PNOZ mml1p

Configurable Control System PNOZmulti

Operating Manual – No. 1002233-EN-04

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SD means Secure Digital.

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1.1 Validity of documentation

This documentation is valid for the product **PNOZ mml1p**. It is valid until new documentation is published.

This operating manual explains the function and operation, describes the installation and provides guidelines on how to connect the product.

1.1.1 Retaining the documentation

This documentation is intended for instruction and should be retained for future reference.

1.2 Overview of documentation

1 Introduction

The introduction is designed to familiarise you with the contents, structure and specific order of this manual.

2 Overview

This chapter provides information on the product's most important features.

3 Safety

This chapter must be read as it contains important information on intended use.

4 Function Description

This chapter describes the product's mode of operation.

5 Installation

This chapter explains how to install the product.

6 Commissioning

This chapter describes the product's commissioning and wiring.

7 Operation

This chapter describes how to operate the product and gives tips in the case of a fault.

8 Technical Details

This chapter contains the product's technical details and order reference.

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1.3 Definition of symbols

Information that is particularly important is identified as follows:



DANGER!
This warning must be heeded! It warns of a hazardous situation that poses an immediate threat of serious injury and death and indicates preventive measures that can be taken.



WARNING!
This warning must be heeded! It warns of a hazardous situation that could lead to serious injury and death and indicates preventive measures that can be taken.



CAUTION!
This refers to a hazard that can lead to a less serious or minor injury plus material damage, and also provides information on preventive measures that can be taken.



NOTICE
This describes a situation in which the unit(s) could be damaged and also provides information on preventive measures that can be taken. It also highlights areas within the text that are of particular importance.



INFORMATION
This gives advice on applications and provides information on special features.

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2.1 Unit structure

2.1.1 Scope of supply

- Expansion module **PNOZ mml1p**
- Jumper 779 260

2.1.2 Unit features

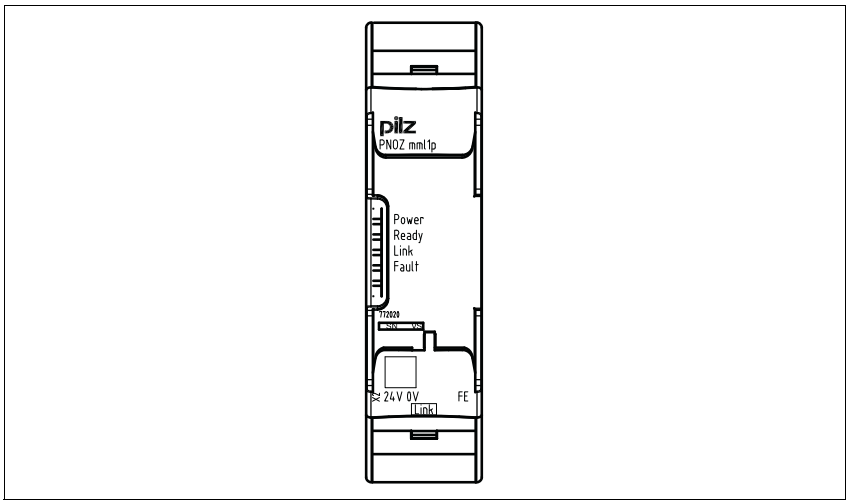
Using the product **PNOZ mml1p**:

Link module to safely connect two configurable control systems PNOZmulti.

The product has the following features:

- Connection options:
  - Two PNOZmulti Mini base units
    or
  - One PNOZmulti Mini base unit with one PNOZmulti base unit
- Can be configured in the PNOZmulti Configurator
- Point-to-point connection via 4-core shielded and twisted-pair cable
- 32 virtual inputs and 32 virtual outputs
- Status indicators
- Max. 4 PNOZ mml1p units can be connected to the base unit
- LEDs for
  - Operating state
  - Error
  - Connection status
- Plug-in connection terminals:
  either spring-loaded terminal or screw terminal available as an accessory (see order reference)

2.2 Front view



Key:

- X2:
  - 0 V, 24 V:Supply connections
  - FE: Functional earth
- Link:
  Connection
- LEDs:
  - Power
  - Ready
  - Link
  - Fault

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3.1 Intended use

The expansion module is used for the point-to-point connection of safe virtual inputs and outputs between two base units.

The expansion module may only be connected to a base unit PNOZmulti Mini from the configurable control system PNOZmulti (please refer to the document "PNOZmulti System Expansion" for details of the base units PNOZmulti Mini that can be connected).

The configurable control system PNOZmulti is used for the safety-related interruption of safety circuits and is designed for use in:
- E-STOP equipment
- Safety circuits in accordance with VDE 0113 Part 1 and EN 60204-1

Intended use includes making the electrical installation EMC-compliant. The product is designed for use in an industrial environment. It is not suitable for use in a domestic environment, as this can lead to interference.

The following is deemed improper use in particular:
- Any component, technical or electrical modification to the product
- Use of the product outside the areas described in this manual
- Use of the product outside the technical details (see chapter entitled “Technical Details”)

3.1.1 System requirements

Please refer to the "Product Modifications" document in the "Version overview" section for details of which versions of the base unit and PNOZmulti Configurator can be used for this product.

3.2 Safety regulations

3.2.1 Use of qualified personnel

The products may only be assembled, installed, programmed, commissioned, operated, maintained and decommissioned by competent persons.

A competent person is someone who, because of their training, experience and current professional activity, has the specialist knowledge required to test, assess and operate the work equipment, devices, systems, plant and machinery in accordance with the general standards and guidelines for safety technology.

It is the company's responsibility only to employ personnel who:

- Are familiar with the basic regulations concerning health and safety / accident prevention
- Have read and understood the safety guidelines given in this description
- Have a good knowledge of the generic and specialist standards applicable to the specific application.

3.2.2 Warranty and liability

All claims to warranty and liability will be rendered invalid if:

- The product was used contrary to the purpose for which it is intended
- Damage can be attributed to not having followed the guidelines in the manual
- Operating personnel are not suitably qualified
- Any type of modification has been made (e.g. exchanging components on the PCB boards, soldering work etc.).

3.2.3 Disposal

- In safety-related applications, please comply with the mission time t_M in the safety-related characteristic data.
- When decommissioning, please comply with local regulations regarding the disposal of electronic devices (e.g. Electrical and Electronic Equipment Act).

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3.2 Safety regulations

3.2.4 For your safety

The unit meets all necessary conditions for safe operation. However, you should always ensure that the following safety requirements are met:

- This operating manual only describes the basic functions of the unit. Information on the advanced functions can be found in the online help for the PNOZmulti Configurator and in the PNOZmulti technical catalogue. Only use these functions after you have read and understood the documentation. All necessary documentation can be found on the PNOZmulti Configurator CD.
- Do not open the housing or make any unauthorised modifications.
- Please make sure you shut down the supply voltage when performing maintenance work (e.g. exchanging contactors).

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4.1 Device properties

4.1.1 Integrated protection mechanisms

The relay conforms to the following safety criteria:

- The circuit is redundant with built-in self-monitoring.
- The safety function remains effective in the case of a component failure.

4.1.2 Function description

4.1.2.1 Operation

The link module **PNOZ mml1p** is used to safely transfer the input information from 32 virtual inputs and 32 virtual outputs between two PNOZmulti systems. One link module is assigned to each base unit. Data is exchanged cyclically.

The function of the inputs and outputs on the control system depends on the safety circuit created using the PNOZmulti Configurator. A chip card is used to download the safety circuit to the base unit. The base unit has 2 microcontrollers that monitor each other. They evaluate the input circuits on the base unit and expansion modules and switch the outputs on the base unit and expansion modules accordingly.

The LEDs on the base unit and expansion modules indicate the status of the configurable control system PNOZmulti.

The online help on the PNOZmulti Configurator contains descriptions of the operating modes and all the functions of the PNOZmulti control system, plus connection examples.

Data exchange:

- Data is exchanged cyclically.
- After the end of a PNOZmulti cycle, each base unit sends its output data to its link module. This output data is immediately sent to the link module on the other base unit.
- At the same time, the base unit reads the input data from the link module.

4.1 Device properties

Connection of multiple base units:

Any number of base units can be connected via link modules. Two link modules are required for a connection between two base units. However, only a maximum of 4 link modules may be connected to any one base unit.

Data transmission time:

The t_{BUS} data transmission time is the time between the virtual output at base unit 1 being set and the virtual input at base unit 2 becoming available (see "Technical details").

The maximum reaction time for series connection of n base units

This is the time between the activation of a safety function at the input on one base unit and the switching of an output on the connected base unit.

- The maximum reaction time t_{SUM} includes the following times:
  t_{ON}: Input delay = 4 ms
  t_{COND}: Switch-off delay of semiconductor output = 30 ms
  t_{REL}: Switch-off delay of relay output = 50 ms
  t_{BUS}: Data transmission time between two base units = 35 ms
  n: Number of connections between base units

The maximum reaction time t_{SUM} for series connection of n base units

- On semiconductor outputs:
  $tS_{UM} = t_{ON} + (n * t_{BUS}) + t_{COND}$
- On relay outputs:
  $t_{SUM} = t_{ON} + (n * t_{BUS}) + t_{REL}$

CAUTION!
For signals that are forwarded or received via the link module, a calculation must always be made in accordance with the above formulas.

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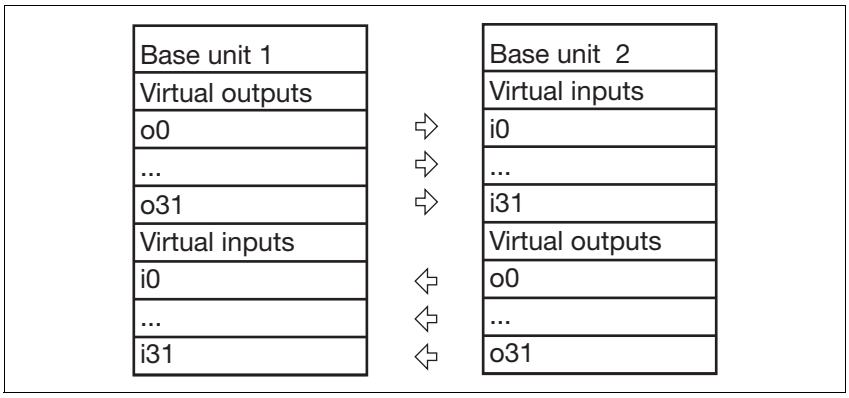
4.1 Device properties

- Input delay and switch-off delay are only included once in the reaction time. The data transmission time between the link modules is multiplied by the number of connections.
- Please refer to the connection examples under "Preparing for operation".

CAUTION!
For signals that are forwarded or received via the link module, the overall reaction time, e.g. the maximum reaction time of the series connection of n base units, must always be considered in the risk assessment.
The risk assessment must consider all hazards as regards the reaction time and the safety distance. The overall reaction time must not delay the arrival of a safe condition by more than the permitted time.

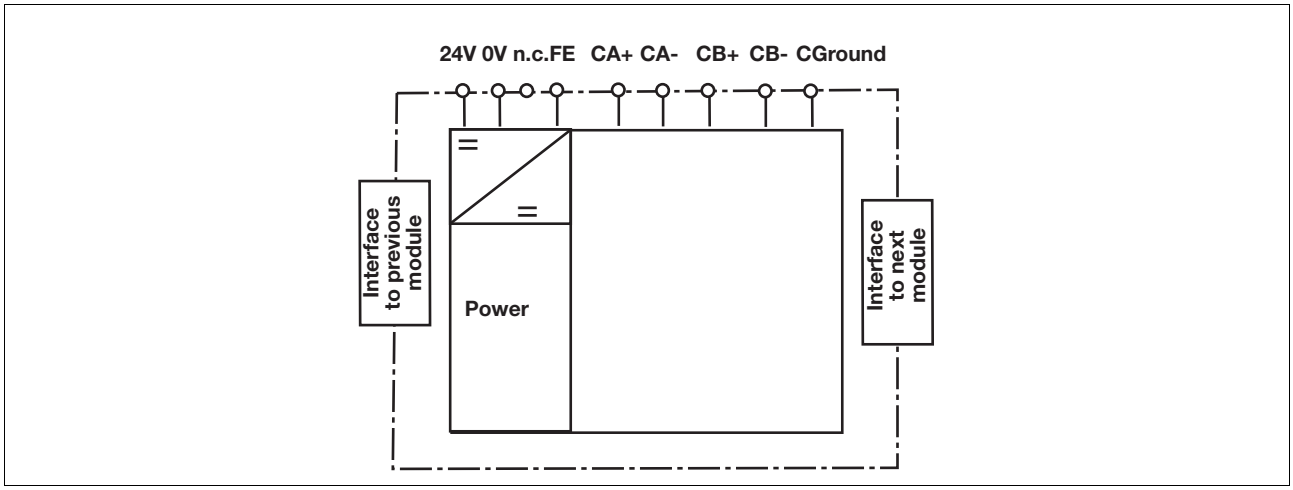
Virtual inputs and outputs:

Inputs and outputs for both PNOZmulti systems are assigned in the PNOZmulti Configurator. Inputs and outputs with the same number are assigned to each other, e.g. output o5 on one PNOZmulti system to input i5 on the other PNOZmulti system.



4.1 Device properties

4.1.2.2 Internal wiring diagram



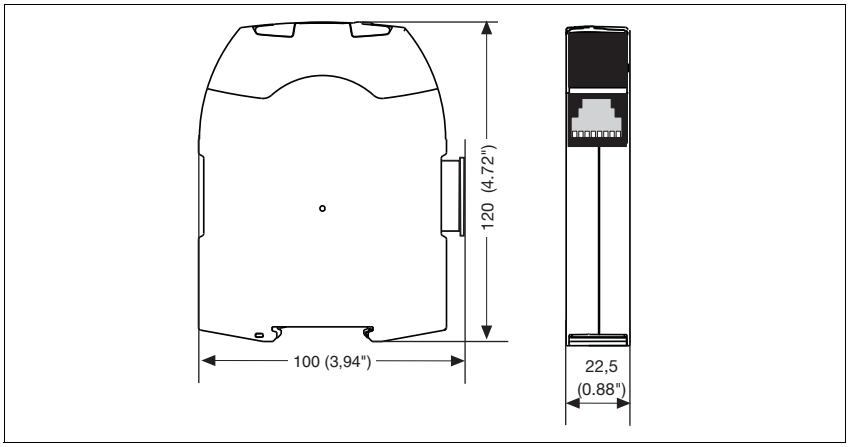
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5.1 General installation guidelines

- The unit should be installed in a control cabinet with a protection type of at least IP54.
- Fit the safety system to a horizontal mounting rail. The venting slots must face upwards and downwards. Other mounting positions could destroy the safety system.
- Use the notch on the rear of the unit to attach it to a mounting rail.
- In environments exposed to heavy vibration, the unit should be secured using a fixing element (e.g. retaining bracket or end angle).
- Push the unit upwards or downwards before lifting it from the mounting rail.
- To comply with EMC requirements, the mounting rail must have a low impedance connection to the control cabinet housing.
- The ambient temperature of the PNOZmulti units in the control cabinet must not exceed the figure stated in the technical details, otherwise air conditioning will be required.

CAUTION!
Damage due to electrostatic discharge!
Electrostatic discharge can damage components. Ensure against discharge before touching the product, e.g. by touching an earthed, conductive surface or by wearing an earthed armband.

5.1.1 Dimensions



5.2 Connecting the base unit and expansion modules

You can install a maximum of 4 **PNOZ mmI1p** to the left of the base unit.

Connect the base unit and the expansion module as described in the operating instructions for the base units.

- Connect the black/yellow terminator to the expansion module
- Install the expansion module in the position in which it is configured in the PNOZmulti Configurator.

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6.1 General wiring guidelines

The wiring is defined in the circuit diagram of the PNOZmulti Configurator.

Note:

- Information given in the "Technical details" must be followed.
- The power supply must meet the regulations for extra low voltages with safe separation.
- 2 connection terminals are available for each of the supply connections 24 V and 0 V. This means that the supply voltage can be looped through several connections. The current at each terminal may not exceed 3 A.
- The max. cable length between two link modules on a connection with one link module
  - PNOZ ml1p <V2.0: 100 m
  - PNOZ ml1p from V2.0, PNOZ mml1p: 1000 m
- Connect the inputs and outputs from two link modules with 4-core shielded cable. The cables must be twisted in pairs (see “Preparing for operation”).
- Note the crossover cabling, e.g. CA+ with CB+.
- The cables must be classified into a minimum of Category 5 in accordance with ISO/IEC 11801.

CAUTION!
Only connect and disconnect the expansion module when the supply voltage is switched off.

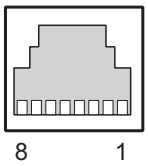
6.2 Preparing for operation

6.2.1 Download modified project to the PNOZmulti safety system

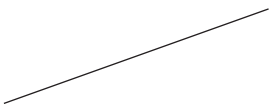
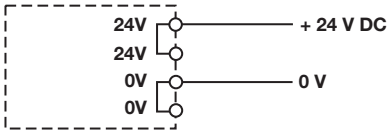
As soon as an additional expansion module has been connected to the system, the project must be amended using the PNOZmulti Configurator. Proceed as described in the operating instructions for the base unit.

NOTICE
For the commissioning and after every program change, you must check whether the safety devices are functioning correctly.

6.2.2 Connection

RJ45 socket 8-pin	PIN	Layout
	1	CA+
	2	CA-
	3	CB+
	4	n.c.
	5	n.c.
	6	CB-
	7	n.c.
	8	n.c.
	Shield	CGround

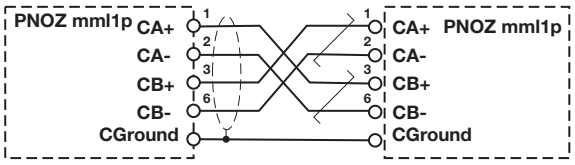
- Supply voltage

Supply voltage	AC	DC
		

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6.2 Preparing for operation

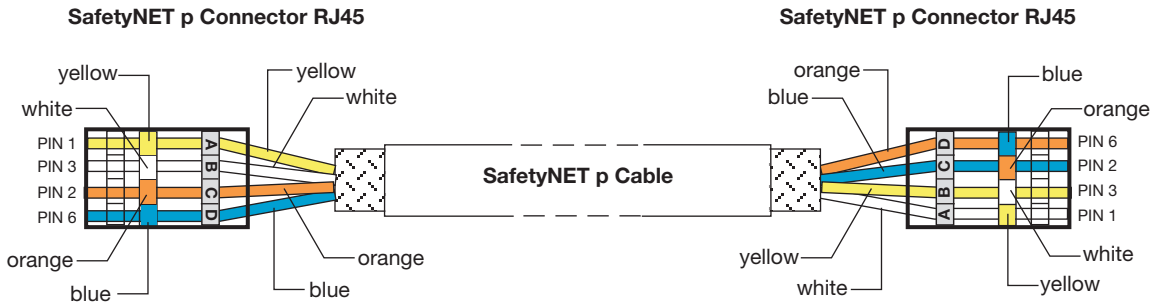
- Connection of two base units PNOZmulti Mini via PNOZ mml1p



- Connection cable configuration when using:

- 2 plug-in connectors "SafetyNET p Connector RJ45"
- 1 connection cable "SafetyNET p Cable"

(available as accessory, see order reference)

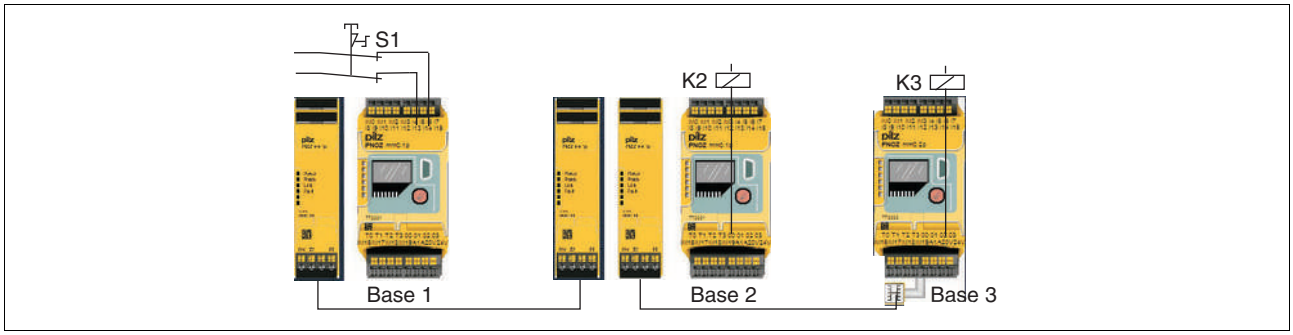


6.2 Preparing for operation

6.2.3 Connection examples

6.2.3.1 Example: Series connection of 3 base units

Reaction time t_{SUM} between base unit Base 1 and Base 2:
Input delay t_{ON} at I4 and I6 + data transmission time1 * t_{BUS} through link module/interface + switch-off delay t_{COND} of the semiconductor output at O0
$t_{SUM} = t_{ON} + (n * t_{BUS}) + t_{COND}$
t_{SUM} = 4 ms + (1 * 35 ms) + 30 ms = 69 ms
Reaction time t_{SUM} between base unit Base 1 and Base 3:
Input delay t_{ON} at I4 und I6 + data transmission time 2 * t_{BUS} through link modules/interfaces + switch-off delay t_{COND} of the semiconductor output at O1
$t_{SUM} = t_{ON} + (n * t_{BUS}) + t_{COND}$
t_{SUM} = 4 ms + (2 * 35 ms) + 30 ms = 104 ms



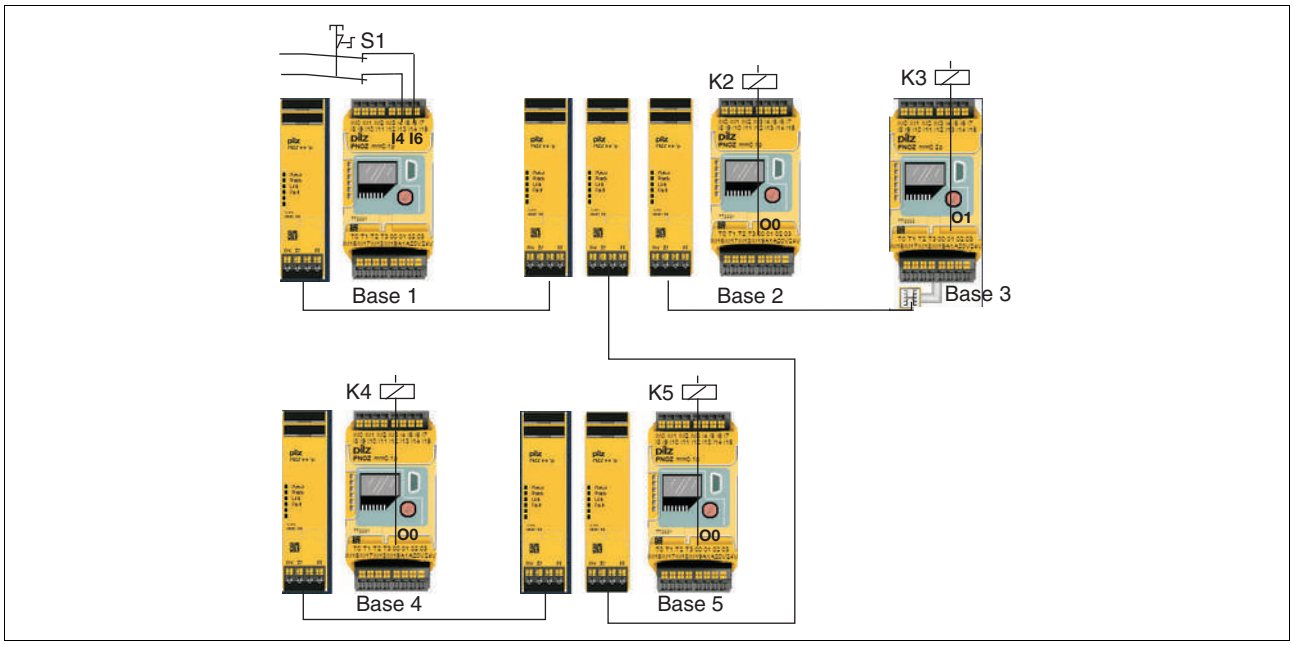
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6.2 Preparing for operation

6.2.3.2 Example: Connection of 5 base units

The reaction times are calculated in the same way as application example 1. After pressing S1 on Base 1, the semiconductor outputs switch after the following reaction times t_{SUM}:

O0 on Base 2: 69 ms
O1 on Base 3: 104 ms
O0 on Base 4: 139 ms
O0 on Base 5: 104 ms



7.1 Messages

When the supply voltage is switched on, the PNOZmulti safety system copies the configuration from the chip card.

The LEDs "POWER","DIAG", "FAULT", "IFAULT" and "OFAULT" light up on the base unit.

The PNOZmulti safety system is ready for operation when the "POWER" and "RUN" LEDs on the base unit and the "READY" LED on the **PNOZ mml1p** are lit continuously.

7.2 Display elements

Legend:

☼	LED on
◐	LED flashes
●	LED off

7.2.1 Display elements for device diagnostics

LED	LED status		Meaning
Power	●		No supply voltage
	☼	Green	Supply voltage is present
Ready	☼	Green	The unit is ready for operation
	●		The unit is not ready for operation
Fault	☼	Red	External error
	◐	Red	Internal error
	●		No fault
Link	☼	Yel-low	Connection to another PNOZ mml1p available
	●		No connection to another PNOZ mml1p

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7.3 Fault detection

Each base unit contains information about
- its own link module (in order, defective, no supply voltage)
- the status of the connection (yes, no)
- the operating status of the connected base unit (RUN, STOP)

When the connection is interrupted, the base units switch the virtual inputs to zero. The base units remains in a RUN condition.

Defective link module:
- The corresponding base unit switches to a STOP condition. The virtual outputs on the link module are set to zero.
- The connected base unit remains in a RUN condition.

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8.1 Technical Details

Technical details	
Electrical data	
Supply voltage U_B DC	**24 V**
Voltage tolerance	**-15 %/+20 %**
Power consumption at U_B DC	
without load	**5.0 W**
Residual ripple DC	**5 %**
Status display	**LED**
Times	
Switch-on delay	**5.00 s**
Supply interruption before de-energisation	**20 ms**
Max. data transmission time	**35 ms**
Inputs	
Number of virtual inputs	**32**
Virtual outputs	
Number of virtual outputs	**32**
Environmental data	
Climatic suitability	**EN 60068-2-14**, **EN 60068-2-1**, **EN 60068-2-2**, **EN 60068-2-30**, **EN 60068-2-78**
Ambient temperature	**0 - 60 °C**
Storage temperature	**-25 - 70 °C**
Climatic suitability in accordance with **EN 60068-2-30**, **EN 60068-2-78**	**93 % r. h. at 40 °C**
Condensation	**no**
EMC	**EN 61131-2**
Vibration to **EN 60068-2-6**	
Frequency	**10 - 150 Hz**
Max. acceleration	**1g**
Shock stress	
EN 60068-2-27	**15g**
	11 ms
EN 60068-2-29	**25g**
	6 ms
Mechanical data	
Protection type	
Mounting (e.g. cabinet)	**IP54**
Housing	**IP20**
Terminals	**IP20**
DIN rail	
Top hat rail	**35 x 7.5 EN 50022**
Recess width	**27 mm**
Max. cable length between two link modules	**1 km**
Housing material	
Housing	**PC**
Front	**PC**
Cross section of external conductors with screw terminals	
1 core flexible	**0.25 - 2.50 mm² , 24 - 12 AWG**
2 core, same cross section, flexible:	
without crimp connectors or with TWIN crimp connectors	**0.20 - 1.50 mm² , 24 - 16 AWG**
Torque setting with screw terminals	**0.50 Nm**

8.1 Technical Details

Mechanical data	
Cross section of external conductors with spring-loaded terminals: Flexible with/without crimp connectors	**0.20 - 2.50 mm² , 24 - 12 AWG**
Spring-loaded terminals: Terminal points per connection	**2**
Stripping length	**9 mm**
Dimensions	
Height	**100.0 mm**
Width	**22.5 mm**
Depth	**120.0 mm**
Weight	**95 g**

Safety characteristic data

Unit	Operating mode	EN ISO 13849-1: 2006 PL	EN 954-1 Category	EN IEC 62061 SIL CL	PFH [1/h]	EN ISO 13849-1: 2006 T_M [year]
		PL e (Cat. 4)	**Cat. 4**	**SIL CL 3**	**8.82E-09**	**20**

All the units used within a safety function must be considered when calculating the safety characteristic data.

The standards current on **2011-01** apply.

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8.2 Order reference

Order reference		
Product type	**Features**	**Order no.**
PNOZ mml1p	Expansion module	772 020

Order reference: Accessories		
Product type	**Features**	**Order no.**
Spring terminals PNOZ mmc2p, mml1p 1 pc.	Spring-loaded terminals, 1 pieces	783 538
Spring terminals PNOZ mmc2p,mml1p 10 pcs	Spring-loaded terminals, 10 pieces	783 539
Screw terminals PNOZ mmc2p, mml1p 1 pc.	Screw terminals, 1 piece	793 538
Screw terminals PNOZ mmc2p,mml1p 10 pcs.	Screw terminals, 10 pieces	793 539

Order reference: Terminator, jumper		
Product type	**Features**	**Order no.**
PNOZ mm0.xp connector left	Black/yellow jumper to connect the modules on the left-hand side, 1 piece	779 260

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