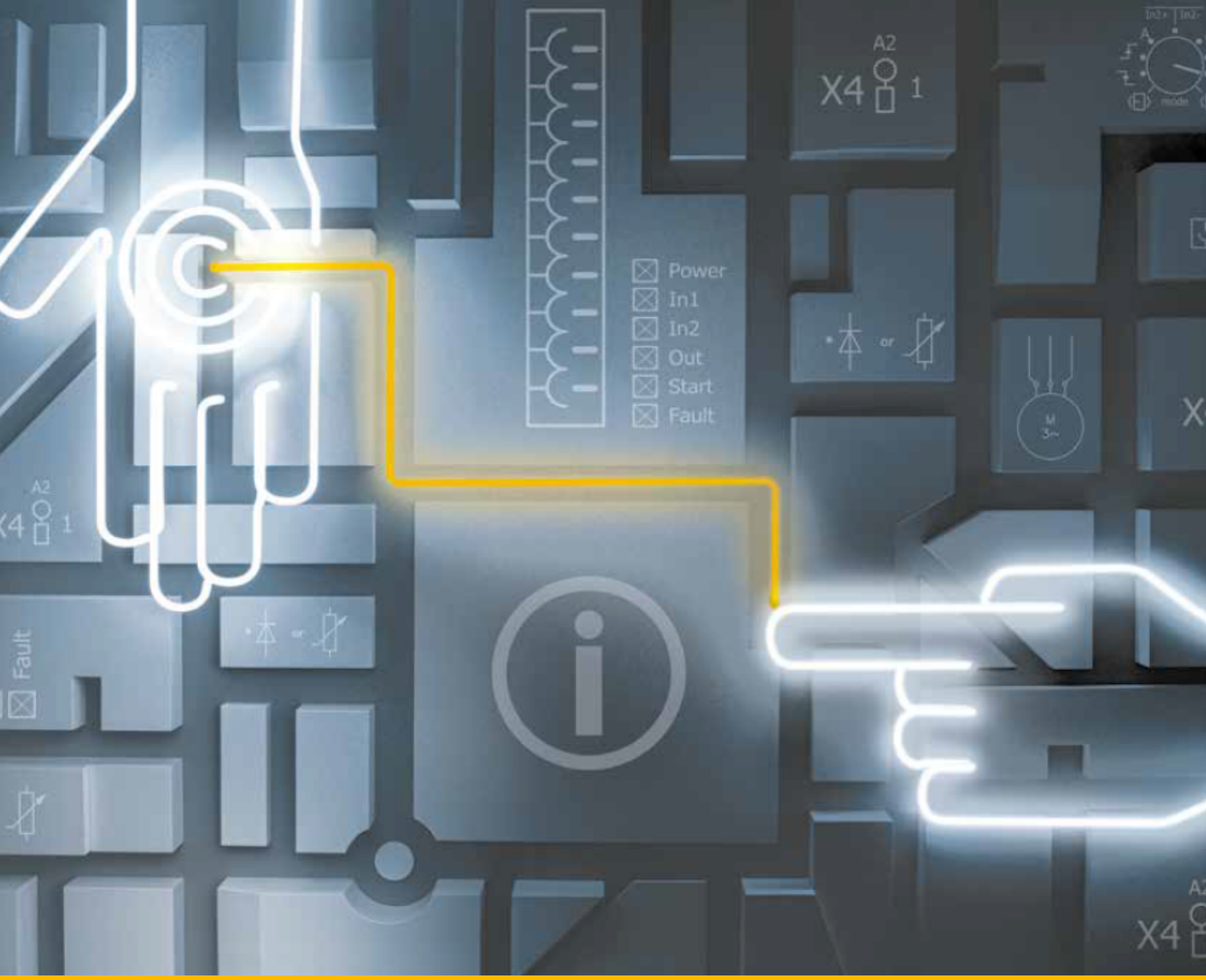


System expansion

PILZ
THE SPIRIT OF SAFETY

Operating Manual-1002217-EN-20

- Configurable, safe small controllers PNOZmulti Classic
- Configurable, safe compact controllers PNOZmulti Mini
- Configurable, safe small controllers PNOZmulti 2




This document is the original document.

Where unavoidable, for reasons of readability, the masculine form has been selected when formulating this document. We do assure you that all persons are regarded without discrimination and on an equal basis.

1 Introduction

The configurable control systems PNOZmulti, PNOZmulti 2 and PNOZmulti Mini each consist of a base unit and expansion modules, where necessary.

Various expansion modules may be connected, depending on the base unit type.

The PNOZmulti Configurator software provides support when assembling a PNOZmulti system.

The maximum system expansion is limited by the maximum permitted number of expansion modules that can be connected.

Positioning of units

- A maximum of one base unit can be used.
- Expansion modules may be connected to the left and right, depending on the base unit type.
- The maximum number per type is given in the tables below.
- The positions of the expansion modules are defined in the PNOZmulti Configurator.

2 Configurable safe small controllers PNOZmulti 2

Maximum system expansion:

- **To the right of the base unit:**

  PNOZ m B0

  – 6 expansion modules

  PNOZ m B1

  – 12 expansion modules (restriction: The number of modules PNOZ m EF 4DI4DOR, PNOZ m EF 4DI4DORD and PNOZ m EF 2MM is limited to a maximum of 8 in total)

  – Until 10/2022 up to Firmware version 1.8: 1 standard module (position: last module to the right of the safety modules)

  – Until 11/2022 up to Firmware version 1.8: 6 standard modules (position: to the right of the safety modules)

  PNOZ m B0.1

  – 1 expansion module

  PNOZ m C0

  – No expansion module

- **To the left of the base unit**

  PNOZ m B0

  – 4 expansion modules

  – 1 communication module

  – 1 fieldbus module

  PNOZ m B1

  – 4 expansion modules

  – 1 fieldbus module

  or

  – 3 expansion modules

  – 1 PNOZ m EF EtherCAT FSoE

  PNOZ m B0.1

  – 4 expansion modules

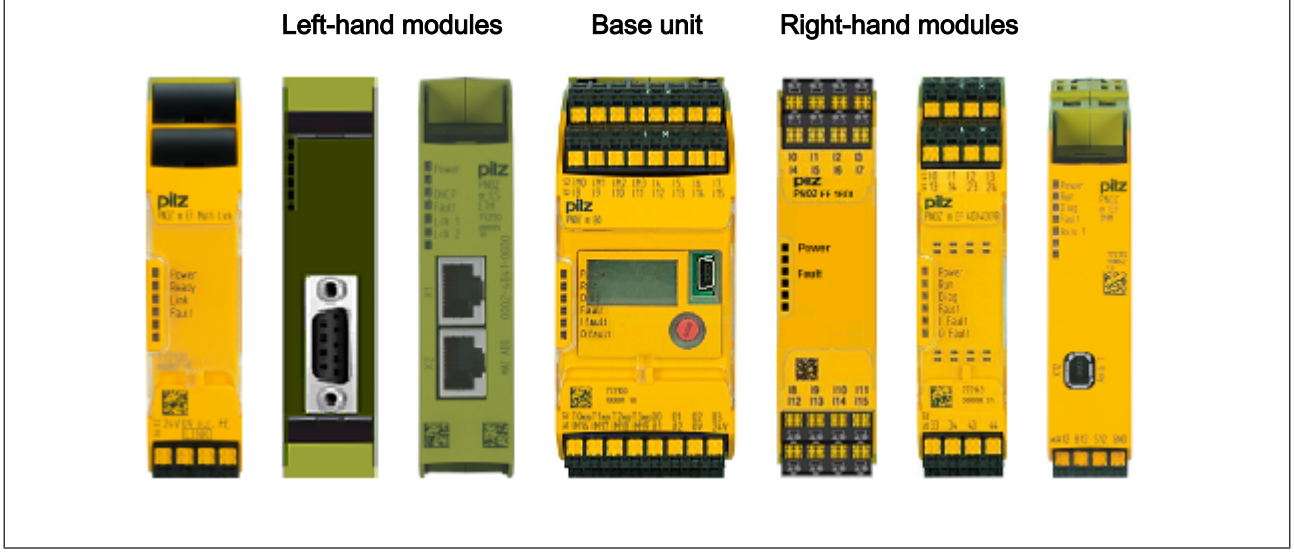
  – 1 communication module

  – 1 fieldbus module

  PNOZ m C0

  – No expansion module

Example of a control system PNOZmulti 2: Base unit PNOZ m B0 with expansion modules



System expansion depends on the base units:

Expansion modules		**Slot**	**PNOZ m B0**	**PNOZ m B0.1**	**PNOZ m B1 PNOZ m B1 Burner**
			Number of connectable modules		
Link modules		**Left**	**4**	**4**	**4**
PNOZ m EF Multi Link	To connect 2 base units				
PNOZ m EF PDP Link	To connect a base unit to up to 4 de-centralised mod-ules PDP67				
PNOZ m EF SafetyNET	To connect up to 16 SafetyNET p RTFL subscribers in a linear struc-ture	**Left** 1st safe module to the left of the base unit	**1**	**-**	**1**
Analogue input modules		**Right**	**6**	**-**	**12**
PNOZ m EF 4AI	4 safe analogue inputs				
Input module for standard applications		**Right**	**-**	**-**	**6**
PNOZ m ES 16DI	16 inputs				

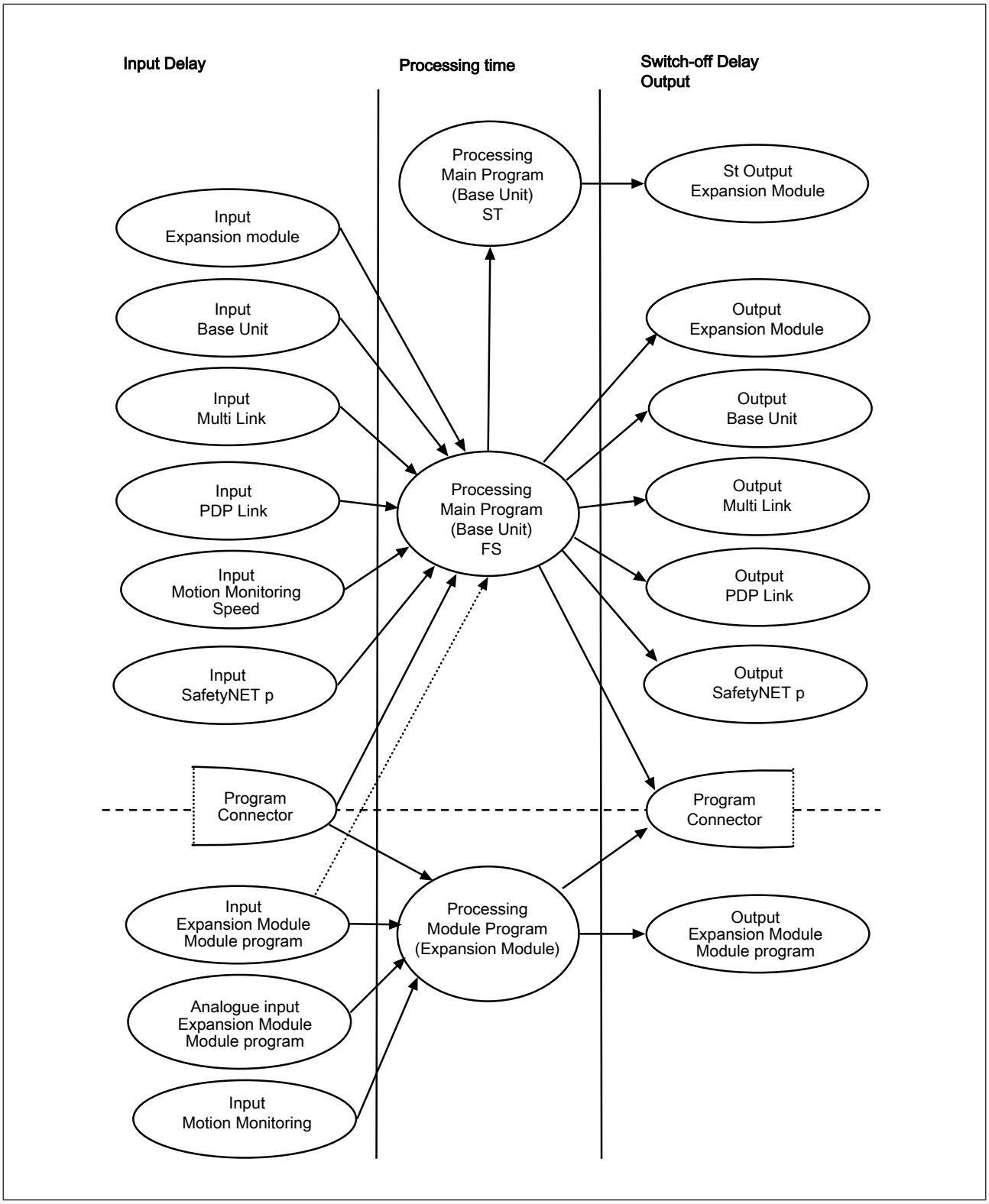
Expansion modules		Slot	PNOZ m B0	PNOZ m B0.1	PNOZ m B1 PNOZ m B1 Burner
Input module		**Right**	**6**	**1**	**12**
PNOZ m EF 16DI	16 safe inputs				
Input and output modules					
PNOZ m EF 8DI4DO	8 safe inputs, 4 safe semiconductor outputs				
PNOZ m EF 8DI2DOT	8 safe inputs, 2 safe dual-pole semiconductor outputs				
PNOZ m EF 4DI4DOR	4 safe inputs, 4 safe relay outputs				**8** (in total with PNOZ m EF 2MM)
PNOZ m EF 4DI4DORD	4 safe inputs, 4 safe diverse relay outputs				
Output module		**Right**	**-**	**1**	**8** (in total with PNOZ m EF 2MM)
PNOZ m EF 2DOR	2 safe relay outputs				
Output module for standard applications		**Right** To the right of the safe expansion modules	-	-	**6**
PNOZ m ES 14DO	14 semiconductor outputs for standard applications				
Motion monitoring modules		**Right**	**6**	**-**	**12**
PNOZ m EF 1MM	Monitoring of 1 axis				
PNOZ m EF 1MM2DO	Monitoring of 1 axis, 2 safe semiconductor outputs, 1 semiconductor output for standard functions				
PNOZ m EF 2MM	Monitoring of 2 axes				**8** (in total with PNOZ m EF 4DI4DOR and PNOZ m EF 4DI4DORD)

Expansion modules		Slot	PNOZ m B0	PNOZ m B0.1	PNOZ m B1 PNOZ m B1 Burner
Fieldbus modules		**Left**	**1**	**1**	**1**
PNOZ m ES Profibus	Profibus				
PNOZ m ES CAN-open	CANopen				
PNOZ m ES CC-Link	CC-Link				
PNOZ m ES Ether-CAT	EtherCAT				
PNOZ m ES Power-link	Powerlink				
PNOZ m ES Ether-Net/IP	EtherNet/IP				
PNOZ m ES Profinet	Profinet				
PNOZ m EF Ether-CAT FSoE	EtherCAT FSoE	**Left**	-	-	**1**
Communication modules		**Left**	**1**	**1**	**-**
PNOZ m ES ETH	Ethernet interface				
PNOZ m ES RS232	Serial interface RS232				

Connected devices		Interface	PNOZ m B0	PNOZ m B0.1	PNOZ m B1
PITreader	System for authentication and authorisation on control systems	Ethernet (Modbus TCP)	-	-	**4**
Visu Panel	Display unit for selecting safe operating modes (approved display units see MSO flex visu system description)	Ethernet (Modbus TCP)	-	-	**4**

2.1 System reaction times

The reaction time between an input switching off and a linked output in the system switching off depends on the delay time at the input, the delay time at the output and the processing time. The times vary depending on which input/output is used by which device.



Calculation of the max. reaction time:

t ReactionMax = **t** Max input delay + **t** Max processing time + **t** Max switch-off delay at the output

Please note that the reaction time is also increased by

- Delay times configured in the user program
- Delay on the sensor that is used
- Delay on the actuator that is used

Maximum reaction times of the base units **and** expansion modules

Modules	Max. input delay	Max. processing time	Max. switch-off delay Output
PNOZ m B0	**2 ms**	**30 ms**	**1 ms**
PNOZ m B0.1	**2 ms**	**30 ms**	**1 ms**
PNOZ m B1 (FS)	-	**30 ms**	-
PNOZ m B1 (ST)	-	**3 ms**	-
PNOZ m EF 16DI	**8 ms**	-	-
PNOZ m EF 4AI	**8 ms +** Signal smoothing (1)	**5 ms**	-
PNOZ m EF 8DI4DO	**8 ms**	-	**3 ms**
PNOZ m EF 4DI4DOR	**8 ms**	-	**22 ms**
PNOZ m EF 4DI4DORD	**8 ms**	-	**22 ms**
PNOZ m EF 2DOR	**8 ms**	-	**22 ms**
PNOZ m EF 8DI2DOT	**8 ms** + Pulse suppression (2)	-	**6 ms**
PNOZ m EF 8DI2DOT Input and output in the module program	**8 ms** + Pulse suppression (2)	-	-
PNOZ m EF EtherCAT FSoE		**20 ms**	
PNOZ m EF Multi Link	**0 ms** (3)	-	**5 ms** (connection's transmission delay)
PNOZ m EF PDP Link	**15 ms** + Max. processing time of the input PDP67 (4)	-	**5 ms**
PNOZ m EF SafetyNET	**0 ms**	-	**25 ms** (connection's transmission delay)
PNOZ m EF 1MM, **PNOZ m EF 2MM** (configuration in the main program)	**1/f_actual + 16 ms** (5)	-	-

Modules	Max. input delay	Max. processing time	Max. switch-off delay Output
PNOZ m EF 1MM, **PNOZ m EF 2MM** (configuration in the module program)	**1/f_actual + 8 ms** (6)	**8 ms**	-
PNOZ m EF 1MM2DO	Speed detection: **1/f_actual + 5 ms** (6) Cascading: **1.6 ms**	**5 ms**	Semiconductor output: **1 ms** Cascading: **1 ms** Signal output: **1 ms**
PNOZ m ES 14DO	-	-	**1 ms**
PNOZ m ES 16DI	**8 ms**	-	-
Program connector	**0 ms** (7)	-	**0 ms**

(1) The signal smoothing can be set in the PNOZmulti Configurator (default setting: 2 ms).

(2) The pulse suppression time can be set in the PNOZmulti Configurator (default setting: 0.8 ms).

(3) An input delay does not need to be considered because it is already considered in the output delay of the communication partner.

(4) See technical details in the operating manual

(5) **1/f_actual** corresponds to the period length T of the measured frequency. The maximum input delay **1/f_actual + X ms** is the reaction time at the input after a limit value is exceeded.

(6) **1/f_actual** corresponds to the period length T of the measured frequency. The maximum input delay (**1/f_actual + X ms) +** Maximum processing time (**X ms**) is the reaction time at the input after a limit value is exceeded.

(7) No additional time needs to be added for data exchange between main program processing and module program processing via the program connectors. This delay is already included in the processing times.

NOTICE

Please note:

If a signal in the user program is repeatedly transferred back and forth between the main program and module program via program connectors, then the processing times must be added multiple times.

To simplify the calculation, the stated times include various times that need to be considered within the system. As a result, transmission times, for example, do not need to be included separately in the calculation.

2.1.1 Example configuration: Input from PNOZ m EF 8DI4DO, output from PNOZ m EF 8DI4DO

Input PNOZ m EF 8DI4DO Max. input delay	Processing in the main program Processing time	Output PNOZ m EF 8DI4DO Switch-off delay
8 ms	30 ms	3 ms

$t_{ReactionMax}$ = 8 ms + 30 ms + 3 ms

$t_{ReactionMax}$ = 41 ms

2.1.2 Example configuration: Input from base unit, output from PNOZ m EF 4DI4DOR

Input PNOZ m B0 Max. input delay	Processing in the main program Processing time	Output PNOZ m EF 8DI4DOR Switch-off delay
2 ms	30 ms	22 ms

$t_{ReactionMax}$ = 2 ms + 30 ms + 22 ms

$t_{ReactionMax}$ = 54 ms

2.1.3 Example configuration: Input from base unit, output from base unit

Base unit input Max. input delay	Processing in the main program Processing time	Base unit output Switch-off delay
2 ms	30 ms	1 ms

$t_{ReactionMax}$ = 2 ms + 30 ms + 1 ms

$t_{ReactionMax}$ = 33 ms

2.1.4 Example configuration: Input from PNOZ m EF 16DI, output for standard applications from PNOZ m ES 14DO

Input PNOZ m EF 16DI Max. input delay	Processing in the main program Processing time (FS + ST)	Output PNOZ m ES 14DO Switch-off delay
8 ms	30 ms + 3 ms	1 ms

$t_{ReactionMax}$ = 8 ms + 30 ms + 3 ms + 1 ms

$t_{ReactionMax}$ = 42 ms

2.1.5 Example configuration: Input from PNOZ m EF 16DI, output for standard applications from PNOZ m ES 14DO

Input PNOZ m EF 16DI Max. input delay	Processing in the main program Processing time (FS + ST)	Output PNOZ m ES 14DO Switch-off delay
8 ms	**30 ms + 3 ms**	**1 ms**

$t_{ReactionMax}$ = 8 ms + 30 ms + 3 ms + 1 ms

$t_{ReactionMax}$ = 42 ms

2.1.6 Example configuration: Input from PNOZ m EF 4AI, output from base unit

$t_{SignalSmoothing}$ = 2 ms

Input PNOZ m EF 4AI Max. input delay	Processing in the module program Processing time	Processing in the main pro-gram Processing time	Base unit output Output delay
8 ms + signal smoothing	**5 ms**	**30 ms**	**1 ms**

$t_{ReactionMax}$ = 8 ms + 2 ms + 5 ms + 30 ms + 1 ms

$t_{ReactionMax}$ = 46 ms

2.1.7 Example configuration: Input from PNOZ m EF 4AI, output from PNOZ m EF 8DI4DO

$t_{SignalSmoothing}$ = 2 ms

Input PNOZ m EF 4AI Max. input delay	Processing in the module program Processing time	Processing in the main pro-gram Processing time	Output PNOZ m EF 8DI4DO Switch-off delay
8 ms + signal smoothing	**5 ms**	**30 ms**	**3 ms**

$t_{ReactionMax}$ = 8 ms + 2 ms + 5 ms + 30 ms + 3 ms

$t_{ReactionMax}$ = 48 ms

2.1.8 Example configuration: Input from PNOZ m EF 8DI2DOT, output from PNOZ m EF 8DI2DOT (in the main program)

Input PNOZ m EF 8DI2DOT Max. input delay	Processing in the main program Processing time	Output PNOZ m EF 8DI2DOT Switch-off delay
8 ms + pulse suppression **0.8 ms**	**30 ms**	**6 ms**

$t_{ReactionMax}$ = 8 ms + 0.8 ms + 30 ms + 6 ms

$t_{ReactionMax}$ = 44.8 ms

2.1.9 Example configuration: Input from PNOZ m EF 8DI2DOT, output from PNOZ m EF 8DI4DO

Input PNOZ m EF 8DI2DOT Max. input delay	Processing in the main program Processing time	Output PNOZ m EF 8DI4DO Switch-off delay
8 ms + pulse suppression **0.8 ms**	**30 ms**	**3 ms**

$t_{ReactionMax}$ = 8 ms + 0.8 ms + 30 ms + 3 ms

$t_{ReactionMax}$ = 41.8 ms

2.1.10 Example configuration: Input from PNOZ m EF 1MM (configured in the main program), output from base unit

f_ist = 100 Hz

Input PNOZ m EF 1MM Max. input delay	Processing in the main program Processing time	Base unit output Switch-off delay
26 ms	**30 ms**	**1 ms**

1/f_ist = 1/100 Hz = 10 ms

1/f_ist + 16 ms = 26 ms

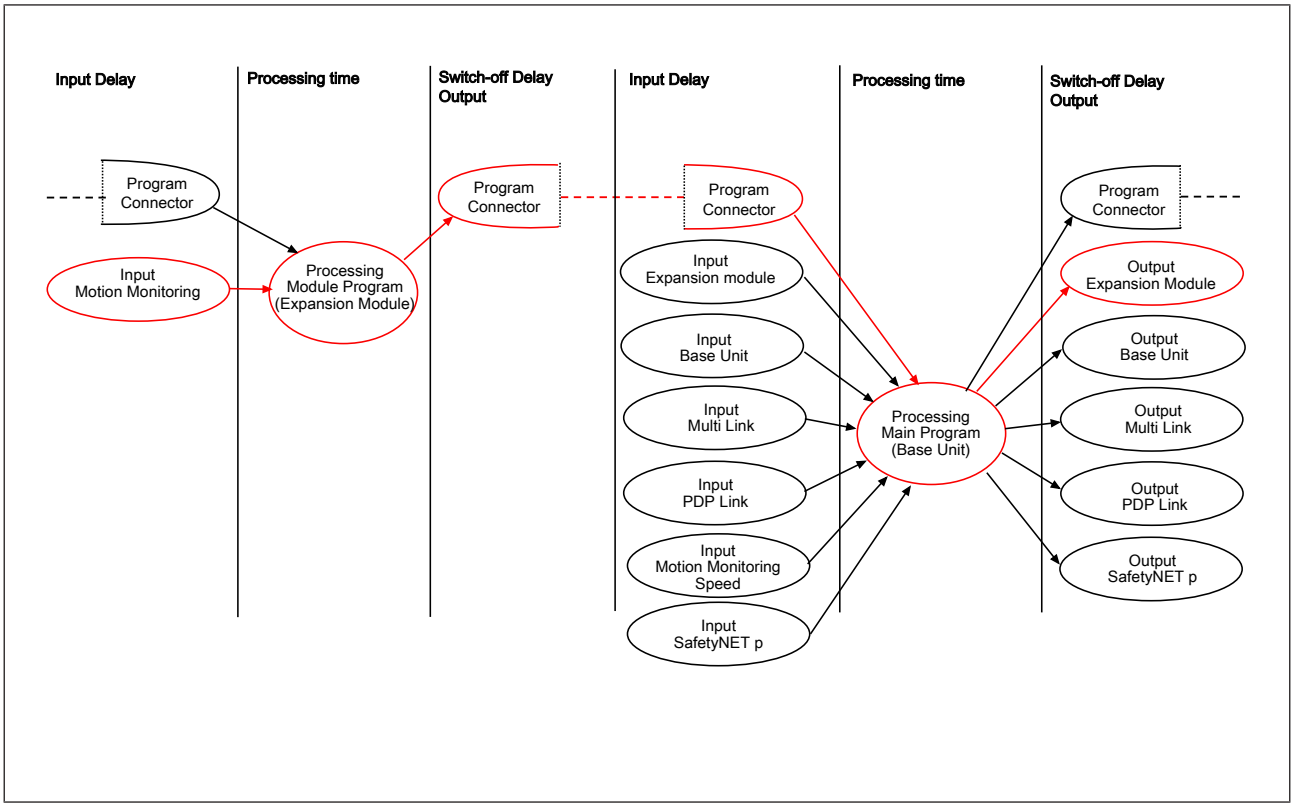
$t_{ReactionMax}$ = 26 ms + 30 ms + 1 ms

$t_{ReactionMax}$ = 57 ms

2.1.11 Example configuration: Input from PNOZ m EF 1MM (configured in the module program), output from PNOZ m EF 8DI4DO

f_actual = 100 Hz

Input PNOZ m EF 1MM Input Delay.Max	Processing in module program Processing Max	Program connectors (output signal from the module program to the main program)	Processing in the main program Processing Max	Output PNOZ m EF 8DI4DO Switch-off delay
18 ms	8 ms	0 ms	30 ms	3 ms



1/f_actual = 1/100 Hz = 10 ms

1/f_actual + 8 ms = 18 ms

$t_{ReactionMax}$ = 18 ms + 8 ms + 30 ms + 1 ms

$t_{ReactionMax}$ = 57 ms

2.1.12 Example configuration: Input from PNOZ m EF 1MM2DO, output from PNOZ m EF 1MM2DO

f_ist = 100 Hz

Input PNOZ m EF 1MM2DO Input Delay.Max	Processing in module program Max. processing time	Output PNOZ m EF 1MM2DO Switch-off delay
15 ms	**4 ms**	**1 ms**

1/f_ist = 1/100 Hz = 10 ms

1/f_ist + 5 ms = 15 ms

$t_{ReactionMax}$ = 15 ms + 4 ms + 1 ms

$t_{ReactionMax}$ = 20 ms

2.1.13 Test pulse suppression at the inputs

On function elements with switch type 3 (see online help for the PNOZmulti Configurator) a test pulse suppression on the inputs can be activated. This function can be used when self-monitored switches are used that create switch-off pulses > 300 µs.

When test pulse suppression is activated please note that the reaction time can increase by up to 15 ms!

2.2 Reaction times EtherCAT FSoE

The maximum EtherCAT FSoE reaction time comprises the delay times of the components involved, including communication.

The following times must be included in the calculation:

- **EtherCAT cycle time**

  Maximum time set by the user in the EtherCAT configuration in the EtherCAT Master.

WARNING!

Hazard due to loss of the safety function

When making the calculation, note that the FSoE reaction time is influenced by a change to the EtherCAT cycle time!

- **Delay time PNOZ m EF EtherCAT FSoE**

  Maximum time that the PNOZ m EF EtherCAT FSoE requires for FSoE protocol processing.
  The max. cycle time of the PNOZ m EF EtherCAT FSoE is used for the calculation.
  Samples must be taken into account for the max. delay time due to asynchronous protocol processing.
  For this reason, twice the max. cycle time is taken:
  Delay time PNOZ m EF EtherCAT FSoE = 2 * cycle time PNOZ m EF EtherCAT FSoE.

- **Delay time FSoE Slave**

Maximum time that an FSoE Slave requires for FSoE protocol processing.
The max. cycle time of the FSoE Slave is used for the calculation.
If there is no information available from the manufacturer of the FSoE Slave, the max. cycle time of the PNOZ m EF EtherCAT FSoE can be adopted as the cycle time.
Samples must be taken into account for the max. delay time due to asynchronous protocol processing.
For this reason, twice the max. cycle time is taken:
Delay time FSoE Slave = 2 * Cycle time FSoE Slave.

- **Delay time due to copying the EtherCAT data (copy time)**

  If you are using an EtherCAT Master that does not copy the EtherCAT data within the EtherCAT cycle time, the copy time must be added when calculating the watchdog time.
  If the EtherCAT data is copied in the user program of the EtherCAT Master, then the copy time corresponds to the cycle time of the user program.

- **FSoE Master watchdog time**

  The watchdog time is the maximum permitted delay time across all communication subscribers in an FSoE connection. For a stable and available connection, the worst case of the individual delays must be used for determining the watchdog time.
  The watchdog time is monitored safely and therefore represents a guaranteed time for the reaction time calculation.
  Calculation of the watchdog time:
  Watchdog time = (4 * EtherCAT cycle time) + (2 * Copy time) + (Delay time PNOZ m EF EtherCAT FSoE) + (Delay time FSoE Slaves)

- **FSoE reaction time max.**

  The max. FSoE reaction time is the reaction time to a change in the process image.
  It is calculated as follows
  Max. FSoE reaction time = (2 * FSoE watchdog time) + (2 * Max. cycle time PNOZ m EF EtherCAT FSoE)

2.2.1 Example configuration: Reaction time of the FSoE Slave to the output PNOZ m EF 8DI4DO

In the example, an EtherCAT cycle time of 1 ms is adopted.

- Delay time PNOZ m EF EtherCAT FSoE
  2 * 10 ms = 20 ms
- Delay time FSoE Slave
  2 * 10 ms = 20 ms
- FSoE Master watchdog time:
  4 ms + 20 ms + 20 ms = 44 ms
- **FSoE reaction time max:**
  (2 * 44 ms) + 20 ms
  = 88 ms + 20 ms = 108 ms

FSoE Slave Input delay Max	FSoE Reaction time Max	Processing in the main program Processing Max	Output PNOZ m EF 8DI4DO Switch-off delay
4 ms	**108 ms**	**30 ms**	**3 ms**

$t_{ReactionMax}$ = 4 ms + 108 ms + 30 ms + 3 ms

$t_{ReactionMax}$ = 145 ms

3 Configurable safe compact controllers PNOZmulti Mini

Maximum system expansion:

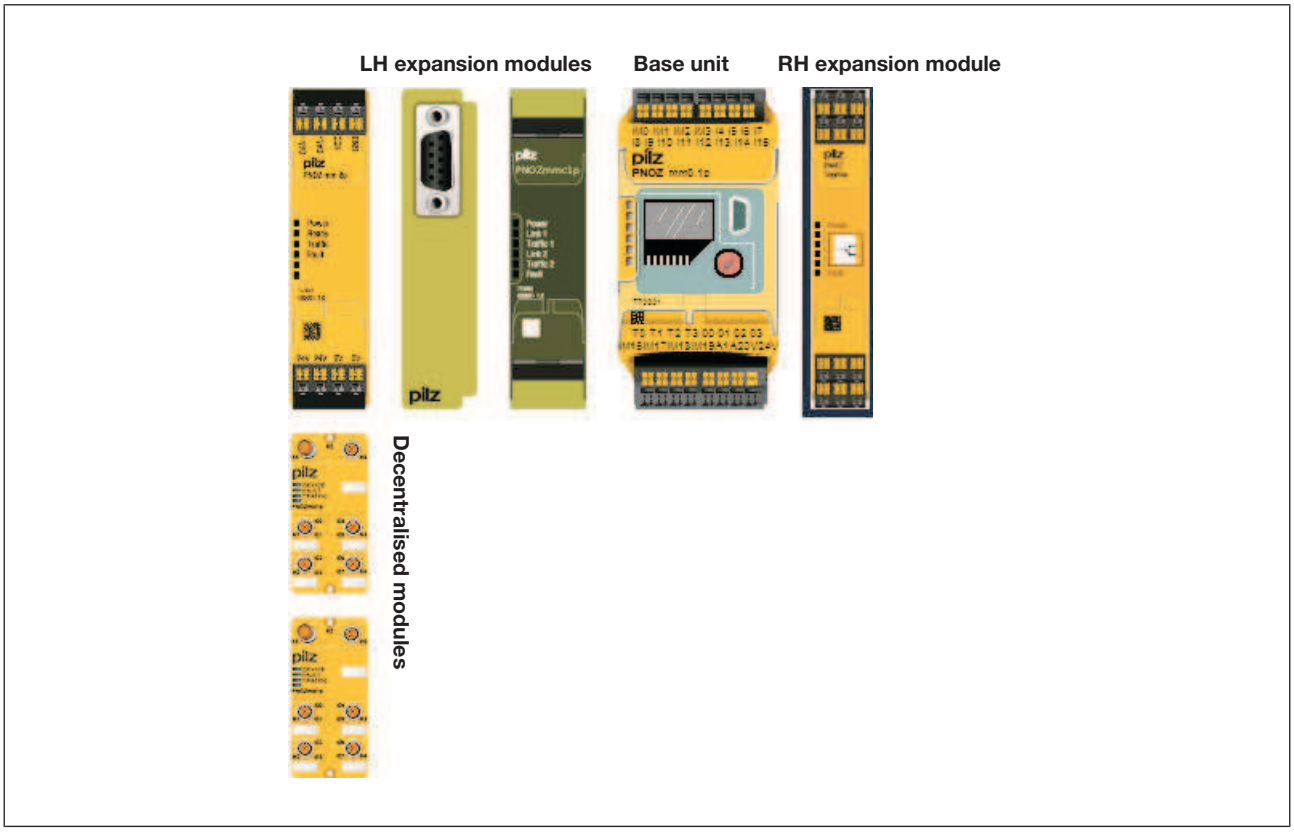
- Right of the base unit:
  - 1 PNOZsigma expansion module (+1 contact expansion)
- Left of the base unit
  - 1 fieldbus module

    and
  - 1 communication module

    and
  - 4 link modules
- Connectable to the link module PNOZ mml2p:

  4 decentralised modules per link module (max. 16 decentralised modules)

Example of a control system PNOZmulti Mini: Base unit PNOZ mm0.1p with expansion modules

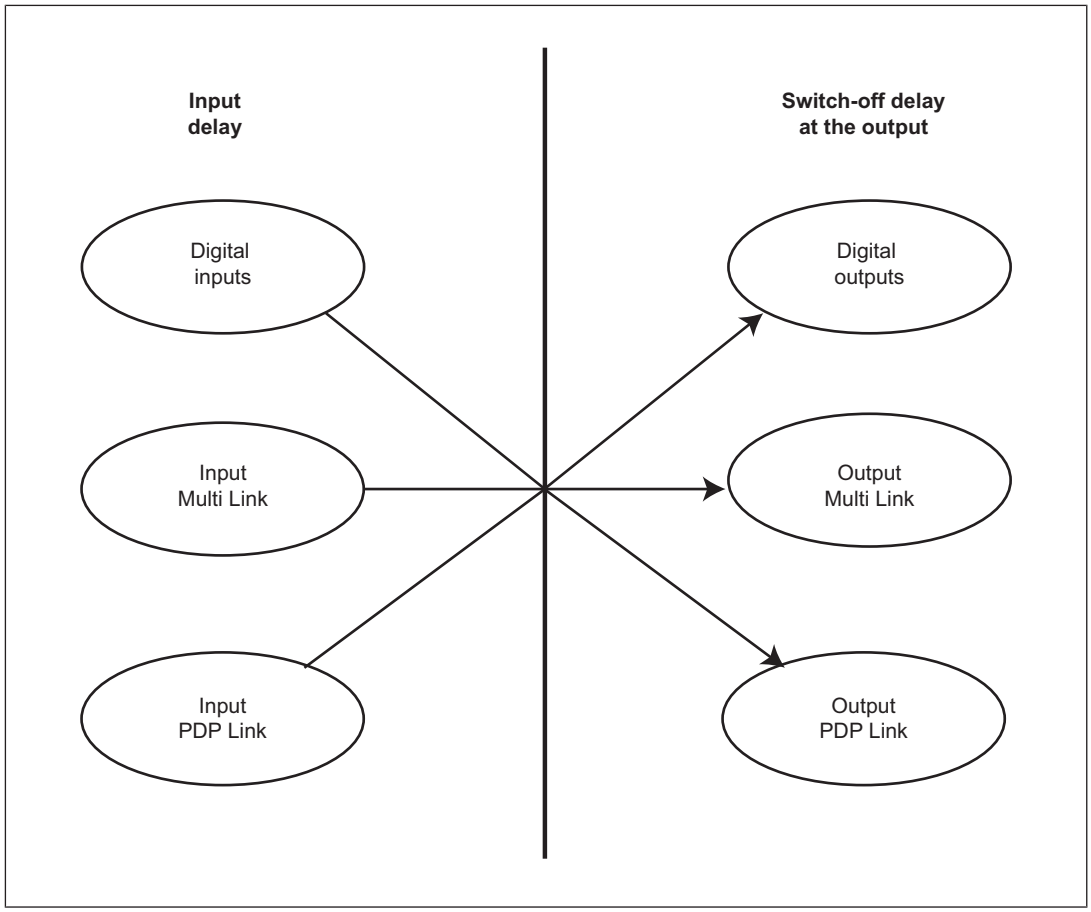


System expansion depends on the base units:

Expansion modules		Slot	PNOZ mm0p	PNOZ mm0.1p	PNOZ mm0.2p
			Number of connectable modules		
Link modules		**Left**	**-**	**4**	**4**
PNOZ mml1p	To connect 2 base units				
PNOZ mml2p	To connect a base unit to up to 4 decentralised modules PDP67 (see below)				
Decentralised modules (connectable to the link module PNOZ mml2p)		**Left**	**-**	**16**	**16**
PDP67 F 8DI ION	IP67, 8 safe inputs				
PDP67 F 8DI ION HP	IP67, 8 safe inputs				
Communication modules		**Left**	**-**	**1**	**1**
PNOZ mmc1p	Ethernet interface				
PNOZ mmc2p	Serial interface RS232				
Fieldbus modules		**Left**	**-**	**1**	**1**
PNOZ mmc3p	PROFIBUS DP				
PNOZ mmc4p	DeviceNet				
PNOZ mmc6p	CANopen				
PNOZ mmc7p	CC-Link				
PNOZ mmc11p	EtherCAT				
PNOZ mmc12p	Ethernet POWERLINK				
PNOZsigma output modules		**Right**	**-**	**1**	**1**
PNOZ s7	1 safe relay output				
PNOZ s7.1	1 safe relay output (+ 1 PNOZ s7, PNOZ s10 or PNOZ s11 can be connected as a contact expansion module)				
PNOZ s7.2	1 safe relay output (+ 1 expansion module PNOZ s7, PNOZ s10 or PNOZ s11 can be connected)				
PNOZ s10	1 safe relay output				
PNOZ s11	1 safe relay output				
PNOZ s22	2 safe relay outputs				

3.1 System reaction times

The reaction time between an input switching off and a linked output in the system switching off depends on the delay time at the input and the delay time at the output. The times vary depending on which input/output is used by which device.



Calculation of the max. reaction time:

t ReactionMax = **t** Max. input delay + **t** Max. switch-off delay at the output

Please note that the reaction time is also increased by

- Delay times configured in the user program
- Delay on the sensor that is used
- Delay on the actuator that is used
- Delay due to periphery devices or control systems

Reaction times of the base units and expansion modules

Modules	Max. input delay	t Max. switch-off delay Output (incl. processing time)
PNOZ mm0p … PNOZ mm0.2p	**4 ms**	**30 ms** (semiconductor output)
PNOZ mm0.2p	**4 ms**	**35 ms** (virtual outputs for data transfer when 2 base units are connected)
PNOZ s7, PNOZ s7.1, PNOZ s7.2, PNOZ s10, PNOZ s11, PNOZ s22	**-**	**30 ms** + delay-on de-energisation of expansion module
PNOZ mml1p	**0 ms** (1)	**35 ms** (connection's transmission delay)
PNOZ mml2p	**15 ms** + input delay PDP67 (2)	**35 ms**

(1) An input delay is not considered because it is already considered in the output delay of the communication partner.

(2) See technical details in the operating manual

To simplify the calculation, the stated times include various times that need to be considered within the system. As a result, transmission times, for example, do not need to be included separately in the calculation. The processing time in the base unit is already considered in the max. switch off delay at the output.

3.1.1 Example configuration: Input from base unit PNOZ mm0.1p, output from PNOZ s7

Input PNOZ mm0.1p Input Delay.Max	Output PNOZ mo4p Switch-off Delay.Max
4 ms	**30 ms + delay-on de-energisation 30 ms**

$t_{ReactionMax}$ = 4 ms + 30 ms + 30 ms

$t_{ReactionMax}$ = 64 ms

4 Configurable safe small controllers PNOZmulti Classic

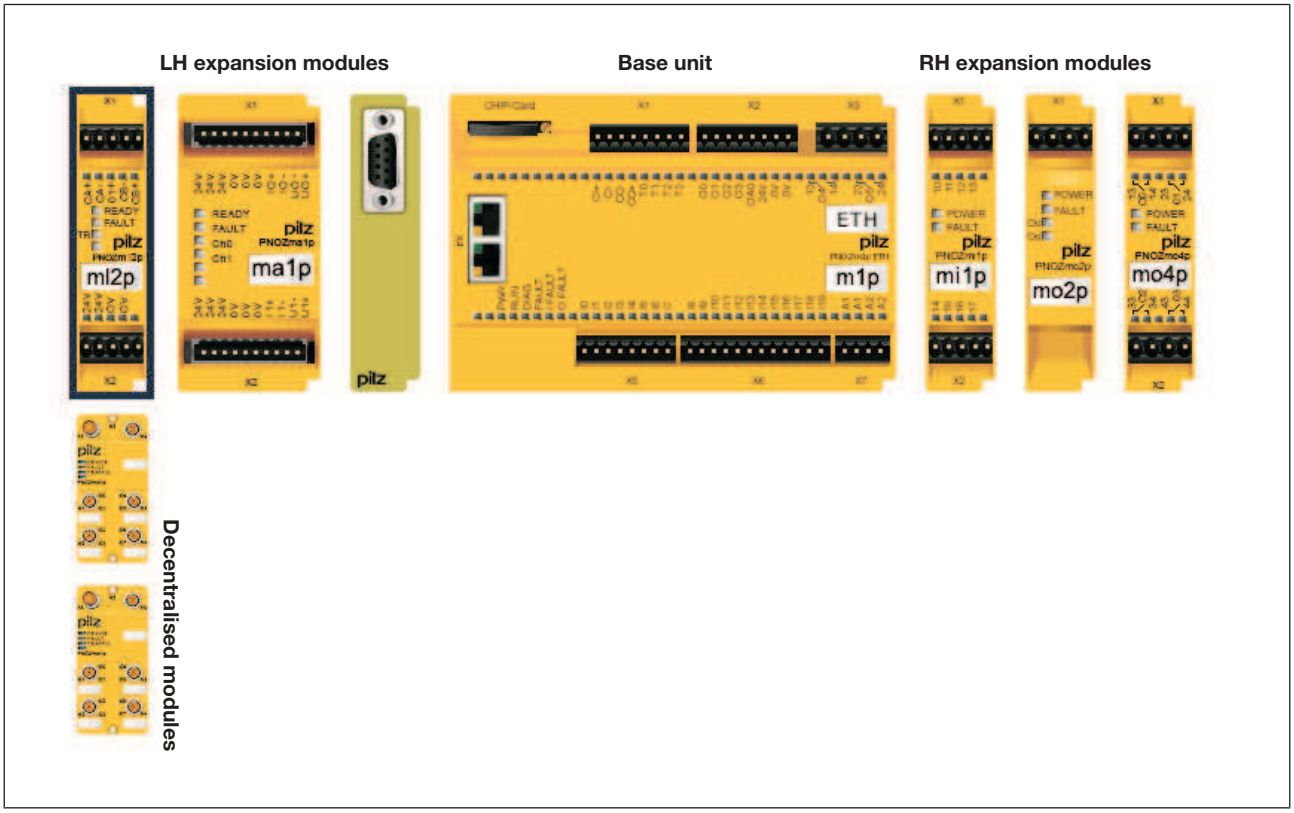
Maximum system expansion:

- Right of the base unit:
  - 8 expansion modules
- Left of the base unit
  - 4 expansion modules

  and
  - 1 fieldbus module
- Connectable to the link module PNOZ ml2p:

  4 decentralised modules per link module (max. 16 decentralised modules)

Example of a control system PNOZmulti: Base unit PNOZ m1p ETH with expansion modules



System expansion depends on the base units:

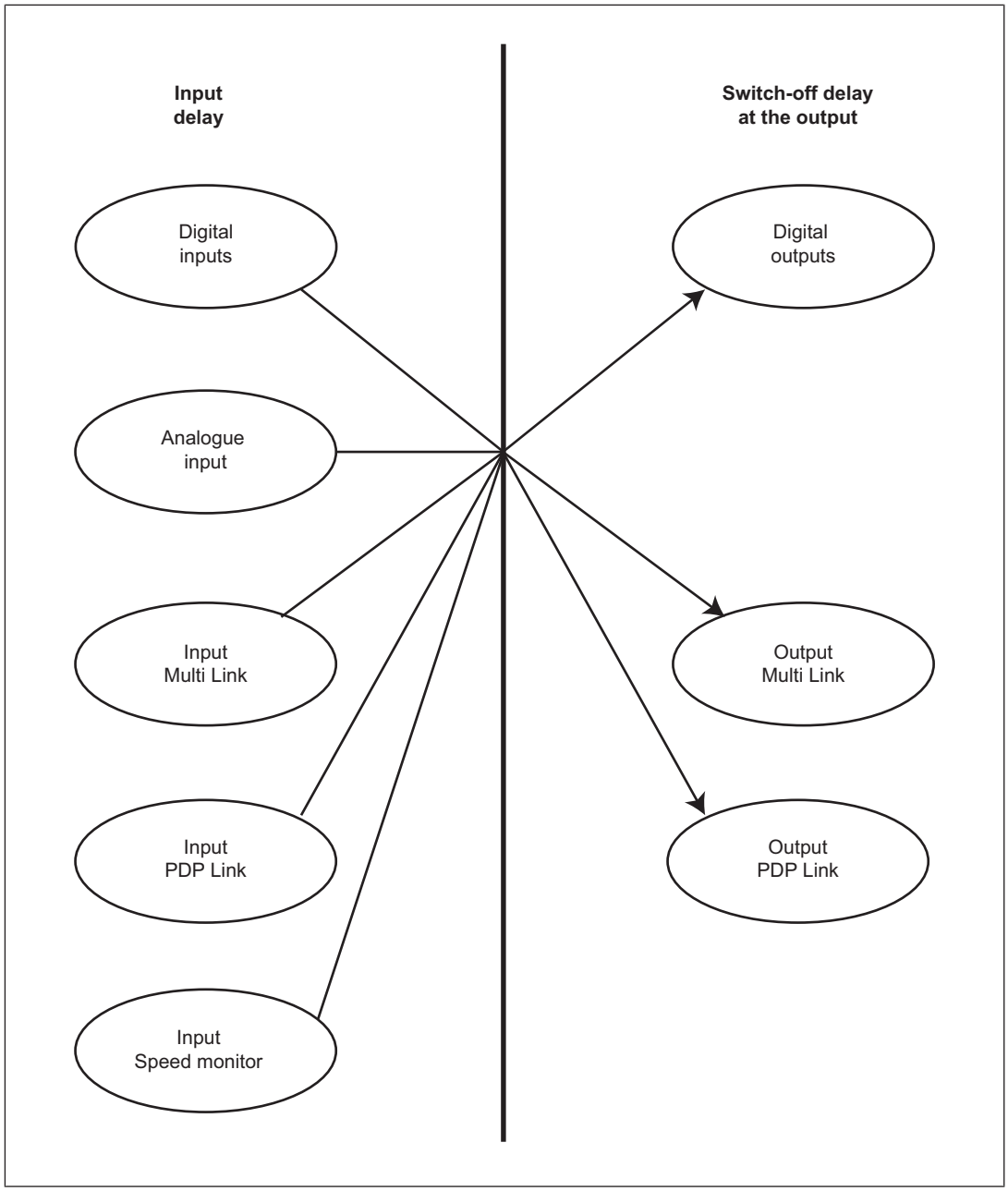
Expansion modules		Slot	PNOZ m0p (ETH)	PNOZ m1p (ETH)	PNOZ m2p (ETH)	PNOZ m3p (ETH)
			Number of connectable modules			
Analogue input modules		**Left**	**-**	**4**	**4**	**4**
PNOZ ma1p	Analogue input module					
Link modules		**Left**	**4**	**4**	**4**	**4**
PNOZ ml1p	To connect 2 base units					
PNOZ ml2p	To connect a base unit to up to 4 decentralised modules PDP67 (see below)					
Decentralised modules (connectable to the link module PNOZ ml2p)		**Left**	**16**	**16**	**16**	**16**
PDP67 F 8DI ION	IP67, 8 safe inputs					
PDP67 F 8DI ION HP	IP67, 8 safe inputs					
Input modules		**Right**	**-**	**8**	**8**	**8**
PNOZ mi1p	8 safe inputs					
PNOZ mi2p	8 inputs for standard applications					
Output modules		**Right**	**-**	**6**	**6**	**6**
PNOZ mo1p	4 safe semiconductor outputs					
PNOZ mo2p	2 safe relay outputs					
PNOZ mo3p	2 safe 2-pole semiconductor outputs					
PNOZ mo4p	4 safe relay outputs					
PNOZ mo5p	4 safe, diverse relay outputs					
Output modules for standard applications		**Right**	**-**	**8**	**8**	**8**
PNOZ mc1p	16 semiconductor outputs for standard applications					

Expansion modules		Slot	PNOZ m0p (ETH)	PNOZ m1p (ETH)	PNOZ m2p (ETH)	PNOZ m3p (ETH)
Speed monitor		**Right**	**-**	**4**	**4**	**4**
PNOZ ms1p	Monitoring of 2 axes Connectable encoders: Proximity switch, incremental encoder Sin/Cos, TTL					
PNOZ ms2p HTL	Monitoring of 2 axes Connectable encoders: Proximity switch, incremental encoder HTL					
PNOZ ms2p TTL	Monitoring of 2 axes Connectable encoders: Proximity switch, incremental encoder Sin/Cos, TTL					
PNOZ ms3p HTL	Monitoring of 2 axes Connectable encoders: Incremental encoder HTL					
PNOZ ms3p TTL	Monitoring of 2 axes Connectable encoders: Incremental encoder Sin/Cos, TTL					
PNOZ ms4p	Monitoring of 1 axis Connectable encoders: Incremental encoder Sin/Cos, TTL, HTL					

Expansion modules		Slot	PNOZ m0p (ETH)	PNOZ m1p (ETH)	PNOZ m2p (ETH)	PNOZ m3p (ETH)
Fieldbus modules		**Left**	**1**	**1**	**1**	**1**
PNOZ mc0p	Power supply to supply voltage to fieldbus modules					
PNOZ mc2p	EtherCAT					
PNOZ mc2.1p	EtherCAT (DS301 V4.02 compliant)					
PNOZ mc3p	PROFIBUS-DP					
PNOZ mc4p	DeviceNet					
PNOZ mc5p	Interbus					
PNOZ mc5.1p	Interbus fibre-optic cable					
PNOZ mc6p	CANopen					
PNOZ mc6.1p	CANopen					
PNOZ mc7p	CC-Link					
PNOZ mc8p	Ethernet IP/Modbus TCP					
PNOZ mc9p	Profinet					
PNOZ mc10p	sercos III					
PNOZ mc12p	Ethernet POWERLINK					

4.1 System reaction times

The reaction time between an input switching off and a linked output in the system switching off depends on the delay time at the input and the delay time at the output. The times vary depending on which input/output is used by which device.



Calculation of the max. reaction time:

t ReactionMax = **t** Max. input delay + **t** Max. switch-off delay at the output

Please note that the reaction time is also increased by

- Delay times configured in the user program
- Delay on the sensor that is used
- Delay on the actuator that is used
- Delay due to periphery devices or control systems

Reaction times of the base units and expansion modules

Modules	Max. input delay	Max. switch-off delay Output (incl. processing time)
PNOZ m0p … **PNOZ m3p**	**4 ms**	**30 ms** (semiconductor output) **50 ms** (relay output)
PNOZ mi1p … **PNOZ mi2p**	**4 ms**	**-**
PNOZ mo1p, **PNOZ mo3p**	**-**	**30 ms**
PNOZ mo2p, **PNOZ mo4p,** **PNOZ mo5p**	**-**	**50 ms**
PNOZ ml1p	**0 ms** (1)	**35 ms** (connection's transmission delay)
PNOZ ml2p	**15 ms** + Max. processing time of the input PDP67 (2)	**35 ms**
PNOZ ma1p	**100 ms**	**-**
PNOZ ms1p … **PNOZ ms4p**	**10 ms [+1/f]** (+conf.switch-off delay)	**-**

(1) An input delay is not considered because it is already considered in the output delay of the communication partner.

(2) See technical details in the operating manual

To simplify the calculation, the stated times include various times that need to be considered within the system. As a result, transmission times, for example, do not need to be included separately in the calculation. The processing time in the base unit is already considered in the max. switch off delay at the output.

4.1.1 Example configuration: Input from PNOZ mi2p, output from PNOZ mo3p

Input PNOZ mi2p tInput Delay.Max	Output PNOZ mo3p tSwitch-offDelay.Max
4 ms	**30 ms**

$t_{ReactionMax}$ = 4 ms + 30 ms

$t_{ReactionMax}$ = 34 ms

4.1.1.1 Example configuration: Input from base unit PNOZ m1p, output from PNOZ mo4p

Input PNOZ m1p Input Delay.Max	Output PNOZ mo4p Switch-off Delay.Max
4 ms	50 ms

$t_{ReactionMax}$ = 4 ms + 50 ms

$t_{ReactionMax}$ = 54 ms

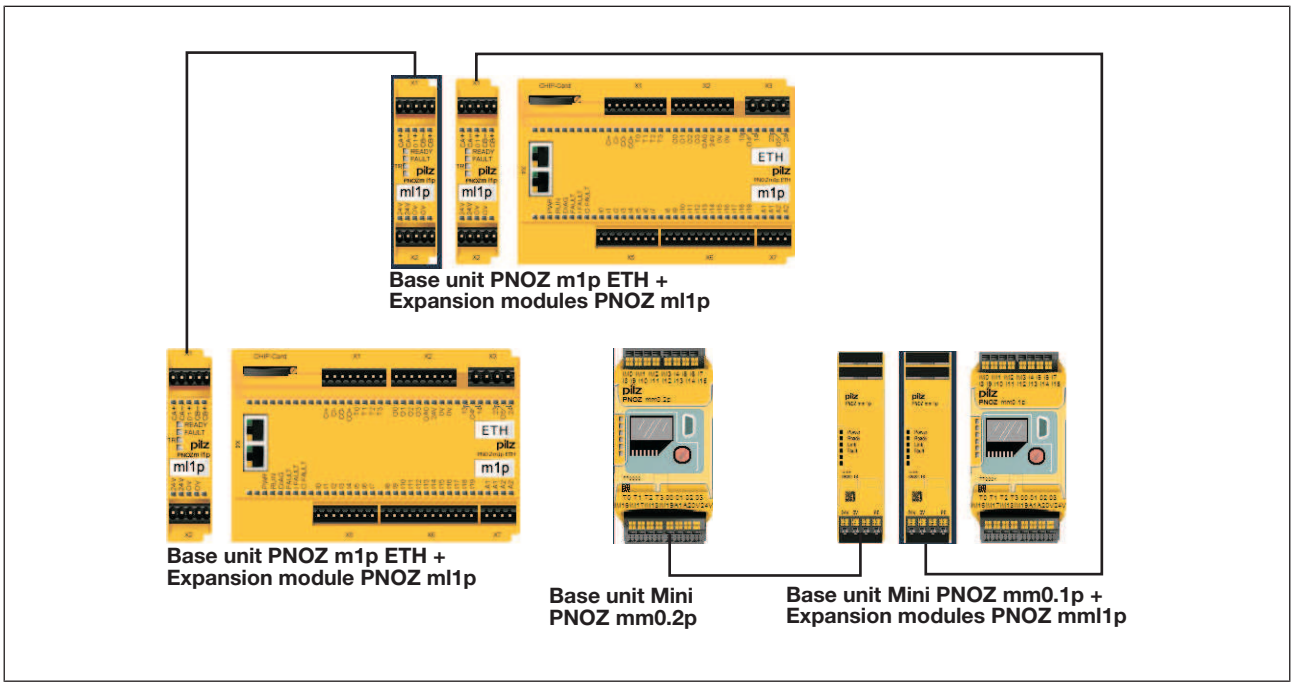
5 Connection of multiple PNOZmulti systems

For safe data exchange two or more configurable control systems PNOZmulti can be connected to each other.
There are various options available:

- **PNOZmulti Link connection**
  The connection is created via two connection modules and/or connection interfaces that are assigned to one base unit each.
  Any number of base units can be connected via connection modules.
  However, only a max. of 4 link modules can be connected to a base unit.
- **SafetyNET p RTFL connection**
  The systems PNOZmulti 2 can also be connected via SafetyNET p RTFL. Up to 16 base units can be connected in a linear structure. Each base unit can create safe connections to the other connected base units. The position of the base units in the line does not matter.
  The reaction times are independent of the number of subscribers and their position in the line.

Connection via PNOZmulti Link

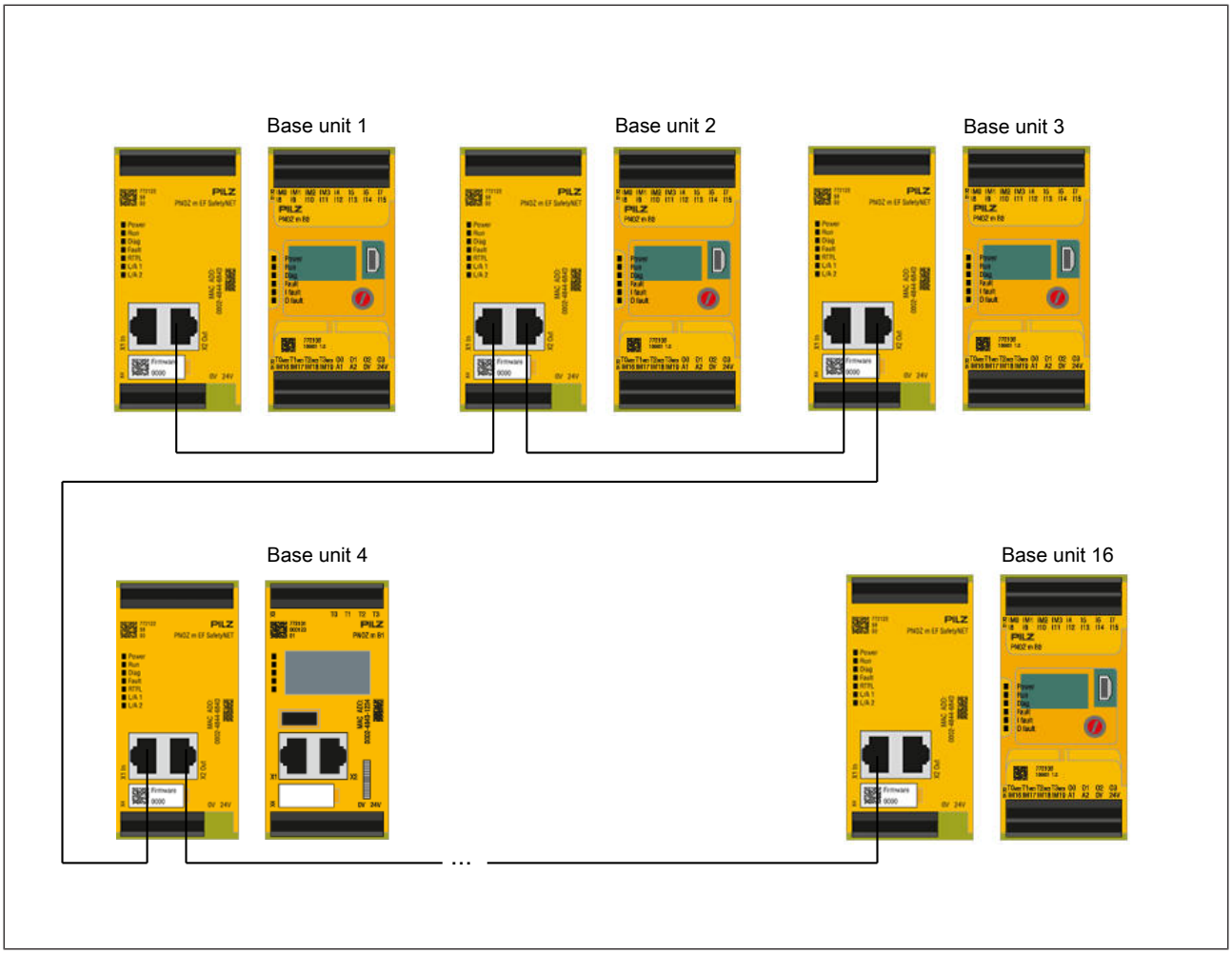
Example: Connecting 4 base units



Connection options

	PNOZ m B0, PNOZ m B1 +PNOZ m EF Multi Link	PNOZ m0p/1p/2p/3p (ETH) +PNOZ ml1p	PNOZ mm0p PNOZ m C0	PNOZ mm0.1p +PNOZ mml1p	PNOZ mm0.2p
PNOZ m B0, PNOZ m B1 +PNOZ m EF Multi Link	x	x		x	x
PNOZ m0p/1p/2p/3p (ETH) +PNOZ ml1p	x	x		x	x
PNOZ mm0p PNOZ m C0					
PNOZ mm0.1p + PNOZ mml1p	x	x		x	x
PNOZ mm0.2p	x	x		x	x

Connection via SafetyNET p



Connection options

	PNOZ m B0, PNOZ m B1 + PNOZ m EF SafetyNET
PNOZ m B0, PNOZ m B1 +PNOZ m EF SafetyNET	x

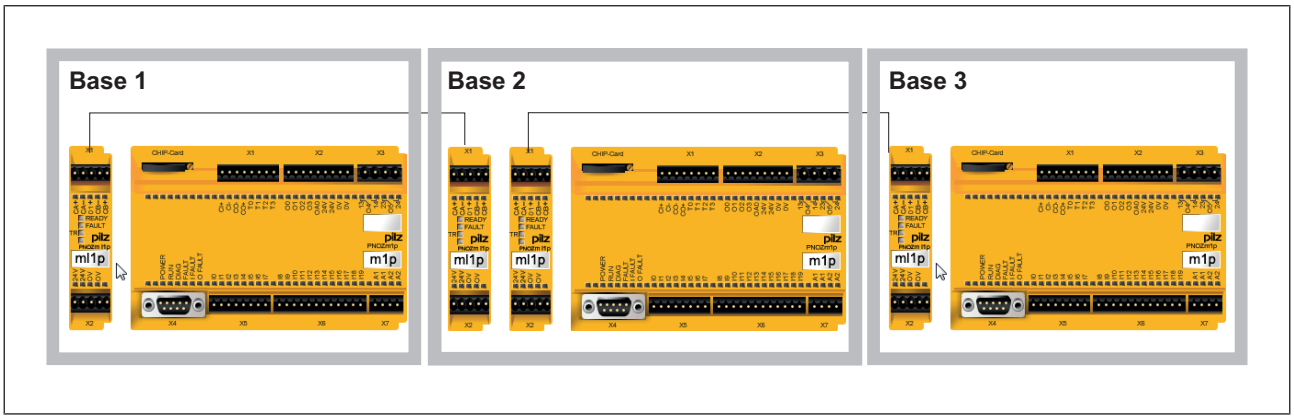
5.1 Reaction times of the Multi Link connection

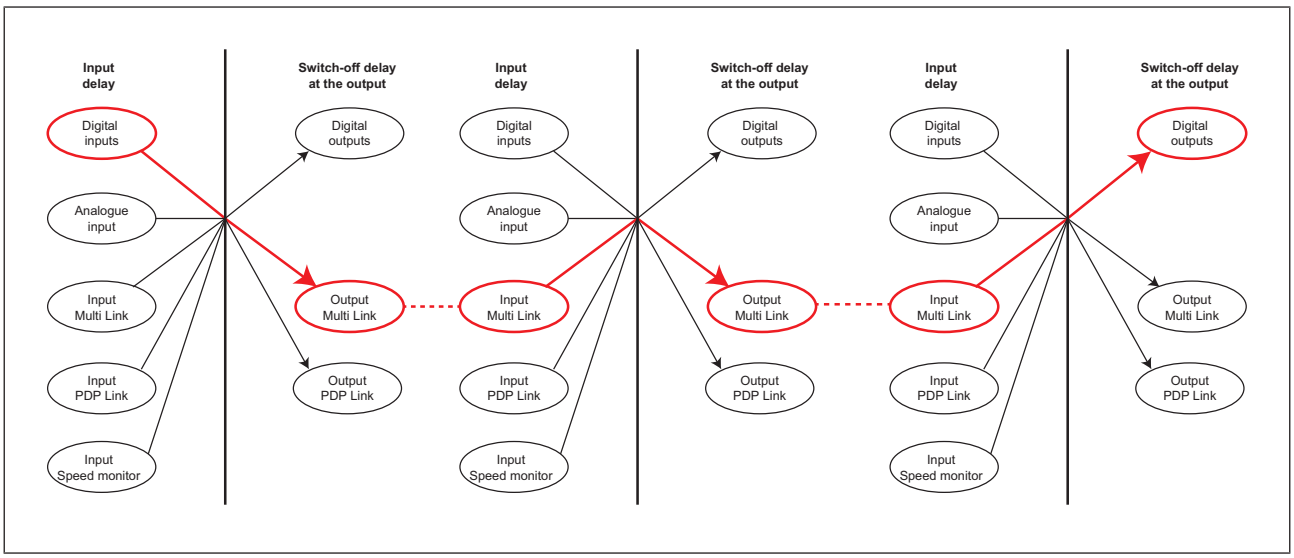
The reaction time when connecting two or more base units is calculated from the transmission delay of the connection at the link module of a communication partner and the input delay at the link module of the connected communication partner.

5.1.1 Example: Connecting 3 base units PNOZmulti

The maximum reaction time $t_{ReactionMax}$ includes the following times:

- Max. input delay PNOZ m1p (Base 1): 4 ms
- Data transfer time of the connection at the PNOZ ml1p (Base 1): 35 ms
- Max. input delay PNOZ ml1p (Base 2): 0 ms
- Data transfer time of the connection at the PNOZ ml1p (Base 2): 35 ms
- Max. input delay PNOZ ml1p (Base 3): 0 ms
- Max. switch-off delay at the output PNOZ m1p: 30 ms





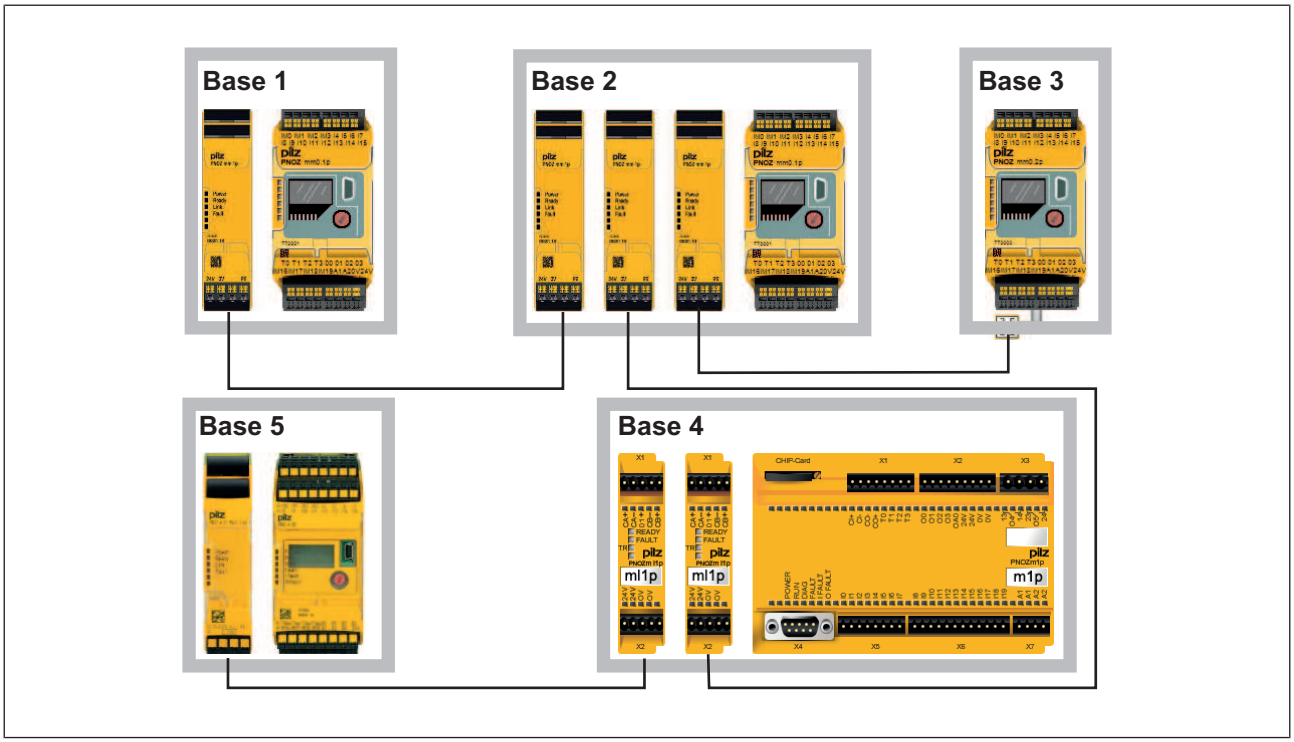
$t_{ReactionMax}$ = **4 ms + 35 ms + 0 ms + 35 ms + 0 ms + 30 ms**

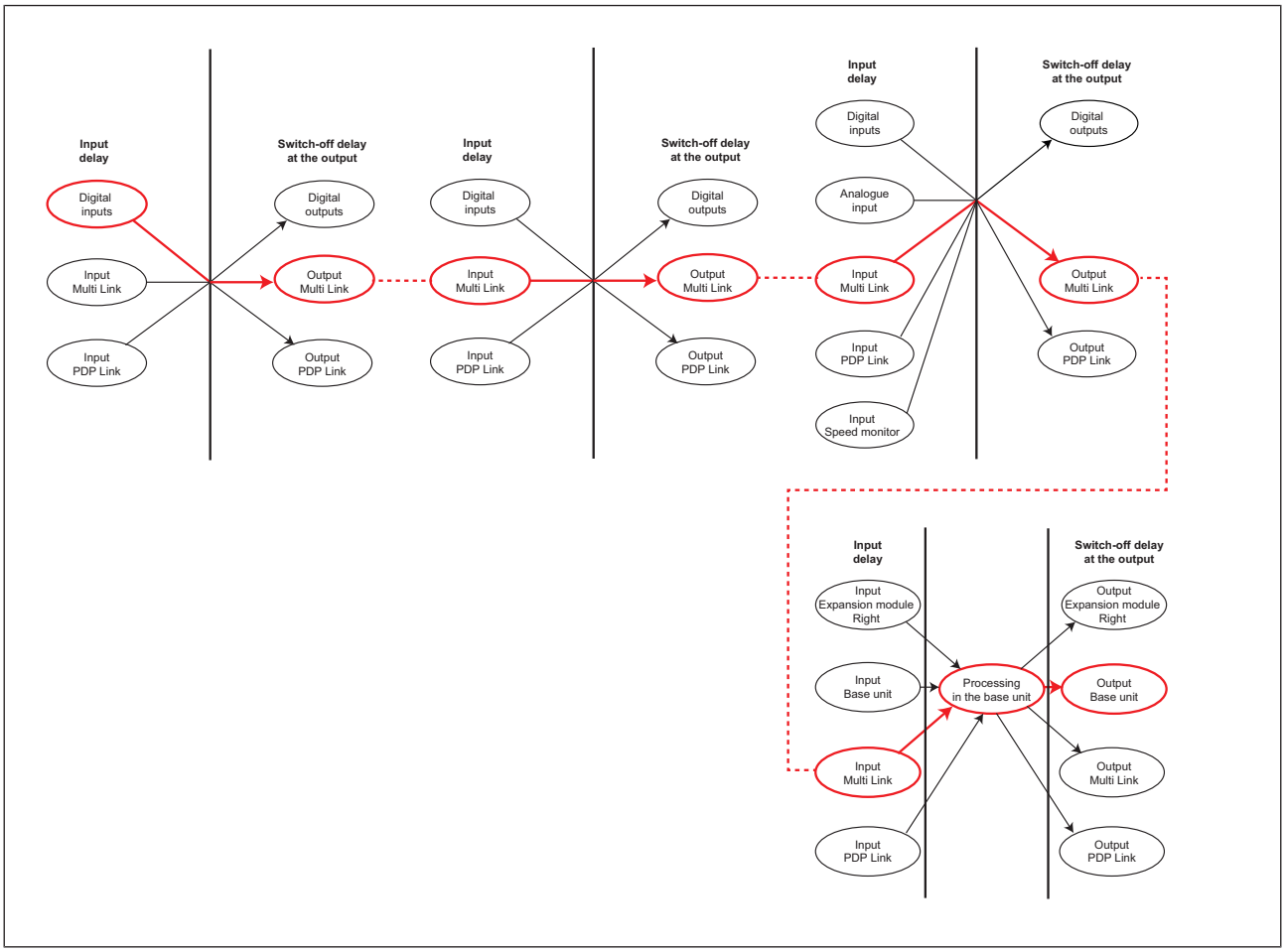
$t_{ReactionMax}$ = **104 ms**

5.1.2 Example: Connecting 5 base units PNOZmulti

The maximum reaction time $t_{ReactionMax}$ includes the following times:

- Max. input delay PNOZ mm0.1p (Base 1): 4 ms
- Data transfer time of the connection at the PNOZ mml1p (Base 1): 35 ms
- Max. input delay PNOZ mml1p (Base 2): 0 ms
- Data transfer time of the connection at the PNOZ mml1p (Base 2): 35 ms
- Max. input delay PNOZ mml1p (Base 2): 0 ms
- Data transfer time of the connection at the PNOZ ml1p (Base 4): 35 ms
- Max. input delay PNOZ m EF Multi Link (Base 5): 0 ms
- Max. processing time PNOZ m B0 (Base 5): 30 ms
- Max. switch-off delay at the output PNOZ m B0 (Base 5): 1 ms





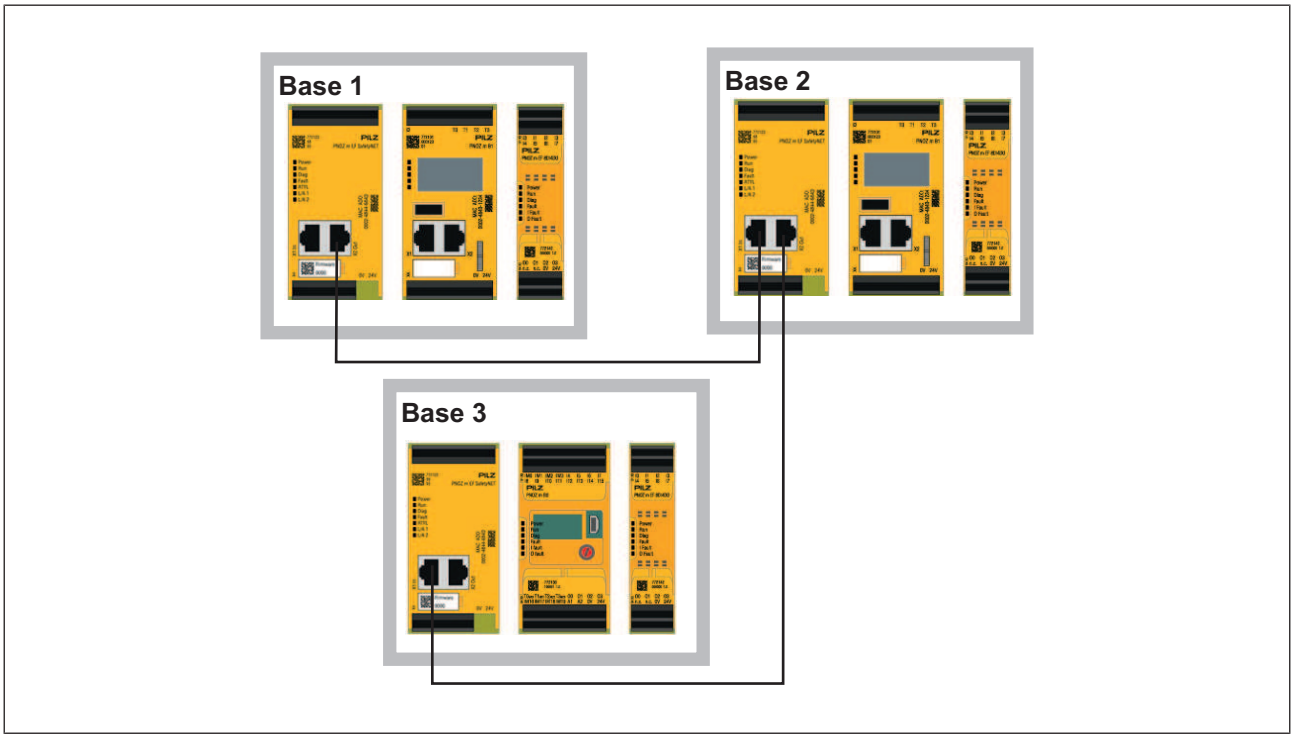
$t_{ReactionMax}$ = **4 ms + 35 ms + 0 ms + 35 ms + 0 ms + 35 ms + 0 ms 30 ms + 1 ms**

$t_{ReactionMax}$ = **140 ms**

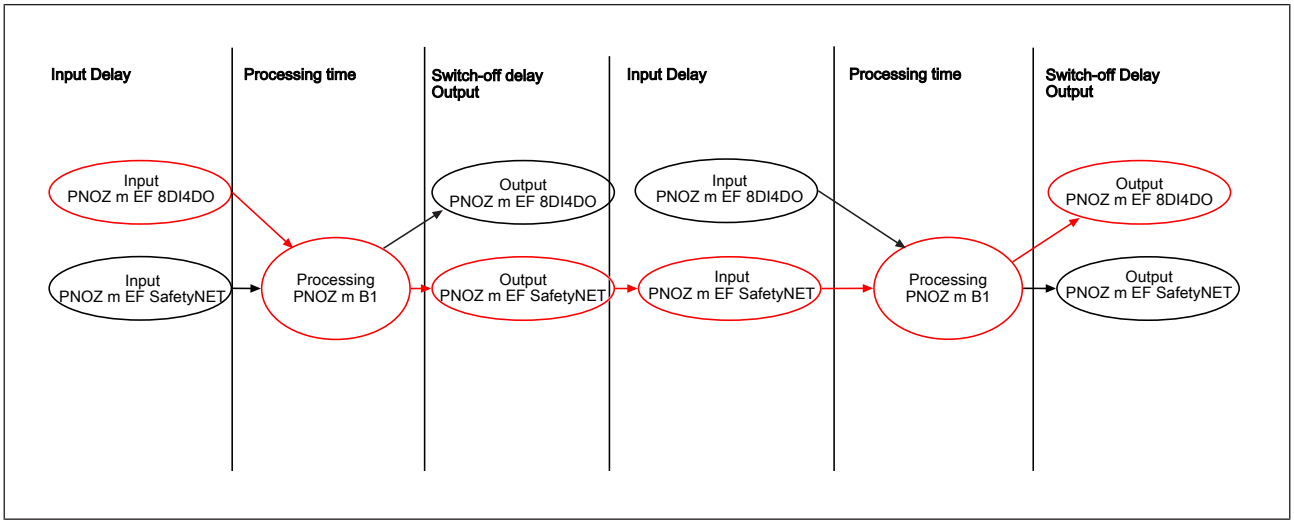
5.2 Reaction times of the connection via SafetyNET p

The reaction time with the SafetyNET p connection of two base units is calculated from the delay of the input and output modules, the processing time of the two base units and the input and output delay of the PNOZ m EF SafetyNET module.

5.2.1 Example configuration: Reaction time of PNOZ m EF 8DI4DO of Base 1 to output PNOZ m EF 8DI4DO of Base 3



Input PNOZ m EF 8DI4DO (Base 1) Input delay Max	Processing in main program Processing Max	Output PNOZ m EF SafetyNET (Base 1) Connection's transmission delay	Input PNOZ m EF SafetyNET (Base 3) Input delay. Max	Processing in the main program Processing Max	Output PNOZ m EF 8DI4DO (Base 3) Switch-off delay
8 ms	30 ms	25 ms	0 ms	30 ms	3 ms



$t_{ReactionMax}$ = 8 ms + 30 ms + 25 ms + 0 ms + 30 ms + 3 ms

$t_{ReactionMax}$ = 96 ms

Support

Technical support is available from Pilz round the clock.

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