USER MANUAL FOR

MOTION CONTROLLERS
EXTENSION MODULE FOR MOOG
RUGGEDIZED MOTION CONTROLLER
(MSC-R-IO)

EXTENSION MODULE WITH ETHERCAT
SLAVE INTERFACE FOR HARSH ENVIRONMENTS
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Subject to changes without prior notice.

All M3000® modules comply with the standards specified in their relevant declaration of conformity.
CE labeling of the M3000® modules is based on proper installation of the automation system with proven electromagnetic compatibility (EMC).
# Table of Contents

List of Tables .............................................................................................................................................iv
List of Figures .............................................................................................................................................v

1 General Information .................................................................................................1
   1.1 About this Manual ........................................................................................................... ............ 1
      1.1.1 Reservation of Changes and Validity ............................................................................. 1
      1.1.2 Exclusion of Liability .................................................................................................... ... 1
      1.1.3 Completeness .............................................................................................................. .. 1
      1.1.4 Place of Storage .......................................................................................................... ... 1
   1.2 Selection and Qualification of Personnel.......................................................................... 2
   1.3 Proper Use .................................................................................................................. ................. 2
      1.3.1 Safety Related Systems................................................................................................. 2
   1.4 Warranty and Liability ...................................................................................................... ........... 3
   1.5 Inspection of Delivery ...................................................................................................... ........... 3
   1.6 Environmental Protection ................................................................................................. ....... 4
      1.6.1 Emissions................................................................................................................. ...... 4
      1.6.2 Disposal.................................................................................................................. ........ 4
   1.7 Standards ................................................................................................................... .................. 4
      1.7.1 CE Labeling of M3000® Modules ................................................................................... 4
      1.7.2 IEC 61131-2 ................................................................................................................ ... 4
      1.7.3 Electromagnetic Compatibility (EMC)............................................................................. 4
   1.8 Trademarks .................................................................................................................. ................ 5
   1.9 Software Copyrights ......................................................................................................... .......... 5

2 Safety Instructions .................................................................................................6
   2.1 Typographical Conventions ................................................................................................... .... 6
   2.2 Safety Instructions .......................................................................................................... ............ 6
      2.2.1 Safety Related Systems ................................................................................................. 6
      2.2.2 Environmental Conditions .............................................................................................. 7
      2.2.3 ESD ................................................................................................................................ 7
      2.2.4 Project Planning and Installation .................................................................................... 8
      2.2.5 Shutdown and Service ................................................................................................... 9
      2.2.6 Transportation and Storage .......................................................................................... 10

3 Environmental Conditions ......................................................................................11
   3.1 Requirements of IEC 61131-2 .................................................................................................. .1 1
   3.2 Use in Special Environments ................................................................................................... 12

4 Mechanical Installation ........................................................................................13
   4.1 Mounting .................................................................................................................. ............... 13
   4.2 Removing .................................................................................................................. ............... 13
# Table of Contents

## 5 Project Planning and Installation
- **5.1 Grounding Concept**
- **5.2 Power Supply**
- **5.3 Connecting Signal Cables**

## 6 Shutdown and Service
- **6.1 Shutdown**
- **6.2 Service**
  - 6.2.1 Maintenance/Servicing
  - 6.2.2 Repair

## 7 Transportation and Storage
- **7.1 Environmental Conditions**

## 8 MSC-R-IO
- **8.1 Performance Characteristics**
- **8.2 General Specifications**
  - 8.2.1 View of the Module
  - 8.2.2 Dimensions
  - 8.2.3 Mechanical Mounting
  - 8.2.4 Environmental Conditions
- **8.3 Block Diagram**
- **8.4 View of the Module and Terminal Assignment**
  - 8.4.1 Terminal Assignment
  - 8.4.2 LEDs
  - 8.4.3 EtherCAT Slave Interface
- **8.5 Power Supply**
- **8.6 Digital I/Os**
  - 8.6.1 Status Display of Digital I/Os
  - 8.6.2 Power Supply of the Digital I/Os
  - 8.6.3 Digital Outputs
  - 8.6.4 Digital Inputs
- **8.7 Temperature Sensor Input**
  - 8.7.1 PT Connection Diagram
- **8.8 EtherCAT Interface**
- **8.9 Nameplate**

## 9 Product Range
- **9.1 DIN Rail Mounting Kit for the MSC-R-IO**
- **9.2 Plug-In Terminal Strips**
10 Appendix..................................................................................................44
   10.1 Typographical Conventions ...............................................................44
   10.2 Abbreviations.......................................................................................45
   10.3 Quoted Standards ..............................................................................47
       10.3.1 CiA DS.........................................................................................47
       10.3.2 DIN .........................................................................................47
       10.3.3 EN .........................................................................................47
       10.3.4 IEC .........................................................................................48
       10.3.5 ISO/DIS ....................................................................................48
       10.3.6 TIA/EIA....................................................................................49

11 Index........................................................................................................50
List of Tables

Table 1: Power Supply Conditions of the Module's Internal Electronics and the Sensors ......................... 18
Table 2: Dimensions of the MSC-R-IO ........................................................................................................ 24
Table 3: Terminal Assignment of MSC-R-IO's Connectors ......................................................................... 29
Table 4: LEDs of the MSC-R-IO .................................................................................................................. 32
Table 5: Pin assignment of M12 EtherCAT connectors .................................................................................. 32
Table 6: Receive PDO 1 ................................................................................................................................. 33
Table 7: Transmit PDO 1 ............................................................................................................................... 33
Table 8: Transmit PDO 2 ............................................................................................................................... 33
Table 9: Transmit PDO 3 ............................................................................................................................... 33
Table 10: U/I Working Ranges of MSC-R-IO's Digital Inputs (Current Consuming) .................................... 40
Table 11: Product Range – DIN Rail Mounting Kit for the MSC-R-IO .......................................................... 43
Table 12: Product Range – Plug-In Terminal Strips ..................................................................................... 43
Table 13: Abbreviations ............................................................................................................................... 45
List of Figures

Figure 1: Grounding Concept ......................................................................................................................... 15
Figure 2: Moog Global Support .................................................................................................................... 21
Figure 3: Front view of MSC-R-IO .............................................................................................................. 23
Figure 4: Dimensions of the MSC-R-IO .................................................................................................... 24
Figure 5: MSC-R DIN Rail Mounting Kit ................................................................................................... 25
Figure 6: Block Diagram of the MSC-R-IO ................................................................................................. 27
Figure 7: View of the MSC-R-IO and Terminal Assignment ........................................................................ 28
Figure 8: Basic Wiring Diagram of a Digital Output of the MSC-R-IO ................................................................ .................................................................................................................................................................................................................................................................................................................. 36
Figure 9: Basic Wiring Diagram of a Digital Input of the MSC-R-IO (Current Consuming).......................... 38
Figure 10: U/I Working Ranges of MSC-R-IO's Digital Inputs (Current Consuming) ....................................... 40
Figure 11: PT connection diagram .............................................................................................................. 41
Figure 12: Position of the Nameplate on the MSC-R-IO ........................................................................... 42
1 General Information

1.1 About this Manual

This manual is valid only for the M3000® automation system and M3000® modules. It contains most important instructions that must be observed in order to operate the M3000® automation system and M3000® modules 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 M3000® automation system and M3000® modules:

- All safety instructions contained in this manual
- All safety instructions contained in the documentation of the M3000® modules
- All safety instructions contained in the product related hardware and software documentation required for the relevant application
- All relevant nationally and internationally applicable safety and accident prevention regulations and standards

1.1.1 Reservation of Changes and Validity

The information contained in this manual is valid at the time of this version's release. 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.

1.1.2 Exclusion of Liability

This manual was prepared with great care and the contents reflect the authors’ 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.

1.1.3 Completeness

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

1.1.4 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 M3000® automation system and M3000® modules or the equipment in which they are installed.
1.2 Selection and Qualification of Personnel

Qualified Users

Only qualified users may work with and on the M3000® automation system or M3000® modules. 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 working on a project must be familiar with safety concepts common in automation.

1.3 Proper Use

Proper Use

The M3000® modular automation system is suitable for control applications in the medium to high end performance ranges.

M3000® 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 M3000®.

M3000® and M3000® modules must not be brought into operation until it has been ensured that the equipment in which they are installed complies with the current version of the EU machinery directive.

The M3000® automation system and M3000® modules may be used only under the conditions and situations specified in this manual and in the documentation of the M3000® modules. Any other or more extensive use is not permissible.

The following is also required for proper use:

- Compliance with the requirements detailed in this manual
- Compliance with the requirements of individual M3000® module documentation
- Compliance with all of the product related hardware and software documentation required for the relevant application
- Compliance with the relevant nationally and internationally applicable regulations, standards, and directives, e.g., the regulations specified by a professional organization, such as TÜV or VDE

1.3.1 Safety Related Systems

Safety Related Systems

**WARNING**

As with any electronic automation system, the failure of certain components when using M3000® or M3000® modules might lead to an uncontrolled and/or unpredictable operational condition. The user should take into consideration the system level effects of all types of failures and implement corresponding safety measures.

Special measures are required to use control technology in safety related systems. When planning to use control technology in a safety related system, the user should seek detailed advice in addition to any available standards or guidelines for safety installations.
1.4 Warranty and Liability

Moog’s standard delivery and payment conditions apply. The owner/operator will have access to these by the time the contract is closed at the latest.

Warranty and liability claims for personal and material damage will be excluded when they are the result of the following, among others:

- Improper use of the M3000® automation system or M3000® modules
  "1.3 Proper Use" on page 2
- Use of the M3000® automation system or M3000® modules in a technically imperfect condition
- Use of the M3000® automation system or M3000® modules by unqualified users
  "1.2 Selection and Qualification of Personnel" on page 2
- Failure to comply with this manual, the documentation of the M3000® modules, or the product related hardware and software documentation required for the relevant application
- Failure to comply with the relevant nationally and internationally applicable regulations such as the regulations of a professional association, the TÜV, or the VDE
- Improper deployment of the M3000® automation system or M3000® modules, such as in a potentially explosive, excessively warm, or excessively cold environment
- Improper storage, transportation, mounting, removing, connection, bringing into operation, operation, cleaning, or maintenance of the M3000® automation system or M3000® modules
- Storage or transportation of M3000® modules or accessories outside of the original packaging
  "7 Transportation and Storage" on page 22
- Unauthorized or improperly executed structural changes to the M3000® automation system or M3000® modules
- Unauthorized or improperly executed repairs on the M3000® automation system or M3000® modules
  "6.2.2 Repair" on page 21
- Damage due to the intrusion of foreign objects or acts of God.

1.5 Inspection of Delivery

After receiving the delivery, please check the original packaging and its contents for any damage. If the packaging or contents exhibit any damage, 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.

It is advisable to retain the original packaging for any future transport or storage needs.
1.6 Environmental Protection

1.6.1 Emissions

M3000® modules do not have any harmful emissions when used properly.

1.6.2 Disposal

The applicable disposal regulations must be observed when disposing of M3000® modules!

1.7 Standards

1.7.1 CE Labeling of M3000® Modules

All M3000® modules comply with the standards specified in their relevant declaration of conformity. CE labeling of the M3000® modules is based on proper installation of the automation system with proven electromagnetic compatibility (EMC).

1.7.2 IEC 61131-2

The M3000® automation system and M3000® modules comply with the requirements of IEC 61131-2.

Where technical requirements lead to deviations from the standard, these are specified in this manual or in the documentation of the relevant M3000® modules.

1.7.3 Electromagnetic Compatibility (EMC)

M3000® modules comply with the requirements and protection targets of the EU directive 2004/108/EC “Electromagnetic Compatibility” (EMC directive) and comply 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.

M3000® modules are designed for use under normal operating conditions in industrial environments and comply with the following standards:

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

If suitable additional measures are taken, M3000® modules 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

Suitable additional measures:

*“3.2 Use in Special Environments” on page 12
If the system does not comply with the requirements of EN 61000-6-1 and
EN 61000-6-3, despite the additional measures, M3000® modules must not
be used in residential, commercial and light-industrial environments.

EMC conformity may be presumed only under the following conditions:

- Sufficient shielding

The MSC-R-IO must be powered from a power supply with SELV (Safety Ex-
tra-Low Voltage) according to EN 60950-1. Therefore the EU low voltage di-
rective is not relevant for the M3000® automation system because the speci-
fied voltage levels are below the limits.

1.8 Trademarks

Moog and Moog Authentic Repair are registered trademarks of Moog Inc.
and its subsidiaries.
EtherCAT® is registered trademark and patented technology licensed by
Beckhoff Automation GmbH, Germany.
M3000® is a trademark of Moog GmbH that is registered in the EU.

All product and company names mentioned in this manual might be pro-
tected trademarks or brands of the relevant manufacturer.
The absence of the symbols ® or ™ does not indicate that the name is
free from trademark protection.

1.9 Software Copyrights

The software that is installed on M3000® products at the time of delivery is
the property of the manufacturer. At the time of delivery, every piece of in-
stalled software is covered by copyright protection. It may be reproduced only
with the approval of the manufacturer or in accordance with the license
agreements.
2 Safety Instructions

This chapter summarizes the most important safety instructions. When handling the M3000® automation system or M3000® modules the safety instructions in the other chapters of this manual must be followed as well as the safety instructions in the product related hardware and software documentation required for the specific application.

Following the safety instructions helps to avoid accidents, faults, and material damage!

2.1 Typographical Conventions

The following symbols and styles are used for identifying the different types of safety instructions:

- **DANGER** Identifies safety instructions that are intended to warn of an immediate and impending danger to life and limb or major property damage. Failure to observe these safety instructions will lead inevitably to death, serious personal injury (disablement) or major property damage!

- **WARNING** Identifies safety instructions that are intended to warn of potential danger to life and limb or the potential for major property damage. Failure to observe these safety instructions might lead to death, serious personal injury (disablement) or major property damage!

- **CAUTION** Identifies safety instructions that are intended to warn of slight personal injury or minor property damage. Failure to observe these safety instructions might lead to slight personal injury or minor property damage.

Additional typographical conventions:

- *"10.1 Typographical Conventions" on page 44*

2.2 Safety Instructions

2.2.1 Safety Related Systems

- **WARNING** As with any electronic automation system, the failure of certain components when using M3000® or M3000® modules might lead to an uncontrolled and/or unpredictable operational condition. The user should take into consideration the system level effects of all types of failures and implement corresponding safety measures.

More on this subject: *"1.3.1 Safety Related Systems" on page 2*
2.2.2 Environmental Conditions

**WARNING** Maintain under all circumstances the required environmental conditions specified for the M3000® automation system or M3000® modules. This ensures fault-free, reliable, and safe operation.

**WARNING** The PC on which tools such as MACS development environment are installed must be suitable for the environmental conditions in which it will operate. This ensures fault-free, reliable, and safe operation.

**WARNING** It is not permissible to operate the M3000® automation system or M3000® modules in a potentially explosive environment.

**WARNING** The M3000® automation system and M3000® modules must not come into direct contact with liquids, except where explicitly specified. Danger of short-circuit! If they do come into direct contact with a liquid, immediately disconnect the power supply! Before bringing the system back into operation, it is essential that all affected components are completely dry and have been inspected by a suitably qualified technician.

More on this subject:
☞ "3 Environmental Conditions" on page 11
☞ "8.2.4 Environmental Conditions" on page 26

2.2.3 ESD

**WARNING** Protect the M3000® automation system, M3000® modules, and the license key from electrostatic discharges! Electrostatic discharges might damage the device's internal components or delete the device's internal memory.

Safety Instructions: Environmental Conditions

Safety Instructions: ESD
2.2.4 Project Planning and Installation

**WARNING**  The vent holes of M3000® modules facilitate convection cooling and must never be covered! Covered vent holes might result in overheating and fire.

**WARNING**  No work of any kind, such as mounting, removing, wiring, or repairs to the M3000® modules may be performed while the modules are in operation!

There is a danger of:
- Uncontrolled movements
- Permanent damage
- Malfunctions

Before performing any work on M3000® modules, it is essential that the system is stopped and the power supply is disconnected.

Therefore, all power supplies must be switched off, including those from attached peripherals such as externally supplied transmitters, programming devices, etc.!

**WARNING**  M3000® modules must be protected from overvoltages and/or reverse energization from the sensor to the module!

There is a danger of:
- Permanent damage by overheating or fire
- Malfunctions

M3000® modules must have the correct voltage, polarity, and terminal assignments.

**WARNING**  The internal electronics of M3000® modules and 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 following problems might arise, depending on the state of the power supply for the internal electronics of the module and sensors (see table 1 on page 18):
- Invalid sensor data
### 2.2.5 Shutdown and Service

**WARNING** Sensors that are connected to digital inputs of M3000® modules with several I/O groups, such as MSC I, QDIO, or RDIO, must always be supplied from the same power supply as the corresponding I/O group to which the sensor is connected!

Otherwise, if the power supply for the internal electronics of the module is switched off, there might be reverse energization from the sensor to the module.

There is a danger of:
- Uncontrolled movements
- Fault or failure of a manual control
- Permanent damage to the module
- Malfunctions

Digital I/Os of MSC II, MSC-R-IO and MSD Motion Controller are protected against reverse energization.

More on these subjects:
- "4 Mechanical Installation" on page 13 or
- "5 Project Planning and Installation" on page 14

**WARNING** To avoid damage to M3000® modules or accessories, cleaning, maintenance, and repair tasks may be performed only by Moog or Moog's authorized service agents.

Warranty and liability claims for personal and material damage are excluded when, among other reasons, they are due to unauthorized repairs or other unauthorized interventions.

- "1.4 Warranty and Liability" on page 3

**WARNING** No work of any kind, such as mounting, removing, wiring, or repairs to the M3000® modules may be performed while the modules are in operation!

There is a danger of:
- Uncontrolled movements
- Permanent damage
- Malfunctions

Before performing any work on M3000® modules, it is essential that the system is stopped and the power supply is disconnected.

Therefore, all power supplies must be switched off, including those from attached peripherals such as externally supplied transmitters, programming devices, etc.!
**WARNING** The M3000® automation system and M3000® modules must not come into direct contact with liquids, except where explicitly specified. Danger of short-circuit!
If they do come into direct contact with a liquid, immediately disconnect the power supply! Before bringing the system back into operation, it is essential that all affected components are completely dry and have been inspected by a suitably qualified technician.

**WARNING** If an M3000® module is to be taken out of operation, the entire system must always be shut down and disconnected from all power supplies.
Therefore, all power supplies must be switched off, including those from attached peripherals such as externally supplied transmitters, programming devices, etc.!
The M3000® module must be protected against unintentional restarting!
If the M3000® module is connected to other devices and/or facilities, always consider the full consequences and take appropriate precautions before switching off the module.

More on these subjects: ⇨ "6 Shutdown and Service" on page 20

### 2.2.6 Transportation and Storage

**WARNING** Maintain, under all circumstances, the required environmental conditions specified for transportation and storage of the M3000® automation system or M3000® modules.
⇦ "7.1 Environmental Conditions" on page 22
This ensures fault-free, reliable, and safe operation.

More on this subject: ⇨ "7 Transportation and Storage" on page 22
3 Environmental Conditions

**WARNING** Maintain under all circumstances the required environmental conditions specified for the M3000® automation system or M3000® modules. This ensures fault-free, reliable, and safe operation.

**WARNING** It is not permissible to operate the M3000® automation system or M3000® modules in a potentially explosive environment.

**WARNING** The M3000® automation system and M3000® modules must not come into direct contact with liquids, except where explicitly specified. Danger of short-circuit! If they do come into direct contact with a liquid, immediately disconnect the power supply! Before bringing the system back into operation, it is essential that all affected components are completely dry and have been inspected by a suitably qualified technician.

### 3.1 Requirements of IEC 61131-2

The M3000® automation system and M3000® modules comply with the requirements of IEC 61131-2.

Where technical requirements lead to deviations from the standard, these are specified in this manual or in the documentation of the relevant M3000® modules.

Environmental conditions for the MSC-R-IO:

> “8.2.4 Environmental Conditions” on page 26

Refer to the relevant documentation for the specified environmental conditions for the other M3000® modules.
3.2 Use in Special Environments

In the following cases, M3000® modules must not be used without taking additional measures, except where explicitly specified:

- At sites with difficult operating conditions, like those caused by
  - 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.

- In systems that require special monitoring, such as:
  - Elevators
  - Electrical systems located in particularly (potentially) hazardous environments
  - In residential, commercial, and light-industrial environments
  - In medical environments

Examples of suitable additional measures in these cases may include:

- Installation in grounded, shielded metal cabinets
- Installation of filters in the power supply cables
- Use of shielded cables outside of cabinets
4 Mechanical Installation

4.1 Mounting

WARNING No work of any kind, such as mounting, removing, wiring, or repairs to the M3000® modules may be performed while the modules are in operation!

There is a danger of:

• Uncontrolled movements
• Permanent damage
• Malfunctions

Before performing any work on M3000® modules, it is essential that the system is stopped and the power supply is disconnected. Therefore, all power supplies must be switched off, including those from attached peripherals such as externally supplied transmitters, programming devices, etc.!

Information about mounting/removing the MSC-R-IO:

*8.2.3 Mechanical Mounting* on page 25

4.2 Removing

WARNING No work of any kind, such as mounting, removing, wiring, or repairs to the M3000® modules may be performed while the modules are in operation!

There is a danger of:

• Uncontrolled movements
• Permanent damage
• Malfunctions

Before performing any work on M3000® modules, it is essential that the system is stopped and the power supply is disconnected. Therefore, all power supplies must be switched off, including those from attached peripherals such as externally supplied transmitters, programming devices, etc.!

Information about mounting/removing the MSC-R-IO:

*8.2.3 Mechanical Mounting* on page 25
5 Project Planning and Installation

The following instructions must be observed in order to ensure that the M3000® automation system 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.)

- **Emergency stop**
  The emergency stop devices (EN 60204) must remain in effect during all of the system's or facility's operational modes.

- **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.

- **Power supply 24 V DC**
  M3000® modules must be supplied only with 24 V DC SELV (Safety Extra-Low Voltage) according to EN 60950-1.
  ⇒ "5.2.1 Power Supply Characteristics" on page 16

- **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 M3000® automation system.
5.1 Grounding Concept

For reasons of functional safety, all circuits must be grounded at a centralized point.

The PE-conductor of the module must have a low resistance connection to the protective earth conductor (PE).

Every circuit must be fused.

If the output current of the power supply is greater than the maximum current of the connector, then the power cable to each M3000® module must be fused to the maximum current of the connector or a lower value or the current must be limited in another way.

Current limits of power connectors are:
- 12 A for MSC I, MSC II, E-Bus extension modules, MSD Motion Controller and DialogController displays
- 4 A for MSC-R
- 6 A for MSC-R-IO

Load-controlled distribution of the circuits (U1…U3)

5.1.1 Front Panel Connectors' Grounding

The metal housings of all front panel connectors of the MSC-R-IO are connected internally to the grounding of the housing.

Grounding Concept

Figure 1: Grounding Concept
5.2 Power Supply

The internal electronics of M3000® modules is usually supplied with power via the power supply terminals of the connectors of the M3000® modules.

Connecting the power supply for the internal electronics:
⇒ "5.2.2 Connecting the Power Supply" on page 17

Power supply terminals of the MSC-R-IO:
⇒ "8.4.1 Terminal Assignment" on page 29

Refer to the relevant documentation for the exact designations of the power supply terminals of the other M3000® modules.

5.2.1 Power Supply Characteristics

**Output voltage**

- **Rated voltage:** 24 V DC, operates at no-load SELV according to EN 60950-1
  ⇒ "5.2.1.1 Safety Extra-Low Voltage (SELV)" on page 17
- **Run-up time (10 to 90 %):** ≤ 0.2 sec.

To ensure compatibility with other components, Moog recommends maintaining the power supply tolerance band specified in IEC 61131-2 (19.2 V to 30 V).

Refer to the relevant documentation for the specified voltage ranges of the M3000® modules.

Besides the specified voltage ranges, a total alternating voltage component with a peak value of 5 % of the rated voltage is also permitted.

**Output current**

If the output current of the power supply is greater than the maximum current of the connector, then the power cable to each M3000® module must be fused to the maximum current of the connector or a lower value or the current must be limited in another way.

Current limits of power connectors are:
- 12 A for MSC I, MSC II, E-Bus extension modules, MSD Motion Controller and DialogController displays
- 4 A for MSC-R
- 6 A for MSC-R-IO

**Maximum permissible duration of power interruptions**

Under full load (severity class PS1 of voltage dips, according to IEC 61131-2): ≤ 1 ms
(duration of interruption during voltage drops and interruptions to the input voltage)

During primary side voltage drops that are 1 ms or shorter in duration, the output voltage must not fall under 19.2 V when under full load. In addition, the interval between the primary side drops must not be shorter than 1 s.
5.2.1.1 Safety Extra-Low Voltage (SELV)

The safety extra-low voltage is a voltage that will not 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.

5.2.2 Connecting the Power Supply

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DANGER</strong></td>
<td>The 24 V power supply terminals of all M3000® modules are protected against reverse polarity. If the polarity of these power supply terminals is reversed, the modules will not work.</td>
</tr>
</tbody>
</table>
| **WARNING** | No work of any kind, such as mounting, removing, wiring, or repairs to the M3000® modules may be performed while the modules are in operation! There is a danger of:  
- Uncontrolled movements  
- Permanent damage  
- Malfunctions |
|              | Before performing any work on M3000® modules, it is essential that the system is stopped and the power supply is disconnected. Therefore, all power supplies must be switched off, including those from attached peripherals such as externally supplied transmitters, programming devices, etc.! |
| **WARNING** | M3000® modules must be protected from overvoltages and/or reverse energization from the sensor to the module! There is a danger of:  
- Permanent damage by overheating or fire  
- Malfunctions |
|              | M3000® modules must have the correct voltage, polarity, and terminal assignments. |
| **WARNING** | The internal electronics of M3000® modules and 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 following problems might arise, depending on the state of the power supply for the internal electronics of the module and sensors (→ table 1 on page 18):  
- Invalid sensor data |
Power supply terminals of the MSC-R-IO:

* "8.4.1 Terminal Assignment" on page 29

Refer to the relevant documentation for information about the power supply terminals of the other M3000\textsuperscript{®} modules.

Internal module capacities might cause power spikes of up to 50 A when switching on the power supply for the internal electronics of the M3000\textsuperscript{®} module. The duration of these spikes is strongly dependent on the internal resistance of the power supply.

### 5.2.2.1 Maximum Admissible Current

All power supply terminals of MSC-R-IO and the associated internal connections are designed for a maximum current of 6 A.

If the output current of the power supply is greater than the maximum current of the connector, then following must be employed:

- Several separately fused circuits or
- Several separate power supplies in separated circuits

### 5.2.3 Connecting Sensors

**WARNING**

The internal electronics of M3000\textsuperscript{®} modules and 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 following problems might arise, depending on the state of the power supply for the internal electronics of the module and sensors (*table 1 on page 18*):

- Invalid sensor data
5.3 Connecting Signal Cables

**WARNING**

No work of any kind, such as mounting, removing, wiring, or repairs to the M3000® modules may be performed while the modules are in operation!

There is a danger of:
- Uncontrolled movements
- Permanent damage
- Malfunctions

Before performing any work on M3000® modules, it is essential that the system is stopped and the power supply is disconnected. Therefore, all power supplies must be switched off, including those from attached peripherals such as externally supplied transmitters, programming devices, etc.!

→ "8.4.1 Terminal Assignment" on page 29

### 5.3.1 Plug-In Terminal Strips

Plug-in terminal strips for the following methods are available from Moog:
- Screw terminals
- Spring loaded terminals

→ "9.2 Plug-In Terminal Strips" on page 43

#### 5.3.1.1 Spring Loaded Terminals

**CAUTION**

When connecting a wire, insert the screwdriver only into the rectangular opening of the spring loaded terminal. If a screwdriver is inserted into the round opening for the wire, the spring loaded terminal might be destroyed. Spring loaded terminals make it easy to rapidly connect supply and signal cables.

Procedure for connecting a wire:

1. Insert the tip of a screwdriver into the rectangular opening of the spring loaded terminal and press the screwdriver downward.
2. Insert the wire into the corresponding round opening.
3. Remove the screwdriver from the opening. The spring will hold the wire in place.
6 Shutdown and Service

**WARNING**
To avoid damage to M3000® modules or accessories, cleaning, maintenance, and repair tasks may be performed only by Moog or Moog's authorized service agents.

Warranty and liability claims for personal and material damage are excluded when, among other reasons, they are due to unauthorized repairs or other unauthorized interventions. 
pliant "1.4 Warranty and Liability" on page 3

**WARNING**
No work of any kind, such as mounting, removing, wiring, or repairs to the M3000® modules may be performed while the modules are in operation!

There is a danger of:
- Uncontrolled movements
- Permanent damage
- Malfunctions

Before performing any work on M3000® modules, it is essential that the system is stopped and the power supply is disconnected. Therefore, all power supplies must be switched off, including those from attached peripherals such as externally supplied transmitters, programming devices, etc.!

**WARNING**
The M3000® automation system and M3000® modules must not come into direct contact with liquids, except where explicitly specified. Danger of short-circuit!

If they do come into direct contact with a liquid, immediately disconnect the power supply! Before bringing the system back into operation, it is essential that all affected components are completely dry and have been inspected by a suitably qualified technician.

### 6.1 Shutdown

**WARNING**
If an M3000® module is to be taken out of operation, the entire system must always be shut down and disconnected from all power supplies. Therefore, all power supplies must be switched off, including those from attached peripherals such as externally supplied transmitters, programming devices, etc.!

The M3000® module must be protected against unintentional restarting!

If the M3000® module is connected to other devices and/or facilities, always consider the full consequences and take appropriate precautions before switching off the module.
6.2 Service

**WARNING**

To avoid damage to M3000® modules or accessories, cleaning, maintenance, and repair tasks may be performed only by Moog or Moog's authorized service agents.

Warranty and liability claims for personal and material damage are excluded when, among other reasons, they are due to unauthorized repairs or other unauthorized interventions. → "1.4 Warranty and Liability" on page 3

**CAUTION**

To avoid damage to the internal components, never attempt to open M3000® modules!

6.2.1 Maintenance/Servicing

M3000® modules are maintenance-free. They do not contain any components (such as batteries) that must be maintained or replaced.

6.2.2 Repair

Only Moog and Moog's authorized service agents can access the required and most up-to-date specifications. These specifications make it possible to restore the M3000® modules' original performance and ensure the same high reliability and long service life of the M3000® modules after repairs are completed.

Moog's Global Support Logo indicates that a Moog repair has been carried out.

- If Moog receives a repair order for defective M3000® modules, Moog and Moog's authorized service agents reserve the right to repair the defective module or, alternatively, to replace the defective module with a module of identical or compatible specifications.

- If Moog receives a repair order for defective M3000® modules, Moog and Moog's authorized service agents accept no liability for software and data installed by the customer.

- Please note: As the MSC-R-IO is sealed, it is not possible to repair the module.
7 Transportation and Storage

**WARNING**
Maintain, under all circumstances, the required environmental conditions specified for transportation and storage of the M3000® automation system or M3000® modules.

- See user manual of the relevant module

- "7.1 Environmental Conditions" on page 22

This ensures fault-free, reliable, and safe operation.

**CAUTION**
To avoid condensation, do not start M3000® modules until they have reached ambient temperature (except MSC-R and MSC-R-IO).

**CAUTION**
To avoid damage, M3000® modules and accessories must be transported and stored in their original packaging.

Warranty and liability claims for personal or material damage will be excluded when they are the result of, among other things, storing or transporting M3000® modules or accessories outside of their original packaging.

- "1.4 Warranty and Liability" on page 3

### 7.1 Environmental Conditions

- **Ambient temperature** (IEC 61131-2)
  - See user manual of the relevant module

- **Relative air humidity** (IEC 61131-2)
  - See user manual of the relevant module

- **Contamination level** (IEC 60664)
  - See user manual of the relevant module

- **Resistance to corrosion** (IEC 60068)
  - See user manual of the relevant module

- **Air pressure** (IEC 61131-2)
  - $\geq 70 \text{ kPa}$ (corresponds to an elevation of $\leq 3,000 \text{ m} (9,843 \text{ ft})$

- **Drop height** (free fall in the original packaging) (IEC 60068-2-31)
  - $\leq 1 \text{ m} (3.281 \text{ ft})$

Environmental conditions of MSC-R-IO are described in

- "8.2.4.1 Environmental Conditions" on page 26
8 MSC-R-IO

The MSC-R-IO is used as remote extension module for the Ruggedized Motion Controller (MSC-R), MSC II Motion Controller, MSD Motion Controller or other EtherCAT master modules. It includes an EtherCAT slave interface.

8.1 Performance Characteristics

8.1.1 Interfaces

The MSC-R-IO provides an EtherCAT slave interface for real time communications to a PLC host system.

8.1.2 I/Os (Inputs/Outputs)

The MSC-R-IO provides the following I/Os:

- 8 Digital isolated outputs, maximum 0.5 A each
- 2x8 Digital isolated inputs
- PT100 temperature measurement input

8.2 General Specifications

Dimensions

Overall W × H × D in mm (in):
160 × 105 × 56 (6.25 × 4.1 × 2.2)

Weight

Approx. 1.5 kg (3.3 lb)

8.2.1 View of the Module

Figure 3: Front view of MSC-R-IO
### 8.2.2 Dimensions

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>160 mm (6.30 in)</td>
</tr>
<tr>
<td>Height</td>
<td>105 mm (4.13 in)</td>
</tr>
<tr>
<td>Depth</td>
<td>58.40 mm (2.30 in)</td>
</tr>
<tr>
<td>Required distances of the mounting holes (middle to middle): Width</td>
<td>150 mm (5.90 in)</td>
</tr>
<tr>
<td>Required distances of the mounting holes (middle to middle): Height</td>
<td>65 mm (2.56 in)</td>
</tr>
</tbody>
</table>

**Dimensions**

![Figure 4: Dimensions of the MSC-R-IO](image)

**Table 2: Dimensions of the MSC-R-IO**
8.2.3 Mechanical Mounting

8.2.3.1 Arrangement

To attain the best result for EMC-compatible installation the module must be attached to a metal mounting plate and connected to the protective earth conductor.

Additional information about the grounding concept for M3000 modules:

- "5.1 Grounding Concept" on page 15

Maintain the sufficient distances to ensure:
- Sufficient room for connecting the supply and signal cables
- Sufficient room for mounting or removing the modules

8.2.3.2 Procedure for Mounting Modules

1. Mark the position for the tapped holes on the backing plate.
2. Cut a tap for each fixing screw in the backing plate.
3. Mount the module on the backing plate.

8.2.3.3 Procedure for Removing Modules

1. Loosen the fixing screws
2. Remove the module

8.2.3.4 MSC-R-IO DIN Rail Mounting Kit

With the MSC-R-IO DIN Rail Mounting Kit the MSC-R-IO can be mounted on a DIN rail. The following figure shows the MSC-R with DIN rail mounting kit as an example.

![Figure 5: MSC-R DIN Rail Mounting Kit](image)

The MSC-R-IO DIN Rail Mounting Kit is available from Moog as accessory

- "9.1 DIN Rail Mounting Kit for the MSC-R-IO" on page 43
8.2.4 Environmental Conditions

**WARNING** Maintain under all circumstances the required environmental conditions specified for the M3000® automation system or M3000® modules. This ensures fault-free, reliable, and safe operation.

**WARNING** It is not permissible to operate the M3000® automation system or M3000® modules in a potentially explosive environment.

### 8.2.4.1 Environmental Conditions

**Ambient temperature** (IEC 61131-2)
- For operation (when installed properly): –40 to +70 °C (–40 to +158 °F)
- For transportation and storage (in the original packaging): –40 to +80 °C (–40 to +176 °F)

**Relative air humidity** (IEC 61131-2)
- For operation: >10 %
- For transportation and storage (in the original packaging): 5 to 95 % non-condensing

**Resistance to corrosion** (IEC 60068)
- No protection

**Operating Elevation** (IEC 61131-2)
\[ \leq 2,000 \text{ m (6,562 ft)} \text{ above MSL} \]

**Air pressure for transportation** (IEC 61131-2)
\[ \geq 70 \text{ kPa (corresponds to an elevation of} \leq 3,000 \text{ m (9,843 ft)}) \]

### 8.2.4.2 Mechanical Conditions and Requirements

**Sinusoidal oscillations** (IEC 60068-2-6)
- at 1 oct/min sweep rate and three orthogonal axes
  - 10 Hz ≤ f ≤ 60 Hz: 2.0 mm (0.08 in) continuous amplitude
  - 60 Hz ≤ f ≤ 2,000 Hz: 30 g continuous constant acceleration

**Shocks, half-sine wave** (IEC 60068-2-27)
- Shocks up to 50 g for a duration of 3 ms, 3 shocks in each of the six orthogonal axes (X±, Y±, Z±)

**Continuous Shocks, half-sine wave** (IEC 60068-2-27)
- Continuous shocks up to 40 g for a duration of 6 ms, 4,000 shocks in each of the six orthogonal axes (X±, Y±, Z±)

**Drop height** (free fall in the original packaging) (IEC 60068-2-31)
\[ \leq 1 \text{ m (3.281 ft)} \]

**Protection class** (IEC 60529) IP 20

### 8.2.4.3 Electrical Conditions and Requirements

**Power supply**
- 24 V DC
- (Safety Extra-Low Voltage (SELV) according to EN 60950-1)
- Specified voltage range: 18 to 36 V DC

*5.2 Power Supply* on page 16
8.3 Block Diagram

Figure 6: Block Diagram of the MSC-R-IO
8.4 View of the Module and Terminal Assignment

Figure 7: View of the MSC-R-IO and Terminal Assignment

X1 Supply
1 - L1+
2 - L1+
3 - M1
4 - M1

X2 EtherCAT Slave In
M12 4 pins
D-coded female
1 - Tx+
2 - Rx+
3 - Tx-
4 - Rx-

X3 EtherCAT Slave Out
M12 4 pins
D-coded female
1 - Tx+
2 - Rx+
3 - Tx-
4 - Rx-

X4 Digital Output
1 - L2+
2 - L2+
3 - M2
4 - M2
5 - Do1
6 - Do2
7 - Do3
8 - Do4
9 - Do5
10 - Do6
11 - Do7
12 - Do8

X5 PT100 Input
1 - RL+
2 - R+
3 - R-
4 - RL-
5 - Shield

X6 Digital Input
1 - L3+
2 - L3+
3 - M3
4 - M3
5 - Di01
6 - Di02
7 - Di03
8 - Di04
9 - Di05
10 - Di06
11 - Di07
12 - Di08

X7 Digital Input
1 - L4+
2 - L4+
3 - M4
4 - M4
5 - Di09
6 - Di10
7 - Di11
8 - Di12
9 - Di13
10 - Di14
11 - Di15
12 - Di16
### 8.4.1 Terminal Assignment

<table>
<thead>
<tr>
<th>Connector</th>
<th>No.</th>
<th>Assignment</th>
<th>Circuit</th>
<th>Circuit Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X1 «Supply»</strong></td>
<td>1</td>
<td>L1+</td>
<td>+24 V power supply for the module</td>
<td>Power Supply</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>L1+</td>
<td>+24 V power supply for the module</td>
<td>Power Supply</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>M1</td>
<td>Ground for the modules’ power supply</td>
<td>Power Supply</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>M1</td>
<td>Ground for the modules’ power supply</td>
<td>Power Supply</td>
</tr>
<tr>
<td><strong>X2 «ECAT Slave In»</strong></td>
<td>1</td>
<td>Tx+</td>
<td>EtherCAT transmit data+</td>
<td>EtherCAT</td>
</tr>
<tr>
<td>M12 D-coded 4 pole (socket contacts)</td>
<td>2</td>
<td>Rx+</td>
<td>EtherCAT receive data+</td>
<td>EtherCAT</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Tx-</td>
<td>EtherCAT transmit data-</td>
<td>EtherCAT</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Rx-</td>
<td>EtherCAT receive data-</td>
<td>EtherCAT</td>
</tr>
<tr>
<td><strong>X3 «ECAT Slave Out»</strong></td>
<td>1</td>
<td>Tx+</td>
<td>EtherCAT transmit data+</td>
<td>EtherCAT</td>
</tr>
<tr>
<td>M12 D-coded 4 pole (socket contacts)</td>
<td>2</td>
<td>Rx+</td>
<td>EtherCAT receive data+</td>
<td>EtherCAT</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Tx-</td>
<td>EtherCAT transmit data-</td>
<td>EtherCAT</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Rx-</td>
<td>EtherCAT receive data-</td>
<td>EtherCAT</td>
</tr>
</tbody>
</table>

Table 3: Terminal Assignment of MSC-R-IO's Connectors (Section 1 of 3)
### Table 3: Terminal Assignment of MSC-R-IO’s Connectors (Section 2 of 3)

<table>
<thead>
<tr>
<th>Connector</th>
<th>No.</th>
<th>Assignment</th>
<th>Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>X5 «Output»</td>
<td>1</td>
<td>L2+</td>
<td>+24 V power supply for digital outputs</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>2</td>
<td>L2+</td>
<td>+24 V power supply for digital outputs</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>3</td>
<td>M2</td>
<td>Ground for the digital output power supply</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>4</td>
<td>M2</td>
<td>Ground for the digital output power supply</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>5</td>
<td>Do1</td>
<td>Digital output 1</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>6</td>
<td>Do2</td>
<td>Digital output 2</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>7</td>
<td>Do3</td>
<td>Digital output 3</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>8</td>
<td>Do4</td>
<td>Digital output 4</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>9</td>
<td>Do5</td>
<td>Digital output 5</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>10</td>
<td>Do6</td>
<td>Digital output 6</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>11</td>
<td>Do7</td>
<td>Digital output 7</td>
</tr>
<tr>
<td>X5 «Output»</td>
<td>12</td>
<td>Do8</td>
<td>Digital output 8</td>
</tr>
<tr>
<td>Connector</td>
<td>No.</td>
<td>Assignment</td>
<td>Circuit</td>
</tr>
<tr>
<td>-----------</td>
<td>-----</td>
<td>------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>X6 «Input»</td>
<td>1</td>
<td>L3+</td>
<td>+24 V power supply for digital inputs</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>L3+</td>
<td>+24 V power supply for digital inputs</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>M3</td>
<td>Ground for the digital output power supply</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>M3</td>
<td>Ground for the digital output power supply</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Di01</td>
<td>Digital input 1</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Di02</td>
<td>Digital input 2</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Di03</td>
<td>Digital input 3</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Di04</td>
<td>Digital input 4</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Di05</td>
<td>Digital input 5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Di06</td>
<td>Digital input 6</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Di07</td>
<td>Digital input 7</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Di08</td>
<td>Digital input 8</td>
</tr>
<tr>
<td>X7 «Input»</td>
<td>1</td>
<td>L4+</td>
<td>+24 V power supply for digital inputs</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>L4+</td>
<td>+24 V power supply for digital inputs</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>M4</td>
<td>Ground for the digital output power supply</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>M4</td>
<td>Ground for the digital output power supply</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Di09</td>
<td>Digital input 1</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Di10</td>
<td>Digital input 2</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Di11</td>
<td>Digital input 3</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Di12</td>
<td>Digital input 4</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Di13</td>
<td>Digital input 5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Di14</td>
<td>Digital input 6</td>
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<td>11</td>
<td>Di15</td>
<td>Digital input 7</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Di16</td>
<td>Digital input 8</td>
</tr>
<tr>
<td>X8 «Temp»</td>
<td>1</td>
<td>RL+</td>
<td>PT100 Input</td>
</tr>
<tr>
<td>PT100 Input</td>
<td>2</td>
<td>R+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>R-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>RL-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Shield</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Terminal Assignment of MSC-R-IO’s Connectors (Section 3 of 3)
8.4.2 LEDs

<table>
<thead>
<tr>
<th>LED</th>
<th>Display</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN</td>
<td>EtherCAT status LED</td>
<td>EtherCAT state display</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LED status</th>
<th>EtherCAT state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>'INIT'</td>
</tr>
<tr>
<td>Blinking</td>
<td>'PRE-OPERATIONAL'</td>
</tr>
<tr>
<td>'Safe flash'</td>
<td>'SAFE-OPERATIONAL'</td>
</tr>
<tr>
<td>Flashes</td>
<td>'INITIALIZATION' or 'BOOTSTRAP'</td>
</tr>
<tr>
<td>On</td>
<td>'OPERATIONAL'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACT</th>
<th>Communication activity</th>
<th>Blinks when communication is active.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1+</td>
<td>Supply voltage OK</td>
<td>Illuminates when the power supply for the MSC-R-IO's internal electronics is OK and the internal voltages are OK.</td>
</tr>
<tr>
<td>L2+</td>
<td>Supply voltage OK</td>
<td>Illuminates when the power supply for the MSC-R-IO's digital outputs is OK.</td>
</tr>
</tbody>
</table>

Table 4: LEDs of the MSC-R-IO

8.4.3 EtherCAT Slave Interface

8.4.3.1 Connection of the EtherCAT Slave Interface

The following connector type is required to connect the EtherCAT Slave In (X2) and the EtherCAT Slave Out connector (X3) of the MSC-R-IO

- M12 D-coded connector

8.4.3.2 Pin assignment of M12 EtherCAT connectors

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tx+</td>
<td>EtherCAT transmit data +</td>
</tr>
<tr>
<td>2</td>
<td>Rx+</td>
<td>EtherCAT receive data +</td>
</tr>
<tr>
<td>3</td>
<td>Tx-</td>
<td>EtherCAT transmit data -</td>
</tr>
<tr>
<td>4</td>
<td>Rx-</td>
<td>EtherCAT receive data -</td>
</tr>
</tbody>
</table>

Table 5: Pin assignment of M12 EtherCAT connectors

8.4.3.3 Cables and Connectors

Use only cables and connectors that fulfill the requirements of at least category 5 (Cat-5) of EN 50173 or ISO 11801. The maximum cable length between two EtherCAT devices is 100 m.

8.4.3.4 Configuration

The configuration is done in the development environment of the EtherCAT master module. If a Moog Motion Controller is used as EtherCAT master module, then the configuration is done in the PLC configurator of the MACS or MASS development environment:

- Append the MSC-R-IO module to the EtherCAT master node in the PLC configurator
- The PDO mapping is fix and not configurable
- EtherCAT slaves do not need any address settings, the addresses are adjusted automatically by the EtherCAT master
8.4.3.5 PDO Mapping List

Receive PDO 1

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Description</th>
<th>Data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3101:1</td>
<td>Digital Output X5</td>
<td>Digital outputs Do1…Do8</td>
<td>UINT8</td>
</tr>
</tbody>
</table>

Table 6: Receive PDO 1

Transmit PDO 1

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Description</th>
<th>Data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3001:1</td>
<td>Digital Input X6</td>
<td>Digital inputs Di01…Di08</td>
<td>UINT8</td>
</tr>
</tbody>
</table>

Table 7: Transmit PDO 1

Transmit PDO 2

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Description</th>
<th>Data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3101:2</td>
<td>Digital Input X7</td>
<td>Digital inputs Di09…Di16</td>
<td>UINT8</td>
</tr>
</tbody>
</table>

Table 8: Transmit PDO 2

Transmit PDO 3

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Description</th>
<th>Data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3101:3</td>
<td>PT100 Input X8</td>
<td>PT100 temperature sensor interface</td>
<td>UINT8</td>
</tr>
</tbody>
</table>

Table 9: Transmit PDO 3

8.4.3.6 Specifications

Supported protocol types to read input data and write output data

Cyclic data transmission via PDO communication. Non-cyclic data via SDO communication is not supported.

Sampling of inputs: digital inputs and temperature sensor

The inputs are sampled with every EtherCAT PDO communication cycle. The sampled data is transmitted with the next Transmit PDO.

Setting of outputs: digital outputs

The outputs are updated after every Receive PDO.

Timeout behavior

A SynchManager watchdog can be configured by the EtherCAT master. If the watchdog expires, then the outputs are set to 0 state. For the Moog Motion Controllers and Machine Controllers the setting of the watchdog is available in the PLC configuration of the MACS and MASS development environment.
8.5 Power Supply

DANGER  The 24 V power supply terminals of all M3000® modules are protected against reverse polarity.  If the polarity of these power supply terminals is reversed, the modules will not work.

WARNING  M3000® modules must be protected from overvoltages and/or reverse energization from the sensor to the module!

There is a danger of:
• Permanent damage by overheating or fire
• Malfunctions

M3000® modules must have the correct voltage, polarity, and terminal assignments.

Additional information about the power supply
☞ "8.2.4.3 Electrical Conditions and Requirements" on page 26
☞ "5.2 Power Supply" on page 16
8.6 Digital I/Os

There are 8 digital outputs and two groups with each 8 inputs.

Basic wiring diagrams:
⇒ Figure 8 on page 36
⇒ Figure 9 on page 38

8.6.1 Status Display of Digital I/Os

The status LEDs on the front panel of the MSC-R-IO show the internal operational state of the digital I/Os.

The associated LED of an input will illuminate when it is internally detected that the input is in the 1 state.

The associated LED of an output will illuminate if the output is set to 1 state via the EtherCAT interface and L2+ (+24 V) and M2 (GND) are connected.

Basic wiring diagrams of the digital outputs: ⇒ Figure 8 on page 36

8.6.2 Power Supply of the Digital I/Os

**DANGER**

The 24 V power supply terminals of all M3000® modules are protected against reverse polarity.

If the polarity of these power supply terminals is reversed, the modules will not work.

**WARNING**

M3000® modules must be protected from overvoltages and/or reverse energization from the sensor to the module!

There is a danger of:

- Permanent damage by overheating or fire
- Malfunctions

M3000® modules must have the correct voltage, polarity, and terminal assignments.
**WARNING** The internal electronics of M3000® modules and 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 following problems might arise, depending on the state of the power supply for the internal electronics of the module and sensors (⇒ table 1 on page 18):

- Invalid sensor data

The power supply for the digital I/Os of the MSC-R-IO is independent of the power supply for the MSC-R-IO's internal electronics (+24 V / GND):

- L1+ / M1 to supply the module electronics
- L2+/M2 to supply the digital outputs
- M3 as 0 Volt reference for digital inputs Di01 to Di08
- L3+ and L4+ can be used to supply sensors connected to the appropriate digital inputs.
  ⇒ “8.6.4.1 Basic Wiring Diagram” on page 38
- M4 as 0 Volt reference for digital inputs Di09 to Di16

Power supply characteristics
  ⇒ "5.2.1 Power Supply Characteristics" on page 16

Connecting sensors to the power supply:
  ⇒ "5.2.3 Connecting Sensors" on page 18

Connecting the power supply for the internal electronics:
  ⇒ "5.2.2 Connecting the Power Supply" on page 17

### 8.6.3 Digital Outputs

The following digital output circuits are available:

- Open emitter outputs, switches to L2+ (+24 V)

![Basic Wiring Diagram of a Digital Output of the MSC-R-IO](image)

**Figure 8: Basic Wiring Diagram of a Digital Output of the MSC-R-IO**

Protective circuit with a limiting voltage of 50 V as protection against induced voltage spikes when there are inductive loads.
  ⇒ “8.6.3.1 Current Limiting and Overload Protection” on page 37
A digital open emitter output in the 1 state (conductive) connects the attached load $R_L$ to the power supply terminal L2+ (+24 V).

8.6.3.1 Current Limiting and Overload Protection

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 been finished thermal cooling it returns to normal operation. If the overload is still connected, then the disable will happen again.

A protective circuit with a limiting voltage of 50 V with respect to L2+ (+24 V) for open emitter outputs protects all outputs against induced voltage spikes when there are inductive loads.

8.6.3.2 Specifications

**Number of digital outputs**

8

⇒ "8.6 Digital I/Os" on page 35

**Type of outputs**

Semiconductor, non-capacitive

**Protective circuitry for inductive loads**

Limiting voltage of 50 V (typ.) with reference to L2+ (+24 V)

**Power dissipation of protection devices when limiting**

Max. 0.5 W per output

Max. 1 W per MSC-R-IO

**Status display**

One status LED per output

⇒ "8.6.1 Status Display of Digital I/Os" on page 35

**Power consumption for the internal control circuit (L2+ / M2)**

$\leq$ 100 mA

8.6.3.3 Load Connection

**Total load**

4 A (8 x 0.5 A), when all 8 outputs are used

**Overload protection**

Electronic current limiting and thermal overload protection

**Max. short-circuit current**

$< 4$ A (L2 fuse)

**Reverse energization protection**

Digital outputs are protected against reverse energization

**Output delay (hardware)**

From 0 to 1: max. 100 µs

From 1 to 0: max. 100 µs

**Update time**

The update time corresponds to the telegram interval time from the EtherCAT master.

**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

8.6.3.4 Insulation Resistance

Insulation resistance
- Rated voltage: 0–50 V DC
- Test voltage for 2,000 m (6,562 ft) operating elevation: 500 V DC

8.6.4 Digital Inputs

The digital inputs are of the type 1 according to IEC 61131-2. They are designed for an input voltage rating of 24 V. The input values (0/1 state) are read synchronized to the EtherCAT telegrams. An open input is interpreted as the 0 state.

8.6.4.1 Basic Wiring Diagram

![Basic Wiring Diagram of a Digital Input of the MSC-R-IO](image-url)

Figure 9: Basic Wiring Diagram of a Digital Input of the MSC-R-IO (Current Consuming)
8.6.4.2 Pulse Detection and Disturbance Suppression

The digital inputs are read synchronized to the EtherCAT telegrams. The sampling time corresponds to the telegram interval time from the EtherCAT master.

For input pulses to be reliably detected, they must be longer than the communication cycle interval of the EtherCAT master. When defining the minimum pulse duration that can be detected by digital I/Os, the following differentiation is made:

- Pulses that are never detected; pulse duration: \( \leq 50 \, \mu s \)
- Pulses that can be detected (if the system reads the input when the pulse appears); pulse duration: \( > 50 \, \mu s \)
- Pulses that are always detected; pulse duration: \( > \) the communication cycle interval of the EtherCAT master

The user may implement multiple sampling in the application program in order to suppress disturbance impulses. In doing so, the user must consider the tradeoff between the desired level of disturbance suppression and the required reaction time of the system.

8.6.4.3 Specifications

**Number of the digital inputs**

16 inputs in 2 groups

- "8.6 Digital I/Os" on page 35

**Type**

Type 1 according to IEC 61131-2, current consuming

**Wire lengths**

In the control cabinet: The voltage drop must be taken into consideration when choosing the wire cross section; there are no other practical limitations.

Field wiring: All relevant national regulations as well as the requirements of IEC 61131-3 must be fulfilled.

**Rated voltage L3+/L4+ (+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**

Achieved with optocouplers

**Status display**

One status LED per input

- "8.6.1 Status Display of Digital I/Os" on page 35

**Alarms**

Can be implemented in the application program

**Input delay (hardware)**

From 0 to 1: max. 100 \( \mu s \)
From 1 to 0: max. 100 \( \mu s \)

**Sampling time**

The sampling time corresponds to the telegram interval time from the EtherCAT master.

- "8.6.4.2 Pulse Detection and Disturbance Suppression" on page 39

**Input capacitance**

Max. 10 nF
Power consumption for the internal control circuit (L3+ / M3 and L4+ / M4)

0 mA (L3+ and L4+ are not used for internal electronics, they may be used for supply of external sensors)

Reverse energization protection
Yes

Insulation resistance
Rated voltage: 0–50 V DC
Test voltage for 2,000 m (6,562 ft) operating elevation: 500 V DC

8.6.4.4 U/I Working Ranges

<table>
<thead>
<tr>
<th>Input voltage (DC) of the external power supply L2+ (+24 V)</th>
<th>rated voltage $U_e = 24$ V</th>
</tr>
</thead>
<tbody>
<tr>
<td>upper limit $U_{e_{\text{max}}} = 36$ V</td>
<td></td>
</tr>
<tr>
<td>lower limit $U_{e_{\text{min}}} = 18$ V</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Limits for the 1 state</th>
</tr>
</thead>
<tbody>
<tr>
<td>upper limit $U_{H_{\text{max}}} = 30$ V</td>
</tr>
<tr>
<td>$I_{H_{\text{max}}} = 15$ mA</td>
</tr>
<tr>
<td>lower limit $U_{H_{\text{min}}} = 15$ V</td>
</tr>
<tr>
<td>$I_{H_{\text{min}}} = 2$ mA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Limits for the 0 state</th>
</tr>
</thead>
<tbody>
<tr>
<td>upper limit $U_{L_{\text{max}}} = 15/5$ V</td>
</tr>
<tr>
<td>$I_{L_{\text{max}}} = 0.5/15$ mA</td>
</tr>
<tr>
<td>lower limit $U_{L_{\text{min}}} = -3$ V</td>
</tr>
<tr>
<td>$I_{L_{\text{min}}} = ND$</td>
</tr>
</tbody>
</table>

Table 10: U/I Working Ranges of MSC-R-IO's Digital Inputs (Current Consuming)

8.7 Temperature Sensor Input

Sensor type
1 channel PT100

Temperature range
8 bit value representing –50 to +205 °C (–58 to +401 °F)

Resolution
1 °C / per digit

Update rate (time between two temperature measurements)
< 1 s

Wiring configuration
Four-wire configuration

Tolerance
±3 °C
8.7.1 PT Connection Diagram

The PT100 interface is designed for 4 wire connection.

![PT Connection Diagram](image-url)
8.8 EtherCAT Interface

The MSC-R-IO provides an EtherCAT slave interface at «X3» and «X4».

The configuration of the network nodes is done in the PLC Configuration of the development environment MACS or MASS (or any other EtherCAT master configurator, if no Moog Motion Controller or Machine Controller is used as EtherCAT master).

**WARNING**

Do not connect EtherCAT to any other Ethernet networks. The high rate of broadcast telegrams which are transmitted by EtherCAT will prevent other devices like computers and servers on the network from transmitting data.

There is a danger of

- Network overload/breakdown
- Malfunction of connected devices
- Data loss at connected devices

It is strongly recommended to use cables of a special color only for EtherCAT connections.

8.9 Nameplate

![Nameplate of the MSC-R-IO]

Figure 12: Position of the Nameplate on the MSC-R-IO
9 Product Range

Chapter 9 describes only a small part of Moog's extensive product range. In addition to the many different M3000® modules, Moog’s current product range includes a large variety of accessories.

9.1 DIN Rail Mounting Kit for the MSC-R-IO

<table>
<thead>
<tr>
<th>Item Designation</th>
<th>Remarks</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIN rail mounting kit for the MSC-R or MSC-R-IO</td>
<td>Accessory kit for mounting the MSC-R or MSC-R-IO on a DIN rail, including: DIN rail clip, mounting plate and screws.</td>
<td>CA94286-001</td>
</tr>
</tbody>
</table>

* 8.2.3.4 MSC-R-IO DIN Rail Mounting Kit* on page 25

Table 11: Product Range – DIN Rail Mounting Kit for the MSC-R-IO

9.2 Plug-In Terminal Strips

Terminal strips for MSC-R-IO

<table>
<thead>
<tr>
<th>Number of required connectors</th>
<th>Pole count</th>
<th>Connector name on module</th>
<th>Maximum conductor cross-section</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>X1</td>
<td>0.5 mm² (20 AWG)</td>
<td>CA96981-004 (Phoenix Contact: FMC 1,5/4-STF-3,5)</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>X5, X6, X7</td>
<td>0.5 mm² (20 AWG)</td>
<td>CA96981-012 (Phoenix Contact: FMC 1,5/12-STF-3,5)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>X8</td>
<td>0.5 mm² (20 AWG)</td>
<td>CA96981-005 (Phoenix Contact: FMC 1,5/5-STF-3,5)</td>
</tr>
</tbody>
</table>

Table 12: Product Range – Plug-In Terminal Strips
10 Appendix

10.1 Typographical Conventions

**DANGER**
Identifies safety instructions that are intended to warn of an immediate and impending danger to life and limb or major property damage. Failure to observe these safety instructions will lead inevitably to death, serious personal injury (disablement) or major property damage!

**WARNING**
Identifies safety instructions that are intended to warn of potential danger to life and limb or the potential for major property damage. Failure to observe these safety instructions might lead to death, serious personal injury (disablement) or major property damage!

**CAUTION**
Identifies safety instructions that are intended to warn of slight personal injury or minor property damage. Failure to observe these safety instructions might lead to slight personal injury or minor property damage.

• / – Identifies listings

➾ Identifies references to another chapter, another page, table or figure in this manual

**blue text** Identifies a hyperlink within the PDF file

Identifies important information

1., 2., … Identifies steps in a procedure that should be performed in consecutive order

1, 2, … Identifies items in a figure that are explained separately

«WCAN» Identifies terminals or connectors (such as: «WCAN») and light emitting diodes (such as: «I/O1») of an M3000® module

'Frequency' Identifies parameters of the MACS development environment (such as: 'Frequency') and outputs of M3000® modules (such as: 'Outputs Enabled')
### 10.2 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Alternating Current</td>
</tr>
<tr>
<td>ADC</td>
<td>Analog to Digital Converter</td>
</tr>
<tr>
<td>AWG</td>
<td>American Wire Gauge (standardized wire gauge system for diameters of wires)</td>
</tr>
<tr>
<td>CAL</td>
<td>CAN Application Layer according to CiA DS 201–207</td>
</tr>
<tr>
<td>CAN</td>
<td>Controller Area Network</td>
</tr>
<tr>
<td>CFC</td>
<td>Continuous Function Chart (random-graphics functional chart editor; programming language for creating PLC programs)</td>
</tr>
<tr>
<td>CiA</td>
<td>CiA in Automation e. V. (international organization of manufacturers and users for CAN users; <a href="http://www.can-cia.org">http://www.can-cia.org</a>)</td>
</tr>
<tr>
<td>CLK</td>
<td>Clock</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
</tr>
<tr>
<td>DAC</td>
<td>Digital to Analog Converter</td>
</tr>
<tr>
<td>DC</td>
<td>Direct Current</td>
</tr>
<tr>
<td>DGND</td>
<td>Digital Ground (Ground for the digital I/Os' power supply of the MSC-R-IO)</td>
</tr>
<tr>
<td>DIN</td>
<td>Deutsches Institut für Normung e. V. (German Institute for Standardization; <a href="http://www.din.de">http://www.din.de</a>)</td>
</tr>
<tr>
<td>DIS</td>
<td>Draft International Standard (preliminary standard)</td>
</tr>
<tr>
<td>DS</td>
<td>Draft Standard (draft standard)</td>
</tr>
<tr>
<td>E-bus</td>
<td>Extension bus of DIN rail modules</td>
</tr>
<tr>
<td>EEPROM</td>
<td>Electrically Erasable Programmable Read Only Memory</td>
</tr>
<tr>
<td>EIA</td>
<td>Electronic Industries Alliance (<a href="http://www.eia.org">http://www.eia.org</a>)</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic Compatibility</td>
</tr>
<tr>
<td>EN</td>
<td>Europa-Norm (European Standard)</td>
</tr>
<tr>
<td>EPROM</td>
<td>Erasable Programmable Read Only Memory</td>
</tr>
<tr>
<td>ESD</td>
<td>Electrostatic Discharge</td>
</tr>
<tr>
<td>EtherCAT</td>
<td>Ethernet-based industrial real-time communication system</td>
</tr>
<tr>
<td>FBD</td>
<td>Function Block Diagram (programming language for creating PLC programs)</td>
</tr>
<tr>
<td>F-Bus</td>
<td>Fieldbus, an industrial communication system such as Profibus</td>
</tr>
<tr>
<td>Flash EEPROM</td>
<td>High speed EEPROM</td>
</tr>
<tr>
<td>FPGA</td>
<td>Field Programmable Gate Array (programmable logic component)</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>HF</td>
<td>High Frequency</td>
</tr>
<tr>
<td>HMI</td>
<td>Human Machine Interface (MACS HMI: Visualization package which can be run without MACS)</td>
</tr>
<tr>
<td>ID</td>
<td>Identifier</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission (<a href="http://www.iec.ch">http://www.iec.ch</a>)</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers, Inc. (<a href="http://www.ieee.org">http://www.ieee.org</a>)</td>
</tr>
<tr>
<td>IL</td>
<td>Instruction List (programming language for creating PLC programs)</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/Output</td>
</tr>
<tr>
<td>IP</td>
<td>International Protection (protection type)</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardizing (<a href="http://www.iso.org">http://www.iso.org</a>)</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid Crystal Display</td>
</tr>
<tr>
<td>LD</td>
<td>Ladder Diagram (programming language for creating PLC programs)</td>
</tr>
</tbody>
</table>
### Abbreviations Table

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>LSB</td>
<td>Least Significant Bit</td>
</tr>
<tr>
<td>M3000®</td>
<td>Moog Automation System</td>
</tr>
<tr>
<td>MACS</td>
<td>Moog Axis Control Software (Development environment according to IEC 61131 for solving complex control tasks)</td>
</tr>
<tr>
<td>Mbit/s</td>
<td>Megabits per second</td>
</tr>
<tr>
<td>MSB</td>
<td>Most Significant Bit</td>
</tr>
<tr>
<td>MSC I</td>
<td>Moog Servo Controller I (Multi axis Moog Motion Controller for DIN top-hat rail mounting)</td>
</tr>
<tr>
<td>MSC II</td>
<td>Moog Servo Controller II (Multi axis Moog Motion Controller for DIN top-hat rail mounting)</td>
</tr>
<tr>
<td>MSC-R</td>
<td>Moog Servo Controller - Ruggedized (Control module in IP67 rugged design)</td>
</tr>
<tr>
<td>MSC-R-IO</td>
<td>Moog Servo Controller - Ruggedized I/O module (Control module in IP20 rugged design)</td>
</tr>
<tr>
<td>MSD</td>
<td>Modular Multi-Axis Programmable Motion Control Servo Drive</td>
</tr>
<tr>
<td>MSD Motion Controller</td>
<td>Multi-Axis High Performance Motion Controller</td>
</tr>
<tr>
<td>MSD Servo Drive</td>
<td>A modular family of electrical servo drives to run permanent magnet synchronous, linear and asynchronous motors</td>
</tr>
<tr>
<td>MSL</td>
<td>Mean Sea Level</td>
</tr>
<tr>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>ND</td>
<td>Not Defined</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PE</td>
<td>Protective Earth</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Control(ler)</td>
</tr>
<tr>
<td>Q-Connector</td>
<td>40 pole lateral connector of DIN rail modules</td>
</tr>
<tr>
<td>R-Modules</td>
<td>Remote modules such as RDIO and RDISP (connection via CAN bus)</td>
</tr>
<tr>
<td>RAM</td>
<td>Random Access Memory (read and write memory that loses its contents when power is removed)</td>
</tr>
<tr>
<td>RDIO</td>
<td>Remote module with digital I/Os and CANopen interface (connection via CAN bus)</td>
</tr>
<tr>
<td>RDISP</td>
<td>Remote Display (display and operating terminal with TIA/EIA 232 and CANopen interface (connection via CAN bus))</td>
</tr>
<tr>
<td>REF</td>
<td>Reference voltage</td>
</tr>
<tr>
<td>RISC</td>
<td>Reduced Instruction Set Computer</td>
</tr>
<tr>
<td>RT-ETH</td>
<td>Real Time Ethernet Interface</td>
</tr>
<tr>
<td>Rx</td>
<td>Receive Data</td>
</tr>
<tr>
<td>SELV</td>
<td>Safety Extra-Low Voltage (according to EN 60950-1)</td>
</tr>
<tr>
<td>SFC</td>
<td>Sequential Function Chart (programming language for creating PLC programs)</td>
</tr>
<tr>
<td>SHLD</td>
<td>Shield</td>
</tr>
<tr>
<td>SIO</td>
<td>Serial I/O (serial interface of the MSC II)</td>
</tr>
<tr>
<td>SSI</td>
<td>Synchronous Serial Interface (digital interface for transferring positioning information, like with position transducers)</td>
</tr>
<tr>
<td>ST</td>
<td>Structured Text (programming language for creating PLC programs)</td>
</tr>
<tr>
<td>TIA</td>
<td>Telecommunications Industry Association (<a href="http://www.tiaonline.org">http://www.tiaonline.org</a>)</td>
</tr>
<tr>
<td>TPU</td>
<td>Time Processing Unit (programmable microprocessor that processes time functions independently of the CPU)</td>
</tr>
<tr>
<td>TÜV</td>
<td>Technischer Überwachungsverein (German agency performing technical inspections)</td>
</tr>
</tbody>
</table>
10.3 Quoted Standards

10.3.1 CiA DS

CiA DS 201–207
CiA Draft Standard: CAN Application Layer (CAL)

CiA DS 301
CiA Draft Standard: CANopen Communication Profile for Industrial Systems – Based on CAL

CiA DS 401
CiA Draft Standard: CANopen Device Profile for Generic I/O Modules

10.3.2 DIN

DIN 41652
Rack and Panel Connectors, Trapezoidal, Round Contacts 1 mm

10.3.3 EN

EN ISO 9227
Corrosion tests in artificial atmospheres - Salt spray tests

EN 60715
Dimensions of Low Voltage Switchgear and Controlgear – Standardized Mounting on Rails for Mechanical Support of Electrical Devices in Switchgear and Controlgear Installations

EN 60950-1
Information Technology Equipment – Safety – Part 1: General Requirements

EN 61000-6-1
Electromagnetic Compatibility (EMC) – Part 6-1: Generic Standards; Immunity for Residential, Commercial and Light-Industrial Environments

EN 61000-6-2
Electromagnetic Compatibility (EMC) – Part 6-2: Generic Standards: Immunity for Industrial Environments
EN 61000-6-3  
Electromagnetic Compatibility (EMC) – Part 6-3: Generic Standards; Emission Standard for Residential, Commercial and Light-Industrial Environments

EN 61000-6-4  
Electromagnetic Compatibility (EMC) – Part 6-4: Generic Standards; Emission Standard for Industrial Environments

EN 60204  
Safety of Machinery – Electrical Equipment of Machines

10.3.4 IEC

IEC 60068  
Environmental Testing

IEC 60068-2-6  
Environmental Testing – Part 2: Tests; Test Fc: Vibration (Sinusoidal)

IEC 60068-2-27  

IEC 60068-2-31  
Environmental Testing – Part 2: Tests; Test Ec: Drop and Topple, Primarily for Equipment-Type Specimens

IEC 60364-4-44  
Electrical Installations of Buildings – Part 4-44: Protection for Safety – Protection against Voltage Disturbances and Electromagnetic Disturbances

IEC 60068-2-52  
Environmental testing - Part 2: Tests, Test Kb: Salt mist, cyclic (sodium chloride solution)

IEC 60529  
Degrees of Protection Provided by Enclosures (IP Code)

IEC 60664  
Insulation Coordination for Equipment within Low Voltage Systems

IEC 60801-2  

IEC 61131  
Programmable Controllers

IEC 61131-1  
Programmable Controllers – Part 1: General Information

IEC 61131-2  
Programmable Controllers – Part 2: Equipment Requirements and Tests

IEC 61131-3  
Programmable Controllers – Part 3: Programming Languages

IEC 61131-4  
Programmable Controllers – Part 1: User Guidelines

10.3.5 ISO/DIS

ISO/DIS 11898  
Road Vehicles – Controller Area Network (CAN)
10.3.6 TIA/EIA

TIA/EIA 232 (previously RS 232)
   Interface Between Data Terminal Equipment and Data Circuit – Termination Equipment Employing Serial Binary Data Interchange

TIA/EIA 422 (previously RS 422)
   Electrical Characteristics of Balanced Voltage Digital Interface Circuits

TIA/EIA 485 (previously RS 485)
   Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

Quoted Standards:
   TIA/EIA
11 Index

A
Abbreviations used • 45
Air humidity, relative
  permissible for operating the MSC-R-IO • 26
  permissible for transportation and storage
  M3000® modules • 22
  MSC-R-IO • 26
Air pressure, permissible
  for transportation and storage
  M3000® modules • 22
  MSC-R-IO • 26
Ambient temperature
  permissible for operating the MSC-R-IO • 26
  permissible for transportation and storage
  M3000® modules • 22
  MSC-R-IO • 26
Arrangement of the MSC-R-IO • 25

B
Basic wiring diagram
  digital input of the MSC-R-IO • 38
  digital output of the MSC-R-IO • 36
Block diagrams
  Block Diagram of the MSC-R-IO • 27

C
CE labeling of the M3000® modules • A, 4
Cleaning
  safety instructions • 9, 20
Contamination level
  M3000® modules • 22
Copying prohibition for this manual • A
Copyright
  for software that is installed on M3000® products • 5
  for this manual • A
Current, maximum admissible current for the power supply
  terminals of the MSC-R-IO • 18

D
Digital
  terminal assignment • 30
Digital input of the MSC-R-IO, digital
  terminal assignment • 31
Digital outputs of the MSC-R-IO • 30
Dimensions
  MSC-R-IO • 23, 24
DIN rail mounting kit for the MSC-R-IO • 25
  part numbers • 43
Disposing M3000® modules • 4
Disturbance suppression of digital inputs • 39
Drop height, permissible
  M3000® modules • 22
  MSC-R-IO • 26
Duplication prohibition for this manual • A

E
Electromagnetic Compatibility • 4
EMC • 4
EMC-compatible installation • 25
Environmental conditions
  for operating M3000® modules • 11
  for operating the MSC-R-IO • 26
  climatic conditions • 26
  electrical conditions and requirements • 26
  mechanical conditions and requirements • 26
  for transporting and storing M3000® modules • 22
  limitations of using M3000® modules • 12
  requirements from IEC 61131-2 • 11
  resistance to corrosion • 26
  safety instructions • 7, 11, 26
Environmental protection
  disposing M3000® modules • 4
  no harmful emissions from M3000® modules (when used
  properly) • 4
ESD
  safety instructions • 7
EtherCAT interface
  MSC-R-IO • 42
Ethernet
  Ethernet interface of the MSC-R-IO
  terminal assignment • 29
  Ethernet LAN connector • 29

F
Figures, list of • v
Front panel
  MSC-R-IO • 28
Front view
  MSC-R-IO • 23

G
Grounding
  grounding concept • 15
  signal grounding of the MSC-R-IO • 15
I

I/Os of the MSC-R-IO, digital • 23, 35–40
  digital inputs • 38–40
    basic wiring diagram • 38
    disturbance suppression • 39
    insulation resistance • 40
    pulse detection • 39
    specifications • 39
  U/I working ranges • 40
  digital outputs • 36–38
    basic wiring diagram • 36
    insulation resistance • 38
    load connection • 37
    open collector outputs • 36
    open emitter outputs • 36
    overload protection • 37
    specifications • 37
  LEDs of the MSC-R-IO for displaying the operational state • 35
  power supply • 35

Insensitivity to corrosion
  M3000® modules • 22
  MSC-R-IO • 26

Installation • 14
  safety instructions • 8, 13, 17, 18

Insulation resistance
  digital inputs of the MSC-R-IO • 38
  digital outputs of the MSC-R-IO • 40

Interfaces of the MSC-R-IO • 23
  terminal assignment • 28–31

L

LAN
  LAN interface of the MSC-R-IO
    terminal assignment of the «X2» connector • 29

LEDs of the MSC-R-IO • 32
  display the operational state of the digital I/Os • 35

Liability
  exclusion of liability • 3
  exclusion of liability for this manual • 1

List of figures • v
List of tables • iv
Load connection of digital outputs • 37

M

Maintenance • 21
  safety instructions • 9, 20

Maximum admissible current for the power supply terminals of the MSC-R-IO • 18
Moog Global Support • 21

Mounting
  MSC-R-IO • 25
  MSC-R-IO DIN rail mounting kit • 25

MSC-R DIN rail mounting kit • 25

MSC-R-IO • 23–42
  dimensions • 23, 24
  environmental conditions for operation • 26
    climatic conditions • 26
    electrical conditions and requirements • 26
    mechanical conditions and requirements • 26
  front panel • 26
  view of the module • 23

N

Nameplate
  MSC-R-IO • 42

O

Operating elevation • 26
Original packaging is to be retained! • 3
Oscillations, permissible for MSC-R-IO • 26
Overload protection of digital outputs • 37

P

Packaging
  Original packaging is to be retained! • 3

Part numbers
  DIN rail mounting kit for the MSC-R-IO • 43
  plug-in terminal strips for DIN rail modules • 43

Personnel, selection and qualification
  only qualified users may work with and on M3000®! • 2

Place of storage for manuals • 1

Proper use
  safety related systems • 2

Protection class of the MSC-R-IO • 26
PT100 Input • 31
Pulse detection of digital inputs • 39

R

Rated voltage of the power supply • 16
Release date of this manual • 1
Removing
  MSC-R-IO • 25
 Repair • 21
  Moog Global Support • 21
    safety instructions • 9, 20
Reproduction prohibition for this manual • A
Reservation of changes for this manual • A, 1
Resistance to corrosion
  MSC-R-IO • 26
Retain the original packaging! • 3
Reverse energization is to be avoided! • 17, 18, 35
S

Safety extra-low voltage SELV • 17
Safety instructions
  cleaning • 9, 20
  environmental conditions • 7, 11, 26
  ESD • 7
  installation • 8, 13, 17, 18
  maintenance • 9, 20
  mounting
    MSC-R-IO • 13
  project planning • 8, 17, 18
  removing
    MSC-R-IO • 13
  repair • 9, 20
  safety related systems • 2, 6
  service • 9, 20
  shutdown • 9, 20
  storing M3000® modules • 10, 22
  transporting M3000® modules • 10, 22
  typographical conventions • 6, 44
Safety related systems • 2
  safety instructions • 2, 6
Sensors
  connecting to the power supply • 18
  connecting with digital I/O cable • 19
Service
  safety instructions • 9, 20
Shock, permissible for MSC-R-IO • 26
Shutdown
  safety instructions • 9, 20
Signal cables
  connection with digital I/O cable • 19
Software
  copyright • 5
Standards
  overview of quoted standards • 47–49
Storing M3000® modules
  environmental conditions • 22
    air pressure, permissible • 22
    ambient temperature, permissible • 22
    contamination level • 22
    insensitivity to corrosion • 22
    relative air humidity, permissible • 22
    safety instructions • 10, 22
Storing manuals
  place of storage • 1

T

Table of Contents • i
Tables, list of • iv
Terminal assignment
  MSC-R-IO • 28–31
Trademarks • 5
Transporting M3000® modules
  environmental conditions • 22
    air pressure, permissible • 22
    ambient temperature, permissible • 22
    contamination level • 22
    insensitivity to corrosion • 22
    relative air humidity, permissible • 22
    safety instructions • 10, 22
Typographical conventions • 44

U

UII working ranges of digital inputs • 40
User manual M3000® and MSC-R
  version number • 1
User manual M3000® and MSC-R-IO
  copyright • A
  date of release • 1
  duplication prohibition • A
  exclusion of liability • 1
  place of storage • 1
  reproduction prohibition • A
  reservation of changes • A, 1

V

Version number of this manual • 1

W

Warranty
  exclusion of warranty • 3
Weight of the MSC-R-IO • 23
TAKE A CLOSER LOOK.

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