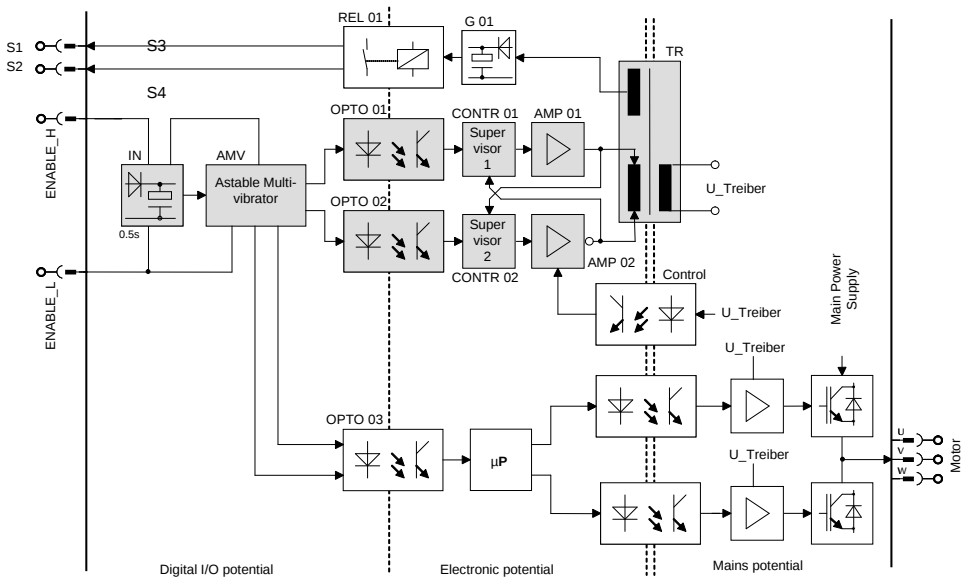
The relay output S1/S2 can be used to provide the status of the safety function. It is not safety-relevant but can be used to test the external safety function.

The stop brake control is not a component of the safety function. If a safe shutdown of the stop brake is required, the +24 V-BR brake supply must also be shut down externally.

For the 24 V supply, only PELV/SELV can be used.

7.7.2 Implementation

The following block diagram gives an overview of the internal switching circuit.



Block diagram for safe restart lock

The blocks in the diagram above have the following functions:

7.7.2.1 Block IN

The input block IN generates the supply voltage for the AMV block. This is formed from the voltage difference between ENABLE_H and ENABLE_L. Power is therefore available shortly after the appropriated signal is applied to ENABLE_H and ENABLE_L. The voltage difference between ENABLE_H and ENABLE_L must exceed the minimum HIGH signal.

The LOW signal ranges from 0 v to +5 V.

The High signal ranges from +15 V to +30 V.

If the input voltage is disconnected, the block maintains the supply voltage for the AMV block for approximately 400 ms. Because the differential voltage is supplied to the OPTO03 block without a delay, the motor can be actively slowed before the amplifier goes into the safe status by disabling U_Driver.

7.7.2.2 Blocks AMV, OPTO 01 and OPTO 02

As long as the AMV block is powered by the IN input block, it generates a pulse with a constant frequency that is transmitted to the sequential electronics through blocks OPTO 01 and OPTO 02.

7.7.2.3 Blocks CONTR 01, CONTR 02, AMP 01, AMP 02 and TR

These blocks form a safe switching power supply, which generates the driver voltage for U_Driver via the transformer TR. The switching supply is prevented from transmitting power when no control signal is sent from the AMV block over OPTO 01 and OPTO 02.

7.7.2.4 Blocks G01 and REL01

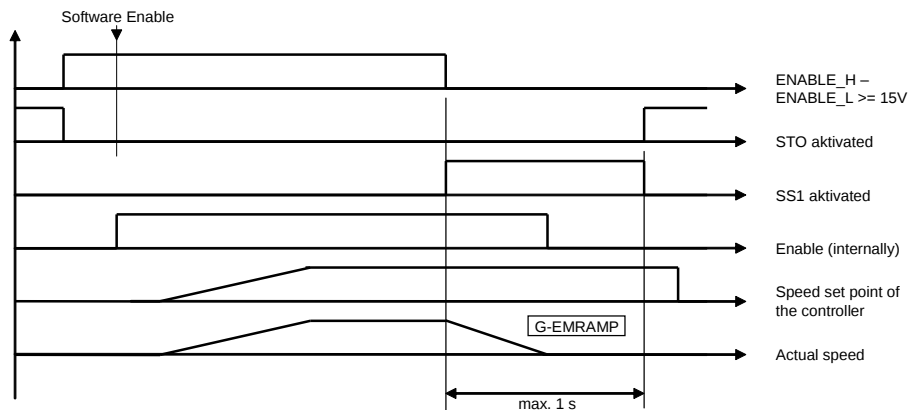
The relay output S1/S2 is closed when the servo amplifier is supplied with 24 V and the safety function is active. The two blocks are not safety-relevant.

7.7.3 Function

The safety functions in the DIAS Drive are controlled via two digital inputs.

The following table shows the status that the ENABLE_L and ENABLE_H inputs must assume to enable normal operation or trigger the safety function.

Input Status		Relay output S3/S4	Description
ENABLE_L	ENABLE_H		
Open	Open	when the servo amplifier is supplied with 24 V, the inputs are closed after a minimum delay of 0.4 seconds and a maximum of 1 second	Safe status of the drive system
Low	Low	when the servo amplifier is supplied with 24 V, the inputs are closed after a minimum delay of 0.4 seconds and a maximum of 1 second	- Single channel safe status only when using classic I/O technology Safety status of the drive system when a safe output is used by a Safety PLC; also when ENABLE_L is connected to "Ext.GND.
Low	Open		
Low	High	Open	Drive system ready



Timing Diagram

If the ENABLE_L and ENABLE_H are changed from any status to the "Drive Ready" status, the servo amplifier is not immediately enabled. In addition, in the software (K-EN = 1) or the corresponding bit in the "control word" must be set so that the software "enable" can be set and the drive switched to the operational mode.

7.7.3.1 FunctionTest



The safety function test is required to ensure correct operation. The entire safety circuit must be tested for full functionality. Tests must be performed at the following times:

- After installation
- In regular intervals, or at least once a year.
- After each change to the machine control

If the function test results in an invalid machine status, the error must be found and corrected before the safety function is retested. If the error reoccurs during the function test, the machine can no longer be operated.

Failure to follow the above safety measures can lead to severe injuries and damage.

Test conditions

The total safety circuit must be tested for functionality

The function test is performed from the following starting condition:

- An operation-ready servo drive system
- Safe input ENABLE_L is LOW and ENABLE_H is HIGH
- Software application is running
- Motor(s) running

Depending on the wiring:

1. Both the ENABLE_L and ENABLE_H inputs are opened

Or when ENABLE_L is connected to "Ext.GND and a safe output of a Safety PLC is used for ENABLE_H.

2. ENABLE_H is open or LOW (depending on the wiring).

The motor speed is expected to slow to null and the relay output S1/S2 to close after a minimum delay of 0.4 s and a maximum of 1s when the servo drive is supplied with 24 V.

The servo drive system should go into safe mode.

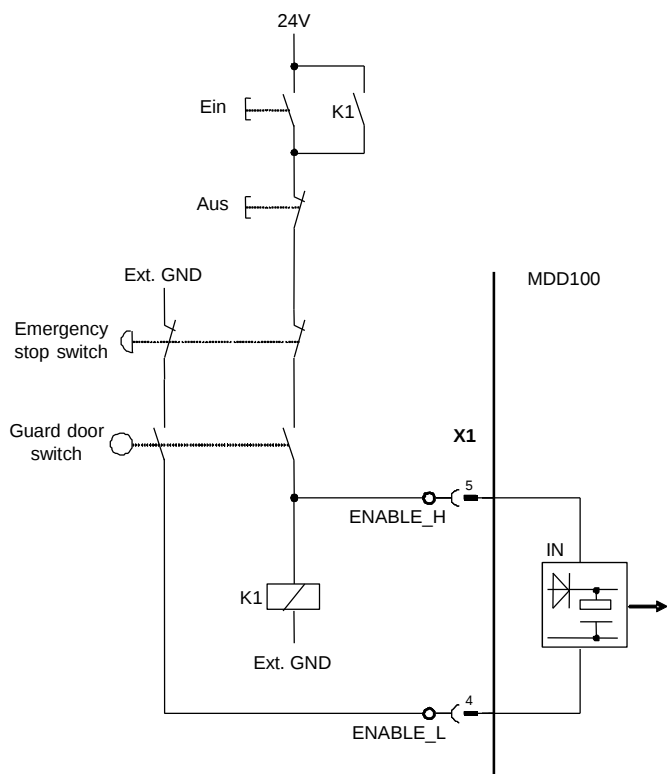
Example Connection with Switch Contacts

To meet the requirements of safety category 4, performance level "e" for EN 13849-1 and SIL3 according to EN 62061, a two-channel control must be provided for the safety functions.

The wiring for both connections must be provided with protective insulation (to avoid the "external voltage supply" error).

For ENABLE_H this means, the other signals that can have a 24 V potential must be connected separately.

For ENABLE_L this means, the other signals that can have a "Ext. GND" potential must be connected separately. Because the 24 V auxiliary voltage in the control cabinet is normally grounded, caution must be taken to avoid a short-circuit with PE. This can occur through, for example, wiring in a cable duct.



The schematic shows the possible wiring for using conventional switch contacts.

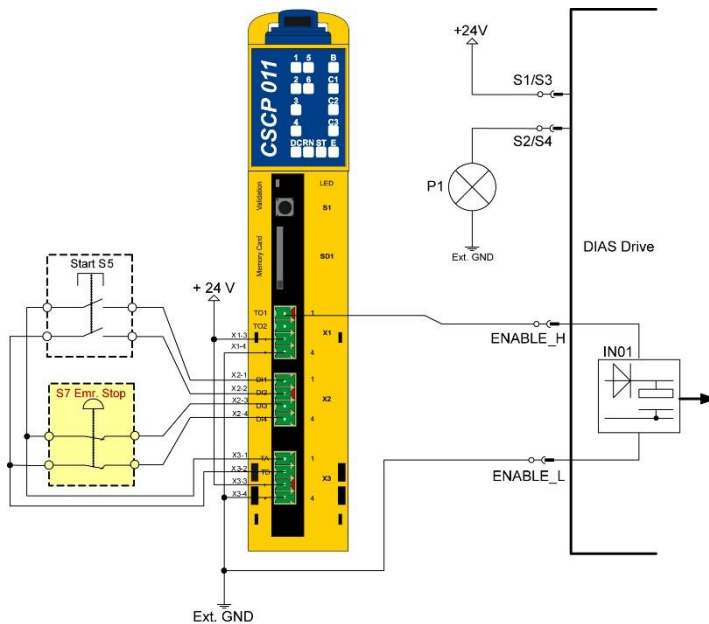
Example: Safety PLC Application

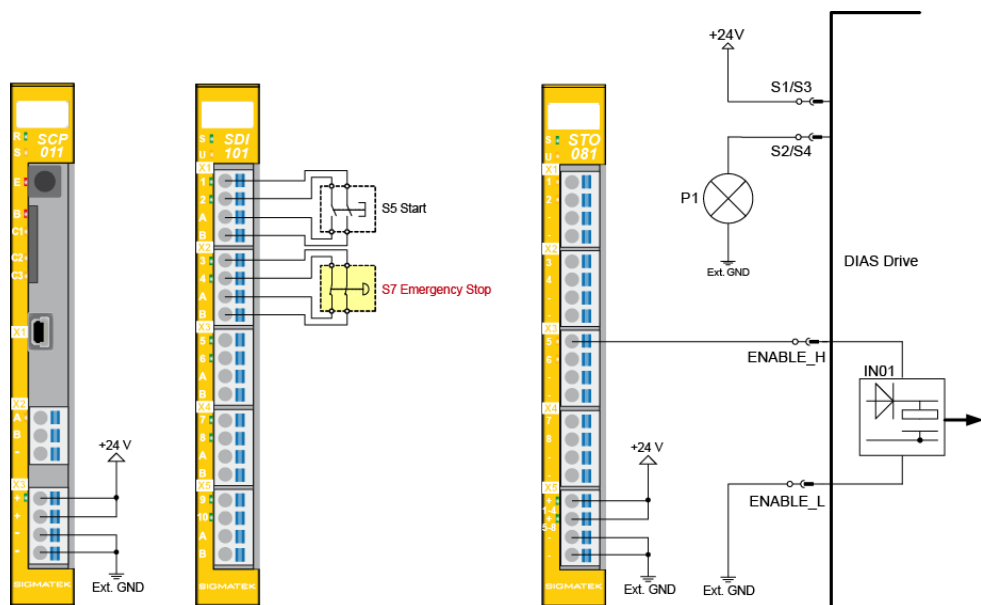
To meet the requirements of safety category 4, performance level "e" for EN 13849-1 and SIL 3 according to EN 62061, an error-proof output of a safety PLC must be used.

There are two types of error-proof outputs.

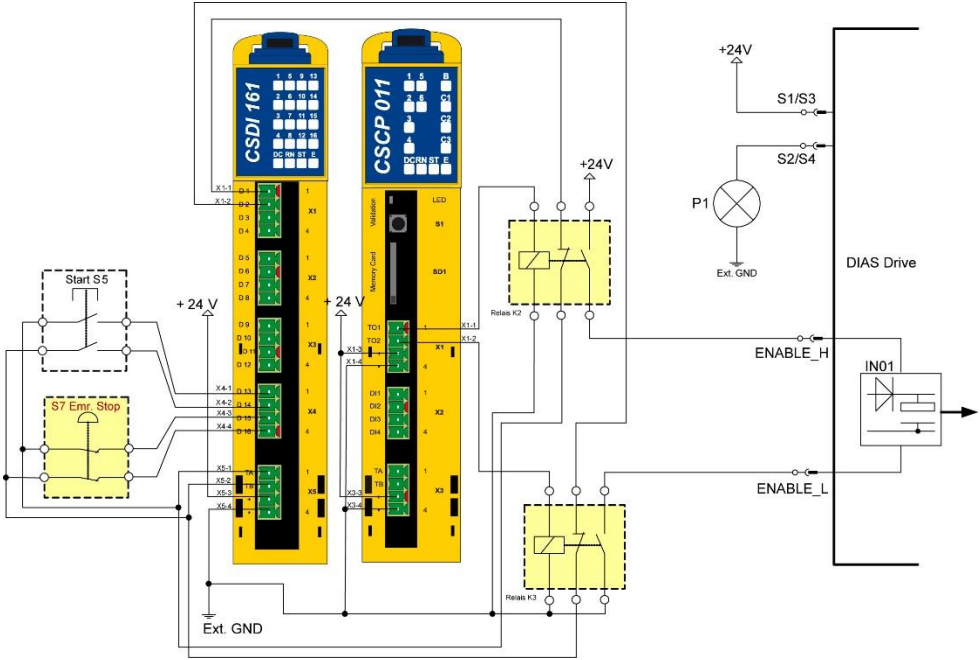
1. A simple error-safe output, which functions based on "Ext. GND" only. This is then connected to the ENABLE_H input.
- The wiring for both connections must be provided with protective insulation (to avoid the "external voltage supply" error).

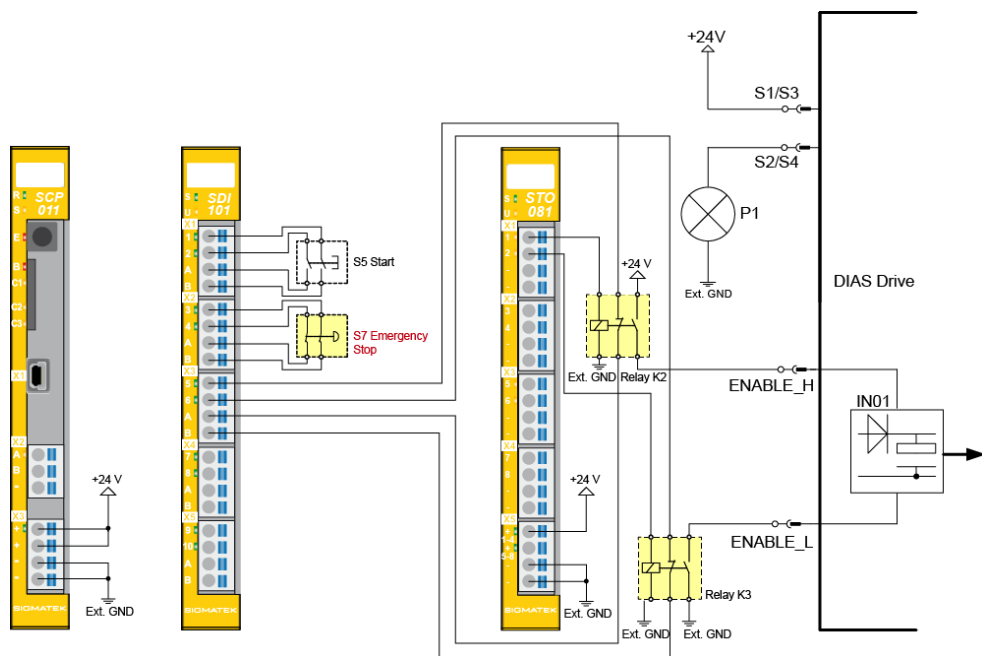
In this case, ENABLE_L is connected to "Ext. GND".





2. Two-channel error-safe relay input with which the + output is connected to ENABLE_H and the - output to ENABLE_L.





7.8 Addressing

Address (hex)	Size (bytes)	Access	Description	Reset value
Axis 1				
0000	1	r/w	Transmit Execution Register Bit 0: 1 = Start Object Transfer Bit 1: 1 = Repeat Object Transfer Bit 2: 1 = Enable Value 3-5 Bit 3...7: Reserved	00
0001	1	r/w	Reserved	00
0002	1	r/w	Drive Control Byte	00
0003	1	r/w	Object Address	00
0004	4	r/w	Object Value	00000000
0008	4	r/w	Value 1	00000000
000C	4	r/w	Value 2	00000000
0010	4	r/w	Value 3	00000000
0014	4	r/w	Value 4	00000000
0018	4	r/w	Value 5	00000000
001C	4	r/w	Reserved	00000000
0020	1	r/w	Receive Status Register Bit 0: 1 = Executed Object Transfer Bit 1: 1 = CRC Error Bit 2...7: Reserved	00
0021	1	r/w	Reserved	00
0022	1	r/w	Digital In/Out Byte	00
0023	1	r/w	Transmit Control Byte	00
0024	4	r/w	Object Value	00000000
0028	4	r	Value 6	00000000
002C	4	r	Value 7	00000000
0030	4	r	Value 8	00000000
0034	4	r	Value 9	00000000
0038	4	r	Value 10	00000000
003C	4	r/w	Reserved	-

Axis 2				
0040	1	r/w	Transmit Execution Register Bit 0: 1 = Start Object Transfer Bit 1: 1 = Repeat Object Transfer Bit 2: 1 = Enable Value 3-5 Bit 3...7: Reserved	00
0041	1	r/w	reserved	00
0042	1	r/w	Drive Control Byte	00
0043	1	r/w	Object Address	00
0044	4	r/w	Object Value	00000000
0048	4	r/w	Value 1	00000000
004C	4	r/w	Value 2	00000000
0050	4	r/w	Value 3	00000000
0054	4	r/w	Value 4	00000000
0058	4	r/w	Value 5	00000000
005C	4	r/w	Reserved	00000000
0060	1	r/w	Receive Status Register Bit 0: 1 = Executed Object Transfer Bit 1: 1 = CRC Error Bit 2...7: Reserved	00
0061	1	r/w	Reserved	00
0062	1	r/w	Digital In/Out Byte	00
0063	1	r/w	Transmit Control Byte	00
0064	4	r/w	Object Value	00000000
0068	4	r/w	Value 6	00000000
006C	4	r/w	Value 7	00000000
0070	4	r/w	Value 8	00000000
0074	4	r/w	Value 9	00000000
0078	4	r/w	Value 10	00000000
007C	4	r/w	Reserved	-
Axis 3				
0080	1	r/w	Transmit Execution Register Bit 0: 1 = Start Object Transfer Bit 1: 1 = Repeat Object Transfer Bit 2: 1 = Enable Value 3-5 Bit 3...7: Reserved	00
0081	1	r/w	Reserved	00
0082	1	r/w	Drive Control Byte	00

0083	1	r/w	Object Address	00
0084	4	r/w	Object Value	00000000
0088	4	r/w	Value 1	00000000
008C	4	r/w	Value 2	00000000
0090	4	r/w	Value 3	00000000
0094	4	r/w	Value 4	00000000
0098	4	r/w	Value 5	00000000
009C	4	r/w	Reserved	00000000
00A0	1	r/w	Receive Status Register Bit 0: 1 = Executed Object Transfer Bit 1: 1 = CRC Error Bit 2...7: Reserved	00
00A1	1	r/w	Reserved	00
00A2	1	r/w	Digital In/Out Byte	00
00A3	1	r/w	Transmit Control Byte	00
00A4	4	r/w	Object Value	00000000
00A8	4	r/w	Value 6	00000000
00AC	4	r/w	Value 7	00000000
00B0	4	r/w	Value 8	00000000
00B4	4	r/w	Value 9	00000000
00B8	4	r/w	Value 10	00000000
00BC	4	r/w	Reserved	-
Axis 3 – Telegram Type 2 (Fast Axis)				
00C0	1	w*	Transmit Execution Register Bit 4: 1 = Enable Telegram Type 2 Bit 5: 1 = Direct Access	00
00C1	1	w*	Reserved	00
00C2	1	w*	Drive Control Byte	00
00C3	1	w*	Reserved	00
00C4	4	w*	Value 3	00000000
00C8	4	w*	Value 4	00000000
00CC	4	w*	Value 5	00000000
00D0	16	-	Reserved	-
00E0	1	r/w	reserved	00

00E1	1	r/w	reserved	00
00E2	1	r/w	Digital In/Out Byte	00
00E3	1	r/w	Transmit Control Byte	00
00E4	4	r/w	Value 8	00000000
00E8	4	r/w	Value 9	00000000
00EC	4	r/w	Value 10	00000000
00F0	16	r/w	reserved	-

For additional addressing, see the VARAN bus specifications

More addressing applications can be found in the DIAS drive parameter documentation.

7.9 Disassembly, Replacement and Repair

Repair: Repairs of the servo drive system must be carried out by the manufacturer.

Error: Error conditions and their rectification are described in the corresponding DIAS-Drive operating instructions.

Exchange: The VAC 013 is maintenance-free and contains no replaceable components. If the VAC 013 has to be replaced as a component of the servo drive system, it is essential to observe the relevant chapter of the operating instructions for the drive.

7.10 Transport, Storage and Disposal

Transport:

- For transport, the original recyclable packaging from the manufacturer must be used.
- During transport dropping should be avoided.
- The storage temperature must be between -20 to +70°C (-13...158°F), change max. 20K/h.
- Maximum 95 % humidity, non-condensing



- The product contains electrostatic sensitive components that can be damaged by improper handling. Before touching, the user must discharge their body by touching a grounded object with a conductive surface. Contact with highly insulated material (synthetic fiber, plastic foil etc.) must be avoided.
- If the packaging is damaged, it is forbidden to install and operate the component! If damaged, the transport company and the manufacturer must be informed.

Packaging:

- Recyclable carton with ESD protection film
- Labeling: Type shield on the outside of the casing

Storage:



- Only the original recyclable packaging from the manufacturer can be used.
- The product contains electrostatic sensitive components that can be damaged by improper handling. Before touching, the user must discharge their body by touching a grounded object with a conductive surface. Contact with highly insulated material (synthetic fiber, plastic foil etc.) must be avoided.
- The storage temperature must be between -20 to 55 °C (-13...158 °F), changes max. 20 K/h.
- The maximum humidity is 95%, non-condensing.

Disposal:

- If the VAC 013 was installed as a component in a servo drive system and this is to be disposed of, it is essential to observe the relevant chapter of the operating manual of the drive for disassembly.



Should you need to dispose of the device, the national electronic scrap regulation must be observed.

The device appliance must not be disposed of as household waste.



7.11 Recommended Shielding for VARAN

The VARAN real-time Ethernet bus system exhibits a very robust quality in harsh industrial environments. Using IEEE 802.3 standard Ethernet physics, the potentials between an Ethernet line and sending/receiving components are separated. In the event of an error, the VARAN Manager resends messages to a bus participant immediately. The shielding described below is mainly recommended.

For applications in which the bus is operated outside the control cabinet, the correct shielding is required. This is especially important, if due to physical requirements, the bus cables must be placed next to sources of strong electromagnetic noise.

SIGMATEK recommends the use of **CAT5e** industrial Ethernet bus cables.

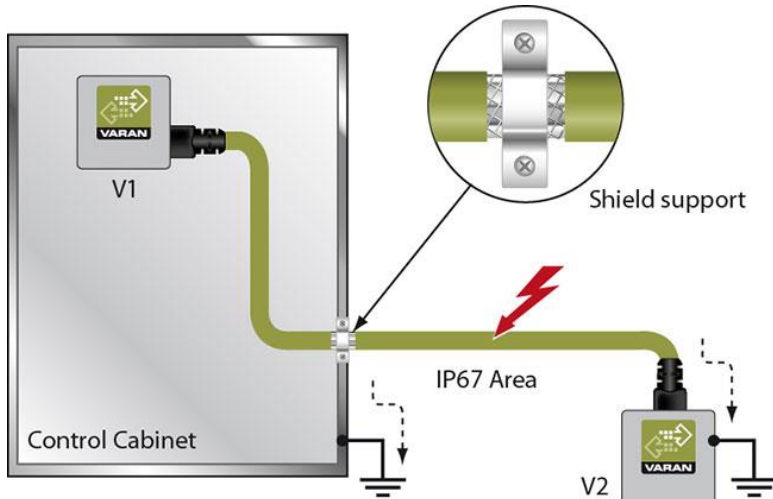
An **S-FTP cable** should be used for the shielding.

An S-FTP bus is a symmetric, multi-wire cable with unshielded pairs. For the entire shielding, a combination of foil and braiding is used. A non-laminated variant is recommended.

The VARAN cable must be secured at a distance of 20 cm from the connector for protection against vibration!

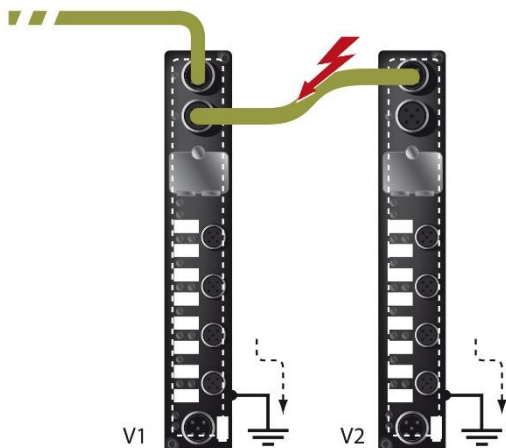
7.11.1 Wiring from the Control Cabinet to an External VARAN Component

If the Ethernet lines are connected from a VARAN component to a VARAN node located outside the control cabinet, the shielding should be placed at the entry point of the control cabinet housing. All noise can then be deflected from the electronic components before reaching the module.



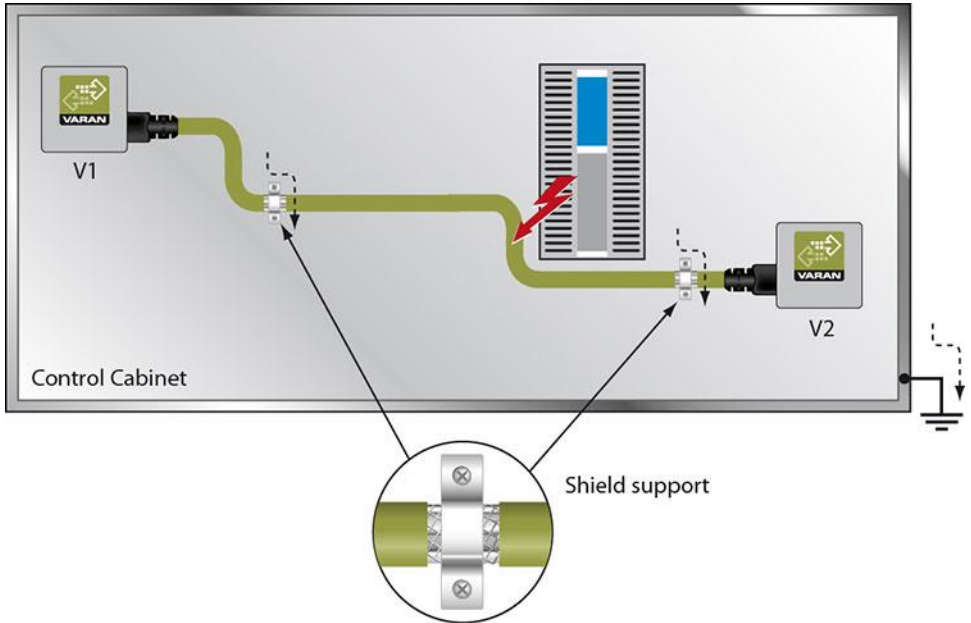
7.11.2 Wiring Outside of the Control Cabinet

If a VARAN bus line must be connected outside of the control cabinet only, no additional shield support is required. A requirement therefore, is that only IP67 modules and connectors can be used outside the control cabinet. These components are very robust and noise resistant. The shielding for all sockets in IP67 modules are electrically connected internally or over the housing, whereby voltage spikes are not dissipated through the electronics.



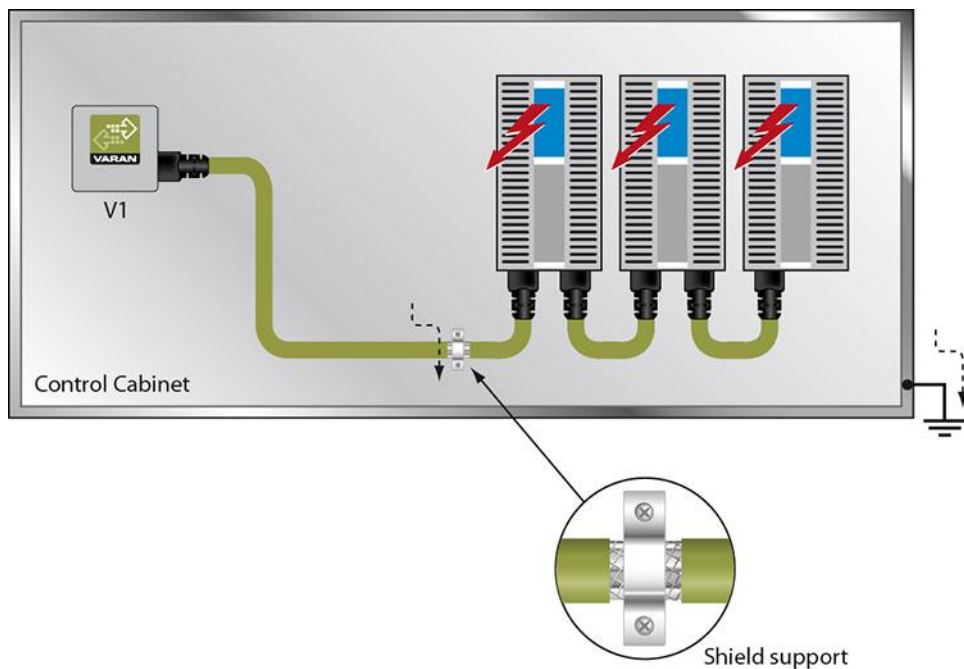
7.11.3 Shielding for Wiring Within the Control Cabinet

Sources of strong electromagnetic noise located within the control cabinet (drives, Transformers, etc.) can induce interference in a VARAN bus line. Spike voltages are deflected over the metallic housing of a RJ45 connector. Noise is conducted through the control cabinet housing without further action from the electronic components. To eliminate sources of noise during data exchange, it is recommended that the shielding for all electronic components be connected within the control cabinet.



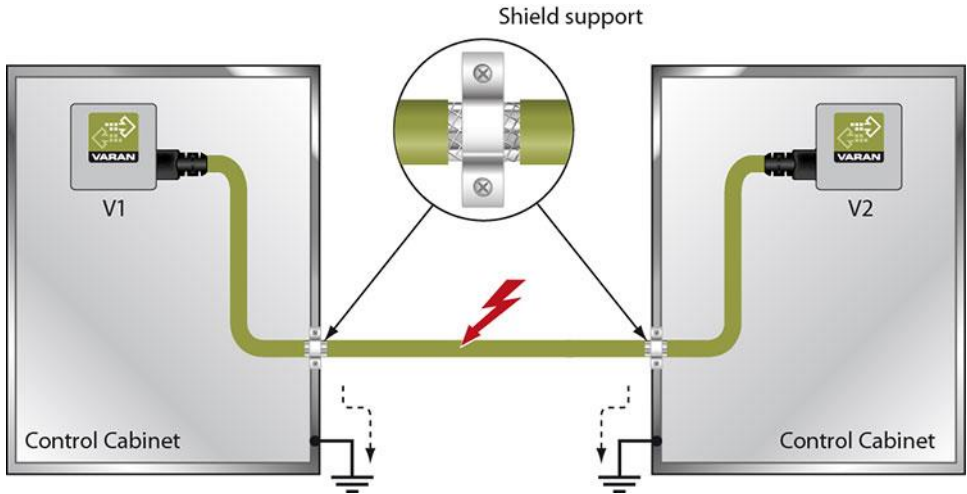
7.11.4 Connecting Noise Generating Components

With the connection of power components, which generate strong electromagnetic interference, it is also critical to ensure correct shielding. The shielding should be placed before a power element (or group of power elements).



7.11.5 Shielding Between Two Control Cabinets

If two control cabinets must be connected over a VARAN bus, it is recommended that the shielding be located at the entry points of both cabinets. Noise can be thereby prevented from reaching the electronics within the control cabinet.



Documentation Changes

Change date	Affected page(s)	Chapter	Note
27.05.2014	19 20		Added leakage currents notice Added shelf life notice
17.07.2014	16		Max. holding brake switching energy added
30.04.2015	45		Sine/Cosine & TTL Encoder feedback changed
08.05.2015	34		main input $\leftrightarrow$ DC-link
25.11.2015	1		VAC 013 note
08.02.2016	Document		AWG corrected Shielding Plate extended VAC 013 documentation added
23.05.2016	16		Limitation 599 Hz
21.11.2016	67, 69, 75, 76		Removed EN / IEC 61508
31.05.2017	16		max. standstill current added
19.07.2017	9		Added note regarding the star-connection
27.09.2017	7		Added warning regarding EMF
21.05.2019	11 21	1.4 European Guidelines and Norms 1.10 Environmental Conditions	Standards updated Table updated
19.02.2020	1	Nameplate	Picture exchanged Chapter removed
09.03.2020	28 59	2.2.4 Connector Models 6.2.2 Dimensions incl. Mounting Set	2 connector types changed (X1B + X3, X4, X5) Dimension corrected
25.01.2021	18	1.8 Technical Data	PWM frequency and Regulator frequency added
31.03.2021	20 29	1.9 Environmental Conditions, Ventilation and Mounting 2.2.6 External Fusing	Overvoltage category added UL Requirement - paragraphs added
28.10.2022	61ff	7 VARAN Interface for DIAS Drive 3xx (VAC 013) Entire document	Chapter added Symbols updated

02.12.2022	42	3.6 Feedback	Feedback: FW version 1.91
07.10.2024	9	1.2 Safety Guidelines	Note on cross-sections