USER MANUAL

# MSC III USER MANUAL

## ORIGINAL INSTRUCTIONS

Rev. A, May 2018

THIS DOCUMENT DESCRIBES THE INSTALLATION, OPERATION AND MAINTENANCE OF THE MOOG MSC III MOTION CONTROLLER

WHAT MOVES YOUR WORLD

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# Foreword

This manual "MSC III User Manual" has been prepared in accordance with EN 82079, "Preparation of instructions for use - Structuring, content and presentation".

The manual was written and checked at the best experience of Moog.

Moog has written this technical documentation in compliance with the requirements of the Machinery Directive 2006/42/EC.



# About Moog

Moog's Industrial Group designs and manufactures high performance motion control solutions combining electric, hydraulic, and hybrid technologies with expert consultative support in a range of applications including test, simulation, plastics, metal forming, and power generation.

Moog customers include leading automotive manufacturers, aerospace manufacturers, testing labs and global automotive racing teams.

We help performance-driven companies design and develop their next-generation machines.

Moog's Industrial Group is part of Moog Inc.

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# Document Version

The following table shows the version of this document and all other possible versions:

| ES | DA | DE | EL | EN | FR | IT | NL | PT | FL | SV | CS | ET | LV | HU | MT | PL | SK | SL | BG | RO | GA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | X | | | | | | | | | | | | | | | | | |

The language of documents and drawings are subject to contractual negotiations with the Customer.

In case of "Translation of the Original Instructions", the manufacturer of the machinery supplies also the "Original Instructions".

## Revision Record

The following table shows the revision record:

| Revision | Description | Prepared | Checked | Approved | Date |
|---|---|---|---|---|---|
| A | Initial version | Dieter Kleiner | | | May 2018 |
| | | | | | |
| | | | | | |
| | | | | | |

## Reader Instructions

The following tables show the symbols adopted in Moog documents:

| ⚠ DANGER |
|---|
| DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury. |

| ⚠ WARNING |
|---|
| WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury. |

| ⚠ CAUTION |
|---|
| CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. |

| NOTICE |
|---|
| NOTICE indicates possible property damage. |

The following table shows the structure of a warning:

| ① ⚠ **DANGER** ② | |
|---|---|
| **Moving machine parts!** | ③ |
| Entrapment hazard! | ④ |
| ▶ Do not enter danger zone! | ⑤ |

Legend

1 Warning symbol
2 Signal word
3 Type and source of hazard
4 Possible consequences of not avoiding the potential hazard
5 How to avoid the hazardous situation

The following table shows other typographic elements:

| Symbol | Explanation |
|---|---|
|  | Notes about important operations and other useful information |
| ▶ | This is an action to be carried out |
| • | This is a bullet list |
| Blue text | Identifies a hyperlink within the PDF file or to an external URL |
| | |
| | |

The following table shows the abbreviations adopted in Moog documents:

| Abbreviation | Explanation |
|---|---|
| AG | Analog Ground (Ground for the analog inputs and outputs) |
| CAN | Controller Area Network |
| CE | Communauté Européenne (European Community) |
| CiA | CAN in Automation, the international users' and manufacturers' group for CAN |
| CPU | Central Processing Unit |
| DC | Direct Current |
| DG | Digital Ground (Ground for the digital sensor interface) |
| DIN | Deutsches Institut für Normung e. V.<br>(German Institute for Standardization; http://www.din.de) |
| EEPROM | Electrically Erasable Programmable Read Only Memory |
| EIA | Electronic Industries Alliance (http://www.eia.org) |
| EMC | Electromagnetic Compatibility |
| EN | Europa-Norm (European Standard) |
| ESD | Electrostatic Discharge |
| IEC | International Electrotechnical Commission (http://www.iec.ch) |
| IP | International Protection (protection type) |
| ISO | International Organization for Standardizing (http://www.iso.org) |
| LED | Light Emitting Diode |
| LSB | Least Significant Bit |
| MASS | Moog Application Software Suite: An IEC 61131 development environment based on CODESYS 3 |
| MSC | Moog Servo Controller |
| NC | Not Connected |
| NVRAM | Non-volatile Random Access Memory |
| PLC | Programmable Logic Controller |
| RAM | Random Access Memory |
| SSI | Synchronous Serial Interface |
| TIA | Telecommunications Industry Association (http://www.tiaonline.org) |
| TÜV | Technischer Überwachungsverein<br>(German agency performing technical inspections) |
| USB | Universal Serial Bus |
| VDC | Volt Direct Current |
| VDE | Verband der Elektrotechnik Elektronik Informationstechnik<br>(Association for Electrical, Electronic & Information Technologies; http://www.vde.de) |

# Contents

## List of Tables

## List of Figures

# 1 Identification

The nameplate of the MSC III is located on the top side of the housing.

## 1.1 Nameplate and Type Designation

Figure 1 shows an example of the nameplate layout of the MSC III:

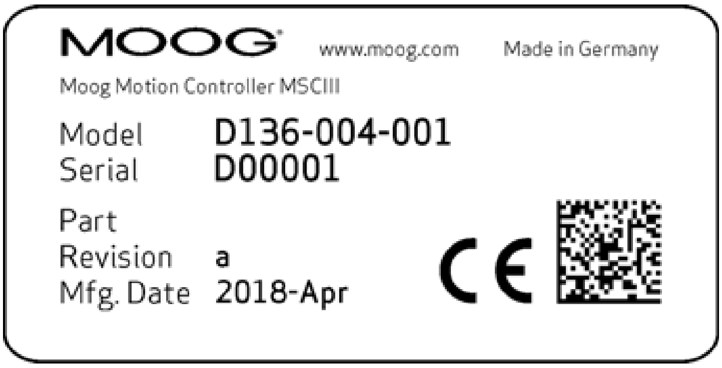



Figure 1: Nameplate of the MSC III

Table 1 shows the details about the information on the MSC III nameplate.

Table 1: Nameplate details

| Characteristic | Description |
|---|---|
| Model | Model number |
| Serial | Serial number |
| Revision | Revision |
| Mfg. Date | Manufacturing date in the format YYYY-Month |
| Data matrix code | The data matrix code includes the model number and the serial number |

## 1.2 Manufacturer Name and Address

Table 2 shows the contact information of the MSC III manufacturer.

Table 2: Information about the manufacturer

| Info | Description |
|---|---|
| Company | Moog GmbH |
| Address | Hans-Klemm-Str. 28 |
| Phone | +49 7031 622 0 |
| Fax | +49 7031 622 100 |
| E-Mail | info.germany@moog.com |
| Web Site | www.moog.com/industrial |

## 1.3 Declaration of Conformity

A copy of the EC Declaration of Conformity is available on request from info.germany@moog.com.

## 1.4 About this Manual

This manual is valid only for the MSC III. It contains the most important instructions that must be observed in order to operate the MSC III in a safe manner.

Every person responsible for machinery planning, mounting, and operation must read, understand, and follow all points covered in this manual. This applies especially to the safety instructions. Following the safety instructions helps to avoid accidents, faults, and material damage!

The following items must be observed as fundamental elements of safety when using the MSC III:

- All safety instructions contained in this manual
- All safety instructions contained in the product related hardware and software documentation required for the relevant application
- All relevant national and international applicable safety and accident prevention regulations and standards

### 1.4.1 Reservation of Changes and Validity

The information contained in this manual is valid at the release time of this version. See footer for version number and release date of this manual. Moog reserves the right to make changes to this manual at any time without specified reasons.

### 1.4.2 Exclusion of Liability

This manual was prepared with great care and the contents reflect the author's best knowledge. However, the possibility of error remains and improvements are possible.

Please feel free to submit any comments regarding errors or incomplete information to Moog.

Moog does not offer any guarantee that the contents conform to applicable legal regulations nor does Moog accept any liability for incorrect or incomplete information and the consequences thereof.

### 1.4.3 Completeness

This manual is complete only when used in conjunction with the product related hardware and software documentation required for the relevant application.

### 1.4.4 Place of Storage

This manual and all other associated documentation for hardware and software must always be kept in a location where they will be readily accessible and close to the MSC III or the equipment in which it is installed.

## 1.5 Software Copyrights

MASS firmware is licensed under the General Terms and Conditions for Software License of Moog GmbH available at: http://www.moog.de/ueber-moog/kontaktieren-sie-moog-deutschl.html

MASS Software may contain Open Source Software. If MASS Software contains Open Source Software, Licensee will receive with regard to such Open Source Software a license in accordance with the terms and conditions applicable to it.

Other products as part of an electrical system or subsystem may pre-equipped with software (e.g. operating system), which is licensed under the terms for software license of the manufacturer of that product. Please refer directly to these licenses.

The Open Source Software that is used as part of the MASS Software as well as the license terms and conditions applicable to it, are set out in the document "Open Source Software Licenses".

You may contact Moog, if you wish to receive the source code of the Open Source Software that is part of the Moog Software licensed to you. The contact details of Moog are as follows:

| **Info** | **Description** |
|---|---|
| Company | Moog GmbH |
| Department | Electronic & SW |
| Address | Hanns-Klemm-Str. 28<br>71034 Böblingen<br>Germany |
| E-Mail | M3000-support@moog.com |

# 2 Safety

This chapter summarizes the most important safety instructions. Follow the safety instructions to avoid accidents, faults, and material damage.

## 2.1 Selection and Qualification of Personnel

Only qualified users may work with and on the MSC III. Qualified users are properly trained experts with the required knowledge and experience. In particular, these experts must have the authorization to bring into operation, ground, and label devices, systems, and power circuits in accordance with safety engineering standards. Those people must be familiar with common safety concepts in automation.

## 2.2 Safety Related Systems

⚠ **WARNING**

**As with any electronic automation system, the failure of certain components when using MSC III might lead to an uncontrolled and/or unpredictable operational condition.**

There is a danger of uncontrolled behavior of the connected system.

- You have to take into consideration the system level effects of all types of failures and implement corresponding safety measures.

Special measures are required to use MSC III in safety related systems.

When planning to use MSC III in a safety related system, you must observe the applicable regulations and standards for safety related systems.

## 2.3 Use in Special Environments

In the following cases, the MSC III must not be used without taking additional measures:

- At sites with difficult operating conditions, like those caused by
  - Large amounts of dust
  - Elevated air humidity
  - Aggressive vapors or gases
  - Corrosive atmospheres
  - Potentially explosive environments

In these cases, the suitable additional measures to be taken may include, for example, installation in specially designed cabinets.

## 2.4 General Warnings

The product has been manufactured according to generally accepted standards of good engineering practice. Nevertheless, if these safety instructions are not adhered to, there is a risk of personal injury and damage to property when using the product.

| | |
|---|---|
| ! | Before commencing any work with the product, be sure to read the product documentation carefully and completely. |

| | |
|---|---|
| ! | Make sure these safety instructions and the product documentation are always accessible to all users. |

| | |
|---|---|
| ! | When passing the product on to third parties, always include these safety instructions and all the required documentation. |

| | |
|---|---|
| ! | The product may only be mounted, started up and maintained in accordance with these safety instructions and the information given in the product documentation. |

## 2.5 Safety Instructions

Observe the following safety instruction for your own safety.

### 2.5.1 Project Planning

The following instructions must be observed in order to ensure that the MSC III will be safely integrated into its application environment:

- IEC 61131
  Especially the information contained in IEC 61131-4.
- Safety
  All safety and accident prevention regulations applicable to the specific application (such as machinery directives, safety instructions contained in documentation, etc.) must be observed.
- Emergency stop
  The emergency stop devices (EN 60204) must remain in effect during all operational modes of the system or facility.
- Restarting
  Unlocking of the emergency stop devices must not lead to uncontrolled or undefined restarting.
  Dangerous operational conditions of any kind must not arise following interruption or failure of the power supply.
- Voltage
  Deviations and fluctuations of the supply and load voltages must not fall below or exceed the specified tolerances. Deviations outside the specified operating range might lead to dangerous conditions and functional disturbances in the automation system.
- Wire fault
  A cable or wire fault must not lead to undefined conditions. All necessary safety precautions must be taken in the hardware and software.
- Connection
  All connection and signal cables must be installed in such a way that inductive or capacitive interferences will not impair the MSC III.

### 2.5.2 Installation, Commissioning and Maintenance

- Do not expose the device to undue stress (mechanical loads, temperature, moisture, corrosive atmospheres, etc.)
- Installation must be performed according to this documentation using suitable equipment and tools
- Only qualified personnel are permitted to install the device
- Electrical installation must be carried out in accordance with applicable guidelines (e.g. line cross sections, fuses, protective ground connections)
- Observe the applicable accident prevention regulations to avoid damages and personal injuries
- No work of any kind, such as mounting, removing, wiring or repairs may be performed while the MSC III or connected devices are in operation
  There is a danger of
  - Uncontrolled movements
  - Permanent damage
  - Malfunctions
- Before you perform any work on the MSC III or the connected devices, you have to stop the system and disconnect the power supply
- Avoid polarity reversal of the data and supply cables as this may cause defects and malfunction of the MSC III and the connected devices
- Ensure proper wiring according to the relevant standards to avoid malfunctions of MSC III and the connected devices
- Ensure correct assignments of pins and connectors to avoid malfunctions of MSC III and the connected devices
- Protect the MSC III and the license key from electrostatic discharges. Electrostatic discharges might damage the device's internal components

### 2.5.3 Connecting the Power Supply to MSC III

- The 24 V power supply terminals of the MSC III are protected against reverse polarity. If the polarity of the power supply terminals is reversed, the module will not work.
- Protect the MSC III from overvoltage.
  There is a danger of:
  - Permanent damage by overheating or fire
  - Malfunctions
- Make sure that the MSC III is supplied with the correct voltage and polarity.
- Make sure that the terminal assignments are correct.

### 2.5.4 Connecting the Power Supply to connected Sensors

The internal electronics of the MSC III and the attached sensors must be supplied with power from a permanently connected (unswitched) power supply that cannot be individually switched off, without switching off the module's power supply. If a switched power supply is used, such as when there are intermediate switching devices (emergency stops, manual operators, etc.), the sensor data might be invalid.

Table 3 shows the status of the MSC III if a sensor is supplied from a different power supply as the MSC III.

Table 3: Power supply of module and sensor

| **Status of module and sensor** | **Power Supply** | |
|---|---|---|
| | **MSC III** | **Sensor** |
| Module and sensors are in operation | On | On |
| Invalid sensor data | On | Off |
| Module and sensors are not in operation | Off | Off |

| | |
|---|---|
| ❗ | The digital inputs/outputs of the MSC III are protected against reverse power feeding from digital inputs/outputs to 24 V supply of the module electronic. |

### 2.5.5 Data Security

Minimize the risk of data security breaches by the following organizational and technical measures:

- Do not connect the MSC III to open networks and the Internet without appropriate security measures (e.g. use of firewalls).
- Use appropriate security measures for remote access (e.g. VPN).
- Keep the software up to date (e.g. use the latest versions of MASS development environment (IDE) and the MASS firmware).
- Use the available security measures of the used software (e.g. security features of MASS and the MASS firmware like access control and encryption).

# 3 General Description

The MSC III Motion Controller is a freely programmable multi-axis motion controller that facilitates rapid and precise control of process variables such as position, speed, and force. It is suitable for use with both hydraulic and electric motion control.

## 3.1 Intended use

The MSC III is a motion controller with included PLC functionality. It is designed for closed loop control, open loop control and PLC applications in the medium to high end performance ranges.

The MSC III is designed for industrial applications.

MSC III is designed for use within the overvoltage category defined by IEC 60364-4-44 for controlling machines and industrial processes in low voltage systems in which the rated supply voltage does not exceed 1,000 V alternating current (50/60 Hz) or 1,500 V direct current.

Qualified project planning and design, proper transportation, storage, installation, and use are required to ensure fault-free, reliable, and safe operation of the MSC III.

MSC III must not be brought into operation until it has been ensured that the equipment in which it is installed complies with the current version of the EU machinery directive.

The MSC III may be used only under the conditions and situations specified in this manual.

Any other or more extensive use is not permissible.

The following are also required for proper use:

- Adhere to the inspection and maintenance instructions from the customer for the plant of installation.
- Follow all of the corresponding relevant supplemental documentation in accordance with the application.
- Observe the relevant regulations applicable nationally and internationally, as well as applicable standards and directives (such as e.g. the EU Machinery Directive and the applicable regulations by the Employer's Liability Insurance Association, TÜV or VDE) as applicable.
- Modification to the design, repairs, maintenance work and performance modifications are unauthorized.
- Adhere to all technical data during storage, transport, assembly, disassembly, connecting, start-up, configuring, operating, cleaning, repairing or resolving any possible failures, especially to the ambient conditions.
- Avoid improper storage, transport, assembly, disassembly, connection, start-up, configuration, operation, cleaning, repairing, resolving any possible failures or disposal.
- Avoid the use of unsuitable or defective accessories or unsuitable or defective spare parts.

## 3.2 Main Technical Features

The MSC III is optimized for closed loop control. It offers

- high CPU performance
- short cycle times
- fast update rates of inputs and outputs
- high accuracy of inputs and outputs
- high accuracy sampling time of the inputs
- high accuracy of task cycle times (low variation of the task interval time, also called jitter)
- high reliability, self-diagnostic and system monitoring

The MASS (Moog Application Software Suite) is used to program the MSC III. MASS is based on CODESYS 3.x, the proven IEC 61131-3 compliant programming system.

The MSC III contains no maintainable parts, specifically, no battery or accumulator. The energy for storage of retain variables at power down and for supplying of the real-time-clock is provided by an internal capacitor.

Due to the low power consumption, the MSC III requires no fan.

The MSC III runs a Linux operating system.

Table 4 shows the main CPU performance characteristics of the MSC III.

Table 4: CPU performance of the MSC III

| **Characteristic** | **Description** |
|---|---|
| Clock frequency | 1.0 GHz, four cores |
| Type | i.MX6 Quad core CPU |
| Size of RAM | 1 GB |
| Size of Flash-EEPROM | 1 GB |
| Size of Retain-Memory | 32 KB NVRAM (Non Volatile Random Access Memory) |
| Real-time-clock (RTC) | Buffer time (the time that the internal real-time-clock continues operation after removing the power supply of the MSC III): 1 week |
| Data retention | Minimum 10 years for all data that is saved in the non-volatile memory, i.e., boot project, retain variables and error messages |

Table 5 shows the type, the number of interfaces and a description of the interfaces of the MSC III.

Table 5: Interfaces of the MSC III

| Type | Number | Description |
|---|---|---|
| Ethernet | 1 | For communication with the respective development environment, e.g., MASS and general Ethernet communication. |
| Real-time Ethernet master | 2 | The type of the real-time Ethernet master interface is configurable, e.g., as EtherCAT master. The supported types are described in the respective configuration software, e.g. in MASS. |
| Real-time Ethernet slave | 2 | The type of the real-time Ethernet slave interface is configurable, e.g., as EtherCAT slave. The supported types are described in the respective configuration software, e.g. in MASS. |
| PROFIBUS-DP slave | 1 | PROFIBUS-DP slave interface with automatic baud rate detection. |
| CAN/CANopen | 1 | The type of the CAN/CANopen interface is configurable, as CAN, CANopen master or CANopen slave. |
| USB 2.0 | 2 | USB 2.0 host interface (type A). |
| Digital sensor interfaces | 4 | SSI or incremental encoders, signals according to TIA/EIA 422. |
| Digital inputs/outputs | 8 | Each configurable as input or output. |
| Digital output 'Outputs Enabled' | 1 | Analog outputs, digital outputs and outputs of the digital sensor interfaces are enabled. |
| Analog outputs | 4 | Each configurable as: ±10 V, ±10 mA, 4 to 20 mA, ±20 mA, 16 bit resolution |
| Reference voltage output | 1 | 10 V |
| Analog inputs | 8 | Each configurable as: ±10 V, ±10 mA or 4 to 20 mA, 16 bit resolution |
| Dot matrix display with push buttons | | For user interaction |

## 3.3 Dimensions and Weight

Table 6 shows the dimensions and weight of the MSC III.

Table 6: Dimensions and weight of the MSC III

| Width [mm (in)] | Depth [mm (in)] | Height [mm (in)] | Weight [kg (lb)] |
|---|---|---|---|
| 94.2 mm (3.71) | 202 (7.95) | 220 (8.66) | 2.3 (4.85) |

## 3.4 Connections

Figure 2 shows the location and the numbering of the MSC IIIs' connectors. All connectors are located at the front panel.

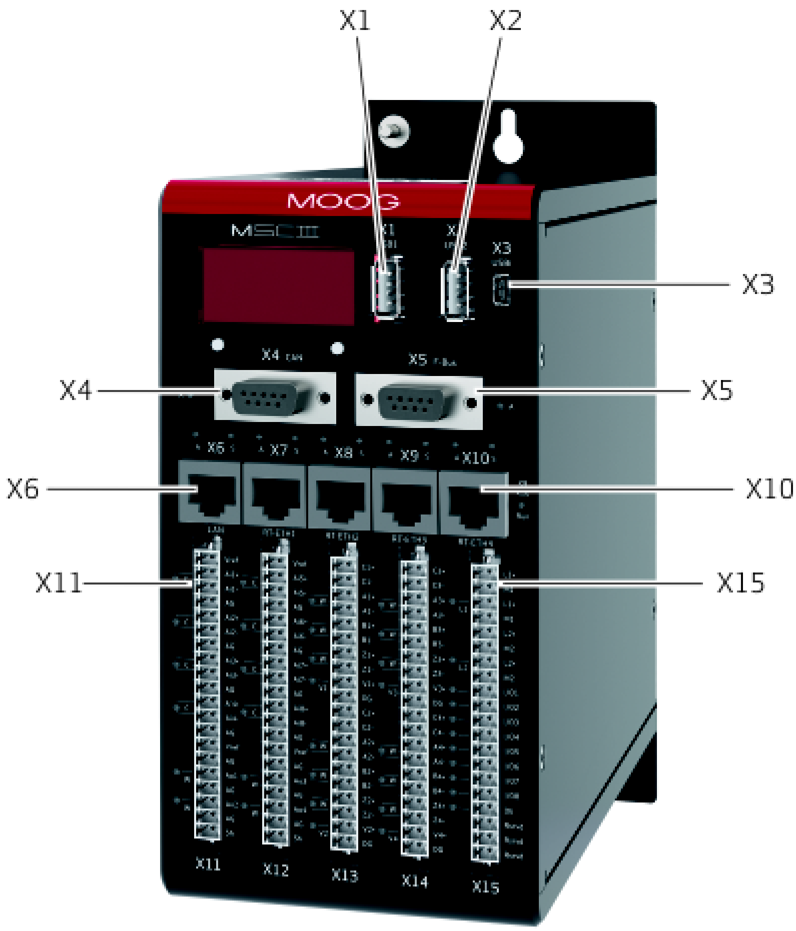



Figure 2: Connectors of the MSC III

Table 7 shows the numbering of the connectors and the type of interfaces at the front panel of the MSC III.

Table 7: Front panel connectors

| Designator | Description |
|---|---|
| X1 | USB1 |
| X2 | USB2 |
| X3 | Production test interface |
| X4 | CAN/CANopen |
| X5 | F-Bus PROFIBUS-DP slave |
| X6 | LAN (10/100/1,000 Mbit/s) Ethernet |
| X7 | RT_ETH1 (10/100/1,000 Mbit/s) real-time Ethernet master |
| X8 | RT_ETH2 (10/100/1,000 Mbit/s) real-time Ethernet master |
| X9 | RT_ETH3 (10/100 Mbit/s) real-time Ethernet slave |
| X10 | RT_ETH4 (10/100 Mbit/s) real-time Ethernet slave |
| X11 | Analog inputs/outputs |
| X12 | Analog inputs/outputs |
| X13 | Digital sensor interfaces |
| X14 | Digital sensor interfaces |
| X15 | Digital inputs/outputs and power supply |

## 3.5 Applicable Standards

### 3.5.1 CE labeling

MSC III complies with the standards specified in the relevant declaration of conformity.

CE labeling of the MSC III is based on proper installation of the automation system with proven electromagnetic compatibility (EMC).

### 3.5.2 IEC 61131-2

MSC III complies with the requirements of IEC 61131-2.

| | |
|---|---|
| ! | Where technical requirements lead to deviations from IEC 61131-2, these are specified in this manual. |

## 3.6 Electromagnetic Compatibility (EMC)

The MSC III complies with the requirements and protection targets of the EU directive 2014/30/EU "Electromagnetic Compatibility" (EMC directive) and complies with the harmonized European standards (EN) that were published in the Official Journals of the European Union for programmable controllers.

Especially important are the rules for proper EMC wiring in cabinets and buildings according to IEC 61131-4. Installation in metal, grounded cabinets is preferred.

MSC III is designed for use under normal operating conditions in industrial environments and complies with the following standards:

- EN 61000-6-2
- EN 61000-6-4

If suitable additional measures are taken, the MSC III may also be employed in residential, commercial and light-industrial environments in compliance with the following standards:

- EN 61000-6-1
- EN 61000-6-3

If the system does not comply with the requirements of EN 61000-6-1and EN 61000-6-3, despite the additional measures, MSC III must not be used in residential, commercial and light-industrial environments.

EMC conformity may be presumed only under the following conditions:

- Sufficient shielding
- Mounting of the module onto an electrically conductive, grounded mounting plate or mounting of the module onto a DIN top-hat rail that is attached to an electrically conductive, grounded mounting plate
- The protective earth connection of the MSC III housing has a low resistance connection to protective earth conductor (PE)

## 3.7 Environmental Conditions and Limits

Table 8 shows the environmental conditions of the MSC III for normal operation and for transportation and storage.

Table 8: Environmental conditions and limits

| Environmental condition | Limit |
|---|---|
| Ambient temperature<br>For operation (when installed properly) | +5 °C to +55 °C (+41 °F to +131 °F) with<br>+50 °C (+122 °F) average temperature over 24 hours |
| Maximum mean temperature in operation for 24 hours | +50 °C (+122 °F) |
| Ambient temperature<br>For transportation and storage (in the original packaging) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Relative air humidity (IEC 61131-2)<br>For operation | 10% to 95% non-condensing |
| Relative air humidity (IEC 61131-2)<br>For transportation and storage (in the original packaging) | 5% to 95% non-condensing |
| Contamination level (IEC 60664) | 2 |
| Resistance to corrosion (IEC 60068) | No protection |
| Maximum operation height | 2,000 m (6,500 ft) |
| Maximum storage height | 3,000 m (9,800 ft) |
| Air pressure for transportation (IEC 61131-2) | ≥ 70 kPa (corresponds to an elevation of ≤ 3,000 m (9,800 ft)) |

## 3.8 Mechanical Conditions and Limits

Table 9 shows the mechanical conditions of the MSC III for normal operation and for transportation in the original package.

Table 9: Mechanical conditions and limits

| Environmental condition | Limit |
|---|---|
| Sinusoidal oscillations (IEC 60068-2-6)<br>10 Hz ≤ f < 57 Hz: | 0.0357 mm (0.0014 in) continual amplitude<br>0.075 mm (0.00295 in) random amplitude |
| Sinusoidal oscillations (IEC 60068-2-6)<br>57 Hz ≤ f < 150 Hz: | 0.5 g continuous constant acceleration<br>1.0 g random constant acceleration |
| Sinusoidal oscillations (IEC 60068-2-6)<br>f > 150 Hz | Not defined |
| Shock (IEC 60068-2-27) | Random peaks up to 15 g longer than 11 ms, half-sine wave in each of the three orthogonal axes |
| Drop height<br>(free-fall in the original packaging)<br>(IEC 60068-2-31) | ≤ 1 m (3.3 ft) |

## 3.9 Required Power Supply

MSC III must be powered from a power supply with SELV (Safety Extra-Low Voltage) according to EN 60950-1.

## 3.10 IP Code

Protection class (IEC 60529): IP20.

## 3.11 Reasonably foreseeable Misuse

| | |
|---|---|
| ! | IMPORTANT: Use of the product in any other way than as described under "Intended use" is considered to be misuse and is therefore not permitted. |

Misuse means operating the MSC III outside the specifically defined application and environmental conditions in relation to:

- Temperature, humidity, condensation
- Operation height
- Shock/vibration
- Protection class
- Electrical and electromagnetic connections
- Operation in explosion hazardous areas
- Use in safety related systems

# 4 Description of the Interfaces

The MSC III Motion Controller offers fieldbus interfaces, high resolution analog inputs/outputs, digital sensor interfaces and digital inputs/outputs.

## 4.1 Layout Plan

Figure 3 shows the location of the connectors at the front panel of the MSC III. All connectors are located at the front panel.

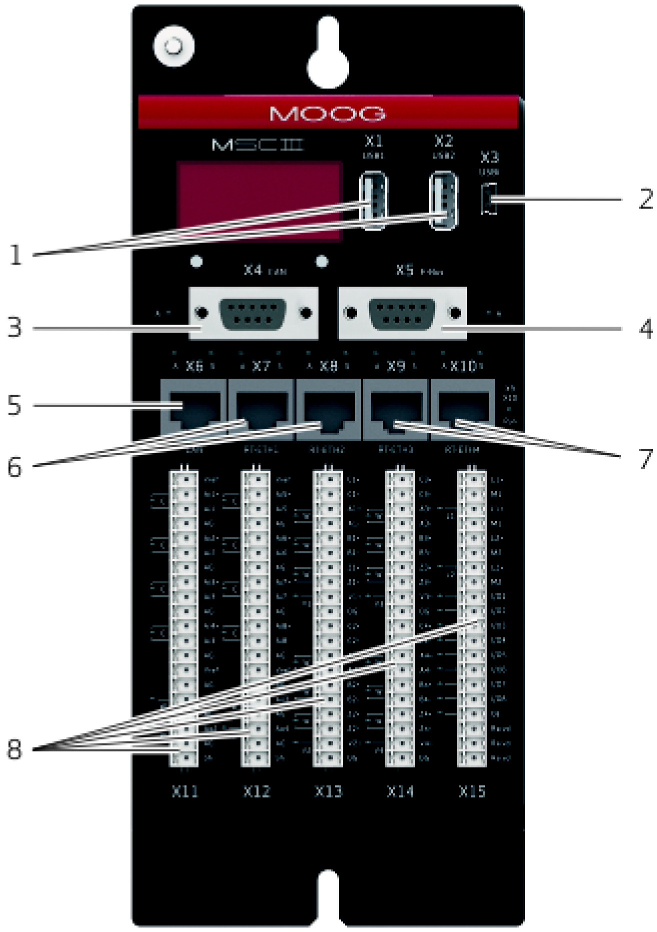



Figure 3: Connectors of the MSC III

Table 10 shows the designation of the connectors and the type of interfaces at the front panel of the MSC III.

Table 10: Interfaces of the MSC III

| **Position** | **Connector** | **Label** | **Functionality** |
|---|---|---|---|
| 1 | X1 | USB1 | USB 2.0 host interface, type A socket |
| | X2 | USB2 | USB 2.0 host interface, type A socket |
| 2 | X3 | USBi | Production test interface |
| 3 | X4 | CAN | CAN with D-Sub socket connector |
| 4 | X5 | F-Bus | PROFIBUS-DP slave with D-Sub socket connector |
| 5 | X6 | LAN | Ethernet LAN with RJ45 connector |
| 6 | X7 | RT-ETH1 | Real-time Ethernet master with RJ45 connector |
| | X8 | RT-ETH2 | Real-time Ethernet master with RJ45 connector |
| 7 | X9 | RT-ETH3 | Real-time Ethernet slave with RJ45 connectors |
| | X10 | RT-ETH4 | Real-time Ethernet slave with RJ45 connectors |
| 8 | X11 | | Analog inputs/outputs, reference voltage output |
| | X12 | | Analog inputs/outputs, reference voltage output |
| | X13 | | Digital sensor interfaces |
| | X14 | | Digital sensor interfaces |
| | X15 | | Digital inputs/outputs, power supply |

## 4.2 Block Diagram

Figure 4 shows the block diagram of the MSC III.

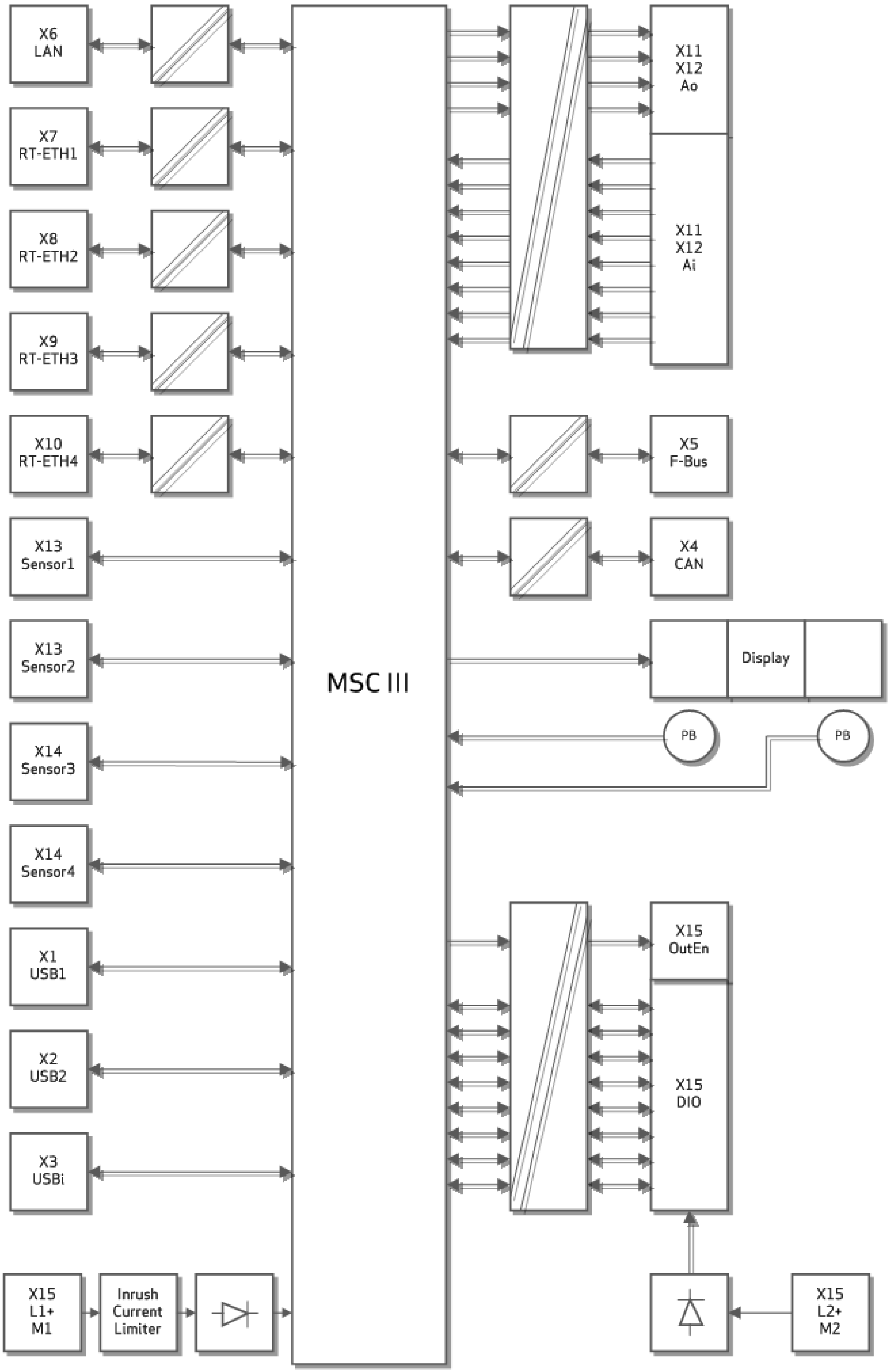



Figure 4: Block diagram of the MSC III

## 4.3 USB 2.0 Host Interface (Type A)

The MSC III provides two USB host interfaces of type A.

Figure 5 shows the labeling of the USB interfaces.

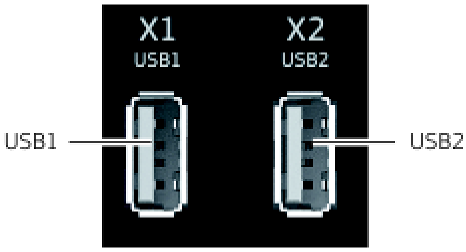
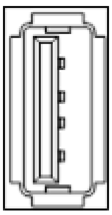



Figure 5: USB 2.0 host interface X1 (USB1) and X2 (USB2)

Table 11 shows the pin numbering, the signal names and the signal descriptions of the USB type A socket interfaces.

Table 11: Terminal assignment of X1 (USB1) and X2 (USB2)

| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 4 | DG | Ground |
| | 3 | D+ | Data + |
| | 2 | D– | Data – |
| | 1 | 5 V+ | +5 V |
| | | | |
| | | | |

## 4.4 CAN and CANopen

The MSC III provides a CAN/CANopen interface with switchable termination resistor.

Figure 6 shows the labeling of the CAN/CANopen interface.

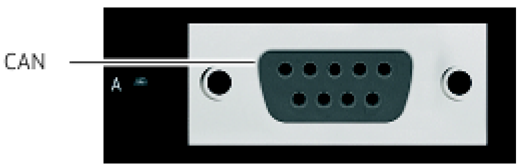



Figure 6: CAN and CANopen X4 (CAN)

### 4.4.1 Terminals and LEDs of X4 (CAN)

Table 12 shows the pin numbering, the signal names and the signal descriptions of the CAN/CANopen D-Sub socket interface.

Table 12: Terminal assignment of X4 (CAN)

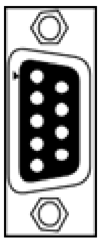
| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 1 | | |
| | 2 | ISO-CAN-L | CAN low |
| | 3 | ISO-CAN-GND | CAN ground |
| | 4 | | |
| | 5 | | |
| | 6 | | |
| | 7 | CAN high | CAN high |
| | 8 | | |
| | 9 | ISO-CAN-5V+ | CAN 5 V+ |

Table 13 shows the label of the LED, the functional description and the meaning of the LED if it is lit.

Table 13: LED assignment of X4 (CAN)

| Label | Description | Meaning |
|---|---|---|
| A | Activity | Flashing green: Transmission activity |

### 4.4.2 CAN Characteristics

CAN is a multi-master system. Every station in the network can send messages. If several stations attempt to send messages at the same time, the highest priority messages will be sent first. This method guarantees bus assignment without destroying the contents of the messages.

### 4.4.3 CANopen Characteristics

CANopen is a CAN based communication protocol.

CANopen is a standardized communication profile that makes it easy to establish a network of CANopen compatible devices from a variety of manufacturers.

The CANopen application layer and communication profile are defined in CiA DS 301 specification.

Various device profiles have been defined by the CiA in order to facilitate the connection of various devices classes, such as drives, controllers, encoders, valves, etc. These device profiles enable uniform control of several devices with the same functionality, regardless of manufacturer and model.

### 4.4.4 Wiring

Table 14 shows the most important characteristics of CAN networks. Always observe them when wiring a CAN network:

Table 14: Characteristics and details for CAN networks

| Characteristic | Details |
|---|---|
| ISO/DIS 11898 | The cables, mating connectors, and termination resistors used in CAN networks must comply with ISO/DIS 11898. |
| Specifications for interface cables | When connecting CAN bus network stations, always use shielded cables with 4 twisted pair wires and an impedance of 120 Ω at 1 MHz. |
| Linear structure of CAN | Avoid branching. Short stub cables with a T-adapter are permitted. If a cable stub (un-terminated cable) or T-connector is used to connect a node to the bus line, then the stub length per node should not exceed 0.3 m (11.8 in) at 1 Mbit/s rate (see CiA. DS 102 version 3.0). |
| CAN bus termination resistors | At both ends of the CAN bus, a termination resistor of 120 Ω ± 10% must be connected between CAN_L and CAN_H.<br>The CAN interface of MSC III has a switchable CAN termination included. |
| Adapt transmission rate to cable length | It is necessary to adapt the transmission rate to the length of the CAN bus interface cable. |
| Potential equalization at only one point | The CAN_GND and CAN_SHLD reference potential may be connected to the signal ground at only one point. |
| Grounding | The power supply for MSC III modules can be grounded at the same point as the CAN_GND wire. |
| Number of network stations | CAN networks with MSC III can include a maximum of 30 CAN network devices. |

### 4.4.5 Interface Cable

Figure 7 shows a CAN Interface cable with 9 pole D-sub mating connectors according to IEC 807-2/DIN 41652.

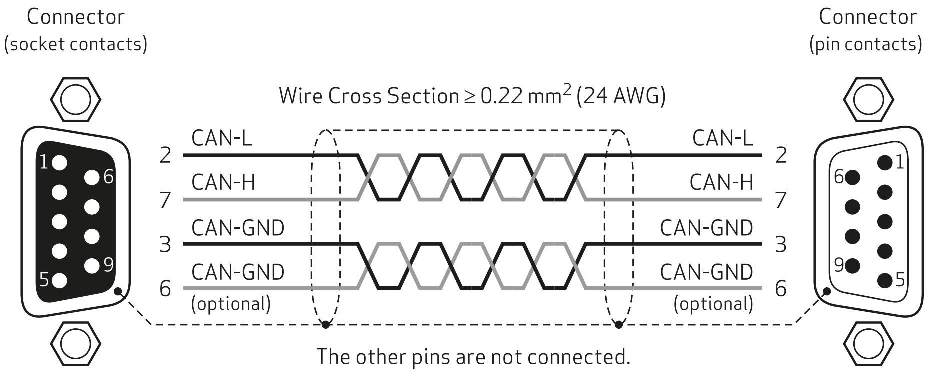



Figure 7: CAN interface cable

### 4.4.6 Cable Length

Table 15 shows the maximum expansion of a CAN network. This is determined by cable length and the transmission rate.

Table 15: Maximum cable lengths in CAN bus networks

| Transmission Rate | Maximum Cable Length |
|---|---|
| 1,000 kbit/s | 25 m (82 ft) |
| 800 kbit/s | 50 m (164 ft) |
| 500 kbit/s | 100 m (328 ft) |
| 250 kbit/s | 250 m (820 ft) |
| 125 kbit/s | 500 m (1,640 ft) |
| 100 kbit/s | 650 m (2,130 ft) |
| 50 kbit/s | 1,000 m (3,280 ft) |

### 4.4.7 Configuration

If the MSC III runs the MASS firmware, then you can configure the CAN interface with the MASS development environment as CAN, CANopen master or CANopen slave. The CAN termination can be enabled with the MASS development environment.

## 4.5 PROFIBUS-DP Slave

The MSC III provides a PROFIBUS-DP slave interface.

Figure 8 shows the labeling of the PROFIBUS-DP slave interface.

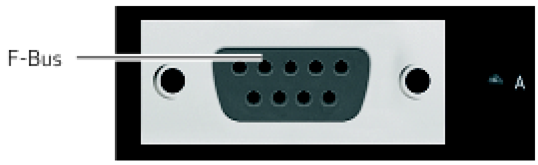



Figure 8: PROFIBUS-DP slave X5 (F-Bus)

### 4.5.1 Terminals and LEDs of X5 (F-Bus)

Table 16 shows the pin numbering, the signal names and the signal descriptions of the PROFIBUS-DP slave D-Sub socket interface.

Table 16: Terminal assignment of X5 (F-Bus)

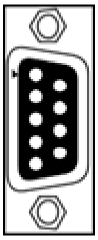
| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 1 | | |
| | 2 | | |
| | 3 | ISO-PB-Data+ | Receive/transmit data positive line; data line B |
| | 4 | | |
| | 5 | ISO-PB-GND | Power supply of the terminators (ground to 5 V) |
| | 6 | ISO-PB-5V+ | Power supply of the terminators (+5 V) |
| | 7 | | |
| | 8 | ISO-PB-Data– | Receive/transmit data negative line; data line A |
| | 9 | | |

Table 17 shows the label of the LED, the functional description and the meaning of the LED if it is lit.

Table 17: LED assignment of X5 (F-Bus)

| Label | Description | Meaning |
|---|---|---|
| A | Activity | Flashing green: Transmission activity |

### 4.5.2 Characteristics

The PROFIBUS-DP is a differential two wire bus. The transmission physics of the serial bus system is defined by the TIA/EIA-485 specification. Shielded twisted pair copper cable with one conductor pair is typically used.

### 4.5.3 Wiring

All devices are connected in a linear bus structure. Up to 32 stations (master or slaves) can be connected in a single segment. The beginning and the end of each segment is fitted with a bus terminator. The bus terminator is usually switched in the connectors.

### 4.5.4 Interface Cable

The cables, mating connectors, and termination resistors used in PROFIBUS-DP networks must comply with IEC 61158/EN 50170. It is recommended to use only connections of cable type A, to use the full bandwidth of 12 Mbit/s.

Figure 9 shows a typical PROFIBUS-DP interface with 9 pole D-sub mating connector and switchable termination according to IEC 61158/EN 50170.

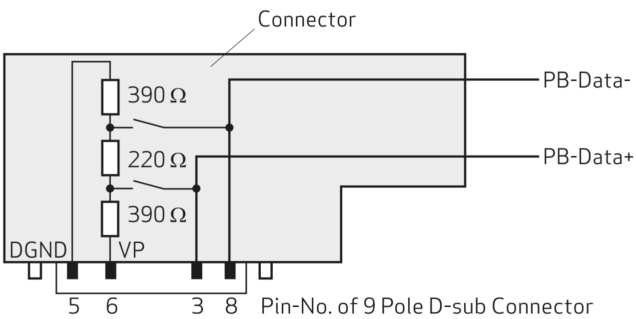



Figure 9: Connector with switchable termination according to IEC 61158/EN 50170

Figure 10 shows a typical PROFIBUS-DP interface with 9 pole D-sub mating connector and internal longitudinal inductivity according to IEC 61158/EN 50170.

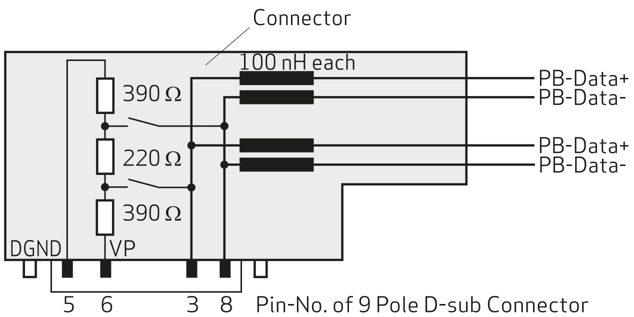



Figure 10: Connector with internal longitudinal inductivity according to IEC 61158/EN 50170

### 4.5.5 Cable Length

Table 18 shows the maximum expansion of a PROFIBUS segment. It is determined by cable length and transmission rate.

Table 18: Maximum cable lengths in PROFIBUS-DP networks

| Transmission Rate | Maximum Cable Length |
|---|---|
| 12 Mbit/s | 100 m (328 ft) |
| 6 Mbit/s | 100 m (328 ft) |
| 3 Mbit/s | 100 m (328 ft) |
| 1.5 Mbit/s | 200 m (656 ft) |
| 500 kbit/s | 400 m (1,310 ft) |
| 187.5 kbit/s | 1,000 m (3,280 ft) |
| 93.75 kbit/s | 1,200 m (3,940 ft) |
| 45.45 kbit/s | 1,200 m (3,940 ft) |
| 19.2 kbit/s | 1,200 m (3,940 ft) |
| 9.6 kbit/s | 1,200 m (3,940 ft) |

### 4.5.6 Configuration

If the MSC III runs the MASS firmware, you can configure the PROFIBUS-DP slave interface at the MASS development environment.

To configure a PROFIBUS-DP master to communicate with the PROFIBUS-DP slave interface of the MSC III:

- Install the GSD (General Station Description) file of the MSC III PROFIBUS-DP slave device at the configuration tool of the PROFIBUS-DP master
- Configure the PROFIBUSDP master and insert the MSC III as PROFIBUS-DP slave according to the description of the PROFIBUS-DP master configuration tool.

## 4.6 Production Test Interface

The production test interface X3 (USBi) is used during the production of the MSC III. Do not use this interface.

Figure 11 shows the labeling of the production test interface.

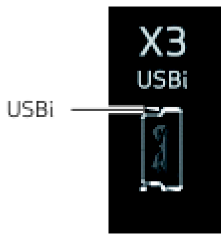



Figure 11: Production test interface X3 (USBi)

## 4.7 Ethernet

The MSC III provides an Ethernet interface. The Ethernet interface supports 10/100/1,000 Mbit/s communication.

Figure 12 shows the labeling of the Ethernet interface.

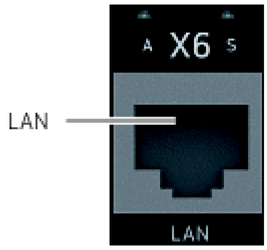



Figure 12: Ethernet X6 (LAN)

### 4.7.1 Terminals and LEDs of X6 (LAN)

Table 19 shows the pin numbering, the signal names and the signal descriptions of the Ethernet interface. The signal assignment depends on the transmission rate.

Table 19: Terminal assignment of X6 (LAN)

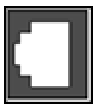
| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 1 | D1+/Tx+ | Data line D1+ (1,000 Mbit/s)<br>Transmit+ (10/100 Mbit/s) |
| | 2 | D1−/Tx− | Data line D1− (1,000 Mbit/s)<br>Transmit− (10/100 Mbit/s) |
| | 3 | D2+/Rx+ | Data line D2+ (1,000 Mbit/s)<br>Receive+ (10/100 Mbit/s) |
| | 4 | D3+ | Data line D3+ (1,000 Mbit/s) |
| | 5 | D3− | Data line D3− (1,000 Mbit/s) |
| | 6 | D2−/Rx− | Data line D2− (1,000 Mbit/s)<br>Receive− (10/100 Mbit/s) |
| | 7 | D4+ | Data line D4+ (1,000 Mbit/s) |
| | 8 | D4− | Data line D4− (1,000 Mbit/s) |

Table 20 shows the labels of the LEDs, the functional description and the meaning of the LED if it is lit.

Table 20: LED assignment of X6 (LAN)

| Label | Description | Meaning |
|---|---|---|
| A | Activity/Link | Steady green: Link is up, no activity<br>Flashing green: Link is up, with activity |
| S | Speed of trans-<br>mission indicator | Dual color LED:<br>Green is lit: 1,000 Mbit/s<br>Yellow is lit: 100 Mbit/s<br>Green and yellow are lit: 10 Mbit/s |

### 4.7.2 Ethernet Cables

Use only cables and plugs according to category 5 (Cat5) or better.

The permissible cable length between two devices is 100 m (328 ft).

The Ethernet interface has automatic cable detection (auto-crossover). Therefore you can use patch cables (1:1 connected) or cross-over Ethernet cables.

## 4.8 Real-Time Ethernet Master

The MSC III provides two real-time Ethernet master interfaces. The real-time Ethernet master interfaces support 10/100/1000 Mbit/s communication.

Figure 13 shows the labeling of the real-time Ethernet master interfaces.

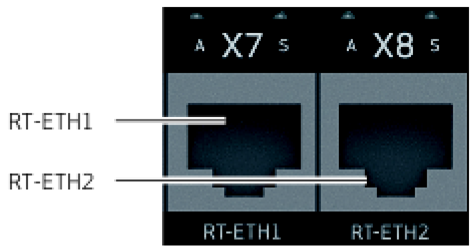



Figure 13: Real-time Ethernet master X7 (RT-ETH1) and X8 (RT-ETH2)

### 4.8.1 Terminals and LEDs of X7 (RT-ETH1) and X8 (RT-ETH2)

Table 21 shows the pin numbering, the signal names and the signal descriptions of the real-time Ethernet master interface. The signal assignment depends on the transmission rate.

Table 21: Terminal assignment of X7 (RT-ETH1) and X8 (RT-ETH2)

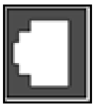
| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 1 | D1+/Tx+ | Data line D1+ (1,000 Mbit/s)<br>Transmit+ (10/100 Mbit/s) |
| | 2 | D1−/Tx− | Data line D1− (1,000 Mbit/s)<br>Transmit− (10/100 Mbit/s) |
| | 3 | D2+/Rx+ | Data line D2+ (1,000 Mbit/s)<br>Receive+ (10/100 Mbit/s) |
| | 4 | D3+ | Data line D3+ (1,000 Mbit/s) |
| | 5 | D3− | Data line D3− (1,000 Mbit/s) |
| | 6 | D2−/Rx− | Data line D2− (1,000 Mbit/s)<br>Receive− (10/100 Mbit/s) |
| | 7 | D4+ | Data line D4+ (1,000 Mbit/s) |
| | 8 | D4− | Data line D4− (1,000 Mbit/s) |

Table 22 shows the labels of the LEDs, the functional description and the meaning of the LED if it is lit.

Table 22: LED assignment of X7 (RT-ETH1) and X8 (RT-ETH2)

| Label | Description | Meaning |
|---|---|---|
| A | Activity/Link | Steady green: Link is up, no activity<br>Flashing green: Link is up, with activity |
| S | Speed of trans-<br>mission indicator | Dual color LED:<br>Green is lit: 1,000 Mbit/s<br>Yellow is lit: 100 Mbit/s<br>Green and yellow are lit: 10 Mbit/s |

### 4.8.2 Real-Time Ethernet Cables

Use only cables and plugs according to category 5 (Cat5) or better.

The permissible cable length between two devices is 100 m (328 ft).

The interface has automatic cable detection (auto-crossover). Therefore you can use patch cables (1:1 connected) or cross-over Ethernet cables.

### 4.8.3 Configuration

All configuration has to be done in the respective configuration software, e.g. in MASS.

## 4.9 Real-Time Ethernet Slave

The MSC III provides two connectors for real-time Ethernet slave interface. The real-time Ethernet slave interface supports 10/100 Mbit/s communication. The assignment of the connectors depends on the type of the configured real-time Ethernet slave.

Figure 14 shows the labeling of the real-time Ethernet slave interfaces.

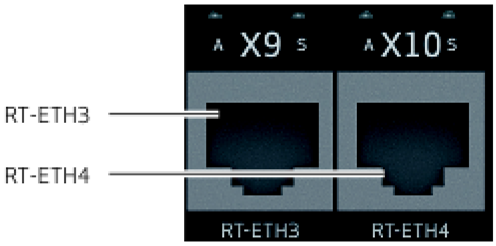



Figure 14: Real-time Ethernet slave X9 (RT-ETH3) and X10 (RT-ETH4)

### 4.9.1 Terminals and LEDs of X9 (RT-ETH3) and X10 (RT-ETH4)

Table 23 shows the pin numbering, the signal names and the signal descriptions of the real-time Ethernet slave interface.

Table 23: Terminal assignment of X9 (RT-ETH3) and X10 (RT-ETH4)

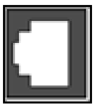
| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 1 | Tx+ | Transmit+ (10/100 Mbit/s) |
| | 2 | Tx− | Transmit− (10/100 Mbit/s) |
| | 3 | Rx+ | Receive+ (10/100 Mbit/s) |
| | | | |
| | | | |
| | 6 | Rx− | Receive− (10/100 Mbit/s) |
| | | | |
| | | | |

Table 24 shows the labels of the LEDs, the functional description and the meaning of the LED if it is lit.

Table 24: LED assignment of X9 (RT-ETH3) and X10 (RT-ETH4)

| Label | Description | Meaning |
|---|---|---|
| A | Activity/Link | Steady green: Link is up, no activity<br>Flashing green: Link is up, with activity |
| S | Speed of transmission indicator | Dual color LED:<br>Yellow is lit: 100 Mbit/s<br>Green and yellow are lit: 10 Mbit/s |
| Run | Status | Status of the real-time Ethernet slave interface |

### 4.9.2 Real-time Ethernet Cables

Use only cables and plugs according to category 5 (Cat5) or better.

The permissible cable length between two devices is 100 m (328 ft).

The interface has automatic cable detection (auto-crossover). Therefore you can use patch cables (1:1 connected) or cross-over Ethernet cables.

### 4.9.3 Configuration

Adjust the configuration settings in the respective configuration software, e.g. in MASS.

## 4.10 Terminal Strips

Terminal strips are used to connect analog and digital inputs/outputs, digital sensors and the 24 V power supplies.

Figure 15 shows the labeling of the terminal strips X11 to X15.

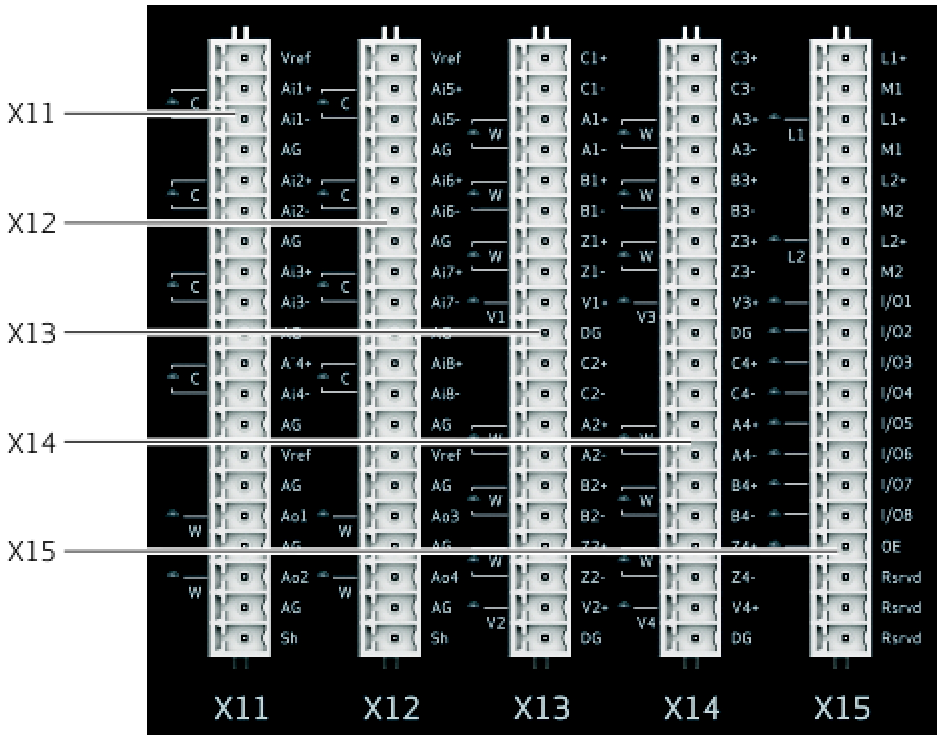



Figure 15: Terminal strips X11 to X15

Use plugin terminal strips with push-in spring connection to connect wires to the MSC III terminals X11 to X15. ➪ "9 Product Range" on page 73

The plug-in terminal strips are suitable for wire cross sections of up to 1.5 $mm^2$ (16 AWG).

## 4.10.1 Terminals and LEDs of X11 and X12, Analog Inputs/Outputs

Table 25 shows the pin numbers, the signal names and the signal descriptions of analog inputs and outputs at the terminal strip X11.

Table 25: Terminal assignment of X11, analog inputs/outputs

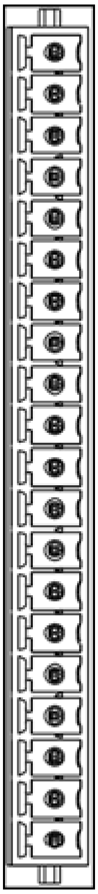
| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 1 | Vref | +10 V reference voltage output |
| | 2 | Ai1+ | Analog input 1 voltage/current non inverting |
| | 3 | Ai1− | Analog input 1 voltage/current inverting |
| | 4 | AG | Analog ground |
| | 5 | Ai2+ | Analog input 2 voltage/current non inverting |
| | 6 | Ai2− | Analog input 2 voltage/current inverting |
| | 7 | AG | Analog ground |
| | 8 | Ai3+ | Analog input 3 voltage/current non inverting |
| | 9 | Ai3− | Analog input 3 voltage/current inverting |
| | 10 | AG | Analog ground |
| | 11 | Ai4+ | Analog input 4 voltage/current non inverting |
| | 12 | Ai4− | Analog input 4 voltage/current inverting |
| | 13 | AG | Analog ground |
| | 14 | Vref | +10 V reference voltage output |
| | 15 | AG | Analog ground |
| | 16 | Ao1 | Analog output 1 voltage/current (referenced to AG) |
| | 17 | AG | Analog ground |
| | 18 | Ao2 | Analog output 2 voltage/current (referenced to AG) |
| | 19 | AG | Analog ground |
| | 20 | Sh | Shield |

Table 26 shows the labels of the LEDs, the relation to the pin number of X11, the functional description and the meaning of each LED if it is lit.

Table 26: LED assignment of X11, analog inputs/outputs

| Label | Related to pin | Description | Meaning |
|---|---|---|---|
| C | 2/3 | Current | Ai1 is configured as current input |
| C | 5/6 | Current | Ai2 is configured as current input |
| C | 8/9 | Current | Ai3 is configured as current input |
| C | 11/12 | Current | Ai4 is configured as current input |
| W | 16 | Wire fault | Wire fault at Ao1 is detected |
| W | 18 | Wire fault | Wire fault at Ao2 is detected |

Table 27 shows the pin numbers, the signal names and the signal descriptions of analog inputs and outputs at the terminal strip X12.

Table 27: Terminal assignment of X12, analog inputs/outputs

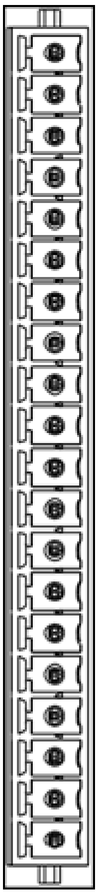
| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 1 | Vref | +10 V reference voltage output |
| | 2 | Ai5+ | Analog input 5 voltage/current non inverting |
| | 3 | Ai5− | Analog input 5 voltage/current inverting |
| | 4 | AG | Analog ground |
| | 5 | Ai6+ | Analog input 6 voltage/current non inverting |
| | 6 | Ai6− | Analog input 6 voltage/current inverting |
| | 7 | AG | Analog ground |
| | 8 | Ai7+ | Analog input 7 voltage/current non inverting |
| | 9 | Ai7− | Analog input 7 voltage/current inverting |
| | 10 | AG | Analog ground |
| | 11 | Ai8+ | Analog input 8 voltage/current non inverting |
| | 12 | Ai8− | Analog input 8 voltage/current inverting |
| | 13 | AG | Analog ground |
| | 14 | Vref | +10 V reference voltage output |
| | 15 | AG | Analog ground |
| | 16 | Ao3 | Analog output 3 voltage/current (referenced to AG) |
| | 17 | AG | Analog ground |
| | 18 | Ao4 | Analog output 4 voltage/current (referenced to AG) |
| | 19 | AG | Analog ground |
| | 20 | Sh | Shield |

Table 28 shows the labels of the LEDs, the relation to the pin number of X12, the functional description and the meaning of each LED if it is lit .

Table 28: LED assignment of X12, analog inputs/outputs

| Label | Related to pin | Description | Meaning |
|---|---|---|---|
| C | 2/3 | Current | Ai5 is configured as current input |
| C | 5/6 | Current | Ai6 is configured as current input |
| C | 8/9 | Current | Ai7 is configured as current input |
| C | 11/12 | Current | Ai8 is configured as current input |
| W | 16 | Wire fault | Wire fault at Ao3 is detected |
| W | 18 | Wire fault | Wire fault at Ao4 is detected |

## 4.10.2 Terminals and LEDs of X13 and X14, Digital Sensor Interfaces

Table 29 shows the pin numbers, the signal names and the signal descriptions of the digital sensor interfaces at the terminal strip X13.

Table 29: Terminal assignment of X13, digital sensor interfaces

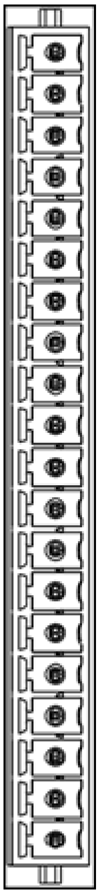
| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 1 | C1+ | TIA/EIA 485 output, SSI sensor 1 signal clock+ |
| | 2 | C1− | TIA/EIA 485 output, SSI sensor 1 signal clock− |
| | 3 | A1+ | TIA/EIA 422 input, incremental sensor 1 signal A+ or SSI sensor 1 signal data+ |
| | 4 | A1− | TIA/EIA 422 input, incremental sensor 1 signal A− or SSI sensor 1 signal data− |
| | 5 | B1+ | TIA/EIA 422 input, incremental sensor 1 signal B+ or SSI sensor 1 signal passive master clock+ |
| | 6 | B1− | TIA/EIA 422 input, incremental sensor 1 signal B− or SSI sensor 1 signal passive master clock− |
| | 7 | Z1+ | TIA/EIA 422 input, incremental sensor 1 signal Z+ |
| | 8 | Z1− | TIA/EIA 422 input, incremental sensor 1 signal Z− |
| | 9 | V1+ | Supply voltage output for sensor 1 |
| | 10 | DG | Ground for the digital sensor interface |
| | 11 | C2+ | TIA/EIA 485 output, SSI sensor 2 signal clock+ |
| | 12 | C2− | TIA/EIA 485 output, SSI sensor 2 signal clock− |
| | 13 | A2+ | TIA/EIA 422 input, incremental sensor 2 signal A+ or SSI sensor 2 signal data+ |
| | 14 | A2− | TIA/EIA 422 input, incremental sensor 2 signal A− or SSI sensor 2 signal data− |
| | 15 | B2+ | TIA/EIA 422 input, incremental sensor 2 signal B+ or SSI sensor 2 signal passive master clock+ |
| | 16 | B2− | TIA/EIA 422 input, incremental sensor 2 signal B− or SSI sensor 2 signal passive master clock− |
| | 17 | Z2+ | TIA/EIA 422 input, incremental sensor 2 signal Z+ |
| | 18 | Z2− | TIA/EIA 422 input, incremental sensor 2 signal Z− |
| | 19 | V2+ | Supply voltage output for sensor 2 |
| | 20 | DG | Ground for the digital sensor interface |

Table 30 shows the labels of the LEDs, the relation to the pin number of X13, the functional description and the meaning of each LED if it is lit.

Table 30: LED assignment of X13, digital sensor interfaces

| Label | Related to pin | Description | Meaning |
|---|---|---|---|
| W | 3/4 | Wire fault | Wire fault detected at A1+/A1– |
| W | 5/6 | Wire fault | Wire fault detected at B1+/B1– |
| W | 7/8 | Wire fault | Wire fault detected at Z1+/Z1– |
| V1 | 9 | Supply voltage | Supply voltage output V1+ is active |
| W | 13/14 | Wire fault | Wire fault detected at A2+/A2– |
| W | 15/16 | Wire fault | Wire fault detected at B2+/B2– |
| W | 17/18 | Wire fault | Wire fault detected at Z2+/Z2– |
| V2 | 19 | Supply voltage | Supply voltage output V2+ is active |

Table 31 shows the pin numbers, the signal names and the signal descriptions of the digital sensor interfaces at the terminal strip X14.

Table 31: Terminal assignment of X14, digital sensor interfaces

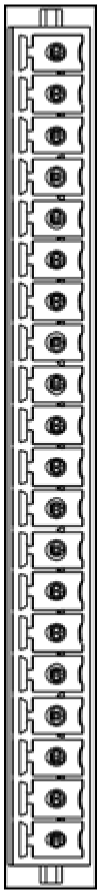
| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 1 | C3+ | TIA/EIA 485 output, SSI sensor 3 signal clock+ |
| | 2 | C3− | TIA/EIA 485 output, SSI sensor 3 signal clock− |
| | 3 | A3+ | TIA/EIA 422 input, incremental sensor 3 signal A+ or SSI sensor 3 signal data+ |
| | 4 | A3− | TIA/EIA 422 input, incremental sensor 3 signal A− or SSI sensor 3 signal data− |
| | 5 | B3+ | TIA/EIA 422 input, incremental sensor 3 signal B+ or SSI sensor 3 signal passive master clock+ |
| | 6 | B3− | TIA/EIA 422 input, incremental sensor 3 signal B− or SSI sensor 3 signal passive master clock− |
| | 7 | Z3+ | TIA/EIA 422 input, incremental sensor 3 signal Z+ |
| | 8 | Z3− | TIA/EIA 422 input, incremental sensor 3 signal Z− |
| | 9 | V3+ | Supply voltage output for sensor 3 |
| | 10 | DG | Ground for the digital sensor interface |
| | 11 | C4+ | TIA/EIA 485 output, SSI sensor 4 signal clock+ |
| | 12 | C4− | TIA/EIA 485 output, SSI sensor 4 signal clock− |
| | 13 | A4+ | TIA/EIA 422 input, incremental sensor 4 signal A+ or SSI sensor 4 signal data+ |
| | 14 | A4− | TIA/EIA 422 input, incremental sensor 4 signal A− or SSI sensor 4 signal data− |
| | 15 | B4+ | TIA/EIA 422 input, incremental sensor 4 signal B+ or SSI sensor 4 signal passive master clock+ |
| | 16 | B4− | TIA/EIA 422 input, incremental sensor 4 signal B− or SSI sensor 4 signal passive master clock− |
| | 17 | Z4+ | TIA/EIA 422 input, incremental sensor 4 signal Z+ |
| | 18 | Z4− | TIA/EIA 422 input, incremental sensor 4 signal Z− |
| | 19 | V4+ | Supply voltage output for sensor 4 |
| | 20 | DG | Ground for the digital sensor interface |

Table 32 shows the labels of the LEDs, the relation to the pin number of X14, the functional description and the meaning of each LED if it is lit.

Table 32: LED assignment of X14, digital sensor interfaces

| Label | Related to pin | Description | Meaning |
|---|---|---|---|
| W | 3/4 | Wire fault | Wire fault detected at A3+/A3− |
| W | 5/6 | Wire fault | Wire fault detected at B3+/B3− |
| W | 7/8 | Wire fault | Wire fault detected at Z3+/Z3− |
| V3 | 9 | Supply voltage | Supply voltage output V3+ is active |
| W | 13/14 | Wire fault | Wire fault detected at A4+/A4− |
| W | 15/16 | Wire fault | Wire fault detected at B4+/B4− |
| W | 17/18 | Wire fault | Wire fault detected at Z4+/Z4− |
| V4 | 19 | Supply voltage | Supply voltage at output V4+ is active |

## 4.10.3 Terminals and LEDs of X15, Power Supply and Digital Inputs/Outputs

Table 33 shows the pin numbers, the signal names and the signal descriptions of the power supply connectors and the digital inputs/outputs at the terminal strip X15.

Table 33: Terminal assignment of X15, power supply and digital inputs/outputs

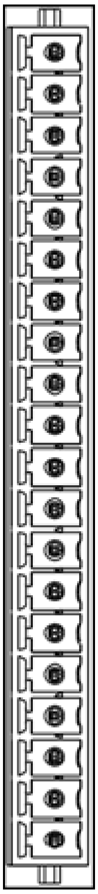
| Connector | Pin | Signal | Description |
|---|---|---|---|
|  | 1 | L1+ | +24 V supply of module electronic |
| | 2 | M1 | Ground supply of module electronic |
| | 3 | L1+ | +24 V supply of module electronic |
| | 4 | M1 | Ground supply of module electronic |
| | 5 | L2+ | +24 V supply of digital inputs/outputs |
| | 6 | M2 | Ground supply of digital inputs/outputs |
| | 7 | L2+ | +24 V supply of digital inputs/outputs |
| | 8 | M2 | Ground supply of digital inputs/outputs |
| | 9 | I/O1 | Digital input/output 1 |
| | 10 | I/O2 | Digital input/output 2 |
| | 11 | I/O3 | Digital input/output 3 |
| | 12 | I/O4 | Digital input/output 4 |
| | 13 | I/O5 | Digital input/output 5 |
| | 14 | I/O6 | Digital input/output 6 |
| | 15 | I/O7 | Digital input/output 7 |
| | 16 | I/O8 | Digital input/output 8 |
| | 17 | OE | Outputs enabled output |
| | 18 | Rsrvd | Reserved, do not use |
| | 19 | Rsrvd | Reserved, do not use |
| | 20 | Rsrvd | Reserved, do not use |

Table 34 shows the labels of the LEDs, the relation to the pin number of X15, the functional description and the meaning of each LED if it is lit.

Table 34: LED assignment of X15, power supply and digital inputs/outputs

| Label | Related to pin | Description | Meaning |
|---|---|---|---|
| L1 | 1 to 4 | L1+/M1 | Supply of module electronic |
| L2 | 5 to 8 | L2+/M2+ | Supply of digital inputs/outputs |
| | 9 | I/O1 | Internal status of digital input/output 1 |
| | 10 | I/O2 | Internal status of digital input/output 2 |
| | 11 | I/O3 | Internal status of digital input/output 3 |
| | 12 | I/O4 | Internal status of digital input/output 4 |
| | 13 | I/O5 | Internal status of digital input/output 5 |
| | 15 | I/O6 | Internal status of digital input/output 6 |
| | 16 | I/O7 | Internal status of digital input/output 7 |
| | 17 | I/O8 | Internal status of digital input/output 8 |
| | 16 | OE | Internal status of outputs enabled output |

## 4.11 Analog Inputs

The MSC III provides 8 analog inputs configurable as: ±10 V, ±10 mA or 4 to 20 mA (each nominal) with 16 bit resolution.

Terminal and LED assignment: ➪ "4.10.1 Terminals and LEDs of X11 and X12, Analog Inputs/Outputs" on page 31

### 4.11.1 Basic Wiring Diagram

Figure 16 shows the basic wiring diagram of the analog inputs Ai1 to Ai8. The upper analog input Aix is configured as a voltage input, the lower analog input Aiy as a current input.

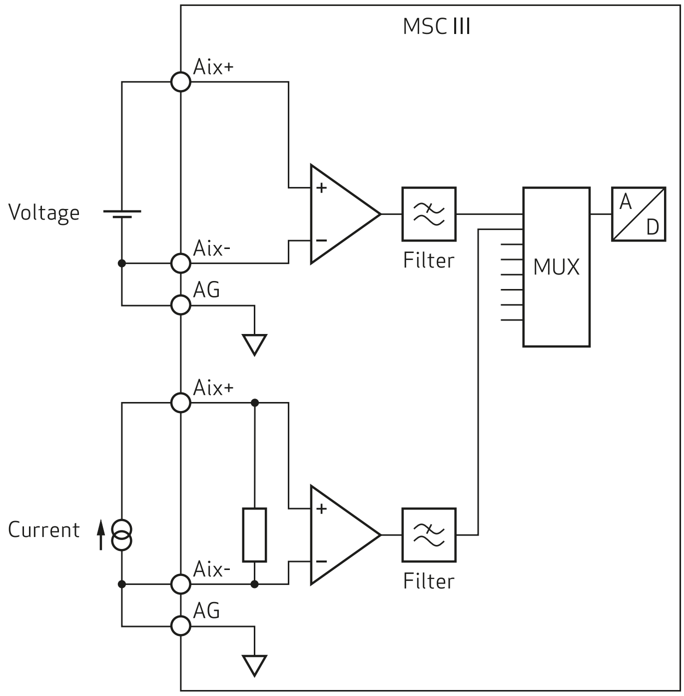



Figure 16: Basic wiring diagram of the analog inputs Ai1 to Ai8

All AG analog ground terminals of the terminal strips X11 and X12 are connected internally.

### 4.11.2 Specification

Table 35 shows the specification of the 8 analog inputs of the MSC III.

Table 35: Specification of analog inputs

| Characteristic | Description |
|---|---|
| Number of analog inputs | 8 |
| Type of analog inputs | Differential, each individually configurable as: ±10 V, ±10 mA or 4 to 20 mA (each nominal) |
| Display of selected range | The LED C is lit when a current input range is configured |
| Common-mode properties | Common-mode rejection: > 85 dB<br>Common-mode voltage range: ±17 V |
| Input impedance within nominal signal range | > 200 kΩ on voltage inputs<br>20 Ω on current inputs |
| Greatest error over the entire temperature range | ±0.5% of full scale value |
| Max. permissible continuous overload (higher load results in damage) | ±36 V on voltage inputs<br>Current inputs internally limited to 50 to 100 mA |
| Digital resolution | 16 bit |
| Data format in the MASS application program | 64 bit floating point |
| Conversion method | Successive approximation |
| Duration of conversion per input | Typ. 2 µs |
| Sampling time | The sampling time corresponds to the task interval of the application program that reads the input. |
| Input filter | Filter type: low pass of 1st order with Butterworth characteristic<br>Crossover frequency: typ. 10 kHz |
| Protective device | Diodes |
| Recommended cable types | Use only shielded cables.<br>The shield must be made of copper braiding with at least 80% coverage.<br>The wire must be made of copper with a cross section of at least 0.25 $mm^2$ (23 AWG).<br>In environments with a high amount of disturbance, use cables with twisted pair wires. |
| Calibration | The analog inputs are calibrated during manufacturing process and don't require any additional calibration. |
| Crosstalk between inputs | < 0.02% |
| Potential separation of analog inputs and outputs | Separation from module electronic and 24 V supply voltage. |

Table 36 shows the nominal, minimum and maximum values of the 8 analog inputs of the MSC III. An analog input returns the minimum value if the actual input value is below the minimum value. An analog input returns the maximum value if the actual input value is above the maximum value.

Table 36: Nominal, minimum and maximum values of analog inputs

| Nominal input | Minimum | Maximum | LSB value (Resolution) |
|---|---|---|---|
| ±10 V | −11.0 V | +11.0 V | 0.337 mV |
| ±10 mA | −11.0 mA | +11.0 mA | 0.35 µA |
| 4 to 20 mA | 0.0 mA | +22.5 mA | 0.35 µA |

### 4.11.3 Configuration

Adjust the configuration settings in the respective configuration software, e.g. in MASS.

### 4.11.4 Connecting the Shielding of Analog Sensors

Figure 17 shows how to connect the shielding of an analog sensor. The "Preferred Shielding" is recommended for installations with proper equipotential bonding. The "Alternative Shielding" avoids equalization current between the shielding connections.

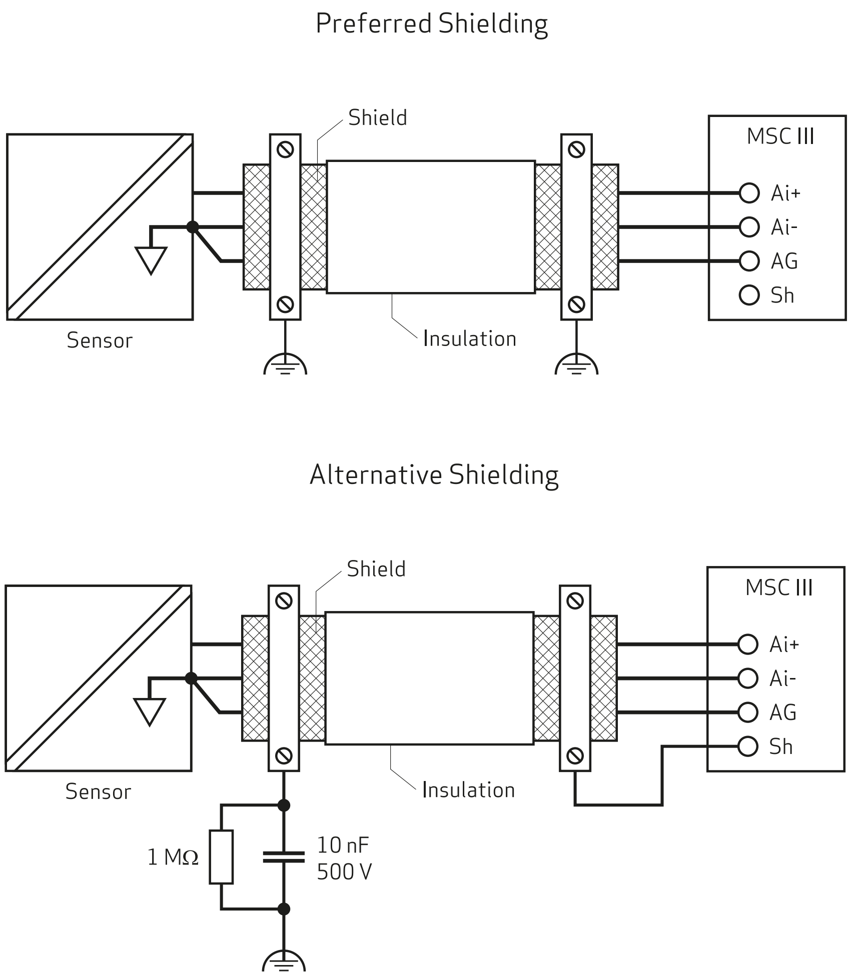



Figure 17: Connecting shielding of an analog sensor

### 4.11.5 Connecting an Isolated Analog Sensor

Figure 18 shows how to connect an isolated analog sensor. In such a configuration it is required to connect the AG signal to get a reference potential for the differential inputs.

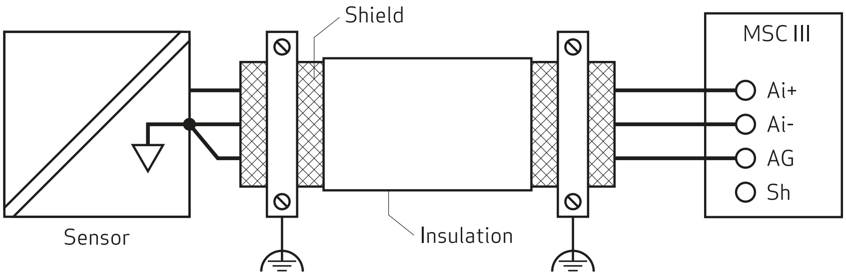



Figure 18: Connecting an isolated analog sensor

### 4.11.6 Connecting a Non-Isolated Analog Sensor

Figure 19 shows how to connect a non-isolated analog sensor using a separate power supply. In such a configuration it is required to connect the AG signal to get a reference potential for the differential inputs.

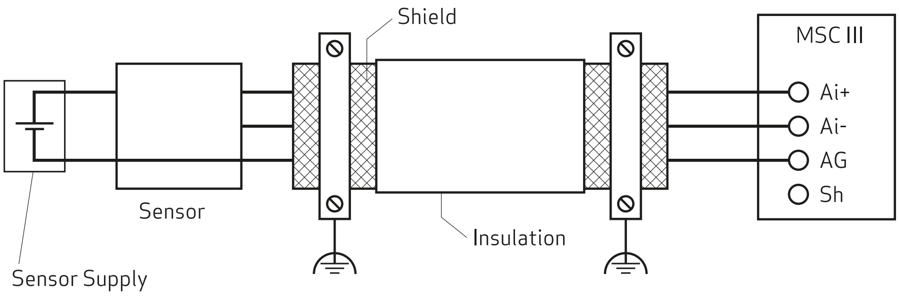



Figure 19: Connecting a non-isolated analog sensor using a separate power supply

Figure 20 shows how to connect a non-isolated analog sensor using the same power supply as the MSC III. In such a configuration it is required to connect the AG signal to get a reference potential for the differential inputs.

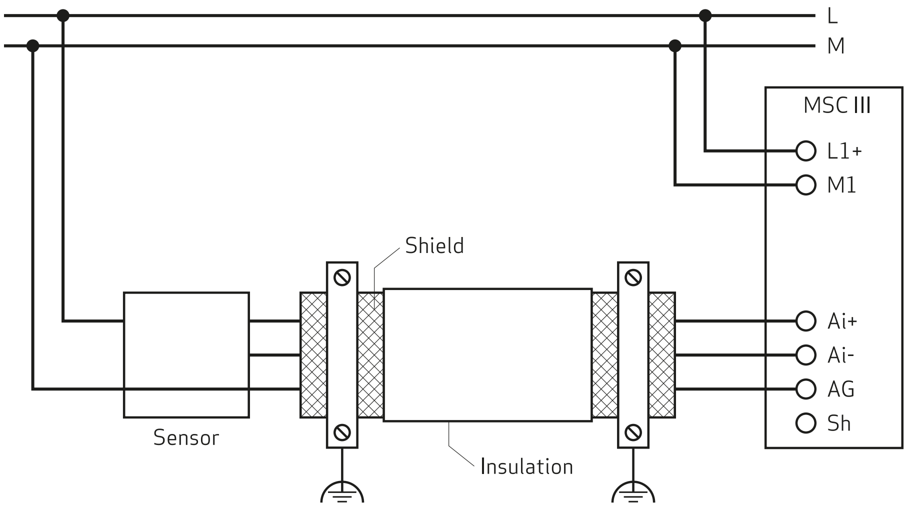



Figure 20: Connecting a non-isolated analog sensor using the same power supply as the MSC III

Figure 21 shows how to connect a non-isolated analog two wire sensor using the same power supply as the MSC III. In such a configuration it is required to connect the AG signal to get a reference potential for the differential inputs.

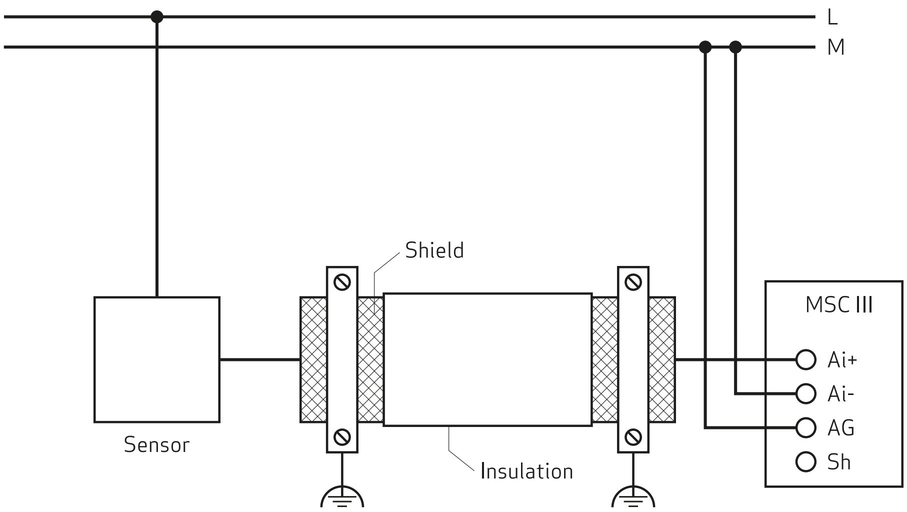



Figure 21: Connecting a non-isolated analog two wire sensor using the same power supply as the MSC III

## 4.12 Reference Voltage Output

The MSC III provides a reference voltage output to supply e.g. resistive sensors.

Terminal and LED assignment: ➪ "4.10.1 Terminals and LEDs of X11 and X12, Analog Inputs/Outputs" on page 31.

The reference voltage output is connected to the Vref terminal of the terminal strips X11 and X12.

### 4.12.1 Specification

Table 37 shows the specification of the reference voltage output of the MSC III.

Table 37: Specification of reference voltage output

| Characteristic | Description |
|---|---|
| Reference voltage | +10 V DC |
| Load current | Max. 5 mA |
| Precision | ±0.3% of full scale value |
| Temperature coefficient | < 280 µV/K |
| Output impedance | < 0.2 Ω |
| Protection | Continuous short-circuit protection; overvoltage protection up to ±36 V |
| Short-circuit current | $I_K$max = 15 mA |

### 4.12.2 Connecting Reference Voltage

Figure 22 shows how to connect a potentiometer to the MSC III using the internal reference voltage.

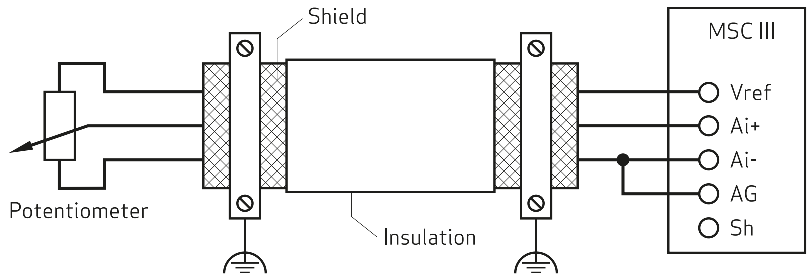



Figure 22: Connecting a non-Isolated analog sensor using the same power supply the MSC III

Figure 23 shows how to connect an analog 4-wire sensor to the MSC III using the internal reference voltage.

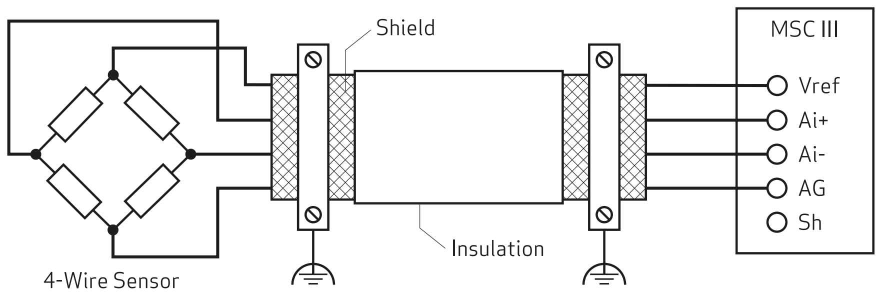



Figure 23: Connecting an analog 4-wire sensor using the reference voltage

## 4.13 Analog Outputs

The MSC III provides 4 analog outputs, each configurable as: ± 10 V, ±10 mA, ±20 mA or 4 to 20 mA (each nominal) with 16 bit resolution.

Terminal and LED assignment: ➪ "4.10.1 Terminals and LEDs of X11 and X12, Analog Inputs/Outputs" on page 31

All AG analog ground terminals of the terminal strips X11 and X12 are connected internally.

### 4.13.1 Basic Wiring Diagram

Figure 24 shows the basic wiring diagram of an analog output. The connection of loads is identical for all voltage and current ranges.

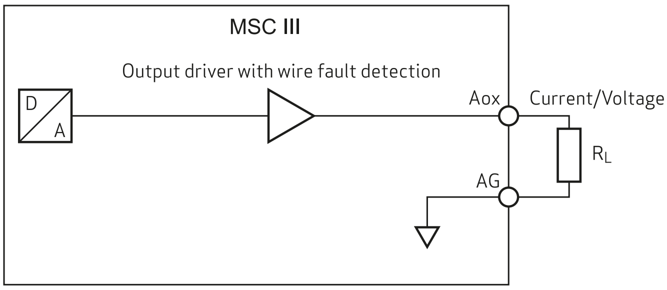



Figure 24: Basic wiring diagram of an analog output

### 4.13.2 Specification

Table 38 shows the specification of the 4 analog outputs of the MSC III.

Table 38: Specification of analog outputs (Part 1 of 2)

| Characteristic | Description |
|---|---|
| Number of analog outputs | 4 |
| Type of analog outputs | Each individually configurable as ±10 V, ±10 mA, ±20 mA or 4 to 20 mA (each nominal) |
| Wire fault monitoring of the analog current outputs | The LED W is lit if a non-zero value is set as output current and one of the following conditions is met:<br>• No load is attached to the corresponding analog current output<br>• The load resistance is too high (the current output can no longer drive the required current)<br>• There is a wire break<br>The status of the wire fault monitoring can be evaluated in the application program. |
| Wire fault monitoring of the analog voltage outputs | The LED W is lit if a non-zero value is set as output voltage and there is a short circuit of the voltage output.<br>The status of the wire fault monitoring can be evaluated in the application program. |
| Output impedance within nominal signal range | < 0.2 Ω (voltage output)<br>Approx. 1 MΩ (current outputs) |
| Greatest error over the entire temperature range | ±1% of full scale value |
| Digital resolution | 16 bit |

Table 38: Specification of analog outputs (Part 2 of 2)

| Characteristic | Description |
|---|---|
| Data format in the MASS application program | 64 bit floating point |
| Load impedance range | Voltage output ±10 V: ≥ 1,000 Ω<br>Current output ±10 mA: ≤ 1,000 Ω<br>Current output ±20 mA: ≤ 600 Ω<br>Current output 4 to 20 mA: ≤ 600 Ω |
| Permissible load types | Resistive load according to "Load impedance range".<br>The stability of the current outputs is ensured up to an inductive load of 100 mH.<br>The stability of the voltage outputs is ensured up to a capacitive load of 10 µF. |
| Update time | The update time corresponds to the task interval of the application program that actuates the output. |
| Protection | Continuous short-circuit protection; overvoltage protection up to ±36 V |
| Short-circuit current $I_K$max | Voltage output ±10 V: $I_K$max = ±15 mA |
| Recommended cable types | Use only shielded cables.<br>The shield must be made of copper braiding with at least 80% coverage.<br>The wire must be made of copper with a cross section of at least 0.25 $mm^2$ (23 AWG).<br>In environments with a high amount of disturbance, use cables with twisted pair wires. |
| Calibration | The analog outputs are calibrated during manufacturing process and don't require any additional calibration. |
| Output current of the voltage output | Max. 10 mA |
| Potential separation of analog inputs and outputs | Separation from module electronic and 24 V supply voltage. |

Table 39 shows the nominal, minimum and maximum values of the 4 analog outputs of the MSC III. An analog output supplies the minimum value if the actual output command value is below the minimum value. An analog output supplies the maximum value if the actual output command value is above the maximum value.

Table 39: Nominal, minimum and maximum values of analog outputs

| Nominal output | Minimum | Maximum | LSB value (resolution) |
|---|---|---|---|
| ±10 V | −12.0 V | +12.0 V | 0.336 mV |
| ±10 mA | −12.0 mA | +12.0 mA | 0.61 µA |
| ±20 mA | −24.0 mA | +24.0 mA | 0.732 µA |
| 4 to 20 mA | 0.0 mA | +24.0 mA | 0.366 µA |

Table 39 shows the typical time that an analog output requires for a step from 10% to 90% of the output value.

Table 40: Rise time $T_{10/90}$ of analog outputs

| Output | | Step | | $R_L$ | Typ. $T_{10/90}$ |
|---|---|---|---|---|---|
| | | From | To | | |
| Voltage output | ±10 V | +10 V | −10 V | ≥ 1,000 Ω | 25 µs |
| | | −10 V | +10 V | | |
| Current Output | ±10 mA | +10 mA | −10 mA | ≤ 1,000 Ω | 5 µs |
| | | −10 mA | +10 mA | | |
| | ±20 mA | +20 mA | −20 mA | ≤ 600 Ω | 7 µs |
| | | −20 mA | +20 mA | | |
| | 4 to 20 mA | 20 mA | 4 mA | ≤ 600 Ω | 5 µs |
| | | 4 mA | 20 mA | | |

## 4.13.3 Configuration

Adjust the configuration settings in the respective configuration software, e.g. in MASS.

## 4.13.4 Connecting a Load

Figure 25 shows how to connect a load with a shielded cable to an analog output. The connection of loads is identical for all voltage and current ranges.

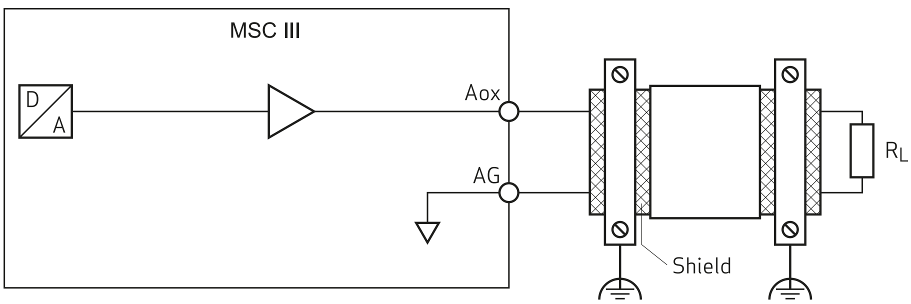



Figure 25: Connecting a load with a shielded cable to an analog output

### 4.13.5 Dependence on the 'Outputs Enabled' Signal

If the digital output OE (Outputs Enabled) is in the 0 state (LED OE does not illuminate), then all other outputs are disabled. The analog outputs are switched off (high impedance state).

Digital output 'Outputs Enable': ➪ "4.17 Digital Output 'Outputs Enabled'" on page 58

## 4.14 Digital Sensor Interfaces

The MSC III provides 4 digital sensor interfaces according to EIA 422 (previously RS 422) for sensors with SSI interface or incremental sensor signals.

Terminal and LED assignment: ➪ "4.10.2 Terminals and LEDs of X13 and X14, Digital Sensor Interfaces" on page 34

### 4.14.1 Specification

Table 41 shows the specification of the 4 digital sensor interfaces of the MSC III.

Table 41: Specification of digital sensor interfaces

| Characteristic | Description |
|---|---|
| Number of interfaces | 4 |
| Supported sensor types | Each sensor interface is configurable as Incremental encoder or SSI (Synchronous Serial Interface). |
| Type of signal | Corresponding to EIA 422 with protection against 24 V |
| Termination resistors | The ports A, B, C and Z are terminated with a 120 Ω resistor |
| Supply voltage output for sensor | Switchable 5 V supply voltage output Vx+ of each sensor interface. |
| Recommended cable types | • Use only shielded cables.<br>• The shield must be made of copper braiding with at least 80% coverage.<br>• The wire must be made of copper with a cross section of at least 0.25 $mm^2$ (23 AWG).<br>• In environments with a high amount of disturbance, use cables with twisted pair wires. |
| Wire fault monitoring | The inputs A, B, and Z of the digital sensor interfaces are monitored for wire faults. The status of the wire fault monitoring is available in the application program if the corresponding input is used by the configured interface. The wire fault monitoring depends on the sensor type that is configured in the application program. |
| Wire fault display | The status of the wire fault monitoring is displayed by LED W of the inputs A, B, and Z for each sensor interface. The respective LED is lit if the corresponding input is used by the configured interface and a wire fault is detected. |
| **Incremental encoder interface** | |
| Data type of the measured value | 32 bit unsigned |
| Underflow/overflow behavior | The counter value is overflowing to 0x0000 0000 or under flowing to 0xFFFF FFFF. |
| Maximum pulse frequency | 8 MHz |
| Edge evaluation of incremental encoders | 4-edge evaluation: e.g. a sensor with 1,024 pulses per revolution returns 4.096 increments per revolution. |
| Supported interface types | Standard, pulse train and frequency modulation |
| Behavior on Z pulse detection | Adjustable in the application program |
| Minimum Z pulse length | 15 ns |
| **SSI interface** | |
| Data type of the measured value | 32 bit unsigned |
| Supported SSI modes | Active master or passive master |
| Data format | Gray or binary |
| Data bits | Up to 32 bit data, including diagnostic information |
| Transmission frequency | In active master mode: 78 kHz to 5 MHz<br>In passive master mode: 160 kHz to 5 MHz |

Figure 26 shows the timing requirements for incremental encoder signals.

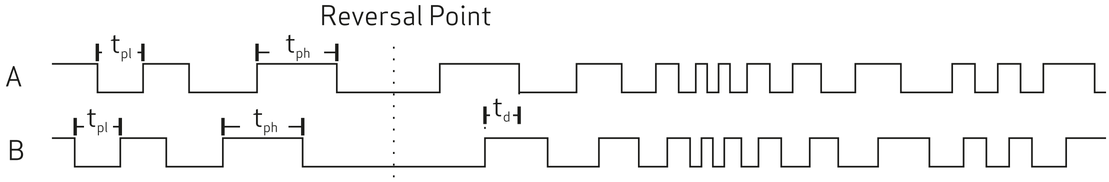



Figure 26: Timing requirements for incremental encoder signals

Table 42 shows the minimum pulse high and pulse low time for incremental encoder signals.

Table 42: Timing requirements for incremental encoder signals

| Time | Minimum | Description |
|---|---|---|
| $t_{pl}$ | 125 ns | Minimum pulse high time |
| $t_{ph}$ | 125 ns | Minimum pulse low time |

## 4.14.2 Functional Description

### SSI active master mode

In SSI active master mode, the digital sensor interface of the MSC III generates the SSI clock (signal Cx).

The clock signal for each interface is generated synchronous to the adjusted task interval of the application program. The interface calculates the duration of a SSI data transmission depending on frequency and number of data bits. The SSI communication cycle is started before each task interval so that the SSI communication cycle is finished before the task interval begins.

| | |
|---|---|
| ! | Select the transmission frequency so that the SSI communication cycle time does not exceed the time of the task interval. Otherwise the data will not be up to date at the start of the task interval. |

Data transmission: When idle, the clock signal is in the 1 state. The first falling edge of the clock signal triggers the SSI sensor to hold its actual value. The clock signal's subsequent rising edge starts the data transmission of the SSI sensor. The output begins with the most significant bit (MSB). After a complete data set has been transmitted, the SSI sensor holds the data signal in the 0 state until the SSI sensor is ready for another transmission.

Figure 27 shows the signals between the MSC III and a 16 Bit SSI sensor. The digital sensor interface of the MSC III sets the clock signal, the SSI sensor responds by sending the data.

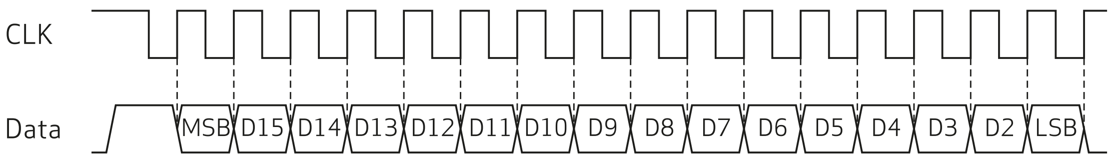



Figure 27: Signals between the MSC III and a 16 Bit SSI sensor (example)

### SSI passive master mode

In SSI passive master mode, the digital sensor interface of the MSC III does not generate the SSI clock (signal Cx). It reads the data and the externally generated clock signal. The interface of the MSC III cannot control the SSI clock frequency and the update rate of the data which is sent by the SSI sensor. In this mode, the interface of the MSC III reads the data bits with every falling edge of the clock.

| | |
|---|---|
| ! | The SSI data is not synchronous to the task interval and may not be updated when the external SSI active master does no longer generate a clock signal. |

| | |
|---|---|
| ! | The clock interface of the external SSI active master and the data interface of the SSI sensor must be capable to drive two EIA 422 inputs (including the termination resistors). Otherwise the communication will not work properly and incorrect data values might be returned by the interface. |

### Incremental encoder quad encoding mode

Figure 28 shows the timing of an incremental encoder with quad encoding.

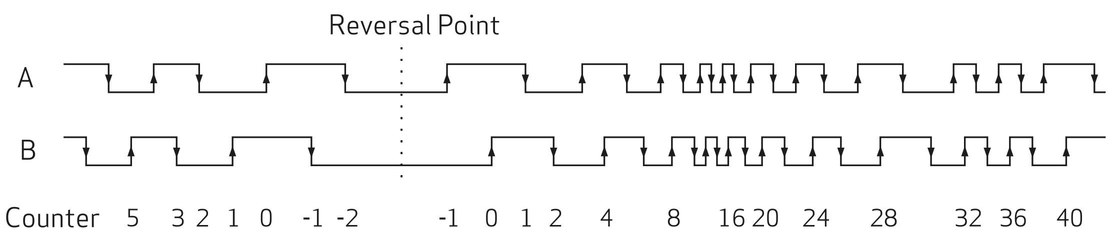



Figure 28: Timing of a standard incremental encoder

On the left side of the dotted line the signal B is leading. On the right side of the dotted line, the direction of the incremental encoder has changed. Now signal A is leading.

While signal A leads, the counter value is incremented with every rising and falling edge of signal A and signal B

While signal B leads, the counter value is decremented with every rising and falling edge of signal A and signal B.

### Incremental encoder pulse train mode with positive logic

Figure 29 shows the timing of pulse train incremental encoder with positive logic.

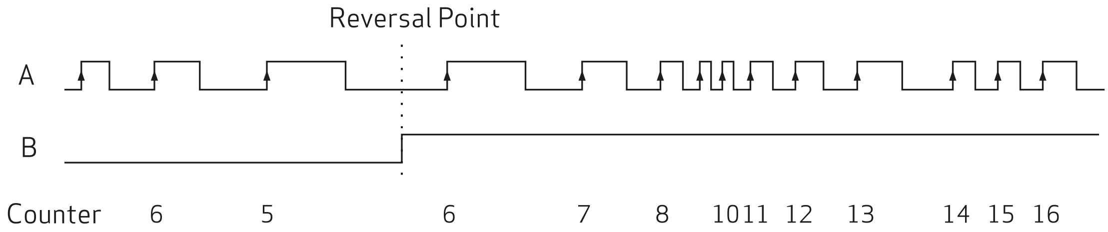



Figure 29: Timing of a pulse train incremental encoder with positive logic

On the left side of the dotted line, while B signal is low, the counter is decremented with every rising edge of signal A.

On the right side, while B signal is high, the direction has changed. Now the counter value is incremented with every rising edge of signal A.

> Make sure that any changes at signal B happens at least 100 ns before a rising edge of signal A.

### Incremental encoder pulse train mode with negative logic

Figure 30 shows the timing of a pulse train incremental encoder with negative logic.

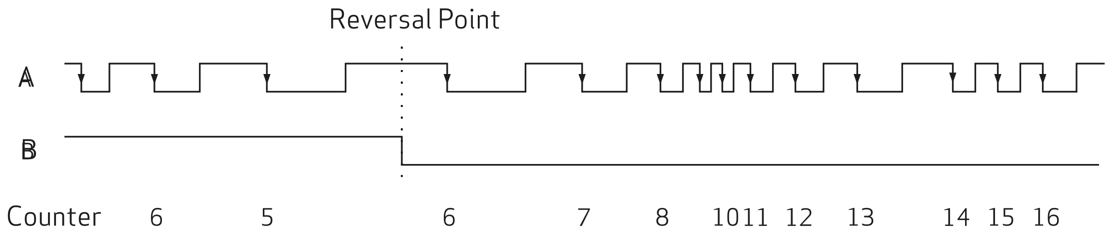



Figure 30: Timing of a pulse train incremental encoder with negative logic

On the left side of the dotted line, while signal B is high, the counter value is decremented at every falling edge of signal A.

On the right side, while signal B is low, the direction has changed. Now the counter value is incremented at every falling edge of signal A.

> Make sure that any changes of signal B happens at least 100 ns before a rising edge of signal A.

### Incremental encoder frequency modulation mode with positive logic

Figure 31 shows the timing of a frequency modulation incremental encoder with positive logic.

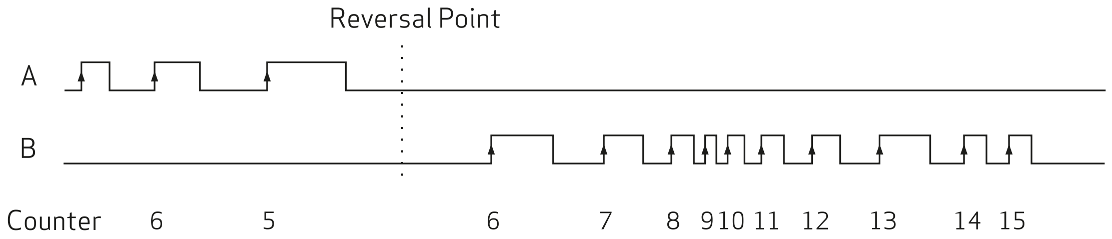



Figure 31: Timing of a frequency modulation incremental encoder with positive logic

On the left side of the dotted line, while signal B is low, the counter value is decremented at every rising edge of signal A.

On the right side, while signal A is low, the direction has changed. Now the counter value is incremented at every rising edge of signal B.

### Incremental encoder frequency modulation mode with negative logic

Figure 32 shows the timing of a frequency modulation incremental encoder with negative logic.

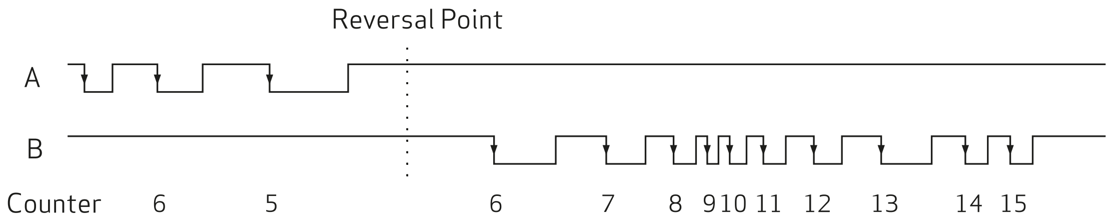



Figure 32: Timing of a frequency modulation incremental encoder with negative logic

On the left side of the dotted line, while signal B is high, the counter value is decremented at every falling edge of signal A.

On the right side, while signal A is high, the direction has changed. Now the counter value is incremented at every falling edge of signal B.

### 4.14.3 Configuration

Adjust the configuration settings in the respective configuration software, e.g. in MASS.

### 4.14.4 Connecting a SSI Sensor in Active Master Mode

Figure 33 shows how to connect a SSI sensor to a SSI active master digital sensor interface. In SSI active master mode, the interface of the MSC III generates the SSI clock (signal Cx).

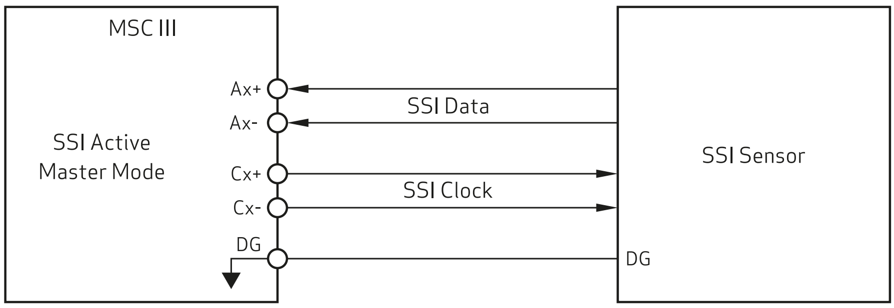



Figure 33: Connecting a SSI sensor to a SSI active master digital sensor interface

### 4.14.5 Connecting a SSI Sensor in Passive Master Mode

Figure 34 shows how to connect a SSI sensor to a SSI passive master digital sensor interface. When in SSI passive master mode, the interface of the MSC III does not generate its own SSI clock signal. It reads the data and the externally generated clock signal.

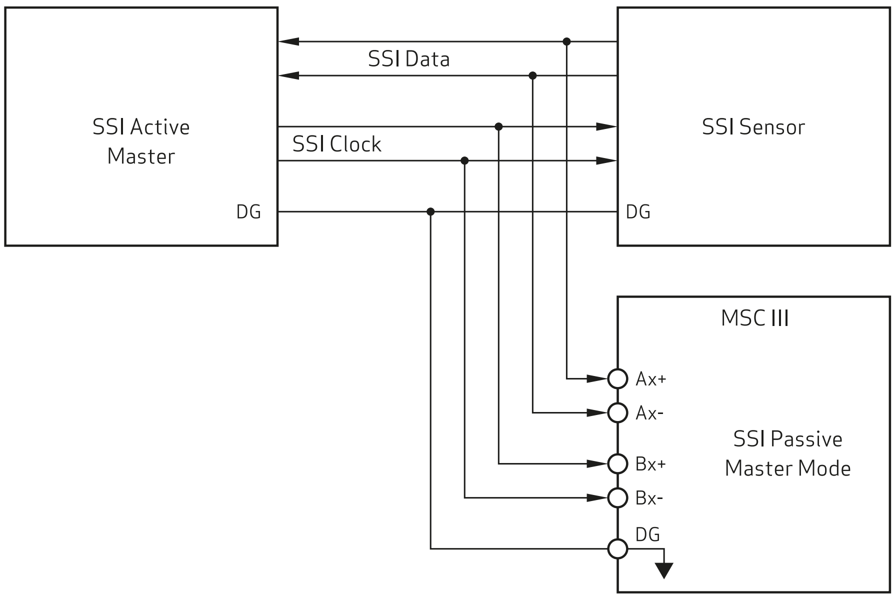



Figure 34: Connecting a SSI sensor to a SSI passive master digital sensor interface

### 4.14.6 Connecting an Incremental Sensor

Figure 35 shows how to connect an incremental encoder to a digital sensor interface. The signals Zx+ and Zx– are not mandatory.

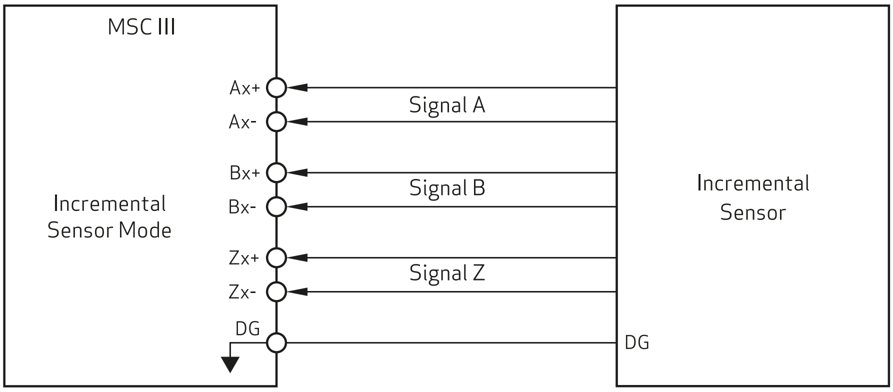



Figure 35: Connecting an incremental encoder to a digital sensor interface

### 4.14.7 Dependence on the 'Outputs Enabled' Signal

If the digital output OE (Outputs Enabled) is in the 0 state (LED OE does not illuminate), then all other outputs are disabled. The outputs of the all digital sensor interfaces (signal C) are switched off (high impedance state).

Digital output 'Outputs Enable': ➪ "4.17 Digital Output 'Outputs Enabled'" on page 58

## 4.15 Digital Inputs and Outputs

Each of the 8-digital terminals I/O1 to I/O8 of the MSC III can be used as either an input or an output. Each digital output is internally connected back to a digital input.

Terminal and LED assignment: ➪ "4.10.3 Terminals and LEDs of X15, Power Supply and Digital Inputs/Outputs" on page 37

### 4.15.1 Power Supply of the Digital I/Os

The power supply for the digital inputs/outputs of the MSC III is independent of the power supply for the internal electronics (+24 V / GND) of the MSC III and is supplied by the terminals L2+ and M2.

### 4.15.2 LEDs I/O1 to I/O8

The status LEDs I/O1 to I/O8 on the front panel of the MSC III shows the internal operational state of the digital inputs/outputs. The LEDs are supplied by the internal electronics of the MSC III.

| | |
|---|---|
| ! | The status LED is lit also if the digital output is in 1 state and L2+ and M2 are not connected or if Outputs Enabled is in 0 state. |

### 4.15.3 Configuration

Adjust the configuration settings in the respective configuration software, e.g. in MASS.

# 4.16 Digital Outputs

## 4.16.1 Basic Wiring Diagram

Figure 36 shows the basic wiring diagram of a digital input/output that is configured as a digital output.

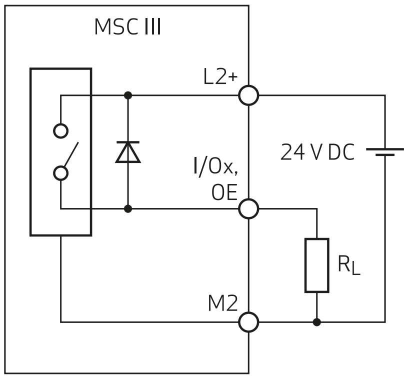



Figure 36: Basic wiring diagram of a digital output

### 4.16.2 Specification

Table 43 shows the specification of the digital outputs. The MSC III offers 8 digital inputs/outputs. Each can be configured as digital input or output.

Table 43: Specification of digital outputs

| Characteristic | Description |
|---|---|
| Number of digital outputs | Maximum 8 |
| Type of outputs | Semiconductor, non-capacitive |
| Protective circuitry for inductive loads | Limiting voltage of 50 V (typ.) with respect to L2+ (+24 V) |
| Power dissipation of protection devices when limiting | Max. 0.5 W per output<br>Max. 1 W per MSC III |
| Status display | One status LED per input/output |
| Power consumption for the internal control circuit (L2+ / M2) | ≤ 100 mA |
| Total load (100%) | 4 A (8 x 0.5 A), when all 8 terminals are used as outputs |
| Overload protection | Electronic current limiting and thermal overload protection |
| Max. short circuit current | Digital output I/O1 to I/O8: 1.7 A<br>Outputs enabled output: 7 A |
| Reverse power feeding protection | Digital outputs are protected against reverse power feeding from digital inputs/outputs to 24 V supply of the module electronic. |
| Output delay (hardware) | From 0 to 1: max. 100 µs<br>From 1 to 0: max. 100 µs |
| Update time | The update time corresponds to the task interval of the application program that actuates the output. |
| Output capacitance | < 20 nF |
| Rated voltage | +24 V DC |
| Voltage loss (at rated current) | < 2 V |
| Rated current in 1 state | 0.5 A |
| Leakage current in 0 state | Max. 0.1 mA |
| Parallel connection of outputs | Not permissible |
| Insulation resistance | Rated voltage: 0-50 V DC<br>Test voltage for 2,000 m (6,500 ft) operating elevation: 500 V DC |

#### Current limiting and overload protection for digital outputs

All digital outputs are protected by an integrated power limiter and a thermal overload protection device.

In an overload condition, the affected output will be automatically disabled. After the output stage has cooled to a normal operating temperature, it will return to normal operation. If the overload condition is still active, then the disable will happen again.

### 4.16.3 Dependence on the 'Outputs Enabled' Signal

If the digital output OE (Outputs Enabled) is in the 0 state (LED OE is not lit), then all other outputs are disabled. In this case, although the internal states of the digital outputs are shown on the front panel status LEDs I/O1 to I/O8, they are not connected through to the output.

## 4.17 Digital Output 'Outputs Enabled'

The digital output Outputs Enabled indicates the enabled state of the analog outputs, digital outputs and the outputs of the digital sensor interface. It can be used to signal another controller that the outputs of the MSC III are enabled.

### 4.17.1 Functional Description

As long as the Outputs Enabled output is in the 1 state, all analog, digital and outputs of the digital sensor interfaces work as configured.

If the Outputs Enabled output is switched to the 0 state (the LED OE is not lit):

- The digital outputs signals I/O1 to I/O8 of the MSC III are switched off although the internal states of the digital outputs are shown on the front panel status LEDs.
- The analog outputs are switched off (high impedance state).
- The outputs of the digital sensor interfaces are disabled.

### 4.17.2 'Outputs Enabled' LED (OE)

The Outputs Enabled LED (OE) indicates the status of the Outputs Enabled output. The LED illuminates when the Outputs Enabled output is in the 1 state.

## 4.18 Digital Inputs

### 4.18.1 Basic Wiring Diagram

Figure 37 shows the basic wiring diagram of a digital input/output that is configured as a digital input.

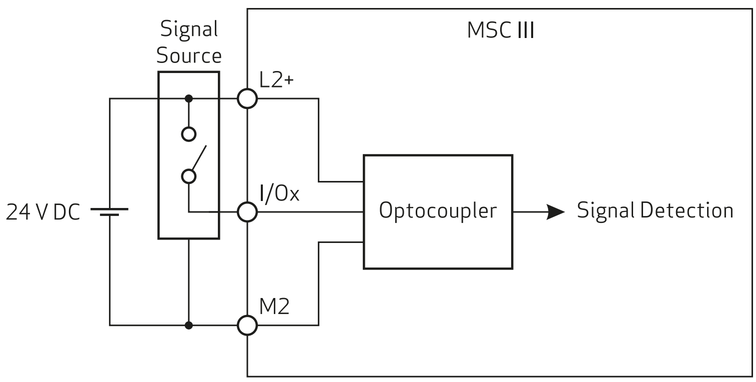



Figure 37: Basic wiring diagram of a digital input

### 4.18.2 Specification

Table 44 shows the specification of the digital inputs. The MSC III offers 8 digital inputs/outputs. Each can be configured as digital input or output.

Table 44: Specification of the digital inputs

| **Characteristic** | **Description** |
|---|---|
| Number of the digital inputs | Maximum 8 |
| Type | Type 1 according to IEC 61131-2, current consuming |
| Wire lengths | The voltage drop must be taken into consideration when choosing the wire cross section; there are no other practical limitations. |
| Load rated voltage L2+ (+24 V) | 24 V DC (safety extra-low voltage SELV according to EN 60950-1) |
| Reverse polarity protection | Digital inputs are protected against reverse polarity |
| Potential isolation | With optocoupler |
| Status display | One status LED per input/output |
| Input delay (hardware) | From 0 to 1: max. 100 µs<br>From 1 to 0: max. 100 µs |
| Sampling time | The sampling time corresponds to the interval of the application task that reads the input. |
| Input capacitance | Max. 10 nF |
| Power consumption for the internal control circuit (L2+ / M2) | ≤ 100 mA |
| Reverse power feeding protection | Digital inputs are protected against reverse power feeding from digital inputs/outputs to 24 V supply of the module electronic. |
| Insulation resistance | Rated voltage: 0-50 V DC<br>Test voltage for 2,000 m (6,500 ft) operating elevation: 500 V DC |

#### Pulse Detection

The digital inputs are read cyclically. The sampling time corresponds to the interval of the application task that reads the input.

The detection of digital input signals depends on the pulse length of the connected signal:

- Pulses that are never detected; pulse duration: ≤ 50 µs
- Pulses that can be detected (if the system reads the input when the pulse appears); pulse duration: > 50 µs
- Pulses that are always detected; pulse duration: > the adjusted task interval

U/I Working Range

Figure 38 shows the typical characteristic input curve of a digital input of the MSC III.

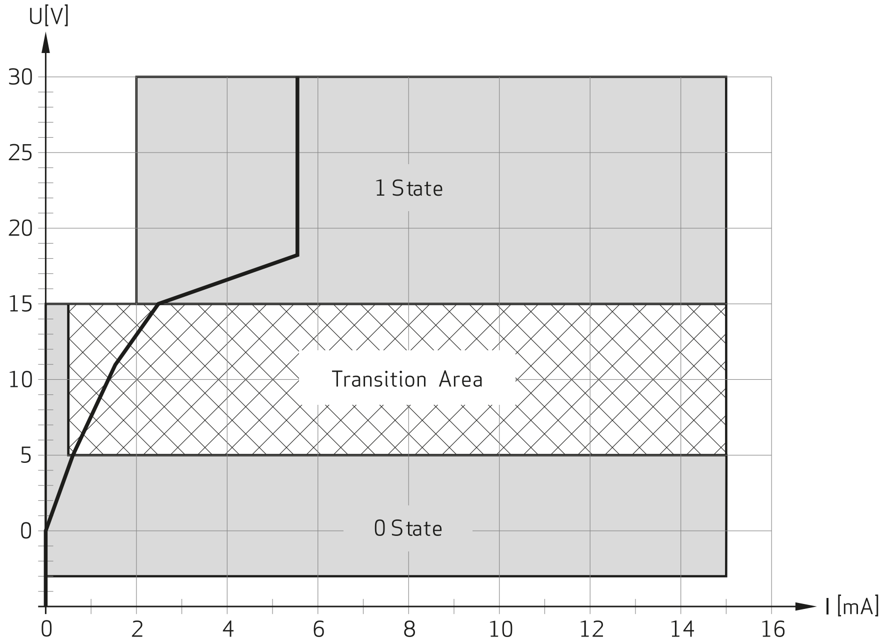



Figure 38: U/I working range of the digital inputs

Table 45: U/I working ranges of the digital inputs (current consuming)

| Description | Characteristic | Voltage/Current |
|---|---|---|
| Input voltage (DC) of the external power supply L2+ (+24 V) | Rated voltage | $U_e$ = 24 V |
| | Upper limit | $U_{e\ max}$ = 36 V |
| | Lower limit | $U_{e\ min}$ = 18 V |
| Limits for the 1 state | Upper limit | $UH_{max}$ = 30 V<br>$IH_{max}$ = 15 mA |
| | Lower limit | $UH_{min}$ = 15 V<br>$IH_{min}$ = 2 mA |
| Limits for the 0 state | Upper limit | $UL_{max}$ = 15/5 V<br>$IL_{max}$ = 0.5/15 mA |
| | Lower limit | $UL_{min}$ = -3 V<br>$IL_{min}$ = ND |

# 4.19 Commissioning

## 4.19.1 Status at Delivery

The MSC III is delivered without firmware loaded. You need to load the firmware first in order to use the MSC III.

### 4.19.2 Required Actions for Commissioning with MASS

MSC III supports MASS.

The following actions are required to commission the MSC III with MASS

- Load the firmware
- Adjust the IP address settings
- Plug the license key
- Adjust the real-time clock
- Download and run an application project

For details, please refer to the release documentation of MASS. This is available on the MASS installation medium. After installing MASS on your PC, it is available at the documentation directory of MASS.

### 4.19.3 Helpline/Support & Service

If you have any questions concerning project planning or commissioning of the MSC III, our Helpline is able to help you quickly and in an application oriented way. For this purpose you should have the following information at hand before you contact support:

- Model number, serial number of the device (see name plate)
- The Moog MASS version used (Help > About)
- The firmware version used (see log of the MASS development environment)
- Description of the error, its generation and boundary conditions
- Name of company and contact, phone number and e-mail address

If you have any technical questions concerning project planning or commissioning of the MSC III, please feel free to contact our helpline.

Helpline - Please contact us:

| | |
|---|---|
| Address: | Moog GmbH<br>Hanns-Klemm-Straße 28<br>D-71034 Böblingen |
| Phone: | +49 7031 622 0 |
| Telefax: | +49 7031 622 100 |
| E-Mail: | M3000-support@moog.com |

Service - Please contact us:
If you need further assistance, our specialists at the Moog Service Center will be happy to help.

| | |
|---|---|
| Phone: | +49 7031 622 0 |
| E-Mail: | info.germany@moog.com |

# 5 Preparing the Product for Use

The MSC III Motion Controller offers fieldbus interfaces, high resolution analog inputs/outputs, position sensor interfaces and digital inputs/outputs.

## 5.1 Transportation and Storage

Conditions for transportation and storage:

➪ "3.7 Environmental Conditions and Limits" on page 14
➪ "3.8 Mechanical Conditions and Limits" on page 14

## 5.2 Inspection of Delivery

Check the original packaging and its contents for any damage after receiving the delivery.

If the packaging or contents are damaged, do not bring the items into operation. In this case, immediately notify Moog or the responsible supplier. In addition, the packaging should be retained. The packaging might be needed to enforce damage compensation claims on the transport company.

After taking the delivery, please check whether all items listed on the delivery docket are present. If anything is missing, immediately notify Moog or the responsible supplier.

Retain the original packaging for any future transport or storage needs.

# 5.3 Assembly

## 5.3.1 View of the Module

Figure 39 shows the view of the module and the position of the interfaces.

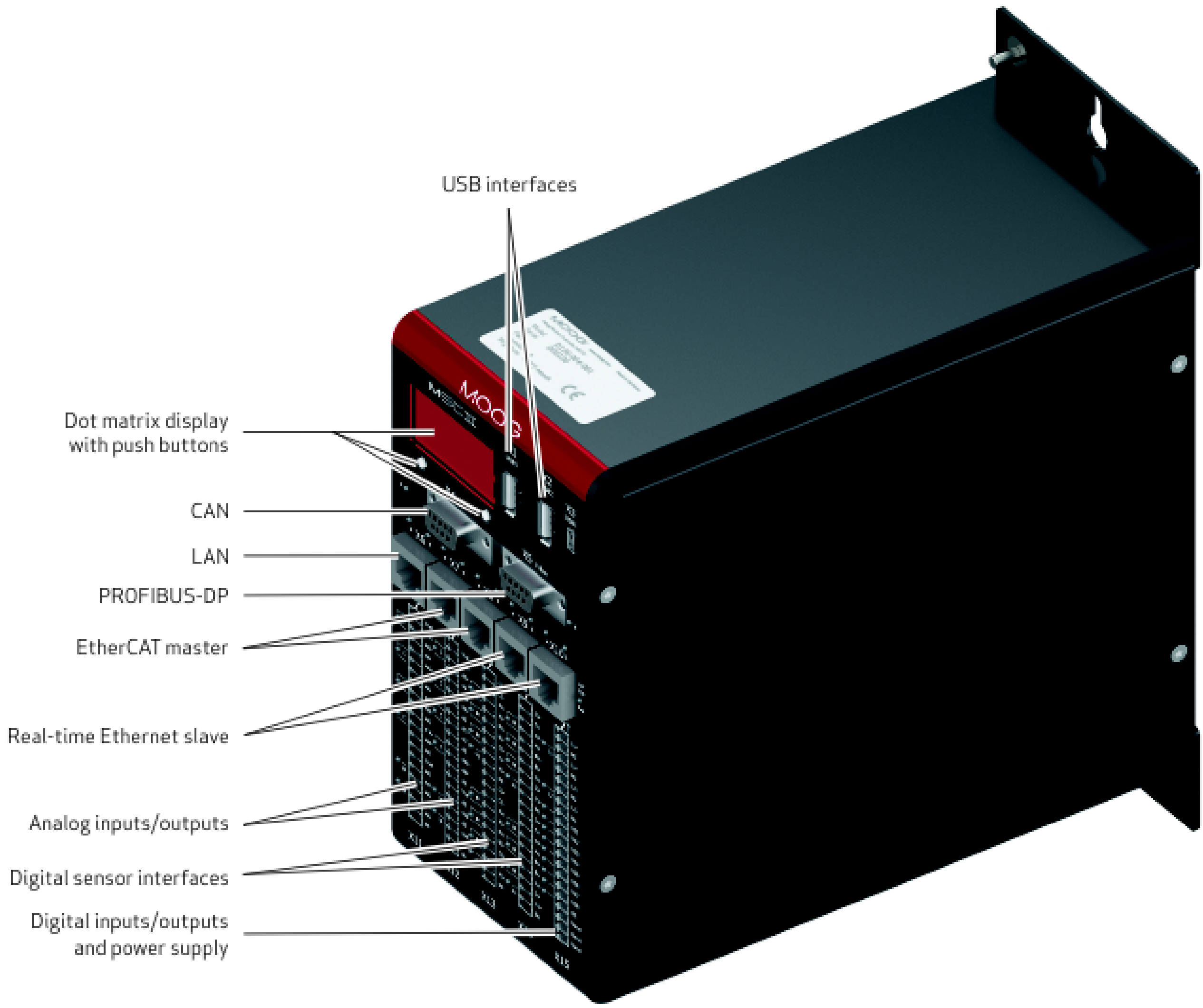



Figure 39: View of the module

### 5.3.2 Dimensions

Figure 39 shows the dimensions of the MSC III.

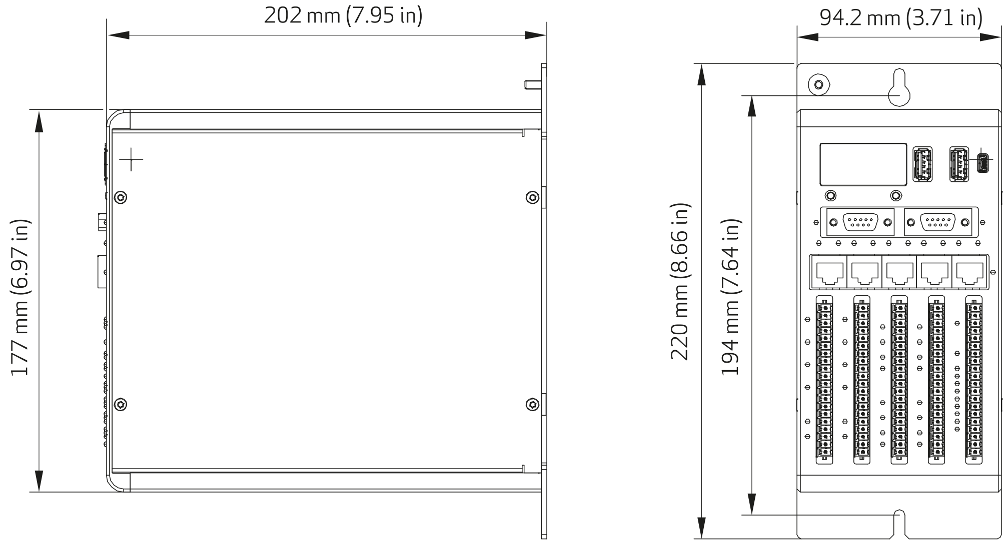



Figure 40: Dimensions of the MSC III

### 5.3.3 Arrangement

Table 46: Arrangement of the MSC III

| Characteristic | Description |
|---|---|
| Mounting orientation | The MSC III can be installed in any orientation. |
| Cooling method | Thermal radiation is used for cooling. There is no air flow through the module. The module is completely covered. |
| Required clearance | 2 cm (0.79 in) beside, above and below the module.<br>The required clearance at the front panel depends on the used connectors. To allow easy plugging and unplugging of the connectors and terminals, it is recommended to have at least 10 cm (3.94 in) clearance at the front panel. |

Figure 41 shows the arrangement of the MSC III and the clearance requirements.

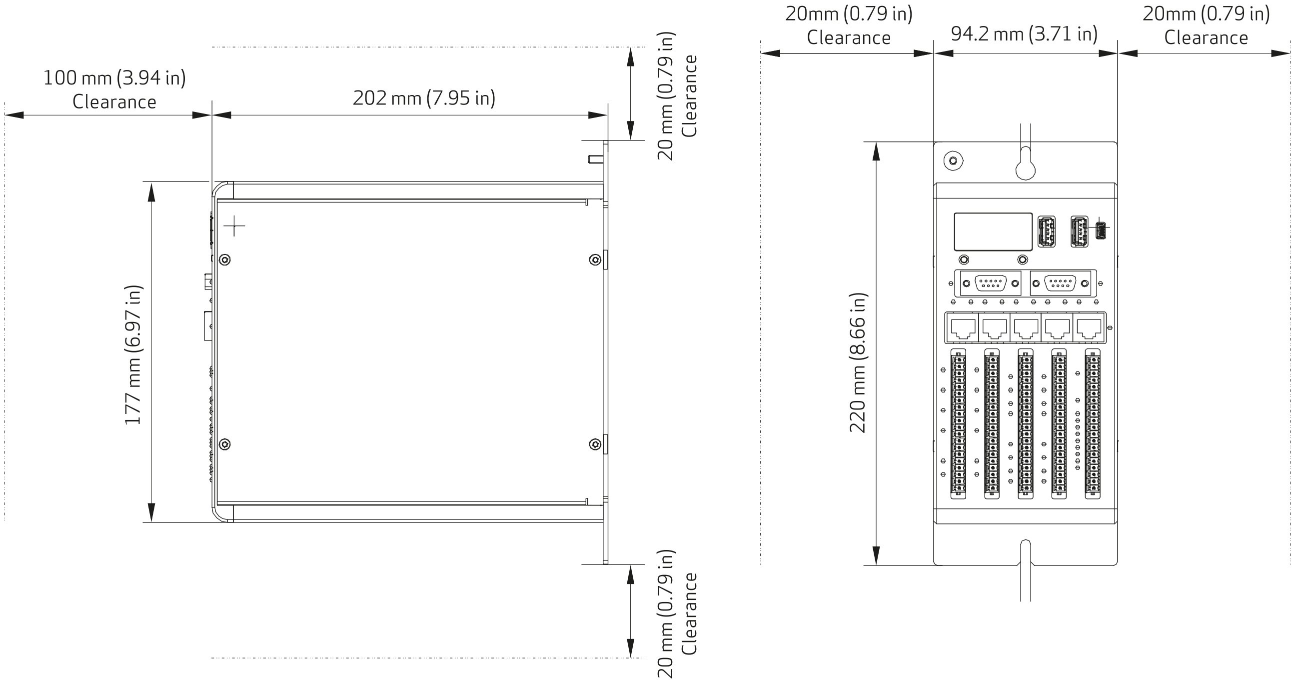



Figure 41: Arrangement of the MSC III

## 5.3.4 Mounting

Dimension: ➪ "5.3.2 Dimensions" on page 64

Procedure for mounting modules:

- Mark out the position of the tapped holes on the backing plate.
- Cut a thread for each fixing screw in the backing plate.
- Mount the module vertically on the backing plate.

Figure 42 shows the mounting dimensions of the MSC III and the position of the mounting cut-outs.

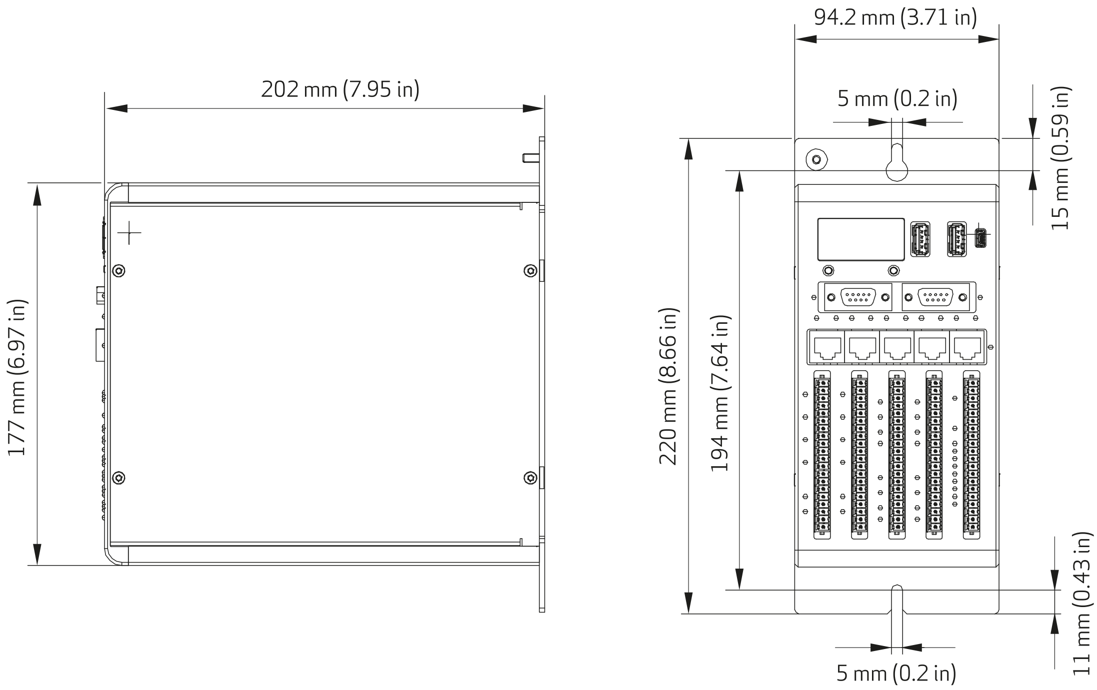



Figure 42: Mounting dimensions of the MSC III

## 5.4 Power Supply

### 5.4.1 Power Supply Requirements

#### Output Voltage of the Power Supply

- Rated voltage: 24 V DC (Safety Extra-Low Voltage (SELV) according to EN 60950-1); a total alternating voltage component with a peak value of 5% of the rated voltage is permitted
- Specified voltage range of MSC III: 18-36 V DC
- The 24 V power supply terminals of the MSC III are protected against reverse polarity. If the polarity of these power supply terminals is reversed, the MSC III will not work

#### Power Consumption

The maximum power consumption of the MSC III is 2 A (plus current for digital outputs).

#### Output Current

If the output current of the power supply is greater than 8 A, the power cable to each MSC III must be fused to ≤ 8 A or the current must be limited in another way.

| | |
|---|---|
| ! | Internal module capacities might cause power spikes of up to 12 A when switching on the power supply for the internal electronics of the MSC III. The duration of these spikes is strongly dependent on the internal resistance of the power supply. |

#### Maximum permissible duration of power interruptions

Under full load (PS1 intensity): ≤ 1 ms (duration of interruption during voltage drops and interruptions to the input voltage).

| | |
|---|---|
| ! | The interval between input voltage drops must not be shorter than 1 s. |

### Safety Extra-Low Voltage (SELV)

The safety extra-low voltage is a voltage that will not, under any operating conditions, exceed 25 V AC or 60 V DC peak or direct voltage as measured between conductors or between a conductor and ground. The circuit in which SELV is used must be separated from the mains power supply by a safety transformer or something of equal functionality. Always observe national regulations when choosing the rated insulation voltage.

### Insulation resistance of MSC III

| | |
|---|---|
| Rated voltage: | 0-50 V DC |
| Test voltage for 2,000 m (6,500 ft) operating elevation: | 500 V DC |

## 5.4.2 Connecting Power Supply and Grounding

Figure 43 shows how to connect the 24 V SELV power supply and the grounding.

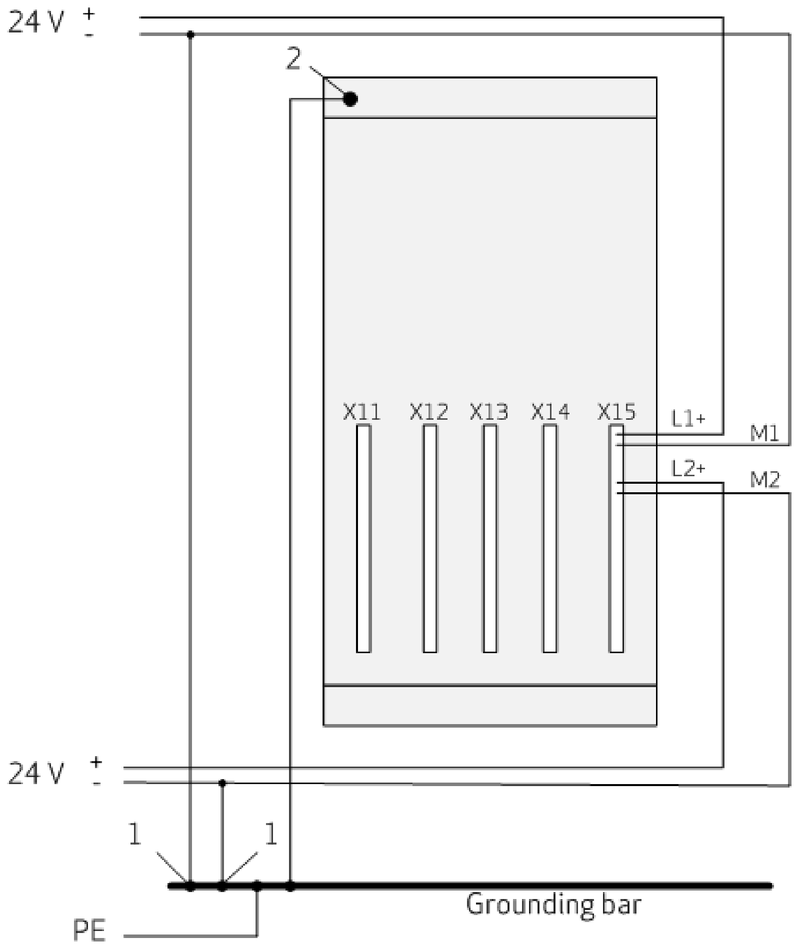



Figure 43: Connecting power supply and grounding

1 For reasons of functional safety, all circuits must be grounded on a central point.
2 The PE conductor of the module must have a low resistance connection to the protective earth conductor (PE).

Table 47: Terminals and potential separation

| Characteristic | Description |
|---|---|
| L1+/M1 terminals | 24 V SELV supply of the module electronic |
| Potential separation | The module electronics generates separate potentials for:<br>• Ethernet<br>• CAN/CANopen<br>• PROFIBUS-DP slave<br>• Analog Inputs/outputs |
| L2+/M2 terminals | 24 V SELV supply of the digital inputs/outputs |
| Grounding of the front panel connectors X1 to X10 | The metal housings of the front panel connectors X1 to X10 are connected internally to the grounding of the housing. |

# 6 Operating Instructions

| | |
|---|---|
| ! | Make sure that the firmware is loaded to the MSC III before you try to operate it.<br>➪ "4.19 Commissioning" on page 60 |

## 6.1 Programming and Configuration with MASS

The MASS development environment is required to create IEC 61131 application programs and configure the MSC III. See online help of MASS and release documentation of MASS for more details.

➪ "9 Product Range" on page 73

### 6.1.1 Communication between MSC III and MASS

The Ethernet interface of the MSC III is used for communication with the MASS development environment.

### 6.1.2 Device Status

The device status is adjusted from the MASS development environment:

- Run
- Stop

Application projects can be downloaded to the RAM memory or stored as boot project (stored in the Flash EEPROM).

### 6.1.3 Behavior at Switching off or Failure of the Power Supply

If the module power supply L1+/M1 is switched off or falls below 18 V for more than 5 ms, then the power down sequence is executed:

- The execution of the application is stopped immediately.
- The variables that have been declared as RETAIN are automatically copied from the fast RAM to the NVRAM (nonvolatile RAM).

| | |
|---|---|
| ! | If the power is switched off and is switched on again before the power off sequence is finished:<br>• The power down sequence continues until it is finished completely.<br>• Then the power on sequence starts. |

### 6.1.4 Behavior at Power on

Power on sequence
Firmware is started

- Communication to MASS development environment (IDE) is possible.
- Web diagnostic interface is working.

If a boot project is stored on the MSC III:

- The boot project is loaded from Flash EEPROM into RAM.
- If RETAIN variables are existing, then these variable values are retained.
- The boot project is started.

### 6.1.5 Web Diagnostic Interface

The web diagnostic interface is available after the MASS firmware is loaded to the MSC III. It starts automatically at power up. The web interface is available in standard browsers. Enter the IP address of the MSC III Ethernet interface into the address field of your browser to access the web diagnostic interface. Example: 192.168.1.2. The web diagnostic interface displays information about the MSC III, the loaded firmware and the running application.

# 7 Maintenance

MSC III is maintenance-free. It does not contain any components (such as batteries or fans) that must be maintained or replaced.

Calibration of analog inputs, analog outputs and reference voltage outputs is done at manufacturing.

# 8 Decommissioning

Switch off the power supply before you start to dismantle the MSC III. If you want to replace the MSC III by another device, then note the position of the wiring.

## 8.1 Dismount the MSC III

- Remove the connected cables and terminals.
- Loosen the fixing screws.
- Remove the module.

## 8.2 Disposal

Please, observe the locally valid regulation for disposal of electronic components.

# 9 Product Range

Table 48 shows the available products, the description and the ordering numbers of the products.

Table 48: Ordering Information (Part 1 of 2)

| Designation | Description | Ordering number |
|---|---|---|
| **MSC III Motion Controller** | | |
| MSC III Motion Controller | MSC III with 1 x LAN, 2 x real-time Ethernet master,<br>2 x real-time Ethernet slave, 1 x CAN, 2 x USB,<br>1 x PROFIBUS-DP slave, 4 x digital sensor interface,<br>8 x analog input, 4 x analog output, 8 x digital input/output | D136-004-001 |
| **MASS Moog Application Software Suite** | | |
| MASS Software Development Suite (Company/Subsidiary multiuser license) | This multi user license is valid for all users in one company at one location/site. Companies with multiple subsidiaries/sites need to purchase a multi user license per subsidiary/site. The software suite allows developing, debugging, visualizing and optimizing complex motion control applications. The package includes CODESYS 3 and allows IEC 61131 compliant programming in all IEC 61131 languages.<br>One year MASS Software Maintenance Agreement (D138-020-001) is already included which includes priority hotline support and free MASS software updates for one year.<br>IMPORTANT!<br>Registration of the MASS Software Maintenance Agreement is necessary at MASS-support@moog.com to receive the software updates. | D138-010-001 |
| MASS Software Maintenance agreement (Company/Subsidiary software maintenance agreement) | This maintenance agreement is valid for all users in one company at one location/site. Companies with multiple subsidiaries/sites need to purchase a multi user maintenance agreement per subsidiary/site.<br>Renewing the MASS Software Maintenance Agreement needs to be done by the user. It can also be renewed in advance of the maintenance agreement expiration. It includes priority hotline support (email & phone) and free MASS software updates for one year.<br>IMPORTANT!<br>Registration of the MASS Software Maintenance Agreement is necessary at MASS-support@moog.com to receive the software updates. | D138-020-001 |
| **License keys** | The MASS license key contains the runtime license for the Moog Application Software Suite (MASS). According to the license key used, assigned functionality of MASS is enabled for usage. | |
| License key 'White' | MASS runtime license with basic functionality:<br>• Moog control technology library | D138-030-001 |
| License key 'Green' | All functions of license key 'White' and additionally:<br>• EtherCAT<br>• CANopen<br>• PROFIBUS-DP slave<br>• Web visualization | D138-030-002 |

Table 48: Ordering Information (Part 2 of 2)

| Designation | Description | Ordering number |
|---|---|---|
| License key 'Black' | All functions of license key 'Green' and additionally:<br>• Generation of motion profiles, caming, gearing: Soft motion | D138-030-003 |
| License key 'Red' | Program parts and / or complete application programs specifically upon customer request | Specific to the order |
| **Accessories** | | |
| Terminal connector | Plug component, number of positions: 20, pitch: 3.5 mm, color: gray, 5 terminal connectors are required for a MSC III.<br>Phoenix FMC 1,5/20-STZ4-3,5 RF GY- 1702670 | CC44534-020 |
| DIN rail mounting kit | For mounting the MSC III on a DIN top hat rail. To be screwed onto the back plate of the MSC III. | CC39899-001 |

# Index

## D



## E



## F



## G



## H



## I

## L



## M



## N



## O



## P

# R



# S



# T



# U



# V



# W

# X

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