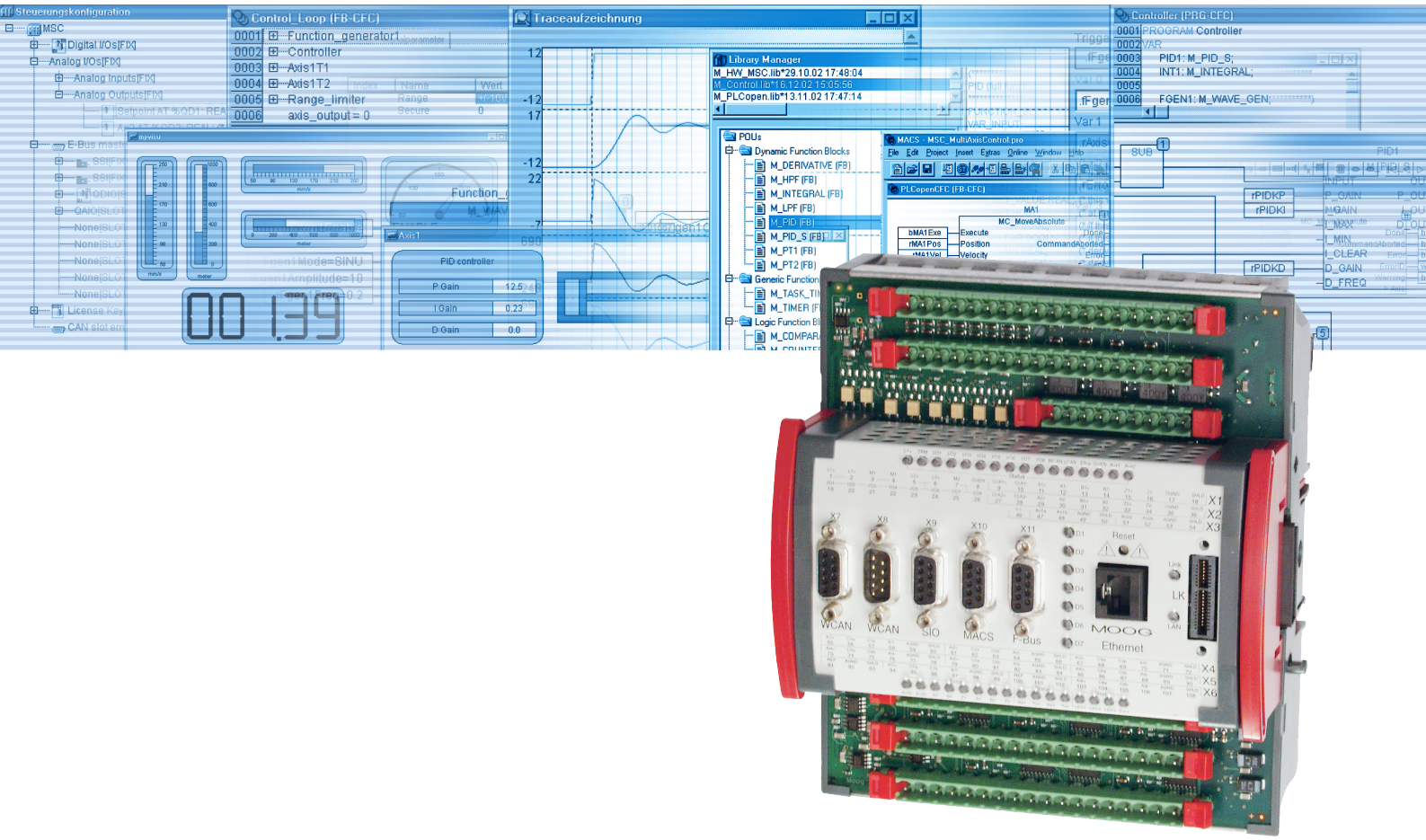
User Manual

M3000® Control System
Control System
MSC (Moog Servo Controller)
Control Module



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http://www.moog.com/QAIO
http://www.moog.com/QDIO
http://www.moog.com/QCAN
http://www.moog.com/MACS

Subject to changes without prior notice.

CE 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 control system with proven electromagnetic compatibility (EMC).

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1 General Information

1.1 About this Manual

About this Manual

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

Using M3000® Safely (Prerequisites)

The following items must be observed as fundamental elements of safety when using the M3000® control 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

Reservation of Changes and Validity for this Manual

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.

Exclusion of Liability for this Manual

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

Completeness of this Manual

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

Place of Storage for this Manual

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® control 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® control 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 control system is suitable for control applications in the medium to high end power 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 management and 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® control 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 are 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 control 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.

Exclusion of Warranty and Liability

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® control system or M3000® modules
  ⇨ "1.3 Proper Use" on page 2
- Use of the M3000® control system or M3000® modules in a technically imperfect condition
- Use of the M3000® control 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® control 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® control system or M3000® modules.
- Storage or transportation of M3000® modules or accessories outside of the original packaging.
  ⇨ "9 Transportation and Storage" on page 66
- Unauthorized or improperly executed structural changes to the M3000® control system or M3000® modules.
- Unauthorized or improperly executed repairs on the M3000® control system or M3000® modules.
  ⇨ "8.2.2 Repair" on page 65
- Damage due to the intrusion of foreign objects or acts of God.

1.5 Inspection of Delivery

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.

Retain the Original Packaging

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.

Environmental Protection: Emissions

1.6.2 Disposal

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

Environmental Protection: Disposal

1.7 Standards

1.7.1 CE Labeling of M3000® Modules

CE

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 control system with proven electromagnetic compatibility (EMC).

CE Labeling of M3000® Modules

1.7.2 IEC 61131-2

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

M3000® and M3000® Modules Comply with 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 89/336/EEC “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.

Electromagnetic Compatibility (EMC)

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:

- DIN EN 61000-6-2
- DIN 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:

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

Suitable additional measures:
⇨ "4.2 Use in Special Environments" on page 27

If the system does not comply with the requirements of DIN EN 61000-6-1 and DIN 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
- Mounting of the DIN rail module onto a DIN top-hat rail that is attached to an electrically conductive, grounded mounting plate
  ⇨ figure 14 on page 30

M3000® modules must be powered from a power supply with SELV (Safety Extra-Low Voltage) according to DIN EN 60950-1. Therefore the EU low voltage directive is not relevant for the M3000® control system because the specified voltage levels lie below the limits.

1.8 Trademarks

Trademarks

Moog and Moog Authentic Repair are registered trademarks of Moog Inc. and its subsidiaries.
M3000® is a trademark of Moog GmbH that is registered in the EU.

All product and company names mentioned in this manual might be protected 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

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 installed 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® control 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

Safety Instructions: 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:
⇨ "12.1 Typographical Conventions" on page 126

2.2 Safety Instructions

2.2.1 Safety Related Systems

Safety Instructions: Safety Related Systems

WARNING

As with any electronic control 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

Safety Instructions: Environmental Conditions

WARNING

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

WARNING

The PC on which the MACS development environment is 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® control system or M3000® modules in a potentially explosive environment.

WARNING

The M3000® control system and M3000® modules must not come into direct contact with liquids. 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:
⇨ "4 Environmental Conditions" on page 26
⇨ "10.2.2 Environmental Conditions" on page 69

2.2.3 ESD

Safety Instructions: ESD

WARNING

Protect the M3000® control 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.

2.2.4 Project Planning and Installation

Safety Instructions: Project Planning and Installation

DANGER

The L2+/M2 power supply terminals of the MSC type D136E001-001 are not protected against reverse polarity (in deviation from the requirements of IEC 61131-2).
Reverse polarity on terminals L2+ and M2 will lead to permanent damage to the MSC!

The L2+/M2 power supply terminals of the other MSC types are protected against reverse polarity.
The L1+/M1 power supply terminals of all MSC types and the power supply terminals of the other M3000® modules are protected against reverse polarity.
If the polarity of these power supply terminals is reversed, the modules will not function.

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® control system or M3000® modules may be performed while the control system or the modules are in operation!

There is a danger of:

- Uncontrolled movements
- Permanent damage
- Malfunctions

Before performing any work on the M3000® control system or M3000® modules, it is essential that the system be stopped and the power supply 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 DIN rail 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 3 on page 40):

- Reverse energization from sensor to module
- Invalid sensor data

WARNING

Sensors that are connected to digital inputs of DIN rail modules with several I/O groups, such as MSC, QDIO, or RDIO, must under all conditions 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

More on these subjects:
⇨ "5 Mechanical Structure" on page 28 or
⇨ "6 Project Planning and Installation" on page 36

2.2.5 Update Rate of E-Bus Messages

WARNING

The I/O extension modules QDIO and QAIO 16/4 monitor the E-bus activity and disable their outputs if they do not receive an E-bus message more frequently than 50 ms.

To avoid this, go to the MACS development environment and set the value of the task interval or the value of 'UpdateRate' so that the product of the two values is less than 50 ms.

Safety Instructions: Update Rate of E-Bus Messages

More on this subject:
⇨ "7.4.3.2 Update Rate of E-Bus Messages" on page 57

2.2.6 Shutdown and Service

Safety Instructions: 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.
⇨ "1.4 Warranty and Liability" on page 3

WARNING

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

There is a danger of:

- Uncontrolled movements
- Permanent damage
- Malfunctions

Before performing any work on the M3000® control system or M3000® modules, it is essential that the system be stopped and the power supply 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® control system and M3000® modules must not come into direct contact with liquids. 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:
⇨ "8 Shutdown and Service" on page 64

2.2.7 Transportation and Storage

WARNING

Maintain, under all circumstances, the required environmental conditions specified for transportation and storage of the control system M3000® or M3000® modules.
⇨ "9.1 Environmental Conditions" on page 66
This ensures fault-free, reliable, and safe operation.

Safety Instructions: Transportation and Storage

More on this subject: ⇨ "9 Transportation and Storage" on page 66

2.2.8 Communication Between MSC and MACS

WARNING

The MSC's operational state can be altered with the MACS development environment when the MSC is connected online with MACS.

This can be done by means of the following actions, for example:

- Stopping or resetting the program
- Setting breakpoints
- Activating the single step mode
- Downloading application programs
- Writing or forcing values

Therefore, the operator must always consider the effects and take appropriate precautions before altering the operational state of the MSC with MACS.

Safety Instructions: Communication Between MSC and MACS

More on this subject:
⇨ "10.5 Programming and Configuration" on page 80

2.2.9 License Key of the MSC

Safety Instructions: License Key of the MSC

WARNING

The license key of the MSC must be protected from electrostatic discharges!
Electrical discharges might damage the license key or delete the contents of the license key's memory.

WARNING

The license key may be inserted or removed only when the MSC is powered down!
Attempting to insert or remove the license key during operation might damage the license key or the MSC permanently.

WARNING

The license key must always remain inserted while the MSC is in operation. Otherwise, the MSC will not function.

If the license key is removed during operation, the application program will stop after a few minutes. If the MSC is connected online to the MACS development environment, a corresponding error message will appear in MACS.
In addition, the digital output 'Outputs Enabled' will be switched to the 0 state, thereby disabling all of MSC's digital and analog outputs and terminating the E-bus communication.
⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116
After switching off the MSC and inserting the license key, the MSC can be brought back into operation.

More on this subject: ⇨ "10.6 License Key" on page 81

2.2.10 Reset Button of the MSC

Safety Instructions: Reset Button of the MSC

WARNING

To avoid damage, use only a suitable, electrically non-conductive tool to actuate the reset button on the front panel of the MSC. A light pressure is sufficient.

WARNING

If the most recent status in the online mode (MACS logged in) was 'Start' before the MSC was switched off or reset, the boot project will always be started after the MSC is switched back on or reset.

This will occur regardless of which application program was previously running.
In other words, the application program that will be started automatically after the MSC is switched on or reset might be different from the application program that was executing immediately prior.
⇨ "10.8.1.3 Examples" on page 87

More on this subject: ⇨ "10.7 Reset Button" on page 84

2.2.11 Switching Back on or Resetting the MSC

WARNING

If the most recent status in the online mode (MACS logged in) was 'Start' before the MSC was switched off or reset, the boot project will always be started after the MSC is switched back on or reset.

This will occur regardless of which application program was previously running.
In other words, the application program that will be started automatically after the MSC is switched on or reset might be different from the application program that was executing immediately prior.
⇨ "10.8.1.3 Examples" on page 87

Safety Instructions: Switching Back on or Resetting the MSC

More on this subject:
⇨ "10.8.1 Behavior at Switching on and Switching off" on page 85

2.2.12 'Outputs Enabled' Output of the MSC

WARNING

If there is a defect in an output stage, the 'Outputs Enabled' signal will not necessarily shut down all of the outputs securely.

Safety Instructions: 'Outputs Enabled' Output of the MSC

More on this subject:
⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116

3 Short M3000® System Overview

Short M3000® System Overview

The M3000® control system comprises the following hardware and software components:

- **M3000® starter kit**
  Complete package including everything needed to get started
  ⇨ "3.2 M3000® Starter Kit" on page 17
- **M3000® modules**
  - **MSC (Moog Servo Controller)**
    Control module for DIN top-hat rail mounting
    ⇨ "3.3.1 MSC" on page 18
  - **QDIO**
    Digital I/O extension module for local extension of the inputs and outputs of MSCs (connection over E-bus)
    ⇨ "3.3.2.1 QDIO and QAIO 16/4" on page 19
  - **QAIO 16/4**
    Analog I/O extension module for local extension of the inputs and outputs of MSCs (connection over E-bus)
    ⇨ "3.3.2.1 QDIO and QAIO 16/4" on page 19
  - **QCAN**
    CAN extension module which can be used to make available the LocalCAN bus of an E-bus group for external CAN bus network stations (over a D-sub front panel connector)
    ⇨ "3.3.2.2 QCAN" on page 20
  - **RDIO**
    Remote module with digital I/Os and CANopen interface (connection over CAN bus)
    ⇨ "3.3.3.1 RDIO" on page 21
  - **RTEMP**
    Temperature control module with TIA/EIA 232 and CANopen interface (connection over CAN bus)
    ⇨ "3.3.3.2 RTEMP" on page 21
  - **RDISP**
    Display and operating terminal with TIA/EIA 232 and CANopen interface (connection over CAN bus)
    ⇨ "3.3.3.3 RDISP" on page 22
- **License keys**
  Hardware keys necessary for the operation of the MSC
  ⇨ "3.4 License Key" on page 23
- **MACS (Moog Axis Control Software)**
  Development environment according to IEC 61131 for solving complex control tasks
  ⇨ "3.5 Application Programs" on page 24
- **MACS HMI (Moog Axis Control Software Human Machine Interface)**
  Visualization package which can be run without MACS
  ⇨ "3.6.1 MACS HMI Visualization Package" on page 25

ⓘ Moog web site on M3000®: http://www.moog.com/M3000

ⓘ The M3000® modules mentioned here represent only a part of Moog's current product range. In addition to other M3000® modules, Moog's product range includes a large variety of accessories.
⇨ "11 Product Range" on page 118

3.1 M3000® System Architecture

M3000® System Architecture

The control system M3000® has the hardware and software structure necessary for modular and flexible automation solutions with distributed intelligence.

TIA/EIA 232

The MSC control module can use a serial TIA/EIA 232 (previously RS 232) connection to communicate over the MACS interface with the PC on which the MACS development environment is installed.
⇨ "10.5.1 Communication Between MSC and MACS" on page 80

Ethernet

The MSC control module can use an Ethernet connection (LAN, company network, peer-to-peer connection) to communicate with another controller, development environment, or visualization package.
⇨ "7.1 Ethernet" on page 46
⇨ "10.5.1 Communication Between MSC and MACS" on page 80
⇨ "10.5.1.2 Ethernet Communication Interface" on page 81

CAN Bus

To create real time capable applications, even in distributed systems and to give the application a better structure, M3000® can also be divided hierarchically (into several CAN buses).
⇨ "7.3 CAN Bus and CANopen" on page 50

WideCAN and LocalCAN are two equal, mutually independent CAN bus interfaces. In a typical application they are used as follows:

WideCAN

- **WideCAN** can be used for networking of individual control groups or remote modules. Usually, WideCAN ist used for synchronization and data exchange between the control groups and operating stations of a machine or system.
  ⇨ "3.3.3 R-Modules (Remote Modules)" on page 20
  ⇨ "7.5.4 WideCAN Bus Groups" on page 62

  In addition, the WideCAN network can integrate other components with a CAN bus or CANopen interface, such as motor controllers, hydraulic valves, and radial piston pumps.

  ⓘ Moog's current product range offers an extensive selection of motor controllers, hydraulic valves, and radial piston pumps.

LocalCAN

- **LocalCAN** connects the DIN rail modules within a LocalCAN bus group and, if applicable, the QCAN to the connected LocalCAN bus groups or CAN sensors/actuators.
  ⇨ "3.3.2.2 QCAN" on page 20
  ⇨ "7.5.3 LocalCAN Bus Groups" on page 61

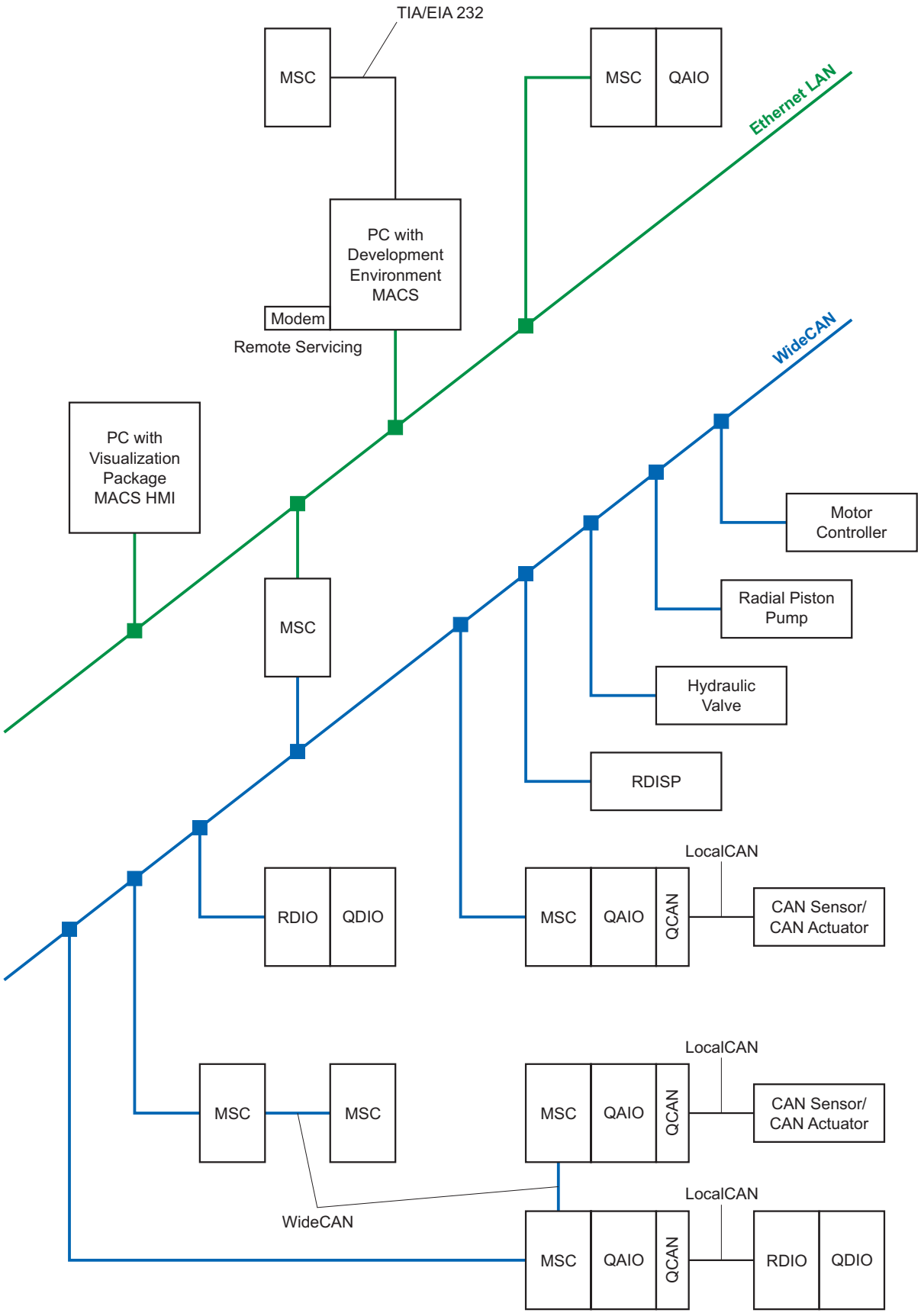


Figure 1: M3000® System Architecture (Example)

3.2 M3000® Starter Kit

M3000® Starter Kit

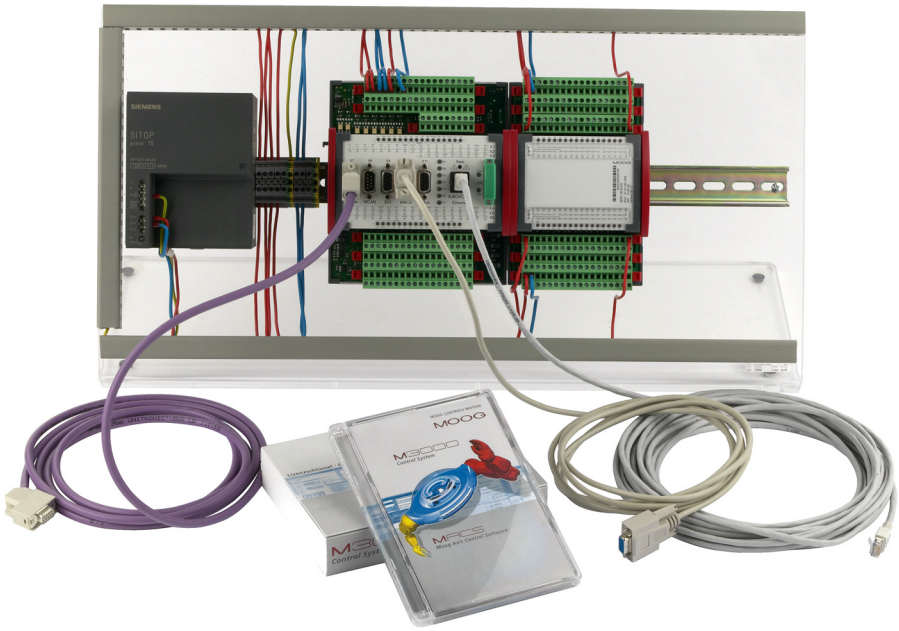


Figure 2: M3000® Starter Kit

The M3000® starter kit includes everything needed to get started:

- MSC with digital open emitter outputs, 2 MB RAM
- Power supply 24 V 10 A
- License key, green
- QDIO 16/16-0,5
- MACS development environment
- Software maintenance contract
- Crossed TIA/EIA 232 interface cable, 5 m (5.47 yd)
- Crossed Ethernet interface cable, 10 m (10.94 yd)
- CAN bus interface cable, 3 m (3.28 yd)
- 11 Plug-in terminal strips with screw terminals, 18 pole
- Plug-in terminal strip with screw terminals, 9 pole

The included DIN rail modules MSC and QDIO are mounted (together with the power supply) on a single mounting plate.
A suitable power cord is the only additional item required to facilitate connection to the power source.

3.3 M3000® Modules

The M3000® modules mentioned here represent only a part of Moog's current product range. In addition to other M3000® modules, Moog's product range includes a large variety of accessories.
⇨ "11 Product Range" on page 118

3.3.1 MSC

MSC

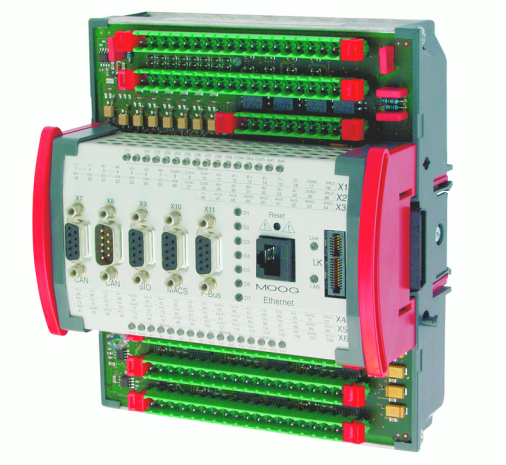


Figure 3: MSC Control Module

The MSC digital control module is a fully programmable multi-axis controller. The inputs and outputs of the MSC can be extended locally by attaching Q-modules. The MSC and the attached modules then form an E-bus group. MSCs and Q-modules within E-bus groups communicate over the internal E-bus.
⇨ "7.5.2 E-Bus Groups" on page 60

The MSC is programmed and configured with the MACS development environment (complies with IEC 61131).
⇨ "3.5 Application Programs" on page 24

Detailed information about the MSC:
⇨ "10 MSC (Moog Servo Controller)" on page 67

Moog web site on the MSC: http://www.moog.com/MSC

3.3.2 Q-Modules

Q-Modules

The following Q-modules are available from Moog:

- QDIO (digital I/O extension module)
  ⇨ "3.3.2.1 QDIO and QAIO 16/4" on page 19
- QAIO 16/4 (analog I/O extension module)
  ⇨ "3.3.2.1 QDIO and QAIO 16/4" on page 19
- QCAN (CAN extension module)
  ⇨ "3.3.2.2 QCAN" on page 20

Q-modules can be used only as E-bus slaves within E-bus groups.
⇨ "7.5.2 E-Bus Groups" on page 60

When using an RDIO as E-bus master, only QDIOs can be used as E-bus slaves.
⇨ "7.4.2.1 E-Bus Master and E-Bus Slaves" on page 56

ⓘ Refer to the Q-modules' documentation for more detailed information.

Moog web site on the Q-modules: http://www.moog.com/Q-Modules

3.3.2.1 QDIO and QAIO 16/4

QDIO and QAIO 16/4

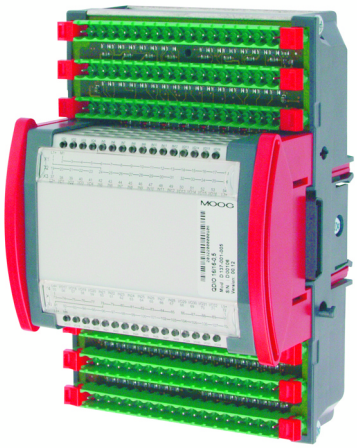


Figure 4: QDIO

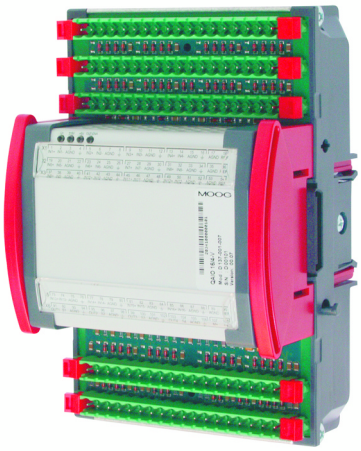


Figure 5: QAIO 16/4

QDIO and QAIO 16/4 I/O extension modules can be used to locally extend the inputs and outputs of an MSC. They have no internal intelligence. Instead, the MSC actuates them via I/O operation directly over the internal E-bus.

QDIO 16/16-0,5

QDIO 16/16-0,5 is a digital I/O extension module with 16 digital inputs and 16 individually configurable digital I/Os.
QDIO 16/16-0,5 provides positive switching inputs and I/Os.
QDIO 16/16-0,5N provides zero switching inputs and I/Os.

QAIO 16/4

QAIO 16/4 is an analog I/O extension module with 16 analog inputs and 4 analog voltage outputs (±10 V).
QAIO 16/4-V provides 16 voltage inputs (±10 V).
QAIO 16/4-A provides 16 current inputs (0–20 mA).

3.3.2.2 QCAN

QCAN

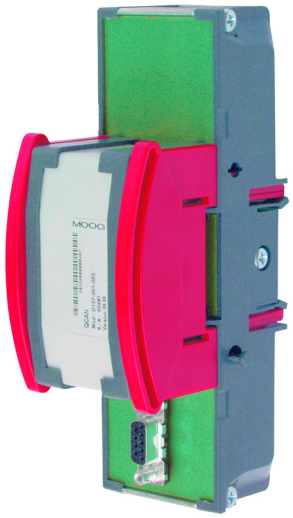


Figure 6: QCAN CAN Extension Module

QCAN is a CAN extension module which can be used to make available the LocalCAN bus of an E-bus group for external CAN bus network stations (over a D-sub front panel connector).

3.3.3 R-Modules (Remote Modules)

R-Modules (Remote Modules)

The following R-modules are available from Moog:

- RDIO (remote module with digital I/Os and CANopen interface)
  ⇨ "3.3.3.1 RDIO" on page 21
- RTEMP (temperature control module)
  ⇨ "3.3.3.2 RTEMP" on page 21
- RDISP (display and operating terminal)
  ⇨ "3.3.3.3 RDISP" on page 22

IEC 61131 application programs cannot run on R-modules.

R-modules connect to other network stations over the CAN bus.
⇨ "7.3 CAN Bus and CANopen" on page 50

ⓘ Refer to the R-modules' documentation for more detailed information.

3.3.3.1 RDIO

RDIO

Figure 7: RDIO 16/16-0,5 Remote I/O Module

RDIO is a remote module with digital I/Os and CANopen interface. RDIOs can be parameterized as a CANopen slave according to CiA DS 401.

RDIO 16/16-0,5 provides 16 positive switching digital inputs and 16 positive switching digital I/Os.

RDIO 16/16-0,5

3.3.3.2 RTEMP

RTEMP

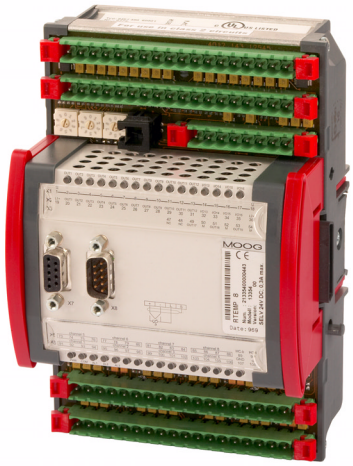


Figure 8: RTEMP 8-CAN Temperature Control Module

RTEMP is a precise temperature control module with TIA/EIA 232 and CANopen interface, setpoint adaptation (without oscillation), automatic soft start, control variable transfer when sensor breaks, heating current monitoring, measurement/control circuit alarm, and configurable alarm outputs. Its self-optimizing feature ensures the shortest possible startup times.

RTEMP 8-CAN is an 8 channel controller.

RTEMP 8-CAN

The CPRTEMP software (needed to program and configure the RTEMP) is not included with RTEMP. CPRTEMP is available from Moog as an accessory.

CPRTEMP

⇨ "11.5.2 Software for R-Modules" on page 122

3.3.3.3 RDISP

RDISP

Figure 9: RDISP 22 Display and Operating Terminal

RDISP is a versatile display and operating terminal with TIA/EIA 232 and CANopen interface as well as a graphical LCD display and function keys which can be labelled. A small slip of paper can be inserted below the keys.

RDISP 22

RDISP 22 provides 22 function keys and a display with max. 8 lines of 40 characters each or random graphics.
Dimensions of RDISP 22:
187 mm × 120 mm × 56 mm (7.36 in × 4.72 in × 2.2 in)

CPRDISP

The CPRDISP software (needed to program and configure the RDISP) is not included with RDISP. CPRDISP is available from Moog as an accessory.
⇨ "11.5.2 Software for R-Modules" on page 122

3.3.4 Identification

Identification of M3000® Modules

M3000® modules can be identified by their nameplate.
Nameplate of the MSC: ⇨ "10.18 Nameplate" on page 117

The DIN rail module's I/O designations are located on the front panel.
Terminal assignment of the MSC:
⇨ "10.4 View of the Module and Terminal Assignment" on page 72

Refer to the relevant documentation for detailed information about the nameplate and terminal assignment of the other M3000® modules.

3.4 License Key

License Key

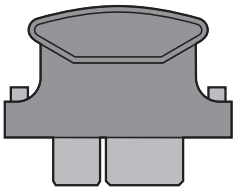


Figure 10: License Key

The license key has to be inserted into the MSC's license key slot «LK» (far right on the front panel of the MSC).
The MSC does not function without license key.
⇨ "10.6 License Key" on page 81

The following information is saved in the license key:

- Run-time license of the MSC and list of accessible MACS libraries
  ⇨ "10.6.1 Run-Time License and Accessible Libraries" on page 82
- CANopen node-ID of the MSC's CAN bus interfaces
  ⇨ "10.6.2 CANopen Node-ID and IP Address" on page 82
- IP address of the MSC's Ethernet interface
  ⇨ "10.6.2 CANopen Node-ID and IP Address" on page 82

If the MSC is replaced, this information will remain saved in the license key. If the license key is inserted into a different MSC, the run-time license, CANopen node-ID and IP address can be used from that MSC.

The extent of the MSC's features depends on the license key used. License keys enabling varying types of features are available from Moog as accessories.
⇨ "11.4 License Keys" on page 121

3.5 Application Programs

Application Programs

Application programs have to be downloaded onto the MSC control module and started to be executed by the MSC.
The MACS development environment is needed to create executable IEC 61131 application programs for the MSC. With MACS, the application program can be programmed, compiled, downloaded and started.
⇨ "3.6 MACS Development Environment" on page 24
⇨ "10.5.1 Communication Between MSC and MACS" on page 80

Application programs can be saved and executed in the MSC in the following manner:

- As a boot project in the flash EEPROM
- In RAM

An application program saved as a boot project will be loaded into RAM whenever the MSC's power supply is switched on or when the MSC is reset.

ⓘ An application program that is only executed in RAM without being saved as a boot project will **not** be saved in the MSC when it is switched off or when the power supply fails.
After the power supply is switched back on, the application program must be downloaded once more from the MACS development environment!

Behavior of the MSC at switching on and switching off the power supply:
⇨ "10.8.1 Behavior at Switching on and Switching off" on page 85

3.6 MACS Development Environment

WARNING

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

MACS must be installed on a personal computer (PC). This PC then represents the PADT (programming and diagnostic tool) specified in IEC 61131.

Scope of Functionality of MACS

Scope of functionality of MACS

- Programming, testing, and optimization of IEC 61131 application programs
- Documentation of IEC 61131 application programs
- Visualization of IEC 61131 application programs
- Hardware configuration of M3000® modules

Programming Languages of MACS

MACS supports the following programming languages:

- Instruction List (IL)
- Structured Text (ST)
- Ladder Diagram (LD)
- Function Block Diagram (FBD)
- Sequential Function Chart (SFC)
- Continuous Function Chart (CFC)

Refer to the documentation for the MACS development environment for more detailed information.

Moog web site on MACS: http://www.moog.com/MACS

The MACS development environment is available from Moog as an accessory.
⇨ "11.5 Software" on page 122

3.6.1 MACS HMI Visualization Package

MACS HMI Visualization Package

MACS is also available from Moog as a MACS HMI visualization package.
⇨ "11.5 Software" on page 122

MACS HMI can be used only for the visualization of an application program. It does not include any functionality for creating or editing application programs.

4 Environmental Conditions

Environmental Conditions: Safety Instructions

WARNING

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

WARNING

The PC on which the MACS development environment is 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® control system or M3000® modules in a potentially explosive environment.

WARNING

The M3000® control system and M3000® modules must not come into direct contact with liquids. 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.

4.1 Requirements of IEC 61131-2

Environmental Conditions: Requirements of IEC 61131-2

The M3000® control 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:
⇨ "10.2.2 Environmental Conditions" on page 69

ⓘ Refer to the relevant documentation for the specified environmental conditions for the other M3000® modules.

4.2 Use in Special Environments

Limitations of Using M3000® Modules

In the following cases, M3000® modules must **not** be used without taking additional measures:

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

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

5 Mechanical Structure

Categories of M3000® Modules

M3000® modules are divided according to their mechanical construction into the following categories:

- DIN rail modules (such as MSC, QAIO 16/4, or QDIO)
- Other M3000® modules (such as RDISP)

Information about the DIN rail modules:
⇨ "5.1 DIN Rail Modules" on page 28

Refer to the relevant documentation for the dimensions of the other M3000® modules and information about their mounting/removing.

5.1 DIN Rail Modules

5.1.1 Views of the Module

Front View of DIN Rail Modules

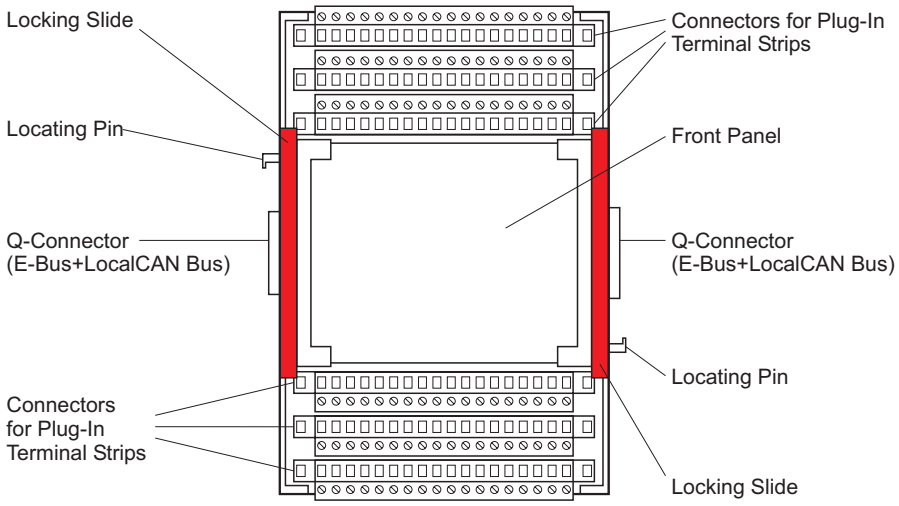


Figure 11: Front View of DIN Rail Modules

Side View of DIN Rail Modules

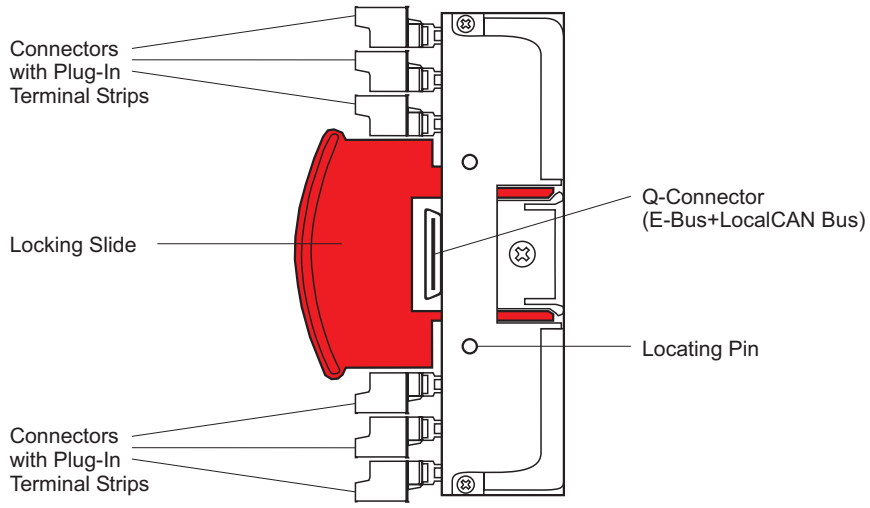


Figure 12: Side View of DIN Rail Modules

5.1.2 Dimensions

Dimensions of DIN Rail Modules

Due to the lateral locating pins, the DIN rail module's installation width will depend on whether it will be installed as a single module, row module, or end module.

	Installed As		
	Individual Module	**Row Module**	**End Module**
Installation Width	Module width + 11 mm (0.43 in) (locating pins protrude at the left and right)	Module width (locating pins disappear into the adjacent modules)	Module width + 5.5 mm (0.22 in) (locating pins protrude on only one side)
Height	170 mm (6.69 in)		
Depth	85.5 mm (3.37 in) (without accessories like mating connectors or plug-in terminal strips) When accessories like mating connectors or plug-in terminal strips are used, an installation depth of 50 mm (2 in) is usually required.		

Table 1: Dimensions of DIN Rail Modules

Refer to the relevant documentation for the overall widths of the various DIN rail modules.

Dimensions of the MSC:
⇨ "10.2 General Specifications" on page 68

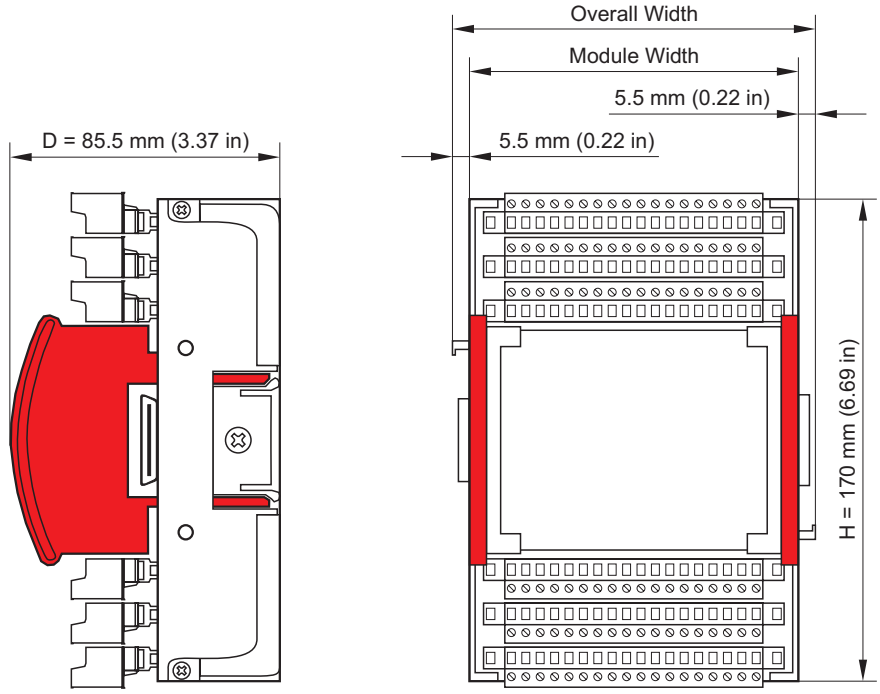


Figure 13: Dimensions of DIN Rail Modules

5.1.3 Arrangement on DIN Top-Hat Rails

WARNING

The vent holes of DIN rail modules facilitate convection cooling and must never be covered!
Covered vent holes might result in overheating and fire.

DIN rail modules must be arranged next to each other on a DIN top-hat rail TH 35-7.5 in accordance with DIN EN 60715.

Arrangement of DIN Rail Modules on a Vertical Mounting Plate

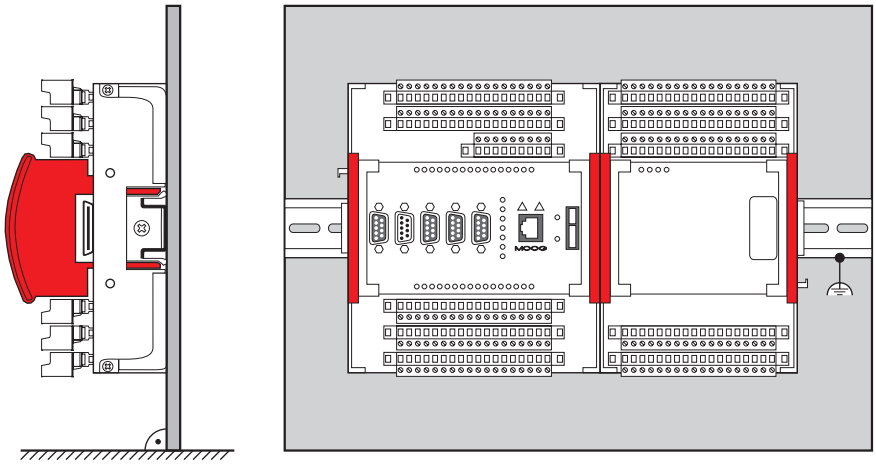


Figure 14: Arrangement of DIN Rail Modules on a Vertical Mounting Plate

The DIN top-hat rail must be attached to a vertical, metal mounting plate and connected to the protective earth conductor.

Additional information about the grounding concept for DIN rail modules:
⇨ "6.1 Grounding Concept" on page 37

Information about mounting/removing DIN rail modules:
⇨ "5.1.4 Mounting and Removing" on page 32

Maintain the minimum distances shown in figure 15 on page 31 to ensure:

- Sufficient room for connecting the supply and signal cables
- Sufficient room for mounting or removing the DIN rail modules
- Convection cooling

If operational reasons force the selection of other arrangements, the performance ratings of the DIN rail modules will decrease or forced cooling measures will be needed.

Additional information about arranging DIN rail modules:
⇨ "7.5.2 E-Bus Groups" on page 60

Arrangement of DIN Rail Modules between Cable Conduits

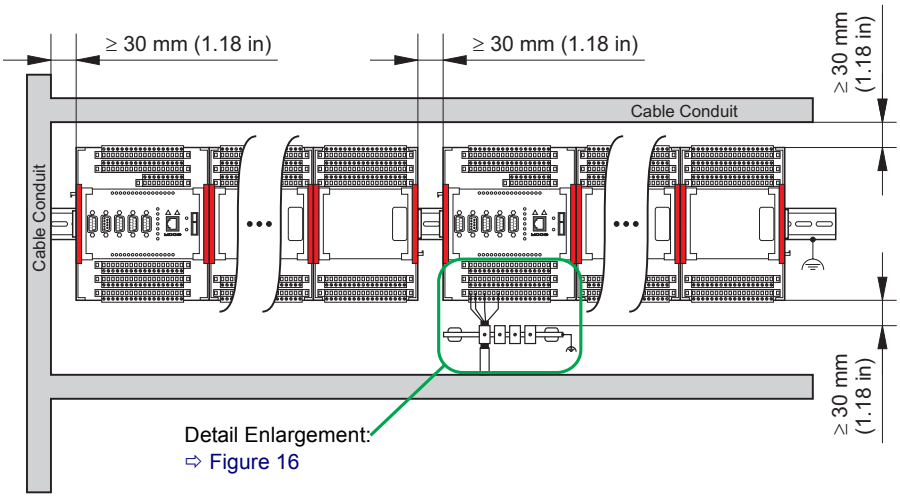


Figure 15: Arrangement of DIN Rail Modules between Cable Conduits

If shielding is required for the signal cables when connecting the signal cables, make sure the distance between the DIN rail modules and the cable conduit is sufficiently large.

Using a Shielding Bar when Connecting a Signal Cable to the MSC

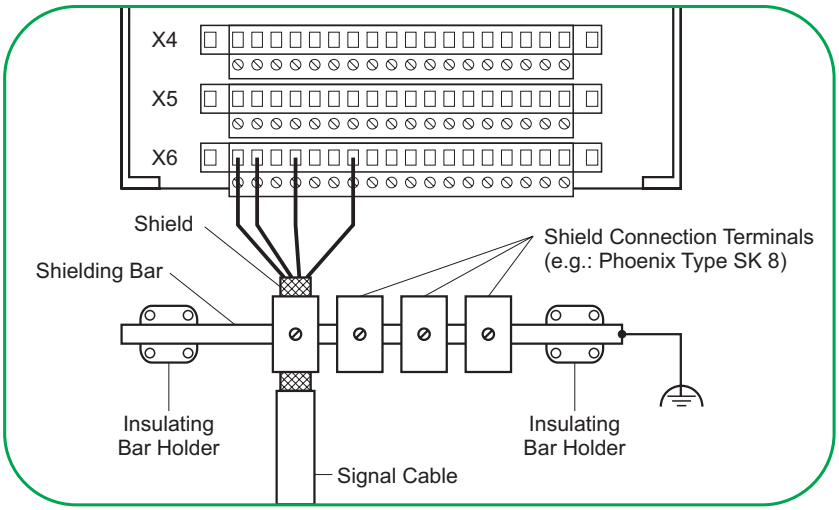


Figure 16: Using a Shielding Bar when Connecting a Signal Cable to the MSC
(Detail from figure 15)

Additional information about shielding signal cables when connecting analog sensors to an MSC:
⇨ "10.12.3.1 Shielding Signal Cables" on page 104

5.1.4 Mounting and Removing

5.1.4.1 Mounting DIN Rail Modules

Mounting DIN Rail Modules: Safety Instructions

WARNING

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

There is a danger of:

- Uncontrolled movements
- Permanent damage
- Malfunctions

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

No tools are needed to mount DIN rail modules.

Mounting DIN Rail Modules

Procedure for mounting DIN rail modules:

1. Unlock the module to be mounted by pulling out the two red locking slides.

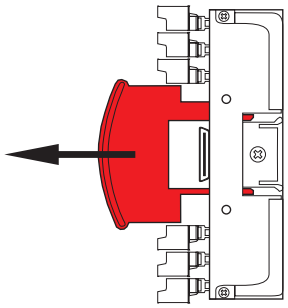


Figure 17: Unlocking a DIN Rail Module

2. If you wish to attach the module next to the right of a previously mounted DIN top-hat rail, then follow step 1 to also unlock the module that is already located on DIN top-hat rail.
   Additional information about arranging the modules:
   ⇨ "5.1.3 Arrangement on DIN Top-Hat Rails" on page 30
   ⇨ "7.5.2 E-Bus Groups" on page 60

CAUTION

To avoid damaging the locating pins of the DIN rail modules, make sure the modules are at least 1 cm apart when placing them on the DIN top-hat rail.

Mounting
DIN Rail Modules

3. Place the module to be mounted on the DIN top-hat rail and carefully push the module towards the DIN top-hat rail until the module engages.

   Do **not yet** push the red locking slides back into the module! If you do push them back in, you will no longer be able to slide the module on the DIN top-hat rail.

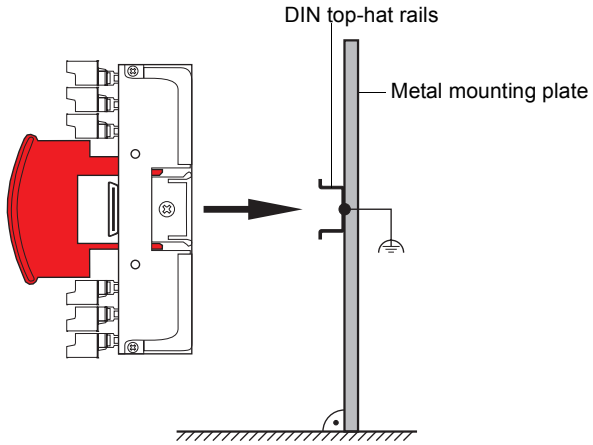


Figure 18: Placing a DIN Rail Module onto a DIN Top-Hat Rail

4. Additional modules can be attached to the right as needed.
   Follow step 1 through step 3 to attach the additional modules.

5. Slide the modules to the left on the DIN top-hat rail until the modules are joined **with no gaps**.
   This establishes contact between the Q-connectors and pushes the locating pins into their mating sockets.

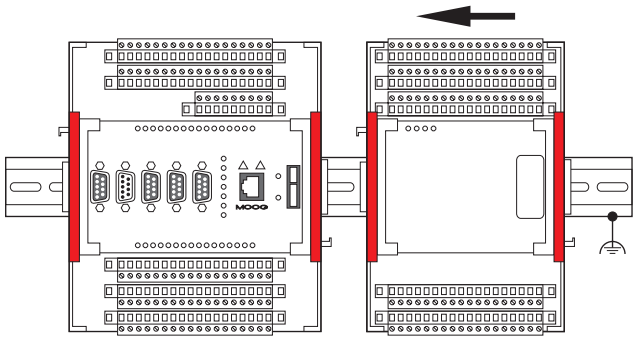


Figure 19: Sliding a DIN Rail Module on a DIN Top-Hat Rail

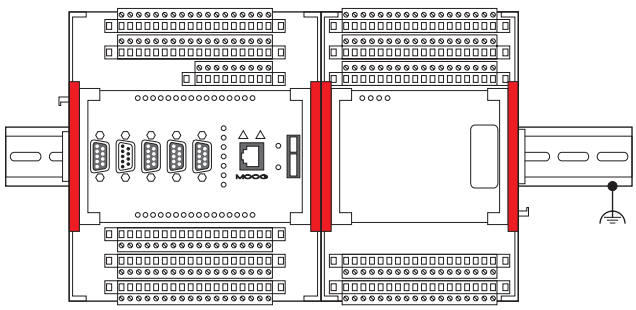


Figure 20: DIN Rail Modules Joined Without Gaps on a DIN Top-Hat Rail

Mounting DIN Rail Modules

6. Push the two red locking slides back into all of the modules. This fixes the modules onto the DIN top-hat rail, establishes an electrical connection with the top-hat rail, and locks the modules together with a secure contact.

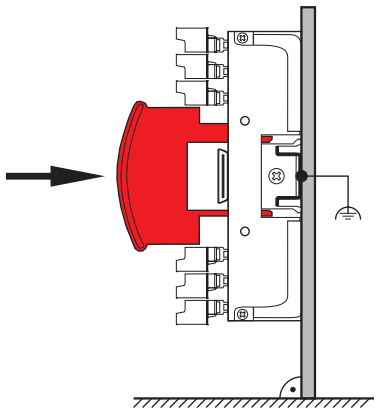


Figure 21: Fixing and Locking a DIN Rail Module

5.1.4.2 Removing DIN Rail Modules

Removing DIN Rail Modules: Safety Instructions

WARNING

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

There is a danger of:

- Uncontrolled movements
- Permanent damage
- Malfunctions

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

No tools are needed to remove DIN rail modules.

Removing DIN Rail Modules

Procedure for removing DIN rail modules:

1. Unlock the module to be removed and, if needed, adjacent modules, by pulling out the two red locking slides.

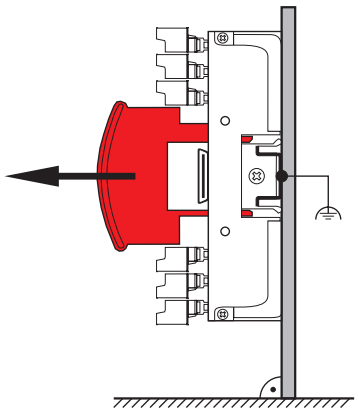


Figure 22: Unlocking a DIN Rail Module

2. Pull the modules at least 1 cm apart.

CAUTION

To avoid damaging the locating pins of the modules, make sure the DIN rail modules are at least 1 cm apart when removing them from the DIN top-hat rail.

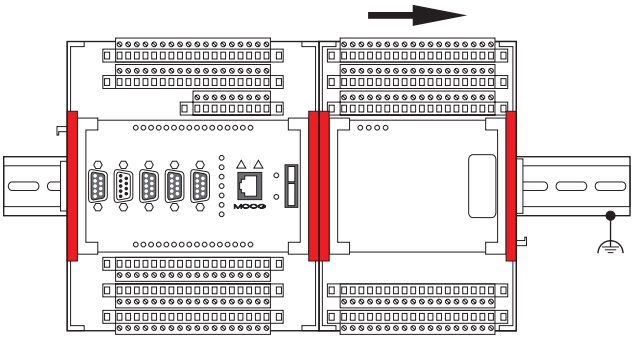


Figure 23: Pulling apart DIN Rail Modules

3. Lift off the module from the DIN top-hat rail.

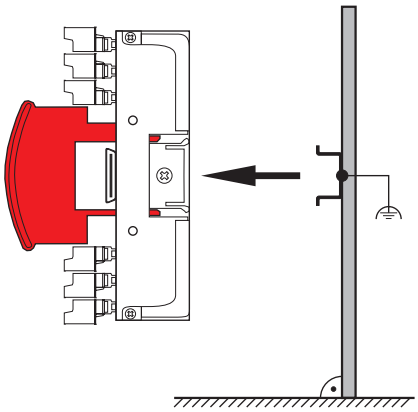


Figure 24: Lifting off a DIN Rail Module from the DIN Top-Hat Rail

6 Project Planning and Installation

Project Planning and Installation

The following instructions must be observed in order to ensure that the M3000® control 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 (DIN 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 control system.
- **Power supply 24 V DC**
  M3000® modules must be supplied only with 24 V DC SELV (Safety Extra-Low Voltage) according to DIN EN 60950-1.
  ⇨ "6.2.1 Power Supply Characteristics" on page 38
- **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® control system.

6.1 Grounding Concept

Grounding Concept

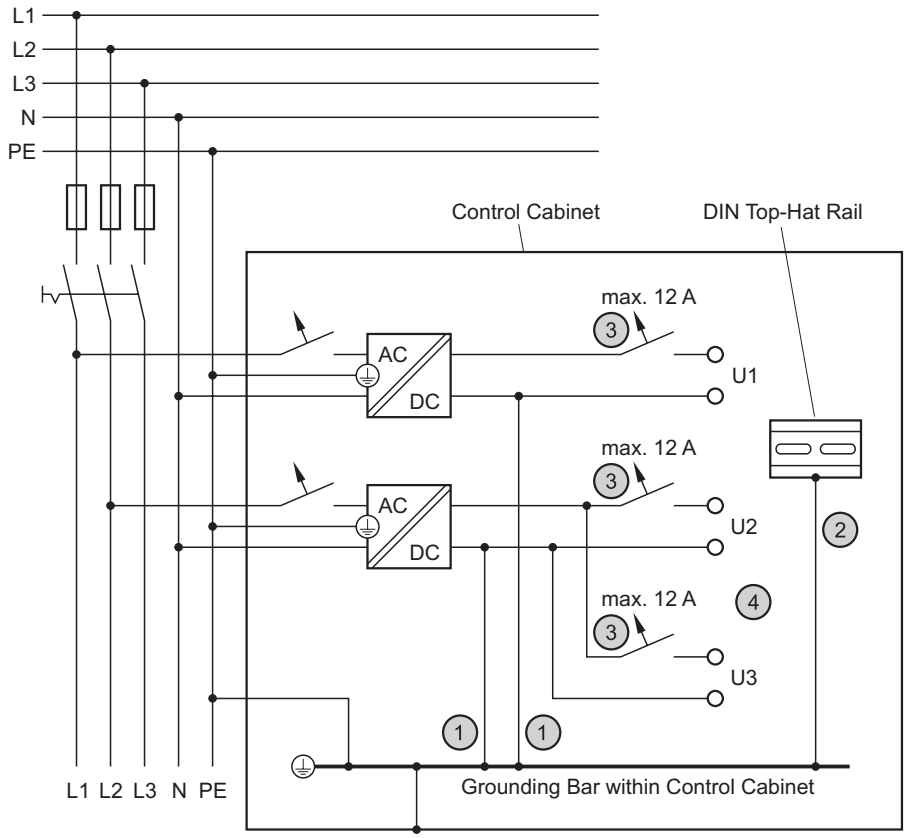


Figure 25: Grounding Concept

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

(2) The DIN top-hat rail must have a low resistance connection to the protective earth conductor (PE). It is essential that the DIN top-hat rail is grounded over a connection with the largest possible cross section.

(3) Every circuit must be fused (maximum 12 A).

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

6.1.1 Front Panel Connectors' Signal Grounding

Front Panel Connectors' Signal Grounding

The metal housings of all front panel connectors of the MSC are connected internally (in a **capacitive** manner) to the signal grounding of the DIN top-hat rail.
The metal housings of the front panel connectors of the other DIN rail modules are connected **directly** to the signal grounding of the DIN top-hat rail.

6.2 Power Supply

Power Supply for M3000® Modules

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:
⇨ "6.2.3 Connecting the Power Supply" on page 39

Power supply terminals of the MSC:
⇨ "10.4.1 Terminal Assignment" on page 73

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

6.2.1 Power Supply Characteristics

Power Supply Characteristics of M3000® Modules

Output voltage

Rated voltage: 24 V DC, operates at no-load
SELV according to DIN EN 60950-1
⇨ "6.2.1.1 Safety Extra-Low Voltage (SELV)" on page 38

Run-up time (10–90 %): ≤ 0.2 sec.

ⓘ In the interest of 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 12 A, the power cable to each M3000® module must be fused to ≤ 12 A or the current must be limited in another way.

Maximum permissible duration of power interruptions

Under full load (PS2 intensity): ≤ 10 ms
(duration of interruption during voltage drops and interruptions to the input voltage)

ⓘ During primary side voltage drops that are 10 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.

6.2.1.1 Safety Extra-Low Voltage (SELV)

Safety Extra-Low Voltage (SELV)

The safety extra-low voltage is a voltage that will not, under any operating conditions, exceed 42.4 V 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.

6.2.2 Power Consumption by DIN Rail Modules

Power Consumption by DIN Rail Modules

DIN Rail Module		Power Consumption [1]	
		From 24 V DC (No-Load [2])	From 24 V DC (Full Load)
MSC	**Internal Electronics**	about 0.5 A	max. 2 A
	Digital Outputs	-	max. 4 A
RDIO		max. 300 mA	max. 10 A
QDIO		-	max. 10 A
QAIO 16/4		about 150 mA	max. 300 mA

Table 2: Power Consumption by DIN Rail Modules

[1] These values are provided only as guidelines for estimating the amount of current required. Refer to the relevant documentation for the exact power consumption by DIN rail modules.

[2] No-load, i.e., there are no loads, external to the module, drawing current.

6.2.3 Connecting the Power Supply

Connecting the Power Supply: Safety Instructions

DANGER

The L2+/M2 power supply terminals of the MSC type D136E001-001 are not protected against reverse polarity (in deviation from the requirements of IEC 61131-2). Reverse polarity on terminals L2+ and M2 will lead to permanent damage to the MSC!

The L2+/M2 power supply terminals of the other MSC types are protected against reverse polarity.
The L1+/M1 power supply terminals of all MSC types and the power supply terminals of the other M3000® modules are protected against reverse polarity.
If the polarity of these power supply terminals is reversed, the modules will not function.

WARNING

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

There is a danger of:

- Uncontrolled movements
- Permanent damage
- Malfunctions

Before performing any work on the M3000® control system or M3000® modules, it is essential that the system be stopped and the power supply 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 DIN rail 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 3 on page 40):

- Reverse energization from sensor to module
- Invalid sensor data

Power Supply for the Module's Internal Electronics and the Sensors

	Power Supply	
	Internal Electronics	**Sensors**
Module and sensors are in operation	on	on
Reverse energization from sensor to module	off	on
Invalid sensor data	on	off
Module and sensors are not in operation	off	off

Table 3: Power Supply Conditions of the Module's Internal Electronics and the Sensors

Power supply terminals of the MSC:
⇨ "10.4.1 Terminal Assignment" on page 73

Refer to the relevant documentation for information about the power supply terminals of the other M3000® 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 DIN rail module. The duration of these spikes is strongly dependent on the internal resistance of the power supply.

6.2.3.1 Connecting to Several Power Supplies

Correct Connection of DIN Rail Modules to Several Power Supplies

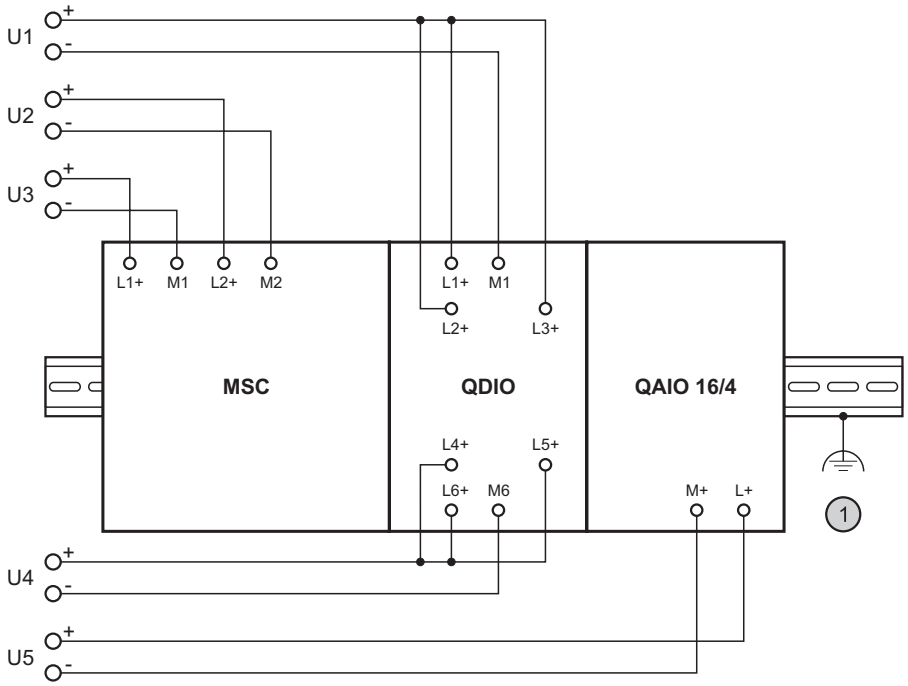


Figure 26: Correct Connection of DIN Rail Modules to Several Power Supplies

(1) DIN rail modules do not have any protective earth conductor terminals. However they are conductively connected to the DIN top-hat rail after they are engaged and locked onto it. The DIN rail modules thereby receive signal grounding. ⇨ "6.1 Grounding Concept" on page 37

6.2.3.2 Connecting to a Single Power Supply

Assuming that the power limits are observed, the internal electronics of DIN rail modules and the attached sensors may also be supplied from a single power supply.

Correct Connection of DIN Rail Modules to a Single Power Supply

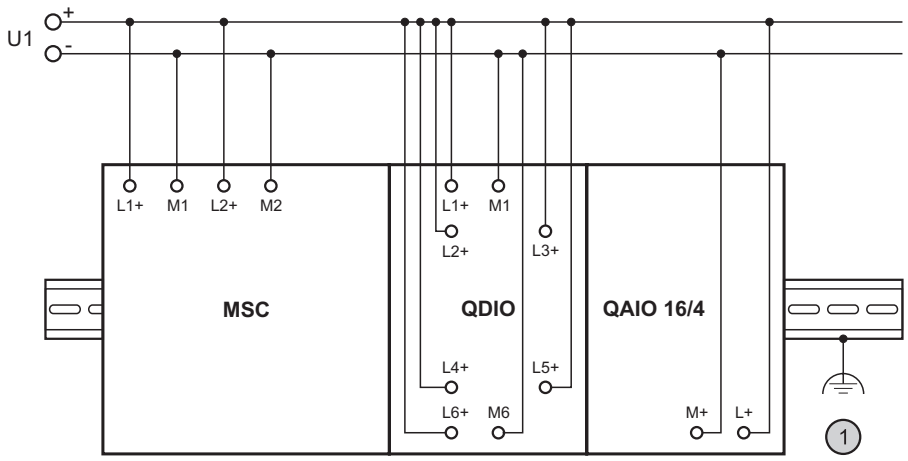


Figure 27: Correct Connection of DIN Rail Modules to a Single Power Supply

(1) DIN rail modules do not have any protective earth conductor terminals. However they are conductively connected to the DIN top-hat rail after they are engaged and locked onto it. The DIN rail modules thereby receive signal grounding. ⇨ "6.1 Grounding Concept" on page 37

6.2.3.3 Maximum Admissible Current

Maximum Admissible Current for M3000® Modules

All of the power supply terminals of M3000® modules and the associated internal connections are designed for a maximum current of 12 A.

If the current is greater than the maximum current, the following must be employed:

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

6.2.4 Connecting Sensors

Connecting Sensors: Safety Instructions

DANGER

The L2+/M2 power supply terminals of the MSC type D136E001-001 are not protected against reverse polarity (in deviation from the requirements of IEC 61131-2). Reverse polarity on terminals L2+ and M2 will lead to permanent damage to the MSC!

The L2+/M2 power supply terminals of the other MSC types are protected against reverse polarity.
The L1+/M1 power supply terminals of all MSC types and the power supply terminals of the other M3000® modules are protected against reverse polarity.
If the polarity of these power supply terminals is reversed, the modules will not function.

WARNING

The internal electronics of DIN rail 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 3 on page 40):

- Reverse energization from sensor to module
- Invalid sensor data

WARNING

Sensors that are connected to digital inputs of DIN rail modules with several I/O groups, such as MSC, QDIO, or RDIO, must under all conditions 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

Correct Power Supply Connection of Sensors via a QDIO

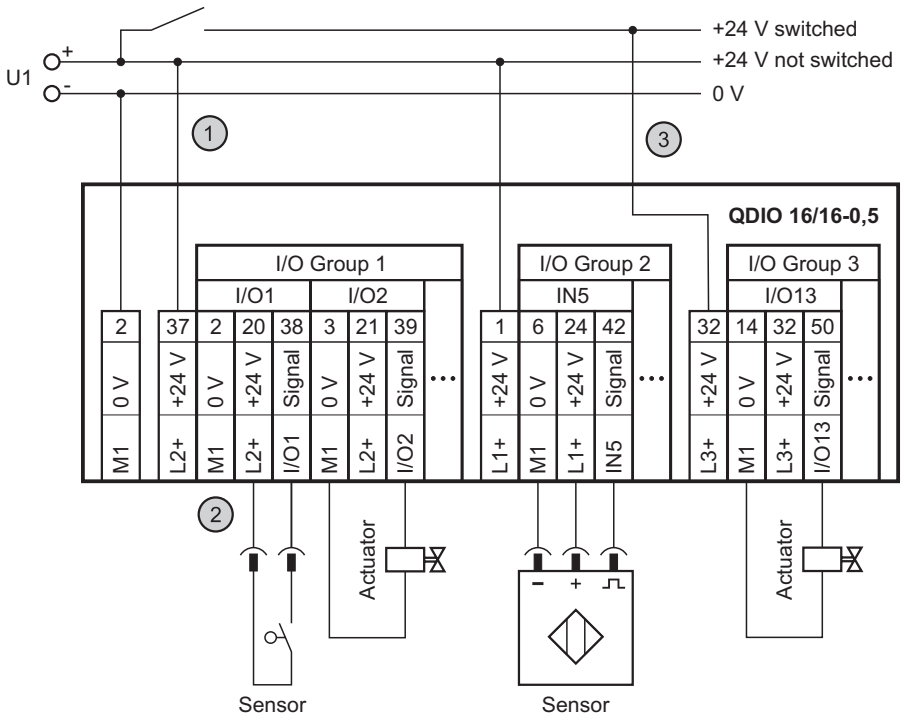


Figure 28: Correct Power Supply Connection of Sensors via a QDIO

(1) The attached sensors must be supplied with power from a permanently connected (unswitched) power supply that cannot be individually switched off, without switching off the module's power supply.
Power must not, as shown in figure 29 on page 44, be supplied from switched power circuits!

(2) The sensors within an I/O group must always be supplied with power from the same power supply that supplies the relevant I/O group.
They must not, as shown in figure 29 on page 44, be supplied from a separate power supply (due to the danger of reverse energization)!

(3) Outputs may be supplied with power from a switched power supply, for example with intermediate devices (emergency stop, manual operation, etc.).

Wrong Power Supply Connection of Sensors via a QDIO

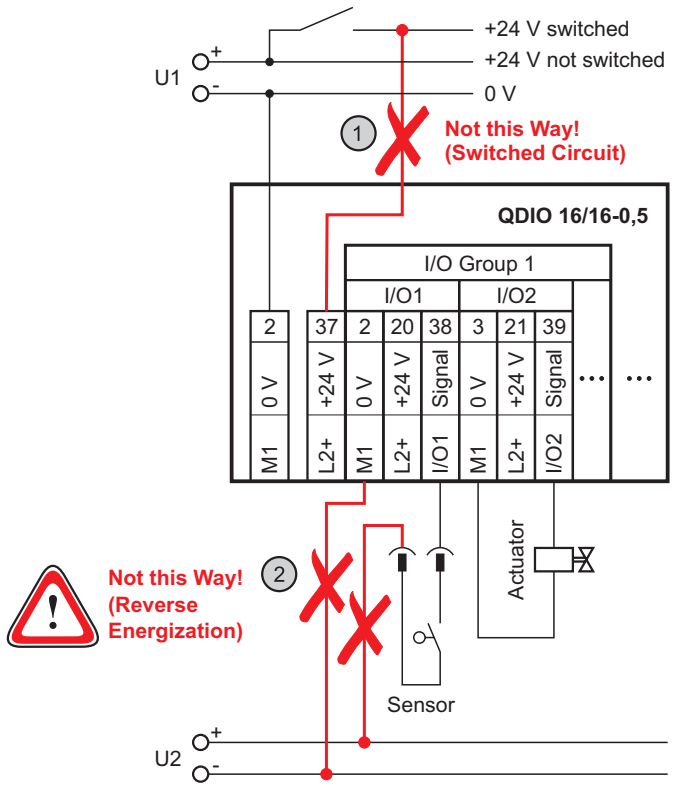


Figure 29: Wrong Power Supply Connection of Sensors via a QDIO

(1) The attached sensors must be supplied with power from a permanently connected (unswitched) power supply that cannot be individually switched off, without switching off the module's power supply.
Power must not, as shown here, be supplied from switched power circuits!

(2) The sensors within an I/O group must always be supplied with power from the same power supply that supplies the relevant I/O group.
They must not, as shown here, be supplied from a separate power supply (due to the danger of reverse energization)!

6.3 Connecting Signal Cables

Connecting Signal Cables: Safety Instructions

WARNING

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

There is a danger of:

- Uncontrolled movements
- Permanent damage
- Malfunctions

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

Connecting Signal Cables over Plug-In Terminal Strips

The signal cables of DIN rail modules are connected over plug-in terminal strips that are inserted into the relevant connectors on the front of the module.

6.3.1 Plug-In Terminal Strips

Connection Methods for Plug-In Terminal Strips of DIN Rail Modules

Plug-in terminal strips for the following methods are available from Moog:

- Screw terminals
- Spring loaded terminals

All plug-in terminal strips are suitable for wire cross sections of up to 2.5 mm² (14 AWG).
⇨ "11.8 Plug-In Terminal Strips" on page 124

6.3.1.1 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

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.

7 Networking M3000® Modules

7.1 Ethernet

Refer to the following for information about using the Ethernet interface to facilitate communication between the MSC control module and the MACS development environment:
⇨ "3.1 M3000® System Architecture" on page 15
⇨ "10.5.1 Communication Between MSC and MACS" on page 80
⇨ "10.5.1.2 Ethernet Communication Interface" on page 81

7.1.1 Peer-to-Peer Connections

Peer-to-Peer Connection of 2 Network Stations

To establish a peer-to-peer connection between 2 stations in an Ethernet network, 10BaseT cables with **crossed** twisted pair wires are needed. The connectors should be indirectly wired, pole 1 to pole 3, pole 2 to pole 6, etc.
⇨ Figure 32 on page 47

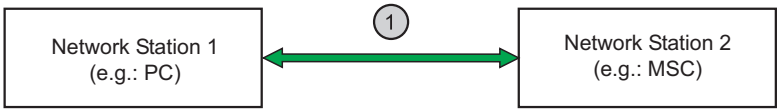


Figure 30: Ethernet Network with exactly 2 Network Stations

(1) 10BaseT cables with **crossed** twisted pair wires

7.1.2 Networking of More Than 2 Network Stations

Ethernet Network with more than 2 Network Stations

A hub is needed for Ethernet networks that have more than 2 stations. The hub transfers the signals sent from one of the stations to every other station in the network. All network stations must be connected radially to the hub using 10BaseT cables with **non-crossed** twisted pair wires. The connectors should be directly wired, pole 1 to pole 1, pole 2 to pole 2, etc.
⇨ Figure 33 on page 47

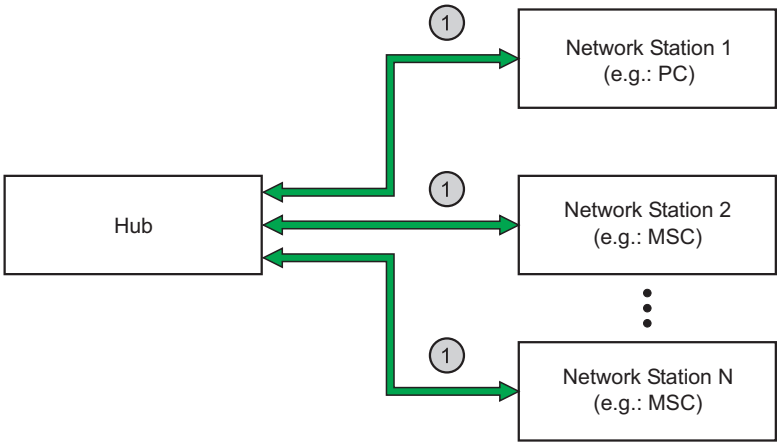


Figure 31: Ethernet Network with more than 2 Network Stations

(1) 10BaseT cables with **non-crossed** twisted pair wires

7.1.3 Ethernet Interface Cables

10BaseT Cable with Crossed Twisted Pair Wires

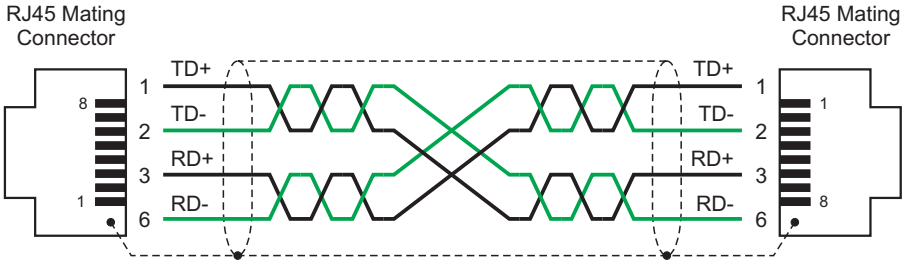


Figure 32: 10BaseT Cable with Crossed Twisted Pair Wires
with 8 Pole RJ45 Mating Connectors, Cable Category 5, Wire Cross Section > 0.22 mm² (24 AWG)

10BaseT Cable with Non-Crossed Twisted Pair Wires

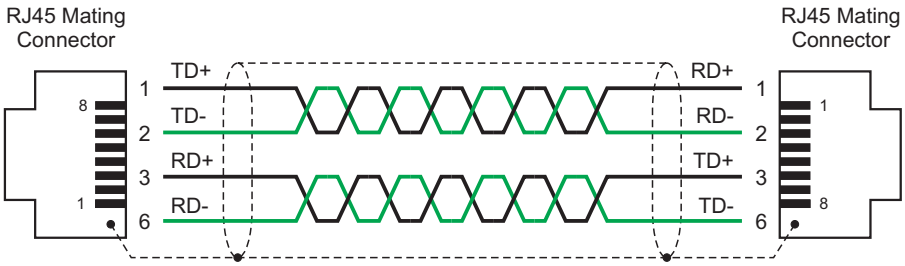


Figure 33: 10BaseT Cable with Non-Crossed Twisted Pair Wires
with 8 Pole RJ45 Mating Connectors, Cable Category 5, Wire Cross Section > 0.22 mm² (24 AWG)

For the terminal assignment of the Ethernet front panel connector of the MSC control module, see: ⇨ Ethernet connector on page 77

7.2 Serial TIA/EIA Interface Cables

Serial TIA/EIA Interface Cables

The following variants of serial TIA/EIA interface cables are possible:

- **Null modem cables**
  ⇨ "7.2.1 TIA/EIA 232 Interface Cables" on page 48
  ⇨ "7.2.2 TIA/EIA 422 Interface Cables" on page 49
- **Interface cables with 1:1 connection**
  For example: when connecting terminals or displays
  ⇨ "7.2.1 TIA/EIA 232 Interface Cables" on page 48
  ⇨ "7.2.2 TIA/EIA 422 Interface Cables" on page 49
  ⇨ "7.2.3 TIA/EIA 485 Interface Cables" on page 49

7.2.1 TIA/EIA 232 Interface Cables

A TIA/EIA 232 null modem cable can be used as a programming cable to connect the MSC and PC.

TIA/EIA 232 Null Modem Cable (Programming Cable)

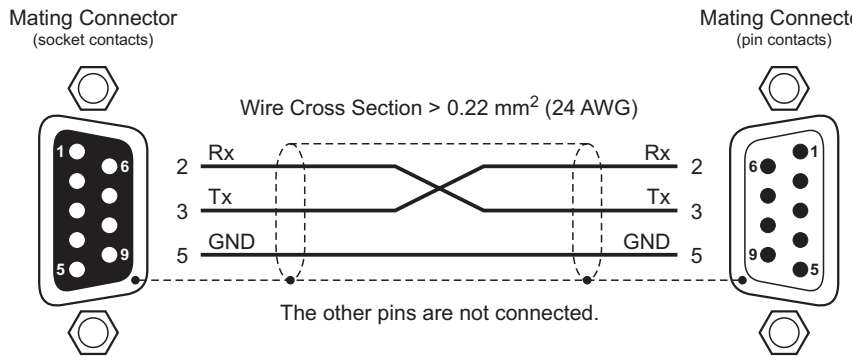


Figure 34: TIA/EIA 232 Null Modem Cable (Programming Cable) with 9 Pole D-Sub Mating Connectors according to DIN 41652

TIA/EIA interface cables with 1:1 connection can be used to connect terminals or displays.

TIA/EIA 232 Interface Cable with 1:1 Connection

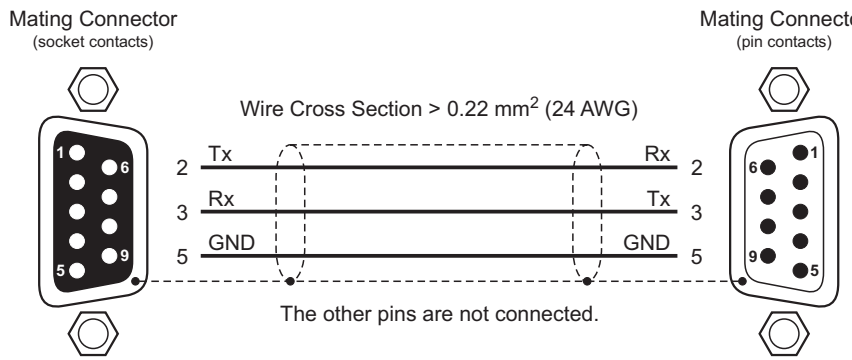


Figure 35: TIA/EIA 232 Interface Cable with 1:1 Connection with 9 Pole D-Sub Mating Connectors according to DIN 41652

7.2.2 TIA/EIA 422 Interface Cables

TIA/EIA 422 Null Modem Cable

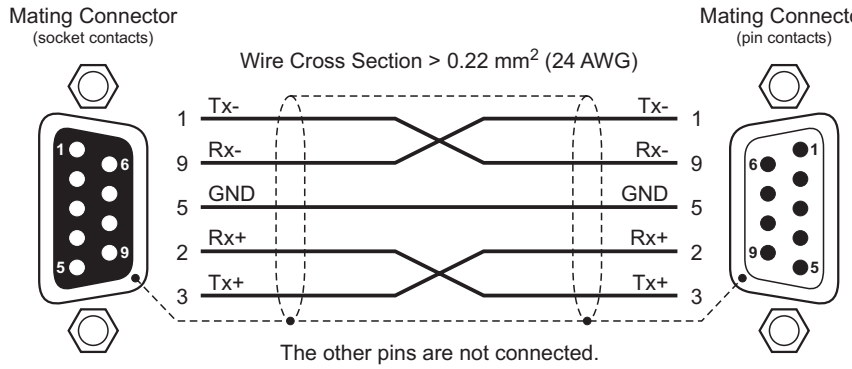


Figure 36: TIA/EIA 422 Null Modem Cable
with 9 Pole D-Sub Mating Connectors according to DIN 41652

TIA/EIA interface cables with 1:1 connection can be used to connect terminals or displays.

TIA/EIA 422 Interface Cable with 1:1 Connection

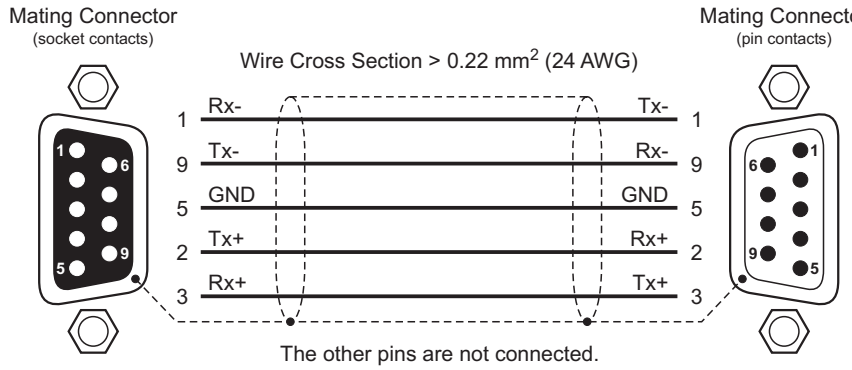


Figure 37: TIA/EIA 422 Interface Cable with 1:1 Connection
with 9 Pole D-Sub Mating Connectors according to DIN 41652

7.2.3 TIA/EIA 485 Interface Cables

TIA/EIA interface cables with 1:1 connection can be used to connect terminals or displays.

TIA/EIA 485 Interface Cable with 1:1 Connection

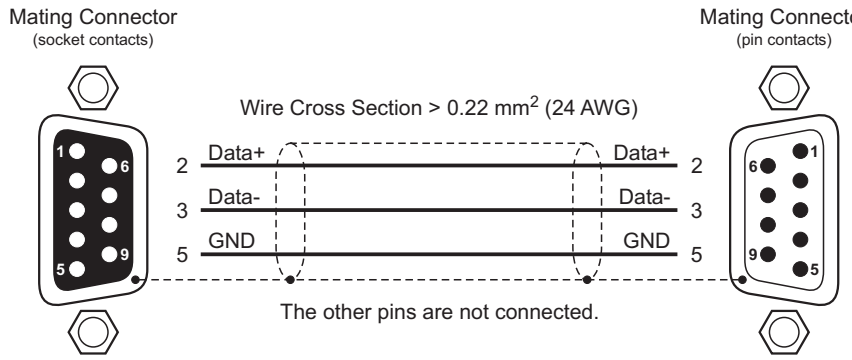


Figure 38: TIA/EIA 485 Interface Cable with 1:1 Connection
with 9 Pole D-Sub Mating Connectors according to DIN 41652

7.3 CAN Bus and CANopen

7.3.1 CAN Bus

CAN Bus

The CAN bus is a differential two wire bus that was originally developed to facilitate rapid and reliable networking of components in motor vehicles.
The many advantages and high reliability of the CAN bus have also made it suitable for use in automation systems and have contributed to it becoming a widespread standard.

7.3.2 CAN Bus Characteristics

CAN Bus Characteristics

CAN bus exhibits the following characteristics:

- Linear topology that can be structured hierarchically
- Message oriented protocol
- Prioritization of messages
- Multi master capability
- Zero loss bus arbitration
- Short block length
- High security of data transmission with very short error recovery times
- Network data consistency
- Detection and disconnection of defective network stations
- Short reaction time for high priority messages
- Standardization (ISO/DIS 11898)
- Cost effective protocol implementation

CAN bus network stations can exchange messages between each other in real time over the CAN bus. For example, set points, actual values, control messages, status messages, as well as configuration and parameter data can be transmitted over the CAN bus.

Identifiers act as message labels in the CAN protocol. The messages can be received by all network stations simultaneously, which is very important for consistency of the data in the network and synchronization of the applications. The identifier determines the message's bus access priority.

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

7.3.3 CANopen

CANopen

CANopen is a standardized communications profile that makes it easy to establish a network of CANopen compatible devices from a variety of manufacturers.
CANopen is based on CAN bus. The communication profile complies with the standard CiA DS 301.

CANopen Device Profiles

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

7.3.4 M3000® Modules with CAN Bus Interfaces

M3000® Modules with CAN Bus Interfaces

M3000® Module		Number of Connectors	Number of CAN Bus Controllers	CAN Bus Termination Resistor
MSC	**LocalCAN**	2 Q-connectors (lateral)	1	switchable
	WideCAN	2 D-sub front panel connectors [1)]	1	-
RDIO		2 D-sub front panel connectors [1)]	1	-
RTEMP		2 Q-connectors (lateral) 2 D-sub front panel connectors [1)]	1	-
RDISP		1 D-sub connector (on the rear)	1	switchable
QCAN	**LocalCAN**	1 Q-connector (lateral) 1 D-sub connector (front)	0	fix

Table 4: M3000® Modules with CAN Bus Interfaces

[1)] The «WCAN» or «CAN» front panel connectors are connected internally 1:1 with each other. As a result, the M3000® module can be connected directly to the CAN bus without a T-adapter.

ⓘ The M3000® modules mentioned here represent only a part of Moog's current product range. In addition to other M3000® modules, Moog's product range includes a large variety of accessories.
⇨ "11 Product Range" on page 118

Information about the CAN bus interface cable:
⇨ "7.3.6 CAN Bus Interface Cable" on page 54

Information about the CAN bus interfaces of the MSC:
⇨ "10.15 CAN Bus Interfaces" on page 113

ⓘ Refer to the relevant documentation for detailed information about the CAN bus interfaces of the other M3000® modules.

7.3.5 CAN Bus Networks

7.3.5.1 Wiring

Wiring CAN Bus Networks

Always observe the following when wiring CAN bus networks:

- **ISO/DIS 11898**
  The cables, mating connectors, and termination resistors used in CAN bus networks must comply with ISO/DIS 11898.
- **Specifications for interface cables**
  When connecting CAN bus network stations, always use shielded cables with 4 twisted pair wires and an impedance of 120 Ω.
  ⇨ "7.3.6 CAN Bus Interface Cable" on page 54
- **Linear structure of CAN bus**
  Avoid branching. Short stub cables with a T-adapter are permitted.
  ⇨ "7.3.5.2 Bus Structure of the CAN Bus" on page 53
- **Stub cables as short as possible**
  Maximum stub cable length: ⇨ table 6 on page 54
- **CAN bus termination resistors**
  At both ends of the CAN bus, a termination resistor of 120 Ω ± 10 % must be connected between CAN_L and CAN_H.
- **Adapt transmission rate to cable length**
  It is necessary to adapt the transmission rate to the length of the CAN bus interface cable.
  ⇨ Table 5 on page 54
- **Sources of interference**
  Do not lay CAN bus interface cables in direct proximity to sources of interference. If this cannot be avoided, double shielded interface cables must be used.
- **Potential equalization at only one point**
  The CAN_GND and CAN_SHLD reference potential may be connected to the signal ground at only one point (at a CAN bus termination resistor, for example).
  ⇨ Figure 39 on page 53
- **Grounding**
  The power supply for M3000® modules must be grounded at the same point as the CAN_GND wire.

7.3.5.2 Bus Structure of the CAN Bus

The CAN bus has a linear structure. Avoid branching. Short stub cables with a T-adapter are permitted.

Linear Structure of the CAN Bus

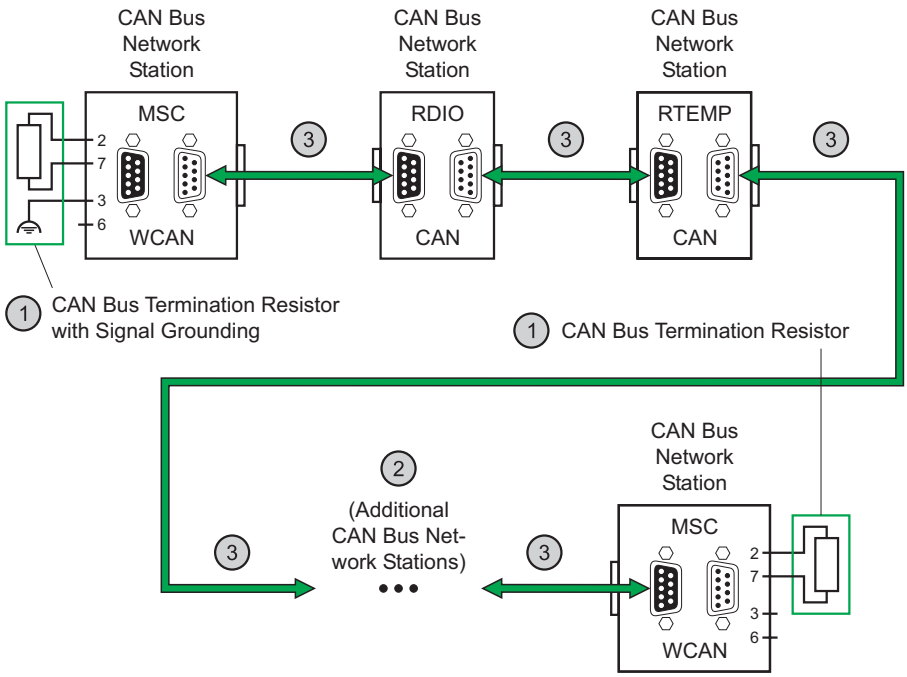


Figure 39: Linear Structure of the CAN Bus
with CAN Bus Termination Resistors and Potential Equalization

1. D-sub connectors with CAN bus termination resistors are available from Moog.
   ⇨ "11.7 CAN Bus Accessories" on page 123
2. CAN bus networks with M3000® modules can only include a maximum of 64 CAN bus network stations.
   ⇨ "7.3.5.3 Number of Network Stations" on page 53
3. CAN bus interface cable
   ⇨ "7.3.6 CAN Bus Interface Cable" on page 54

7.3.5.3 Number of Network Stations

CAN Bus Networks with M3000® Modules: max. 64 Network Stations

CAN bus networks with M3000® modules can only include a maximum of 64 CAN bus network stations.

ISO/DIS 11898 only specifies networks with up to 30 CAN bus network stations.
As a result, when integrating non-system products into a CAN bus network with M3000® modules, the maximum number of CAN bus network stations might be limited by any existing, older CAN bus drivers.

7.3.6 CAN Bus Interface Cable

7.3.6.1 Terminal Assignment

CAN Bus Interface Cable

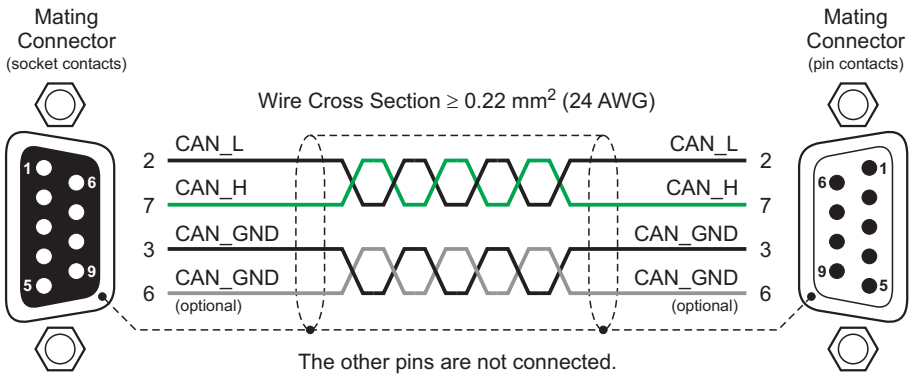


Figure 40: CAN Bus Interface Cable
with 9 Pole D-Sub Mating Connectors according to DIN 41652

To ensure disturbance-free operation, it is required that a CAN_GND wire is used in the cable.

Terminal assignment of the CAN connectors on the front panel of the MSC control module: ⇨ "10.4.1 Terminal Assignment" on page 73

7.3.6.2 Cable Lengths

The maximum expansion of a CAN bus network will be determined by a variety of variables, such as cable length, transmission rate, and resistance in the cable.

Maximum Cable Lengths in CAN Bus Networks

Transmission Rate	Maximum Cable Length
1,000 kBit/s	25 m (27 yd)
800 kBit/s	50 m (54 yd)
500 kBit/s	100 m (109 yd)
250 kBit/s	250 m (273 yd)
125 kBit/s	500 m (546 yd)
100 kBit/s	650 m (710 yd)
50 kBit/s	1,000 m (1,093 yd)
20 kBit/s	2,500 m (2,734 yd)
10 kBit/s	5,000 m (5,468 yd)

Table 5: Maximum Cable Lengths in CAN Bus Networks (Depending on the Transmission Rate)

Permissible Stub Cable Lengths in CAN Bus Networks

Transmission Rate	Maximum Stub Cable Length	
	Maximum	Cumulated
1,000 kBit/s	2 m (2.1 yd)	20 m (21.8 yd)
500 kBit/s	6 m (6.5 yd)	39 m (42.6 yd)
250 kBit/s	6 m (6.5 yd)	78 m (85.3 yd)
125 kBit/s	6 m (6.5 yd)	156 m (170.6 yd)

Table 6: Maximum Permissible Stub Cable Lengths in CAN Bus Networks

ⓘ The guiding values in tables 5 and 6 are valid only for CAN bus networks that were established in compliance with the requirements in "7.3.5.1 Wiring" on page 52.

7.3.6.3 Suitable Cables

Suitable Cables for CAN Bus Interface Cables

Parameters	M3000® Recommendation	Remarks
Number of Wires	≥ 4, twisted pairs	
Wire Cross Section (for Cu)	0.22–0.34 mm² (24–22 AWG)	When the network is spread out over a greater distance, a larger wire cross section will provide a better signal-to-noise ratio.
Cable Structure	2 twisted pairs with shielding	Electrically connect the shield to the mating connector's housing and the shielding shroud of the plug-in devices.
Impedance (1 MHz)	120 Ω	If different cables are used, make sure they have the same impedance.

Table 7: Suitable Cables for CAN Bus Interface Cables

The selection of a suitable cable also depends on site conditions (towing application, environmental considerations, etc.)

ⓘ For normal use Moog recommends the CAN bus data cable "UNITRONIC® BUS LD“ supplied by LAPP KABEL (http://www.lapp.de) or "577 FlexLife™ Thin Cable“ or the "5710 FlexLife™ Mid Cable“ or the "575 FlexLife™ Thick Cable“ supplied by Hans Turck GmbH & Co. KG (http://www.turck.com).

ⓘ CAN bus interface cables are available from Moog as accessories, in a variety of lengths.
⇨ "11.6 Interface Cables" on page 123

7.4 E-Bus

E-Bus

Communication within E-bus groups is done over the E-bus.

Notes on establishing E-bus groups:
⇨ "7.5.2 E-Bus Groups" on page 60

Examples of E-bus groups:
⇨ "7.5.2.1 Examples" on page 61

7.4.1 E-Bus Interface

E-Bus Interface

The E-bus interface is set up as a serial cyclic shift register. Every communication cycle reserves for each extension module four bytes each in the send and receive messages.

Q-Connector

The 40 pole Q-connectors are located laterally on the DIN rail modules that have an E-bus interface.
When the modules are joined with no gaps and are locked on the DIN top-hat rail, the E-bus connection will be properly established over the Q-connectors.

Views of DIN rail modules:
⇨ "5.1.1 Views of the Module" on page 28

Mounting DIN rail modules:
⇨ "5.1.4.1 Mounting DIN Rail Modules" on page 32

E-bus interface of the MSC:
⇨ "10.14 E-Bus Interface" on page 112

7.4.2 E-Bus Communication

E-Bus Communication

Communication within E-bus groups takes place exclusively between the E-bus master and the E-bus slaves.
The master sends E-bus messages with output data to the slaves within its E-bus group and receives from the slaves E-bus messages with input data.
Direct communication between the slaves of an E-bus group over the E-bus is not possible.

7.4.2.1 E-Bus Master and E-Bus Slaves

The following DIN rail modules can be employed as E-bus master in an E-bus group:

- MSC
- RDIO

Permissible Masters and Slaves in E-Bus Groups

Permissible Masters	Permissible Slaves		Remarks
	Number	Modules	
MSC	7	I/O extension modules, such as QAIO 16/4 and QDIO (E-bus must be carried through on the Q-connector)	E-bus groups with MSCs as masters function as stand-alone groups. Configuration of the E-bus interface of the MSC and the slaves: ⇨ "10.14.1 Configuration of the E-Bus Interface" on page 112
RDIO	6	QDIOs ⓘ Other M3000® modules must not be attached to an RDIO!	E-bus groups with RDIOs as master must be actuated over the CAN bus.

Table 8: Permissible Masters and Slaves in E-Bus Groups

The duration of transmission of E-bus messages is not influenced by the number of DIN rail modules in the E-bus group.
⇨ "7.4.3.3 Duration of Transmission of E-Bus Messages" on page 57

7.4.3 MSC as E-Bus Master

7.4.3.1 Starting the E-Bus Communication

Starting the E-Bus Communication

Immediately after logging in with the MACS development environment, the E-bus configuration contained in the PLC configuration will be transferred to the MSC. If slaves are set in the E-bus configuration, the MSC checks whether the configured slaves are actually attached. Communication over the E-bus is possible only when the slaves actually attached correspond with the arrangement set in the PLC configuration. Otherwise, an error message will be displayed in the MACS development environment.

The E-bus communication will be started automatically after an application program is started. If communication over the E-bus is successful, the LED «Ebus» will illuminate on the front panel of the MSC.
⇨ "10.4.2 LEDs" on page 77

If an error occurs during the communication or if the digital output 'Outputs Enabled' of the MSC is switched to the 0 state, the E-bus communication will be terminated and the LED «Ebus» will be turned off.
⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116

7.4.3.2 Update Rate of E-Bus Messages

WARNING

The I/O extension modules QDIO and QAIO 16/4 monitor the E-bus activity and disable their outputs if they do not receive an E-bus message more frequently than 50 ms.

To avoid this, go to the MACS development environment and set the value of the task interval or the value of 'UpdateRate' so that the product of the two values is less than 50 ms.

E-Bus Communication: Message Update Rate

The update rate setting of the E-bus depends on the task interval. The shortest task interval, set in the task configuration, serves as the time basis for the E-bus.

The update rate is defined by setting the E-bus module parameter 'UpdateRate' in the PLC configuration of the MACS development environment. 'UpdateRate' can be set so that an E-bus message will always be sent at the end of this task's cycle (or after 2, 3, 5, 10, 15 or 20 cycles).

Shortest Task Interval	E-Bus Module Parameter 'UpdateRate'	Update Rate of E-Bus Messages
1 ms	'every third cycle'	An E-bus message is started cyclically every 3 ms (1 ms * 3).
10 ms	'every tenth cycle'	An E-bus message would be started cyclically every 100 ms (10 ms * 10). However, since no E-bus message is sent more frequently than 50 ms, the I/O extension modules will disable their outputs. The outputs will be re-enabled with the next E-bus message.

Table 9: Update Rate of E-Bus Messages

7.4.3.3 Duration of Transmission of E-Bus Messages

E-Bus Communication: Duration of Message Transmission

The duration of transmission of the E-bus message, i.e., the length of time required to transmit the E-bus message, is determined by the E-bus clock frequency. The E-bus clock frequency is defined by setting the E-bus module parameter 'Frequency' in the PLC configuration of the MACS development environment.

- Clock frequency = 10 MHz ➙ Duration of transmission = 42 µs
- Clock frequency = 5 MHz ➙ Duration of transmission = 84 µs

The selected E-bus clock frequency does not influence the time required to execute the tasks.

ⓘ When the E-bus group contains QAIOs 16/4, the clock frequency must be set to 5 MHz!

ⓘ The duration of transmission of E-bus messages is not influenced by the number of DIN rail modules in the E-bus group.

7.4.3.4 Scope of E-Bus Messages

E-Bus Communication: Scope of Messages

The scope of the E-bus message depends on the slave types attached to the master.

Communication with digital I/O extension modules (such as QDIO)
All input and output data of every digital I/O extension module is transmitted during every E-bus cycle.

Communication with analog I/O extension modules (such as QAIO 16/4)
The data for one output and one input from each analog I/O extension module will be transmitted during every E-bus cycle. Only the input and output data that is used in the application program will be transmitted.

7.4.3.5 Example

E-Bus Communication: Example

One analog and one digital I/O extension module is connected to an MSC.

The E-bus interface of the MSC and the inputs and outputs of the I/O extension modules are configured in the PLC configuration of the MACS development environment.
⇨ "10.14.1 Configuration of the E-Bus Interface" on page 112

The following inputs and outputs are used in the application program.

- QAIO 16/4: 7 analog inputs QAIO-IN1 to QAIO-IN7
  3 analog outputs QAIO-OUT1 to QAIO-OUT3
- QDIO: 3 digital inputs QDIO-IN5 to QDIO-IN7
  3 digital outputs QDIO-I/O13 to QDIO-I/O15

The shortest task interval is 1 ms. The module parameter 'UpdateRate' is set to 'each cycle'.
Accordingly, the E-bus message starts cyclically every millisecond.
⇨ "7.4.3.2 Update Rate of E-Bus Messages" on page 57

The digital inputs and outputs of the QDIO are updated in every E-bus cycle; once every millisecond in this example.

However, only one analog input and one analog output of the QAIO 16/4 will be updated with each E-bus cycle. For this reason, each analog input is updated only every 7 ms and every analog output is updated only every 3 ms in this example.

Time	Cycle No./ Message No.	Update			
		Outputs		Inputs	
		QDIO	QAIO 16/4	QDIO	QAIO 16/4
1 ms	1	all	OUT1	all	IN1
2 ms	2	all	OUT2	all	IN2
3 ms	3	all	OUT3	all	IN3
4 ms	4	all	OUT1	all	IN4
5 ms	5	all	OUT2	all	IN5
6 ms	6	all	OUT3	all	IN6
7 ms	7	all	OUT1	all	IN7
8 ms	8	all	OUT2	all	IN1
9 ms	9	all	OUT3	all	IN2
…	…	…	…	…	…

Table 10: Update Order for Inputs and Outputs of QDIO and QAIO 16/4

7.5 Networking DIN Rail Modules

Networking DIN Rail Modules

When networking DIN rail modules, a distinction is made between the following control groups:

- E-Bus Groups
  ⇨ "7.5.2 E-Bus Groups" on page 60
- LocalCAN Bus Groups
  ⇨ "7.5.3 LocalCAN Bus Groups" on page 61
- WideCAN Bus Groups
  ⇨ "7.5.4 WideCAN Bus Groups" on page 62

7.5.1 CAN and E-Bus Interfaces

The M3000® modules mentioned here represent only a part of Moog's current product range. In addition to other M3000® modules, Moog's product range includes a large variety of accessories.
⇨ "11 Product Range" on page 118

DIN Rail Modules with CAN and E-Bus Interfaces

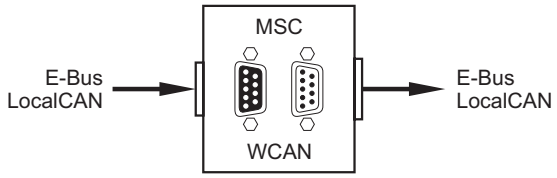
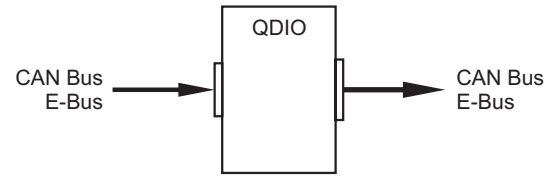
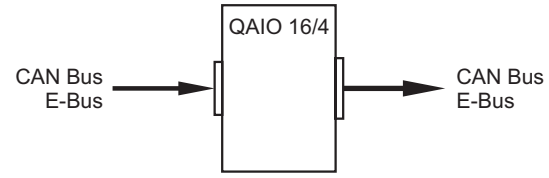
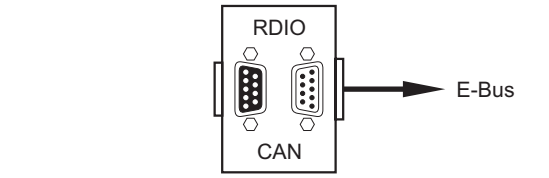
DIN Rail Module	Number of Connectors and Controllers
MSC 	**LocalCAN bus:** 2 Q-connectors (lateral) **WideCAN bus:** 2 D-sub front panel connectors **CAN bus controller:** 2 **E-bus:** 2 Q-connectors (lateral)
QDIO 	**CAN bus:** 2 Q-connectors (lateral) **CAN bus controller:** 0 **E-bus:** 2 Q-connectors (lateral)
QAIO 16/4 	**CAN bus:** 2 Q-connectors (lateral) **CAN bus controller:** 0 **E-bus:** 2 Q-connectors (lateral)
RDIO 	**CAN bus:** 2 D-sub front panel connectors **CAN bus controller:** 1 **E-bus:** 1 Q-connector (right)

Table 11: DIN Rail Modules with CAN and E-Bus Interfaces (Section 1 of 2)

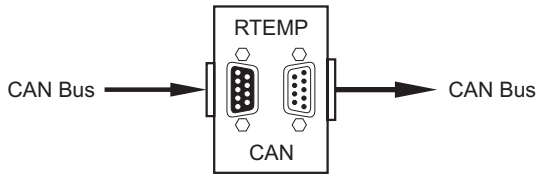
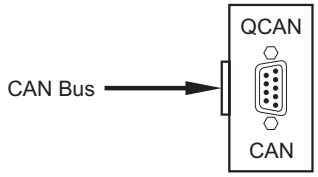
DIN Rail Module	Number of Connectors and Controllers
RTEMP 	**CAN bus:** 2 Q-connectors (lateral) 2 D-sub front panel connectors **CAN bus controller:** 1
QCAN 	**CAN bus:** 1 Q-connector (lateral) 1 D-sub connector (front) **CAN bus controller:** 0

Table 11: DIN Rail Modules with CAN and E-Bus Interfaces (Section 2 of 2)

7.5.2 E-Bus Groups

E-Bus Groups

E-bus groups are formed by joining DIN rail modules together at the Q-connectors. The modules within E-bus groups communicate over the internal E-bus.
⇨ "7.4 E-Bus" on page 55

Observe the following when establishing E-bus groups:

- An E-bus group can have only one master to which the slaves attach.
  ⇨ Table 8 on page 56
- The module located farthest to the left of an E-bus group must be the master.
- The number of slaves that may be attached to a master is limited.
  ⇨ Table 8 on page 56
- The slaves may be attached in any order.
- QCANs can be attached only at the far right because they do not have a Q-connector on the right side.
  QCANs are not slaves and may therefore be attached additionally at the right regardless of the number of slaves.
- Only the master can communicate with the slaves.
  Direct communication between the slaves of an E-bus group over the E-bus is not possible.
  ⇨ "7.4.2 E-Bus Communication" on page 56
- Slaves must be attached to the master in direct succession.
  Modules that do not belong to this E-bus group must not be connected to this E-bus group by the Q-connector.
- RDIOs are not permissible slaves in E-bus groups and therefore must not be attached to the right of an MSC, Q-module, or R-module.
- RTEMPs interrupt the E-bus communication because only the CAN bus is implemented on their Q-connector.
  RTEMPs may be attached to the far right or far left of an E-bus group in order to establish a CAN bus connection over the Q-connector.
- Information about arranging DIN rail modules:
  ⇨ "5.1.3 Arrangement on DIN Top-Hat Rails" on page 30

7.5.2.1 Examples

E-Bus Group (MSC as E-Bus Master)

Figure 41: E-Bus Group (MSC as E-Bus Master)

1 Number of slaves that may be attached to the MSC:
⇨ Table 8 on page 56

E-Bus Group (RDIO as E-Bus Master)

Figure 42: E-Bus Group (RDIO as E-Bus Master)

1 Number of slaves that may be attached to the RDIO:
⇨ Table 8 on page 56

7.5.3 LocalCAN Bus Groups

LocalCAN Bus Groups

LocalCAN bus groups are formed by joining MSCs and RTEMPs together at the Q-connectors. The modules within LocalCAN bus groups communicate over the internal LocalCAN bus.

Observe the following when establishing LocalCAN bus groups:

- The number of modules in a LocalCAN bus group is limited to 64 because CAN bus networks can only include a maximum of 64 network stations.
  ⇨ "7.3.5.3 Number of Network Stations" on page 53
- The switchable CAN bus termination resistor of the MSC can be used as a termination resistor for the LocalCAN bus group.
  ⇨ "10.15.1 CAN Bus Termination Resistor" on page 114
- If a QCAN is attached to the right, then the LocalCAN bus can be made available (using the QCAN) for other CAN bus network stations that do not belong to the LocalCAN bus group.
- Information about arranging DIN rail modules:
  ⇨ "5.1.3 Arrangement on DIN Top-Hat Rails" on page 30

7.5.3.1 Example

LocalCAN Bus Group

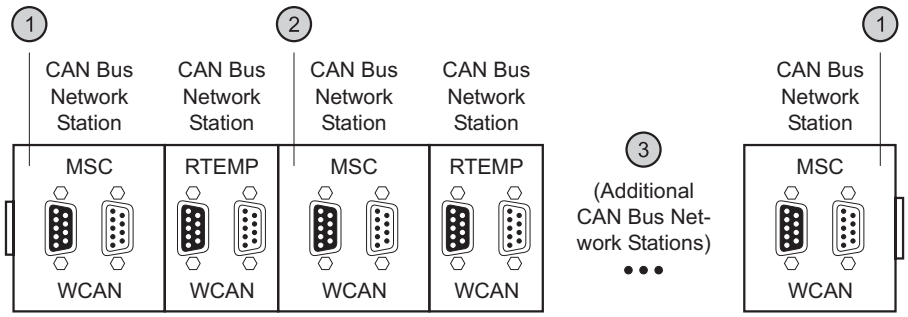


Figure 43: LocalCAN Bus Group (MSCs and RTEMPs as CAN Bus Network Stations)

1. The internal CAN bus termination resistor is switched on for MSCs that are used as the first or last CAN bus network station of a LocalCAN bus group.
   ⇨ "10.15.1 CAN Bus Termination Resistor" on page 114
2. The internal CAN bus termination resistor is not switched on for MSCs that are located between the first and final CAN bus network stations of a LocalCAN bus group.
3. CAN bus networks with M3000® modules can only include a maximum of 64 CAN bus network stations.
   ⇨ "7.3.5.3 Number of Network Stations" on page 53

7.5.4 WideCAN Bus Groups

WideCAN Bus Groups

WideCAN bus groups are formed by connecting the WideCAN terminal of the MSC to additional CAN bus network stations. CAN bus network stations use the internal WideCAN bus to communicate within WideCAN bus groups.

Observe the following when establishing WideCAN bus groups:

- The switchable CAN bus termination resistor of the MSC cannot be used as a termination resistor for the WideCAN bus group.
  Separate pluggable CAN termination resistors must be used for this.
  ⇨ "10.15.1 CAN Bus Termination Resistor" on page 114
- Notes on project planning for CAN bus networks:
  ⇨ "7.3.5 CAN Bus Networks" on page 52

7.5.4.1 Example

WideCAN Bus Group

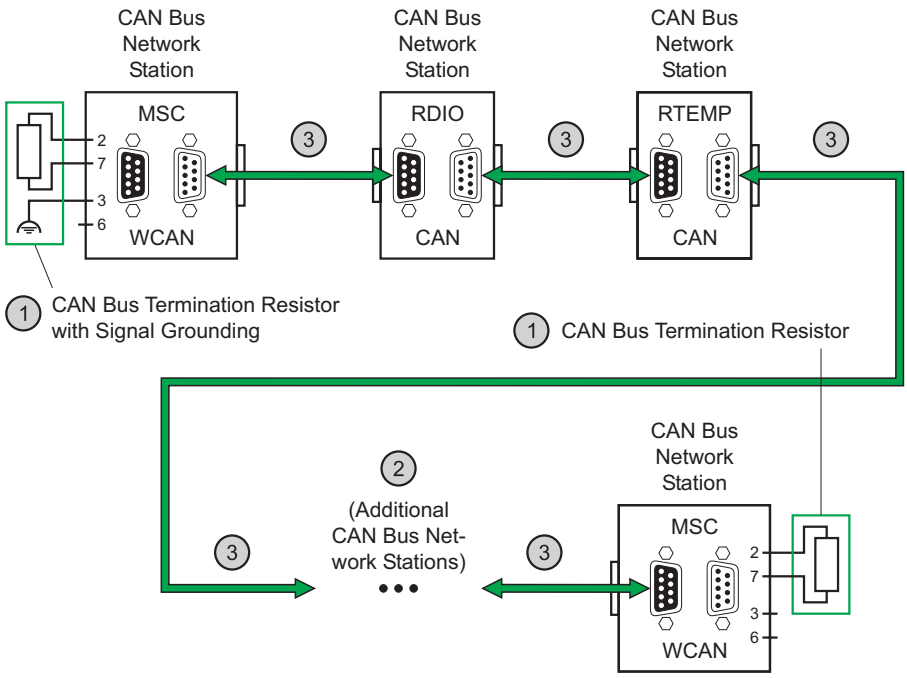


Figure 44: WideCAN Bus Group (MSCs and R-Modules as CAN Bus Network Stations)

(1) D-sub connectors with CAN bus termination resistors are available from Moog.
⇨ "11.7 CAN Bus Accessories" on page 123

(2) CAN bus networks with M3000® modules can only include a maximum of 64 CAN bus network stations.
⇨ "7.3.5.3 Number of Network Stations" on page 53

(3) CAN bus interface cable
⇨ "7.3.6 CAN Bus Interface Cable" on page 54

8 Shutdown and Service

Shutdown and Service: Safety Instructions

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® control system or M3000® modules may be performed while the control system or the modules are in operation!

There is a danger of:

- Uncontrolled movements
- Permanent damage
- Malfunctions

Before performing any work on the M3000® control system or M3000® modules, it is essential that the system be stopped and the power supply 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® control system and M3000® modules must not come into direct contact with liquids. 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.

8.1 Shutdown

Shutdown: Safety Instructions

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.

8.2 Service

Maintenance/Repair: Safety Instructions

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!

8.2.1 Maintenance/Servicing

Maintenance/Servicing

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

8.2.2 Repair

Repair

Only Moog and Moog's authorized service stations perform **Moog Authentic Repairs**. 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.

Repair Seal

Figure 45: Repair Seal

Moog's repair seal is the guarantee that a Moog Authentic 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. Like new modules, repaired modules or replacement modules are delivered only with a bootloader.

9 Transportation and Storage

Transportation and Storage: Safety Instructions

WARNING

Maintain, under all circumstances, the required environmental conditions specified for transportation and storage of the control system M3000® or M3000® modules.
⇨ "9.1 Environmental Conditions" on page 66
This ensures fault-free, reliable, and safe operation.

CAUTION

To avoid condensation, do not start M3000® modules until they have reached ambient temperature.

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

9.1 Environmental Conditions

Transportation and Storage: Environmental Conditions

Ambient temperature (IEC 61131-2)
–25 °C to +70 °C (–13 °F to +158 °F)

Relative air humidity (IEC 61131-2)
5 % to 95 % non-condensing

Contamination level (IEC 60664)
2

Resistance to corrosion (IEC 60068)
No protection

Air pressure (IEC 61131-2)
Š 70 kPa (corresponds to an elevation of £ 3,000 m (3,280 yd))

Drop height (freefall in the original packaging) (IEC 60068-2-31)
≤ 1 m (39 in)

10 MSC (Moog Servo Controller)

MSC: Programmable Multi-Axis Controller

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

The MSC is programmed and configured with the MACS development environment (complies with IEC 61131).
⇨ "3.5 Application Programs" on page 24

10.1 Performance Characteristics

10.1.1 Interfaces

Interfaces of the MSC

The MSC provides the following interfaces:

- 2 Serial interfaces
  - «MACS» front panel connector for use as a programming interface
  - «SIO» front panel connector for use as a free user interface

  ⇨ "10.16 Serial Interfaces" on page 115
- 1 E-bus interface on both lateral Q-connectors
  (for establishing E-bus groups)
  ⇨ "10.14 E-Bus Interface" on page 112
- 2 CAN bus interfaces
  - WideCAN: 2 front panel connectors «WCAN»
    (connected internally 1:1)
  - LocalCAN: 2 internally on both lateral Q-connectors

  ⇨ "10.15 CAN Bus Interfaces" on page 113
- 1 Ethernet interface on the front panel
  - «Ethernet» front panel connector

  ⇨ "10.5.1.2 Ethernet Communication Interface" on page 81
- 1 Field bus interface on the front panel
  - «F-Bus» front panel connector
    (provided for optional field bus extension, such as Profibus)
- 2 Digital sensor interfaces according to TIA/EIA 422 (previously RS 422) for position transducers or shaft encoders with SSI interface or incremental sensor signals

  ⇨ "10.13 Digital Sensor Interfaces" on page 108

10.1.2 I/Os (Inputs/Outputs)

I/Os (Inputs/Outputs) of the MSC

The MSC provides the following I/Os:

- 8 Digital I/Os
  each individually configurable as an input or an output
  ⇨ "10.9 Digital I/Os" on page 91
- 2 Analog outputs
  each with a voltage output stage ±10 V and an additional current output stage, configurable as: ±10 mA, ±50 mA or 4–20 mA (each nominal)
  ⇨ "10.10 Analog Outputs" on page 99
- 1 Reference voltage output 10 V
  ⇨ "10.11 Reference Voltage Output" on page 101
- 8 Analog inputs
  configurable as: ±10 V, ±10 mA or 4–20 mA (each nominal)
  ⇨ "10.12 Analog Inputs" on page 102
- 1 Digital output 'Outputs Enabled'
  ⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116

ⓘ The I/Os are configured in the PLC configuration of the MACS development environment.

10.1.3 Safety Functions

Safety Functions of the MSC

The MSC provides the following safety functions:

- Watchdog for monitoring the functionality of hardware and software
  ⇨ "10.17.1 Watchdog" on page 115
- Output 'Outputs Enabled' for signaling the activation of all outputs as well as E-bus communication
  ⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116

10.2 General Specifications

General Specifications of the MSC

Dimensions

Overall width/module width × H × T in mm (in):
160/149 × 170 × 85.5 (6.3/5.87 × 6.69 × 3.37)
⇨ Figure 46 on page 69

Dimensions of the other DIN rail modules:
⇨ "5.1.2 Dimensions" on page 29

Weight

Approx. 1 kg (2.2 lb) without plug-in terminal strips, with license key

Processor

PowerPC CPU 40 MHz, 32 Bit, RISC architecture with floating point unit

Memory

4 MB flash EEPROM
2/4 MB RAM

Data retention

> 10 Years for all data that is saved in the flash EEPROM, i.e., boot project, RETAIN variables and error messages

Behavior during power supply failure

The data to be saved during a power supply failure is specified in the MACS development environment.

10.2.1 Dimensions

Dimensions of the MSC

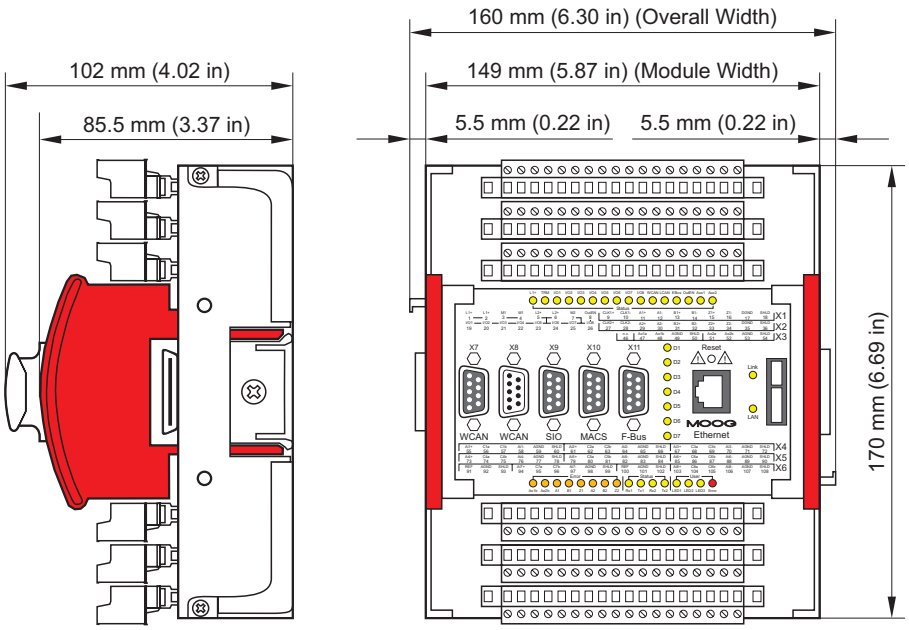


Figure 46: Dimensions of the MSC

10.2.2 Environmental Conditions

Environmental Conditions: Safety Instructions

WARNING

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

WARNING

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

WARNING

The M3000® control system and M3000® modules must not come into direct contact with liquids. 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.

10.2.2.1 Climatic Conditions

Environmental Conditions: Climatic Conditions

Ambient temperature (IEC 61131-2)

For operation (when installed properly):	+5 °C to +55 °C (+41 °F to +131 °F)
Average temp. over 24 hours:	max. +50 °C (+122 °F)
For transportation and storage (in the original packaging):	–25 °C to +70 °C (–13 °F to +158 °F)

Relative air humidity (IEC 61131-2)

For operation:	10 % to 95 % non-condensing
For transportation and storage (in the original packaging):	5 % to 95 % non-condensing

Contamination level (IEC 60664)
2

Resistance to corrosion (IEC 60068)
No protection

Operating Elevation (IEC 61131-2)
≤ 2,000 m (2,187 yd) above MSL

Air pressure for transportation (IEC 61131-2)
Š 70 kPa (corresponds to an elevation of £ 3,000 m (3,280 yd))

10.2.2.2 Mechanical Conditions and Requirements

Environmental Conditions: Mechanical Conditions and Requirements

Sinusoidal oscillations (IEC 60068-2-6)

10 Hz ≤ f < 57 Hz:	0.0357 mm (0.0014 in) continual amplitude 0.075 mm (0.00295 in) random amplitude
57 Hz ≤ f < 150 Hz:	0.5 g continuous constant acceleration 1.0 g random constant acceleration
f > 150 Hz:	not defined

Shock (IEC 60068-2-27)
Random peaks up to 15 g longer than 11 ms, half-sine wave in each of the three orthogonal axes

Drop height (freefall in the original packaging) (IEC 60068-2-31)
≤ 1 m (39 in)

Protection class (IEC 60529)
IP20

10.2.2.3 Electrical Conditions and Requirements

Environmental Conditions: Electrical Conditions and Requirements

Power supply
24 V DC
(Safety Extra-Low Voltage (SELV) according to DIN EN 60950-1)
Specified voltage range: 18–36 V DC
⇨ "6.2 Power Supply" on page 38

Insulation resistance
Rated voltage: 0–50 V DC
Test voltage for 2,000 m (2,187 yd) operating elevation: 500 V DC

10.3 Block Diagram

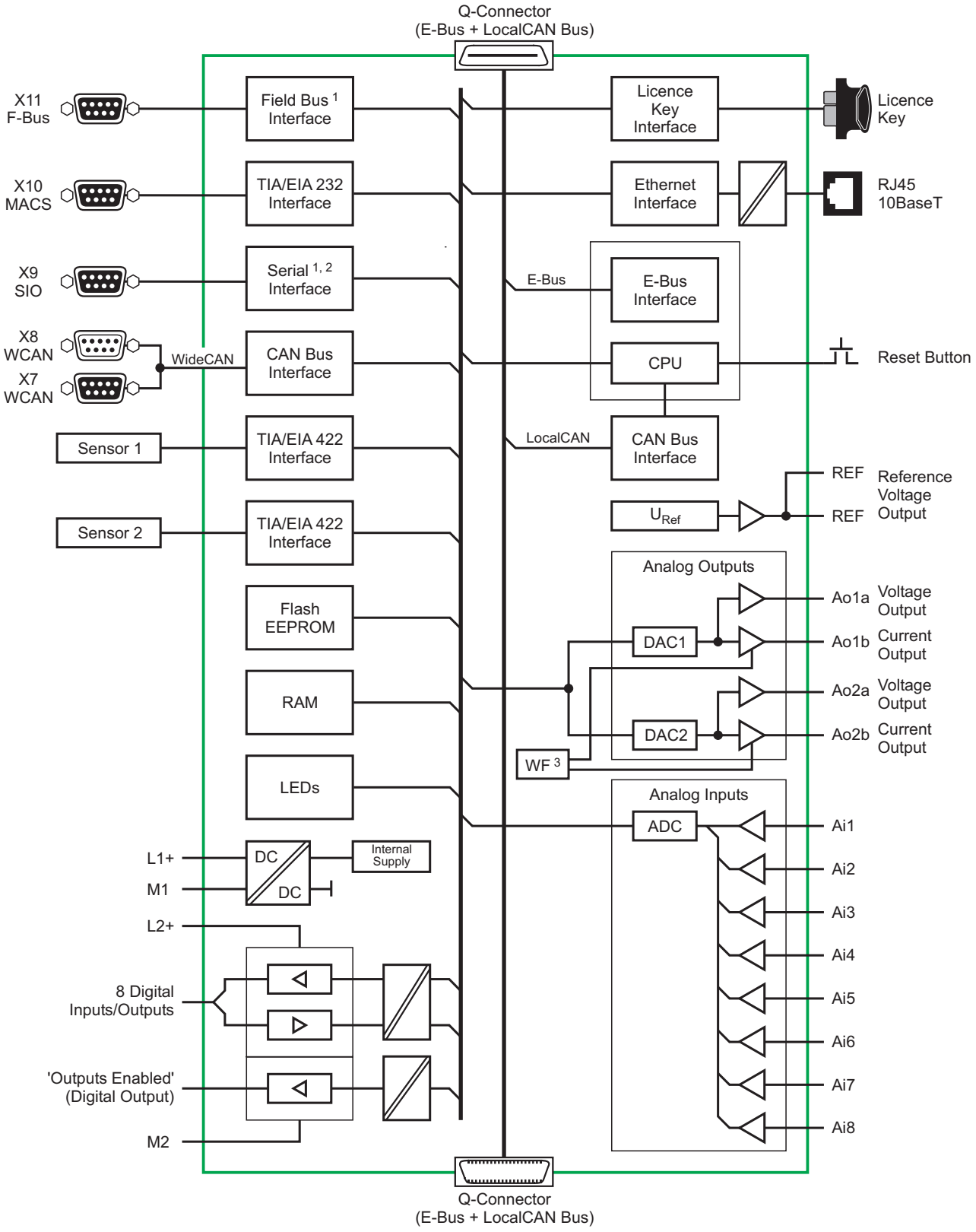


Figure 47: Block Diagram of the MSC

1) Hardware option. When ordering the MSC, the type of the field bus interface must be specified.

2) Available serial interfaces: TIA/EIA 232 (previously RS 232), TIA/EIA 422 (previously RS 422) or TIA/EIA 485 (previously RS 485)

3) Wire fault monitoring of the analog current outputs

10.4 View of the Module and Terminal Assignment

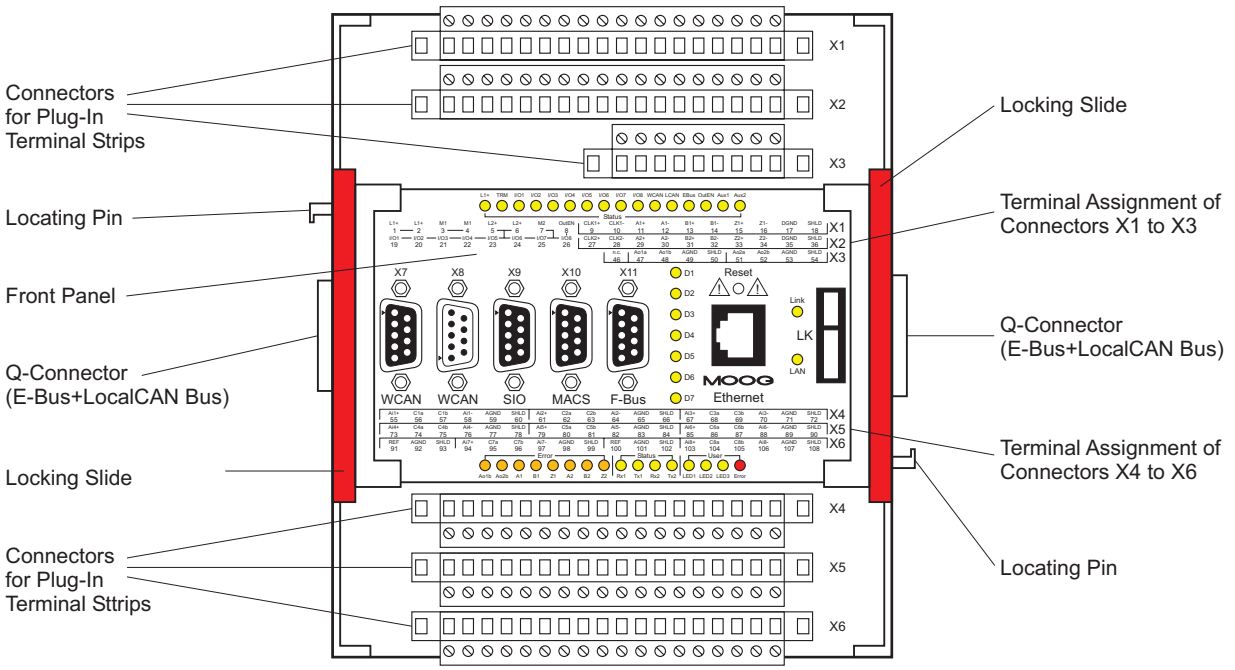


Figure 48: Front View of the MSC

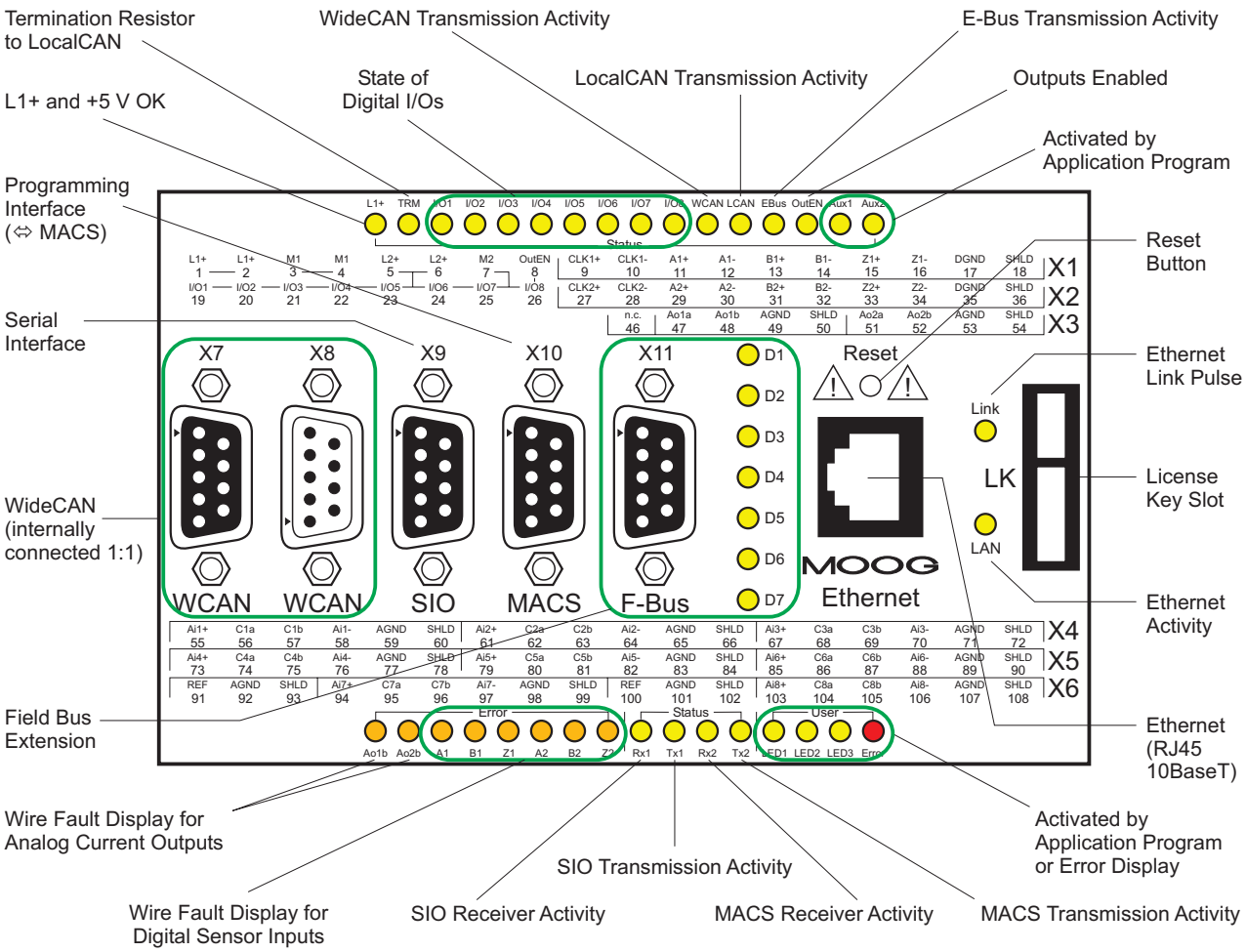


Figure 49: Front Panel of the MSC

10.4.1 Terminal Assignment

Connector	No.	Assign-ment	Circuit	
X1 	1	L1+	Power supply for the MSC's internal electronics (24 V DC SELV) ⇨ "6.2 Power Supply" on page 38	Power Supply
	2	L1+	Power supply for the MSC's internal electronics (24 V DC SELV)	
	3	M1	Ground for the internal electronics' power supply	
	4	M1	Ground for the internal electronics' power supply	
	5	L2+	Power supply for the MSC's digital I/Os (24 V DC SELV) ⇨ "10.9.2 Power Supply" on page 92	Digital I/Os
	6	L2+	Power supply for the MSC's digital I/Os (24 V DC SELV)	
	7	M2	Ground for the digital I/Os' power supply	
	8	OutEN	Digital output 'Outputs Enabled' ⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116	
	9	CLK1+	TIA/EIA 422 output, SSI sensor signal 1 clock+ ⇨ "10.13 Digital Sensor Interfaces" on page 108	Digital Sensor Interface 1
	10	CLK1-	TIA/EIA 422 output, SSI sensor signal 1 clock-	
	11	A1+	TIA/EIA 422 input, incremental sensor signal 1 A+ or SSI sensor signal 1 data+	
	12	A1-	TIA/EIA 422 input, incremental sensor signal 1 A- or SSI sensor signal 1 data-	
	13	B1+	TIA/EIA 422 input, incremental sensor signal 1 B+ or SSI sensor signal 1 slave clock+	
	14	B1-	TIA/EIA 422 input, incremental sensor signal 1 B- or SSI sensor signal 1 slave clock-	
	15	Z1+	TIA/EIA 422 input, incremental sensor signal 1 Z+	
	16	Z1-	TIA/EIA 422 input, incremental sensor signal 1 Z-	
	17	DGND	Ground for the digital sensor interface	
	18	SHLD	Optional shield	
X2 	19	I/O1	Digital I/O 1 ⇨ "10.9 Digital I/Os" on page 91	Digital I/Os
	20	I/O2	Digital I/O 2	
	21	I/O3	Digital I/O 3	
	22	I/O4	Digital I/O 4	
	23	I/O5	Digital I/O 5	
	24	I/O6	Digital I/O 6	
	25	I/O7	Digital I/O 7	
	26	I/O8	Digital I/O 8	
	27	CLK2+	TIA/EIA 422 output, SSI sensor signal 2 clock+ ⇨ "10.13 Digital Sensor Interfaces" on page 108	Digital Sensor Interface 2
	28	CLK2-	TIA/EIA 422 output, SSI sensor signal 2 clock-	
	29	A2+	TIA/EIA 422 input, incremental sensor signal 2 A+ or SSI sensor signal 2 data+	
	30	A2-	TIA/EIA 422 input, incremental sensor signal 2 A- or SSI sensor signal 2 data-	
	31	B2+	TIA/EIA 422 input, incremental sensor signal 2 B+ or SSI sensor signal 2 slave clock+	
	32	B2-	TIA/EIA 422 input, incremental sensor signal 2 B- or SSI sensor signal 2 slave clock-	
	33	Z2+	TIA/EIA 422 input, incremental sensor signal 2 Z+	
	34	Z2-	TIA/EIA 422 input, incremental sensor signal 2 Z-	
	35	DGND	Ground for the digital sensor interface	
	36	SHLD	Optional shield	

Table 12: Terminal Assignment of MSC's Connectors (Section 1 of 5)

Connector	No.	Assign-ment	Circuit	
X3 	46	NC		
	47	Ao1a	Analog voltage output 1 (referenced on AGND) ⇨ "10.10 Analog Outputs" on page 99	**Analog Output 1**
	48	Ao1b	Analog current output 1 (referenced on AGND)	
	49	AGND	Ground for the analog I/Os	
	50	SHLD	Optional shield	
	51	Ao2a	Analog voltage output 2 (referenced on AGND) ⇨ "10.10 Analog Outputs" on page 99	**Analog Output 2**
	52	Ao2b	Analog current output 2 (referenced on AGND)	
	53	AGND	Ground for the analog I/Os	
	54	SHLD	Optional shield	
X4 	55	Ai1+	Analog input 1 (not inverting) ⇨ "10.12 Analog Inputs" on page 102	**Analog Input 1**
	56	C1a	Connect the current load (connect with C1b)	
	57	C1b	Connect the current load (connect with C1a)	
	58	Ai1-	Analog input 1 (inverting)	
	59	AGND	Ground for the analog I/Os	
	60	SHLD	Optional shield	
	61	Ai2+	Analog input 2 (not inverting) ⇨ "10.12 Analog Inputs" on page 102	**Analog Input 2**
	62	C2a	Connect the current load (connect with C2b)	
	63	C2b	Connect the current load (connect with C2a)	
	64	Ai2-	Analog input 2 (inverting)	
	65	AGND	Ground for the analog I/Os	
	66	SHLD	Optional shield	
	67	Ai3+	Analog input 3 (not inverting) ⇨ "10.12 Analog Inputs" on page 102	**Analog Input 3**
	68	C3a	Connect the current load (connect with C3b)	
	69	C3b	Connect the current load (connect with C3a)	
	70	Ai3-	Analog input 3 (inverting)	
	71	AGND	Ground for the analog I/Os	
	72	SHLD	Optional shield	

Table 12: Terminal Assignment of MSC's Connectors (Section 2 of 5)

Connector	No.	Assign-ment	Circuit	
X5 	73	Ai4+	Analog input 4 (not inverting) ⇨ "10.12 Analog Inputs" on page 102	**Analog Input 4**
	74	C4a	Connect the current load (connect with C4b)	
	75	C4b	Connect the current load (connect with C4a)	
	76	Ai4-	Analog input 4 (inverting)	
	77	AGND	Ground for the analog I/Os	
	78	SHLD	Optional shield	
	79	Ai5+	Analog input 5 (not inverting) ⇨ "10.12 Analog Inputs" on page 102	**Analog Input 5**
	80	C5a	Connect the current load (connect with C5b)	
	81	C5b	Connect the current load (connect with C5a)	
	82	Ai5-	Analog input 5 (inverting)	
	83	AGND	Ground for the analog I/Os	
	84	SHLD	Optional shield	
	85	Ai6+	Analog input 6 (not inverting) ⇨ "10.12 Analog Inputs" on page 102	**Analog Input 6**
	86	C6a	Connect the current load (connect with C6b)	
	87	C6b	Connect the current load (connect with C6a)	
	88	Ai6-	Analog input 6 (inverting)	
	89	AGND	Ground for the analog I/Os	
	90	SHLD	Optional shield	
X6 	91	REF	Reference voltage output 10 V ⇨ "10.11 Reference Voltage Output" on page 101	**Analog Input 7**
	92	AGND	Ground for the analog I/Os	
	93	SHLD	Optional shield	
	94	Ai7+	Analog input 7 (not inverting) ⇨ "10.12 Analog Inputs" on page 102	
	95	C7a	Connect the current load (connect with C7b)	
	96	C7b	Connect the current load (connect with C7a)	
	97	Ai7-	Analog input 7 (inverting)	
	98	AGND	Ground for the analog I/Os	
	99	SHLD	Optional shield	
	100	REF	Reference voltage output 10 V ⇨ "10.11 Reference Voltage Output" on page 101	**Analog Input 8**
	101	AGND	Ground for the analog I/Os	
	102	SHLD	Optional shield	
	103	Ai8+	Analog input 8 (not inverting) ⇨ "10.12 Analog Inputs" on page 102	
	104	C8a	Connect the current load (connect with C8b)	
	105	C8b	Connect the current load (connect with C8a)	
	106	Ai8-	Analog input 8 (inverting)	
	107	AGND	Ground for the analog I/Os	
	108	SHLD	Optional shield	

Table 12: Terminal Assignment of MSC's Connectors (Section 3 of 5)

Connector	No.	Assign-ment	Circuit	
X7  **WCAN**	1			**WCAN (WideCAN)**
	2	CAN-L	CAN-	
	3	DGND	Ground for the CAN bus interface	
	4			
	5			
	6			
	7	CAN-H	CAN+	
	8			
	9			
X8  **WCAN**	1			**WCAN (WideCAN)**
	2	CAN-L	CAN-	
	3	DGND	Ground for the CAN bus interface	
	4			
	5			
	6			
	7	CAN-H	CAN+	
	8			
	9			
X9  **SIO** TIA/EIA 232	1			**SIO TIA/EIA 232**
	2	Rx	TIA/EIA 232 receive data	
	3	Tx	TIA/EIA 232 send data	
	4			
	5	DGND	Ground for the TIA/EIA 232 interface	
	6			
	7			
	8			
	9			
X9  **SIO** TIA/EIA 422 optional	1	Tx-	TIA/EIA 422 Send data-	**SIO TIA/EIA 422**
	2	Rx+	TIA/EIA 422 Receive data+	
	3	Tx+	TIA/EIA 422 Send data+	
	4			
	5	DGND	Ground for the TIA/EIA 422 interface	
	6			
	7			
	8			
	9	Rx-	TIA/EIA 422 Receive data-	
X9  SIO TIA/EIA 485 optional	1			**SIO TIA/EIA 485**
	2	Data+	TIA/EIA 485 data+ (bidirectional send and receive data)	
	3	Data-	TIA/EIA 485 data- (bidirectional send and receive data)	
	4			
	5	DGND	Ground for the TIA/EIA 485 interface	
	6			
	7			
	8			
	9			

Table 12: Terminal Assignment of MSC's Connectors (Section 4 of 5)

Connector	No.	Assign-ment	Circuit	
X10  **MACS**	1			**MACS**
	2	Rx	Receive data	
	3	Tx	Send data	
	4			
	5	DGND	Ground for the MACS interface	
	6			
	7			
	8			
	9			
X11  **F-Bus**	1		The front panel connector «F-Bus» is provided for optional field bus extensions, such as Profi-bus. The terminal assignment and circuit of the F-bus interface will depend on the type of field bus.	**F-Bus**
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
 **Ethernet**	1	TD+	Send data+	**Ethernet**
	2	TD-	Send data-	
	3	RD+	Receive data+	
	4	NC	reserved	
	5	NC	reserved	
	6	RD-	Receive data-	
	7	NC	reserved	
	8	NC	reserved	

Table 12: Terminal Assignment of MSC's Connectors (Section 5 of 5)

10.4.2 LEDs

Area	LED	Display	Explanation
Status	L1+	L1+/M1 and internal +5 V ok	Illuminates when the power supply for the MSC's internal electronics is OK and the internal power pack is supplying +5 V. ⇨ "6.2 Power Supply" on page 38
	TRM	Termination resistor on LocalCAN	Illuminates when the termination resistor of the LocalCAN interface is switched on. ⇨ "10.15.1 CAN Bus Termination Resistor" on page 114
	I/O1	Internal status of the digital I/O 1	⇨ "10.9.1 Display of the Operational State" on page 91
	I/O2	Internal status of the digital I/O 2	
	I/O3	Internal status of the digital I/O 3	
	I/O4	Internal status of the digital I/O 4	
	I/O5	Internal status of the digital I/O 5	
	I/O6	Internal status of the digital I/O 6	
	I/O7	Internal status of the digital I/O 7	
	I/O8	Internal status of the digital I/O 8	
	WCAN	WideCAN transmission activity	Flashes in synchronization with the data that the MSC is sending over the WideCAN interface. ⇨ "10.15 CAN Bus Interfaces" on page 113

Table 13: LEDs of the MSC (Section 1 of 2)

Area	LED	Display	Explanation
Status	LCAN	LocalCAN transmission activity	Flashes in synchronization with the data that the MSC is sending over the LocalCAN interface. ⇨ "10.15 CAN Bus Interfaces" on page 113
	EBus	E-bus transmission activity	Illuminates when the MSC is sending data over the E-bus. ⇨ "7.4.3 MSC as E-Bus Master" on page 56
	OutEN	Outputs enabled	Illuminates when all outputs and the E-bus communication are under the control of the application program. ⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116
	Aux1	Activated by application program	Illuminates when the application program activates the LED.
	Aux2	Activated by application program	
Error	Ao1b	Wire fault in the analog current output 1	Illuminates when no receiver is attached to the corresponding current output, the load resistance is too great, or there is a wire fault. ⇨ "Wire fault monitoring of the analog current outputs" on page 101
	Ao2b	Wire fault in the analog current output 2	
	A1	Wire fault in the digital sensor input A1	Illuminates when no receiver is attached to the corresponding digital sensor interface or when there is a wire fault. ⇨ "10.13.1.1 Wire Fault Display LEDs" on page 108
	B1	Wire fault in the digital sensor input B1	
	Z1	Wire fault in the digital sensor input Z1	
	A2	Wire fault in the digital sensor input A2	
	B2	Wire fault in the digital sensor input B2	
	Z2	Wire fault in the digital sensor input Z2	
Status	Rx1	SIO receiver activity	Illuminates when the MSC is receiving data over the SIO interface
	Tx1	SIO transmission activity	Illuminates when the MSC is sending data over the SIO interfaces. If «Tx2» illuminates in addition to «Tx1», this indicates an error during loading of the hardware driver. ⇨ Table 14 on page 79
	Rx2	MACS receiver activity	Illuminates when the MSC is receiving data over the MACS interface.
	Tx2	MACS transmission activity	Illuminates when the MSC is sending data over the MACS interface. If «Tx1» illuminates in addition to «Tx2», this indicates an error during loading of the hardware driver. ⇨ Table 14 on page 79
User	LED1	Activated by application program or error display	As long as LED «Error» does not illuminate, the application program can activate these LEDs (provided that the MSC has successfully started and that the application program has started). The states that these LEDs will indicate while the application program is running are set in the application program. If «Error» illuminates or flashes in addition to these LEDs, this indicates MSC's elementary operational states or errors. ⇨ Table 14 on page 79
	LED2	Activated by application program or error display	
	LED3	Activated by application program or error display	
	Error	Error display	Illuminates when there is an error. The type of error is specified in «LED1», «LED2», and «LED3». ⇨ Table 14 on page 79
Ethernet	Link	Ethernet link pulse	Illuminates when the Ethernet link pulse is available
	LAN	Ethernet activity	Illuminates when the MSC is receiving or sending data over the Ethernet interface.
F-Bus	D1 … D7	The LEDs «D1» through «D7» are provided for optional field bus extensions, such as Profibus. The assignment of the LEDs «D1» through «D7» will depend on the field bus type.	

Table 13: LEDs of the MSC (Section 2 of 2)

10.4.2.1 Display of Elementary Operational States and Errors

State	Explanation	User LEDs				Status LEDs	
		LED1	LED2	LED3	Error	Tx1	Tx2
Ready	The MSC was started successfully. The user LEDs «LED1», «LED2» and «LED3» are now available for the application program.	0	0	0	0	-	-
Error	An error occurred during starting of the run-time system. ⓘ If this error occurs, please contact Moog or Moog's authorized service agents.	1	0	0	1	-	-
Error	An error occured during loading of the TPU. ⓘ If this error occurs, please contact Moog or Moog's authorized service agents.	0	1	0	1	-	-
Load procedures	FPGA was loaded successfully.	1	0	0	0	-	-
	TPU was loaded successfully	1	1	0	0	-	-
Initialization	Initialization of the flash file system. ⓘ The initialization phase after the firmware loads or updates can take up to several minutes. ⓘ The MSC must not be switched off or reset during the initialization phase. If it is switched off or reset during the initialization phase, the firmware must be reloaded.	1	1	1	0	-	-
Error	An error occured during loading of the hardware driver. ⓘ If this error occurs, please contact Moog or Moog's authorized service agents.	-	-	-	-	1	1

1: LED illuminates
0: LED does not illuminate
-: Display not relevant

Table 14: LEDs for Displaying Elementary Operational States and Errors after Switching on or Resetting the MSC

ⓘ When the MSC starts successfully, FPGA and TPU will load automatically and the flash file system will initialize automatically. The load proceeds so quickly that it is difficult to see the user LEDs «LED1» and «LED2» illuminate with the naked eye.
It is possible to observe the user LEDs «LED1», «LED2» and «LED3» illuminate during the initialization phase.

10.5 Programming and Configuration

Programming and Configuration of the MSC

The MACS development environment is needed to create IEC 61131 application programs and configure the MSC.
⇨ "3.5 Application Programs" on page 24

10.5.1 Communication Between MSC and MACS

WARNING

The MSC's operational state can be altered with the MACS development environment when the MSC is connected online with MACS.

This can be done by means of the following actions, for example:

- Stopping or resetting the program
- Setting breakpoints
- Activating the single step mode
- Downloading application programs
- Writing or forcing values

Therefore, the operator must always consider the effects and take appropriate precautions before altering the operational state of the MSC with MACS.

Communication Between MSC and MACS

The MSC can use the following interfaces to communicate with the PC on which MACS is installed:

- **MACS interface** according to TIA/EIA 232 (previously RS 232)
  with «MACS» front panel connector of the MSC
  ⇨ "10.5.1.1 MACS Communication Interface" on page 80
  ⇨ "7.2.1 TIA/EIA 232 Interface Cables" on page 48
- **Ethernet interface**
  with «Ethernet» front panel connector of the MSC
  ⇨ "7.1 Ethernet" on page 46
  ⇨ "10.5.1.2 Ethernet Communication Interface" on page 81

The MACS and Ethernet interface are configured in the PLC configuration of the MACS development environment.
Refer to the documentation of the MACS development environment for detailed information about this.

10.5.1.1 MACS Communication Interface

Communication Parameters of the MACS Interface

Settings in the MACS development environment (communication parameters)

Port = COM1 (depending on which PC serial interface is selected)
Baud rate = 38400 Bit/s
Parity = No
Stop Bits = 1
Motorola Byteorder = Yes

Interface cables

⇨ "7.2 Serial TIA/EIA Interface Cables" on page 47

10.5.1.2 Ethernet Communication Interface

Communication Parameters of the Ethernet Interface

Settings in the MACS development environment (communication parameters)

IP address at delivery = 10.49.40.1 (identical for all MSCs!)
Port = 1200
TargetId = 0
Motorola Byteorder = Yes

Each IP address may be used only once within a network. Therefore, when operating the MSC within a network, the IP address should be changed only after consulting with the responsible system administrator.

The IP address is saved in the license key.
⇨ "10.6 License Key" on page 81

Interface cables

⇨ "7.1.3 Ethernet Interface Cables" on page 47

10.6 License Key

License Key of the MSC: Safety Instructions

WARNING

The license key of the MSC must be protected from electrostatic discharges!
Electrical discharges might damage the license key or delete the contents of the license key's memory.

WARNING

The license key may be inserted or removed only when the MSC is powered down!
Attempting to insert or remove the license key during operation might damage the license key or the MSC permanently.

WARNING

The license key must always remain inserted while the MSC is in operation. Otherwise, the MSC will not function.

If the license key is removed during operation, the application program will stop after a few minutes. If the MSC is connected online to the MACS development environment, a corresponding error message will appear in MACS.
In addition, the digital output 'Outputs Enabled' will be switched to the 0 state, thereby disabling all of MSC's digital and analog outputs and terminating the E-bus communication.
⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116
After switching off the MSC and inserting the license key, the MSC can be brought back into operation.

10.6.1 Run-Time License and Accessible Libraries

License Key of the MSC: Run-Time License and Accessible Libraries

The run-time license of the MSC is saved in the license key.

The accessible MACS libraries also depend on the license key. If the application program attempts to access a MACS library that is not released by the license key used, the application program will not be able to start.

Detailed information about the MACS libraries accessible with the various license keys:
⇨ Table 27 on page 121

10.6.2 CANopen Node-ID and IP Address

License Key of the MSC: CANopen Node-ID and IP Address

The CANopen node-ID of the MSC's CAN bus interfaces and the IP address of the MSC's Ethernet interface are saved in the license key.

The CANopen node-ID and IP address can be set or modified in the following places:

- In the application program
- With the PLC browser in the MACS development environment

The IP address is read from the license key only when the power supply is switched on or when the MSC is reset.

10.6.3 Mounting and Removing

License Key of the MSC with Attachment Screws

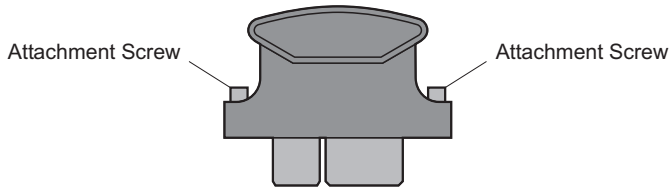


Figure 50: License Key of the MSC with Attachment Screws

10.6.3.1 Required Tool

License Key of the MSC: Tool required for Mounting and Removing

The following tool is required to mount and remove the license key:

- 3 mm screwdriver

10.6.3.2 Mounting the License Key

Mounting the License Key: Safety Instructions

WARNING

The license key may be inserted or removed only when the MSC is powered down!
Attempting to insert or remove the license key during operation might damage the license key or the MSC permanently.

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.

CAUTION

When using a screwdriver, use caution to avoid slipping and causing personal injury or damage to the MSC.

Procedure for mounting the license key:

Mounting the License Key

1. Switch off the MSC power supply.
2. Insert the license key into the slot labeled «LK» (far right on the front panel of the MSC).
3. Fix the license key in place by carefully tightening the attachment screws.

   Incorrectly tightened attachment screws might cause license key errors.

10.6.3.3 Removing the License Key

WARNING

The license key may be inserted or removed only when the MSC is powered down!
Attempting to insert or remove the license key during operation might damage the license key or the MSC permanently.

Removing the License Key: Safety Instructions

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.

CAUTION

When using a screwdriver, use caution to avoid slipping and causing personal injury or damage to the MSC.

Procedure for removing the license key:

Removing the License Key

1. If it is running, stop the application program in the MACS development environment.
2. Switch off the power supply for the MSC.
3. Loosen the license key's attachment screws.
4. Remove the license key from the slot labeled «LK» (far right on the front panel of the MSC).

10.7 Reset Button

Reset Button of the MSC

WARNING

To avoid damage, use only a suitable, electrically non-conductive tool to actuate the reset button on the front panel of the MSC. A light pressure is sufficient.

WARNING

If the most recent status in the online mode (MACS logged in) was 'Start' before the MSC was switched off or reset, the boot project will always be started after the MSC is switched back on or reset.

This will occur regardless of which application program was previously running.
In other words, the application program that will be started automatically after the MSC is switched on or reset might be different from the application program that was executing immediately prior.
⇨ "10.8.1.3 Examples" on page 87

Pressing the reset button will reset the MSC.
The processor will stop as soon as the reset button is pressed. No variables will be saved at that time.
When the reset button is released, the MSC will behave as if the power supply has been switched on.
⇨ "10.8.1.1 Switching on the Power Supply" on page 86

In addition, the MSC can be reset with the MACS development environment. Refer to the documentation of the MACS development environment for detailed information about this.

10.8 Power Supply

Power Supply of the MSC: Safety Instructions

DANGER

The L2+/M2 power supply terminals of the MSC type D136E001-001 are not protected against reverse polarity (in deviation from the requirements of IEC 61131-2). Reverse polarity on terminals L2+ and M2 will lead to permanent damage to the MSC!

The L2+/M2 power supply terminals of the other MSC types are protected against reverse polarity.
The L1+/M1 power supply terminals of all MSC types and the power supply terminals of the other M3000® modules are protected against reverse polarity.
If the polarity of these power supply terminals is reversed, the modules will not function.

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
⇨ "10.2.2.3 Electrical Conditions and Requirements" on page 70
⇨ "6.2 Power Supply" on page 38

10.8.1 Behavior at Switching on and Switching off

Contents of the Flash EEPROM

The following internal data will be saved in the flash EEPROM of the MSC:

- Values of the RETAIN variables
- Boot projects
- Error messages

The MSC provides an energy reserve used to save this data, even when the power supply for the MSC's internal electronics (L1+/M1) is switched off or has failed.
There is no battery buffered memory area. The MSC is maintenance-free.

Switching Back on or Resetting the MSC: Safety Instructions

WARNING

If the most recent status in the online mode (MACS logged in) was 'Start' before the MSC was switched off or reset, the boot project will always be started after the MSC is switched back on or reset.

This will occur regardless of which application program was previously running.
In other words, the application program that will be started automatically after the MSC is switched on or reset might be different from the application program that was executing immediately prior.
⇨ "10.8.1.3 Examples" on page 87

Application programs can be saved and executed in the MSC in the following manner:

- As a boot project in the flash EEPROM
- In RAM

An application program saved as a boot project will be loaded into RAM whenever the MSC's power supply is switched on or when the MSC is reset.

An application program that is only executed in RAM without being saved as a boot project will **not** be saved in the MSC when it is switched off or when the power supply fails.
After the power supply is switched back on, the application program must be downloaded once more from the MACS development environment!

10.8.1.1 Switching on the Power Supply

Switching on the Power Supply: Safety Instructions

WARNING

If the most recent status in the online mode (MACS logged in) was 'Start' before the MSC was switched off or reset, the boot project will always be started after the MSC is switched back on or reset.

This will occur regardless of which application program was previously running.
In other words, the application program that will be started automatically after the MSC is switched on or reset might be different from the application program that was executing immediately prior.
⇨ "10.8.1.3 Examples" on page 87

MSC's Behavior at Switching on the Power Supply

After the power supply for the MSC's internal electronics (L1+/M1) is switched on, the MSC will perform the following actions:

1. The boot project (if one exists) is loaded into RAM.
2. The values of the RETAIN variables are loaded (assuming that variables of this type are used).
3. The boot project starts (if one exists and the most recent status in the online mode (MACS logged in) was 'Start').

After these actions are complete, the MSC is ready to communicate with the MACS development environment.

10.8.1.2 Switching off or Failure of the Power Supply

MSC's Behavior at Switching off or Failure of the Power Supply

The low voltage detection of the MSC ensures that the internal module control state will always be 'RUN', 'SAVE', 'IDLE' or 'OFF', even after the power supply for the MSC's internal electronics (L1+/M1) is switched off or fails.
Explanations of these states: ⇨ table 15 on page 88

Behavior of the MSC after the power supply for the MSC's internal electronics (L1+/M1) is switched off or fails:
⇨ "10.8.2.1 Power Failures" on page 88
⇨ "10.8.2.2 Long Duration Low Voltage" on page 89
⇨ "10.8.2.3 Short Duration Low Voltage" on page 90

10.8.1.3 Examples

MSC's Behavior after Switching off or Resetting (Examples)

For a new or changed application program to start automatically after the power supply for the MSC's internal electronics is switched on or the MSC is reset, it must be saved as a boot project. In addition, the most recent status in the online mode (MACS logged in) must have been 'Start'.

Example 1

An application program will be loaded and started on an MSC which has no boot project saved in it. However, the applicaton program will not be saved as a boot project.

Behavior after switch-off or reset:
The next time the power supply is switched back on or the MSC is reset, no application program will be started because nothing has been saved as a boot project.

Example 2

An application program is saved in the MSC as a boot project. After saving, it is changed in the MACS development environment and is executed in RAM. The changed application program is not saved as a boot project. The most recent status in online mode (MACS logged in) is 'Start'.

Behavior after switch-off or reset:
The next time the power supply is switched on or the MSC is reset, the changed application program will not be loaded; instead, the saved boot project will be loaded and started.

Example 3

There is already a boot project on the MSC. A new application program is created in the MACS development environment and is loaded and started on the MSC. The application program is not saved as a boot project. The most recent status in online mode (MACS logged in) is 'Start'.

Behavior after switch-off or reset:
The next time the power supply is switched on or the MSC is reset, the previously executed application program will not be loaded; instead, the saved boot project will be loaded and started.

10.8.2 Low Voltage Detection

Low Voltage Detection of the MSC

The MSC provides an integrated low voltage detection for the power supply for the MSC's internal electronics (L1+/M1).
If the power supply is interrupted for longer than 5 ms, the low voltage detection will respond.
The threshold limit is < 18 V (typ. 16 V).
If the voltage falls below the threshold limit, the MSC will go into the 'SAVE' state.

The low voltage detection of the MSC ensures that the internal module control state will always be 'RUN', 'SAVE', 'IDLE' or 'OFF', even after the power supply for the MSC's internal electronics (L1+/M1) is switched off or fails.
Explanations of these states: ⇨ table 15 on page 88

'RUN', 'SAVE', 'IDLE', 'OFF'

State	Explanation
RUN	Normal program sequence according to the programmed application program.
SAVE	The application program is stopped. However, this does not guarantee that the current cycle is terminated. In other words, the program execution is stopped at the point where the loss of power supply is detected. All outputs are disabled, the output 'Outputs Enabled' is switched to the 0 state, and the LED «OutEN» extinguishes. ⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116 The internal data (the values saved in the RETAIN variables, the boot project, and any error messages) is saved permanently in the flash EEPROM. The MSC provides the energy reserves required to do this.
IDLE	Waiting to restart according to the programmed application program (as long as the energy reserve is sufficient).
OFF	MSC inactive

Table 15: Possible States of the Internal Module Control of the MSC

10.8.2.1 Power Failures

If the input voltage U fails (falls to zero and does not recover), the MSC will behave in the manner shown below.

States of the MSC when the Input Voltage U Fails

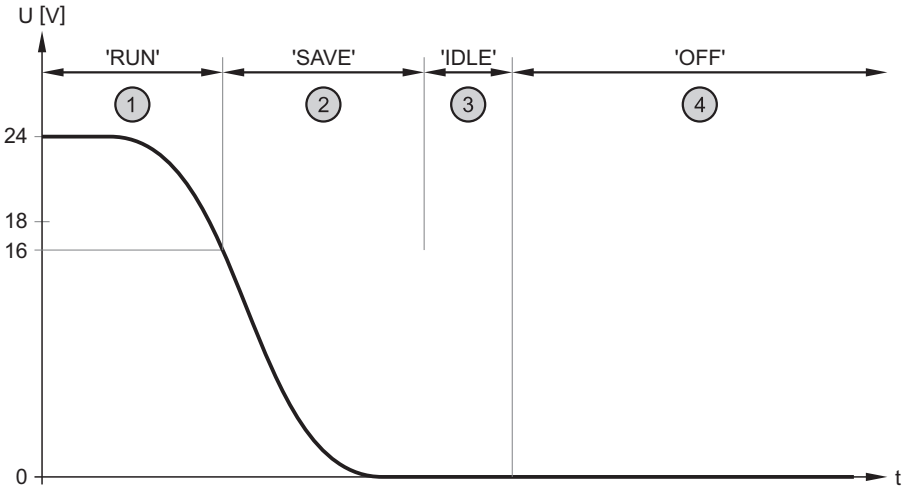


Figure 51: States of the MSC when the Input Voltage U Fails

1. As long as the input voltage is above the threshold limit, the MSC will be in the 'RUN' state, i.e., the application program will be executed. Explanations of the states: ⇨ table 15 on page 88
2. If the voltage falls below the threshold limit, the MSC will go into the 'SAVE' state.
3. As soon as the internal data is saved, the MSC will go into the 'IDLE' state.
4. When the internal energy reserve is exhausted, the MSC will go into the 'OFF' state.

10.8.2.2 Long Duration Low Voltage

A low voltage condition is designated as long duration when the input voltage U falls below the threshold limit and then does not exceed 18 V until the internal data has been saved in the flash EEPROM.

The MSC will behave in the manner shown below during long duration low voltage conditions:

States of the MSC During Long Duration Low Voltage Conditions

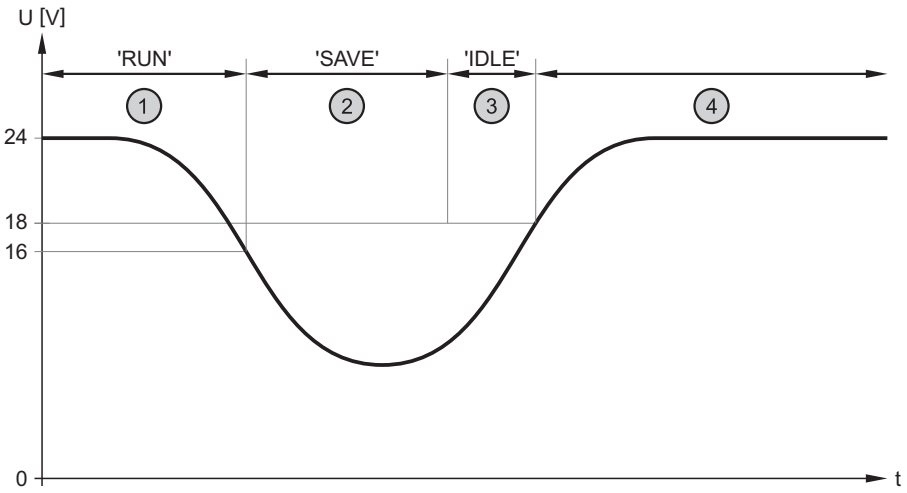


Figure 52: States of the MSC During Long Duration Low Voltage Conditions

1. As long as the input voltage is above the threshold limit, the MSC will be in the 'RUN' state, i.e., the application program will be executed.
   Explanations of the states: ⇨ table 15 on page 88
2. If the voltage falls below the threshold limit, the MSC will go into the 'SAVE' state.
3. As soon as the internal data is saved, the MSC will go into the 'IDLE' state. As long as the input voltage does not exceed 18 V, the MSC will remain in the 'IDLE' state and the outputs will remain disabled.
4. When the input voltage again exceeds 18 V, the MSC will behave as if the power supply had been switched on.
   ⇨ "10.8.1.1 Switching on the Power Supply" on page 86

10.8.2.3 Short Duration Low Voltage

A low voltage condition is designated as short duration when the input voltage U falls below the threshold limit for longer than 5 seconds and then exceeds 18 V before the internal data has been saved in the flash EEPROM.

The MSC will behave in the manner shown below during short duration low voltage conditions:

States of the MSC During Short Duration Low Voltage Conditions

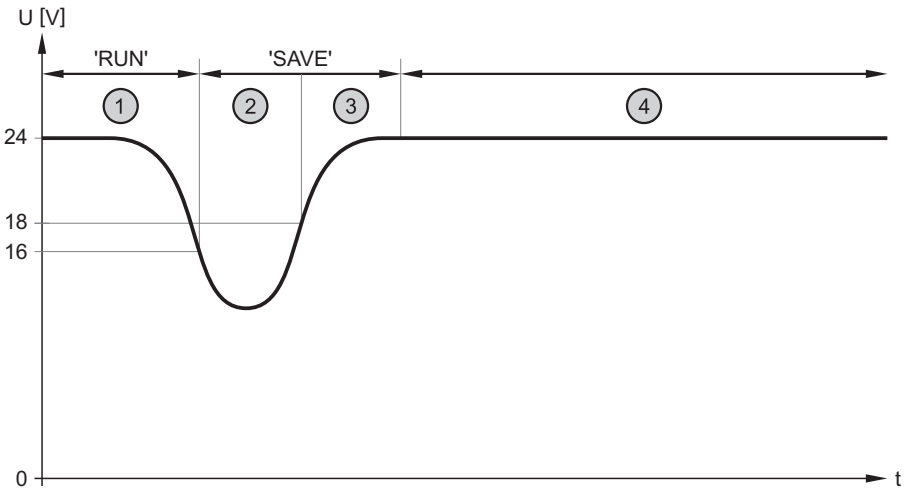


Figure 53: States of the MSC During Short Duration Low Voltage Conditions

1. As long as the input voltage is above the threshold limit, the MSC will be in the 'RUN' state, i.e., the application program will be executed.
   Explanations of the states: ⇨ table 15 on page 88
2. If the voltage falls below the threshold limit, the MSC will go into the 'SAVE' state.
3. The MSC will remain in the 'SAVE' state until the internal data has been completely saved. This means that the outputs will also remain disabled as long as the internal data is being saved, even if the voltage has already exceeded 18 V.
4. When the internal data has been completely saved, the MSC will behave as if the power supply had been switched on.
   ⇨ "10.8.1.1 Switching on the Power Supply" on page 86

10.9 Digital I/Os

Digital I/Os I/O1…I/O8 of the MSC

Each of the 8 digital terminals I/O1…I/O8 of the MSC can be used as either an input **or** an output. Each digital output is internally connected back to a digital input.
This enables the application program to read the status of the digital outputs and compare it to the requested value.

ⓘ Whether a terminal will be used as an input **or** an output is set in the PLC configuration of the MACS development environment.

The following digital output circuits are available:

- Open emitter outputs, switches to +24 V (L2+)
- Open collector outputs, switches to ground (M2)

Basic wiring diagrams of these circuits: ⇨ figure 54 on page 93

ⓘ When ordering the MSC, the wiring of the digital outputs must be specified.

10.9.1 Display of the Operational State

Yellow Status LEDs «I/O1»…«I/O8»

The yellow status LEDs «I/O1»…«I/O8» on the front panel of the MSC show the internal operational state of the digital I/Os. These status LEDs are activated only when the application program is running.

If a terminal is configured to be an input, the associated LED will illuminate when it is internally detected that the input is in the 1 state and the input is used in the application program.

When a terminal is configured to be an output, the associated LED will illuminate if the output in the application program is in the 1 state.
When MSCs have open emitter outputs, the LED will illuminate if the terminal is connected through to +24 V (L2+).
When MSCs have open collector outputs, the LED will illuminate if the terminal is connected through to ground (M2).
Basic wiring diagrams of the digital outputs: ⇨ figure 54 on page 93

ⓘ The status LEDs «I/O1»…«I/O8» will illuminate also if L2+ or M2 are not connected.

ⓘ The operational state of the digital I/Os can be queried with the aid of function blocks in the application program.

10.9.2 Power Supply

Power Supply of the Digital I/Os of the MSC: Safety Instructions

DANGER

The L2+/M2 power supply terminals of the MSC type D136E001-001 are not protected against reverse polarity (in deviation from the requirements of IEC 61131-2). Reverse polarity on terminals L2+ and M2 will lead to permanent damage to the MSC!

The L2+/M2 power supply terminals of the other MSC types are protected against reverse polarity.
The L1+/M1 power supply terminals of all MSC types and the power supply terminals of the other M3000® modules are protected against reverse polarity.
If the polarity of these power supply terminals is reversed, the modules will not function.

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 DIN rail 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 3 on page 40):

- Reverse energization from sensor to module
- Invalid sensor data

WARNING

Sensors that are connected to digital inputs of DIN rail modules with several I/O groups, such as MSC, QDIO, or RDIO, must under all conditions 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

Power Supply of the Digital I/Os of the MSC

The power supply for the digital I/Os of the MSC is independent of the power supply for the MSC's internal electronics (L1+/M1) and is established over the terminals L2+ and M2.

Power supply characteristics
⇨ "6.2.1 Power Supply Characteristics" on page 38

Connecting sensors to the power supply:
⇨ "6.2.4 Connecting Sensors" on page 42

Connecting the power supply for the internal electronics:
⇨ "6.2.3 Connecting the Power Supply" on page 39

10.9.3 Digital Outputs

Digital Outputs of the MSC

The following digital output circuits are available:

- Open emitter outputs, switches to +24 V (L2+)
- Open collector outputs, switches to ground (M2)

Basic Wiring Diagram of a Digital Output of the MSC

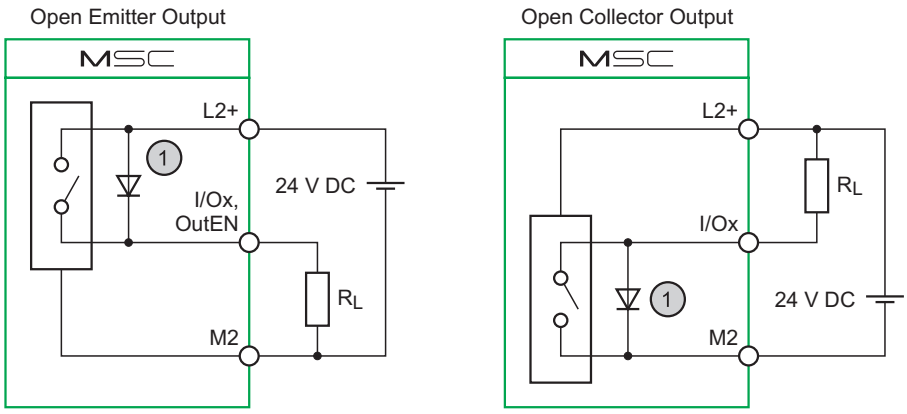


Figure 54: Basic Wiring Diagram of a Digital Open Emitter/Collector Output of the MSC

(1) Protective circuit with a limiting voltage of 50 V as protection against induced voltage spikes when there are inductive loads.
⇨ "10.9.3.2 Current Limiting and Overload Protection" on page 94

Open Emitter Output

A digital **open emitter output** in the 1 state (conductive) connects the attached load R_L to the power supply terminal L2+.

Open Collector Output

A digital **open collector output** in the 1 state connects the attached load R_L to the ground potential terminal M2 of the power supply.

When ordering the MSC, the wiring of the digital outputs must be specified.

The output 'Outputs Enabled' is always an open emitter output.
⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116

10.9.3.1 Dependence on the 'Outputs Enabled' Signal

Dependence of MSC's Digital Outputs on the 'Outputs Enabled' Signal

If the digital output 'Outputs Enabled' is in the 0 state (LED «OutEN» does not illuminate), all other outputs are disabled.
In this case, although the internal states of the digital outputs are shown on the front panel status LEDs «I/O1»…«I/O8» of the MSC, they are not connected through to the output.
⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116

Behavior of the digital outputs when the power supply for the MSC's internal electronics is switched off or fails:
⇨ "10.8.1.2 Switching off or Failure of the Power Supply" on page 86

10.9.3.2 Current Limiting and Overload Protection

Current Limiting and Overload Protection for Digital Outputs of the MSC

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 overload has been removed and thermal cooling is complete, the application program can re-enable the output. To re-enable the output, the overloaded output must first be switched to the 0 state. It will then be available as normal.

A protective circuit with a limiting voltage of 50 V with respect to +24 V (L2+) for open emitter outputs or with respect to ground (M2) for open collector outputs protects all outputs against induced voltage spikes when there are inductive loads.

Reverse energization or induced voltage spikes might cause the overload protection of unaffected outputs to trigger prematurely.

10.9.3.3 Overload Behavior

Overload Behavior of MSC's Digital Outputs

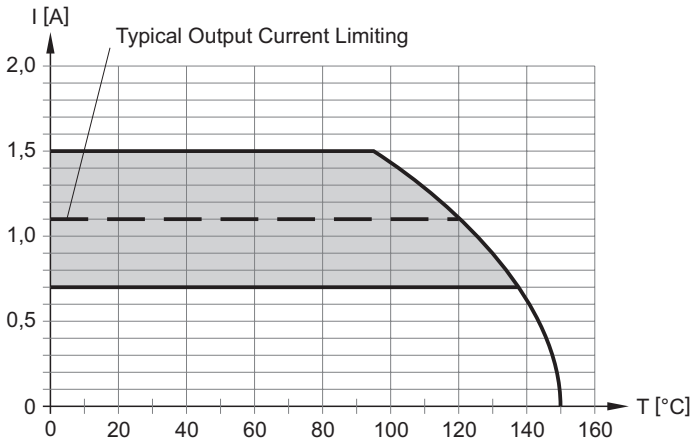


Figure 55: Typical Output Current I Limiting of MSC's Digital Outputs verses the Temperature T of the Transistor

10.9.3.4 Specifications

Specifications of MSC's Digital Outputs

Number of digital outputs
Maximum 8
⇨ "10.9 Digital I/Os" on page 91

Type of outputs
Semiconductor, non-capacitive

Protective circuitry for inductive loads
Limiting voltage of 50 V (typ.) with respect to +24 V (L2+) for open emitter outputs or with respect to ground (M2) for open collector outputs

Power dissipation of protection devices when limiting
Max. 0.5 W per output
Max. 4 W per MSC

Status display
One yellow status LED per I/O
⇨ "10.9.1 Display of the Operational State" on page 91

Diagnosis function
The operational state of the digital I/Os can be queried with the aid of function blocks in the application program.

Power consumption for the internal control circuit (L2+/M2)
≤ 200 mA

10.9.3.5 Load Connection

Load Connection of MSC's Digital Outputs

Total load (100 %)
4 A (8 x 0.5 A), when all 8 terminals are used as outputs

Overload protection
Electronic current limiting and thermal overload protection
⇨ "10.9.3.2 Current Limiting and Overload Protection" on page 94

Threshold limit of the overload or short-circuit protection
Min. 0.7 A, typ. 1.1 A

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 task interval of the application program that actuates the output.

ⓘ The task interval (and thereby the update time of the outputs) is set in the task configuration of the MACS development environment.

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

10.9.3.6 Insulation Resistance

Insulation Resistance of MSC's Digital Outputs

Insulation resistance

Rated voltage: 0–50 V DC

Test voltage for 2,000 m (2,187 yd) operating elevation: 500 V DC

10.9.4 Digital Inputs

Digital Inputs of the MSC

The digital inputs are current consuming inputs 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 cyclically. An open input is interpreted as the 0 state.

10.9.4.1 Basic Wiring Diagram

Basic Wiring Diagram of a Digital Input of the MSC (Current Consuming)

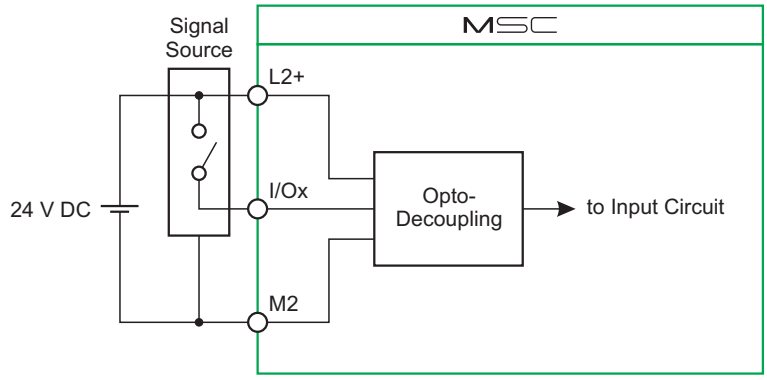


Figure 56: Basic Wiring Diagram of a Digital Input of the MSC (Current Consuming)

10.9.4.2 Pulse Detection and Disturbance Suppression

Pulse Detection and Disturbance Suppression of MSC's Digital Inputs

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

ⓘ The task interval (and thereby the sampling time of the inputs) is set in the task configuration of the MACS development environment.

For input pulses to be reliably detected, they must be longer than the task interval specified in the application program.
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: ≤ 50 µs
- Pulses that can be detected (if the system reads the input when the pulse appears); pulse duration: > 50 µs
- Pulses that are always detected; pulse duration: > the set task interval

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.

10.9.4.3 Specifications

Specifications of MSC's Digital Inputs

Number of the digital inputs

Maximum 8

⇨ "10.9 Digital I/Os" on page 91

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.

Load rated voltage L2+

24 V DC (safety extra-low voltage SELV according to DIN EN 60950-1)

Reverse polarity protection

Digital inputs are protected against reverse polarity

Potential isolation

Achieved with optocouplers

Status display

One yellow status LED per I/O

⇨ "10.9.1 Display of the Operational State" on page 91

Alarms

Can be implemented in the application program

Input delay (hardware)

From 0 to 1: max. 100 µs
From 1 to 0: max. 100 µs

Sampling time

The sampling time corresponds to the task interval of the application program that reads the input.

⇨ "10.9.4.2 Pulse Detection and Disturbance Suppression" on page 96

ⓘ The task interval (and thereby the sampling time of the inputs) is set in the task configuration of the MACS development environment.

Input capacitance

Max. 10 nF

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

≤ 200 mA

10.9.4.4 U/I Working Ranges

U/I Working Ranges of MSC's Digital Outputs (Current Consuming)

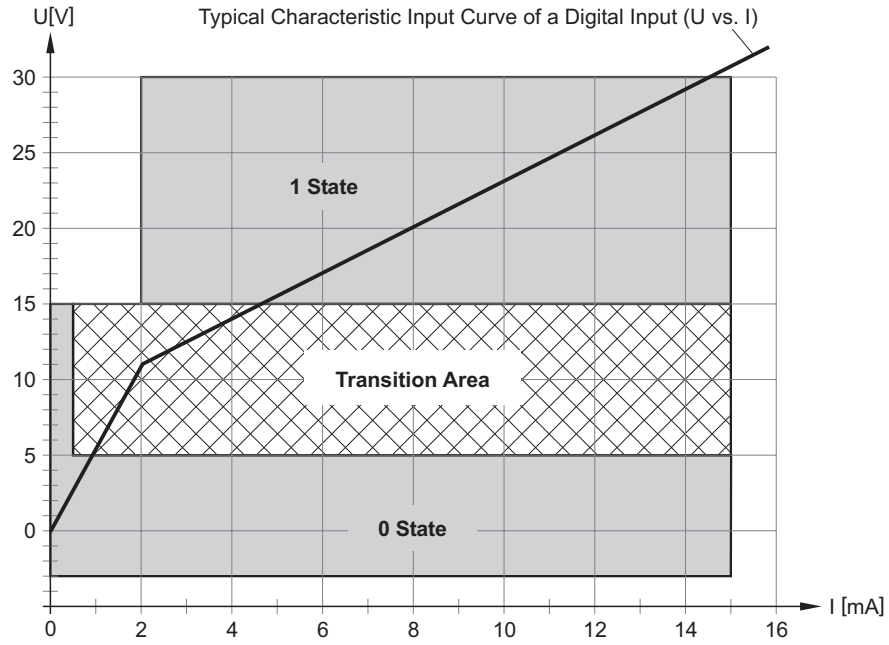


Figure 57: U/I Working Ranges of MSC's Digital Outputs (Current Consuming)

Input voltage (DC) of the external power supply L2+	rated voltage	U_e = 24 V
	upper limit	$U_{e\,max}$ = 36 V
	lower limit	$U_{e\,min}$ = 18 V
Limits for the 1 state	upper limit	UH_{max} = 30 V IH_{max} = 15 mA
	lower limit	UH_{min} = 15 V IH_{min} = 2 mA
Limits for the 0 state	upper limit	UL_{max} = 15/5 V IL_{max} = 15 mA
	lower limit	UL_{min} = –3 V IL_{min} = ND

Table 16: U/I Working Ranges of MSC's Digital Outputs (Current Consuming)

10.9.4.5 Insulation Resistance

Insulation Resistance of MSC's Digital Inputs

Insulation resistance

Rated voltage: 0–50 V DC

Test voltage for 2,000 m (2,187 yd) operating elevation: 500 V DC

10.10 Analog Outputs

10.10.1 Basic Wiring Diagram

Basic Wiring Diagram of an Analog Output of the MSC

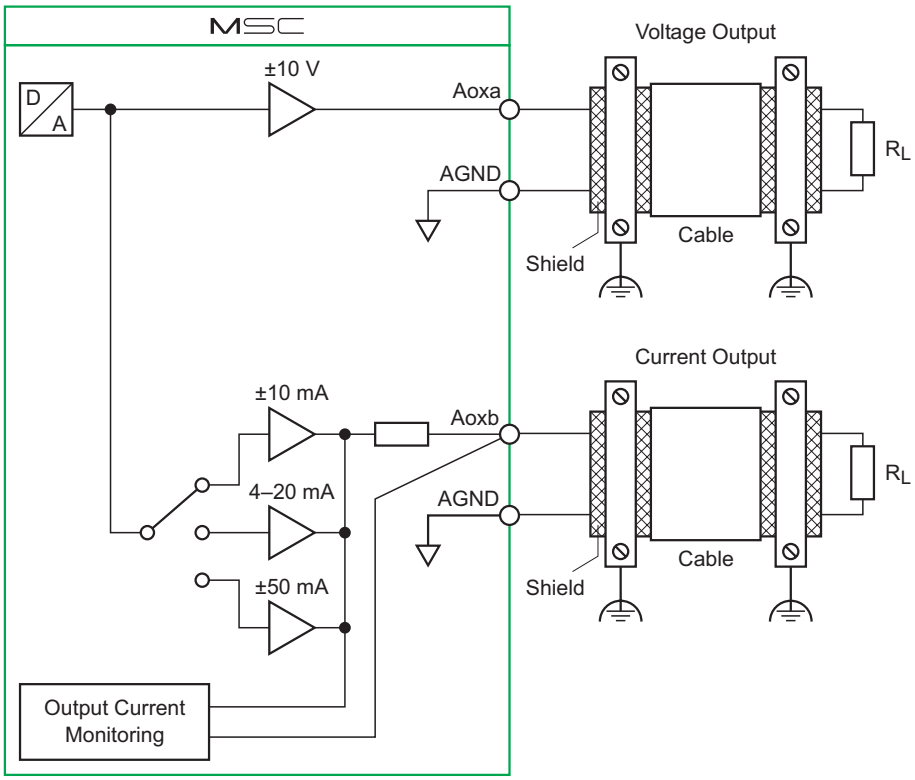


Figure 58: Basic Wiring Diagram of an Analog Output Aox of the MSC (when Used as a Voltage and Current Output)

10.10.2 Specifications

Specifications of MSC's Analog Outputs

Number of analog outputs

2

Analog output type

Voltage output ±10 V nominal
Additionally one current output each:
configurable as: ±10 mA, ±50 mA or 4–20 mA (each nominal)

ⓘ The analog outputs are configured in the PLC configuration of the MACS development environment.

Output impedance within nominal signal range

< 0.2 Ω (voltage output)
Approx. 1 MΩ (current outputs)

Greatest error over the entire temperature range

±1 % of full scale value

Specifications of MSC's Analog Outputs

Output ranges

Nominal	Minimum	Maximum	LSB Value
±10 V	−10.92 V	+10.92 V	0.333 mV
±10 mA	−10.92 mA	+10.92 mA	0.333 µA
±50 mA	−54.61 mA	+54.61 mA	1.667 µA
4–20 mA	+3.262 mA	+20.74 mA	0.267 µA

Table 17: Output Ranges of MSC's Analog Outputs

Digital resolution

16 bit

Data format in the application program

32 bit floating point

Load impedance range

Voltage output ±10 V: ≥ 1,000 Ω
Current output ±10 mA: ≤ 1,000 Ω
Current output ±50 mA: ≤ 200 Ω
Current output 4–20 mA: ≤ 500 Ω

ⓘ The load impedance range of the current output 4–20 mA does not comply with IEC 61131-2. (IEC 61131-2 requires a load impedance range of ≤ 600 Ω.)

Update time

The update time corresponds to the task interval of the application program that actuates the output.

ⓘ The task interval (and thereby the update time of the outputs) is set in the task configuration of the MACS development environment.

Rise time $T_{10/90}$

Output		Step From	Step To	R_L	Typ. $T_{10/90}$
Voltage Output	±10 V	+10 V	-10 V	≥ 1,000 Ω	140 µs
		-10 V	+10 V		
Current Output	±10 mA	+10 mA	-10 mA	1,000 Ω	60 µs
		-10 mA	+10 mA		
	±50 mA	+50 mA	-50 mA	200 Ω	125 µs
		-50 mA	+50 mA		
	4–20 mA	20 mA	4 mA	500 Ω	70 µs
		4 mA	20 mA		

Table 18: Rise Time $T_{10/90}$ of MSC's Analog Outputs

Protection

Continuous short-circuit protection; overvoltage protection up to ±36 V

Short-circuit current $I_K$max

Voltage output ±10 V: $I_K$max = ±15 mA
Current output ±10 mA: $I_K$max = ±10.92 mA
Current output ±50 mA: $I_K$max = ±54.61 mA
Current output 4–20 mA: $I_K$max = ±20.74 mA

Specifications of MSC's Analog Outputs

Recommended cable types

Use only shielded cables.
The shield must be made of copper braiding with at least 80% coverage.
The wire must be made of copper with a cross section of at least 0.25 mm^2 (23 AWG).
In environments with a high amount of disturbance, use cables with twisted pair wires.

Calibration

The MSC is calibrated at the factory and does not require any additional calibration.

Permissible load types

Resistive load according to "Load impedance range" on page 100.

ⓘ The stability of the current outputs is ensured up to an inductive load of 100 mH.

ⓘ The stability of the voltage outputs is ensured up to a capacitive load of 10 µF.

Output current of the voltage output

Max. 10 mA

Wire fault monitoring of the analog current outputs

The analog current outputs are monitored for wire faults. The status of the wire fault monitoring can be evaluated in the application program.
The «Ao1b» or «Ao2b» front panel error LEDs of the MSC illuminate if:

- No load is attached to the corresponding analog current output
- The load resistance is too great (the current output can no longer drive the required current)
- There is a wire break

10.11 Reference Voltage Output

Reference Voltage Output of the MSC

Reference voltage

+10 V DC

Load current

Max. 5 mA

Precision

±0.3 % of full scale value

Temperature coefficient

< 280 µV/K

Output impedance

< 0.2 Ω

Protection

Continuous short-circuit protection; overvoltage protection up to ±36 V

Short-circuit current

$I_K$max = 15 mA (residual current of the terminals 91 (REF) and 100 (REF) of the connector X6)

10.12 Analog Inputs

10.12.1 Basic Wiring Diagram

Basic Wiring Diagram of an Analog Input of the MSC

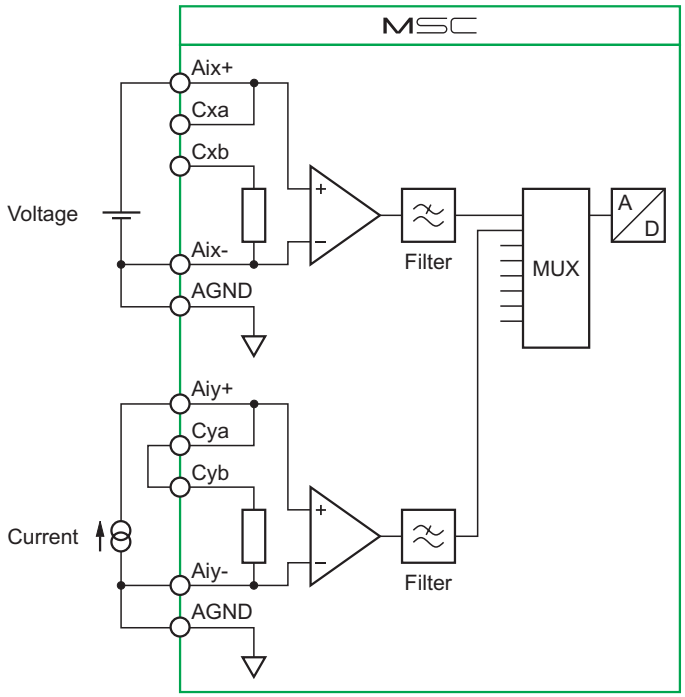


Figure 59: Basic Wiring Diagram of the Analog Inputs Ai1…Ai8 of the MSC

The upper analog input Aix in figure 59 is configured as a voltage input, the lower analog input Aiy as a current input.

An analog input Aix can only be used as a current input if the terminal Cxa is connected to the terminal Cxb.
Example: If Ai4 will be used as an analog current input, C4a must be connected to C4b.

Insertion bridges for connecting the MSC terminals Cxa and Cxb are available from Moog as accessories.
⇨ "11.8 Plug-In Terminal Strips" on page 124

10.12.2 Specifications

Specifications of MSC's Analog Inputs

Number of analog inputs
8

Type of analog inputs
Differential, configurable as: ±10 V, ±10 mA or 4–20 mA (each nominal)

The analog inputs are configured in the PLC configuration of the MACS development environment.

Common-mode properties
Common-mode rejection: > 85 dB
Common-mode voltage range: ±17 V

Input impedance within nominal signal range
> 100 kΩ on voltage inputs
200 Ω on current inputs

Specifications of MSC's Analog Inputs

Greatest error over the entire temperature range
±0.5 % of full scale value

Permissible measurement range

Nominal	Minimum	Maximum	LSB Value
±10 V	−10.92 V	+10.92 V	$0.\overline{3}$ mV
±10 mA	−10.92 mA	+10.92 mA	$0.\overline{3}$ µA
4–20 mA	+3.262 mA	+20.74 mA	$0.2\overline{6}$ µA

Table 19: Permissible Measurement Range of MSC's analog inputs

Max. permissible continuous overload (higher load results in damage)
±36 V on voltage inputs
±36 mA on current inputs (or ±6.4 V without current limiting)

Digital resolution
16 bit

Data format in the application program
32 bit floating point

Output values when below or above measurement range
Maximum or minimum values: ⇨ table 19 on page 103

Conversion method
Successive approximation

Duration of conversion per input
Typ. 12.5 µs

Sampling time
The sampling time corresponds to the task interval of the application program that reads the input.
All 8 analog inputs are sampled continuously in succession, i.e., every analog input is updated every 100 µs (max. 8 inputs à 12.5 µs of conversion time). The most recent value is used in the application program.

ⓘ The task interval (and thereby the sampling time of the inputs) is set in the task configuration of the MACS development environment.

Input filter
Filter type: low pass of 3rd order with Bessel characteristic
Crossover frequency: typ. 1.5 kHz

Protective device
Diodes

Recommended cable types
Use only shielded cables.
The shield must be made of copper braiding with at least 80% coverage.
The wire must be made of copper with a cross section of at least 0.25 mm^2 (23 AWG).
In environments with a high amount of disturbance, use cables with twisted pair wires.

Calibration
The MSC is calibrated at the factory and does not require any additional calibration.

Crosstalk between inputs
< 0.02 %

10.12.3 Connecting Analog Sensors

Connecting Analog Sensors to the MSC

Recommended cable types

Use only shielded cables.

The shield must be made of copper braiding with at least 80% coverage.

The wire must be made of copper with a cross section of at least 0.25 mm^2 (23 AWG).

In environments with a high amount of disturbance, use cables with twisted pair wires.

10.12.3.1 Shielding Signal Cables

Shielding the Signal Cable when Connecting an Analog Sensor to the MSC

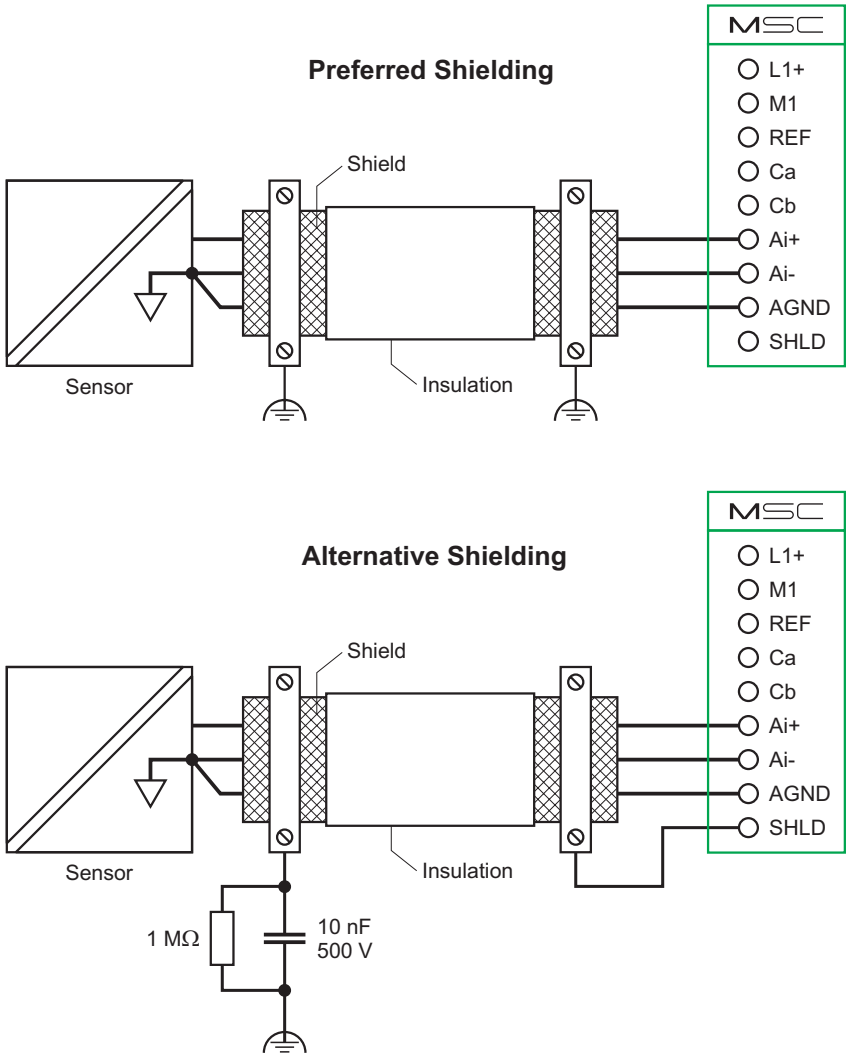


Figure 60: Shielding the Signal Cable when Connecting an Analog Sensor to the MSC

10.12.3.2 Isolated Sensors

Connecting Isolated Analog Sensors to the MSC

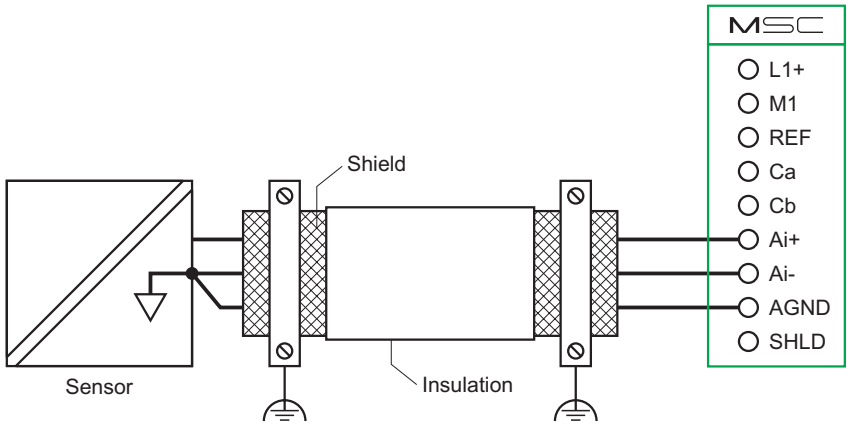


Figure 61: Connecting an Isolated Analog Sensor to the MSC (Voltage Signal)

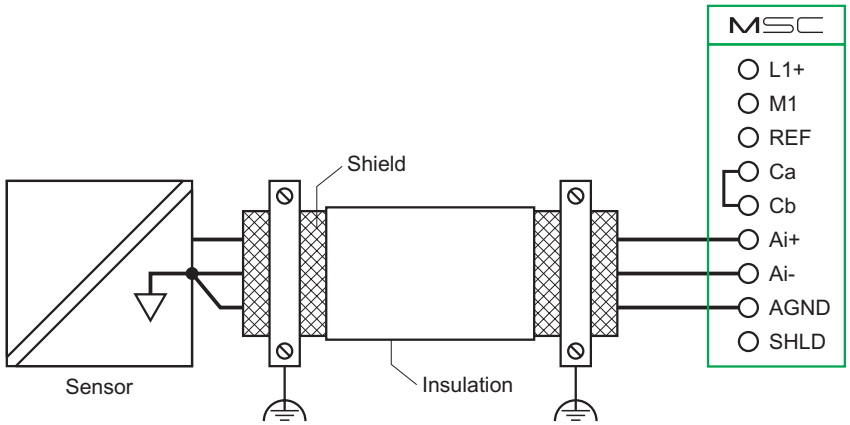


Figure 62: Connecting an Isolated Analog Sensor to the MSC (Current Signal)

10.12.3.3 Non-Isolated Sensors

Sensors with their own auxiliary energy connection

Connecting Non-Isolated Analog Sensors with their Own Auxiliary Energy Connection to the MSC

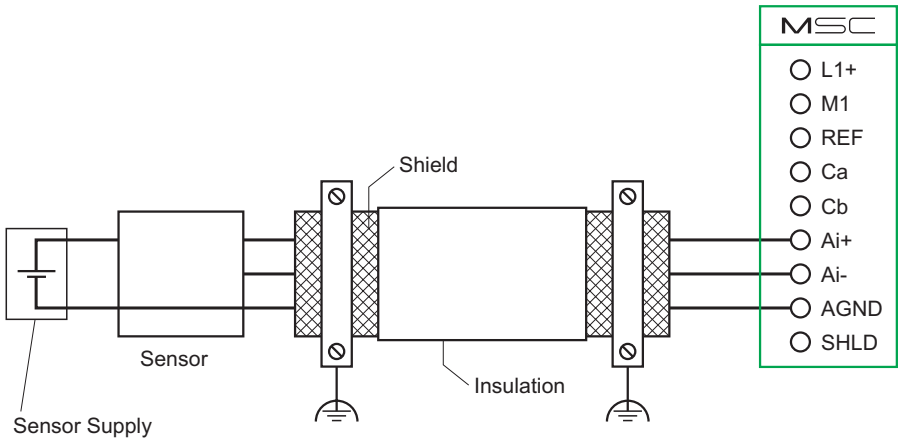


Figure 63: Connecting a Non-Isolated Analog Sensor (Voltage Signal) with its Own Auxiliary Energy Connection to the MSC

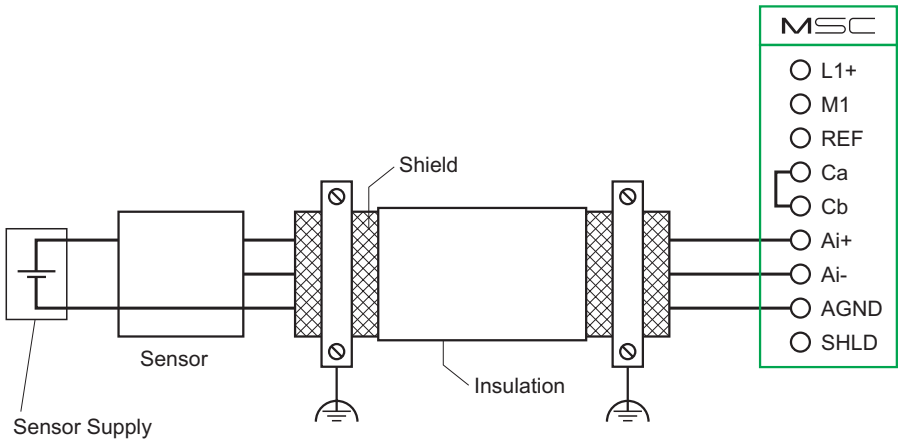


Figure 64: Connecting a Non-Isolated Analog Sensor (Current Signal) with its Own Auxiliary Energy Connection to the MSC

Sensors with the same auxiliary energy connection as the MSC

Connecting Non-Isolated Analog Sensors with the Same Auxiliary Energy Connection as the MSC

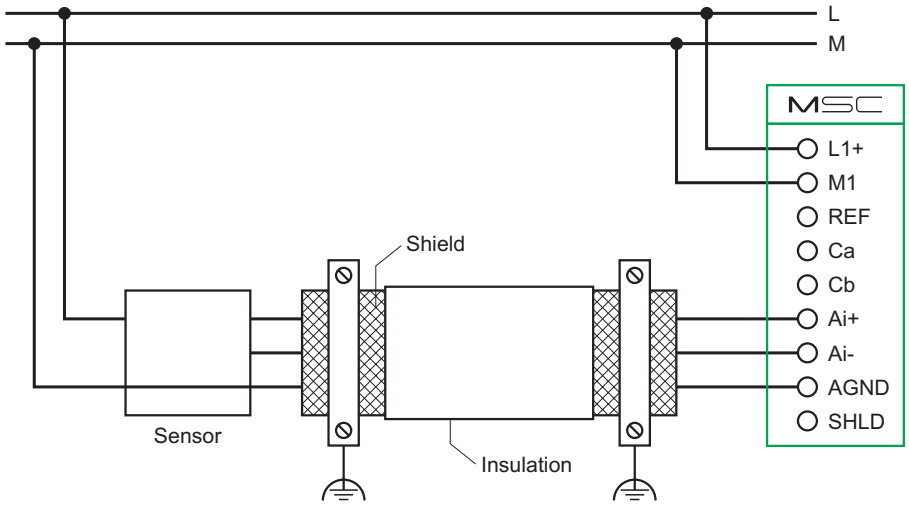


Figure 65: Connecting a Non-Isolated Analog Sensor (Voltage Signal) with the Same Auxiliary Energy Connection as the MSC

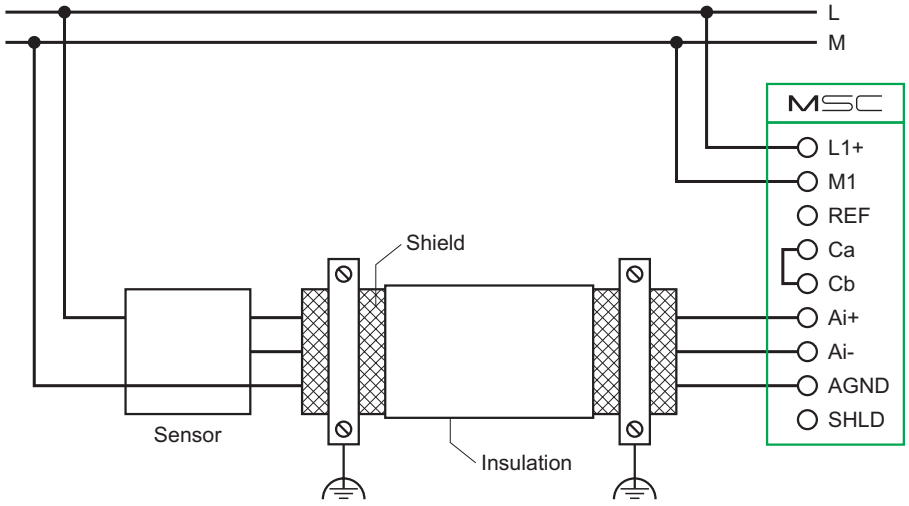


Figure 66: Connecting a Non-Isolated Analog Sensor (Current Signal) with the Same Auxiliary Energy Connection as the MSC

Connecting Non-Isolated Analog Two Wire Sensors with the Same Auxiliary Energy Connection as the MSC

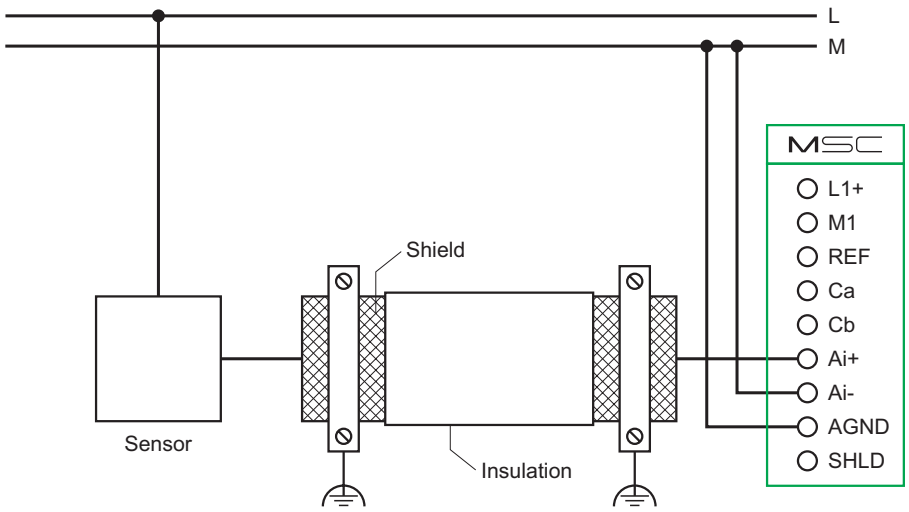


Figure 67: Connecting a Non-Isolated Two Wire Analog Sensor (Voltage Signal) with the Same Auxiliary Energy Connection as the MSC

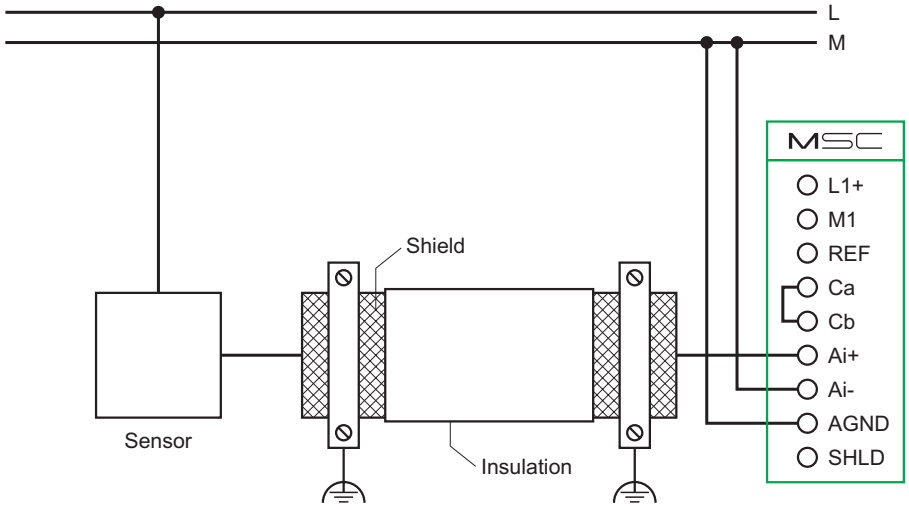


Figure 68: Connecting a Non-Isolated Two Wire Analog Sensor (Current Signal) with the Same Auxiliary Energy Connection as the MSC

10.12.3.4 Using the MSC's Internal Reference Voltage

Connecting a Potentiometer to the MSC Using the MSC's Internal Reference Voltage

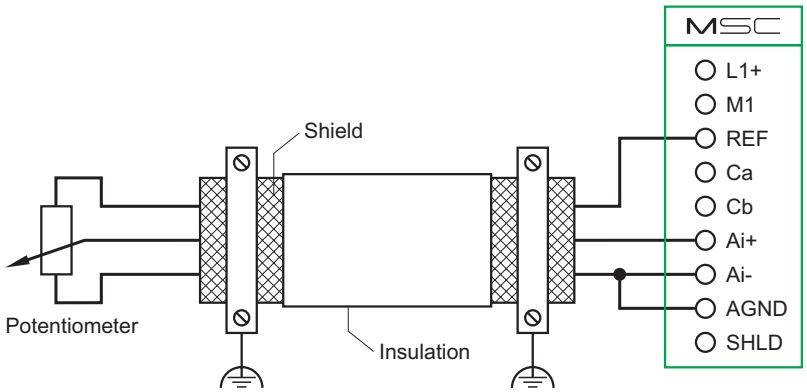


Figure 69: Connecting a Potentiometer to the MSC Using the MSC's Internal Reference Voltage

Connecting an Analog 4-Wire Sensor to the MSC Using the MSC's Internal Reference Voltage

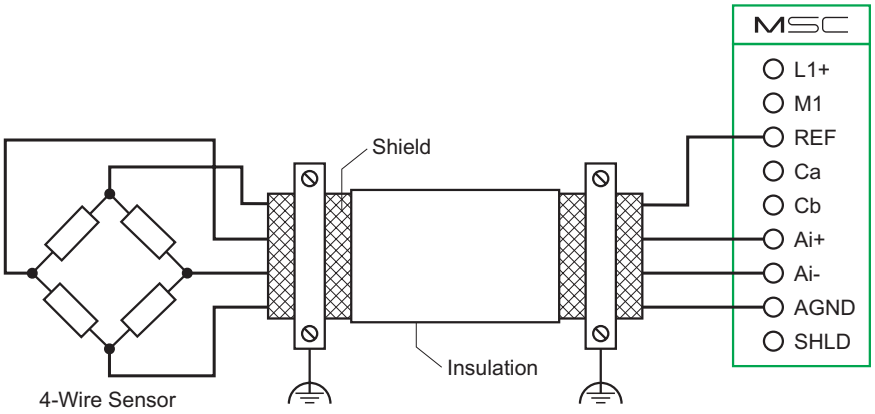


Figure 70: Connecting an Analog 4-Wire Sensor to the MSC Using the MSC's Internal Reference Voltage

10.13 Digital Sensor Interfaces

Digital Sensor Interfaces of the MSC

The MSC provides 2 digital sensor interfaces according to TIA/EIA 422 (previously RS 422) that can be used with devices such as position transducers or shaft encoders with an SSI interface or incremental sensor signals.
⇨ "10.13.2 Connecting SSI Sensors" on page 109
⇨ "10.13.3 Connecting Incremental Sensors" on page 111

ⓘ The sensor interfaces are configured in the PLC configuration of the MACS development environment.

Recommended cable types

Use only shielded cables.
The shield must be made of copper braiding with at least 80% coverage.
The wire must be made of copper with a cross section of at least 0.25 mm^2 (23 AWG).
In environments with a high amount of disturbance, use cables with twisted pair wires.

10.13.1 Wire Fault Monitoring

Wire Fault Monitoring of MSC's Digital Sensor Interfaces

The inputs A, B, and Z of the digital sensor interfaces of the MSC are monitored for wire faults, regardless of which type of sensor is attached.

The signals supplied by the wire fault monitoring function are available in the application program. The user is responsible for evaluating these signals and defining the appropriate reaction to the appearance of a wire fault.

The status of wire fault monitoring is displayed by 6 front panel error LEDs of the MSC. Each of the 6 TIA/EIA 422 inputs is assigned to one LED.
⇨ "10.13.1.1 Wire Fault Display LEDs" on page 108

10.13.1.1 Wire Fault Display LEDs

Wire Fault Display LEDs of MSC's Digital Sensor interfaces

The 6 front panel error LEDs «A1», «B1», «Z1», «A2», «B2», and «Z2» of the MSC will illuminate if:

- No sensor is attached to the corresponding sensor interface
- There is a wire break

10.13.2 Connecting SSI Sensors

Connecting SSI Sensors to the MSC

An SSI sensor supplies an absolute position signal or angle signal that can be read through the MSC's sensor interface. The current value is available in the application program continuously.

If an SSI sensor is attached to the sensor interface of the MSC, the MSC can be used as a master or a slave. The sensor interface must then be inserted and configured as a master or slave, respectively, in the PLC configuration of the MACS development environment.

ⓘ If the MSC is used as a master, the terminal assignment of the SSI interface will be different than if it is used as a slave!

MSC connection diagram (master mode): ⇨ figure 71 on page 109
MSC connection diagram (slave mode): ⇨ figure 72 on page 110

10.13.2.1 SSI Master Mode

MSC in SSI Master Mode

In SSI master mode, the MSC generates the SSI clock internally (sensor 1: CLK1, sensor 2: CLK2) with adjustable frequencies in the range between 78 kHz and 5 MHz. The frequencies are set in the PLC configuration of the MACS development environment.

When idle, the clock signal will be in the 1 state. The first falling egde of the clock signal tells the SSI sensor to hold its momentary value. The clock signal's subsequent rising egde starts the data transmission of the SSI sensor. The output begins with the most significant bit (MSB). After a complete data set has been transmitted, the SSI sensor holds the data signal in the 0 state until the SSI sensor is ready for another transmission. The return of the data signal to the 1 state simultaneously fulfills the condition the SSI interface needs to trigger a new read-in cycle.

Connection Diagram of the MSC in Master Mode

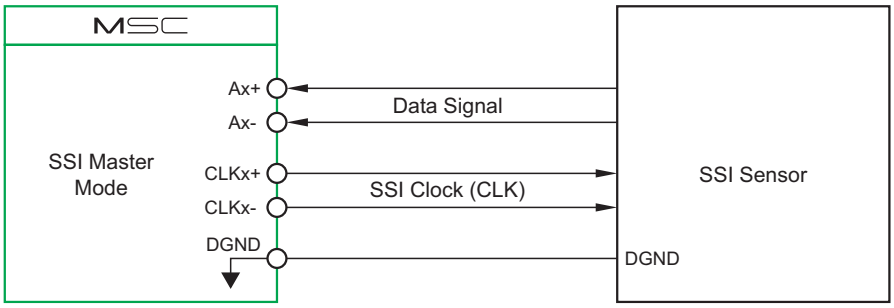


Figure 71: Connection Diagram of the MSC in Master Mode

10.13.2.2 SSI Slave Mode

MSC in SSI Slave Mode

When in SSI slave mode, the MSC does not generate its own SSI clock; instead, it reads the data in synchronization with an externally generated clock signal. When it is an SSI slave, the MSC influences neither the SSI clock frequency nor the update rate with which new data is requested from the SSI sensor. In this mode, the MSC reads the data signal with every falling egde of the clock.

With a symmetrical clock, the sensor interface can evaluate signals in the frequency range of 78 kHz to 5 MHz.
When the clock signal is asymmetrical, the width of the positive pulse must be smaller than 6.3 µs so that the sensor interface that is configured as an SSI slave will not perceive prematurely that the data transmission is concluded.
The clock signal must be in the 1 state for longer than 6.5 µs so that the sensor interface will save the value that has been read.

Connection Diagram of the MSC in Slave Mode

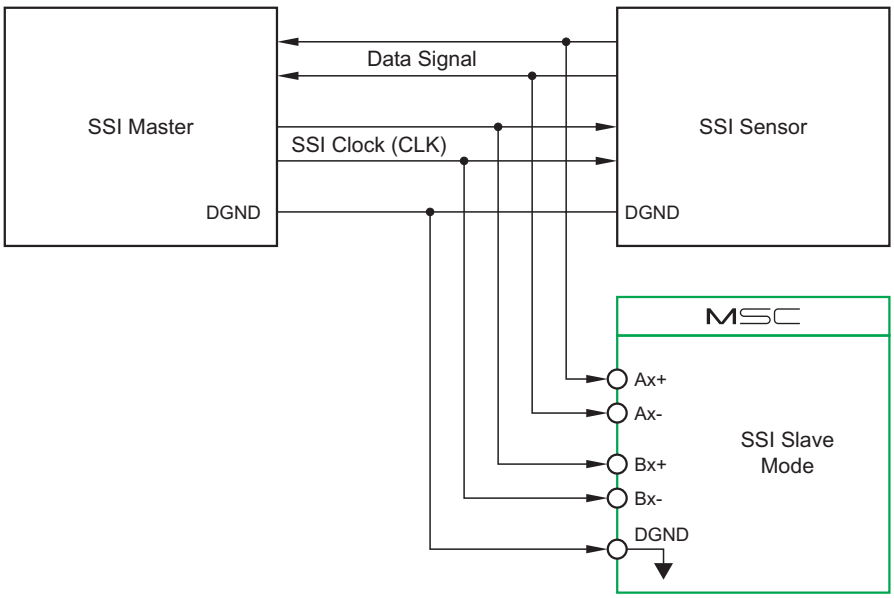


Figure 72: Connection Diagram of the MSC in Slave Mode

Signals Between the MSC and a 16 Bit SSI Sensor (Example)

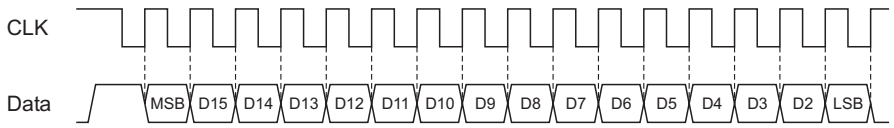


Figure 73: Signals Between the MSC and a 16 Bit SSI Sensor (Example)

The signal levels comply with the standard TIA/EIA 422 (previously RS 422).

SSI sensors can be used that supply either gray code or binary coded data. The maximum possible resolution is 32 bits.

The adaptation for the application program is done in the MACS development environment. For this, the proper function blocks (as appropriate for the coding of the sensor) must be inserted into the application program.

ⓘ The external SSI master must be capable of driving two TIA/EIA 422 inputs (including the termination resistors)!

10.13.3 Connecting Incremental Sensors

Connecting Incremental Sensors to the MSC

Incremental sensors supply a relative position or angle signal that the MSC can read. In doing so, it can detect and evaluate, without error, impulse sequences with frequencies up to 8 MHz. The adjustable 32 bit actual value in the MSC is varied dependent on the leading or lagging sequence of A and B signals. Only 4 egdes evaluation is used for this.

Example:
With 4 egdes evaluation, a sensor with 1,024 dashes per revolution will supply to the application program 4,096 increments per revolution.

A check will be performed with every rising and falling egde of the A and B signals to determine whether the B signal is lagging behind the A signal. If this is the case, the actual value will be increased by 1. If the A signal lags behind the B signal, the actual value will be decreased by 1.

Connection Diagram of the MSC with an Incremental Sensor

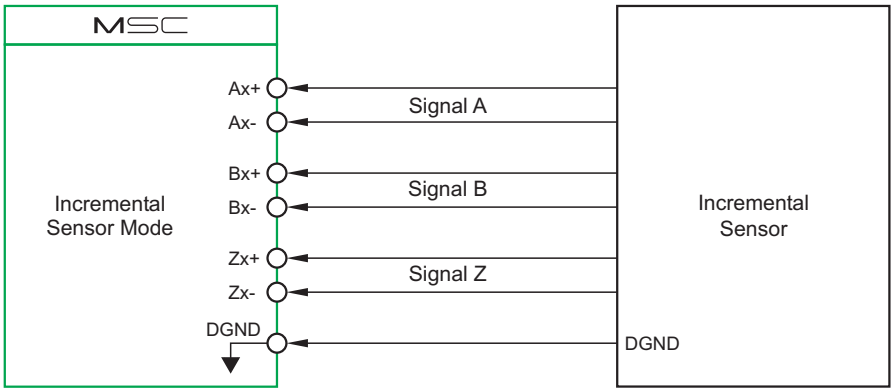


Figure 74: Connection Diagram of the MSC with an Incremental Sensor

Incremental Sensor Signals A and B with Reversal Point and Speed Change

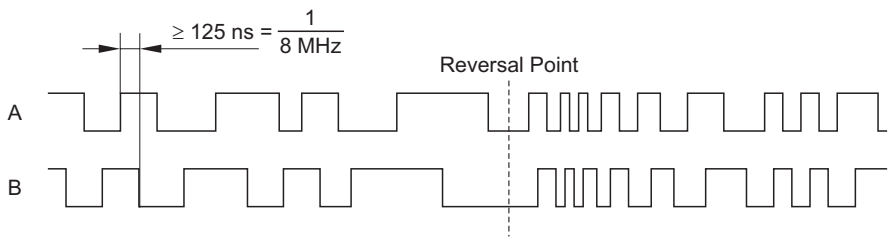


Figure 75: Incremental Sensor Signals A and B with Reversal Point and Speed Change

To the left of the reversal point in figure 75, signal B leads the signal A. The actual value is decreased by 1 with every egde of A and B.
To the right of the reversal point, signal A leads; as a result, the actual value is increased by 1 with every egde of A and B.

The signal levels comply with the standard TIA/EIA 422 (previously RS 422).

The terminal designations will vary, depending on the manufacturer of the incremental sensor.

Designations of Incremental Sensor Terminals

	Terminal Designation					
MSC	A+	A-	B+	B-	Z+	Z-
Sensor supplied by Heidenhain	U_{a1}	$\overline{U_{a1}}$	U_{a2}	$\overline{U_{a2}}$	U_{a0}	$\overline{U_{a0}}$
Sensor supplied by Hengstler	a	$\overline{a}$	B	$\overline{B}$	N	$\overline{N}$
Sensor supplied by Stegmann	a	$\overline{a}$	B	$\overline{B}$	M	$\overline{M}$
Sensor supplied by Allen-Bradley	a	$\overline{a}$	B	$\overline{B}$	Z	$\overline{Z}$

Table 20: Designations of Incremental Sensor Terminals
(MSC and Incremental Sensors from Various Manufacturers)

The adaptation for the application program is done in the MACS development environment. For this, the proper function blocks (as appropriate for the coding of the sensor) must be inserted into the application program.

10.14 E-Bus Interface

E-Bus Interface of the MSC

The MSC's inputs and outputs can be extended locally by establishing an E-bus group (by attaching up to 7 E-bus slaves to the E-bus interface).

Examples:

- After 7 QDIO 16/16-0,5 extension modules are attached, an additional 112 digital inputs and 112 individually configurable digital I/Os will be available.
- After attaching 4 QAIO 16/4 extension modules and 3 QDIO 16/16-0,5 extension modules, an additional 64 analog inputs, 16 analog outputs, 48 digital inputs, and 48 individually configurable digital I/Os will be available.

Additional information about the E-bus interface and E-bus groups:
⇨ "7.4.1 E-Bus Interface" on page 55
⇨ "7.4.2 E-Bus Communication" on page 56
⇨ "7.5.2 E-Bus Groups" on page 60

10.14.1 Configuration of the E-Bus Interface

Configuration of the E-Bus Interface

The E-bus interface of the MSC is configured in the PLC configuration of the MACS development environment. The number and type of attached E-bus slaves must be specified in the configuration.
The inputs and outputs of the attached E-bus slaves are also configured in the PLC configuration.

10.15 CAN Bus Interfaces

CAN Bus Interfaces of the MSC

The MSC is equipped with the following independent CAN bus interfaces that can be operated within CAN bus networks:

- **WideCAN** (2 «WCAN» front panel connectors of the MSC)
- **LocalCAN** (2 internally on the lateral Q-connectors of the MSC)

A separate CAN bus controller is included for every CAN bus interface.

CAN Bus Interfaces of the MSC

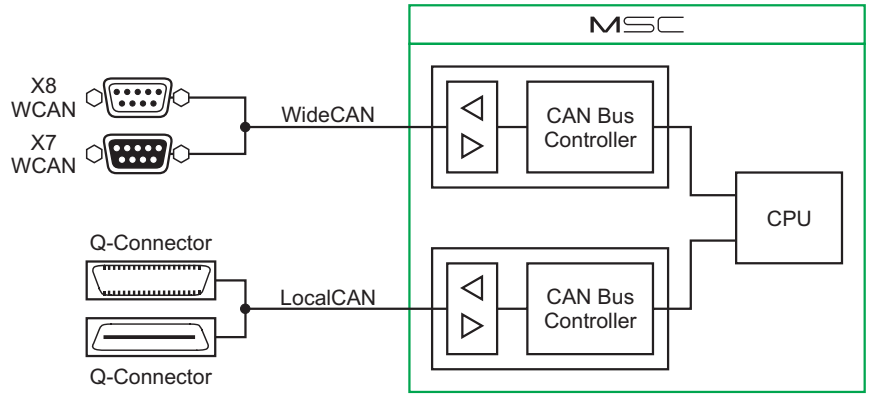


Figure 76: CAN Bus Interfaces of the MSC

Although both CAN bus interfaces are equally fast and have equal priority, WideCAN is typically used for communication between all the network stations of a wide area control system, while LocalCAN is preferred for rapid local communication between fewer network stations.

Status LEDs «WCAN» and «LCAN» of the MSC

ⓘ The «WCAN» and «LCAN» front panel status LEDs of the MSC flash synchronously to the flow of data that the MSC is sending over the WideCAN or LocalCAN interface, respectively.

The «WCAN» front panel connectors are connected internally 1:1 with each other. As a result, the MSC can be connected directly to the CAN bus without a T-adapter.

The functionality of the CAN bus interfaces is defined in the application program.

Information about CAN bus and CANopen:
⇨ "7.3 CAN Bus and CANopen" on page 50

Information about the CAN bus interface cable:
⇨ "7.3.6 CAN Bus Interface Cable" on page 54

10.15.1 CAN Bus Termination Resistor

CAN Bus Termination Resistor of the MSC

The LocalCAN interface of the MSC is equipped with a switchable CAN bus termination resistor. The termination resistor can be switched on in the PLC configuration of the MACS development environment.

The «TRM» front panel status LED of the MSC illuminates when the termination resistor of the LocalCAN interface is switched on.
⇨ "10.4.2 LEDs" on page 77

The switchable CAN bus termination resistor of the MSC can be used as a termination resistor only on LocalCAN bus groups.
⇨ "7.5.3 LocalCAN Bus Groups" on page 61

In WideCAN bus groups, the switchable CAN bus termination resistor of the MSC **cannot** be used as a termination resistor! Separate pluggable CAN termination resistors must be used for this.
⇨ "7.5.4 WideCAN Bus Groups" on page 62

D-sub connectors with CAN bus termination resistors are available from Moog.
⇨ "11.7 CAN Bus Accessories" on page 123

10.15.2 Setting the CANopen Node-ID

Setting/Modifying MSC's CANopen Node-ID

The CANopen node-ID of the CAN bus interface of the MSC can be set or modified in the following places:

- In the application program
- With the PLC browser in the MACS development environment

The CANopen node-ID is saved in the license key.
⇨ "10.6.2 CANopen Node-ID and IP Address" on page 82

10.15.3 Setting the CAN Bus Baud Rate

The CAN bus baud rate is set in the application program.

10.16 Serial Interfaces

Serial Interfaces of the MSC

The MSC provides the following serial interfaces:

- **MACS interface** according to TIA/EIA 232 (previously RS 232) with «MACS» front panel connector as a programming interface
  ⇨ "10.5.1 Communication Between MSC and MACS" on page 80

  ⓘ The MACS interface is configured in the PLC configuration of the MACS development environment.

- **SIO interface** with «SIO» front panel connector
  SIO interfaces according to the following TIA/EIA standards are available from Moog:
  - TIA/EIA 232 (previously RS 232)
  - TIA/EIA 422 (previously RS 422)
  - TIA/EIA 485 (previously RS 485)

  ⓘ When ordering the MSC, the type of the SIO interface must be specified.

  ⓘ The SIO interface's communication parameters are set in the application program.

Terminal assignment of the serial interfaces:
⇨ "10.4.1 Terminal Assignment" on page 73

Serial interface cables:
⇨ "7.2 Serial TIA/EIA Interface Cables" on page 47

10.17 Safety Functions

10.17.1 Watchdog

Watchdog of the MSC

The MSC provides a function for monitoring whether the hardware and software are functioning properly. When there is a fault, this function can disable all outputs. Depending on the selected output type, this will mean that the output is switched either to a currentless or zero potential condition. As a result, the user can set up systems that have a greatly reduced risk of fatal malfunctions.

In the MSC, this function is implemented in the M_WATCHDOG function block, which can be used in the application program to be monitored. If this function block is used, it must be actuated cyclically in order to keep the outputs enabled.
When there is a fault (when the application program can no longer actuate the function block within the set time period), the outputs will be disabled.

If the M_WATCHDOG function block is not used in the application program, the MSC's watchdog will not operate. In this case, the outputs will always be enabled and they will output the value calculated in the application program.

ⓘ The digital output 'Outputs Enabled' indicates the enabled state of all digital outputs, analog outputs, and the MSC's E-bus communication.

10.17.2 'Outputs Enabled' Output (LED «OutEN»)

'Outputs Enabled' Output (LED «OutEN») of the MSC

WARNING

If there is a defect in an output stage, the 'Outputs Enabled' signal will not necessarily shut down all of the outputs securely.

The digital output 'Outputs Enabled' indicates the enabled state of all digital outputs, analog outputs, and the MSC's E-bus communication. It can be used to tell another controller that all of the MSC's outputs were disabled.

As long as the 'Outputs Enabled' output is in the 1 state, the application program will control all outputs and the E-bus communication.

If the 'Outputs Enabled' output is switched to the 0 state, all outputs will be disabled and the E-bus communication will be terminated.

If the digital output 'Outputs Enabled' is in the 0 state (LED «OutEN» does not illuminate), all other outputs are disabled.
In this case, although the internal states of the digital outputs are shown on the front panel status LEDs «I/O1»…«I/O8» of the MSC, they are not connected through to the output.

The digital output 'Outputs Enabled' will be switched to the 1 state only if the following conditions are fulfilled simultaneously:

- An error-free application program has been loaded onto the MSC and will be started once after every reset of the MSC
- A valid license key is inserted
- The M_WATCHDOG function block is not used
  or the M_WATCHDOG function block is used in the application program and is actuated cyclically within the set time

If any one of these conditions is not fulfilled, the 'Outputs Enabled' output will be switched to the 0 state, thereby disabling all of the MSC's other outputs. In addition, the E-bus communication will be terminated.

10.17.2.1 «OutEN» LED

«OutEN» LED of the MSC

The front panel LED «OutEN», located of the MSC, indicates the status of the 'Outputs Enabled' output. The LED «OutEN» illuminates when the 'Outputs Enabled' output is in the 1 state.

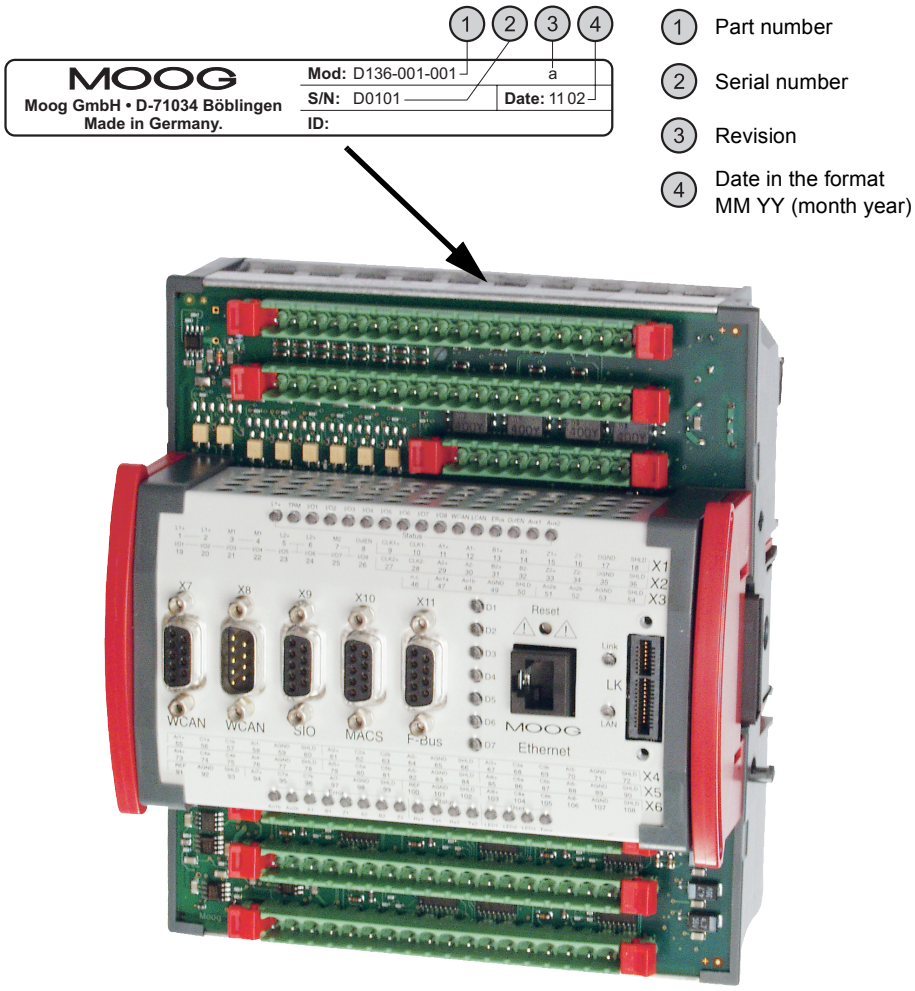
10.17.3 Stopping the Application Program

Stopping the Application Program

An application program (executed in the MSC) can be stopped in the MACS development environment.
After an application program stops, all analog and digital outputs will automatically be switched to a secure state. This secure value can be set for each output individually by modifying the 'Secure' channel parameter in the PLC configuration.

If the «OutEN» LED does not illuminate (when the 'Outputs Enabled' output is in the 0 state), this secure value will **not** be at the outputs because the outputs will be disabled.
⇨ "10.17.2 'Outputs Enabled' Output (LED «OutEN»)" on page 116

10.18 Nameplate



Nameplate of the MSC

1. Part number
2. Serial number
3. Revision
4. Date in the format MM YY (month year)

Figure 77: Position of the Nameplate on the MSC

11 Product Range

The following chapter 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.

11.1 M3000® Starter Kit

Product Range: M3000® Starter Kit

Item Designation	Remarks	Part Number
M3000® Starter Kit	Complete package including everything needed to get started ⇨ "3.2 M3000® Starter Kit" on page 17	D147E001-002

Table 21: Product Range – M3000® Starter Kit

11.2 M3000® Modules

11.2.1 MSC (Moog Servo Controller)

Product Range: MSC

Item Designation	Remarks	Part Number
MSC	Programmable multi-axis controller ⇨ "3.3.1 MSC" on page 18 MSC with digital open emitter outputs, 2 MB RAM ⇨ figure 54 on page 93	D136E001-001
MSC 4 MB	Programmable multi-axis controller ⇨ "3.3.1 MSC" on page 18 MSC with digital open emitter outputs, 4 MB RAM ⇨ figure 54 on page 93	D136-001-008

Table 22: Product Range – MSC

The plug-in terminal strips, that may be needed for connection of power and signal cables, are not included in delivery. The plug-in terminal strips are available from Moog as accessories.
⇨ "11.8 Plug-In Terminal Strips" on page 124

The MSC does not function without license key. This license key is not included in the standard delivery. It is available from Moog as an accessory.
⇨ "11.4 License Keys" on page 121

11.2.2 Q-Modules

Product Range: Q-Modules

Item Designation	Remarks	Part Number
QDIO 16/16-0,5	Digital I/O extension module for local extension of the inputs and outputs of MSCs (connection over E-bus) 16 inputs and 16 I/Os Positive switching ⇨ "3.3.2 Q-Modules" on page 19	D137-001-005
QDIO 16/16-0,5N	Digital I/O extension module for local extension of the inputs and outputs of MSCs (connection over E-bus) 16 inputs and 16 I/Os Zero switching ⇨ "3.3.2 Q-Modules" on page 19	D137-001-004
QAIO 16/4-V	Analog I/O extension module for local extension of the inputs and outputs of MSCs (connection over E-bus) 16 voltage inputs (±10 V) 4 voltage outputs (±10 V) ⇨ "3.3.2 Q-Modules" on page 19	D137-001-007
QAIO 16/4-A	Analog I/O extension module for local extension of the inputs and outputs of MSCs (connection over E-bus) 16 current inputs (0–20 mA) 4 voltage outputs (±10 V) ⇨ "3.3.2 Q-Modules" on page 19	D137-001-006
QCAN	CAN extension module which can be used to make available the LocalCAN bus of an E-bus group for external CAN bus network stations (over a D-sub front panel connector) ⇨ "3.3.2.2 QCAN" on page 20	D137-001-003

Table 23: Product Range – Q-Modules

The plug-in terminal strips, that may be needed for connection of power and signal cables, are not included in delivery. The plug-in terminal strips are available from Moog as accessories.
⇨ "11.8 Plug-In Terminal Strips" on page 124

11.2.3 R-Modules (Remote Modules)

Product Range: R-Modules (Remote Modules)

Item Designation	Remarks	Part Number
RDIO 16/16-0,5	Remote module with digital I/Os and CANopen interface (connection over CAN bus) 16 inputs and 16 I/Os Positive switching ⇨ "3.3.3 R-Modules (Remote Modules)" on page 20	D137-002-001
RTEMP 8-CAN	Temperature control module with TIA/EIA 232 and CANopen interface (connection over CAN bus) 8 channel controllers ⇨ "3.3.3 R-Modules (Remote Modules)" on page 20 ⓘ The CPRTEMP software (needed to program and configure the RTEMP) is not included with RTEMP. CPRTEMP is available from Moog as an accessory. ⇨ "11.5.2 Software for R-Modules" on page 122	D137-002-002
RDISP 22	Display and operating terminal with TIA/EIA 232 and CANopen interface and 22 keys (connection over CAN bus) ⇨ "3.3.3 R-Modules (Remote Modules)" on page 20 ⓘ The CPRDISP software (needed to program and configure the RDISP) is not included with RDISP. CPRDISP is available from Moog as an accessory. ⇨ "11.5.2 Software for R-Modules" on page 122	D137-004-001

Table 24: Product Range – R-Modules (Remote Modules)

ⓘ The plug-in terminal strips, that may be needed for connection of power and signal cables, are not included in delivery. The plug-in terminal strips are available from Moog as accessories.
⇨ "11.8 Plug-In Terminal Strips" on page 124

11.3 Power Supply for M3000® Modules

Product Range: Power Supply for M3000® Modules

Item Designation	Remarks	Part Number
Power supply 24 V 10 A	Power-supply for mounting on DIN top-hat rails with short-circuit protection Input: 230 V AC or 115 V AC Output: 24 V DC, 10 A max.	D137-003-001

Table 25: Product Range – Power Supply for M3000® Modules

11.4 License Keys

Product Range: License Keys

Item Designation	Remarks	Part Number
License key Controls	gray	D138-002-001
License key Motion	green	D138-002-002

Table 26: Product Range – License Keys

License Keys: Features

Feature	License Key: Controls (Gray)	License Key: Motion (Green)
Run-time license of the MSC	•	•
CoDeSys operators and standard IEC 61131 library	•	•
Library with hardware-related functions: M_HW_MSC.Lib	•	•
Library for control engineering: M_Control.Lib	•	•
Library for the TIA/EIA 232 and CAN bus interface: M_SIO.Lib	•	•
Support for OPC and DDE interfaces	•	•
Ethernet and TIA/EIA 232 communication with the MACS development environment	•	•
Library for motion control according to PLCopen: M_PLCopen.Lib		•
Library with transfer functions (Z-functions): M_Transfer_Functions.Lib		•
Libraries for CANopen, Profibus DP, TCP, UDP, and TCP/IP (depending on MSC option)		•

• Feature included

Table 27: Features Provided by the Various License Keys

The MSC does not function without license key.
⇨ "3.4 License Key" on page 23
⇨ "10.6 License Key" on page 81

11.5 Software

11.5.1 MACS (Moog Axis Control Software)

Product Range: Software – MACS

Item Designation	Remarks	Part Number
MACS development environment	Development environment according to IEC 61131 for solving complex control tasks (1 license) ⇨ "3.5 Application Programs" on page 24	D138-001-001
	1 additional license	D138-001-002
	5 licenses	D138-001-005
	10 licenses	D138-001-010
MACS HMI	Visualization package which can be run without MACS Run-time license for 1 system ⇨ "3.6.1 MACS HMI Visualization Package" on page 25	D138-003-001
	Run-time license for 10 systems	D138-003-010
	Run-time license for 50 systems	D138-003-050
Software maintenance contract	Support and MACS updates for 1 year (for 1 license)	B95914-001-001
	1 additional license	B95914-001-002
	5 licenses	B95914-001-005
	10 licenses	B95914-001-010

Table 28: Product Range – Software – MACS

11.5.2 Software for R-Modules

Product Range: Software for R-Modules

Item Designation	Remarks	Part Number
CPRTEMP	Software for programming and configuring RTEMP ⇨ "3.3.3.2 RTEMP" on page 21	D138-004-001
CPRDISP	Software for programming and configuring RDISP ⇨ "3.3.3.3 RDISP" on page 22	D138-006-001

Table 29: Product Range – Software for R-Modules

11.6 Interface Cables

Product Range: Interface Cables

Item Designation	Remarks	Part Number
Crossed TIA/EIA 232 interface cable, 5 m (5.47 yd)	Null modem cable which can be used as programming cable for connecting the MSC and PC (MACS) with 9 pole D-sub mating connectors ⇨ figure 34 on page 48	B95884-001
Crossed Ethernet interface cable, 10 m (10.94 yd)	10BaseT Cable with Crossed Twisted Pair Wires with 8 pole RJ45 mating connectors ⇨ figure 32 on page 47	B95909-001
Non-crossed Ethernet interface cable, 1 m (1.09 yd)	10BaseT Cable with Non-Crossed Twisted Pair Wires with 8 pole RJ45 mating connectors ⇨ figure 33 on page 47	B95909-004
Non-crossed Ethernet interface cable, 10 m (10.94 yd)	10BaseT Cable with Non-Crossed Twisted Pair Wires with 8 pole RJ45 mating connectors ⇨ figure 33 on page 47	B95909-002
Connection cable for RTEMP	Cable for connecting RTEMP to a PC with Western Phone and 9 pole D-sub mating connector	B95908-001
CAN bus interface cable, 3 m (3.28 yd)	⇨ "7.3.6 CAN Bus Interface Cable" on page 54	B95863-001
CAN bus interface cable, 10 m (10.94 yd)	⇨ "7.3.6 CAN Bus Interface Cable" on page 54	B95863-002

Table 30: Product Range – Interface Cables

11.7 CAN Bus Accessories

Product Range: CAN Bus Accessories

Item Designation	Remarks	Part Number
USB CAN adapter	Adapter (USB1.1 to CAN bus) with 9 pole D-sub mating connector with pin contacts	C43094-001
CAN bus termination resistor 120 Ω	9 pole D-sub mating connector with socket contacts	B95864-001
CAN bus termination resistor 120 Ω /GND	9 pole D-sub mating connector with pin contacts; CAN_GND internally connected to signal ground	B95865-001

Table 31: Product Range – CAN Bus Accessories

11.8 Plug-In Terminal Strips

Product Range: Plug-In Terminal Strips for DIN Rail Modules

Item Designation	Remarks	Part Number
Plug-in terminal strip with screw terminals	8 pole (up to max. 2.5 mm² (14 AWG) wire cross section)	VK055-008
	9 pole (up to max. 2.5 mm² (14 AWG) wire cross section)	VK055-009
	18 pole (up to max. 2.5 mm² (14 AWG) wire cross section)	VK055-018
Plug-in terminal strip with spring loaded terminals	8 pole (up to max. 2.5 mm² (14 AWG) wire cross section)	B95907-008
	9 pole (up to max. 2.5 mm² (14 AWG) wire cross section)	B95907-009
	18 pole (up to max. 2.5 mm² (14 AWG) wire cross section)	B95907-018
Labels for plug-in terminal strips	For labeling plug-in terminal strips Printed with the numbers 1–108 Includes six labels	B95885-001
Insertion bridge	For connecting adjoining terminals of the plug-in terminal strips	A69102
Coding tab	For coding plug-in terminal strips	C43145-001
Coding profile	For coding plug-in terminal strip connectors of M3000® modules	C43146-001

Table 32: Product Range – Plug-In Terminal Strips

The various DIN rail modules require different numbers of plug-in terminal strips.
⇨ "11.8.1 Number of Required Plug-In Terminal Strips" on page 124

11.8.1 Number of Required Plug-In Terminal Strips

Number of Required Plug-In Terminal Strips for DIN Rail Modules

DIN Rail Module	Number of Plug-In Terminal Strips Required		
	8 Poles	9 Poles	18 Poles
MSC	-	1	5
RDIO	-	-	6
RDISP	-	-	-
RTEMP	1	-	4
QDIO	-	-	6
QAIO 16/4	-	-	5
QCAN	-	-	-

Table 33: Number of Plug-In Terminal Strips Required for Various DIN Rail Modules

11.9 Training Programs

Product Range: Training Programs

Item Designation	Remarks	Part Number
Software training, English MACS and IEC 61131	Content of the training: • Programming, testing, optimizing, and documenting IEC 61131 application programs • Visualization of IEC 61131 application programs	B95992
Software training, German MACS and IEC 61131	Content of the training: • Programming, testing, optimizing, and documenting IEC 61131 application programs • Visualization of IEC 61131 application programs	B95993
Hardware training, English MSC and extension modules	Content of the training: • Configuring and using MSC and extension modules • Using control-engineering libraries Knowledge about creating IEC 61131 application programs is required to participate in the hardware training. This knowledge is imparted in the MACS and IEC 61131 software training.	B95994
Hardware training, German MSC and extension modules	Content of the training: • Configuring and using MSC and extension modules • Using control-engineering libraries Knowledge about creating IEC 61131 application programs is required to participate in the hardware training. This knowledge is imparted in the MACS and IEC 61131 software training.	B95995

Table 34: Product Range – Training Programs

12 Appendix

12.1 Typographical Conventions

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

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')

12.2 Abbreviations

Table 35: Abbreviations

Abbreviation	Explanation
AC	**A**lternating **C**urrent
ADC	**A**nalog to **D**igital **C**onverter
AGND	**A**nalog **Grou**n**d** (Ground for the analog I/Os of the MSC)
CAL	**C**AN **A**pplication **L**ayer according to CiA DS 201–207
CAN	**C**ontroller **A**rea **N**etwork
CAN_GND	**CAN Grou**n**d**
CAN_H	**CAN H**igh (CAN bus signal (dominant high))
CAN_L	**CAN L**ow (CAN bus signal (dominant low))
CAN_SHLD	**CAN Shi**e**ld** (optional shield)
CFC	**C**ontinuous **F**unction **C**hart (random-graphics functional chart editor; programming language for creating PLC programs)
CiA	**C**AN **i**n **A**utomation e. V. (international organization of manufacturers and users for CAN users; http://www.can-cia.org)
CLK	**Cl**oc**k**
CPU	**C**entral **P**rocessing **U**nit
DAC	**D**igital to **A**nalog **C**onverter
DC	**D**irect **C**urrent
DGND	**D**igital **Grou**n**d** (Ground for the digital sensor interface of the MSC)
DIN	**D**eutsches **I**nstitut für **N**ormung e. V. (German Institute for Standardization; http://www.din.de)
DIS	**D**raft **I**nternational **S**tandard (preliminary standard)
DS	**D**raft **S**tandard (draft standard)
E-Bus	**E**xtension **bus** of DIN rail modules
EEPROM	**E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory
EIA	**E**lectronic **I**ndustries **A**lliance (http://www.eia.org)
EMC	**E**lectro**m**agnetic **C**ompatibility
EN	**E**uropa-**N**orm (European Standard)
EPROM	**E**rasable **P**rogrammable **R**ead **O**nly **M**emory
ESD	**E**lectro**s**tatic **D**ischarge
FBD	**F**unction **B**lock **D**iagram (programming language for creating PLC programs)
Flash EEPROM	High speed EEPROM
FPGA	**F**ield **P**rogrammable **G**ate **A**rray (programmable logic component)
GUI	**G**raphical **U**ser **I**nterface
HF	**H**igh **F**requency
HMI	**H**uman **M**achine **I**nterface (MACS HMI: Visualization package which can be run without MACS)
ID	**Id**entifier
IEC	**I**nternational **E**lectrotechnical **C**ommission (http://www.iec.ch)
IEEE	**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers, Inc. (http://www.ieee.org)
IL	**I**nstruction **L**ist (programming language for creating PLC programs)
I/O	**I**nput/**O**utput
IP	**I**nternational **P**rotection (protection type)
IP	**I**nternet **P**rotocol
ISO	**I**nternational **O**rganization for **S**tandardizing (http://www.iso.org)
LAN	**L**ocal **A**rea **N**etwork
LCD	**L**iquid **C**rystal **D**isplay

Table 35: Abbreviations (Section 1 of 3)

Table 35: Abbreviations

Abbreviation	Explanation
LD	**L**adder **D**iagram (programming language for creating PLC programs)
LED	**L**ight **E**mitting **D**iode
LSB	**L**east **S**ignificant **B**it
M3000®	Moog Control System
MACS	Moog **A**xis **C**ontrol **S**oftware (Development environment according to IEC 61131 for solving complex control tasks)
MSB	**M**ost **S**ignificant **B**it
MSC	Moog **S**ervo **C**ontroller (Control module for DIN top-hat rail mounting)
MSL	**M**ean **S**ea **L**evel
NC	**N**ot **C**onnected
ND	**N**ot **D**efined
PADT	**P**rogramming **A**nd **D**iagnostic **T**ool (programming and diagnostic tool in IEC 61131, here: PC on which the MACS development environment is installed)
PC	**P**ersonal **C**omputer
PE	**P**rotective **E**arth
PLC	**P**rogrammable **L**ogic **C**ontrol(ler)
Q-Modules	DIN rail modules for local extension of MSCs (connected over E-bus)
Q-Connector	40 pole lateral connector of DIN rail modules
QAIO	Analog I/O extension module for local extension of the inputs and outputs of MSCs (connection over E-bus)
QCAN	CAN extension module which can be used to make available the LocalCAN bus of an E-bus group for external CAN bus network stations (over a D-sub front panel connector)
QDIO	Digital I/O extension module for local extension of the inputs and outputs of MSCs (connection over E-bus)
R-Modules	Remote modules such as RDIO, RTEMP, and RDISP (connection over CAN bus)
RAM	**R**andom **A**ccess **M**emory (read and write memory that loses its contents when power is removed)
RD	**R**eceive **D**ata
RDIO	Remote module with digital I/Os and CANopen interface (connection over CAN bus)
RDISP	**R**emote **Disp**lay (display and operating terminal with TIA/EIA 232 and CANopen interface (connection over CAN bus))
REF	**Ref**erence voltage
RISC	**R**educed **I**nstruction **S**et **C**omputer
RTEMP	Temperature control module with TIA/EIA 232 and CANopen interface (connection over CAN bus)
SELV	**S**afety **E**xtra-**L**ow **V**oltage (according to DIN EN 60950-1)
SFC	**S**equential **F**unction **C**hart (programming language for creating PLC programs)
SHLD	**Sh**ie**ld**
SIO	**S**erial **I/O** (serial interface of the MSC)
SSI	**S**ynchronous **S**erial **I**nterface (digital interface for transferring positioning information, like with position transducers)
ST	**S**tructured **T**ext (programming language for creating PLC programs)
TD	**T**ransmit **D**ata
TIA	**T**elecommunications **I**ndustry **A**ssociation (http://www.tiaonline.org)
TPU	**T**ime **P**rocessing **U**nit (programmable microprocessor that processes time functions independently of the CPU)

Table 35: Abbreviations (Section 2 of 3)

Table 35: Abbreviations

Abbreviation	Explanation
TÜV	**T**echnischer **Ü**berwachungs**v**erein (German agency performing technical inspections)
V DC	**V**olt **D**irect **C**urrent (unit of direct voltage)
VDE	**V**erband **d**er **E**lektrotechnik Elektronik Informationstechnik (Association for Electrical, Electronic & Information Technologies; http://www.vde.de)
VDMA	**V**erband **D**eutscher **M**aschinen- und **A**nlagenbau e. V. (Federation of Engineering Industries; http://www.vdma.org)
WF	**W**ire **F**ault

Table 35: Abbreviations (Section 3 of 3)

12.3 Quoted Standards

12.3.1 CiA DS

Quoted Standards: 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

12.3.2 DIN and DIN EN

Quoted Standards: DIN and DIN EN

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

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

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

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

DIN EN 61000-6-2
Electromagnetic Compatibility (EMC) – Part 6-2: Generic Standards: Immunity for Industrial Environments

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

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

DIN EN 60204
Safety of Machinery – Electrical Equipment of Machines

12.3.3 IEC

Quoted Standards: IEC

IEC 60068
Environmental Testing

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

IEC 60068-2-27
Environmental Testing – Part 2: Tests; Test Ea and Guidance: Shock

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 60529
Degrees of Protection Provided by Enclosures (IP Code)

IEC 60664
Insulation Coordination for Equipment within Low Voltage Systems

IEC 60801-2
Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment – Part 2: Electrostatic Discharge Immunity Requirements

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

12.3.4 ISO/DIS

Quoted Standards: ISO/DIS

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

12.3.5 TIA/EIA

Quoted Standards: TIA/EIA

TIA/EIA 232 (previously RS 232)
Interface Between Data Terminal Equipment and Data Circuit – Terminating 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

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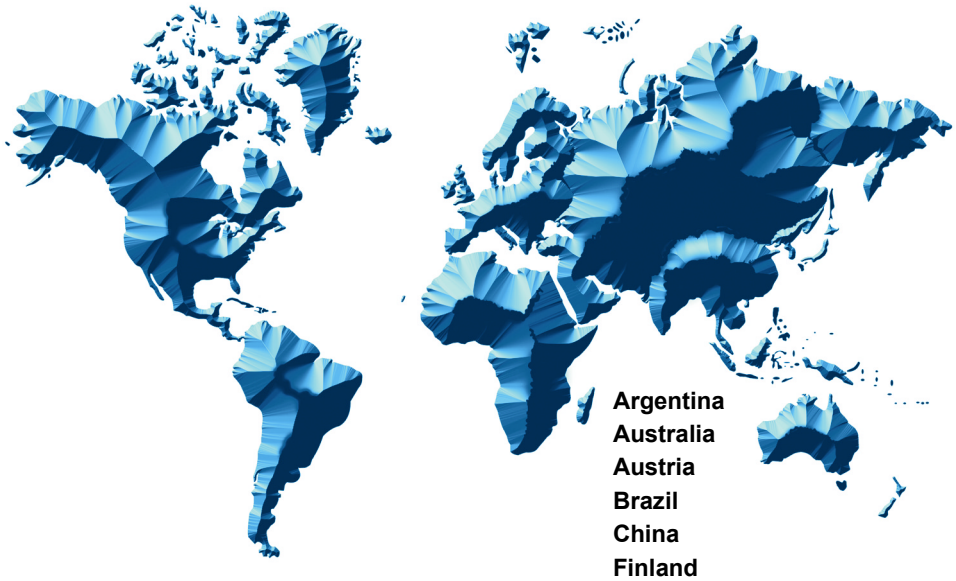
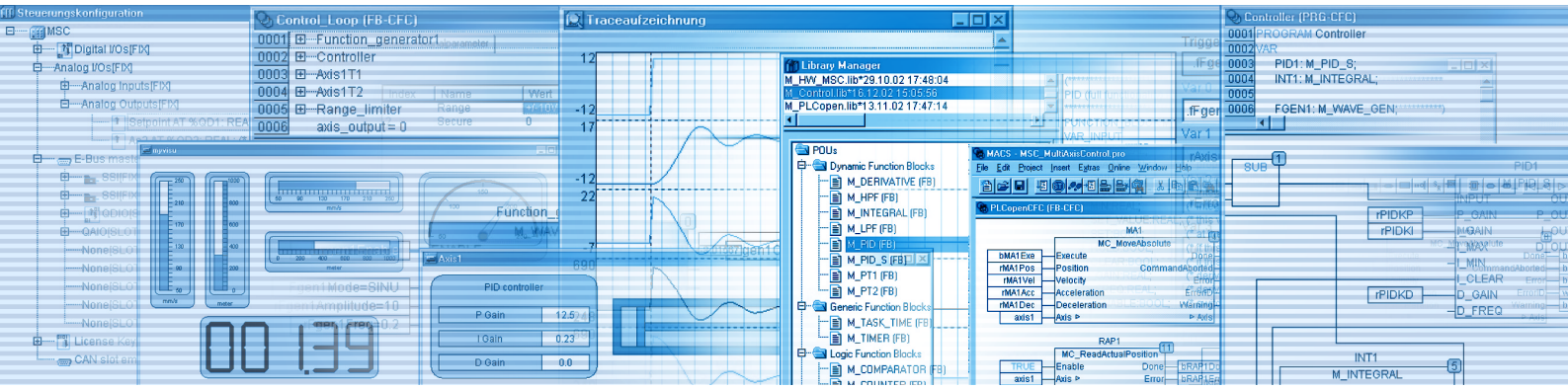


Argentina
Australia
Austria
Brazil
China
Finland
France
Germany
India
Ireland



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