

# Module Carrier MDM 011, 021, 031 and 041

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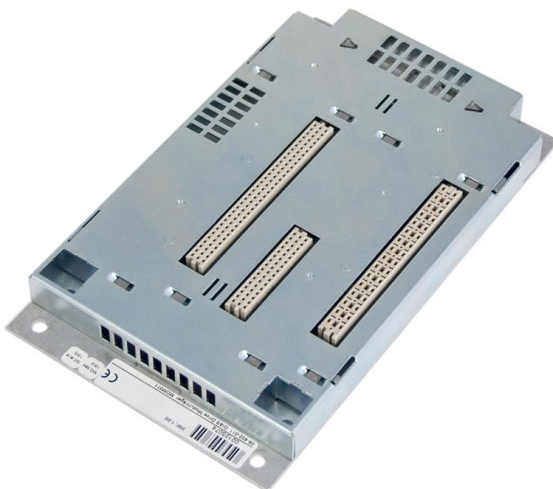
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# 1 Overview

The module carrier MDM serves as a mount in the control cabinet for the individual modules. For the highest possible flexibility and to optimize the control cabinets space the module carrier is available for 2, 3, 4 or 5 modules.

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 230 V and 400 V, which have a scalable output current range of the 2 axes.

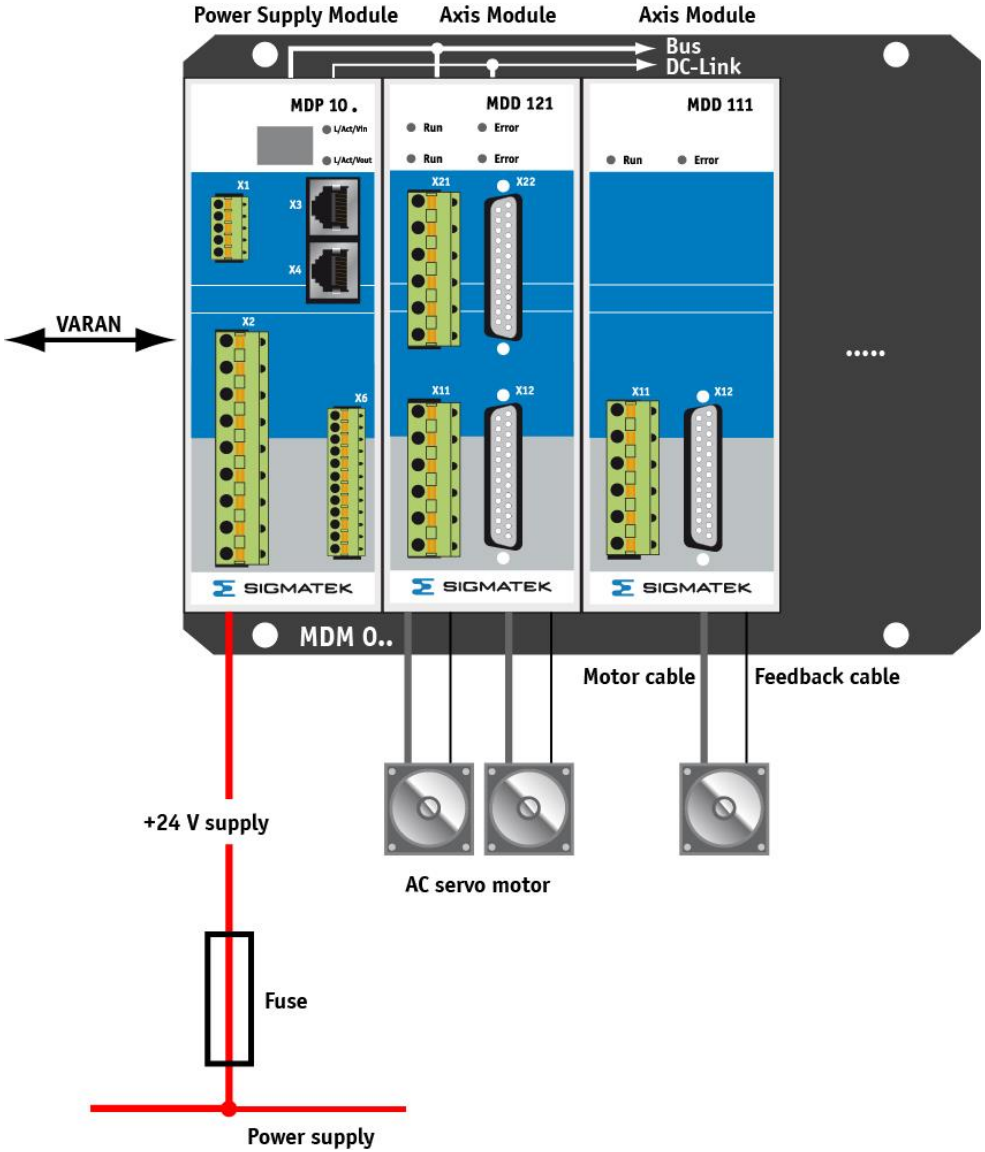
The supply module and the axes modules are put on a module carrier, which is mounted on the mounting plate of the cabinet.

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.

# 1.1 Components of a servo system



## 2 General

### 2.1 About this manual

The manual describes the MDM 011, 021, 031 and 041 module carrier.

The information provided is:

- Technical Data for the module carriers
- 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 3.5mA. 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 take 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, represented by EN 60204, and the EC Directive on EMC 2004/108/EC



**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 EC Directive on EMC 2004/108/EC and the Low Voltage Directive 2006/95/EC 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 2006/95/EC.

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 EMC Directive 2004/108/EC.

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.

- Anyone who works with the products in any way has to read and understand the safety instructions, the prescribed use and the non-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 personnel or property.
- The servo drive has to operate 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 in which they are delivered (without any mechanical or electrical modification).
- Do not mount or start-up mechanically or electrically damaged or faulty components.
- The servo drive is intended to control synchronous servo, linear, torque and asynchronous 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 system.
- The servo drive is developed for usage in an 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.

## 2.6 Non-prescribed use

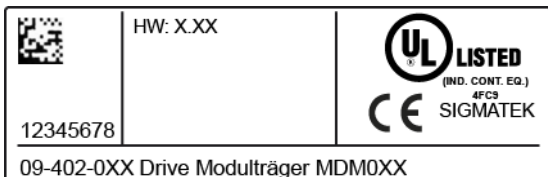
“Prescribed use” means, that the servo drive system is used according to the environmental conditions described in this documentation.

- 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.)

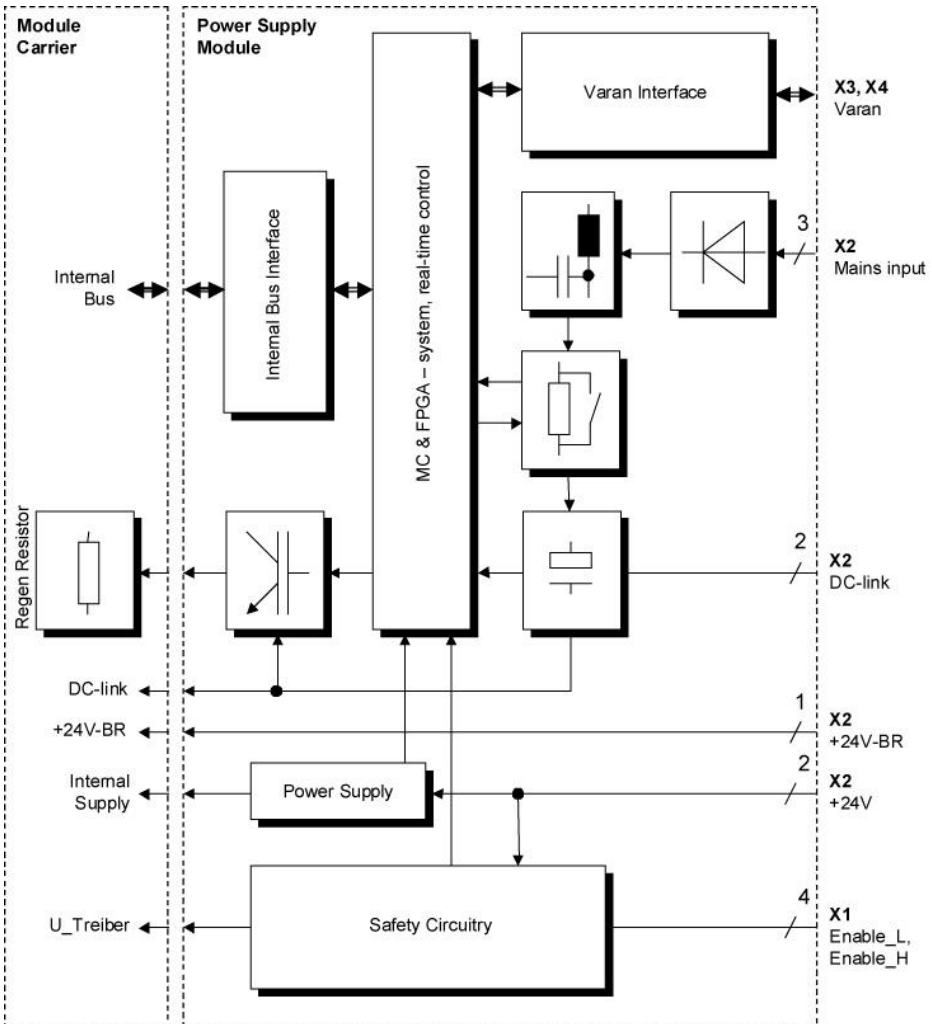
Be very careful in plants, where conductive material (carbon fiber, graphite with machining of graphite cast iron or similar) is easily purgeable in the factory floor. In this case, the switchgear cabinet has to be sealed very carefully (no forced ventilation with blower filter) or be placed outside 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 Series label

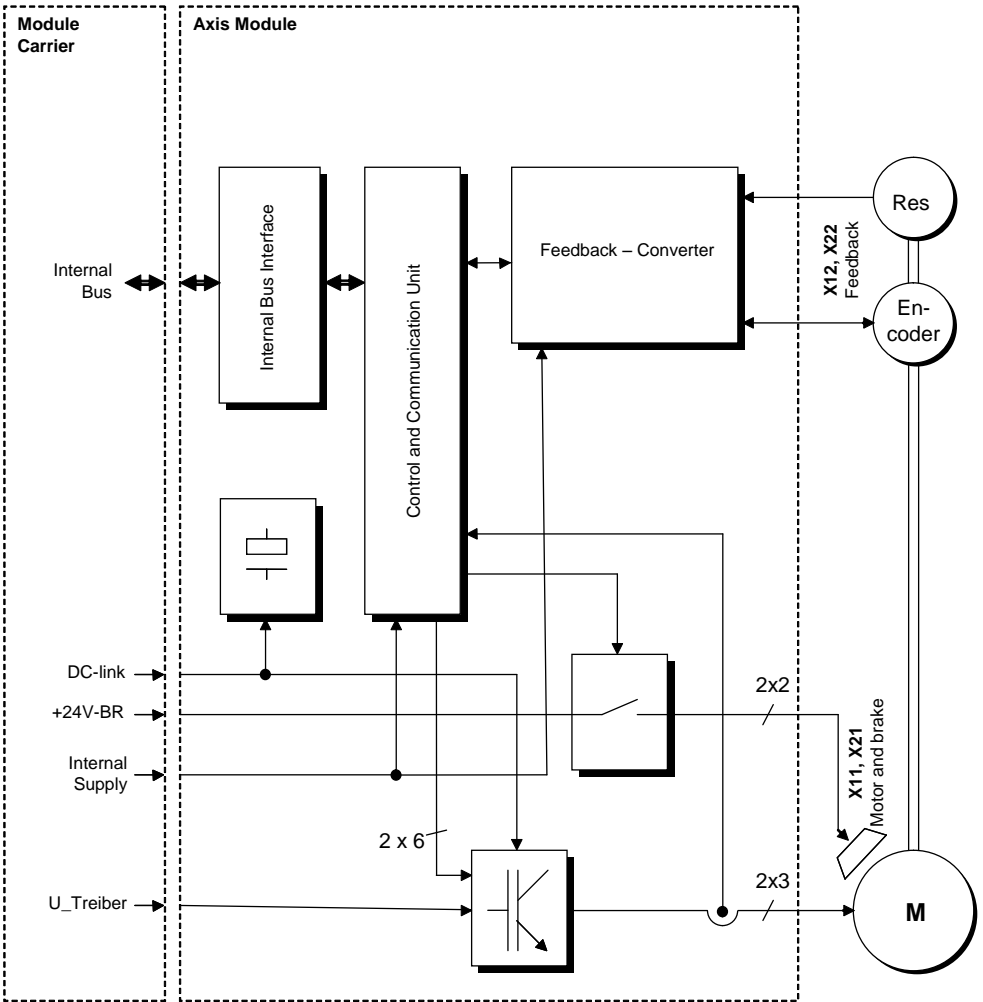
The series label is placed on the backside of the module carrier.



## 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<sup>2</sup>T 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 Module Carrier

	DIM	MDM011	MDM021	MDM031	MDM041
Article number		09-402-011	09-402-021	09-402-031	09-402-041
<b>Rated Data</b>					
Wattage of the regen resistor <sup>1)</sup>	W	30	50	50	70
Value of internal regen resistor	Ω	100	33		
Number of axes modules	-	1	2	3	4
<b>Mechanics</b>					
Height	mm	187.5			
Width	mm	120	180	240	300
Depth	mm	18			
Weight	kg	0.6	0.8	1	1.2
<b>General</b>					
Standard		UL 508C, NMMS.E336350			

- 1) The wattage of the regen resistor is calculated for a mounting plate size in the cabinet of 0.5 m x 0.5 m = 0.25 m<sup>2</sup>. If a smaller size is used, the wattage of the regen resistor has to be reduced by following formula:

$$P_{\text{regen\_red}} = A_{\text{mp}} / 0.25 \text{ m}^2 * P_{\text{regen\_max}}$$

$P_{\text{regen\_max}}$  Value given from the table  
 $A_{\text{mp}}$  Mounting plate size in m<sup>2</sup>  
 $P_{\text{regen\_red}}$  Reduced value for the regen wattage

## 2.10 Ambient conditions, ventilation and mounting

Storage conditions	⇒ page 50
Transport conditions	⇒ page 50
Ambient temperature in operation	0 to +45 °C (32 to 113 °F) at rated data +45 to 55 °C (113 to 131 °F) with power derating of 2.5 % / K
Humidity in operation	Relative humidity 85 %, no condensation
Site altitude	Up to 1000 m above sea level at rated data 1000 to 2500 m above sea level with derating of 1.5 % / 100 m
Pollution degree	Pollution degree 2
Servo drive enclosure protection class	IP 20
Mounting position	⇒ page 29
Ventilation	Forced ventilation by controlled internal fan

## 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 24.
- 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 34.

- Route the motor and control cables separately (distance about 100mm). 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 0.4s. Following actions which need the safety function STO (Safe Torque off) e.g. manually engagement into the machine, must not be released before 1s

- 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.

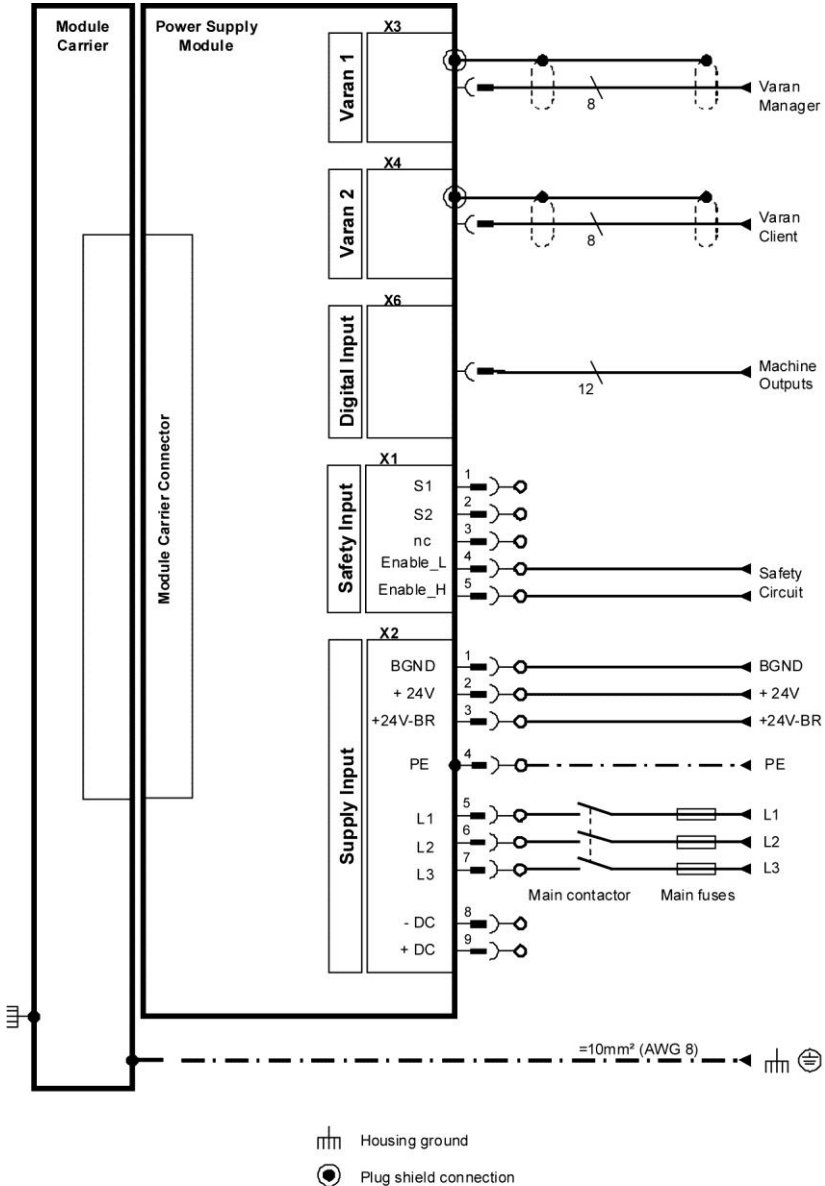


- Taking measures for cleaning, maintenance and repair
- Taking out of service for a longer time

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

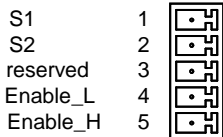
### 3.3 Planning of the switchgear cabinet

#### 3.3.1 Connection diagram and pin assignment of power supply module

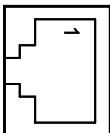




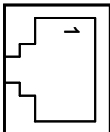
**Safety Input  
X1**



**Varan 1  
X3**



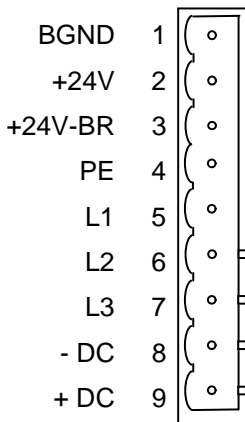
1	TX/RX+
2	TX/RX-
3	RX/TX+
6	RX/TX-
4,5,7,8	-



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

**Varan 2  
X4**

**Supply Input  
X2**

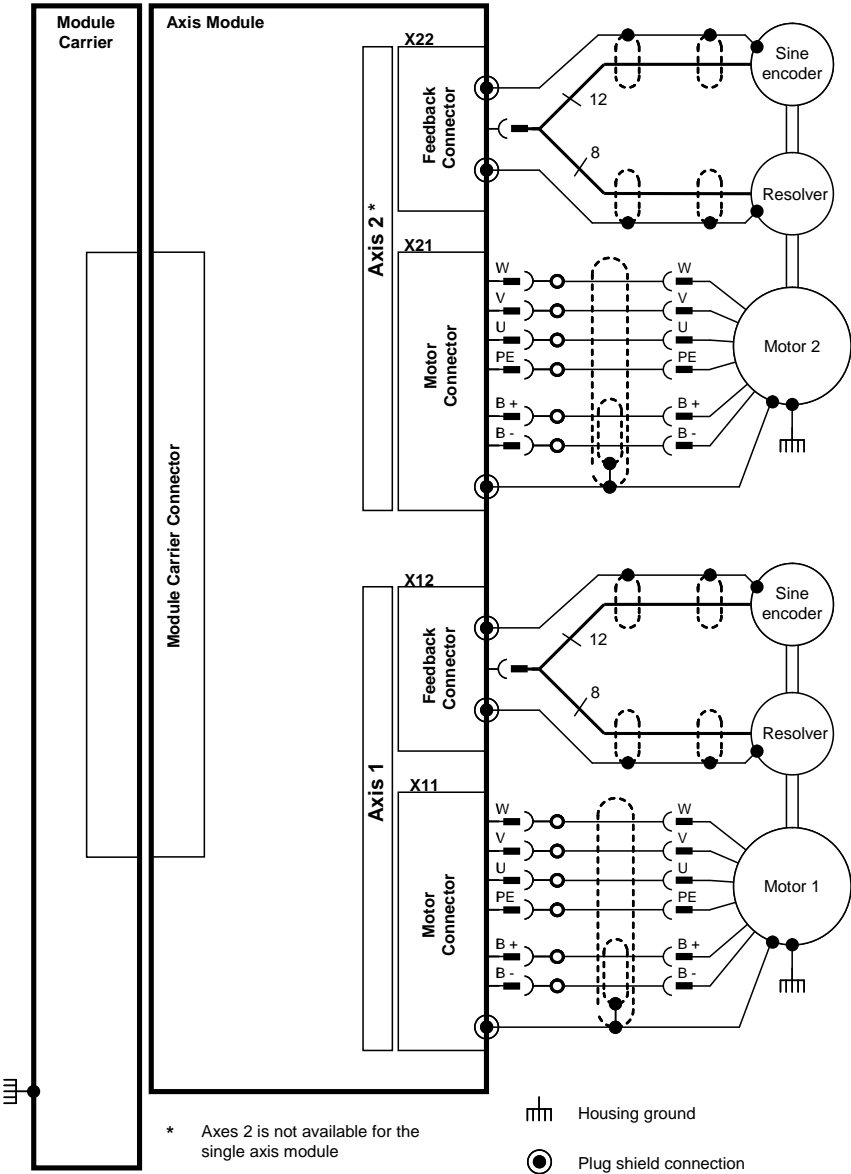


**Digital Input  
X6**

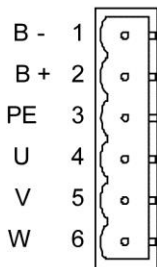


12	V_BAT
11	V_BAT_GND
10	reserved
9	Dig_IN1
8	Dig_IN2
7	Dig_IN3
6	Dig_IN4
5	Dig_IN5
4	Dig_IN6
3	Dig_IN7
2	Dig_IN8
1	24V_GND_IO

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

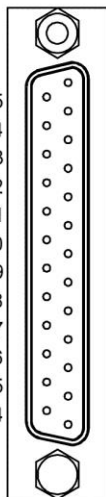


**Motor  
(X11, X21)**



Resolver R1 (Reference -) ResR1 18  
 Resolver S1 (Cosinus +) ResS1 17  
 Resolver S4 (Sinus +) ResS4 16  
 Gnd\_e 15  
 Ground Gnd\_e 14

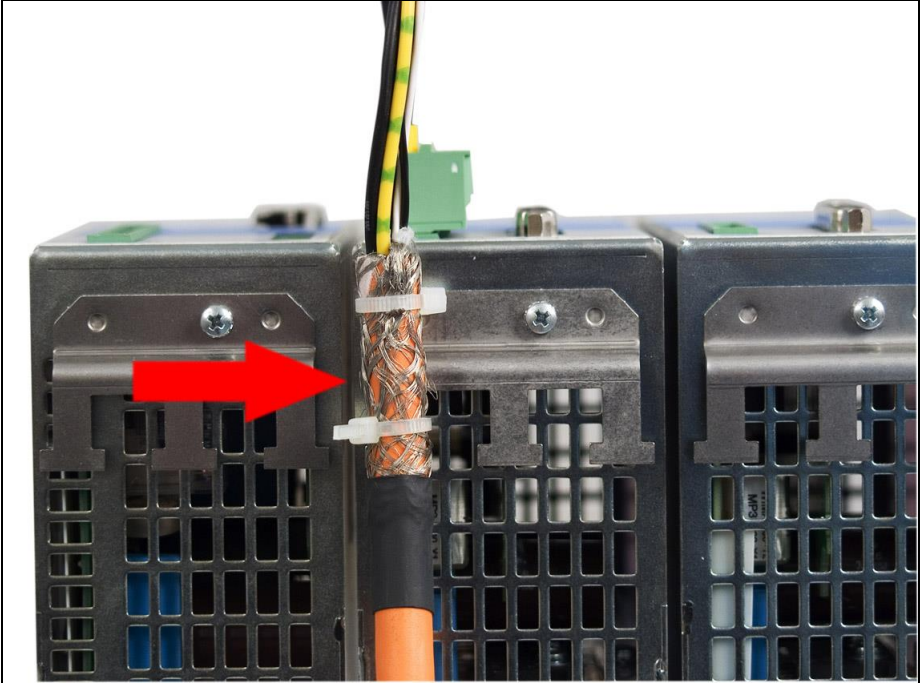
**Feedback  
(X12, X22)**



Gnd\_e 25  
 CLOCK + 24  
 DATA - 23  
 Gnd\_e 22  
 D-IN + 21  
 B - (Cosine) 20  
 A - (Sine) 19  
 ResR2 Resolver R2 (Reference +) 13  
 ResS3 Resolver S3 (Cosinus -) 4  
 ResS2 Resolver S2 (Sinus -) 3  
 V-BAT 2  
 d Motor Thermal contact 1

### 3.3.3 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.

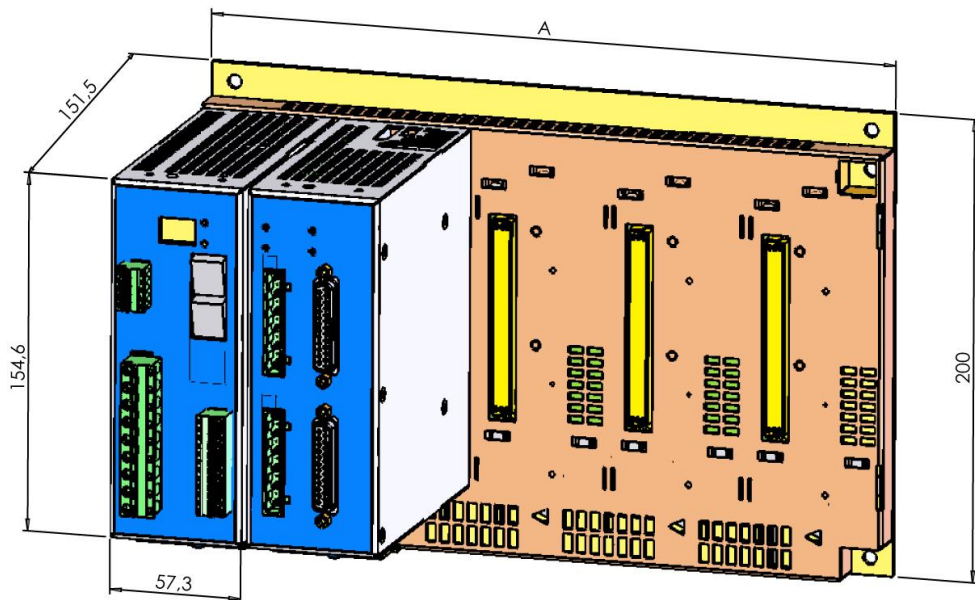


The grounding can be done with an eyelet through the right or the left drill hole.



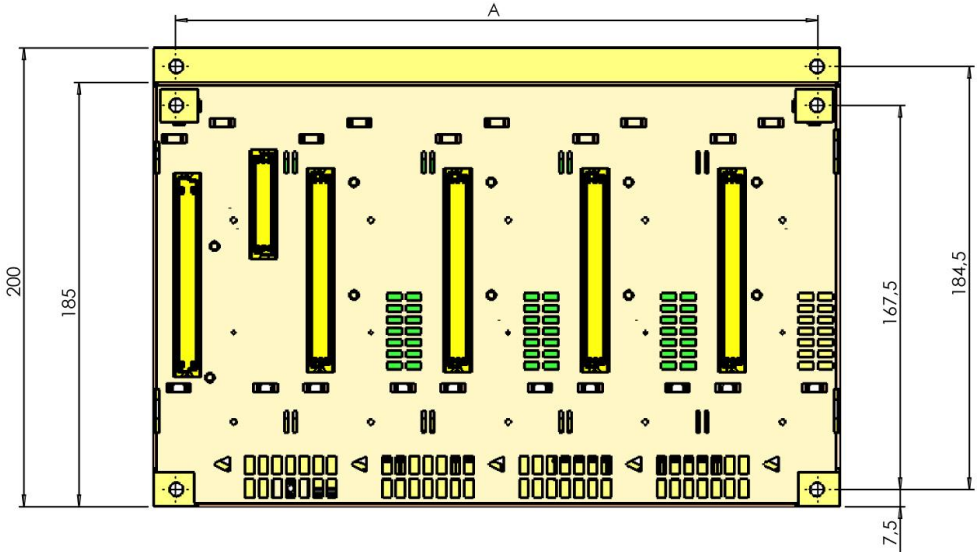
The entire MDD System is grounded over the module carrier in the control cabinet.

### 3.3.4 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

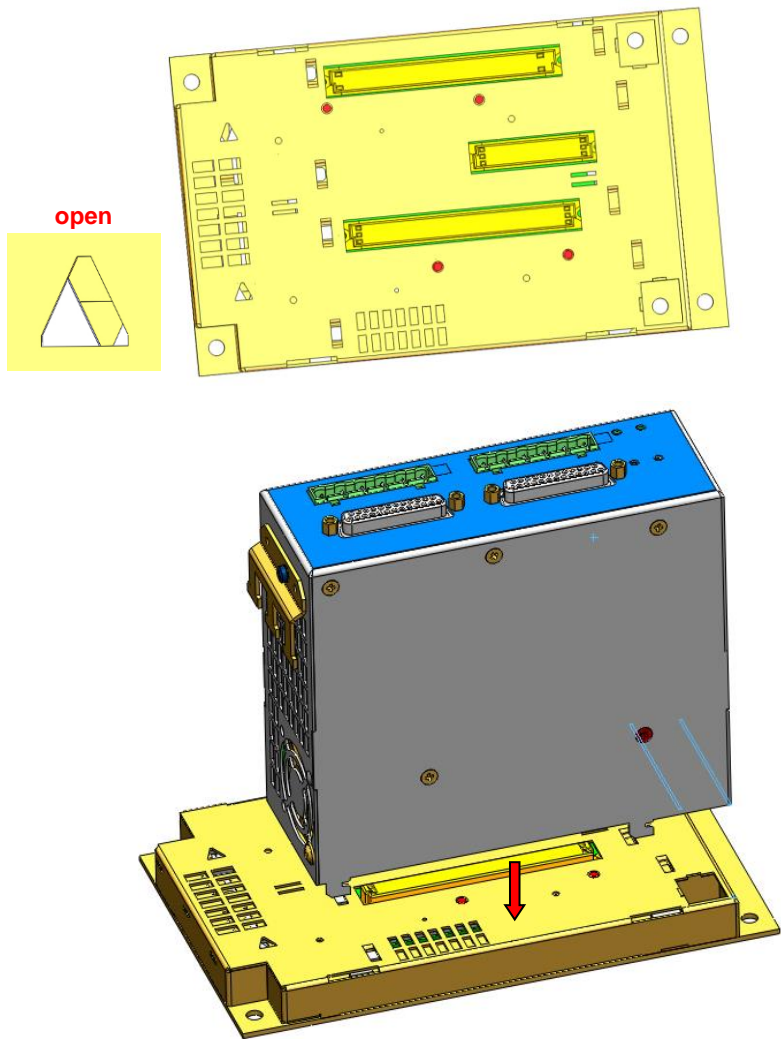
The cable ducts below must be placed with a minimum distance of 10 mm to the module carrier.

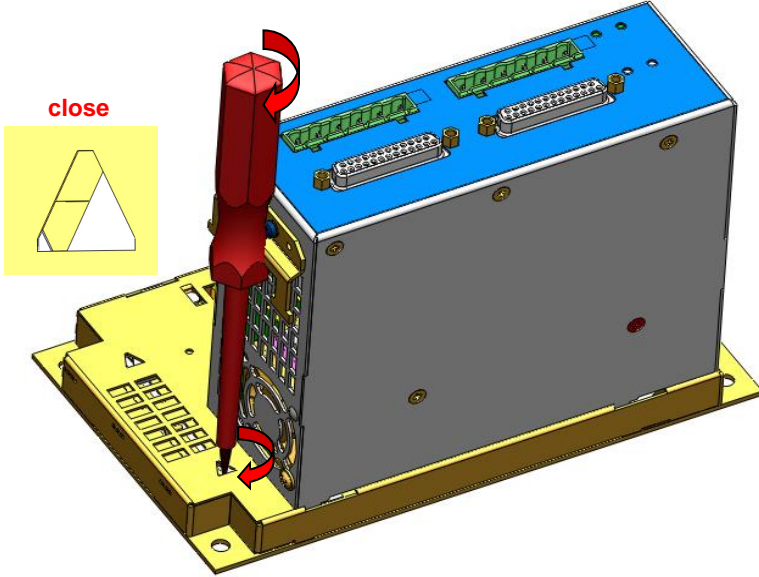
The cable duct above must be placed with a distance of 40 mm to the module carrier. This is necessary to get enough air through the heat sink.

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 -

### 3.3.5 Module mounting







### 3.3.6 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/9-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)

### 3.3.7 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.25 m, 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 <120 pF/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!

### 3.3.8 External Fusing

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

Signal	Fuses, time delay
AC mains input (L1-L3)  The fuse ratings depend on the MDP modules used.	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)
24 VDC input (24 V, 24 V-BR to BGnd)	Limited to 12 A time delay at 2.5 mm <sup>2</sup> / 14 AWG

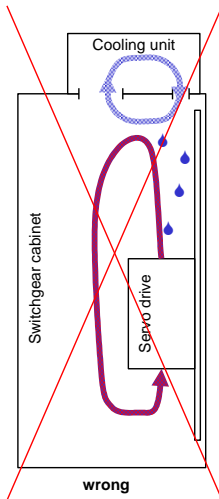
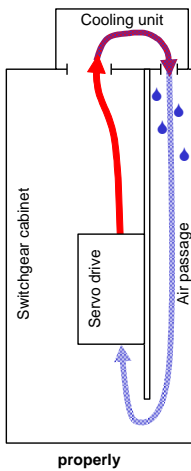
### 3.3.9 Usage of cooling units

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.

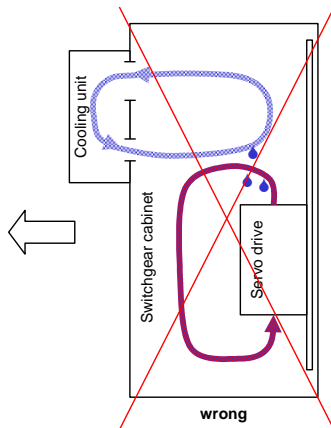
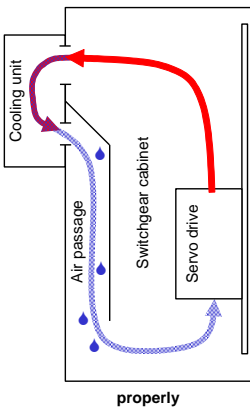


Note: Principally, the usage of a cooling unit can and will produce condensation water. So it is important to observe following:

- 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



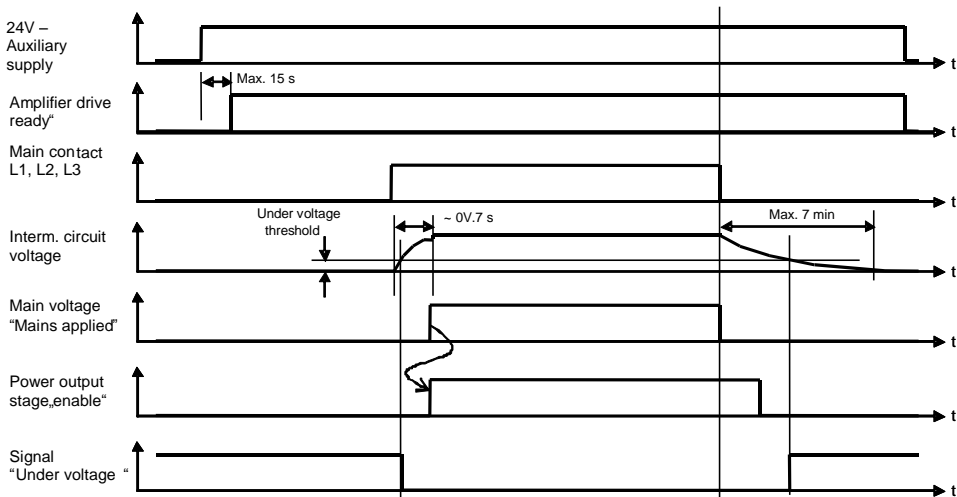
Cooling unit in the door of the switchgear cabinet

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.

### 3.3.10 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.

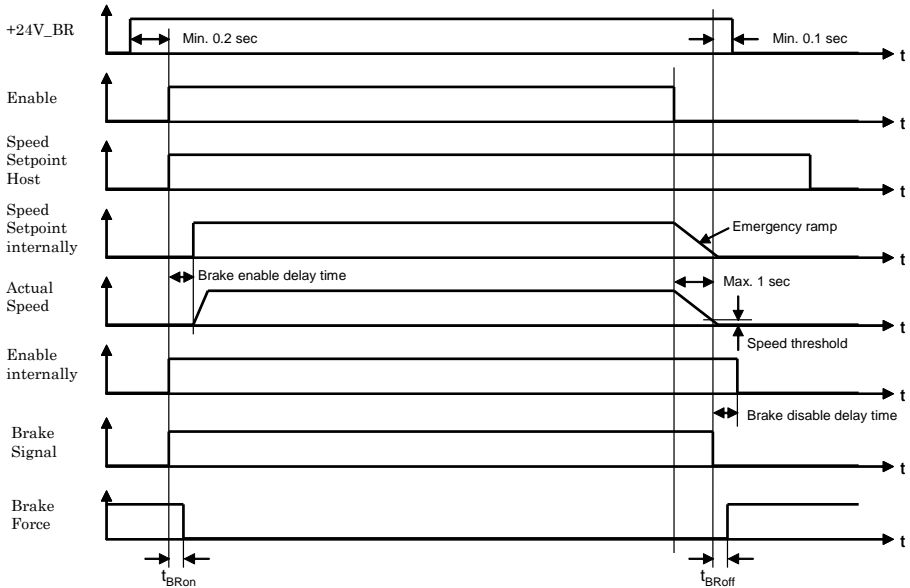
Since the memory of the servo amplifier is volatile, received parameters must be stored in the host controller. The advantage here lies in the automatic download of program data when an amplifier is changed.

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.

### 3.3.11 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.

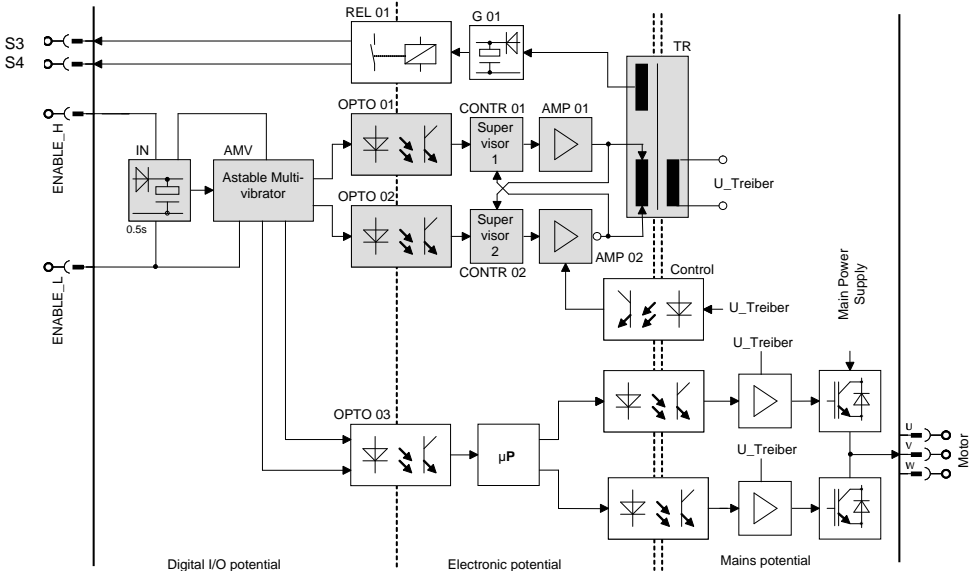
The relay output S1/S2 can be used to provide the status of the safety function. It is not safety-relevant, but can be used to test the external safety function.

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**

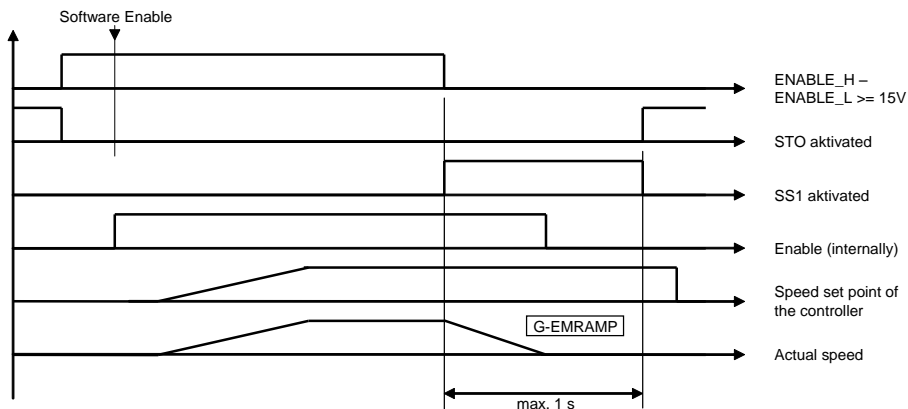
The relay output S1/S2 is closed when the servo amplifier is supplied with 24 V and the safety function is active. The two blocks are not safety-relevant.

## 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.

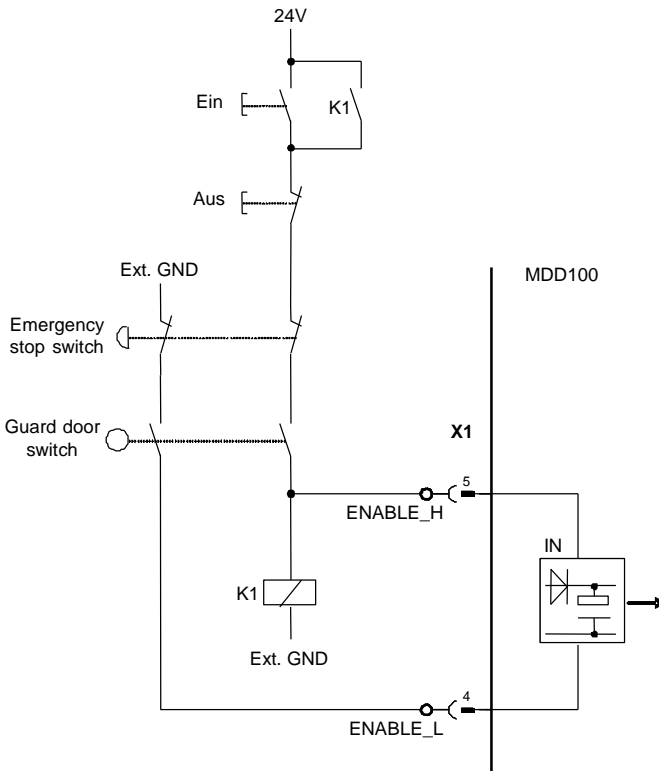
### 4.4 Example Connection with Switching Contacts

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. This can occur through, for example, wiring in a cable duct.



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

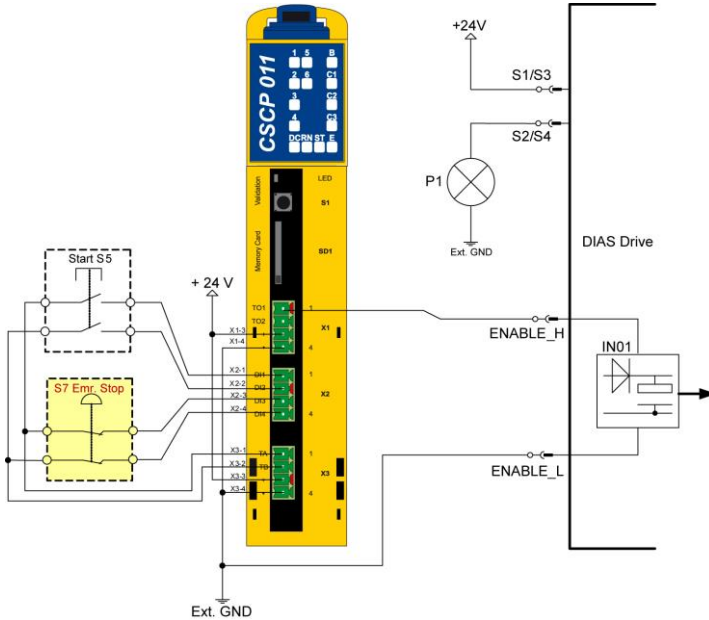
## 4.5 Example: Safety PLC Application

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.

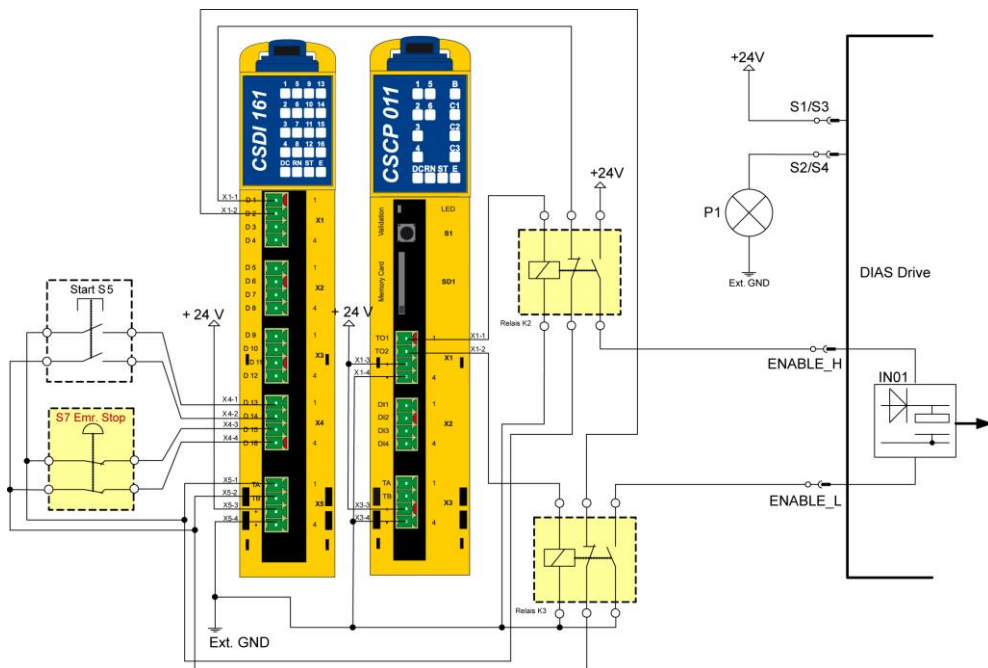
There are two Types of error-safe outputs.

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"



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



## 5 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.

### 5.1 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



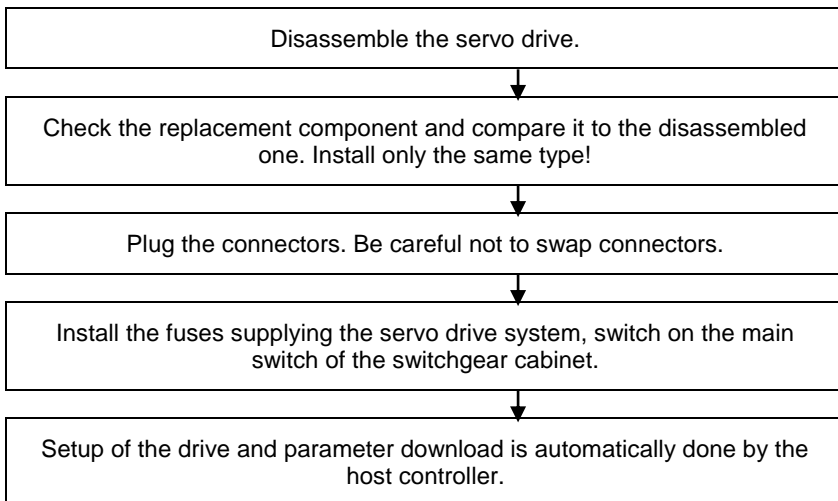
Wait at least 7 minutes after disconnecting the servo drive system from the mains supply voltage before touching live sections of the equipment (e.g. contacts) or undoing connections. Capacitors can still have dangerous voltages present up to 7 minutes after switching off the supply voltages. To be sure, 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.





## 6 Appendix

### 6.1 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.

## 6.2 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
– <b><i>I-FPOS</i> shows decrementing values when the motor rotates clockwise (view of the motor shaft)</b>	– Feedback system is not connected correctly	– Connect feedback system according to drawing
– <b>Motor does not rotate</b> – <b>Motor current is at the limit without torque</b>	– Motor is not connect in correct orientation	– Connect motor in correct relation to terminals U, V, W
– <b>The motor casts without set point</b> – <b>The motor torque is too low or different in the both directions</b>	– <b><i>M-OFF</i></b> is not set to the right value – Motor and/or feedback connection is wrong	– Set <b><i>M-OFF</i></b> to the right value – Connect motor and feedback correctly
– <b>The motor stops in certain positions</b>	– The setting of <b><i>M-POL</i></b> and/ or <b><i>M-RPOL</i></b> is not correct – The motor cable has a broken wire – Not all wires of the motor cable are connected	– Set <b><i>M-POL</i></b> and <b><i>M-RPOL</i></b> according to the to the data of the motor – Replace motor cable (especially with drag chains) – Connect all wires of the motor cable
– <b>The motor oscillates</b>	– Control gain too high – Shielding of the feedback cable has a break	– Reduce <b><i>V-KP</i></b> and/or <b><i>P-KV</i></b> – 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>	– Drive is software enabled without enabling the safety function	– Enable drive only if ENABLE_H = high and ENABLE_L = low
21	<b>Driver voltage fault</b>	– The supply voltage of the power stage drivers is switched off, when the drive is enabled	– Enable drive only if ENABLE_H = high and ENABLE_L = low
22	<b>DC over voltage and regen limitation</b>	– regen power is insufficient. Regen power limit was reached and the regen resistor was switched off.	
23	<b>Brake supply fault</b>	– Holding brake supply +24V-BR is not supplied when software enable is set ( <b>M-BRAKE</b> = 1)	– When the motor has a holding brake, enable the drive only when the holding brake input +24V-BR is supplied
24	<b>Brake enable fault</b>	– not available	
25	<b>I2t fault</b>	– When <b>I-<i>I2T</i></b> exceeds the warning level <b>A-<i>I2TERR</i></b>	– Increase the level <b>A-<i>I2TERR</i></b>
26	<b>Motor temperature warning</b>	– When motor temperature <b>I-<i>TEMPM</i></b> exceeds the warning level <b>A-<i>TEMPMW</i></b>	– Increase the warning level <b>A-<i>TEMPMW</i></b>
27	<b>Motor Parameter Error</b>	– When a feedback system with parameter storage has no valid data	<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>	– When the multiturn EnDAT or Hiperface encoder has a overflow	<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>	– When the sum output power of all axes exceeds the power supply limitation	– Servo drive system meets not the demands of the Application
30	<b>reserved</b>		
31	<b>Fan error</b>	– The fan does not reach the minimum rotation speed.	– Exchange axis module.



## 7 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.

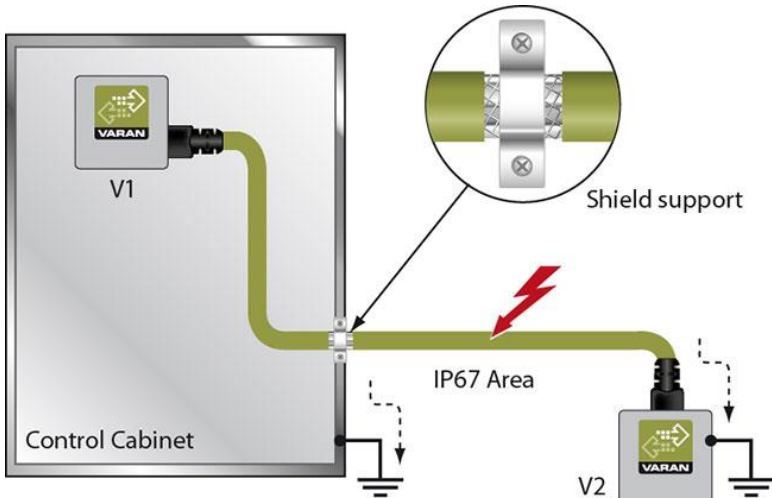
SIGMATEK recommends the use of **CAT5e** industrial Ethernet bus lines.

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!**

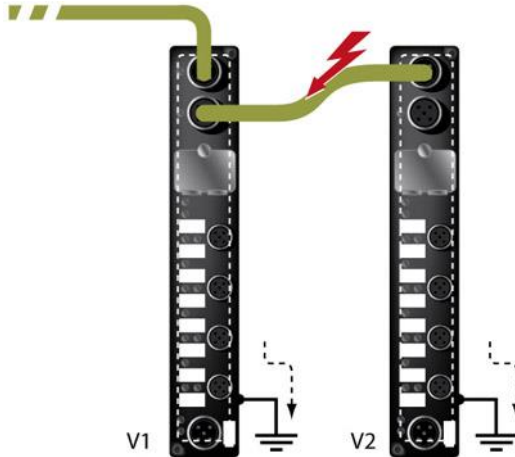
## 7.1 Wiring from the Control Cabinet to an External VARAN Component

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.



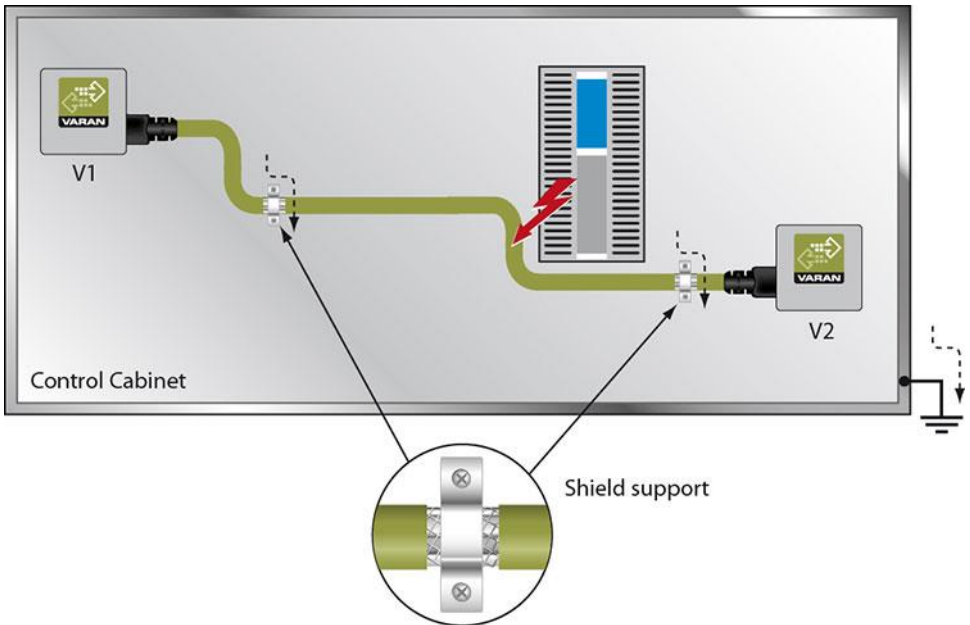
## 7.2 Wiring Outside of the Control Cabinet

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.



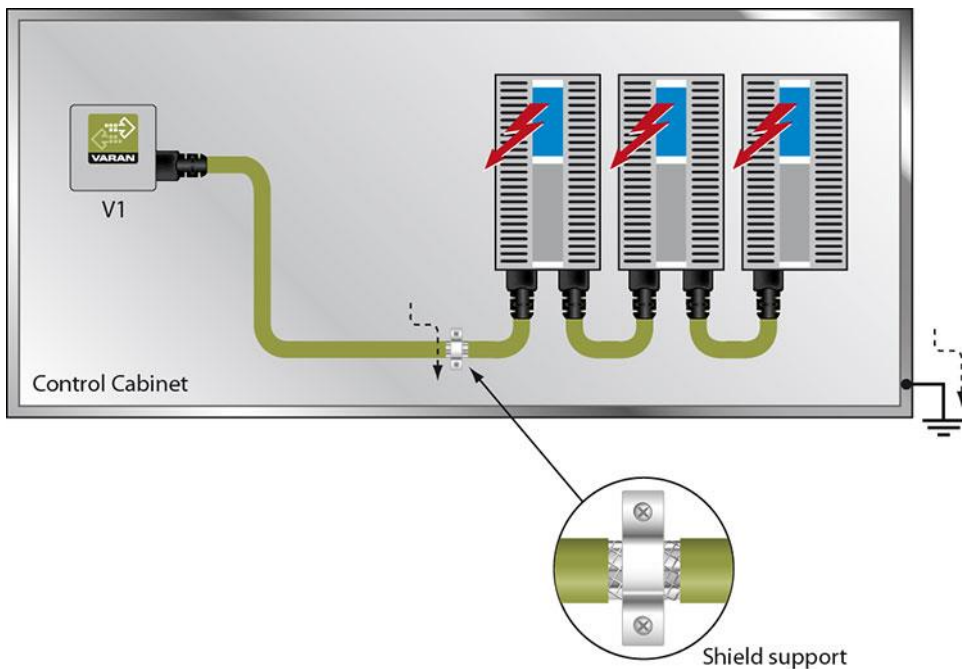
### 7.3 Shielding for Wiring Within the Control Cabinet

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.



## 7.4 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).



## 7.5 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.

