

# Axis Module 400 V/480 V

# MDD 111-1

## 1 Overview

The MDD 111-1 is an axis module for one axis with a Rated output current of 6 A at 230 V and 4 A at 400/480 V and a peak output current of 15 A at 230 V and 9A at 400/480 V.

MDD 100 is a small to midsize power range servo drive system, especially developed for multi-axial applications in the low, middle and high performance range.

It is fully integrated in the LASAL operating system and has 1 to 8 servo axes.

Depending on the supply module used and the motor type, the system is a 1-phase 230 VAC or a 3-phase 400-480 VAC system.

Four axis modules are available, two single-axis modules for 230 V and 400 V and two dual-axes module for 230V and 400 V, which have a scalable output current range of the 2 axes.

The supply module and the axes modules are put on a module carrier, which is mounted on the mounting plate of the cabinet.

The current, speed, and position control of the up to 8 axes work with a cycle time of 62.5  $\mu$ s. MDD 100 has a high flexibility in connection of various feedback systems.

VARAN connects the servo drive system to the machine controller.

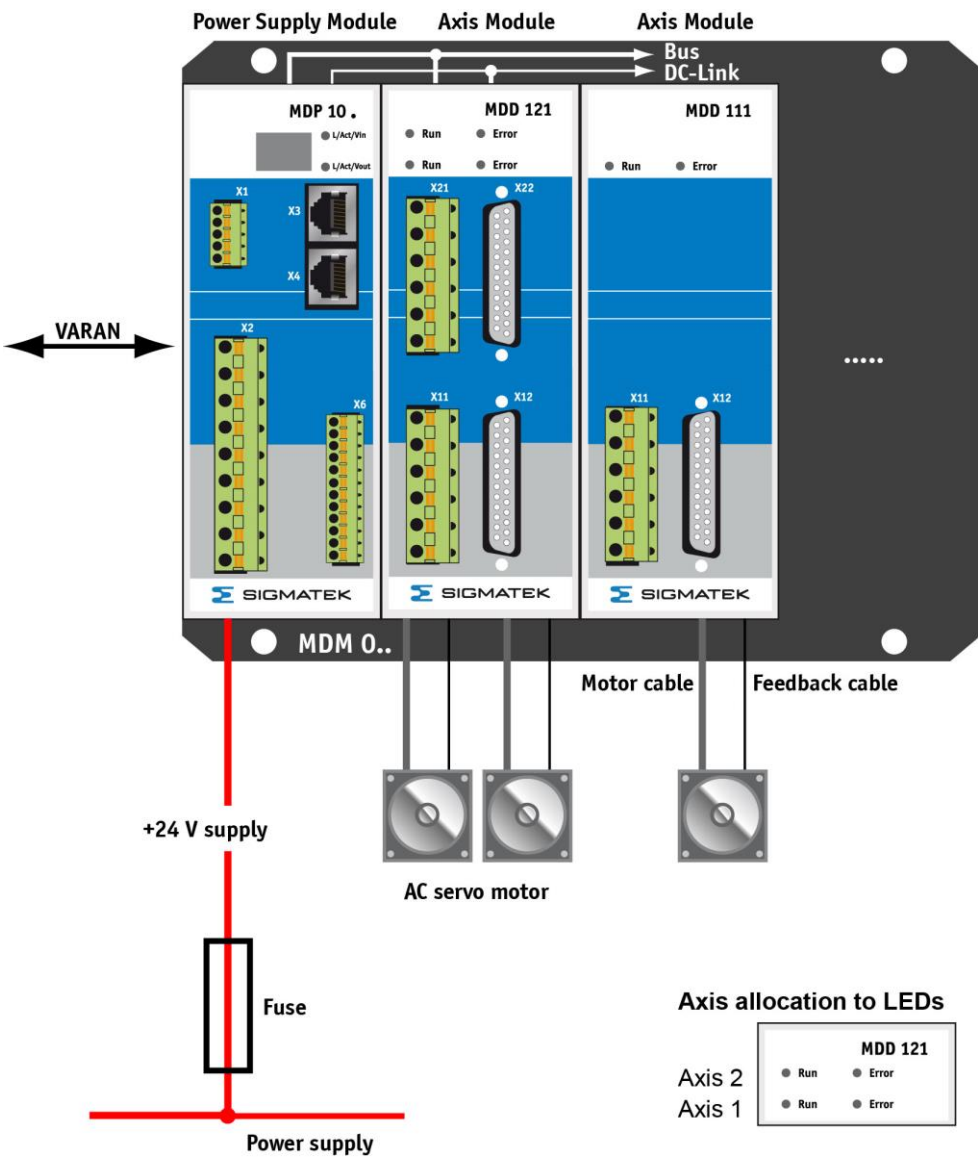
Integrated safety functions “Safe Torque off” STO and “Safe Stop 1” SS1 with a high safety level ease the integration into the safety concept of the machine.



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# 1.1 Components of a servo system



## 2 General

### 2.1 About this manual

The manual describes the MDD 111-1 axis module 400 V/480 V.

The information provided is:

- Technical Data for the axis module 400 V/480 V
- Description of the safety function
- Assembly and Installation
- Interface description
- Setup of the servo drive
- Accessories
- Transport, storage, maintenance, disposal

### Abbreviations used in this manual

| Abbreviation | Meaning                                     |
|--------------|---------------------------------------------|
| AWG          | American gauge wire                         |
| BGND         | Earth of 24 V help and break supply voltage |
| CE           | Communauté Européenne                       |
| CLOCK        | Clock pulse signal                          |
| EMV          | Electromagnetic compatibility               |
| EN           | European standard                           |
| IGBT         | Insulated Gate Bipolar Transistor           |
| LED          | Light Emitting Diode                        |
| PELV         | Protected extra low voltage                 |
| RES          | Resolver                                    |
| V AC         | AC voltage                                  |
| V DC         | DC voltage                                  |

## 2.2 Symbols used in this manual



**Danger!**    **Shock current**    Danger to personnel from electricity



**Caution!**    **General**    General warning, see document



**Caution!**    **Hot surface**    Hot surface more than 80 °C (176 °F)



**Important note**    See document

## 2.3 Safety Instructions



The safety instructions must be read before installation and set-up of the servo drive system, to prevent injury or material damage. It is fundamental that the technical data and information for connection requirements be followed (on the nameplate and in the documentation).

Only qualified personnel are permitted to perform activities such as transport, installation, setup and maintenance. Properly qualified persons are those who are familiar with the transport, assembly, installation, setup and operation of the product.

The manufacturer of the machine must generate a safety analysis for the entire machine. The manufacturer has to take appropriate measures to ensure that unforeseen movements cannot cause injury or equipment damage.

Inappropriate handling of the servo drive system or ignoring the warnings below and inappropriate engagement in the safety arrangement can result in equipment damage, personal injury, electric shock or death in an extreme situation.

### Annotations



#### **Danger!**      **Shock current**

Wait at least 7 minutes after disconnecting the servo drive system from the mains supply voltage before touching live sections of the equipment (e.g. contacts) or undoing connections. Capacitors can still have dangerous voltages levels for up to 7 minutes after switching off the supply voltages. To be sure, measure the voltage in the DC-link circuit and wait until it has fallen below 40 V.

Never remove the electrical connections to the servo drive system while it is under voltage.

There is a danger of electrical arcing with damage to contacts and danger to personnel.

If a leakage current sensor is used in the mains supply of the servo drive system, a leakage current sensor RCD type B must be used. If a RCD type A or AC is used, there is a risk, that the DC ground current of the servo drive will inhibit the leakage current sensor.

**Failure to follow any one of these instructions will result in death, serious injury or equipment damage.**



#### Caution

#### General

The availability of the servo drive system is limited according to EN61800-3. This product can cause radio interference problems in living quarters. In this case, it may be necessary for the operator to take adequate measures.

The servo drive system contains components that are sensitive to electro static, which can be damaged by incorrect handling. Ground yourself before touching the servo drive system by touching any grounded unpainted metal surface. Avoid contact with highly insulating materials (artificial fabrics, plastic film etc.). Place the servo drive on a conductive surface.

Do not open the units. Keep all covers and switchgear cabinet doors closed during operation. Otherwise there are deadly hazards that pose a severe danger to health or could cause material damage.

During operation, servo amplifiers may have uncovered live components, depending on their degree of enclosure protection. Control and power connections may be live, even if the motor is not rotating.

The leakage current of the servo drive system is higher than 3.5 mA. Therefore particular attention has to be taken on the grounding of the servo drive system. See technical data of the power supply modules.

The +24 V auxiliary power supply and also the power supply for the +24 V-BR holding brake supply must be galvanically isolated with SELV output voltage according to EN 60950.

**Failure to observe these precautions can result in severe injury and equipment damage.**

**Caution! Hot surface**

During operation, the housing of the servo drive can become hot and may reach temperatures above 80 °C (176 °F).

Especially the rear side of the module carrier will get hot, if the system is not mounted on a mounting plate in the cabinet. This is due to the related dissipated breaking energy in the ballast resistor. See technical data of module carrier.

Check (measure) the housing and the module rack temperature and wait until it has cooled down below 40 °C (104 °F) before touching it.

**Failure to observe this precaution can result in severe injury**

**Caution! Electromagnetic Fields (EMF)****Mortal danger!**

Due to the electromagnetic fields generated during operation of the servo drive system, 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.**

## 2.4 Conformity with European Directives

Servo drives are components, which are built into electrical equipment and machines for industrial use.

The operation is forbidden, until the machine or plant fulfils the requirements defined by the EC Directive on Machines 2006/42/EC and the Electromagnetic Compatibility (EMC) directive 2014/30/EU.



**Note: To ensure unforeseen movement, which can cause injury or damage to personnel or property, the manufacturer of the machine must generate a safety analysis for the machine.**

### CE – Conformity

The conformance to the Electromagnetic Compatibility (EMC) directive 2014/30/EU and the Low voltage directive 2014/35/EU is mandatory for the supply of servo drives within the European Community.

The harmonized standard EN 61800-5-1 (Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy) is applied to the servo drive in connection with the Low voltage directive 2014/35/EU.

The harmonized standard EN 61800-3 (Adjustable speed electrical power drive systems - Part 3: EMC product standard including specific test methods) is applied to the servo drive in connection with the Electromagnetic Compatibility (EMC) directive 2014/30/EU.

The correct installation to meet the EMC regulations can be found in this documentation, particularly information on:

- shielding
- grounding
- layout of the cabinet cabling
- filters (if necessary)

The servo drives of the MDD 100 series have been tested in a defined configuration with the system components that are described in this documentation.

Any divergence from the configuration and installation described in this documentation means that new measurements must be made to ensure that the regulatory requirements are met.

## 2.5 Prescribed use

The servo drives of SIGMATEK GmbH & Co KG are developed and produced according to the actual prior art. The products are fully tested before delivery, especially in terms of fail-safe conditions.

They are components, which are built into electrical equipment and can only be used as integral components of such equipment.

Before the products are installed, the following requirements must be fulfilled to meet the prescribed use.

- Everyone who is working in any way with the products has to read and understand the safety instructions, the prescribed use and the not prescribed use.
- The machine builder has to generate a safety analysis for the machine to ensure that unforeseen movements cannot cause injury or damage to any person or property.
- The servo drive has to run under the mounting and installation conditions described in this documentation, especially the environmental conditions (temperature, protection class, humidity, mains input, EMC and the mounting position)
- It must be mounted in a closed switchgear cabinet with **minimum IP54**.
- The servo drive has to be used in the way they are delivered (without any mechanical or electrical modification).
- Do not mount or start-up mechanical or electrical damaged or faulty servo drives.
- The servo drive is intended to control synchronous servo motors in closed loop control of torque, speed or position.
- The rated voltage of the motor must be at least as high as the setting of the mains input voltage (230 V, 400 V or 480 V) of the servo drive.
- Only motors with star-connection may be used.
- The servo drive is developed for usage in industrial environment. If it is used in residential areas, then an additional filter must be installed in the mains input line.

- Power supply modules MDP101-1 and MDP 102-1 are to be used with axis modules MDD111-1 and MDD121-1 only.
- Drives must to be used with motors provided with over temperature sensing.

## 2.6 Non-prescribed use

“Prescribed use” means, that the servo drive system is used according to the environmental conditions described in this documentation.

- It must not be used in electrical equipment on ships (service afloat) or in offshore applications because of the conductive pollution.
- It must not be used in environmental conditions that do not meet the conditions described in this documentation (too hot, without closed switchgear cabinet, wrong mounting position, etc.)

Be very careful in plants, where conductive material (carbon fiber, graphite with machining of graphite cast iron or similar) is easily purgeable in the factory floor. In this case, the switchgear cabinet has to be sealed very carefully (no forced ventilation with blower filter) or be placed outside the factory floor. Especially during start-up of the machine, the risk is high because of open switchgear cabinet doors. Servo drives, which become contaminated, cannot be used anymore.

## 2.7 Nameplate

**SIGMATEK GmbH & Co KG**

Sigmatekstraße 1

5112 Lamprechtshausen / Austria


**Model Number**

MDD 111-1

**Input ratings:**

Max. DC bus voltage

750Vdc

Max. DC bus current (at 45°C)

6.0A

**Output ratings:**

Output voltage

0 ... 528Vac

Max. output current (at 45°C)

6.0A

Number of phases

3

Frequency range

0 ... 8000Hz


**LISTED**

(IND. CONT. EQ.)

4FC9

Date (Year - KW)

**VORSICHT!**

Gefährliche Restspannung. Nach dem Abschalten 7 Minuten warten!

**WARNING!**

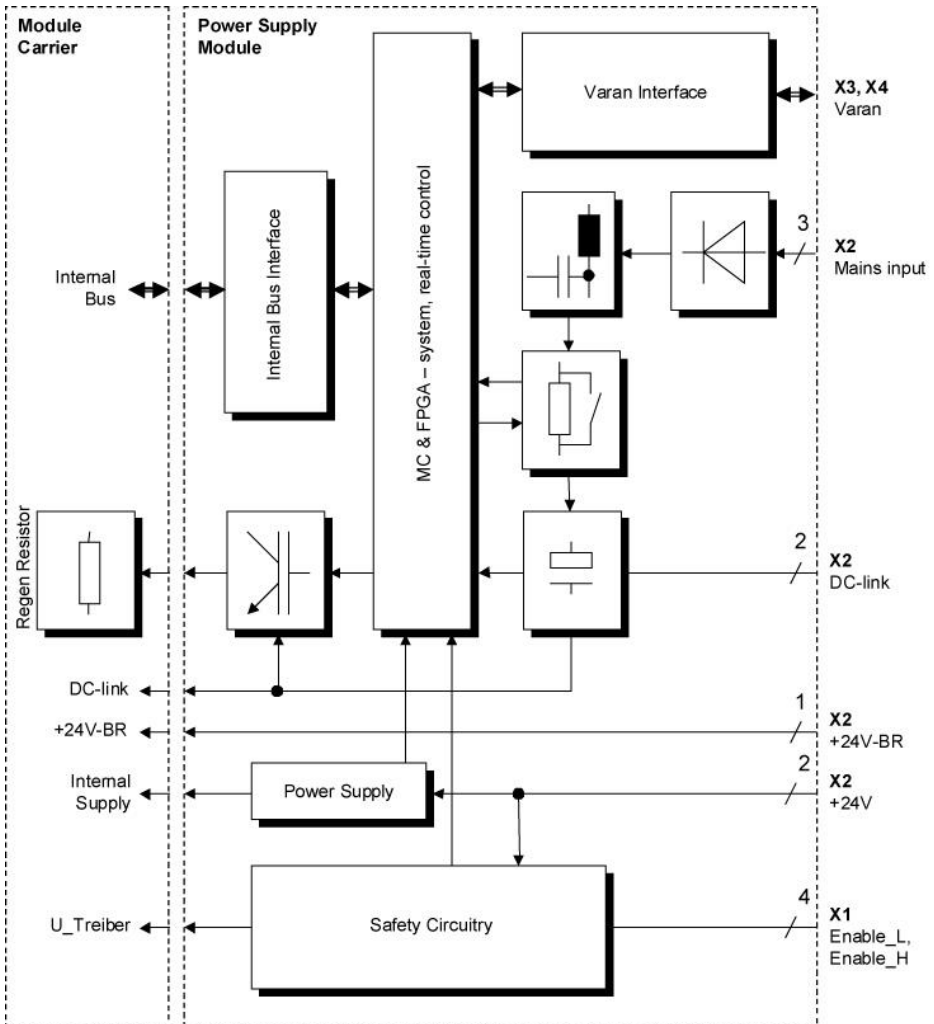
Residual voltage. Wait 7 minutes after removing power!

**ATTENTION!**

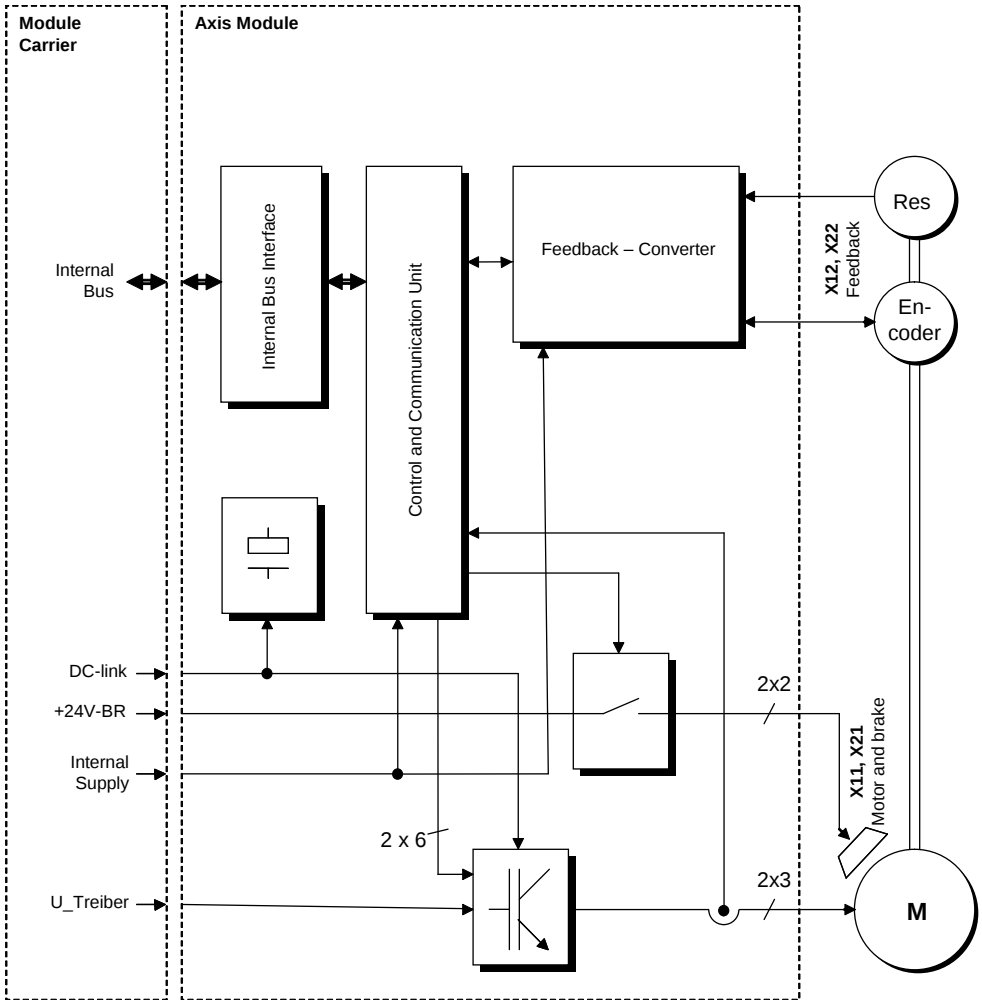
Tension résiduelle dangereuse! Après déconnection, attendez 7 minutes!

[www.sigmatek-automation.com](http://www.sigmatek-automation.com)

## 2.8 Block Diagram and Concept



Block diagram of the Power Supply Module



Block diagram of the Axis Module

## Hardware

- Mains input is fed to the power rectifier, the input filter and the inrush circuit
- DC-link connection for connecting the DC-link to other drives for power distribution
- Regen unit with internal regen resistor.
- Auxiliary power supply input for the internal supply
- Separate power supply input for the holding brake for safety reasons
- Integrated safety functions
- Micro controller system with communication unit
- IGBT – power stage with isolated current measurement (short circuit protected)
- Feedback converter for resolver and high resolution feedback devices
- 8 digital Capture-inputs to record the momentary actual position of the selected axis.

## Concept of the MDD 100

- Servo drive system contains of different components
  - Power supply module for up to eight logical axes
  - Axis module in different configurations
    - Single axis module
    - Dual axis module
  - Module carrier in different configurations for one to 4 axis modules
- Auto range function to optimize the resolution of the actual current
- Wide mains input voltage range  $3 \times 230 \text{ VAC}_{-10\%} \dots 3 \times 480 \text{ VAC}_{+10\%}$  directly from TN-system or TT-system with grounded neutral point mains. TT-systems with ungrounded or missing neutral point need additional circuitry.
- Inrush circuitry to limit the maximum charge current at switch on of the mains contactor
- Fusing provided by the user (phase failure detection in the drive)
- 24 V auxiliary supply input, electrically isolated for internal supply
- Separate 24 V input for holding brake supply
- Input EMI – filter for AC-input, 24 V auxiliary supply and holding brake supply for class A (industrial environment)
- Safety functionality STO (Safe Torque off) and SS1 (Safe Stop 1) with performance level „e“ according to ISO 13849 and SIL3 according to EN 62061
- All shield connections at the housing
- Protection functions against:
  - DC-link under/over voltage
  - Several short circuit conditions
  - Phase failure of the mains input
  - Overheating of the regen resistor
  - Over temperature protection (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.**

**Software functionality**

- Modified space vector modulation (SVM) technique to reduce the power stage losses
- Field oriented current controller (update time 62.5  $\mu$ s)
- Feedback converter and speed controller (update time 62.5  $\mu$ s)
- Spline interpolator and position controller (update time 62.5  $\mu$ s)
- Full synchronization down to the power stage, to the beat of the host controller with cycle times of 250  $\mu$ s, 500  $\mu$ s, 1 ms and every ms up to 8 ms
- The servo drive has no non-volatile data memory. So after switch-on, the parameters have to be send via the host communication to the servo drive

## 2.9 Technical Data Axis Module 400 V/480 V

|                                                                                                        | DIM                  | MDD 111-1                             |
|--------------------------------------------------------------------------------------------------------|----------------------|---------------------------------------|
| Article number                                                                                         |                      | 09-404-111-1                          |
| <b>Rated Data</b>                                                                                      |                      |                                       |
| Nominal allowed mains voltage                                                                          | V <sub>AC</sub>      | 230/ 400 / 480                        |
| Max. holding brake current per axis                                                                    | A <sub>DC</sub>      | 1                                     |
| Holding brake voltage drop from +24 V-BR to output                                                     | V <sub>DC</sub>      | Max. 1 (at 1 A holding brake current) |
| Max. holding brake switching energy                                                                    | mJ                   | 34                                    |
| Max. continuous sum current of all axes (heat sink) at 230 V                                           | A <sub>rms</sub>     | -                                     |
| Rated output current axis 1 (rms +/- 3 %) at 230 V                                                     | A <sub>rms</sub>     | 6                                     |
| Rated output current axis 2 (rms +/- 3 %) at 230 V                                                     | A <sub>rms</sub>     | -                                     |
| Max. continuous sum current of all axes (heat sink) at 400 V/480 V                                     | A <sub>rms</sub>     | -                                     |
| Rated output current axis 1 (rms +/- 3 %) at 400 V/480 V                                               | A <sub>rms</sub>     | 4                                     |
| Rated output current axis 2 (rms +/- 3 %) at 400 V/480 V                                               | A <sub>rms</sub>     | -                                     |
| Max. peak sum current of all axes at 230 V for max 5 sec.                                              | A <sub>rms</sub>     | -                                     |
| Peak output current axis 1 for max 5 sec. (rms +/- 3 %) at 230 V                                       | A <sub>rms</sub>     | 15                                    |
| Peak output current axis 2 for max 5 sec. (rms +/- 3 %) at 230 V                                       | A <sub>rms</sub>     | -                                     |
| Max. peak sum current of all axes at 400 V/480 V for max 5 sec.                                        | A <sub>rms</sub>     | -                                     |
| Peak output current axis 1 for max 5 sec. (rms +/- 3 %) at 400 V/480 V                                 | A <sub>rms</sub>     | 9                                     |
| Peak output current axis 2 for max 5 sec. (rms +/- 3 %) at 400 V/480 V                                 | A <sub>rms</sub>     | -                                     |
| Power stage losses (sum average currents of the 3 axis and multiply with factor), without regen losses | W / A <sub>rms</sub> | 10                                    |
| Output frequency of the power stage                                                                    | kHz                  | 8                                     |
| Regulator frequency                                                                                    | kHz                  | 16                                    |
| DC-Link capacitance                                                                                    | µF                   | 60                                    |
| <b>Plug types</b>                                                                                      |                      |                                       |
| Feedback (X12, X22))                                                                                   | -                    | Sub-D 25-pole (female)                |
| Motor (X11, X21)                                                                                       | -                    | Phoenix GMSTB 2,5HCV/ 6-ST-7,62       |

| <b>Mechanics</b>                               |    |                       |
|------------------------------------------------|----|-----------------------|
| Height                                         | mm | 155                   |
| Width                                          | mm | 60                    |
| Depth with module carrier (without/with plugs) | mm | 152/195               |
| Weight                                         | kg | 1.2                   |
| <b>General</b>                                 |    |                       |
| Article number                                 |    | 09-404-111-1          |
| Standard                                       |    | UL 508C, NMMS.E336350 |
| Approbations                                   |    | UKCA                  |

- \*) Is limited to the equivalent continuous sum current depending on axis 2
- \*\*) Is limited to the equivalent peak sum current depending on axis 2

## 2.10 Ambient conditions, ventilation and mounting

|                                        |                                                                                                                  |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Storage conditions                     | ⇒ page 60                                                                                                        |
| Transport conditions                   | ⇒ page 60                                                                                                        |
| Ambient temperature in operation       | 0 to +45 °C (32 to 113 °F) at rated data<br>+45 to 55 °C (113 to 131°F) with power derating of 2.5 % / K         |
| Humidity in operation                  | Relative humidity 95 %, no condensation                                                                          |
| Installation altitude above sea level  | 0-2000 m without derating<br>> 2000 m with derating of the maximum environmental temperature by 0.5 °C per 100 m |
| Pollution degree                       | 2                                                                                                                |
| Servo drive enclosure protection class | IP 20                                                                                                            |
| Mounting position                      | ⇒ page 29                                                                                                        |
| Ventilation                            | Forced ventilation by controlled internal fan                                                                    |
| Replacement fan                        | 09-404-111-Z3 (up to HW 1.10)<br>09-404-111-Z2 (starting from HW 1.20)                                           |

## 2.11 Auxiliary Power Supply

The power supply that is used for the +24 V auxiliary power supply voltage and the holding brake supply (+24 V-BR) must be a power supply with a galvanically isolated SELV output voltage according to EN60950. Due to the inrush current of the drive during switch-on, the current rating must be at least 5 A.

## 3 Installation

### 3.1 Important instructions



- If a leakage current sensor is used in the mains supply of the servo drives, a leakage current sensor RCD type B has to be used in any case.  
If a RCD type A or AC is used, there is a risk, that the DC ground current of the servo drive inhibits the leakage current sensor.
- Take care, that the servo drive and the motor are grounded properly. Use uncoated, zinc plated mounting plates (subplates).



- The servo drive system MDD 100 has a high leakage current higher than 3.5 mA. Therefore particular attention has to be taken on the grounding of the servo drive system:

#### a) Stationary machine mains supply connection:

- Parallel connection of the protective conductor on X2/Pin4 and at the module carrier with the same gage wire size, or
- Ground the MDD 100 with a minimum wire size of 10 mm<sup>2</sup> (AWG 8) at the module carrier, or
- Automatically switch-off of the mains supply at cable break of the protective conductor

#### b) Variable machine mains supply connection:

Mains connection with industry connector according to EN 60309 and a minimum wire cross section of the protective conductor of 2.5 mm<sup>2</sup> (AWG 13) as part of a multi-conductor supply cable. Use an adequate pull relief.

- Check the mechanics of the servo drive. If the housing is damaged e.g. by transport, don't use it. Don't touch electronic components in the drive.
- Compare the rated voltage and current of the servomotor to the data of the servo drive. Do the wiring according to the **Connection diagram**, page 25.
- Make sure, that the mains input voltage, under any condition, not exceeds the maximum rating of the servo drive. Note also Possibilities of mains supply.
- Define the external fusing of the mains input, 24 V auxiliary supply and holding brake supply according to **External fusing**, page 32.

- Route the motor and control cables separately (distance about 100 mm). This improves the noise level of the control signals because of the high radiation of the motor cables. Use only screened motor and feedback cable with shield connections on both ends.
- The prescribed mounting position is vertical as shown on page 29.
- The airflow in the switchgear cabinet has to be in a way, that the servo drives has enough cool and filtered air. See **Ambient conditions** page 19.
- **Any modification of the servo drive will invalidate the warranty**, except setting the software functions by parameter.
- At start-up of the servo drive, check the setting of the peak current of the servo drive. Especially small motors are damaged very quickly, if the setting of the servo drive is too high (e.g. a 1 A – motor and the 6 A-unit, not reduced to 1 A!)

## 3.2 Important instructions for the Safety Function



- All control components (switches, relays, PLC, etc.) and the control cabinet must comply with the requirements of the ISO 13849. This includes:
  - Door – switches, etc. with protection class IP54 as minimum
  - Control cabinet with protection class IP54 as minimum
- Use adequate insulated wire end sleeves
- External source voltage at the inputs ENABLE\_L and ENABLE\_H has to be excluded in the cabinet and outside. Make sure, that short circuits between single cables are excluded! See also EN ISO 13849.
- All safety-relevant cables (e. g. control cable) has to be installed e. g. in a cable duct, if pass outside the control cabinet
- The connector pin X1 / 3 is marked as “reserved” and must not be connected externally
- If the safety function SS1 (Safe Stop 1) is used, the minimum switch-off time is 0.4 s. Following actions which need the safety function STO (Safe Torque off) e.g. manually engagement into the machine, must not be released before 1 s

- When an external force is likely to act with the function "safe restart lock" (e.g. force to the load by hanging load) additional measures have to be provided (e.g. double-disc spring set brake, instead of permanent magnetic-excited brake)

**Failure to observe this precaution can result in severe injury and equipment damage.**

The mains supply voltage of the servo drive system has to be switched off by the main switch in following cases.

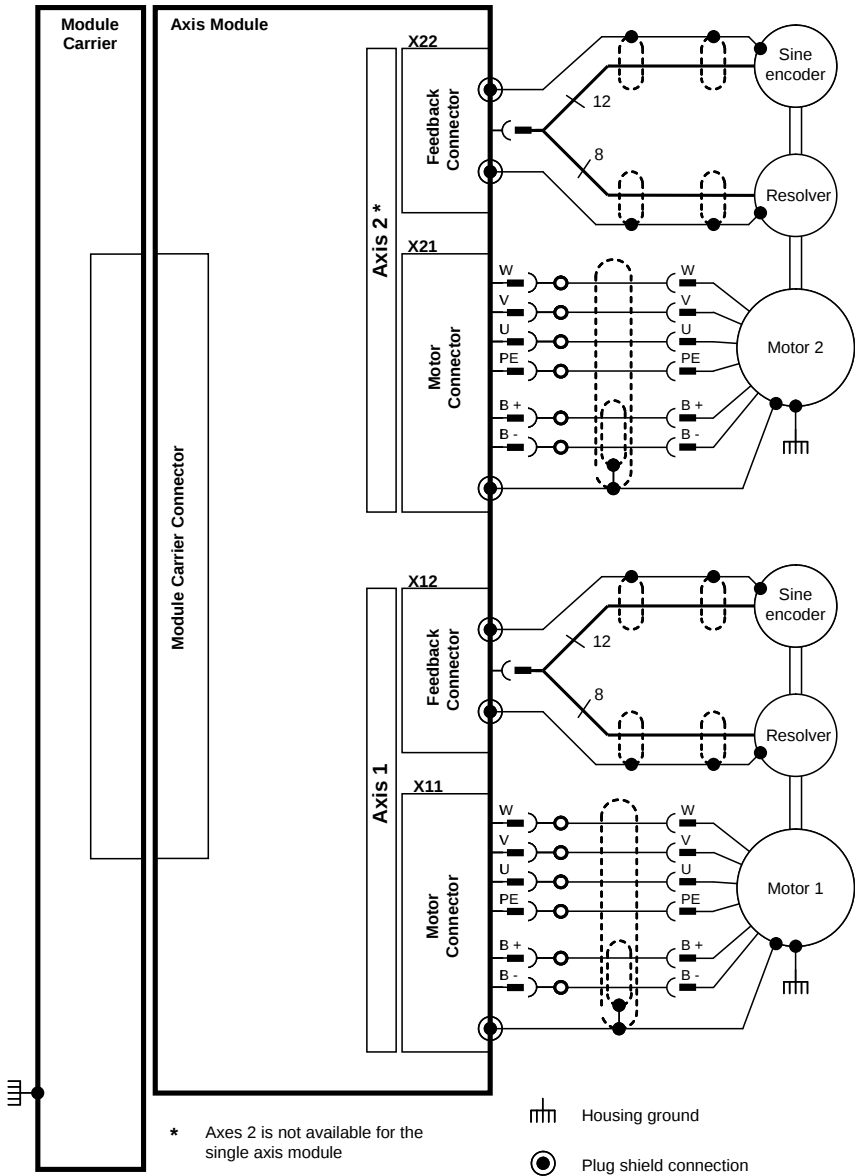


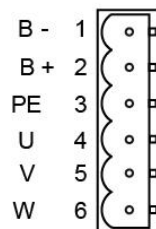
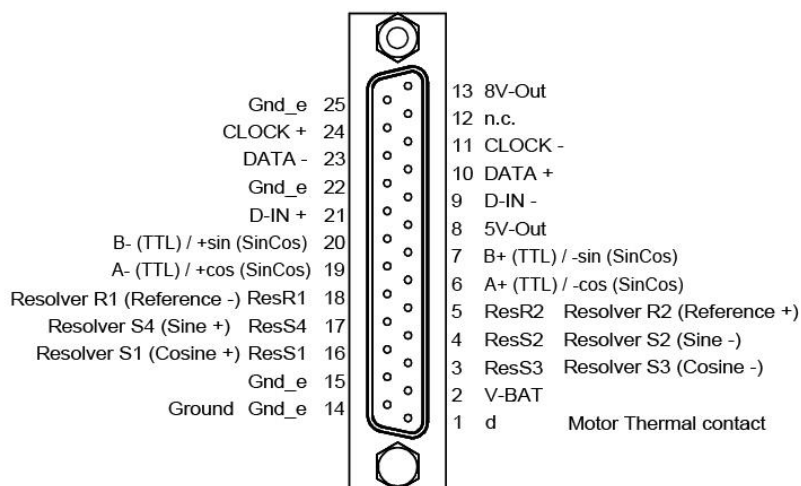
- Taking measures for cleaning, maintenance and repair
- Taking out of service for a longer time

**Failure to observe this precaution can result in severe injury and equipment damage.**

### 3.3 Planning of the switchgear cabinet

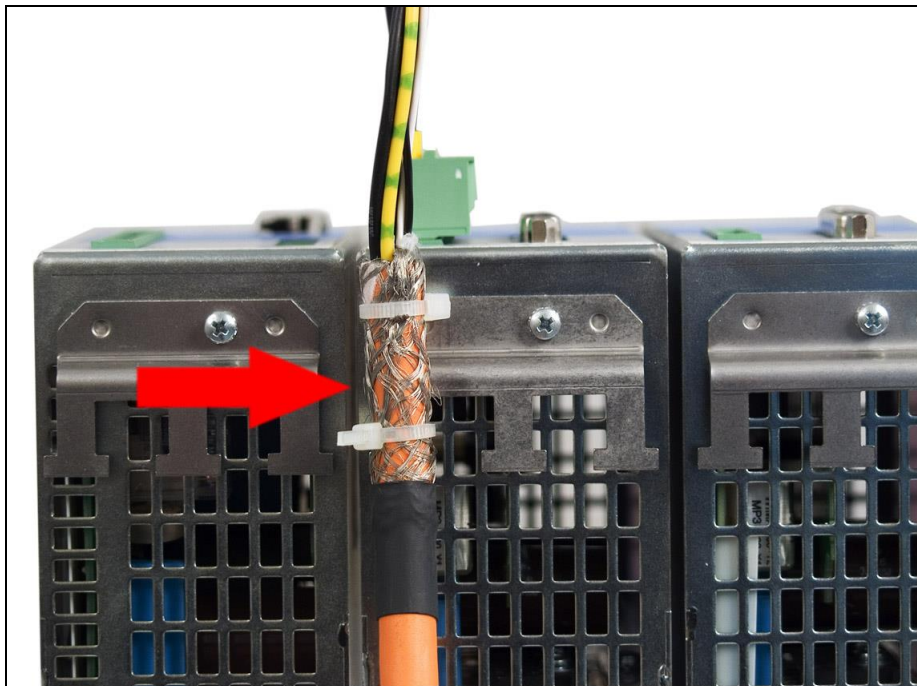
#### 3.3.1 Connection diagram and pin assignment of the axis module



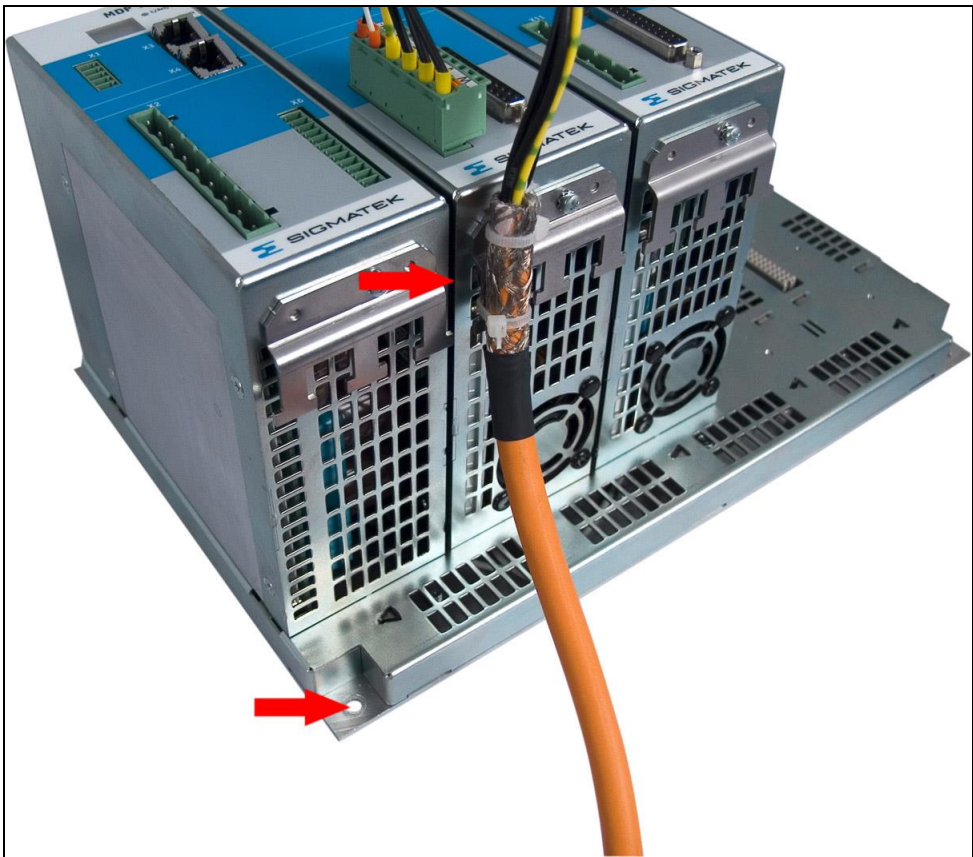
**Motor  
(X11, X21)**

**Feedback  
(X12, X22)**


### 3.3.2 Ground

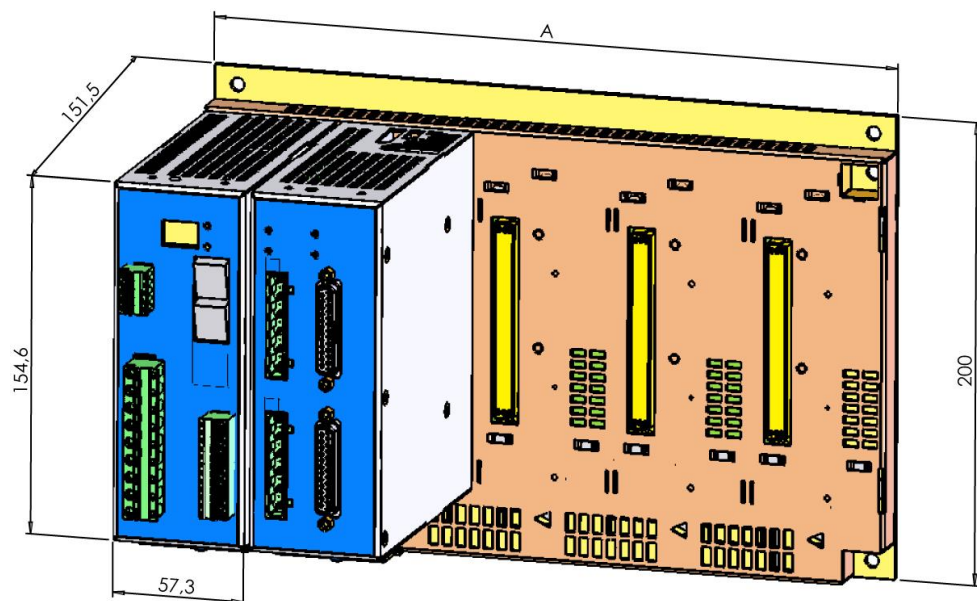
On the MDD module a mounting bracket is found, which serves as stress relief as well as shielding. Here, the cable shield is connected.



The entire MDD System is grounded over the module carrier in the control cabinet.

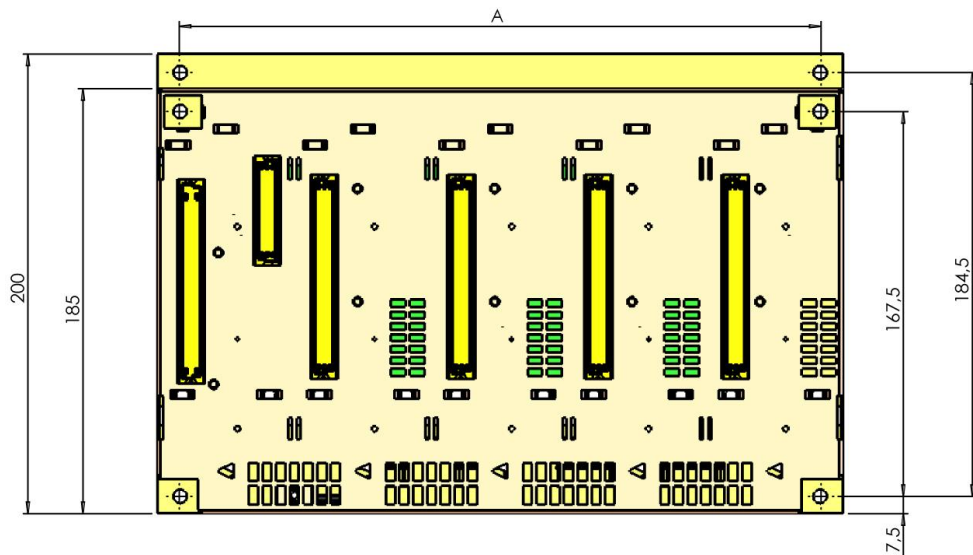


### 3.3.3 Mechanical construction and mounting



The mechanical dimensions of the servo drive system above are:

- A depends on the selected module carrier
- 120 mm for MDM 011
  - 180 mm for MDM 021
  - 240 mm for MDM 031
  - 300 mm for MDM 041



The mechanical dimensions of the module carrier and the fastening on the mounting plate of the cabinet above are:

- A depends on the selected module carrier
- 100 mm for MDM 011
  - 160 mm for MDM 021
  - 220 mm for MDM 031
  - 280 mm for MDM 041

The cable ducts below must be placed with a minimum distance of 10 mm to the module carrier.

The cable duct above must be placed with a distance of 40 mm to the module carrier. This is necessary to get enough air through the heat sink.

The specified installation clearances can be reduced under some conditions. Provided that the appropriate measures and technical precautions are taken to dissipate the heat generated from loss.

Fastening material: 4 hexagon socket screws to DIN 912, M5

Tool required: 4 mm Allen key

### 3.3.4 Connector properties

All connections of the servo drive system (except the ground bolt) are plugging style connectors. This makes it easier to install the cables and to replace a drive. Never the less it also opens the possibility to create cable sets for high volume machines.

The mechanical properties of the interface connectors are:

| Connector   | Type                          | Wire size                               | Max. screw torque          |
|-------------|-------------------------------|-----------------------------------------|----------------------------|
| X1          | Phoenix FMC1,5/5-ST-3,5       | 0.2 – 1.5 mm <sup>2</sup> (16 – 24 AWG) | Cage clamp                 |
| X2          | Phoenix GMSTB2,5HCV/9-ST-7,62 | 1 – 2.5 mm <sup>2</sup> (14 – 16 AWG)   | 0,56-0,79 Nm (5-7 inch lb) |
| X3, X4      | RJ 45                         | -                                       | -                          |
| X6          | Phoenix FMC1,5/12-ST-3,5      | 0.2 – 1.5 mm <sup>2</sup> (16 – 24 AWG) | Cage clamp                 |
| X12, X22    | D-Sub 25 with metal housing   | 0.25 – 0.5 mm <sup>2</sup> (20-22 AWG)  | Solder or crimp            |
| X11, X21    | GMSTB2,5HCV/6-ST-7,62         | 1 – 2.5 mm <sup>2</sup> (14 – 16 AWG)   | 0,56-0,79 Nm (5-7 inch lb) |
| Ground bolt | M5                            | 10 mm <sup>2</sup> (8 AWG)              | 3.5 Nm (31 inch lb)        |

### 3.3.5 Wire sizing

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

| Signal                        |                                                                                                     | Cable rating            |
|-------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------|
| AC mains input                | Maximum 2.5 mm <sup>2</sup> (14 AWG)                                                                | 600 V, 105 °C (221 °F)  |
| DC-link                       | Maximum 2.5 mm <sup>2</sup> (14 AWG)                                                                | 1000 V, 105 °C (221 °F) |
| Motor cable                   | 1.0 mm <sup>2</sup> (16 AWG), shielded, max.25m, capacitance <150pF/m                               | 600 V, 105 °C (221 °F)  |
| Holding brake                 | Min. 0.5 mm <sup>2</sup> (18 AWG), part of the motor cable, shielded separately, check voltage drop | 600 V, 105 °C (221 °F)  |
| Resolver with thermal contact | 4x2x0.25 mm <sup>2</sup> (22 AWG), twisted pairs, shielded, max.25 m, capacitance <120pF/m          |                         |
| EnDat <sup>®</sup> encoder    | 7x2x0.25 mm <sup>2</sup> (22 AWG) twisted pairs, shielded, max.10 m, capacitance <120 pF/m          |                         |
| +24 V and +24 V-BR input      | Maximum 2.5 mm <sup>2</sup> (14 AWG), check voltage drop                                            |                         |

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

### 3.3.6 External Fusing

The AC-mains and 24 V – fuses are calculated depending on customer needs.

| Signal                                                                                                                                                                                                                                                                                                                                                                                                                | Fuses, time delay                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>AC mains input (L1-L3)</p> <p>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 10 A/600 V with MDP101-1 or</p> <p>Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 253 Volts maximum when protected by RK5 Class Fuses rated 15 A/300 V with MDP102-1.</p> | <p>Size fuses to the average power, needed by the servo drives, connected to the circuit. Maximum rating is 12 A time delay corresponding to cable diameter of 2.5 mm<sup>2</sup> (14 AWG) (FRS-25)</p> |
| <p>24 VDC input (24 V, 24 V-BR to BGnd)</p>                                                                                                                                                                                                                                                                                                                                                                           | <p>Limited to 12 A time delay at 2.5 mm<sup>2</sup> / 14 AWG</p>                                                                                                                                        |

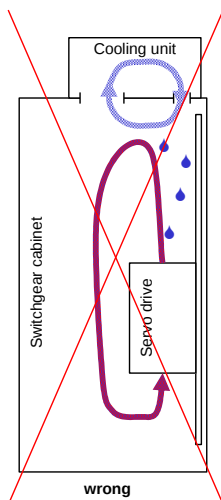
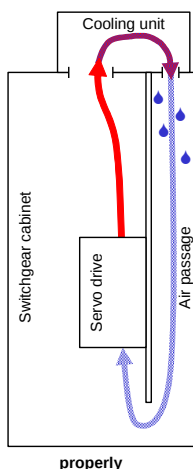
### 3.3.7 Usage of cooling units

The servo drive system operates up to 45 °C (55 °C with power reduction) ambient temperature. This means, that there could be a need to use a cooling unit.

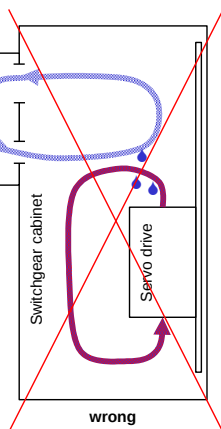
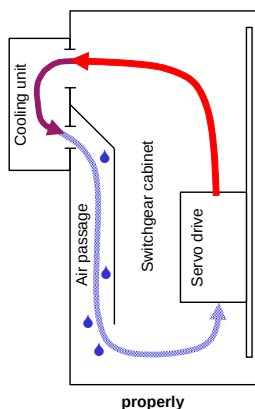


Note: Principally, the usage of a cooling unit can and will produce condensation water. So it is important to observe following:

- Mount cooling units in a way that condensation water does not leak into electronic devices in the switchgear cabinet.
- Mount cooling units, by which amassed condensation water cannot be sprayed into electronic devices by the fan of the cooling unit.



Cooling unit  
on top of  
the  
switchgear  
cabinet



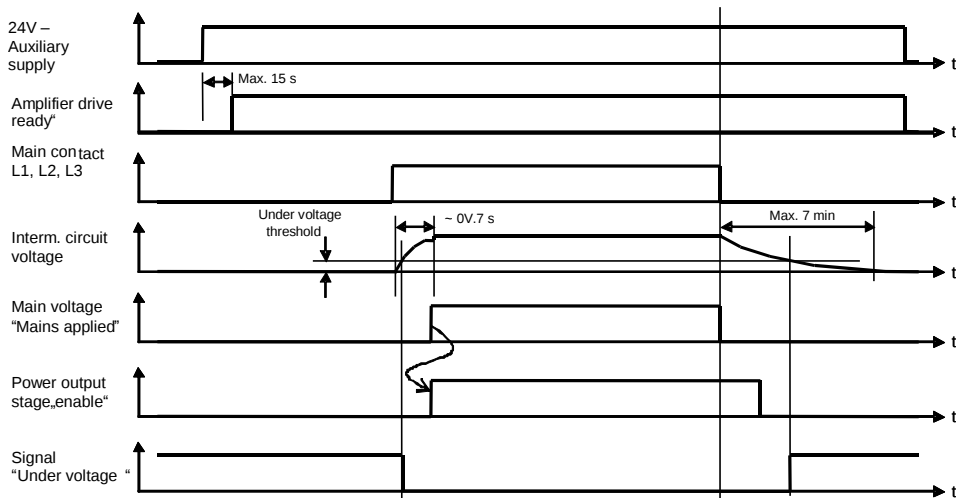
Cooling unit in the door of  
the switchgear cabinet

Avoid condensation also by observing the following rules:

- Set the set point of the temperature control of the cooling unit minimal to the temperature of the factory building.
- Use only properly sealed switchgear cabinets to avoid condensation by the moist external air.
- Especially during installation or servicing while the machine is running with open switchgear cabinet doors, make sure that the temperature of the electronic devices is not cooler than the air in the switchgear cabinet. This will generate condensation in the electronic devices.

### 3.3.8 Turn on/off response of the servo amplifier

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



5 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.

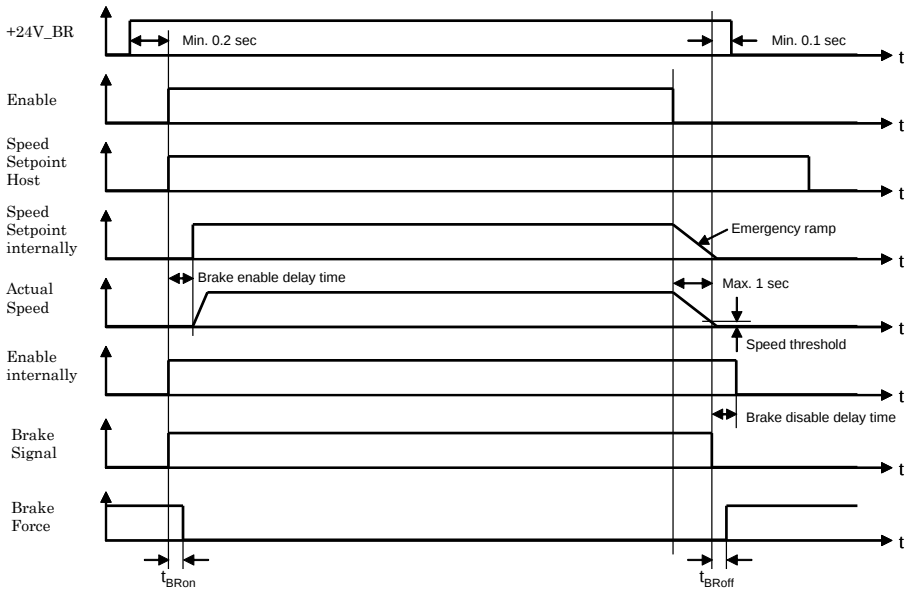
Since the memory of the servo amplifier is volatile, received parameters must be stored in the host controller. The advantage here lies in the automatic download of program data when an amplifier is changed.

If the main supply is turned on, the capacitors in the intermediate circuit are charged. This requires approximately 0.7 seconds.

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 7 minutes, the intermediate circuit is discharged.

### 3.3.9 Holding brake control



The figure above shows the processing of the holding brake.

A standard holding brake with 24 VDC input voltage and maximum 1 A can be directly executed by the servo drive.



The circuit has a high level of functional safety, but is **not personnel safe**.

## 4 Safety Function

The MDD 100 servo drive system 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 und ENABLE\_H.

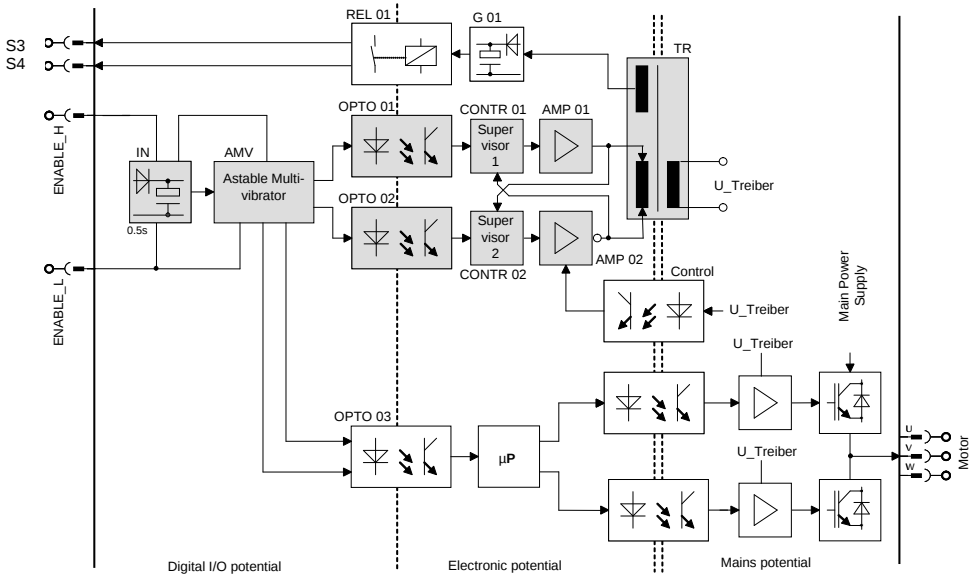
The relay output S1/S2 can be used to provide the status of the safety function. It is not safety-relevant, but can be used to test the external safety function.

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.

## 4.1 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:

### 4.1.1 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\_Treiber.

#### **4.1.2 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.

#### **4.1.3 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\_Treiber through the transformer TR01. It is ensured that the switching supply cannot transmit any energy when no control signal is sent from the AMV block over OPTO 01 and OPTO 02.

#### **4.1.4 Blocks G01 and REL01**

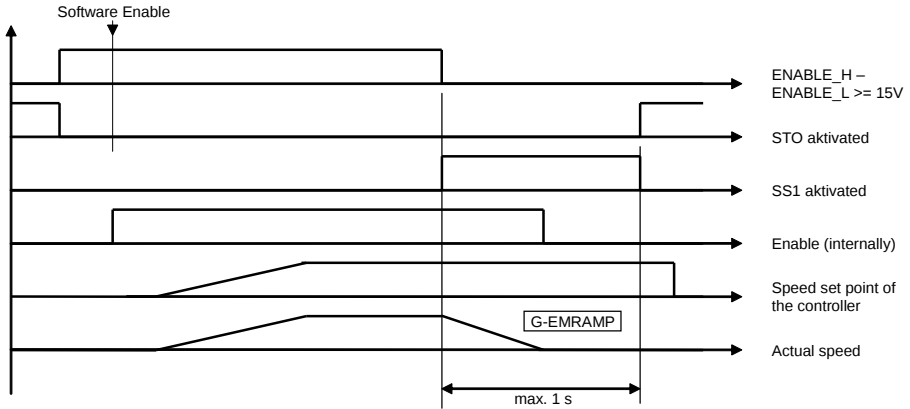
The relay output S1/S2 is closed when the servo amplifier is supplied with 24 V and the safety function is active. The two blocks are not safety-relevant.

## 4.2 Function

The safety functions in the DIAS Drive are controlled over 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 0.4 of seconds and a maximum of 1 seconds | <b>Safe status of the drive system</b>                                                                                                                                                                                                                             |
| Low          | Low      | When the servo amplifier is supplied with 24 V, the inputs are closed after a minimum delay 0.4 of seconds and a maximum of 1 seconds | <ul style="list-style-type: none"> <li>• Single channel safe status only when using classic I/O technology</li> <li>• <b>Safe status of the drive system</b>, when a safe output is used by a Safe PLC, also when ENABLE_L is connected with „Ext. GND“</li> </ul> |
| Low          | Open     |                                                                                                                                       |                                                                                                                                                                                                                                                                    |
| Low          | High     | Open                                                                                                                                  | <b>Drive system ready</b>                                                                                                                                                                                                                                          |



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 therefore switched to the operational mode.

## 4.3 Function Test



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.

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.

### 4.3.1 Test conditions

The total safety circuit must be tested for functionality

The function test is performed from the following start 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** if ENABLE\_L is connected to "Ext. GND" and the 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.

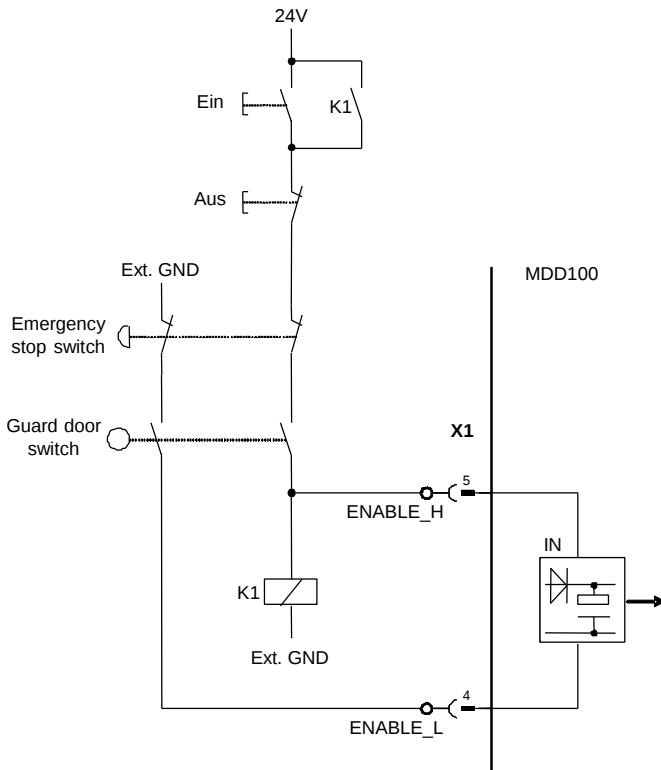
## 4.4 Example Connection with Switching Contacts

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 wired separately.

For ENABLE\_L this means, the other signals that can have "Ext. GND" potential must be wired 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. The can occur through, for example, wiring in a cable duct.



The schematic shows the possible wiring for use of conventional switch contacts.

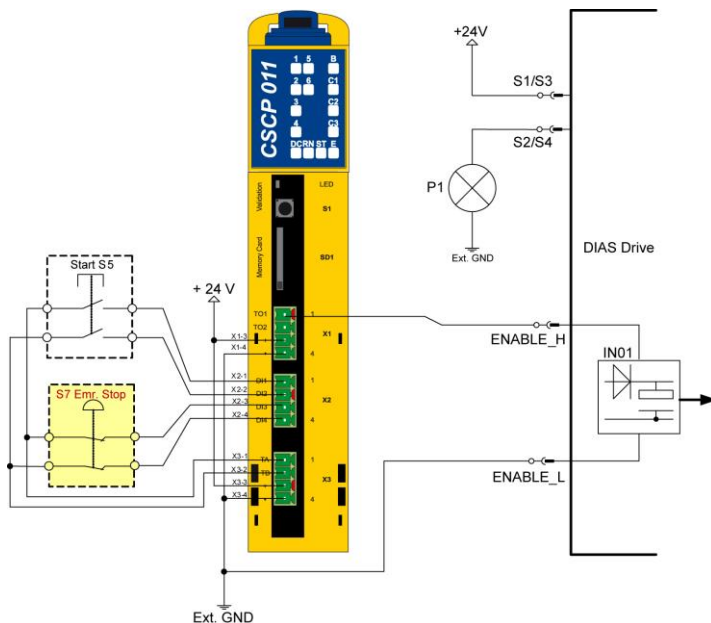
## 4.5 Example: Safety PLC Application

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.

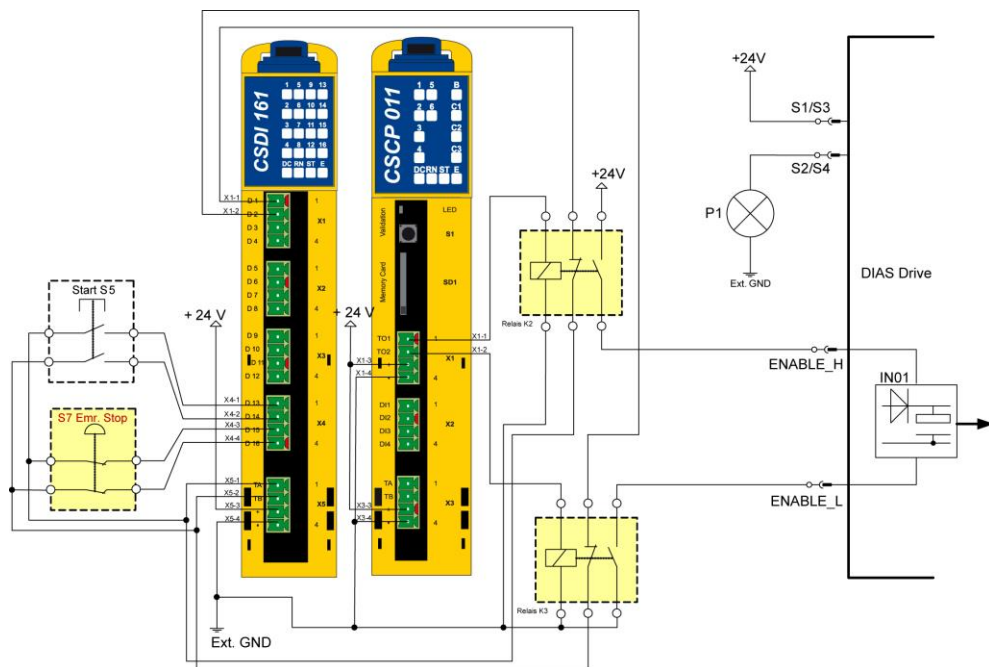
There are two Types of error-safe outputs.

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-proof relay output, with which the + output is connected to ENABLE\_H and the – output to ENABLE\_L.

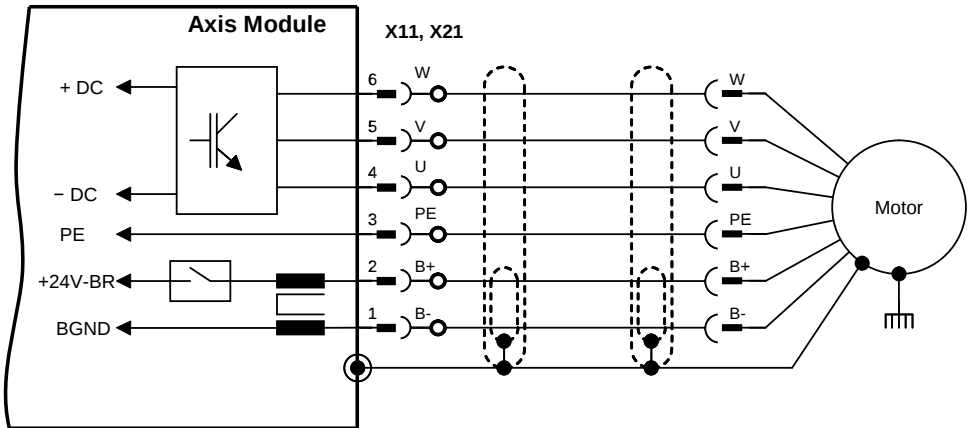


## 5 Interfaces

### 5.1 Motor connector (X11, X21)

#### 5.1.1 Standard configuration

The motor cable length is limited to 20 m. If a longer motor cable is required, use an addition motor choke in the output of the servo drive.

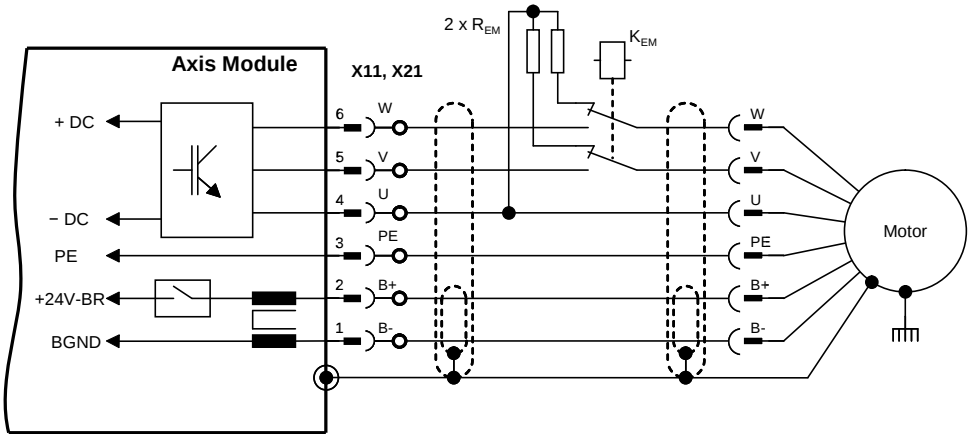


#### 4.4.2 Classic emergency stop function (stop category 0)

The motor cable length is limited to 20 m. If a longer motor cable is required, use an addition motor choke in the output of the servo drive.



Note: The contactor  $K_{EM}$  has to be switched on, before the servo drive is enabled and to be switched off minimal 1ms after disable.



The resistance and wattage of the resistors  $R_{EM}$  are calculated using following formulas:

$$R_{EM} [\Omega] = \frac{\max SPEED \cdot K_{Erms}}{I_{max} \cdot 0.8}$$

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

maxSPEED

$I_{max}$

$K_{Erms}$

maximum application speed [rpm]

maximum allowed rms current of the motor [A]

Voltage const. of the motor [V\*min]

## 5.2 Feedback (X12, X22)

The servo drive has feedback inputs for several different feedback devices.

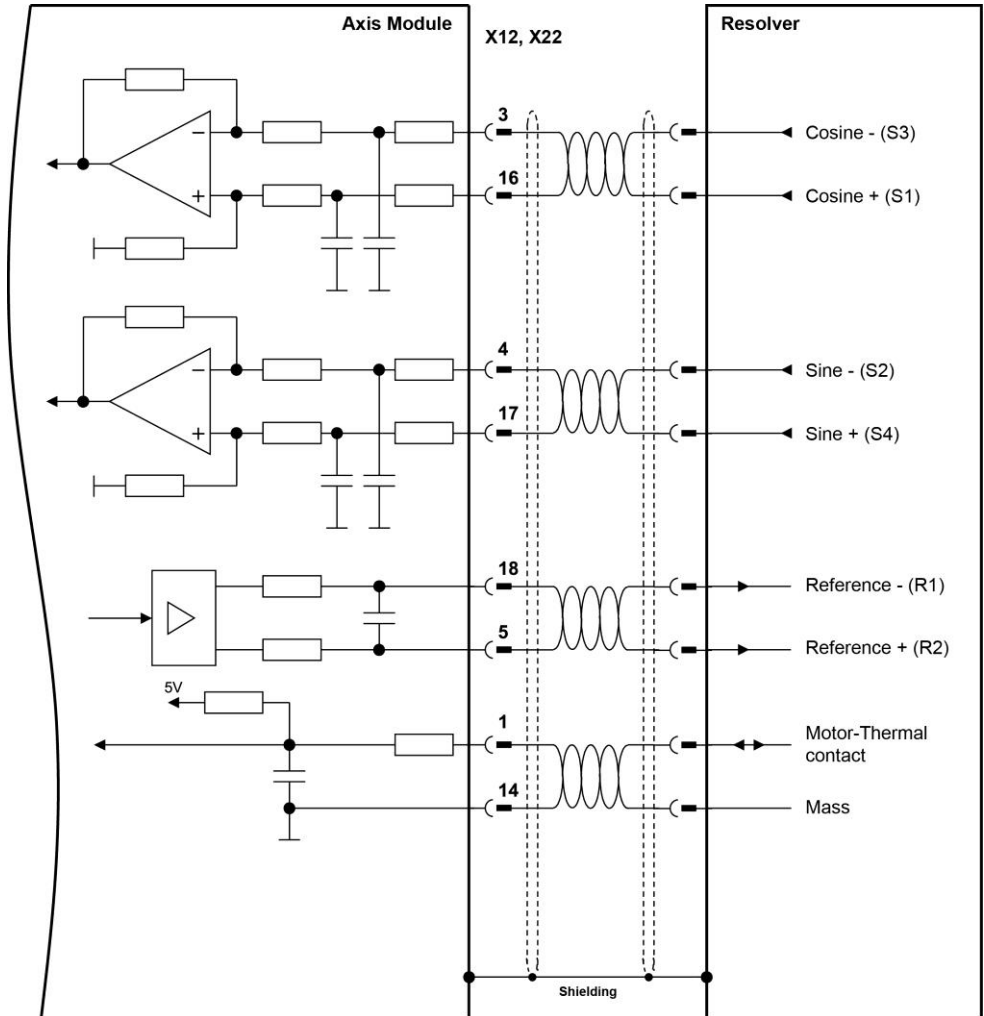
- Resolver Feedback with thermal contact in the motor winding
- EnDat® encoder (single and multiturn)
- Hiperface® encoder (single and multiturn)
- Sin/Cos & TTL encoder
- Sanyo Denki absolute encoder
- Panasonic encoder
- BiSS C encoder

For EnDat, Hiperface, Sin/Cos, TTL and Sanyo Denki encoder systems, a maximum number of 8192 feedback signals per mechanical rotation is supported (M-RPULSE).

## 5.2.1 Resolver Feedback

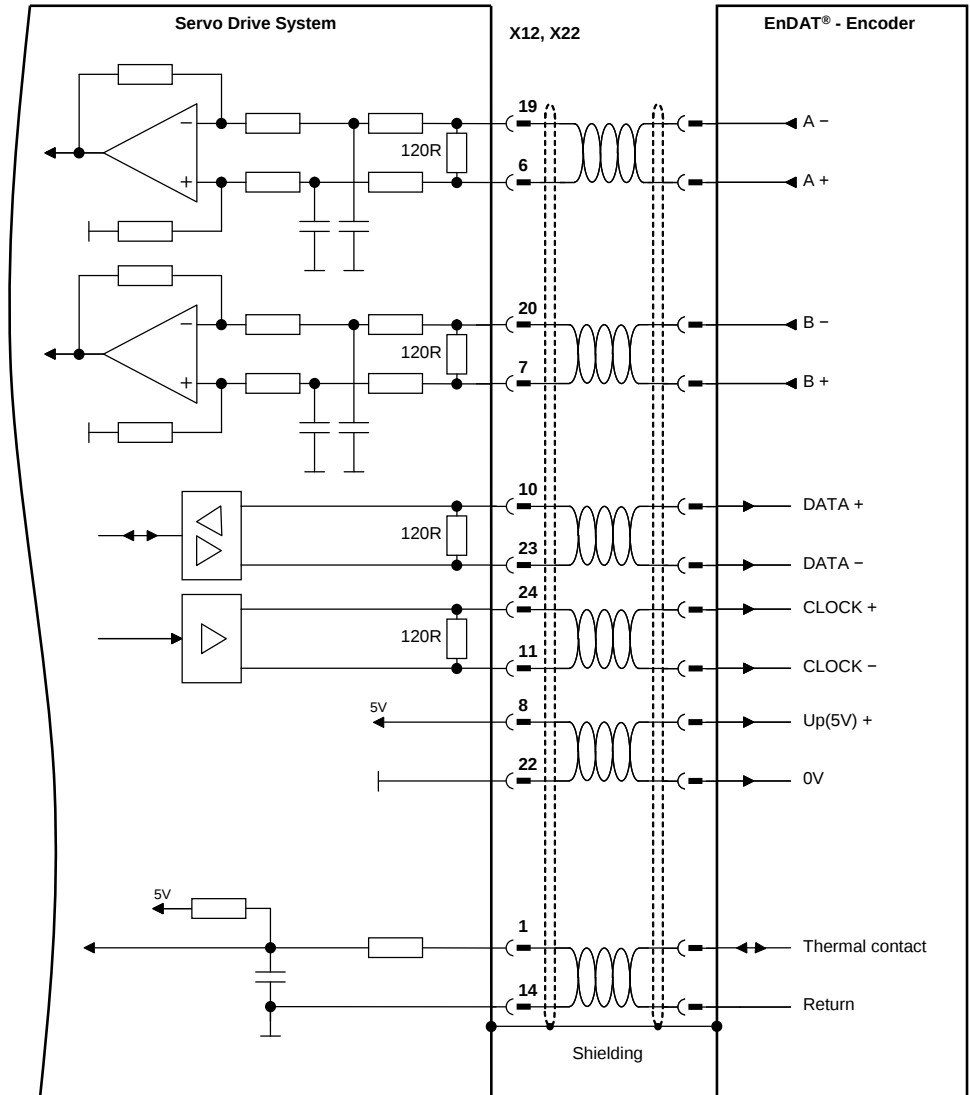
The standard feedback system for servomotors is resolver feedback. The servo drive allows evaluation of single speed (2-pole) and also multi speed resolvers (up to 32-pole). The maximum cable length is limited to 50 m.

If a thermal contact is used in the motor, the signal is also connected via the resolver cable.



## 5.2.2 EnDat® Feedback

One of the high-resolution feedback systems for servomotors is the encoder with EnDat interface. The maximum cable length is limited to 10 m. If a thermal contact is used in the motor, the signal is also connected via the encoder cable.



The Maximum cable length is 10 m, with the exception of the following encoders:

| Type code description | Motor type  | Encoder Type | Max. Length |
|-----------------------|-------------|--------------|-------------|
| LA                    | AKM2 – AKM3 | ECI 1118     | 8,2 m       |
| LB                    | AKM2 – AKM3 | EQI 1130     | 6,9 m       |
| DB                    | AKM2 – AKM4 | EQN 1125     | 9,4 m       |

When using EnDAT® with the MDD 100, the cable length must be taken into consideration (voltage drop)!

Formula for calculating the cable length (max. 10 m):

$$(A * U) / (\rho * l * 2) = L_{\text{cable}}$$

Example of cable length calculation:

For **AKM2xx - xxxxDBxx** (ECN 1125 encoder with 4.75 V minimum supply and 0,14 A maximum current):

$$\text{Maximum voltage drop} = 5 \text{ V} - 4.75 \text{ V} = 0.25 \text{ V}$$

$$(0.18 \text{ mm}^2 * 0.25 \text{ V}) / (0.017 \Omega * \text{mm}^2/\text{m} * 0.14 \text{ A} * 2) = 9.4 \text{ m}$$

Table for EnDat® encoder cable lengths:

| Type code description | Motor type | Encoder Type | Encoder Performance | Max. Length |
|-----------------------|------------|--------------|---------------------|-------------|
| DA                    | AKM2-4     | ECN 1113     | 4,75 V 110 mA       | 10 m        |
| DA                    | AKM5-8     | ECN 1313     | 3,6 V 110 mA        | 10 m        |
| DB                    | AKM2-4     | EQN 1125     | 4,75 V 140 mA       | 9,4 m       |
| DB                    | AKM5-8     | EQN 1325     | 3,6 V 140 mA        | 10 m        |
| LA                    | AKM2-3     | ECI 1118     | 4,75 V 160 mA       | 8,2 m       |
| LB                    | AKM2-3     | EQI 1130     | 4,75 V 190 mA       | 6,9 m       |

Derivation of the formula:

$$R = U / I \quad \text{Maximum resistance, calculated via the encoder power}$$

$$R = \rho * L_{\text{wire}} / A \quad \text{wire resistance over the entire wire length}$$

Applied:

$$R = \rho * L_{\text{wire}} / A$$

Solved for the maximum wire length calculation:

$$(A * U) / (\rho * I) = L_{\text{wire}}$$

Cabel length is halved since the supply and GND line form the entire length.

$$L_{\text{Cable}} = L_{\text{wire}} / 2$$

Legend:

U = Voltage drop ( 5 V supply – minimum encode supply)

R = Wire resistance

I = Maximum required encoder current

$\rho$  (rho) = Specific resistance of the wire (0.017  $\Omega$  for copper)

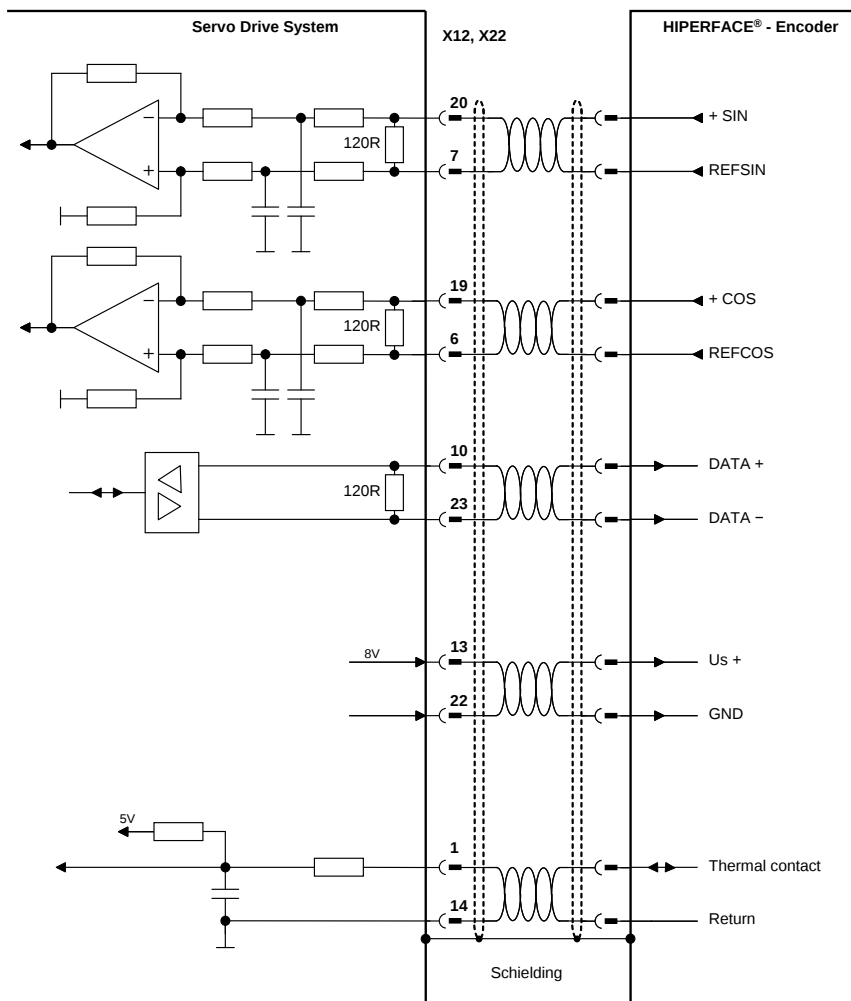
$L_{\text{wire}}$  = Entire wire length (supply line + ground line)

$L_{\text{cable}}$  = Entire cable length ( $L_{\text{wire}} / 2$ )

A = Encoder cable cross section

### 5.2.3 Hiperface® Feedback

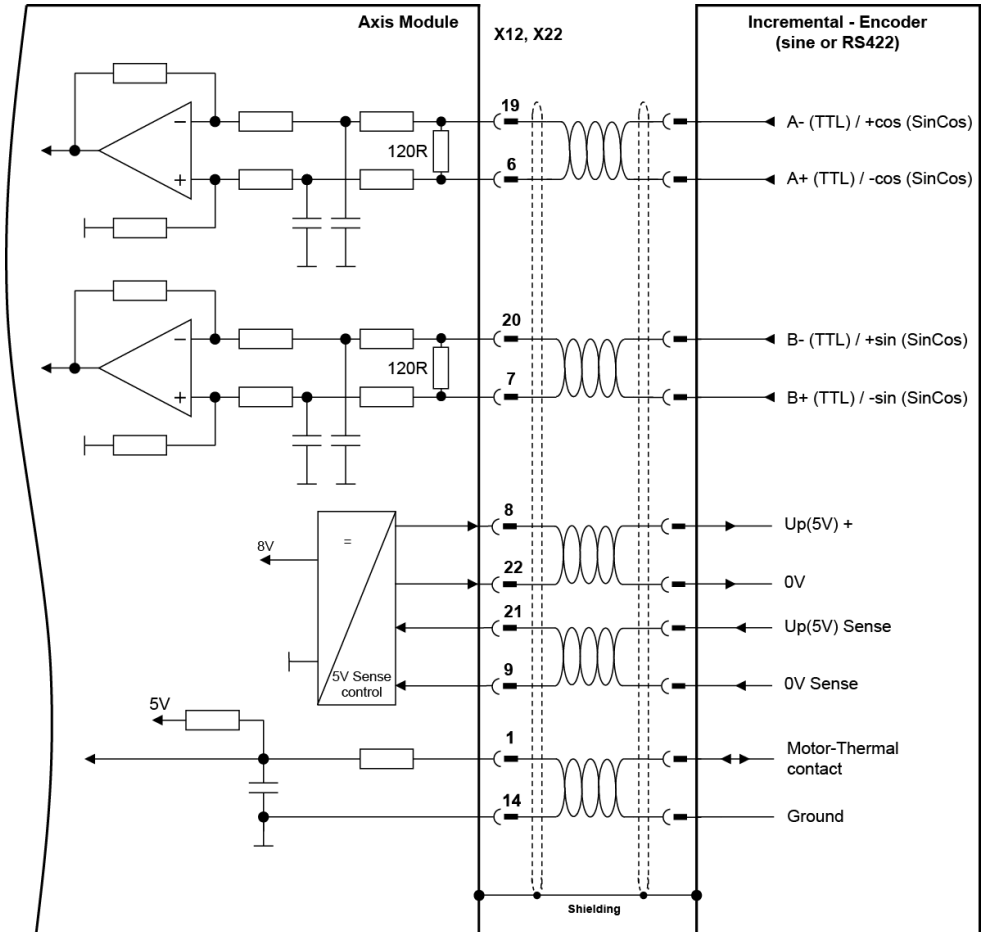
An encoder with Hiperface® interface is a high-resolution interface for servomotors. The maximum cable length is limited to 25 m. If a thermal contact is used in the motor, the signal is also connected via the encoder cable.



## 5.2.4 Sine Encoder Feedback

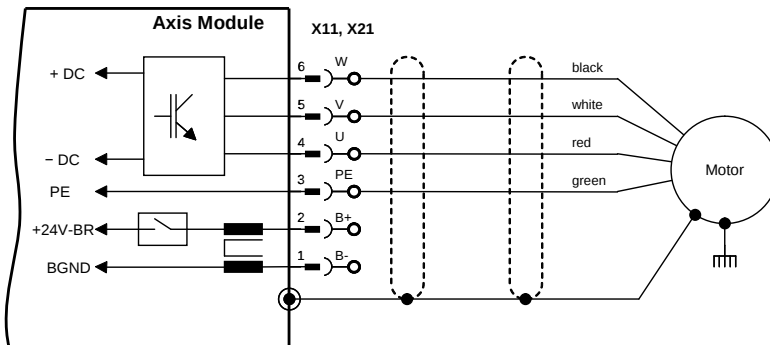
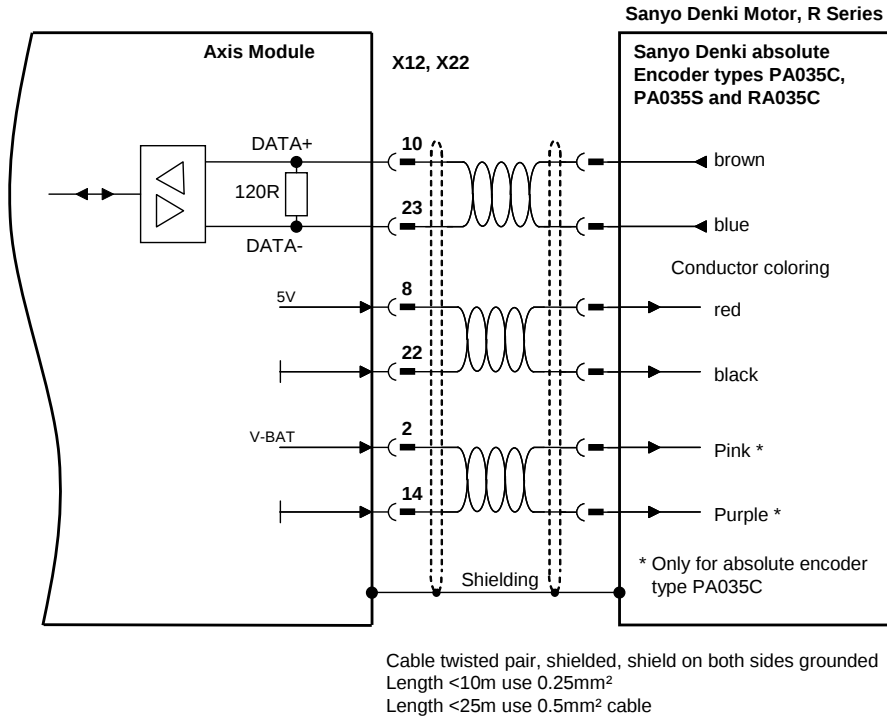
A sine encoder is a high-resolution feedback system, used with linear or torque servomotors. The maximum cable length is limited to 10 m. If a thermal contact is used in the motor, the signal is also connected via the encoder cable.

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



## 5.2.5 Sanyo Denki Motor

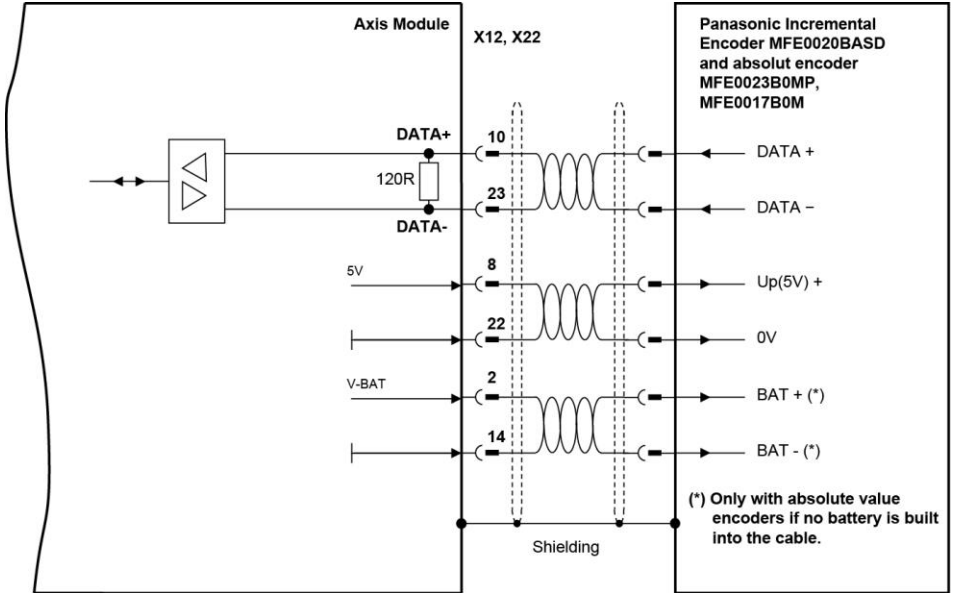
A Sanyo Denki motor with an absolute encoder with no battery can be connected to the MDD 100. The maximum cable length is limited to 25 m. The battery type is in preparation.



## 5.2.6 Panasonic Feedback

The Panasonic feedback analysis is supported starting with FW version 1.84 in combination with the MDD FPGA version v22 (see parameter I-HC).

The maximum cable length is 25 m.



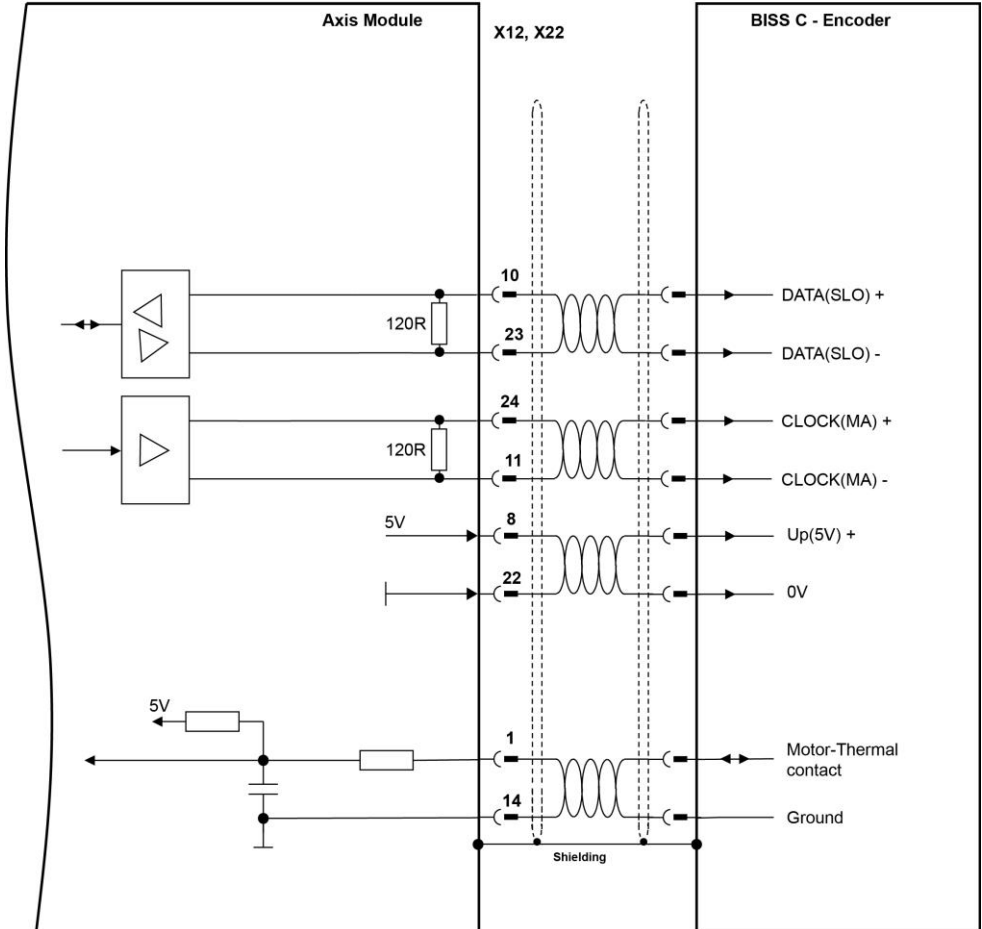
Shielded, twisted-pair cable, shielding connected on both sides  
 Length < 10 m, wire cross section 0.25 mm<sup>2</sup>  
 Length < 25 m, wire cross section 0.5 mm<sup>2</sup>

## 5.2.7 BiSS C Feedback

The BiSS C analysis is supported starting with FW version 1.84 in combination with the MDD FPGA version v22 (see parameter I-HC).

The maximum cable length is 10 m.

If a thermos contact is used the signal is wired via the feedback cable.



## 6 Maintenance

The servo drive does not require any maintenance.



Note: Opening the enclosure invalidates the warranty

If the casing is dirty, clean with Isopropanol or similar cleaning agent.

- Dirt inside the unit must be cleaned by the manufacturer
- Dirty protective grill (fan) may be cleaned with a dry brush
- Do not immerse or spray.

### 6.1 Replace and repair

**Repair:** The repair of the servo drive has to be done by the manufacturer.

**Replace:** If a component of the servo drive system has to be replaced, notice following checklist (no special mounting tools are required):

Switch off the main switch of the switchgear cabinet and remove the fuses supplying the servo drive system



Wait at least 7 minutes after disconnecting the servo drive system from the mains supply voltage before touching live sections of the equipment (e.g. contacts) or undoing connections. Capacitors can still have dangerous voltages present up to 7 minutes after switching off the supply voltages. To be sure, measure the voltage in the DC-link circuit and wait until it has fallen below 40 V.

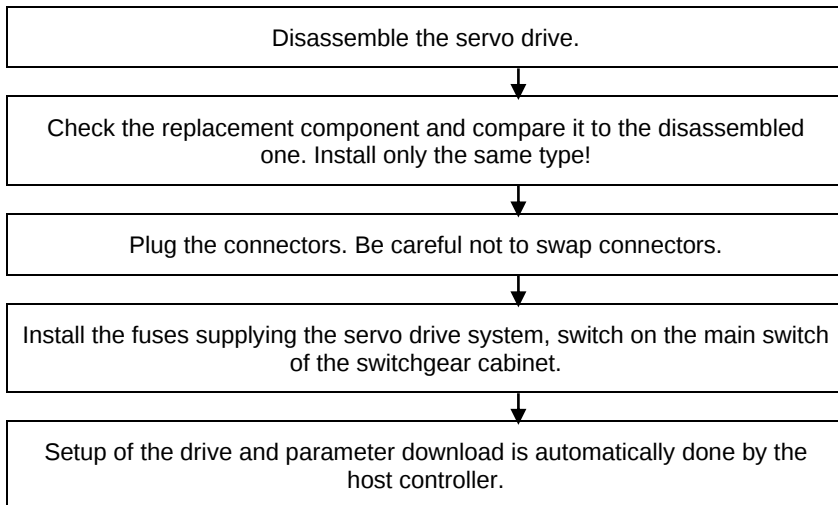


During operation, the heat sink of components of the servo drive system can become hot and may reach temperatures above 80 °C (176 °F). Check (measure) the heat sink temperature and wait until it has cooled below 40 °C (104 °F) before touching it.



Remove the connectors. Make sure, that the identification is clear, not to swap the connectors at installation of the replacement.





## 7 Appendix

### 7.1 Transport, storage and disposal

#### Transport:

- Use only the manufacturer's original recyclable packaging
- Avoid shocks
- Maximum temperature range  $-25$  to  $+70$  °C ( $-13...158$  °F), maximum 20 K/hr rate of change
- Maximum 95 % relative humidity, not condensing
- The servo drive contains electro statically sensitive components, which can be damaged by incorrect handling. Discharge yourself before touching the servo amplifier. Avoid contact with highly insulating materials (artificial fabrics, plastic films etc.). Place the servo drive on a conductive surface.
- If the packaging is damaged, check the unit for visible damage. In this case, inform the shipper and the manufacturer. Do not install and operate the unit in this case!

#### Packaging:

- Card box, can be recycled
- Labeling: nameplate outside at the box

#### Storage:

- Only in the manufacturer's original recyclable packaging
- The servo amplifiers contain electro statically sensitive components, which can be damaged by incorrect handling. Discharge yourself before touching the servo amplifier. Avoid contact with highly insulating materials (artificial fabrics, plastic films etc.). Place the servo amplifier on a conductive surface.
- Maximum stacking height 10 card boxes.
- Storage temperature range  $-25$  to  $+55$  °C ( $-13...131$  °F), maximum 20 K/hr rate of change
- Maximum relative humidity 95 %, not condensing.

- Storage duration:  
**< 1 year:** without restriction  
**≥ 1 year:** capacitors must be re-formed before operating the servo drive. To re-form, remove all electrical connections, and supply the servo amplifier for about 30 min. from 230 VAC, single-phase, on terminals L1 / L2.

**Disposal:**

- The servo drives can be reduced to its principal components by removing the screws (aluminum heat sink, steel housing sections, electronics boards)
- Disposal should be carried out by a certified disposal company.

# 7.2 Troubleshooting and Fault Elimination

Faults and warnings can be detected by LED and bus system.  
 The list “Status Register” helps you eliminate the errors.

## 6.2.1 LED Indication

Each axis module of the MDD 100 servo drive system has two LED's for each axis, which display the status of the corresponding axis.

| LED           |              | Description                                                 |
|---------------|--------------|-------------------------------------------------------------|
| Green         | Red          |                                                             |
| On            | On           | Controller in boot mode (no or damaged firmware)            |
| 1 Hz flashing | Off          | Ready to switch on, no enable                               |
| 8 Hz flashing | Off          | Output current limited by I2T limitation (one or more axes) |
| On            | Off          | Running                                                     |
| On            | 1Hz flashing | Warning condition                                           |
| Off           | On           | Fault condition                                             |

## 6.2.2 Malfunction of the drive

| Malfunction of the drive                                                                                 | Cause                                                                                                                                                         | Remedy                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| – <i>I-FPOS</i> shows decrementing values when the motor rotates clockwise (view of the motor shaft)     | – Feedback system is not connected correctly                                                                                                                  | – Connect feedback system according to drawing (see page 48)                                                                                                                    |
| – Motor does not rotate<br>– Motor current is at the limit without torque                                | – Motor is not connect in correct orientation                                                                                                                 | – Connect motor in correct relation to terminals U, V, W                                                                                                                        |
| – The motor casts without set point<br>– The motor torque is too low or different in the both directions | – <i>M-ROFF</i> is not set to the right value<br>– Motor and/or feedback connection is wrong                                                                  | – Set <i>M-ROFF</i> to the right value<br>– Connect motor and feedback correctly                                                                                                |
| – The motor stops in certain positions                                                                   | – The setting of <i>M-POL</i> and/ or <i>M-RPOL</i> is not correct<br>– The motor cable has a broken wire<br>– Not all wires of the motor cable are connected | – Set <i>M-POL</i> and <i>M-RPOL</i> according to the to the data of the motor<br>– Replace motor cable (especially with drag chains)<br>– Connect all wires of the motor cable |
| – The motor oscillates                                                                                   | – Control gain too high<br>– Shielding of the feedback cable has a break                                                                                      | – Reduce <i>V-KP</i> and/or <i>P-KV</i><br>– Replace feedback cable (especially with drag chains)                                                                               |

### 6.2.3 Status Register

The MDD 100 has a status register, read by **I-STATUS**. It is a 32-Bit variable that contains all error and status information. The internal behavior of the drive to the different bits can be set by **G-MASKE1**, **G-MASKE2**, **G-MASKW** and **G-MASKD**. According to the setting of the different masks, the drive detects an error, warning or does not react at all. The different bits have default values and also limitations on attribution to the masks.

| Bit | Fault                      | Cause                                                                                                                                                       | Remedy                                                                                                                                                                                                                                                                      |
|-----|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0   | <b>One mains phase</b>     | <ul style="list-style-type: none"> <li>– No 3-phase supply from the mains</li> </ul>                                                                        | <ul style="list-style-type: none"> <li>– check fuses in the mains</li> <li>– check electrical supply</li> </ul>                                                                                                                                                             |
| 1   | <b>Mains fault</b>         | <ul style="list-style-type: none"> <li>– Drive system is enabled without mains applied</li> </ul>                                                           | <ul style="list-style-type: none"> <li>– check fuses in the mains</li> <li>– check electrical supply</li> <li>– Drive is enabled, before DC – link charged and vice versa</li> </ul>                                                                                        |
| 2   | <b>Not used</b>            |                                                                                                                                                             |                                                                                                                                                                                                                                                                             |
| 3   | <b>DC over voltage</b>     | <ul style="list-style-type: none"> <li>– internal regen resistor damaged</li> </ul>                                                                         | <ul style="list-style-type: none"> <li>– replace module rack</li> </ul>                                                                                                                                                                                                     |
| 4   | <b>DC under voltage</b>    | <ul style="list-style-type: none"> <li>– mains supply voltage too low when drive is enabled</li> </ul>                                                      | <ul style="list-style-type: none"> <li>– disable drive before the DC-link voltage crosses the under voltage threshold set by <b>G-VBUSM</b></li> </ul>                                                                                                                      |
| 5   | <b>Not used</b>            |                                                                                                                                                             |                                                                                                                                                                                                                                                                             |
| 6   | <b>Holding brake fault</b> | <ul style="list-style-type: none"> <li>– No holding brake connected with <b>M-BRAKE</b> = 1</li> <li>– Short circuit at the holding brake output</li> </ul> | <ul style="list-style-type: none"> <li>– Connect motor with holding brake</li> <li>– Check wiring of the holding brake</li> <li>– Set <b>M-BRAKE</b> = 0 if no brake is at the motor</li> <li>– Check wiring of the holding brake</li> <li>– Check holding brake</li> </ul> |
| 7   | <b>Brake switch fault</b>  | <ul style="list-style-type: none"> <li>– No holding brake connected with <b>M-BRAKE</b> = 1</li> <li>– Internal brake supply switch is defect</li> </ul>    | <ul style="list-style-type: none"> <li>– Connect motor with holding brake</li> <li>– Set <b>M-BRAKE</b> = 0 if no brake is at the motor</li> <li>– replace drive</li> </ul>                                                                                                 |
| 8   | <b>Not used</b>            |                                                                                                                                                             |                                                                                                                                                                                                                                                                             |
| 9   | <b>Motor temperature</b>   | <ul style="list-style-type: none"> <li>– motor thermostat has switched off</li> <li>– break in feedback cable or connectors</li> </ul>                      | <ul style="list-style-type: none"> <li>– check why the motor became so hot (undersized, bad environmental conditions)</li> <li>– check feedback cable and connectors, replace it, if necessary</li> </ul>                                                                   |

|    |                              |                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                               |
|----|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 | <b>Ambient temperature</b>   | <ul style="list-style-type: none"> <li>– internal temperature too high</li> </ul>                                                                                                                              | <ul style="list-style-type: none"> <li>– improve ventilation in the cabinet and check mounting position according to this manual</li> </ul>                                                                                                                                   |
| 11 | <b>Heat sink temperature</b> | <ul style="list-style-type: none"> <li>– heat sink temperature too high</li> </ul>                                                                                                                             | <ul style="list-style-type: none"> <li>– improve ventilation in the cabinet, check mounting position according to this manual or use a cooling unit</li> </ul>                                                                                                                |
| 12 | <b>Feedback fault</b>        | <ul style="list-style-type: none"> <li>– feedback cable has a break</li> <li>– feedback device defect</li> <li>– feedback connector not properly stucked</li> </ul>                                            | <ul style="list-style-type: none"> <li>– replace feedback cable</li> <li>– replace feedback device</li> <li>– stuck feedback connector properly</li> </ul>                                                                                                                    |
| 13 | <b>Commutation fault</b>     | <ul style="list-style-type: none"> <li>– wrong phasing of the motor</li> <li>– Wrong wiring of motor or feedback cable</li> </ul>                                                                              | <ul style="list-style-type: none"> <li>– Check <b>M-ROFF</b></li> <li>– Check wiring</li> </ul>                                                                                                                                                                               |
| 14 | <b>Motor over speed</b>      | <ul style="list-style-type: none"> <li>– wrong phasing of the motor</li> <li>– Wrong wiring of motor or feedback cable</li> <li>– High speed overshoot (more than <math>1.2 * V-NMAX</math>)</li> </ul>        | <ul style="list-style-type: none"> <li>– Check <b>M-ROFF</b></li> <li>– Check wiring</li> <li>– Optimise control loops</li> </ul>                                                                                                                                             |
| 15 | <b>Following error</b>       | <ul style="list-style-type: none"> <li>– Following error window <b>P-PEMAX</b> too small</li> </ul>                                                                                                            | <ul style="list-style-type: none"> <li>– Increase <b>P-PEMAX</b> and/or optimise control loops</li> </ul>                                                                                                                                                                     |
| 16 | <b>Trajectory error</b>      | <ul style="list-style-type: none"> <li>– Position change results in speed set point of &gt; 10000 rpm</li> </ul>                                                                                               | <ul style="list-style-type: none"> <li>– Check setting of <b>P-PSCALE</b> and <b>P-SSCALE</b> and position set point generation of the controller</li> </ul>                                                                                                                  |
| 17 | <b>Host communication</b>    | <ul style="list-style-type: none"> <li>– Two set point or actual value telegrams in series were wrong or not sent</li> <li>– Internal communication error in combination with the used option board</li> </ul> | <ul style="list-style-type: none"> <li>– Synchronisation is not locked. Check <b>A-CTIME</b> and accuracy of the cycle time of the controller</li> <li>– <b>A-STIME</b> is not set right</li> <li>– Communication is disturbed</li> <li>– See also <b>I-DError</b></li> </ul> |
| 18 | <b>Drive Error E2</b>        | <ul style="list-style-type: none"> <li>– Different internal faults</li> </ul>                                                                                                                                  | <ul style="list-style-type: none"> <li>– See also <b>I-DError</b></li> <li>– Contact manufacturer</li> </ul>                                                                                                                                                                  |
| 19 | <b>Drive Error E1</b>        | <b>Different internal faults</b>                                                                                                                                                                               | <ul style="list-style-type: none"> <li>– See also <b>I-DError</b></li> <li>– Contact manufacturer</li> </ul>                                                                                                                                                                  |

|    |                                             |                                                                                                                                                                                              |                                                                                                                                                                     |
|----|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                                             | <b>Power stage fault:</b> <ul style="list-style-type: none"> <li>motor cable has (ground) short circuit</li> <li>motor has (ground) short circuit</li> <li>power stage is damaged</li> </ul> | <ul style="list-style-type: none"> <li>replace motor cable</li> <li>replace motor</li> <li>replace drive</li> </ul>                                                 |
|    |                                             | <b>Regen fault:</b> <ul style="list-style-type: none"> <li>regen resistor has (ground) short circuit</li> <li>regen power stage is damaged</li> </ul>                                        | <ul style="list-style-type: none"> <li>replace module rack</li> <li>replace drive</li> </ul>                                                                        |
| 20 | <b>Enable locked fault</b>                  | <ul style="list-style-type: none"> <li>Drive is software enabled without enabling the safety function</li> </ul>                                                                             | <ul style="list-style-type: none"> <li>Enable drive only if ENABLE_H = high and ENABLE_L = low</li> </ul>                                                           |
| 21 | <b>Driver voltage fault</b>                 | <ul style="list-style-type: none"> <li>The supply voltage of the power stage drivers is switched off, when the drive is enabled</li> </ul>                                                   | <ul style="list-style-type: none"> <li>Enable drive only if ENABLE_H = high and ENABLE_L = low</li> </ul>                                                           |
| 22 | <b>DC over voltage and regen limitation</b> | <ul style="list-style-type: none"> <li>regen power is insufficient. Regen power limit was reached and the regen resistor was switched off.</li> </ul>                                        |                                                                                                                                                                     |
| 23 | <b>Brake supply fault</b>                   | <ul style="list-style-type: none"> <li>Holding brake supply +24 V-BR is not supplied when software enable is set (<b>M-BRAKE</b> = 1)</li> </ul>                                             | <ul style="list-style-type: none"> <li>When the motor has a holding brake, enable the drive only when the holding brake input +24 V-BR is supplied</li> </ul>       |
| 24 | <b>Brake enable fault</b>                   | <ul style="list-style-type: none"> <li>not available</li> </ul>                                                                                                                              |                                                                                                                                                                     |
| 25 | <b>I2t fault</b>                            | <ul style="list-style-type: none"> <li>When <b>I-I2T</b> exceeds the warning level <b>A-I2TERR</b></li> </ul>                                                                                | <ul style="list-style-type: none"> <li>Increase the level <b>A-I2TERR</b></li> </ul>                                                                                |
| 26 | <b>Motor temperature warning</b>            | <ul style="list-style-type: none"> <li>When motor temperature <b>I-TEMPM</b> exceeds the warning level <b>A-TEMPMW</b></li> </ul>                                                            | <ul style="list-style-type: none"> <li>Increase the warning level <b>A-TEMPMW</b></li> </ul>                                                                        |
| 27 | <b>Motor Parameter Error</b>                | <ul style="list-style-type: none"> <li>When a feedback system with parameter storage has no valid data</li> </ul>                                                                            | <ul style="list-style-type: none"> <li>Store valid data in the feedback</li> <li>Replace Motor</li> </ul>                                                           |
| 28 | <b>Multiturn Revolution Error</b>           | <ul style="list-style-type: none"> <li>When the multiturn EnDat or Hiperface encoder has a overflow</li> </ul>                                                                               | <ul style="list-style-type: none"> <li>Multiturn range exceeds the 4096 revolutions</li> <li>Multiturn range has to adjusted to the range of the machine</li> </ul> |
| 29 | <b>Max. Sum Power Limitation</b>            | <ul style="list-style-type: none"> <li>When the sum output power of all axes exceeds the power supply limitation</li> </ul>                                                                  | <ul style="list-style-type: none"> <li>Servo drive system meets not the demands of the Application</li> </ul>                                                       |
| 30 | <b>reserved</b>                             |                                                                                                                                                                                              |                                                                                                                                                                     |
| 31 | <b>Fan error</b>                            | <ul style="list-style-type: none"> <li>The fan does not reach the minimum rotation speed.</li> </ul>                                                                                         | <ul style="list-style-type: none"> <li>Exchange axis module.</li> </ul>                                                                                             |

## 8 VARAN Recommended Shielding

The VARAN real-time Ethernet bus system offers robust performance in harsh industrial environments. Through the use of IEEE 802.3 standard Ethernet physics, the potential between an Ethernet line and sending/receiving components is kept separate. The VARAN Manager resends messages to a bus participant immediately when an error occurs. It is principally recommended that the shielding guidelines below be followed.

For applications in which the bus line is run outside the control cabinet, correct shielding is required. This is especially important, if due to physical requirements, the bus lines must be placed next to sources of strong electromagnetic noise. It is recommended that whenever possible, to avoid wiring VARAN-Bus lines parallel to power cables.

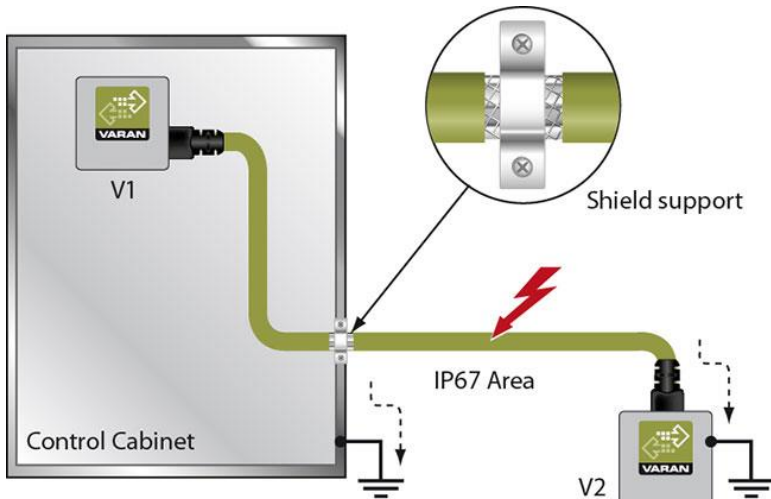
SIGMATEK recommends the use of **CAT5e** industrial Ethernet bus lines.

For the shielding variants, an S-FTP bus line is recommended, which is a symmetric, multi-wire cable with unshielded pairs. For the total shielding, a combination of foil and braiding is used; it is recommended that an unvarnished variant be used.

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

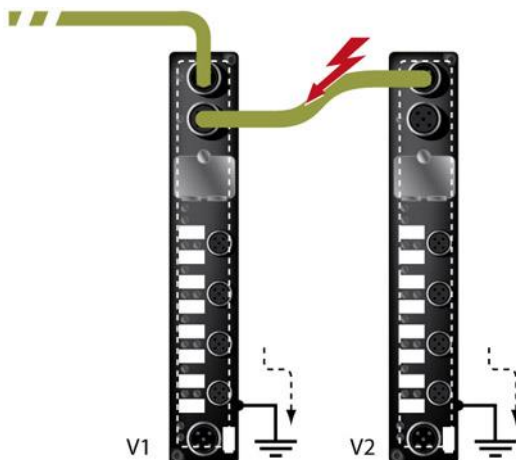
## 8.1 Wiring from the Control Cabinet to an External VARAN Component

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



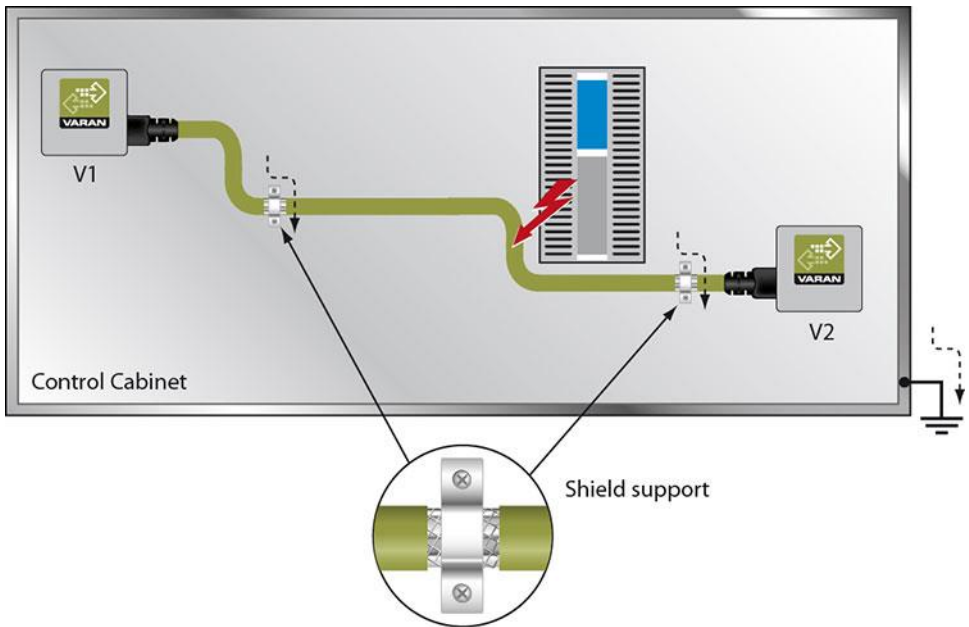
## 8.2 Wiring Outside of the Control Cabinet

If a VARAN bus cable must be placed outside of the control cabinet only, no additional shield connection is required. This requires that only IP67 modules and connectors be used. These components are very robust and noise resistant. The shielding for all sockets in IP67 modules are internally connected to common bus or electrically connected to the housing, whereby the deflection of voltage spikes does not flow through the electronics.



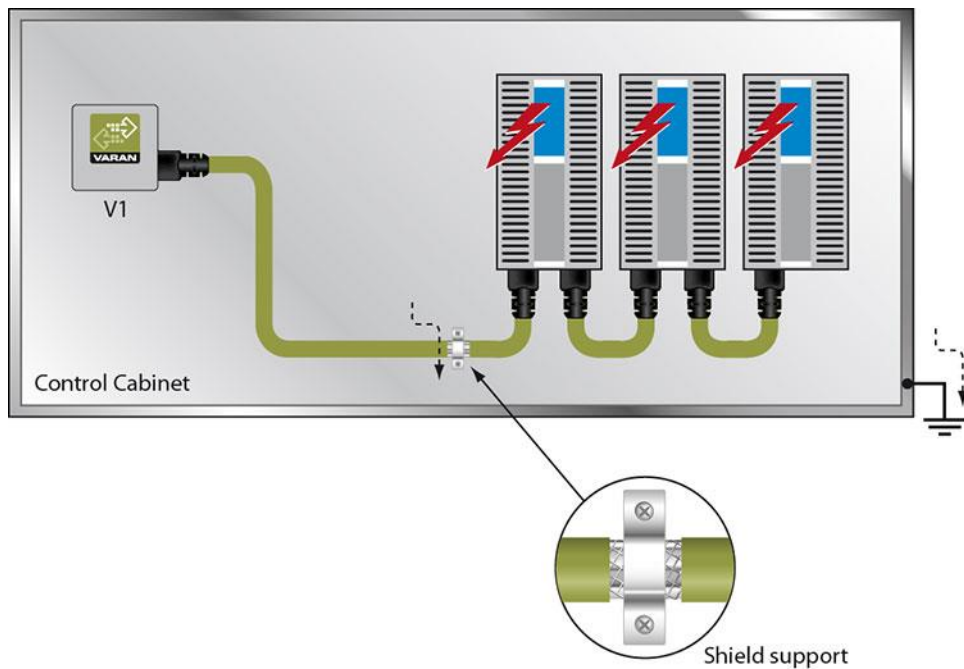
### 8.3 Shielding for Wiring Within the Control Cabinet

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 transfer, it is recommended that the shielding from all electronic components be connected within the control cabinet.



## 8.4 Connecting Noise-Generating Components

With the connection of power components that generate strong electromagnetic noise, it is also critical to ensure correct shielding. The shielding should be placed before a power component (or a group thereof).



## 8.5 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 to both cabinets. Noise can thereby be kept from reaching the electronics within the control cabinet.

