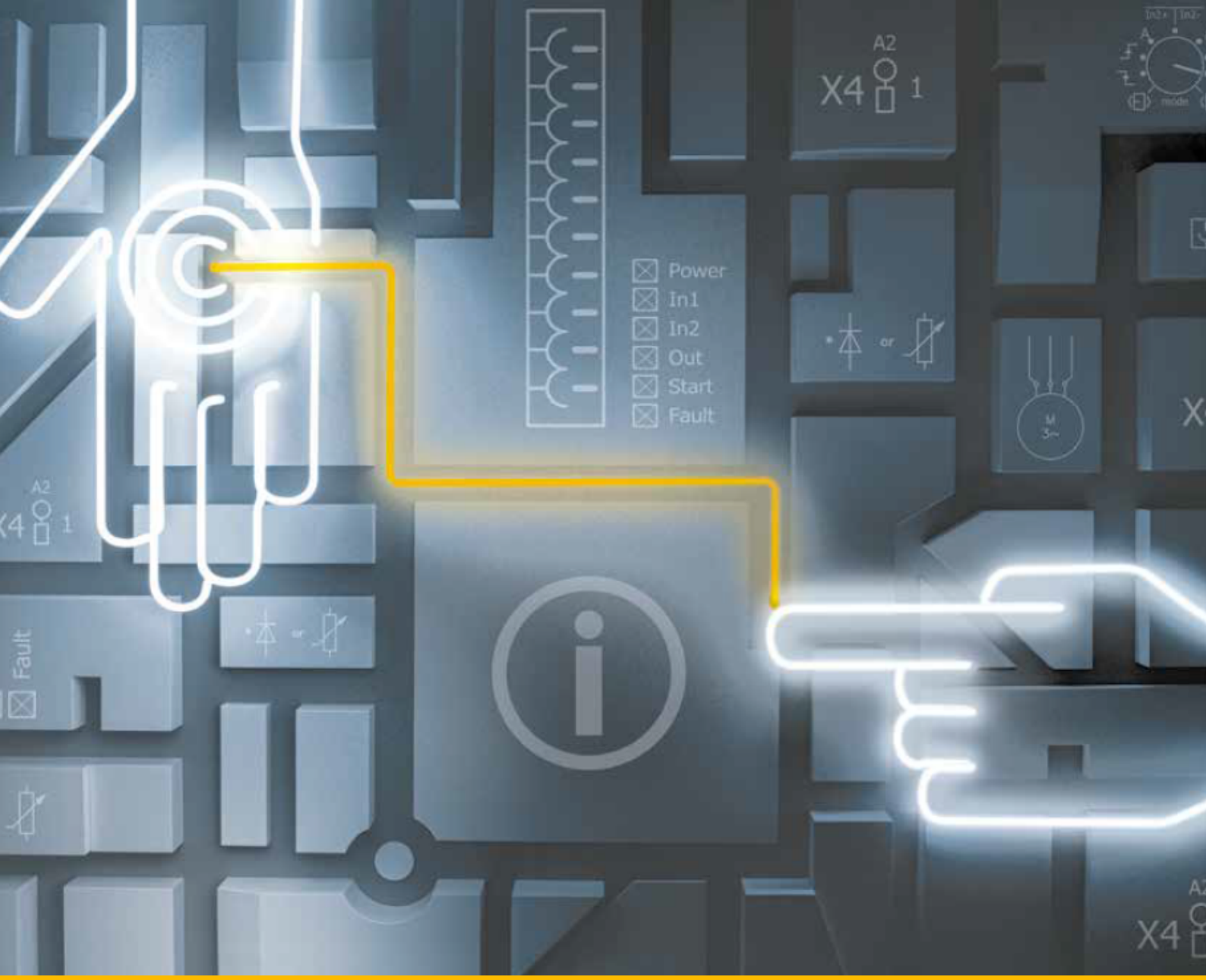


Special Applications

PILZ
THE SPIRIT OF SAFETY

Operating Manual-1002337-EN-08

- Configurable small control systems PNOZmulti




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

1.1 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 product or devices 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.

2 Muting

2.1 Introduction

This chapter describes the muting function with units from the configurable control system PNOZmulti. The safe inputs and outputs from base units and expansion modules are suitable.

NOTICE

With a muting application, please refer to the operating manuals provided with the units. Please also refer to the PNOZmulti technical catalogue.

2.2 Safety

2.2.1 Intended use

The muting logic element is used to override safety functions (ESPE/AOPD) for a limited period of time without interrupting the process (muting) in accordance with EN 61496-1. For a limited period of time, and for a specific operational phase (e.g. when feeding materials), it will suspend the effect of safety devices during the working process. Once completed, it will reset the safety function.

Use of this operating mode and the arrangement of the sensors are machine or plant-specific. They depend on the risk assessment of the plant or machine.

It is essential to note the warnings provided in other sections of this configuration guide and in the online help for the PNOZmulti Configurator. These are highlighted visually through the use of symbols.

CAUTION!

Note the safety requirements in this configuration guide and in the online help for the PNOZmulti Configurator, otherwise any warranty will be rendered invalid.

2.2.2 Standards

Knowledge of and compliance with the relevant standards and directives are a prerequisite for using the muting function. The following gives an overview of the most important standards:

- DIN CLC/TS 62046: Safety of machinery - Application of protective equipment to detect the presence of persons
- EN 61496-1: Safety of machinery - Electrosensitive protective equipment
- EN 60947-5-3: Low voltage switchgear and controlgear - Control circuit devices and switching elements
- DIN EN ISO 13855: Safety of machinery - The positioning of protective equipment in respect of approach speeds of parts of the body

This overview does not claim to be exhaustive.

2.2.3 Safety guidelines

WARNING!

The following information must be heeded! Failure to comply can lead to **serious injury or death**.

- Refer to EN 61496-1 and EN 60947-5-3 when configuring, setting up and operating the muting device.
- Refer to DIN EN ISO 13855 with regard to the layout of the AOPD.
- Measures must be taken to exclude common cause failures, e.g. by the use of non-equivalent signals or diverse sensors.
- Muting switches should be positioned so that it is impossible for a person to trigger the muting function.
- The vehicle should be designed to make it impossible for people to ride on it.
- Limit the size of the entry area by applying appropriate safety measures. People must not be able to enter the danger zone during the muting phase.
- If various transport speeds are being used, consider the total duration of the muting phase.
- Remember that a new muting phase can only be introduced once the previous phase has been completed.
- Maintenance gates should be provided if you secure equipment through muting.
- Please note that if the maintenance gates are opened, the plant **absolutely must** be brought to a standstill in accordance with the risk classification.
- Use of muting sensors with contacts: supply the contacts on the muting sensors via test pulse outputs (test pulses).
- Use of ESPE as muting sensors: test pulses cannot be used. For this reason, be sure to use a N/O contact as sensor 1 and a N/C contact as sensor 2 for fault detection (shorts across contacts).
- Laying the connection cable to the sensors in a way that is protected against shorts (i.e. separate) may provide an alternative to non-equivalent sensors.

2.3 Configuration in the PNOZmulti Configurator

2.3.1 Functions

- Muting via light barriers or limit switches
- Option to override in the case of an error
- Max. muting time monitoring can be set
- Monitoring of the muting sensors for simultaneity
- Sequence monitoring of the muting sensors

- Operating modes:
  - Sequential muting
  - Parallel muting
  - Cross muting
  - L-muting

2.3.2 Input parameters

- *Muting sensor 1*

  N/O contact of muting sensor 1

  Muting sensor 1 = 0: Not operated

  Muting sensor 1 = 1: Operated
- *Muting sensor 2*

  N/O contact of muting sensor 2

  Muting sensor 2 = 0: Not operated

  Muting sensor 2 = 1: Operated
- *Light curtain*

  Light curtain = 0: Interrupted

  Light curtain = 1: Not interrupted

  Assign the *Light curtain* input parameter to the output of the ***Light curtain*** element. The ***Light curtain*** element must be configured with an automatic start.
- *Muting sensor 3*

  N/O contact of muting sensor 3

  Muting sensor 3 = 0: Not operated

  Muting sensor 3 = 1: Operated
- *Muting sensor 4*

  N/O contact of muting sensor 4

  Muting sensor 4 = 0: Not operated

  Muting sensor 4 = 1: Operated
- *Muting override*

  Muting override = 0/1 pulse edge: Suspend the muting function if an error occurs (override) to override the muting channel.
- *Reset*

  Reset = 0/1 pulse edge: Reset the muting element after an error or start the muting time

2.3.3 Output parameters

- *Enable*

  Enable bit

  Enable = 0: Error detected (e.g. simultaneity exceeded)

  Enable = 1: The enable is granted if no error has been detected.
- *Muting active*

  Muting active = 0: No muting (light curtain not suspended)

Muting active = 1: Muting active (light curtain suspended)

2.3.4 Monitoring times

- Maximum muting time

  This setting is used to adjust the maximum permitted muting time.

  Permitted value range: 1 ... 900s (= 15 minutes)

- Simultaneity

  This setting is used to define the maximum time (synchronisation time) which is permitted to elapse between the actuation (0/1-pulse edge) of muting sensors 1 and 2 or muting sensors 3 and 4.

  Permitted value range for parallel muting and cross muting: 1 ... 3 s

  Permitted value range for sequential muting: 1 ... 30 s

  Permitted value range for L-muting: 0.5 ... 4 s, increments of 0.1 s

- Sensor enable time (only with L-muting)

  This setting is used to define the maximum time that may elapse between (re-)clearing MS1 and clearing MS2.

  Permitted value range: 0.5 ... 4 s, increments of 0.1 s

2.3.5 Suspension of muting (override)

If there are faults, the muting station can be overridden via the muting override input parameter.

- **Start-up condition**

  Muting override can be switched on if at least one of the muting sensors is active. The enable output and *muting active* output parameter are set during the override. The override is monitored and has a maximum duration that corresponds to the set muting time.

- **Switch-off condition**

  Muting override is switched off if

  – the muting time has elapsed

  or

  – no muting sensor is active and the light curtain is clear

  or

  – muting override is reset to 0 (release override button).

CAUTION!

The following additional safety requirements apply to the muting override:

- The override switch must be fitted with an automatic reset/restart (hold-to-run switch).
- The override switch must be installed in a fixed position outside the danger zone.
- The danger zone and the muting station must be visible from the override switch position.
- The danger zone must be identified as clear before the override switch is operated and while it is operated.

2.3.6 Reset

Reset resets the muting element after a fault or during start-up if

- no muting sensor is operated

  and

- the light curtain is clear.

CAUTION!

The following additional safety requirements apply for the reset button:

- The danger zone and the muting station must be visible from the reset button position.
- The reset button may not be operated until the danger zone has been viewed and has been identified as clear.

2.3.7 Restarting the muting time

Reset resumes muting and restarts the muting time if

- muting was ended as a result of the muting time having elapsed (e.g. by the conveyor feed stopping)

  and

- the muting sensors are returning feasible signals and the light curtain has not been interrupted.

2.4 Operating modes

The following operating modes can be implemented:

- Sequential muting
- Parallel muting
- Cross muting
- L-muting

WARNING!

"During muting safe conditions shall be provided by other means" (EN 954-1). For example, this may be achieved by the conveyed item blocking access to the danger zone. Even openings in or between the individual parts of the conveyor flow must never enable access.

2.4.1 Terminology

- **Muting On**

  "Muting On" is the switch condition for switching on the muting function. When muting is switched on, the *Muting active* output parameter has a 1 signal and time monitoring runs.

- **Muting Off**

  "Muting Off" is the switch condition for ending the muting function. When the muting function is ended, output parameter *Muting active* has a 0 signal.

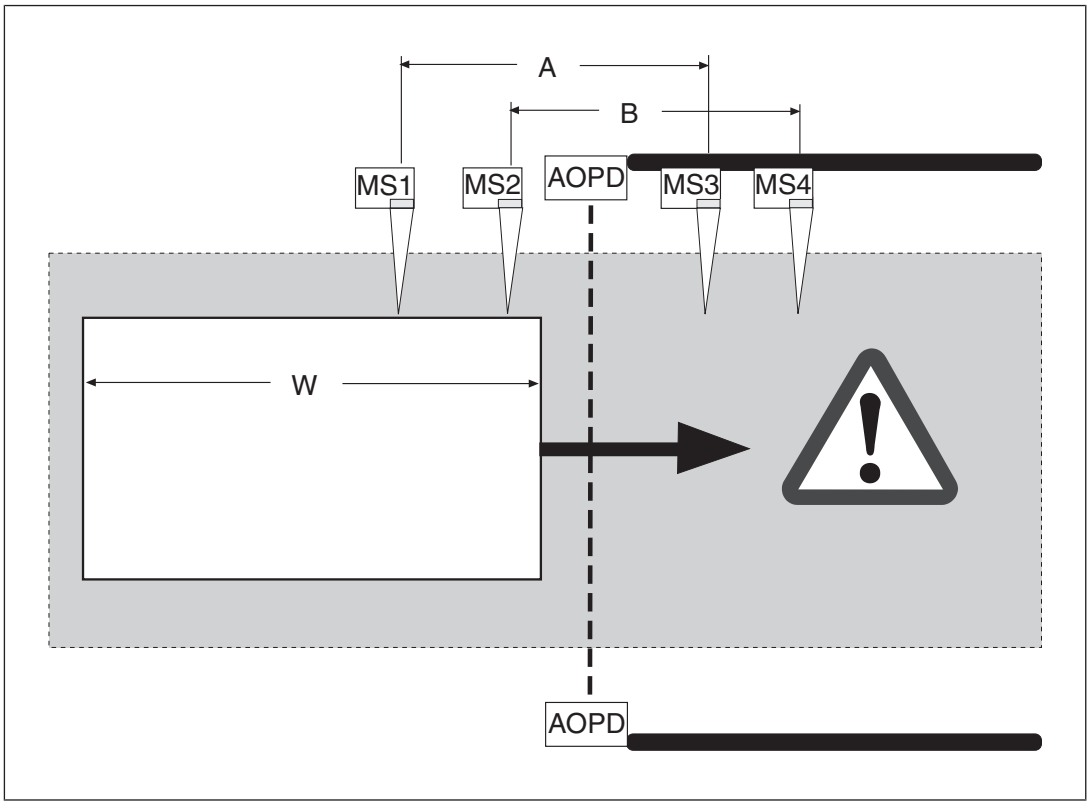
INFORMATION

You will find important additional information on the use of sensors or contacts in the section entitled "Safety".

2.4.2 Sequential muting

2.4.2.1 Position of the muting sensors

- The distance between the muting sensors MS1 and MS2 / MS3 and MS4 should be as large as possible.
- Vehicle length W must be greater than the distance between MS1 and MS3 or MS2 and MS4 (W > A and W > B).
- MS2 and MS3 must be positioned as close as possible in front of/behind the AOPD.



2.4.2.2 Switch conditions in sequential mode

Muting On

Entering the danger zone:

1. Muting sensors MS1 and MS2 must be operated consecutively (first MS1, then MS2) within the configured simultaneity period. Muting is activated by operating MS2.
2. Muting sensors MS3 and MS4 must be operated consecutively (first MS3, then MS4) within the configured simultaneity period.
3. MS1 and MS2 must be cleared consecutively (first MS1, then MS2).
4. MS3 and MS4 must be cleared consecutively (first MS3, then MS4).

Leaving the danger zone:

1. Muting sensors MS4 and MS3 must be operated consecutively (first MS4, then MS3) within the configured simultaneity period. Muting is activated by operating MS3.
2. MS2 and MS1 must be operated consecutively (first MS2, then MS1).
3. MS4 and MS3 must be cleared consecutively (first MS4, then MS3).
4. MS2 and MS1 must be cleared consecutively (first MS2, then MS1).

Muting Off

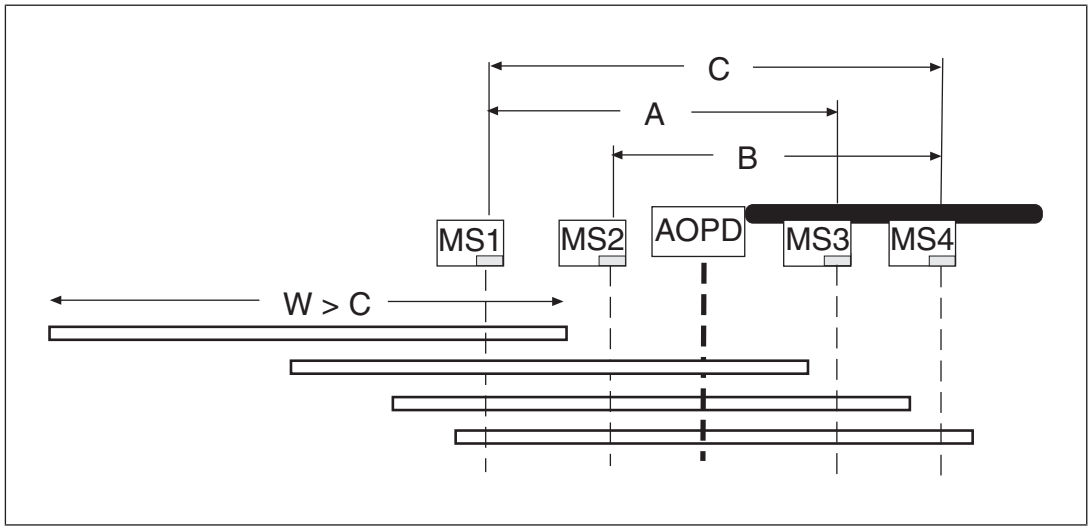
Suspension of the safety function is cancelled as soon as the penultimate muting sensor, MS2 or MS3, is no longer operated, i.e. only one muting sensor remains operated.

2.4.2.3 Sequence errors

The muting sensors must be operated in a specific sequence in sequential mode. Once a particular directional movement has started (entry or exit), it must be fully completed. Any deviation from the sequence shown causes a reset of the enable output (enable = 0) and the output parameter *Muting active*.

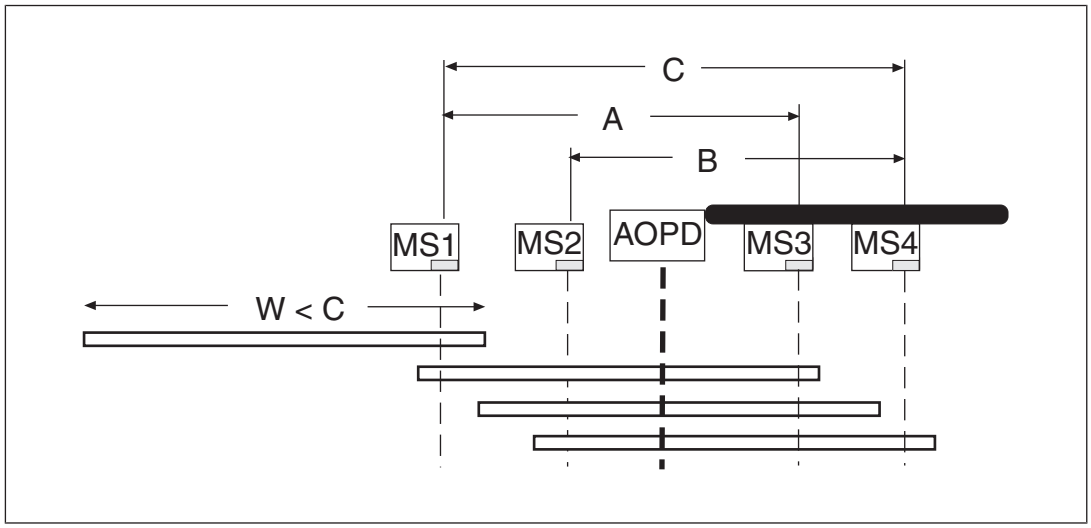
Vehicle length W greater than distance C between MS1 and MS4

All sensors are temporarily operated as the vehicle passes through. The first muting sensor (MS1 upon entering, MS4 upon exiting) only becomes clear once all muting sensors have been operated.



Vehicle length W less than distance C between MS1 and MS4

As the vehicle passes through, the first muting sensor becomes clear (MS1 upon entering, MS4 upon exiting) before the last muting sensor has been operated.



MS1	MS2	MS3	MS4	Travel direction	
0	0	0	0		
1	0	0	0		
1	1	0	0		
1	1	1	0		
1/0	1	1	1/0		
0	1	1	1		
0	0	1	1		
0	0	0	1		
0	0	0	0		

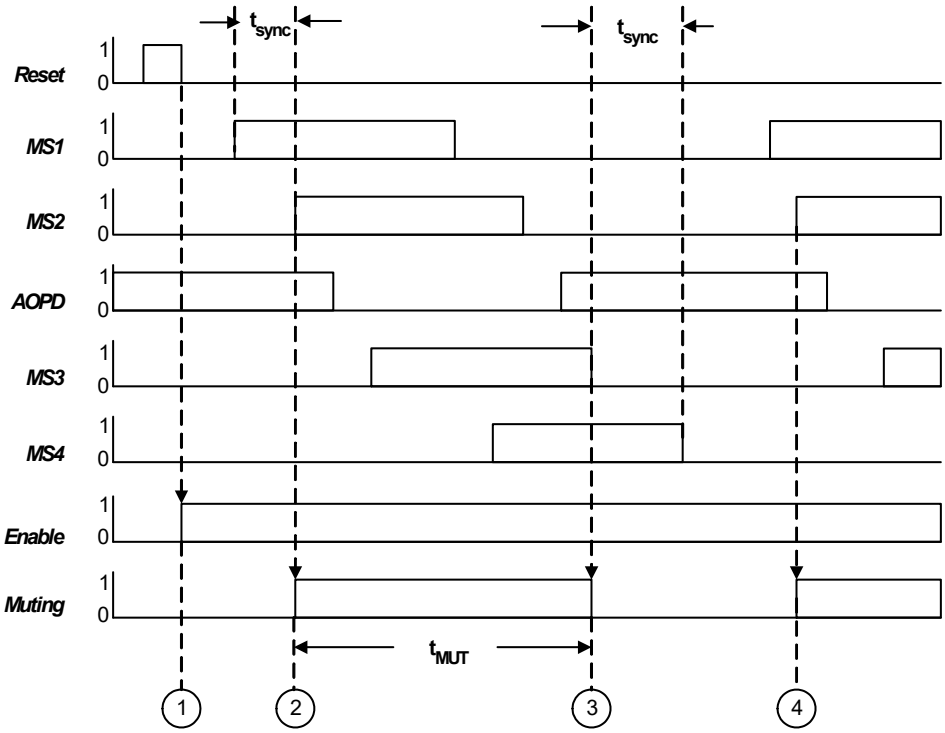
2.4.2.4 Diagnostic word

Messages can be queried in the PNOZmulti Configurator in bit mode and linked further within the program.

- Bit 1: Light curtain, interrupted (without active muting)
- Bit 2: Waiting for reset/restart (Reset)
- Bit 3: Sensor status unfeasible, override required
- Bit 8: Muting time exceeded
- Bit 9: Feasibility error, simultaneity period exceeded on muting sensors 1 and 2, only one sensor operated
- Bit 10: Feasibility error, simultaneity period exceeded on muting sensors 3 and 4, only one sensor operated

2.4.2.5 Timing diagram (example)

Vehicle length W less than distance C between MS1 and MS4



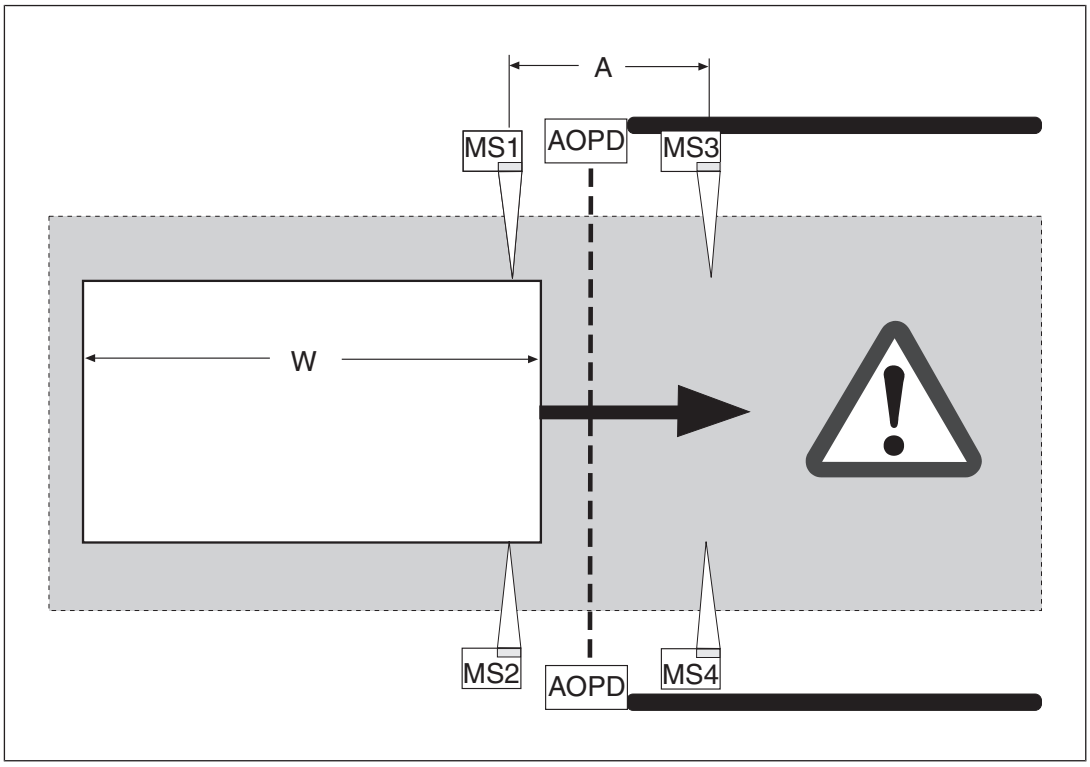
Legend:

t_{sync} = Simultaneity
t_{MUT} = Muting time
①: Enable is set via reset
②: Muting is started through MS1/MS2
③: Muting is ended by clearing MS3
④: Muting is restarted through MS1/MS2

2.4.3 Parallel muting

2.4.3.1 Position of the muting sensors

- Muting sensors MS1 and MS2/MS3 and MS4 must be positioned at the same height to the left and right of the vehicle.
- The vehicle length W must be greater than distance A between MS1 and MS3/MS2 and MS4.
- The distance between the light curtain and the muting sensor must be as short as possible.



2.4.3.2 Switch conditions in parallel mode

Muting On

Entering the danger zone:

1. Muting sensors MS1 and MS2 must be operated within the configured simultaneity period. Muting is activated.
2. Muting sensors MS3 and MS4 must be operated within the configured simultaneity period, before MS1 and MS2 are cleared.

Leaving the danger zone:

1. Muting sensors MS3 and MS4 must be operated within the configured simultaneity period. Muting is activated.
2. Muting sensors MS1 and MS2 must be operated before MS3 and MS4 are cleared.

Muting Off

Suspension of the safety function is cancelled as soon as the penultimate muting sensor, MS3/MS4 upon entering or MS1/MS2 upon exiting, is no longer operated. In other words, only one muting sensor remains operated.

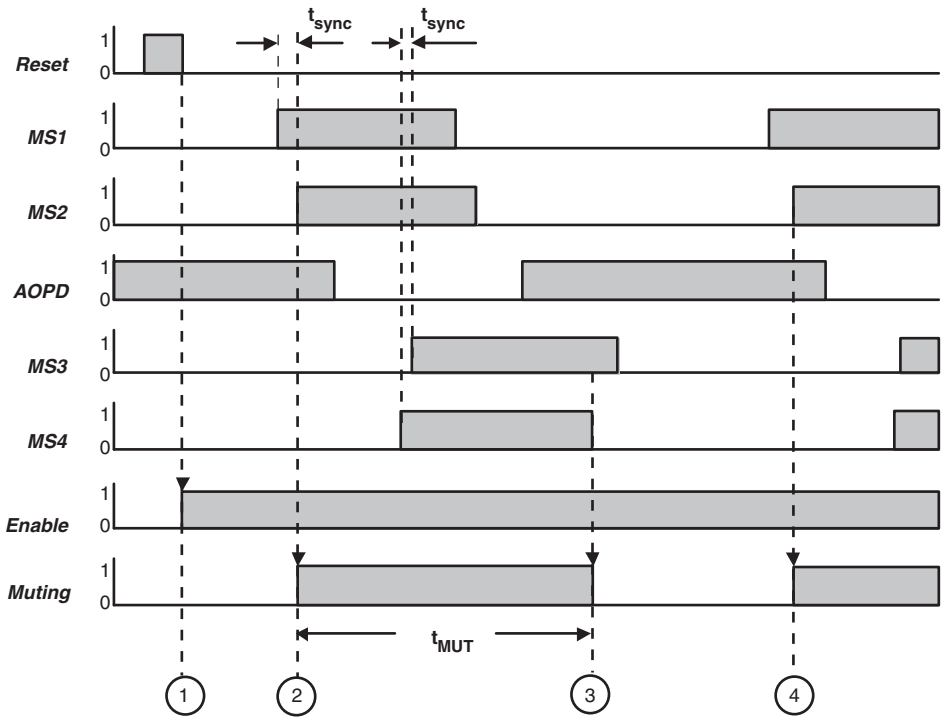
2.4.3.3 Diagnostic word

Messages can be queried in the PNOZmulti Configurator in bit mode and linked further within the program.

- Bit 1: Light curtain, interrupted (without active muting)
- Bit 2: Waiting for reset/restart (Reset)
- Bit 3: Sensor status unfeasible, override required

- Bit 8: Muting time exceeded
- Bit 9: Feasibility error, simultaneity period exceeded on muting sensors 1 and 2, only one sensor operated
- Bit 10: Feasibility error, simultaneity period exceeded on muting sensors 3 and 4, only one sensor operated

2.4.3.4 Timing diagram (example)

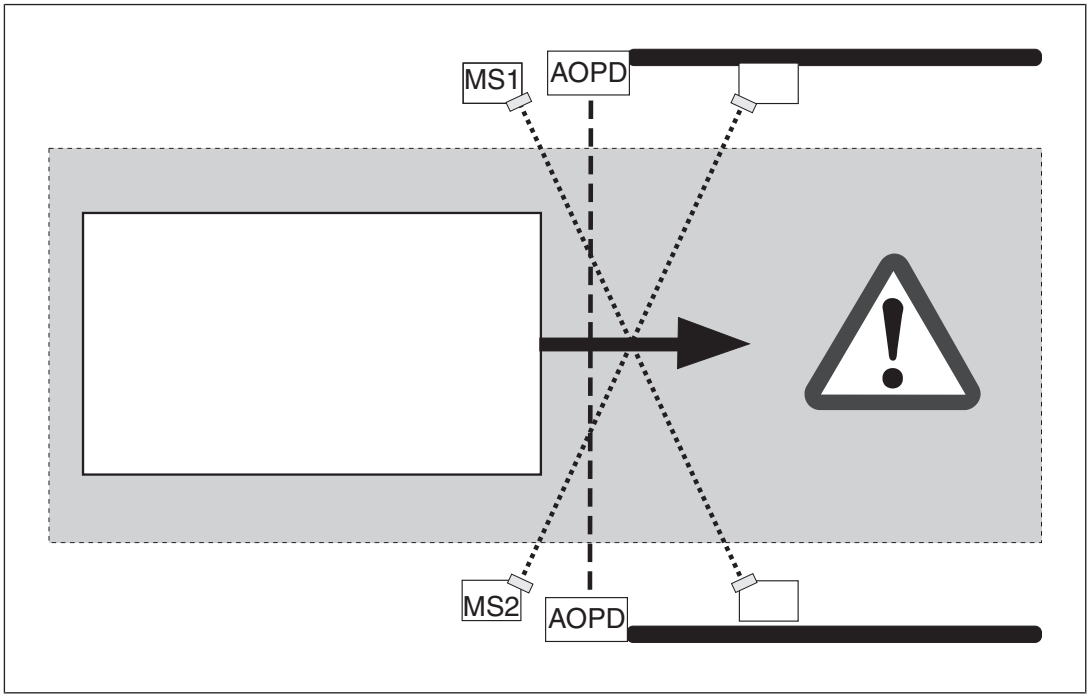


Legend:
t_{sync} = Simultaneity
t_{MUT} = Muting time
①: Enable is set via reset
②: Muting is started through MS1/MS2
③: Muting is ended by clearing MS3 or MS4
④: Muting is restarted through MS1/MS2

2.4.4 Cross muting

2.4.4.1 Position of the muting sensors

- Muting sensors may be reflective or send/receive light beam devices, for example. The beams must always intersect within the danger zone.
- The muting sensors must be positioned in such a way that the light curtain is interrupted before the beam intersection can be reached from outside the danger zone.
- Muting sensors MS3 and MS4 are not used.



WARNING!

Loss of safety function due to incorrect position of muting sensors

Depending on the application, serious injury or death may result.

Ensure that you comply with the installation dimensions shown in the figure overleaf.

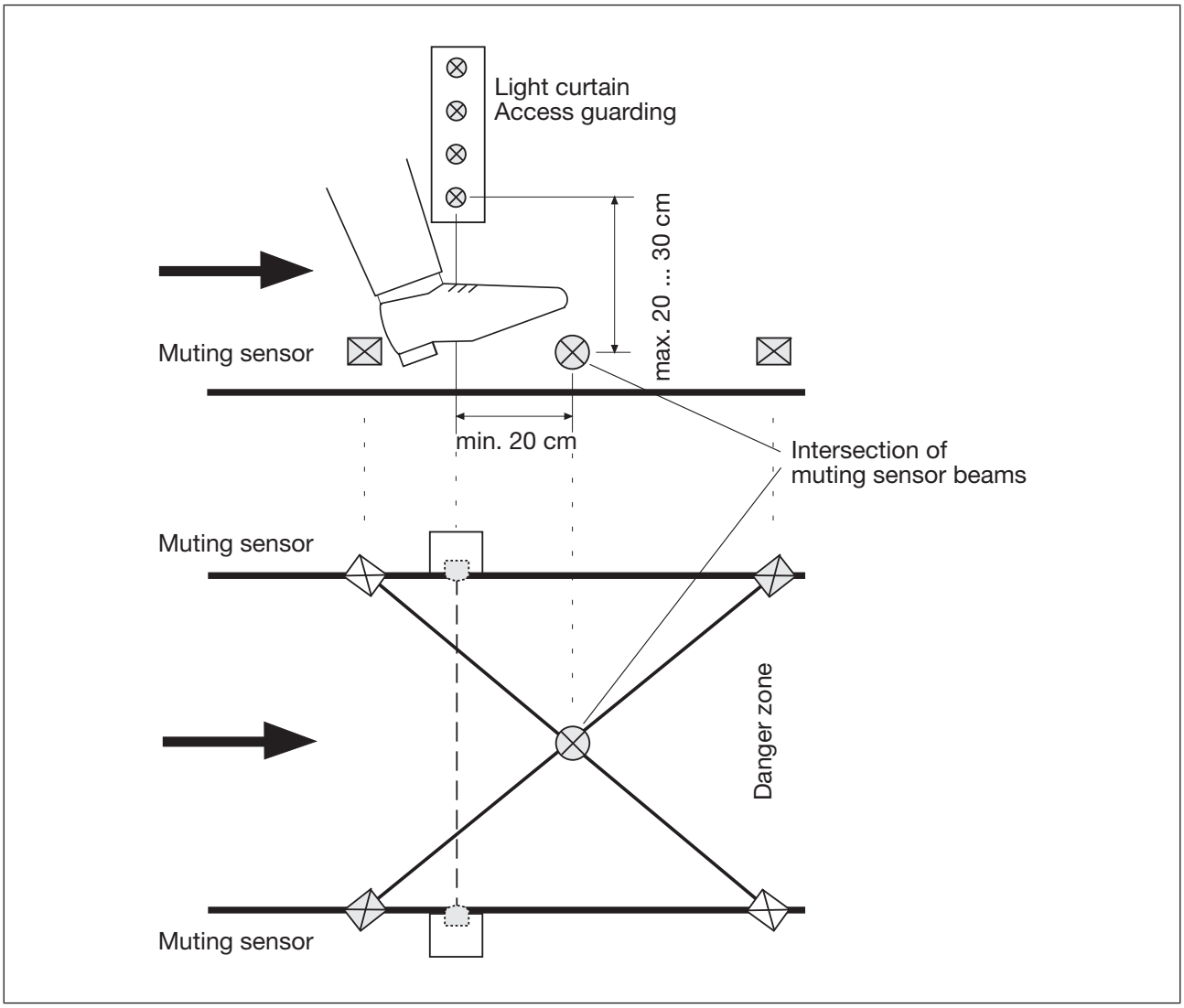


Fig.: Position of the muting sensors (side view and plan view)

2.4.4.2 Switch conditions in cross mode

Muting On

Muting sensors MS1 and MS2 must be operated within the configured simultaneity period.

Muting Off

Suspension of the safety function is cancelled as soon as one muting sensor at most is still operated.

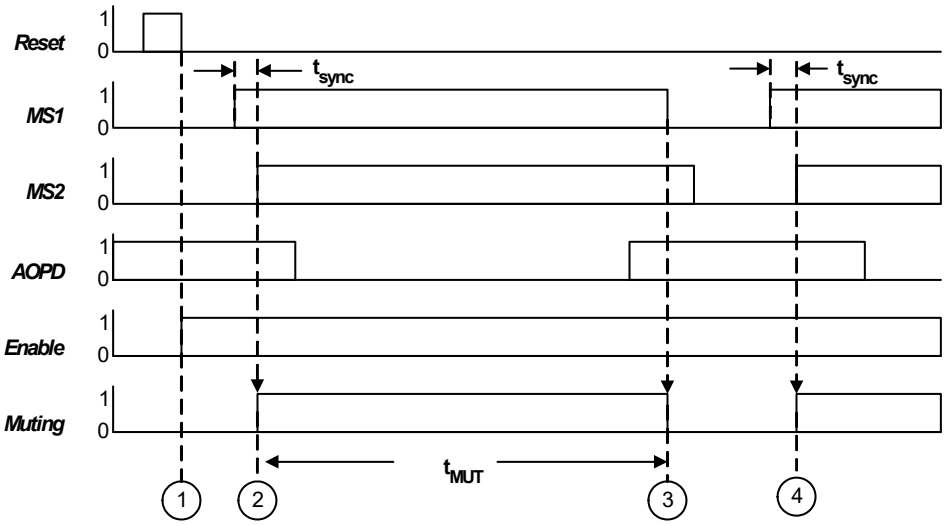
2.4.4.3 Diagnostic word

Messages can be queried in the PNOZmulti Configurator in bit mode and linked further within the program.

- Bit 1: Light curtain, interrupted (without active muting)
- Bit 2: Waiting for reset/restart (Reset)
- Bit 3: Sensor status unfeasible, override required

- Bit 8: Muting time exceeded
- Bit 9: Feasibility error, simultaneity period exceeded on muting sensors 1 and 2, only one sensor operated

2.4.4.4 Timing diagram (example)



Legend:

t_{sync} = Simultaneity
t_{MUT} = Muting time

①: Enable is set via reset
②: Muting is started through MS1/MS2
③: Muting is ended by clearing MS1 or MS2
④: Muting is restarted through MS1/MS2

3 Safety Mat/Safe Edge

3.1 Introduction

This chapter describes the use of pressure-sensitive protective devices (pressure-sensitive mats and edges) with the PNOZmulti.

You must also refer to

- The operating manuals provided with the PNOZmulti units
- The PNOZmulti technical catalogue
- The TÜV certificate for the respective product range (PNOZmulti or PNOZmulti 2)
- The installation manual and user information provided by the manufacturer of the pressure-sensitive mats /edges (see "Intended use").

Pressure-sensitive mat

A pressure-sensitive mat is a protective device which detects a person standing on it or stepping on to it. The pressure-sensitive mat comprises a sensor which responds to the application of pressure, a control unit and an output signal switching device.

With a pressure-sensitive mat, the effective sensing area is deformed locally when the sensor is operated.

Pressure-sensitive edge

A pressure-sensitive edge is a protective device which is designed to detect contact from a person or any part of a person's body. It comprises:

- A sensor, which generates a signal when pressure is applied to part of its surface, whereby:
  - Its length is greater than its width
  - Its cross section is constant across its length
  - Cross-sectional width is greater than 8 mm
  - The effective sensing area is deformed locally to actuate the sensor
- A control unit that responds to a signal from the sensor and generates an output signal that it sends to the machine control system.

3.2 Safety

3.2.1 Intended use

Approved units from the PNOZmulti systems are suitable for connecting pressure-sensitive protective devices (see TÜV certificate for the respective product range PNOZmulti or PNOZmulti 2).

- The units may only be used as a safety system in conjunction with the approved pressure-sensitive protective devices (see TÜV certificate for the respective product range PNOZmulti or PNOZmulti 2).
- The pressure-sensitive protective devices must be connected to the inputs on the PNOZmulti units via the PSEN im1 interface or type 1N4007 diodes (see "Commissioning the safety system").

- Only pressure-sensitive protective devices without installed terminating resistors are suitable.
- The following are not permitted: Walking aids such as canes and wheeled vehicles
- The configurable control system PNOZmulti is used for signal processing and as a shutdown device in accordance with EN 13856-1.

CAUTION!

When pressure-sensitive protective devices are connected to PNOZmulti units, the units (including the coated version) may only be operated at an ambient temperature of 0 ... +60 °C.

3.2.2 Safety guidelines

Do not install and commission the safety system until you have read and understood this chapter, the technical catalogue and the installation manual from the manufacturer of the pressure-sensitive mat/edge.

You must also be familiar with the applicable regulations for health and safety at work and accident prevention.

- In particular you should refer to EN 13856-1 and EN 13856-2.
- In the event of a fault, the safety system complies with Category 3, PL d of EN ISO 1349-1 and SIL 2 of EN IEC 62061. With the pressure-sensitive mat it is important to consider Note 3 to Clause 4.15 of EN 13856-1
- The categories in accordance with EN 13849-1 for pressure-sensitive mats on machinery are specified in type C standards.

3.3 Function description

The pressure-sensitive safety device is supplied with PNOZmulti test pulse outputs. The test pulses are evaluated by PNOZmulti inputs (see section titled "Commissioning the safety system"). Short across contacts and open circuits are detected.

3.4 Configuration in the PNOZmulti Configurator

- Operating modes
  - Automatic reset/restart (Start):
    After the pressure-sensitive protective device has been activated, the output immediately returns to "1" once the pressure-sensitive protective device is cleared.
  - Manual reset/restart (Start):
    The output does not return to "1" until the start button has been pressed. This eliminates the possibility of the start button being overridden, triggering automatic activation. A reset/restart is only possible if the pressure-sensitive protective device is not activated.
- Start-up test
  The start-up test prevents an automatic restart after a power failure and subsequent return of voltage. The unit checks whether the non-activated pressure-sensitive protective device was activated and cleared after supply voltage was applied.

- The output of the pressure-sensitive protective device function element is "1" if the pressure-sensitive protective device has **not** been activated. This safety function must be retained when this signal is linked further within the PNOZmulti Configurator:
  - Semiconductor outputs: High signal
  - Relay outputs: Safety contacts closed

3.4.1 Allocation of test pulses to inputs

The following test pulses must be used in pairs:

Test pulse T0 and test pulse T1

Test pulse T2 and test pulse T3

In other words, in the PNOZmulti Configurator the test pulses can only be assigned to the inputs as follows:

- Input 1: Test T0
- Input 2: Test pulse T1

  or
- Input 1: Test pulse T2
- Input 2: Test pulse T3

INFORMATION

Test pulses that you use for the pressure-sensitive protective device cannot be reused for test pulses in conjunction with other safety devices.

3.5 Commissioning the safety system

3.5.1 Preparing for commissioning

Please note the following when preparing for commissioning:

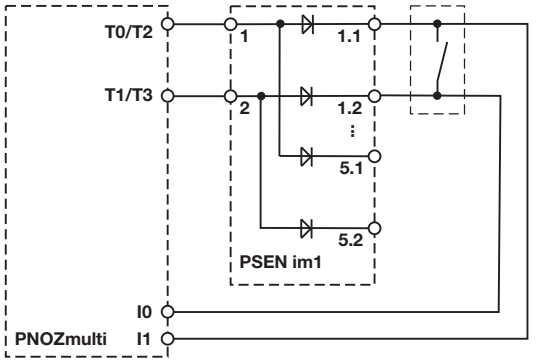
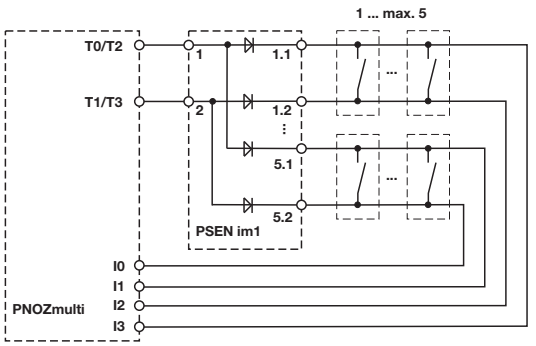
- Cables that have to be laid outside the control cabinet must be protected from mechanical damage, e.g. by installing them in a conduit.
- Do not route the test pulse lines together with actuator cables within an unprotected multicore cable.
- Pressure-sensitive protective devices may not be fitted with a terminating resistor.
- The configured test pulse outputs should be used exclusively for test pulses on the pressure-sensitive protective devices. You must refer to the information under Technical requirements [26].

3.5.2 Preparing for operation

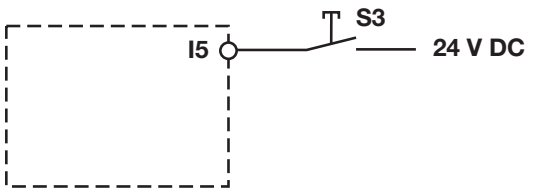
- Connect the pressure-sensitive protective device to the test pulse outputs and the inputs (in examples I0 to I3).
- Please note:
  Always connect the pressure-sensitive protective devices to the PNOZmulti units via
  - the interface PSEN im1,

– diodes of type 1 N4003 ...1N4007,

– or via the terminal block with filter, order no. 774 195, 774 196.
0 V may not be connected to the terminal block!

Input circuit	
Connecting **one** pressure-sensitive protective device, max. area of pressure-sensitive protective device = 8 m^2	
Connecting multiple pressure-sensitive protective devices, permitted per dual-pole input: max. 5 pressure-sensitive protective devices in series, max. area of pressure-sensitive protective device = 8 m^2	

- Set the start features through wiring of the start circuit (in example I5). Only effective if *manual start/restart* is configured in the PNOZmulti Configurator.

Manual reset/restart	
	

3.6 Operation

The safety system can only be started if the pressure-sensitive protective device has not been activated. The unit detects the operating mode set on start-up.

3.6.1 Diagnostic word

Messages can be queried bit by bit in the PNOZmulti Configurator and linked further within the program.

- Bit 0: Pressure-sensitive protective device clear, enable issued
- Bit 2: Pressure-sensitive protective device activated
- Bit 3: Waiting for reset/restart
- Bit 4: Waiting for start-up test

- Bit 6: Open circuit detected, signal error

3.7 Technical requirements

To ensure safe operation you must comply with the following values:

Response time (from activation of the pressure-sensitive protective device until an instantaneous safety output drops out)*	**< 200 ms**
Max. area of pressure-sensitive protective devices per dual-pole input	**8 m^2**
Max. number of pressure-sensitive protective devices connected in series per dual-pole input	**5**
Max. number of dual-pole inputs that can be assigned to a test pulse pair	**5**
Min. conductor cross section	**0.5 mm^2**
Max. cable length, PNOZmulti - pressure-sensitive protective device	**100 m**
Max. resistance of safety mat/safe edge	**150 ohms**

*The stated reaction time is the maximum value for pressure-sensitive protective devices. For details of the specific response time in conjunction with the respective approved safety mat or safe edge, please refer to the TÜV certificate for the respective product range (PNOZmulti or PNOZmulti 2).

4 Burners

4.1 Introduction

This chapter describes the control and monitoring of burners with base units PNOZ m3p from the configurable small controllers PNOZmulti Classic or PNOZ m B1 Burner from the configurable small controllers PNOZmulti 2.
Control and monitoring of a burner is configured in the PNOZmulti Configurator using the burner element.

When using the burner element please also refer to:

- The operating manuals provided with the PNOZmulti units
- The online help for the PNOZmulti Configurator.

4.2 Safety

4.2.1 Intended use

The burner element can only be used in conjunction with the following devices:

- Base unit PNOZ m3p from the configurable small controllers PNOZmulti Classic or
- Base unit PNOZ m B1 Burner from the configurable small controllers PNOZmulti 2.

The burner element in the PNOZmulti Configurator is designed to control and monitor burners in accordance with the standards:

- EN 298: Automatic gas burner control systems for gas burners and gas burning appliances with or without fans
- EN 12953-7: Shell boilers
- EN 12952-8: Water-tube boilers and auxiliary installations
- EN 50156-1: Electrical equipment for furnaces
- EN/IEC 61508: SIL 3: Functional safety of safety-related electrical/electronic/programmable electronic systems
- EN 230: Automatic burner control systems for oil burners
- EN 267: Automatic forced draught burners for liquid fuels (draft)
- EN 298: Automatic gas burner control systems for gas burners and gas burning appliances with or without fans
- EN 676: Automatic forced draught burners for gaseous fuels
- EN 746-2: Industrial thermoprocessing equipment
- EN 1643: Valve proving systems for automatic shut-off valves for gas burners and gas appliances

Activation of a burner's safety valves in accordance with EN 50156:

- The following applies for configurable small controllers PNOZmulti Classic:
  The relay output module PNOZ mo5p has diverse relay outputs and is therefore suitable for activating a burner’s safety valves in accordance with EN 50156.

- The following applies for configurable small controllers PNOZmulti 2:
  The relay output module PNOZ m EF 4DI4DORD has diverse relay outputs and is therefore suitable for activating a burner's safety valves in accordance with EN 50156.

4.3 Configuration in the PNOZmulti Configurator

4.3.1 Functions

The burner element contains all the functions needed to control and monitor burners.

These include
monitoring of

- Safety chains
- Combustion air pressure
- Ignition
- Flame monitoring
- External compound controller
- Tightness control

and control of

- Safety valves
- Ignition valves
- Vent valve
- Ignition
- External compound controller
- Combustion air blower

The following oil and gas burner types can be controlled and monitored:

- Master burner with direct ignition
- Master burner with indirect ignition and joint flame monitoring
- Master burner with indirect ignition and separate flame monitoring
- Slave burner with direct ignition
- Slave burner with indirect ignition and joint flame monitoring
- Slave burner with indirect ignition and separate flame monitoring

In PNOZmulti Configurator the required burner type and necessary monitoring and control functions can be set (see Monitoring functions/settings for the burner cycle). This will influence the burner cycle.

A burner cycle has several phases (steps). The configuration determines which steps are carried out (see Burner cycle).

Provided the input signals match the set values within a step, the program cycle will be continued. The system will pass to the next step as soon as the configured step time has elapsed.

If the input signals do not match the set values within a step, an error will be detected. This will lead either to a fault lockout or a safety shutdown, depending on the input signal and configuration.

4.3.2 Monitoring functions/settings for the burner cycle

4.3.2.1 Combustion air pressure monitoring, activating the combustion air blower, compound controller monitoring

You can set whether the activated burner is a master burner or a slave burner.

- **Master burners**

  Master burners have their own combustion air supply, which is controlled and monitored directly. The following monitoring/control functions are performed on master burners:

  – The combustion air pressure is monitored. For this, the "AirP" input must be linked to the device that monitors the required air amount (generally an air pressure monitor).

  – The combustion air blower is activated via the "BLOW" output.

  – The compound controller can be activated and monitored. This is necessary when an electronic compound controller is present (see section below, entitled "Compound controller").

- **Slave burners**

  Slave burners do not have their own combustion air supply. As a result, no monitoring takes place. This burner type is used for multi-burners, for example, which are fitted with a central combustion air supply and a monitoring function.

WARNING!

Loss of safety function due to incorrect use of the *Slave burner* type

If the *Slave burner* type is used to avoid pre-purge and a combustion air supply is not guaranteed, serious injury or death may result, depending on the application.
Only use the slave burner type if the combustion air supply is guaranteed elsewhere.

Please also note the following with the *Slave burner* type:

- The "AirP" input must be connected to a signal indicating the presence of a central combustion air supply that is functioning correctly. There is no check to ensure that this input is at rest position when the burner is switched off.
- The burner cannot be started (signal at the "Start" input) until it is guaranteed that there is no flammable mixture within the combustion chamber or associated areas or within the exhaust system.

4.3.2.2 Ignition

The ignition transformer is activated via the "IGNT" output.

You can select two types of ignition in the PNOZmulti Configurator:

- **Direct ignition**

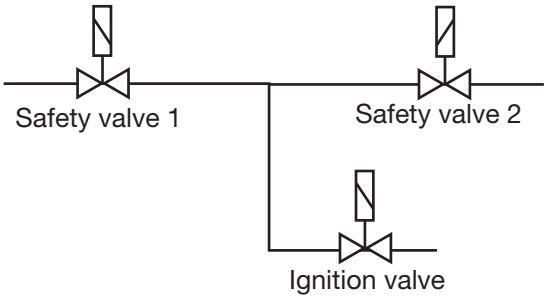
  With direct ignition, no separate ignition burner is present. The main burner is ignited directly via the ignition transformer.

- **Indirect ignition**

With indirect ignition, a separate ignition burner is present. The main burner is ignited by an ignition flame, which is ignited via an ignition transformer. Fuel may not be supplied to the main burner until the ignition burner has been ignited and the ignition flame is stable. The ignition valve is activated via the IV output.
The following setting options are available for the behaviour of the ignition flame:

– Ignition valve is closed after ignition,
  i.e. the ignition flame is to be extinguished once the main burner is successfully ignited, or
– (only possible when separate flame monitoring is configured (see section entitled "Flame monitoring")): Ignition valve remains open after ignition,
  i.e. the ignition flame is to stay lit once the main burner is successfully ignited.

The ignition valve must be positioned as follows:



4.3.2.3 Flame monitoring

Flame monitoring is used to establish and signal the presence of a flame. To ensure that the signal is actually a result of the flame and not of some external light source, the absence of the flame is monitored during a burner cycle (e.g. during pre-purge). With direct ignition, the main flame is monitored.
With indirect ignition you can select between two types of flame monitoring:

- **Joint flame monitoring**

  Ignition flame and main flame are monitored jointly. The FLAM input for the main flame must be logically linked to flame monitoring. The FLAI input for the ignition flame will not then be evaluated.

- **Separate flame monitoring**

  Ignition flame and main flame are monitored separately; each have their own flame monitoring device.

4.3.2.4 Compound controller

If master burners have an external electronic compound controller, the compound controller must be activated and monitored via the burner element

The compound controller controls and monitors the fuel/air ratio. The regulating devices for the amount of combustion air and fuel are activated for this purpose.

- The "PURG" output is activated during the step: "Compound controller to pre-purge position". This output signal is intended to switch the compound controller to the pre-purge position (maximum amount of combustion air).

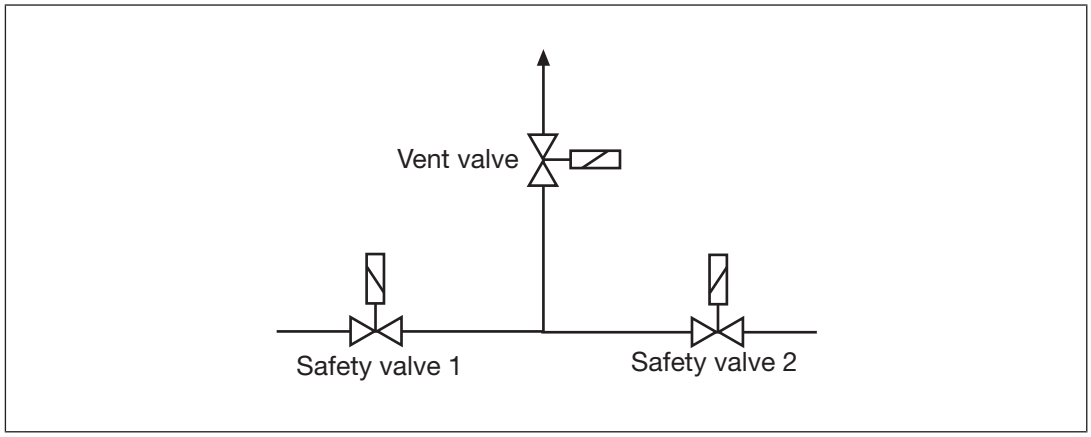
- During the steps "Pre-purge ...", a signal is expected at the "PUR" input from the compound controller, indicating that the compound controller is in "pre-purge" position. This signal must not occur until the airflow rate required for pre-purge is present.
- The "IGNI" output is activated during the step: "Compound controller to ignition position". This output signal is intended to switch the compound controller to the ignition position (optimum fuel/air ratio for ignition).
- During the steps "Ignition ...", a signal is expected at the "IGN" input from the compound controller, indicating that the compound controller is in "ignition" position. This signal must not occur until the optimum fuel/air ratio for ignition is present.

4.3.2.5 Tightness control

You can select whether to carry out tightness control. With tightness control, the section between the two safety valves will first be vented, then refilled and the pressure measured. The pressure is monitored at the "GP" input.
The plant must undergo a hazard analysis to determine whether tightness control is necessary. The hazard analysis should also determine whether venting is permitted via safety valve 2.

The following configuration options are available:

- Vent via the vent valve (the vent valve is activated via the VV output)
  The vent valve must be positioned as follows:



or

- Vent via safety valve 2
- Continuous vent (in which case, tightness control is not carried out)
- No tightness control and no continuous vent

It's also possible to configure when tightness control is to be carried out:

- Tightness control prior to ignition
- Tightness control after the burner has shut down. (Even with this setting, tightness control will be carried out prior to ignition if the previous burner cycle was interrupted due to an error.)

4.3.2.6 High temperature

"High temperature" mode can be activated via the "HTmp" input if the conditions for high temperature in high temperature plants have been met in accordance with EN 746-2 and the fuel in the combustion chamber self-ignites safely.
As the fuel in the combustion chamber self-ignites in high temperature mode, the burner cycle will change.

The following steps are no longer performed in high temperature mode:

- Any steps in connection with pre-purge and post-purge
- Tightness control
- Pre-ignition
- Afterburn

Flame monitoring is also deactivated; the outputs for activating "Compound controller for pre-purge position" (PURG) and the ignition transformer (IGNT) are no longer activated.

WARNING!

Potential loss of safety functions in "High temperature" mode!

If the conditions for high temperature in accordance with EN 746-2 are not met, safety-related steps in "High temperature" mode will no longer be carried out. Depending on the application, serious injury or death may result. Make sure that "High temperature" mode is only active when the conditions for high temperature in accordance with EN 746-2 are met.

In any of the steps within the cycle, the "HTmp" input can be used to switch between high temperature mode and normal mode (see also section entitled "Inputs and outputs").

4.3.2.7 Plant-dependent monitoring functions

Plant-dependent monitoring functions, which are intended to trigger a burner shutdown where necessary (e.g. when the temperature is too high), must be incorporated into the safety sequences. In other words, they must be linked to inputs CHA1, CHA2 or CHAi.

Monitoring functions which are intended to be active from burner start-up to burner shutdown must be linked to either CHA1 or CHA2.

Monitoring functions which are only intended to be active during ignition and burner operation must be linked to CHAi (see also section entitled "Inputs and outputs").

4.3.2.8 Shutdown types

A controlled shutdown can be performed via the "Stop" input (e.g. if energy is no longer required). The burner is then brought to a stop.

WARNING!

Loss of safety function due to incorrect use of the "Stop" input!

If the "Stop" input is used to reproduce a safety shutdown or fault lockout, serious injury or death may result, depending on the application.
Only use the "Stop" input for a controlled shutdown.

An error is detected if the input signals within a step do not match the values set for the monitoring operation. This will lead either to a fault lockout or a safety shutdown, depending on the input signal and configuration. With both shutdown types, all outputs on the burner element are shut down immediately and the sequence program is aborted.

- Safety shutdown

  After a safety shutdown, the burner cycle is automatically restarted after a configurable period, if there is no error present.

- Fault lockout

  With a fault lockout, if there is no error present, it is necessary to reset and then manually restart to enable a new burner cycle.

For the following steps you can select which shutdown type will occur in the event of an error in the PNOZmulti Configurator:

- Safety chain 1 broken (input CHA1)
- Safety chain 2 broken (input CHA2)
- Ignition and operation safety chain broken (input CHAi)
- No air pressure during operation (during start-up: fault lockout)
- Faulty flame signal during operation (during start-up: fault lockout)

Please note:

The plant must undergo a hazard analysis to determine whether a safety shutdown is permitted for an error.

4.3.2.9 Step times

You can set a time for most of the steps within a cycle (see View burner cycle, define step times). The time determines how long the step will be active. While the step is active, the inputs must conform to the pre-defined set values. Once this time has elapsed, the next step will be started (see also Burner cycle).

When configuring the step times, please note the following with the steps below:

- Steps 5 - 9 "Pre-purge...)

  The total duration of steps 5 - 9 for pre-purge must not be less than the minimum duration for pre-purge calculated via the plant's hazard analysis.

- Step 13 "Ignite ignition flame / 1st safety time"

  The configured step time must not be longer than the 1st safety time. The maximum duration of the 1st safety time is calculated based on a hazard analysis of the plant.

- Step 15 "Ignite ignition flame / 2nd safety time"

  The configured step time must not be longer than the 2nd safety time. The maximum duration of the 2nd safety time is calculated based on a hazard analysis of the plant.

A step time cannot be set for the following steps: "Burner switched off", "Check start conditions" and "Burner in operation/control enable".

4.4 Burner cycle

4.4.1 Steps

Each step has a fixed step identifier (0 ... 31).
The steps are performed consecutively within the burner cycle (step 1 first, then step 2). Some steps are only important internally and are not displayed (e.g. step 4). That's why some numbers from 0 to 31 are not listed as steps.
The length of the steps depends on the configuration and the burner cycle. There are steps for which you can set a step time in the PNOZmulti Configurator; others have a fixed step time, or the step time depends on the burner cycle.

A step time cannot be set for the following steps. They are run in each burner cycle, irrespective of the configuration.

- Step 0: Burner switched off
- Step 1: Check start conditions
- Step 18: Burner in operation/controller enable

A step time can be set for the following steps. Your configuration will determine which of these steps are performed in your burner cycle.

- Step 2: Start-up combustion air blower
- Step 3: Compound controller to pre-purge position
- Step 5: Pre-purge/tightness control: Vent
- Step 6: Pre-purge/tightness control: Test air pressure
- Step 7: Prepurge/tightness control, filling:
- Step 8: Prepurge/tightness control, test fuel pressure
- Step 9: Continue pre-purge
- Step 10: Compound controller to ignition position
- Step 12: Pre-ignition
- Step 13: Ignite ignition flame/1st safety time
- Step 14: Stabilise ignition flame
- Step 15: Ignite main flame/2nd safety time
- Step 16: Stabilise main flame
- Step 17: Burner in operation/start position
- Step 20: Afterburn
- Step 21: Post-purge
- Step 22: Run down combustion air blower
- Step 24: Tightness control, vent
- Step 25: Tightness control, test air pressure
- Step 26: Tightness control, filling
- Step 27: Tightness control, test fuel pressure

4.4.2 Errors during the burner cycle

An error is detected if the input signals within a step fail to match the values set for the monitoring operation. This will lead either to a fault lockout or a safety shutdown, depending on the input signal and configuration. Some of the monitoring functions during a burner cycle depend on the step, while others are continuous. In other words, some monitoring processes occur in a specific step, while others may be active across the whole cycle.

- **Step-dependent errors**

  With step-dependent errors, the set value of the input signals in the various steps may vary.
  E.g.: With combustion air monitoring, the input must have a "0" signal during the "Check start conditions" step and a "1" signal during the "Burner in operation" step.
  The following monitoring functions have errors that depend on the specific step:

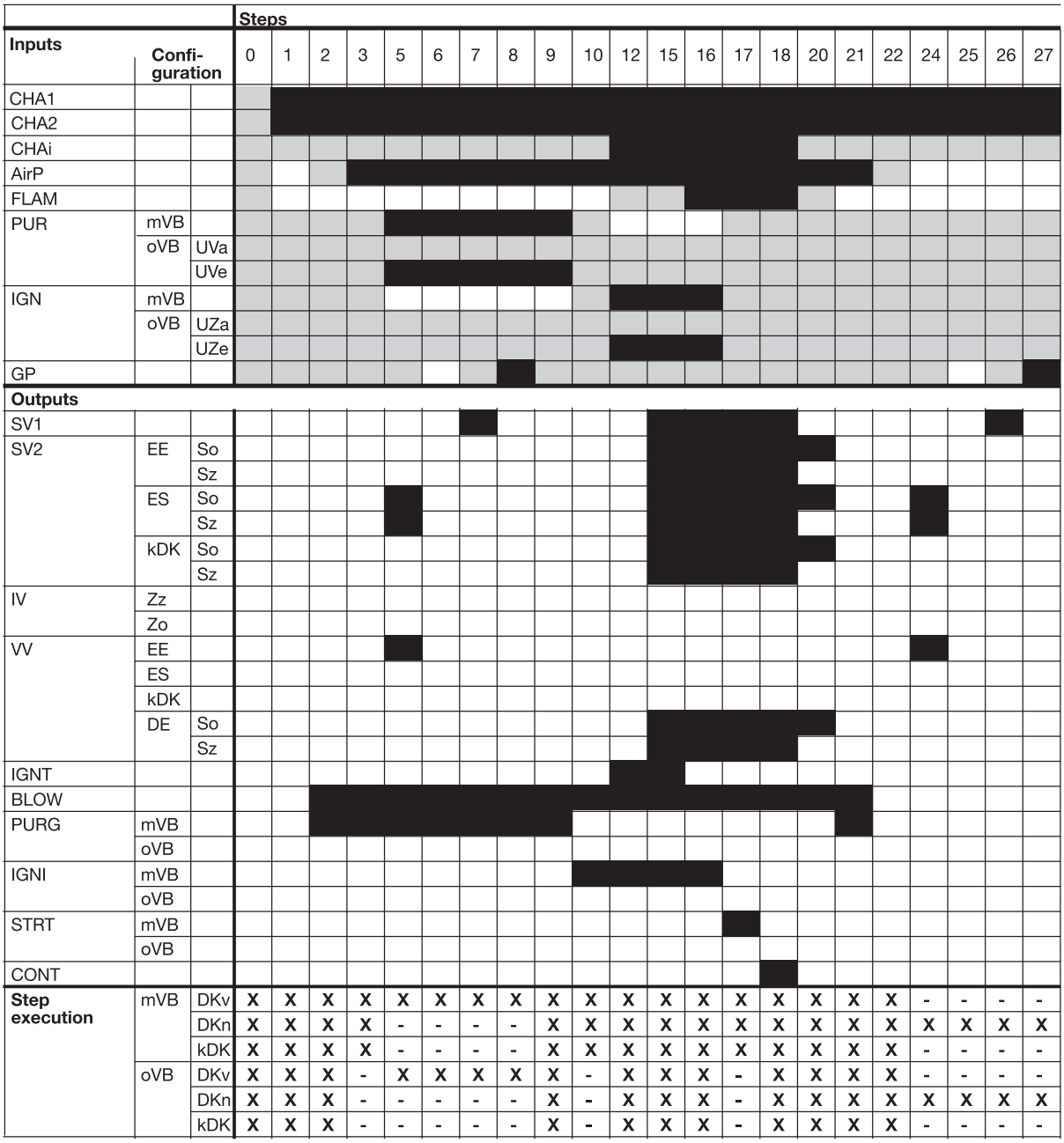
  – Combustion air monitoring
  – Flame monitoring of ignition flame
  – Flame monitoring of main flame
  – Tightness control
  – Compound controller not in pre-purge position
  – Compound controller not in ignition position
  – Ignition and operation safety chain

- **Step-independent errors**

  Where errors are independent of the specific step, the same set value applies for each step: The input must have a "1" signal.
  The following monitoring functions have errors that are independent of the specific step:

  – Safety chain 1
  – Safety chain 2

4.4.3 Master burner with direct ignition

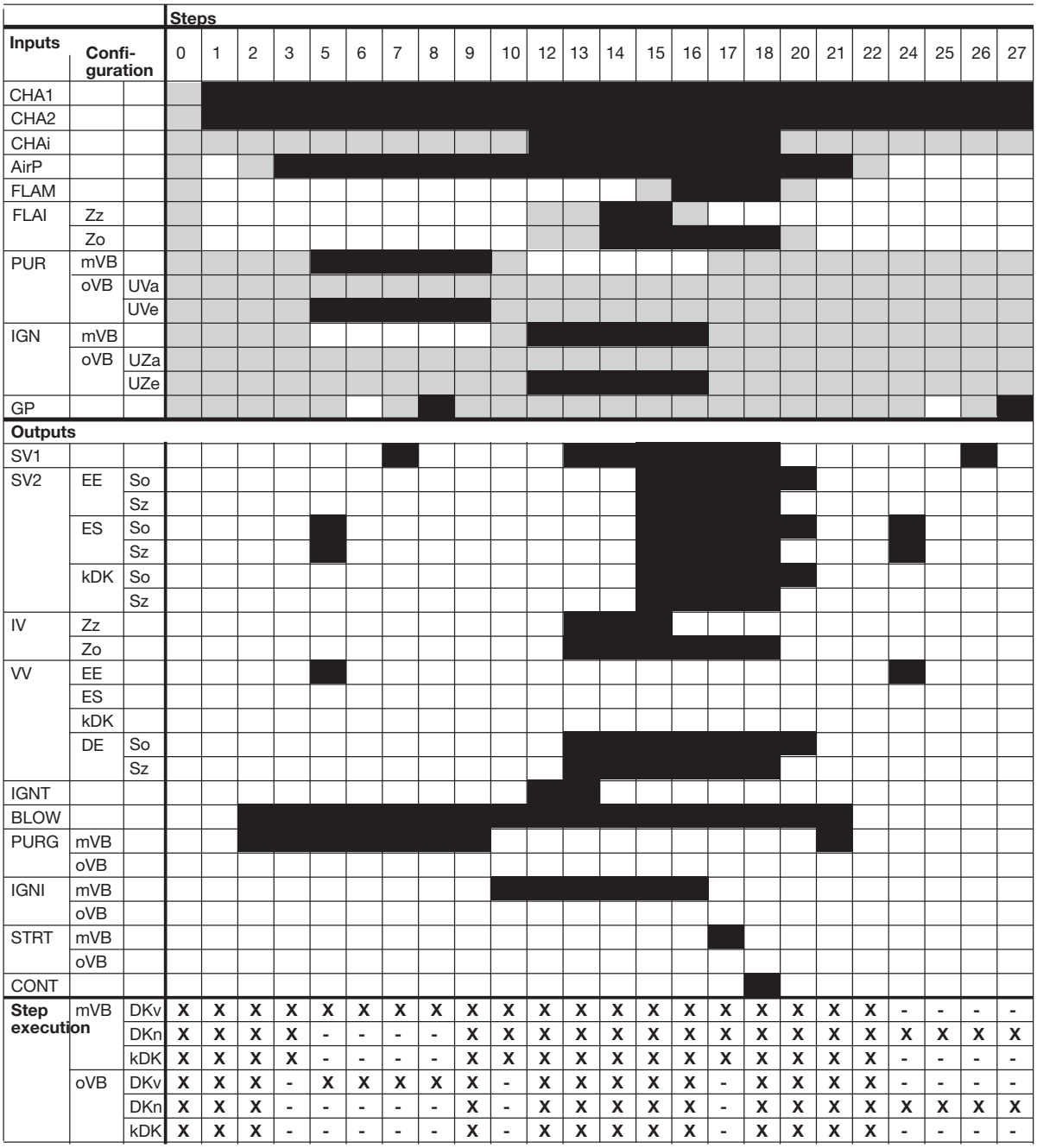


Configuration:
mVB: Cycle with compound controller
oVB: Cycle without compound controller
UZe: Monitoring of ignition conditions on
UZa: Monitoring of ignition conditions off
UVe: Monitoring of pre-purge conditions on
UVa: Monitoring of pre-purge conditions off
DE: Continuous vent
DKv: Tightness control prior to ignition
DKn: Tightness control after shutdown
kDK: No tightness control, no continuous vent
EE: Vent via vent valve
ES: Vent via safety valve 2
Zz: Ignition valve is closed after ignition
Zo: Ignition valve remains open after ignition
So: Safety valve 2 open during afterburn
Sz: Closed

Status of inputs/outputs:
Signal must be/is '1'
No monitoring active
Signal must be/is '0'

Step execution
X Step is executed
\- Step is not executed

4.4.4 Master burner with separate flame monitoring



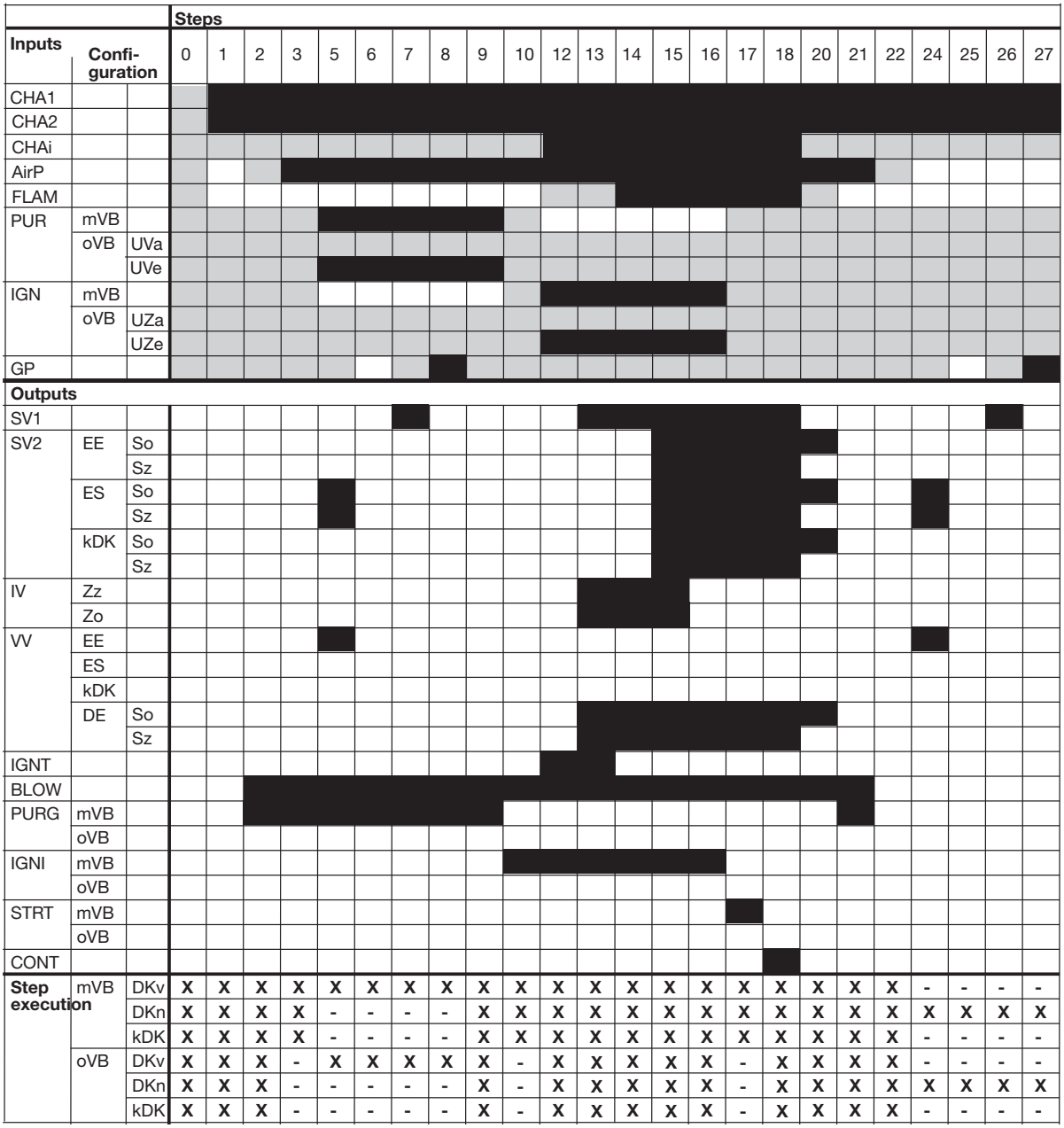
Inputs	Configuration		Steps 0	1	2	3	5	6	7	8	9	10	12	13	14	15	16	17	18	20	21	22	24	25	26	27
CHA1																										
CHA2																										
CHAi																										
AirP																										
FLAM																										
FLAI	Zz																									
	Zo																									
PUR	mVB																									
	oVB	UVa																								
		UVe																								
IGN	mVB																									
	oVB	UZa																								
		UZe																								
GP																										
Outputs																										
SV1																										
SV2	EE	So																								
		Sz																								
	ES	So																								
		Sz																								
	kDK	So																								
		Sz																								
IV	Zz																									
	Zo																									
VV	EE																									
	ES																									
	kDK																									
	DE	So																								
		Sz																								
IGNT																										
BLOW																										
PURG	mVB																									
	oVB																									
IGNI	mVB																									
	oVB																									
STRT	mVB																									
	oVB																									
CONT																										
Step execution	mVB	DKv	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		DKn	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		kDK	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
	oVB	DKv	X	X	X	-	X	X	X	X	X	-	X	X	X	X	X	-	X	X	X	X	-	-	-	-
		DKn	X	X	X	-	-	-	-	-	X	-	X	X	X	X	X	-	X	X	X	X	X	X	X	X
		kDK	X	X	X	-	-	-	-	-	X	-	X	X	X	X	X	-	X	X	X	X	-	-	-	-

Configuration:
mVB: Cycle with compound controller
oVB: Cycle with compound controller
UZe: Monitoring of ignition conditions on
UZa: Monitoring of ignition conditions off
UVe: Monitoring of pre-purge conditions on
UVa: Monitoring of pre-purge conditions off
DE: Continuous vent
DKv: Tightness control prior to ignition
DKn: Tightness control after shutdown
kDK: No tightness control, no continuous vent
EE: Vent via vent valve
ES: Vent via safety valve 2
Zz: Ignition valve is closed after ignition
Zo: Ignition valve remains open after ignition
So: Safety valve 2 open during afterburn
Sz: Closed

Status of inputs/outputs:
Signal must be/is '1'
No monitorint active
Signal must be/is '0'

Step execution:
X Step is executed
\- Step is not executed

4.4.5 Master burner with joint flame monitoring

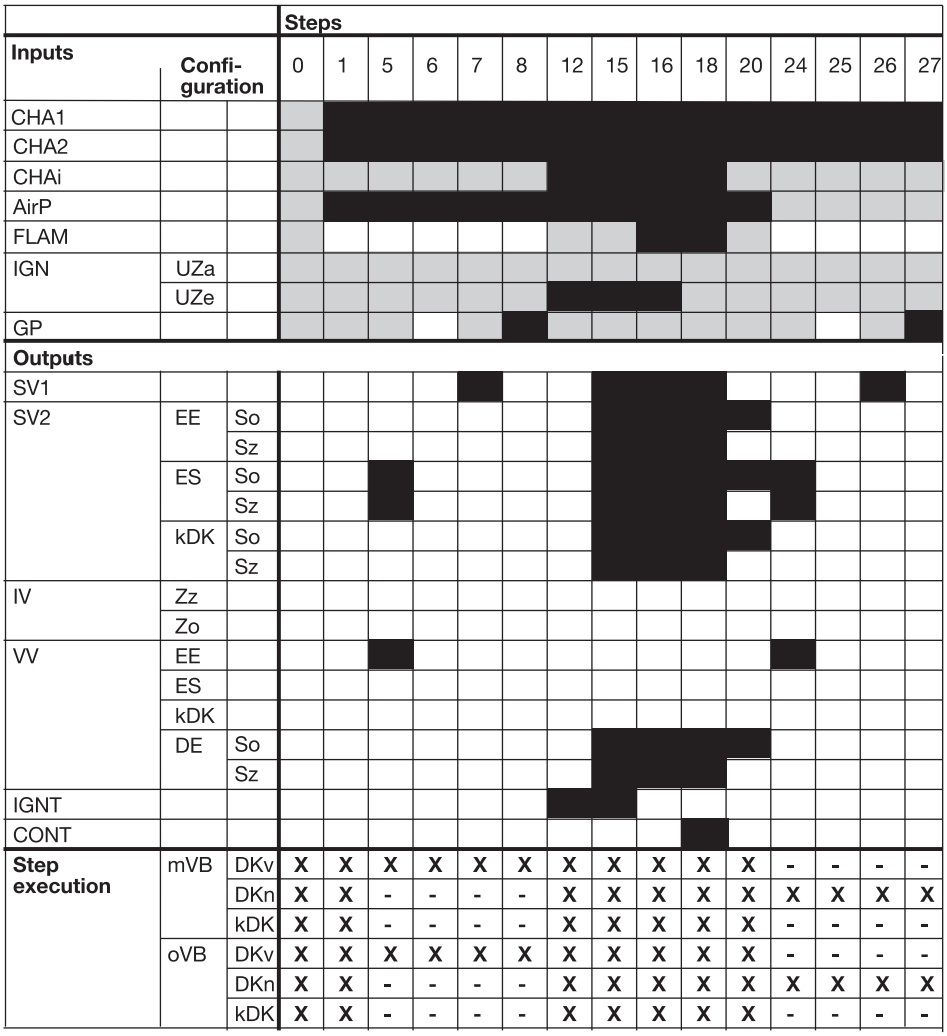


Configuration:
mVB: Cycle with compound controller
oVB: Cycle without compound controller
UZe: Monitoring of ignition conditions on
UZa: Monitoring of ignition conditions off
UVe: Monitoring of pre-purge conditions on
UVa: Monitoring of pre-purge conditions off
DE: Continuous vent
DKv: Tightness control prior to ignition
DKn: Tightness control after shutdown
kDK: No tightness control, no continuous vent
EE: Vent via vent valve
ES: Vent via safety valve 2
Zz: Ignition valve is closed after ignition
Zo: Ignition valve remains open after ignition
So: Safety valve 2 open during afterburn
Sz: Closed

Status of inputs/outputs:
Signal must be/is '1'
No monitoring active
Signal must be/is '0'

Step execution:
X Step is executed
\- Step is not executed

4.4.6 Slave burner with direct ignition



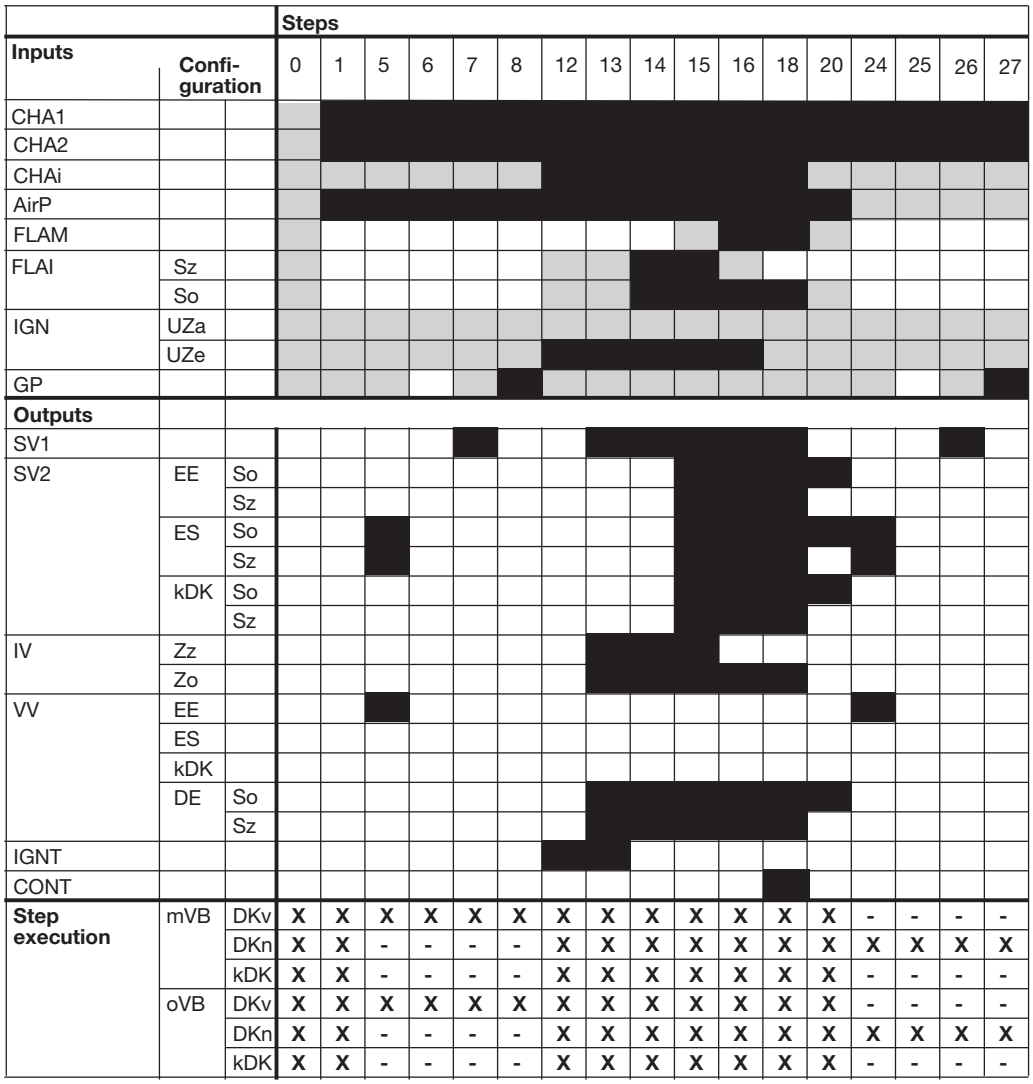
			Steps														
Inputs	**Configuration**		0	1	5	6	7	8	12	15	16	18	20	24	25	26	27
CHA1																	
CHA2																	
CHAi																	
AirP																	
FLAM																	
IGN	UZa																
	UZe																
GP																	
Outputs																	
SV1																	
SV2	EE	So															
		Sz															
	ES	So															
		Sz															
	kDK	So															
		Sz															
IV	Zz																
	Zo																
VV	EE																
	ES																
	kDK																
	DE	So															
		Sz															
IGNT																	
CONT																	
Step execution	mVB	DKv	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		DKn	X	X	-	-	-	-	X	X	X	X	X	X	X	X	X
		kDK	X	X	-	-	-	-	X	X	X	X	X	-	-	-	-
	oVB	DKv	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		DKn	X	X	-	-	-	-	X	X	X	X	X	X	X	X	X
		kDK	X	X	-	-	-	-	X	X	X	X	X	-	-	-	-

Configuration:
mVB: Cycle with compound controller
oVB: Cycle without compound controller
UZe: Monitoring of ignition conditions on
UZa: Monitoring of ignition conditions off
UVe: Monitoring of pre-purge conditions on
UVa: Monitoring of pre-purge conditions off
DE: Continuous vent
DKv: Tightness control prior to ignition
DKn: Tightness control after shutdown
kDK: No tightness control, no continuous vent
EE: Vent via vent valve
ES: Vent via safety valve 2
Zz: Ignition valve is closed after ignition
Zo: Ignition valve remains open after ignition
Safety valve 2 open during
Sz: Closed
So: Afterburn

Status of inputs/outputs:
Signal must be/is '1'
No monitoring active
Signal must be/is '0'

Step execution:
X Step is executed
\- Step is not executed

4.4.7 Slave burner with separate flame monitoring



Inputs	Configuration		Steps 0	1	5	6	7	8	12	13	14	15	16	18	20	24	25	26	27
CHA1																			
CHA2																			
CHAi																			
AirP																			
FLAM																			
FLAI	Sz																		
	So																		
IGN	UZa																		
	UZe																		
GP																			
Outputs																			
SV1																			
SV2	EE	So																	
		Sz																	
	ES	So																	
		Sz																	
	kDK	So																	
		Sz																	
IV	Zz																		
	Zo																		
VV	EE																		
	ES																		
	kDK																		
	DE	So																	
		Sz																	
IGNT																			
CONT																			
Step execution	mVB	DKv	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		DKn	X	X	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X
		kDK	X	X	-	-	-	-	X	X	X	X	X	X	X	-	-	-	-
	oVB	DKv	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		DKn	X	X	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X
		kDK	X	X	-	-	-	-	X	X	X	X	X	X	X	-	-	-	-

Configuration:
mVB: Cycle with compound controller
oVB: Cycle without compound controller
UZe: Monitoring of ignition conditions on
UZa: Monitoring of ignition conditions off
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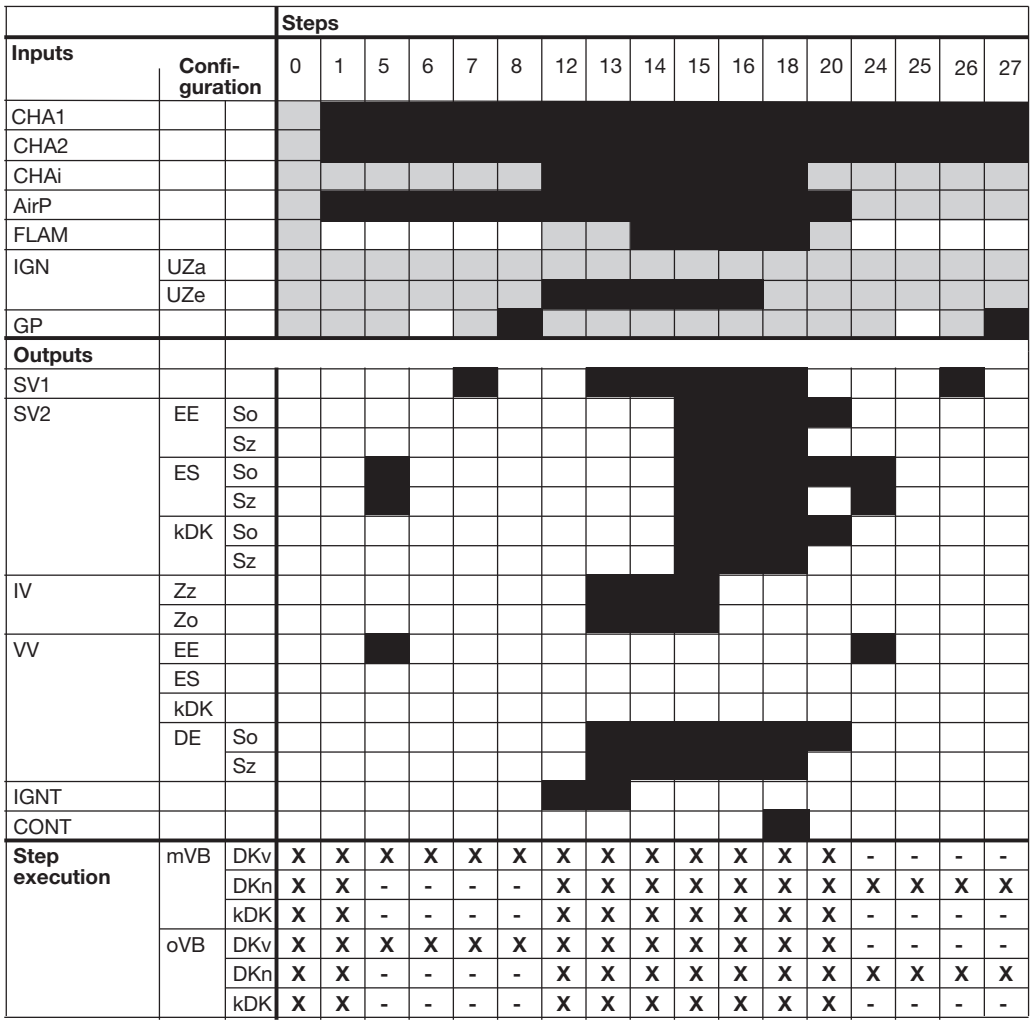
UVa: Monitoring of pre-purge conditions off
DE: Continuous vent
DKv: Tightness control prior to ignition
DKn: Tightness control after shutdown
kDK: No tightness control,
_____ no continuous vent
EE: Vent via vent valve
ES: Vent via safety valve 2
Zz: Ignition valve is closed after ignition
Zo: Ignition valve remains open after ignition
So: Safety valve 2 open during afterburn
Sz: Closed

Status of inputs/outputs:
Signal must be/is '1'
No monitoring active
Signal must be/is '0'

Step execution:
X Step is executed
\- Step is not executed

4.4.8 Slave burner with joint flame monitoring



			Steps																
Inputs	**Configuration**		0	1	5	6	7	8	12	13	14	15	16	18	20	24	25	26	27
CHA1																			
CHA2																			
CHAi																			
AirP																			
FLAM																			
IGN	UZa																		
	UZe																		
GP																			
Outputs																			
SV1																			
SV2	EE	So																	
		Sz																	
	ES	So																	
		Sz																	
	kDK	So																	
		Sz																	
IV	Zz																		
	Zo																		
VV	EE																		
	ES																		
	kDK																		
	DE	So																	
		Sz																	
IGNT																			
CONT																			
Step execution	mVB	DKv	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		DKn	X	X	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X
		kDK	X	X	-	-	-	-	X	X	X	X	X	X	X	-	-	-	-
	oVB	DKv	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		DKn	X	X	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X
		kDK	X	X	-	-	-	-	X	X	X	X	X	X	X	-	-	-	-

Configuration:
mVB: Cycle with compound controller
oVB: Cycle without compound controller
UZe: Monitoring of ignition conditions on
UZa: Monitoring of ignition conditions off
UVe: Monitoring of pre-purge conditions on
UVa: Monitoring of pre-purge conditions off
DE: Continuous vent
DKv: Tightness control prior to ignition
DKn: Tightness control after shutdown
kDK: No tightness control, no continuous vent
EE: Vent via vent valve
ES: Vent via safety valve 2
Zz: Ignition valve is closed after ignition
Zo: Ignition valve remains open after ignition
So: Safety valve 2 open during afterburn
Sz: Closed

Status of inputs/outputs:
Signal must be/is '1'
No monitoring active
Signal must be/is '0'

Step execution:
X Step is executed
\- Step is not executed

4.4.9 Example: Viewing the burner cycle in the PNOZmulti Configurator

The steps listed above will be performed during the burner cycle, depending on the configuration.

Once you have made the settings for your configuration in the PNOZmulti Configurator, you can then view this burner cycle.

The following information may be displayed:

- An overview of your configuration
- The steps that are performed with this configuration

- The set status of the inputs and the status of the outputs during the respective steps

Example:

You have made the following settings in the PNOZmulti Configurator:

Burner type	Master burner, indirect ignition, separate flame monitoring
Cycle with compound controller	Enabled
Ignition valve	Closed after ignition
Type of tightness control	Vent via vent valve
Time of tightness control	During pre-purge
Afterburn	Safety valve 2 is closed during afterburn
Temperature	Enable 'High temperature' operating mode

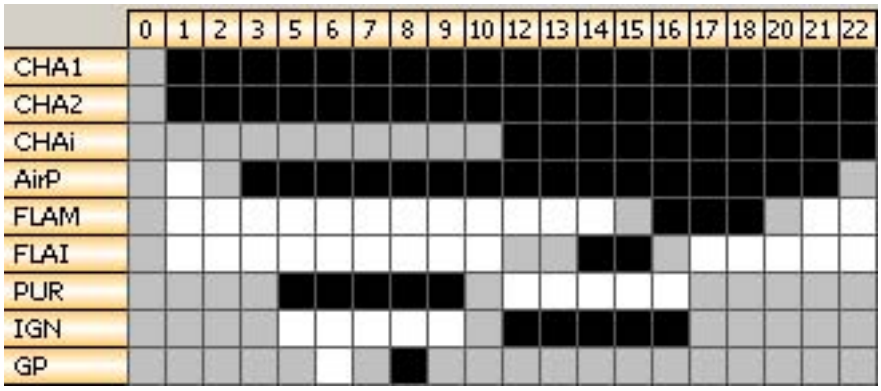
The 2 tables *Set status of inputs* and *Status of outputs* are displayed in the PNOZmulti Configurator. Your own individual burner cycle is represented in these tables.

The first row contains all the steps that will be performed during the burner cycle (step identifiers 0 ... 31).
The first column contains all the inputs/outputs used in your application.

The field markings show the set state of the inputs and the state of the outputs during the respective steps:

Black	An input must = "1" in the step concerned, or an output = "1" in the step concerned.
White	An input or output must = "0" in the step concerned, or an output = "0" in the step concerned.
Grey	Monitoring of an input is deactivated in the step concerned, i.e. it is not evaluated.

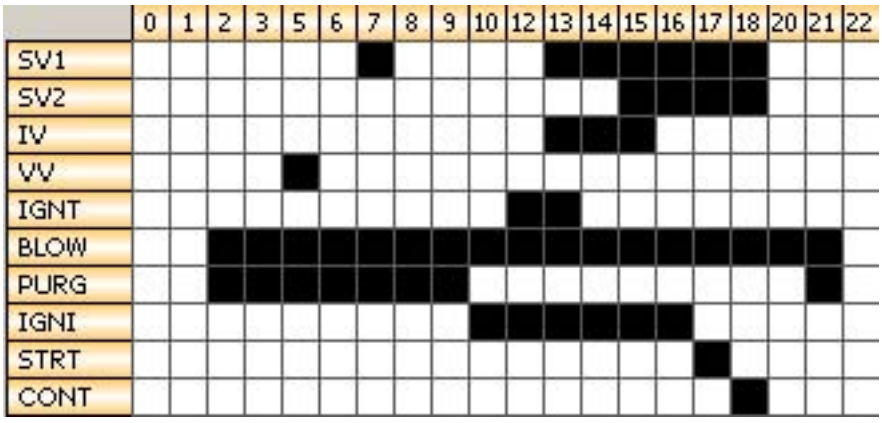
Set status of inputs



Examples:

- In step 2, "Start-up combustion air blower", the safety chain must be closed (input CHA2 = 1)
- In step 1, "Check start conditions", a main flame must not be detected (input FLAM = 0).

Status of outputs



Examples:

- In step 5 "Pre-purge/tightness control: vent", the vent valve is activated (output VV = 1).
- In step 9 "Continue pre-purge", the ignition transformer is not activated (output IGNT = 0).

4.5 Inputs and outputs

4.5.1 Element's inputs

4.5.1.1 Operation

- **Start: Switch burner on**

  The cycle is started via the start signal. The system can only be started if no error is present.

  Start = 0, no action

  Start = 1, switch burner on (pulse edge 0 -> 1)

- **Stop: Switch burner off**

  Shutdown of the burner is started via the stop signal.

  Stop = 0, no action

  Stop = 1, switch off burner

- **Reset: Fault lockout/reset error**

  The reset input is used to cancel the restart interlock after a fault lockout. A reset signal resets the cycle to "Burner switched off" status; the burner cycle can be restarted using the start signal.

  Reset = 0, no action

  Reset = 1, reset (pulse edge 0 -> 1)

4.5.1.2 Monitoring functions

- **CHA 1: Safety chain 1**

The inputs can be assigned to any signals. We recommend that you connect E-STOP pushbuttons, which switch off the burner in an emergency, or plant-dependent monitoring functions, such as temperature or pressure monitoring devices, for example.

CHA 1 = 0: Safety chain interrupted

CHA 1 = 1: Safety chain closed

- **CHA 2: Safety chain 2**

  Safety chain 2 has the same function as safety chain 1. Both safety chains are of equal value. They are differentiated to improve diagnostics.

  CHA 2 = 0: Safety chain interrupted

  CHA 2 = 1: Safety chain closed

- **CHAi: Ignition and operation safety chain**

  This input has the same function as safety chains 1 and 2. However, when there is a 0 signal, a fault lockout or safety shutdown will only occur in between the steps Pre-ignition and Burner in operation, inclusive. If the input has a 0 signal before or after this point, it will have no effect.

  CHAi = 0: Safety chain interrupted

  CHAi = 1: Safety chain closed

- **AirP: Combustion air pressure monitoring**

  The combustion air pressure is monitored at this input.

  AirP = 0: Combustion air pressure absent

  AirP = 1: Combustion air pressure present

  On slave burners it is assumed that the furnace is fitted with a central combustion air supply. In this case, the "AirP" input must be connected to a signal indicating the presence of a correctly functioning combustion air supply.

- **FLAM: Flame monitoring of main flame**

  The main flame is monitored at this input. If a burner type with joint flame monitoring is configured, this input will also be used to monitor the ignition flame.

  FLAM = 0: Flame absent

  FLAM = 1: Flame present

- **FLAI: Flame monitoring for ignition flame**

  If a burner type with separate flame monitoring is configured, this input will be used to monitor the ignition flame.

  FLAI = 0: Ignition flame absent

  FLAI = 1: Ignition flame present

- **PUR: Compound controller in pre-purge position**

  At this input, a signal is expected from the compound controller, indicating that the compound controller is in "pre-purge" position. This signal must not come from the compound controller until the airflow rate required for pre-purge is present.

  PUR = 0: Compound controller not in pre-purge position

  PUR = 1: Compound controller in pre-purge position

- **IGN: Compound controller in ignition position**

At this input, a signal is expected from the compound controller, indicating that the compound controller is in "ignition" position. This signal must not occur until the optimum fuel/air ratio for ignition is present.

IGN = 0: Compound controller not in ignition position

IGN = 1: Compound controller in ignition position

- **GP: Tightness control (gas pressure)**

  The pressure between the two safety valves is monitored at this input.

  GP = 0: Section vented (atmospheric pressure)

  GP = 1: Gas pressure present

- **HTmp : High temperature mode**

  This input is used to switch between "Normal mode" and "High temperature mode". It is only possible to switch to high temperature mode if *Allow "High temperature" mode* has been selected in the PNOZmulti Configurator.

  HTmp = 0: Normal operation

  HTmp = 1: High temperature

4.5.2 Element’s outputs

- **SV1: Safety valve 1**

  Safety valve 1 is activated via this output. Safety valve 1 is on the fuel side.

  SV 1 = 0: Close safety valve 1

  SV 1 = 1: Open safety valve 1

  If the safety valves are activated via relay outputs, the special requirements of EN 50156 must be considered.

  – For PNOZmulti Classic systems we recommend that the safety valves are activated via the PNOZmulti expansion module PNOZ mo5p (see section entitled "Examples", under "Connecting the safety valves").

  – For PNOZmulti 2 systems, the relay output module PNOZ m EF 4DI4DOR can be used. However, it does not have diverse relay outputs. To activate a burner's safety valves in accordance with EN 50156, appropriate external measures should be used to establish diversity of the shut-off elements.
  For example, an appropriate measure may be an additional, monitored switching element (contactor or relay), which is activated by a safe semiconductor output and is switched in series with both relay outputs.

- **SV2: Safety Valve 2**

  Safety valve 2 is activated via this output. Safety valve 2 is on the burner side.

  SV 2 = 0: Close safety valve 2

  SV 2 = 1: Open safety valve 2

  If the safety valves are activated via relay outputs, the special requirements of EN 50156 must be considered.

  – For PNOZmulti Classic systems we recommend that the safety valves are activated via the PNOZmulti expansion module PNOZ mo5p (see section entitled "Examples", under "Connecting the safety valves").

– For PNOZmulti 2 systems, the relay output module PNOZ m EF 4DI4DOR can be used. However, it does not have diverse relay outputs. To activate a burner's safety valves in accordance with EN 50156, appropriate external measures should be used to establish diversity of the shut-off elements.
For example, an appropriate measure may be an additional, monitored switching element (contactor or relay), which is activated by a safe semiconductor output and is switched in series with both relay outputs.

- **IV: Ignition valve**

  The ignition valve is activated via this output.

  IV = 0: Close ignition valve

  IV = 1: Open ignition valve

- **VV: Vent valve**

  The vent valve is activated via this output. If tightness control is not configured but continuous vent is, this valve must be designed to be "normally open". If neither tightness control nor continuous vent is configured, the output is inactive.

  VV = 0: Close vent valve

  VV = 1: Open vent valve

- **IGNT: Ignition transformer**

  The ignition transformer is activated via this output.

  IGNT = 0: Switch off ignition transformer

  IGNT = 1: Switch on ignition transformer

- **BLOW: Combustion air blower**

  The combustion air blower is activated via this output.

  BLOW = 0: Switch off combustion air blower

  BLOW = 1: Switch on combustion air blower

- **PURG: Compound controller to pre-purge position**

  This output is used to signal to the compound controller to go to pre-purge position.

  PURG = 0: Compound controller not activated

  PURG = 1: Compound controller to pre-purge position

- **IGNI: Compound controller to ignition position**

  This output is used to signal to the compound controller to go to ignition position.

  IGNI = 0: Compound controller not activated

  IGNI = 1: Compound controller to ignition position

- **STRT: Compound controller: Start position**

  This output is used to signal to the compound controller to go to start position.

  STRT = 0: Compound controller not activated

  STRT = 1: Compound controller to start position

- **CONT: Controller enable**

  This output provides the signal for the controller enable.

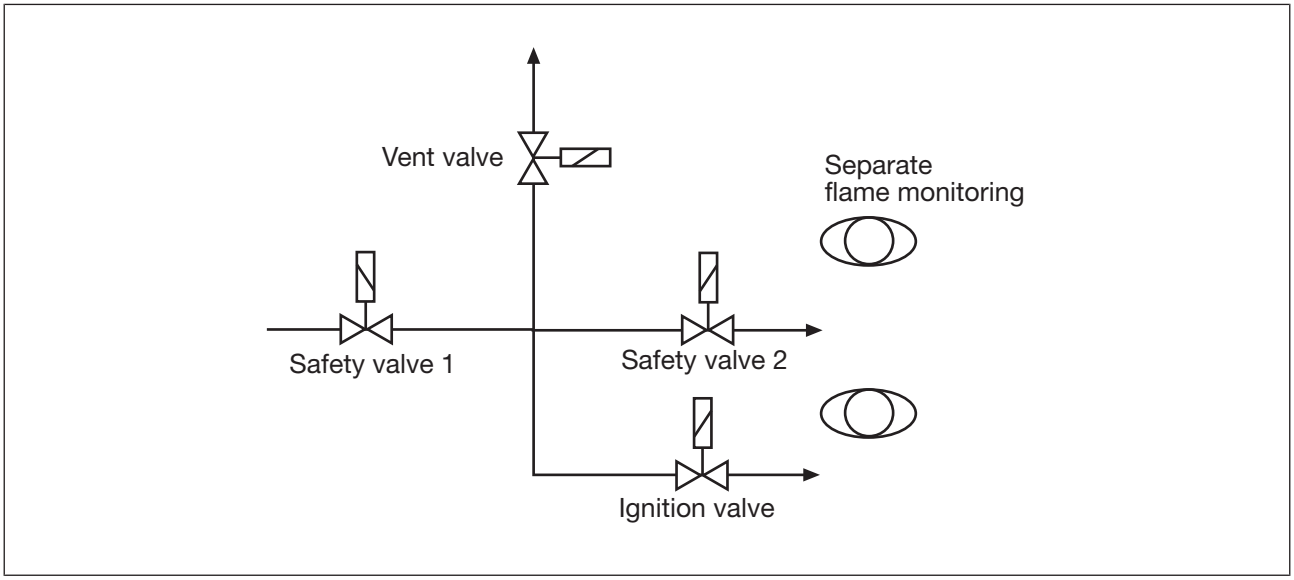
  CONT = 0: No controller enable

  CONT = 1: Controller enable

4.6 Configuration examples

4.6.1 Burner configuration

4.6.1.1 Burner structure



4.6.1.2 Burner properties

The burner has the following properties:

- The burner has its own combustion air supply.
- An electronic compound controller is present
- A separate ignition burner is present
- The ignition flame is extinguished once the main burner is successfully ignited.
- Ignition and main flame are each monitored using their own flame monitoring device.
- A tightness control check is carried out prior to ignition (during pre-purge).
- With tightness control, the section between the two safety valves is vented via the vent valve.
- Safety valve 2 is closed during afterburn.

4.6.1.3 Configuration in the PNOZmulti Configurator

Select burner type

Burner properties	Configuration
Own combustion air supply	Master burner
Separate ignition burner	Indirect ignition
Separate monitoring of ignition and main flame	Separate flame monitoring

- Select *Master burner, indirect ignition, separate flame monitoring*

Configure monitoring of the compound controller

Burner properties	Configuration
Electronic compound controller present	*Cycle with compound controller*

Configure monitoring of combustion air pressure

Burner properties	Configuration
A bounce time must be stated for shutting down the combustion air blower	Debounce time: *300 ms*

Configure ignition

Burner properties	Configuration
Ignition flame is extinguished once the main burner is ignited	Ignition valve *Closed after ignition*

Configure tightness control

Burner properties	Configuration
Vent via vent valve	Type of tightness control *Vent via vent valve*
Tightness control occurs prior to ignition	Time of tightness control *Prior to ignition*

Configure settings for shutting down the burner

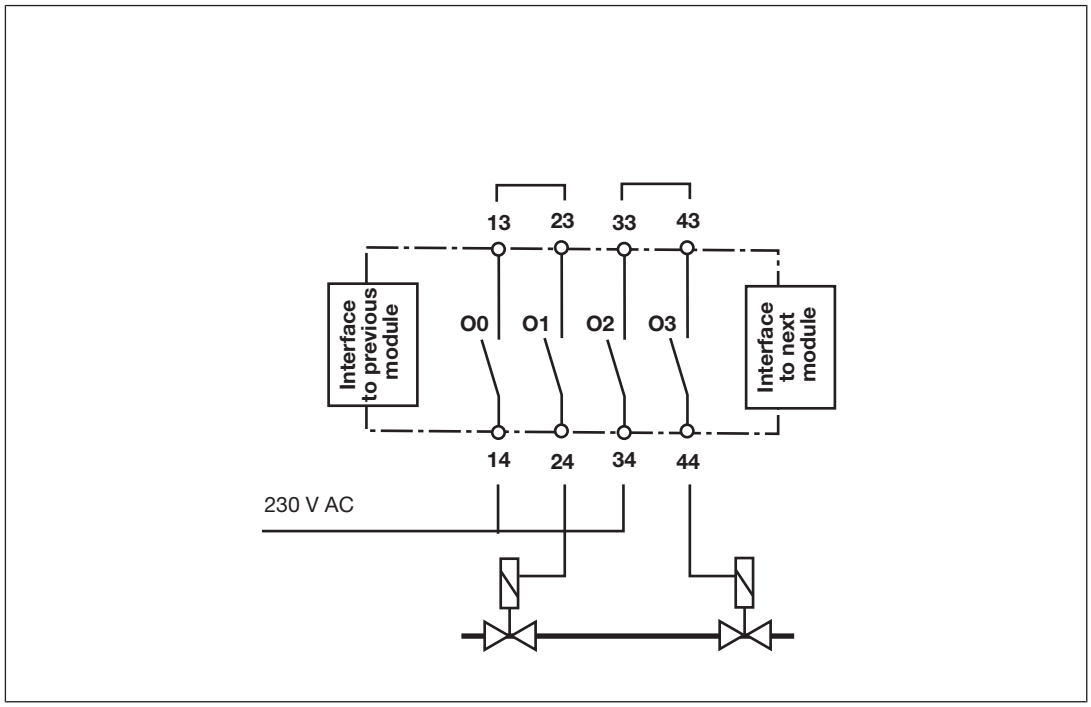
Burner properties	Configuration
Safety valve 2 is closed during afterburn.	*Safety valve 2 is closed during afterburn*

4.6.2 Connecting the safety valves on PNOZmulti Classic systems

If the safety valves are activated via relay outputs, diverse relays must be used.

For PNOZmulti Classic systems, the relay output module PNOZ mo5p is provided for this purpose. This module has 4 relay outputs:
Output O0 is diverse from O1,
Output O2 is diverse from output O3

Connecting the safety valves on a burner in accordance with EN 50156


13
23
33
43
Interface to previous module
O0
O1
O2
O3
Interface to next module
14
24
34
44
230 V AC

5 Loop formation (LOOP)

5.1 Introduction

This chapter describes the "Loop formation" function, in which LOOP inputs and outputs are configured in the PNOZmulti Configurator. This function is available from Version 8.1.0 of the PNOZmulti Configurator. Details of which base units support Version 8.1.0 are available in the "Product Modifications" document in the "Version overview" section.

5.1.1 Intended use

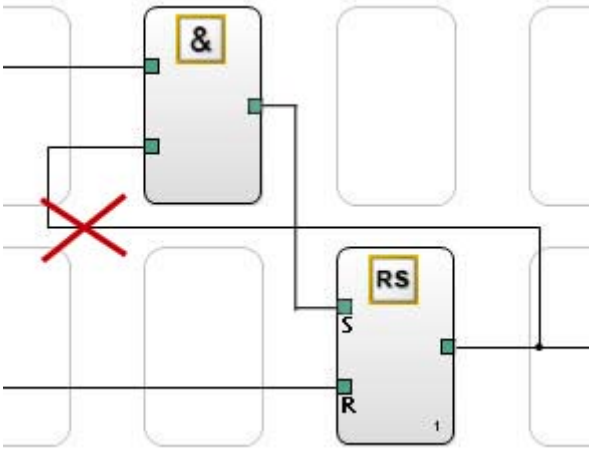
The loop formation (LOOP) function is used to feedback output information to the inputs.

NOTICE

When forming a loop, please note that the switch-off delay of the connected output is increased (see section entitled "Function description").

5.2 Function description

The connection of an output to an input of the same element is detected as an invalid loop in the PNOZmulti Configurator and cannot be configured in the user program.



Such a loop is necessary in certain applications. For example, applications containing a step sequence, where the status of the previous step influences the step that follows.

To meet this requirement you can configure a LOOP output and one or more assigned LOOP inputs in the PNOZmulti Configurator.

The output information from the LOOP output is then made available to the assigned LOOP inputs.

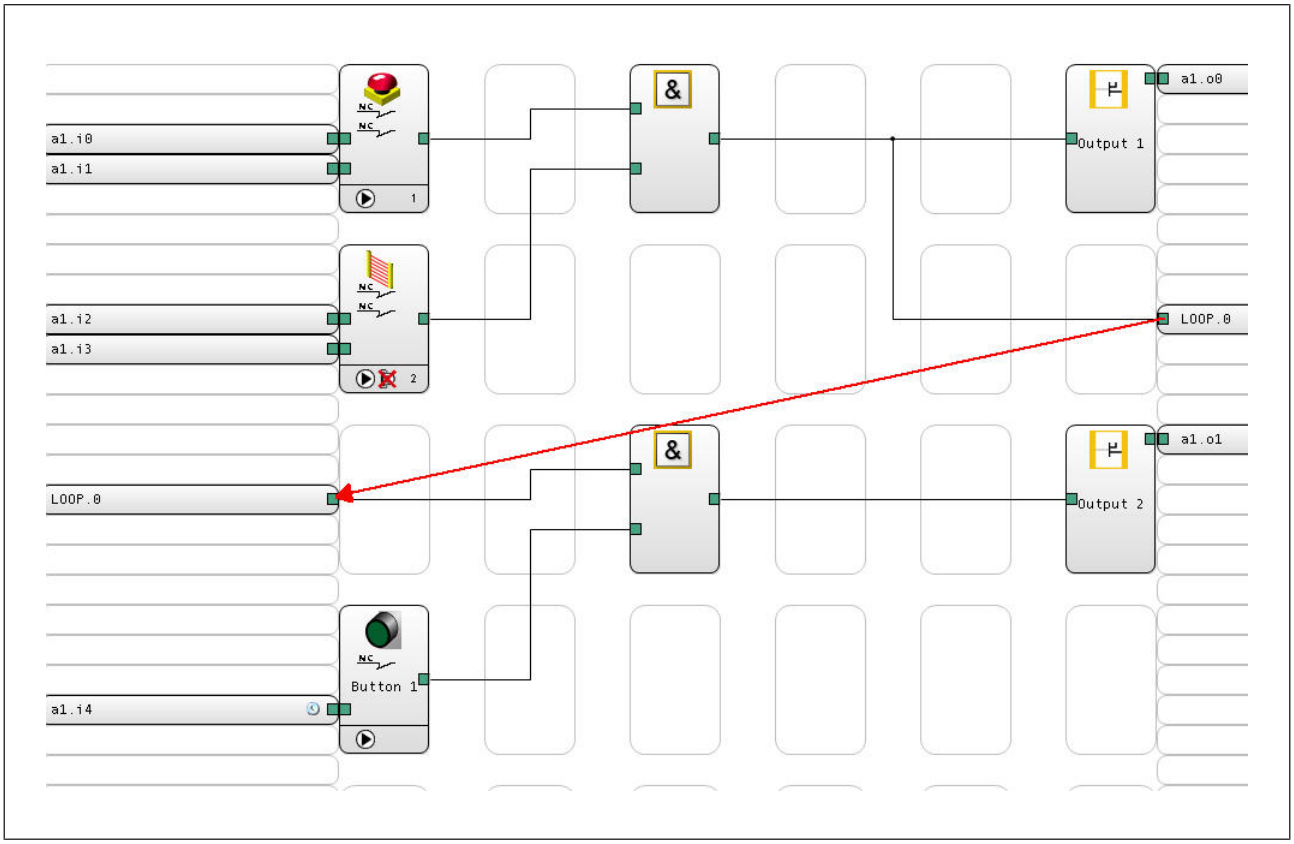
NOTICE

When forming a loop, please note that the presence of the output signal at the LOOP input is delayed by up to one cycle (15 ms); as a result, the switch off delay of the connected output is increased by up to one cycle.

5.3 Example configurations

5.3.1 Application using one loop

In the example configuration below, the status of the "LOOP 0" output is made available one cycle later at the "LOOP 0" input. Logically, the "Output 2" output switches off one cycle later than the "Output1" output.



Calculating the off-delay of semiconductor output "Output 2" (a1.o1) when the E-STOP pushbutton is operated (a1.i0/a1.i1)

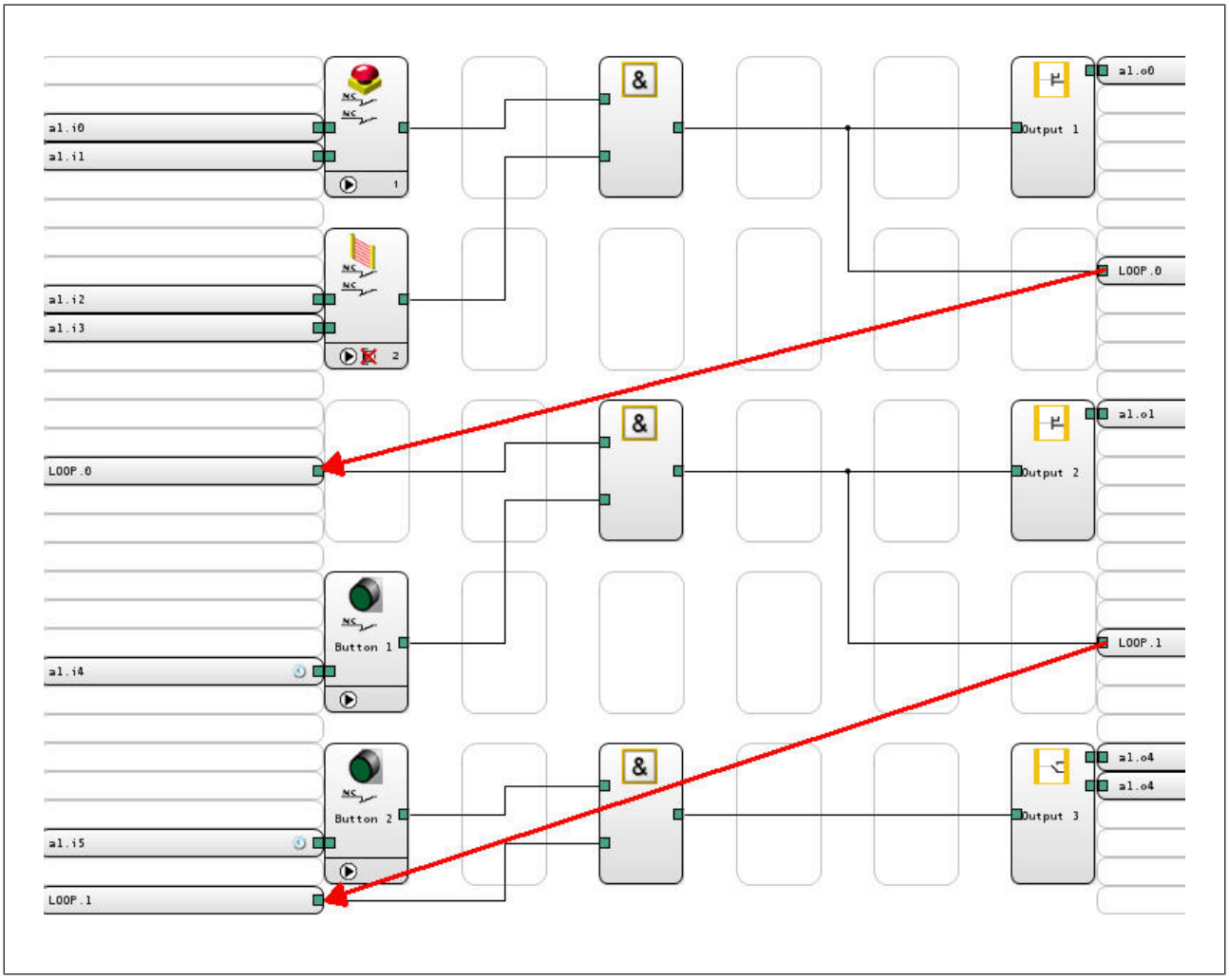
System's cycle time	15 ms
Off-delay of semiconductor output	30 ms
Number of loops	1

Off-delay of Output 2
= (Number of loops * Cycle) + Off-delay of semiconductor output
= (1*15 ms) + 30 ms
= 45 ms

5.3.2 Application using two loops

In the example configuration, the status of the "LOOP 0" output is made available one cycle later at the "LOOP 0" input. Logically, the "Output 2" output switches off one cycle later than the "Output1" output.

One more cycle later, the status of the "LOOP1" output is made available at the "LOOP1" input.
This means that the "Output 3" output switches off 2 cycles later than the "Output1" output.



Calculating the off-delay of the "Output 3" relay output (a1.o4/a1.o4) when the E-STOP pushbutton is operated (a1.i0/a1.i1)

System's cycle time	15 ms
Off-delay of relay output	50 ms
Number of loops	2

Off-delay of Output 3
= (Number of loops * Cycle) + Off-delay of relay output
= (2*15 ms) + 50 ms
= 80 ms

6 Safety solution SSC

6.1 Introduction

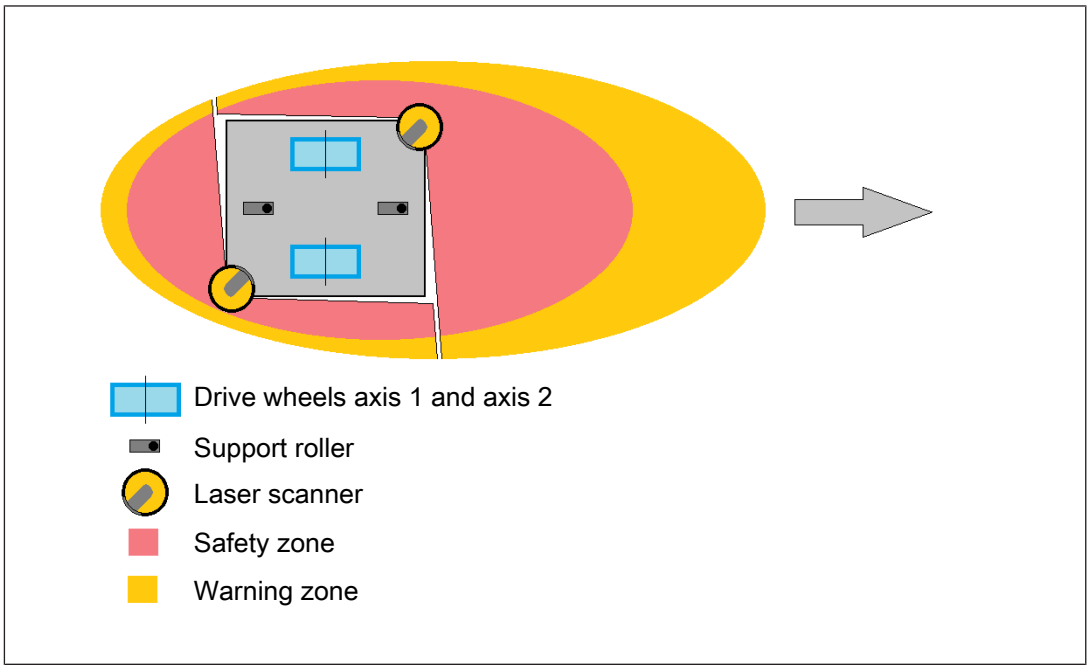
This chapter uses an example to describe a safety solution for freely navigating mobile platforms, using the motion monitoring function ***safe speed comparison (SSC)***.

The motion monitoring element ***safe speed comparison (SSC)*** is available for configuration in the PNOZmulti Configurator from Version 11.3.0.

The supported versions of the base units and motion monitoring module are described in the ***Version overview*** in the ***Product changes*** document.

6.2 Description of example

- On an automated guided vehicle with differential drive, the speed at the drive wheels ***axis 1*** and ***axis 2*** is compared using the motion monitoring element ***safe speed comparison (SSC)***.
- Based on the speed difference, the direction of travel can be determined and direction signals can be generated at the outputs.
- The direction signals are used, for example, to control the safety zones on a laser scanner in accordance with the direction of travel.
- Safe monitoring of the protection zones is used to adjust the speed and avoid collisions for the automated guided vehicle.

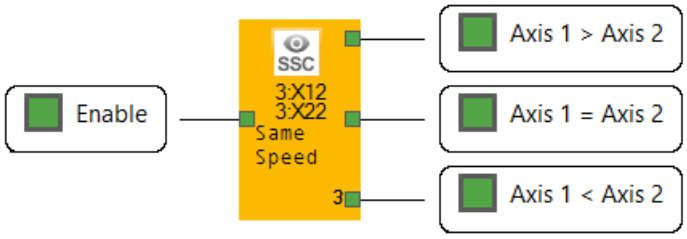


6.3 Configuration in PNOZmulti Configurator

Record the direction of travel with the safe speed comparison element

The motion monitoring element ***safe speed comparison*** is used to configure the motion monitoring module PNOZ m EF 2MM from unit version 2.5.

3 outputs for speed comparison monitoring are available on the motion monitoring element ***safe speed comparison (SSC)***.

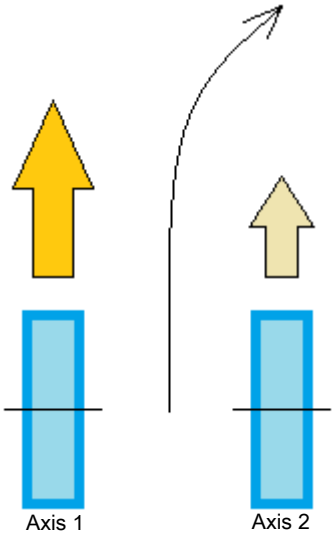


Three directions of travel can be recorded using the SSC element: curve to the right, straight ahead, curve to the left:

- **Speed at Axis 1 > Speed at Axis 2**

  If the speed at axis 1 is greater than the speed at axis 2 and the speed difference is greater than the configured tolerance, then the output **Axis 1 > Axis 2** is switched on.

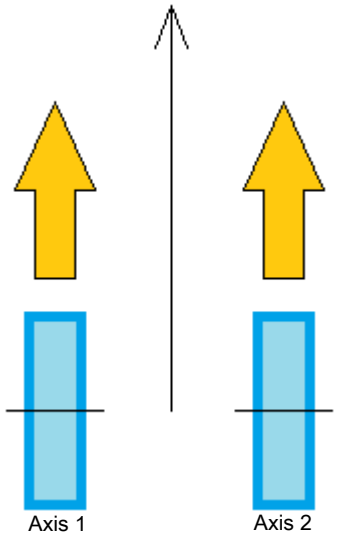
  The determined direction of travel is **right**.



- **Speed at Axis 1 = Speed at Axis 2**

  In synchronism, if the speed difference is within the configured tolerance, the output **Axis 1 = Axis 2** is switched on.

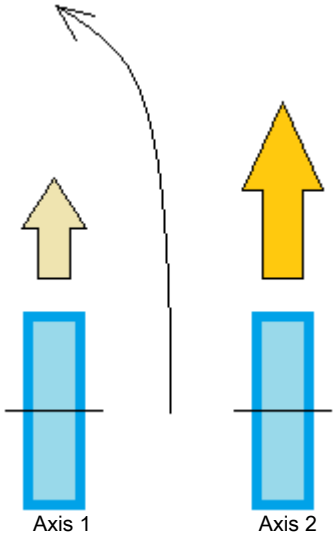
The determined direction of travel is **straight ahead**.



- **Speed at Axis 1 < Speed at Axis 2**

  If the speed at axis 1 is less than the speed at axis 2 and the speed difference is greater than the configured tolerance, then the output **Axis 1 < Axis 2** is switched on.

  The determined direction of travel is **left**.



If the speed difference is outside the configured range (< 100 mHz), the outputs switch off. As soon as the speed difference returns to within the configured range (plus hysteresis), the corresponding output switches back on.

This can be used, for example, to control a ***safe operating stop monitoring*** element, in order to detect standstill.

CAUTION!

At 100 mHz, it takes 10 seconds (1/Hz = Sec) to detect standstill. Alternative stop information, from the drive controller for example, must be used to achieve faster control of the SOS element.

There are three directions of travel that can be recorded using the SSC element.

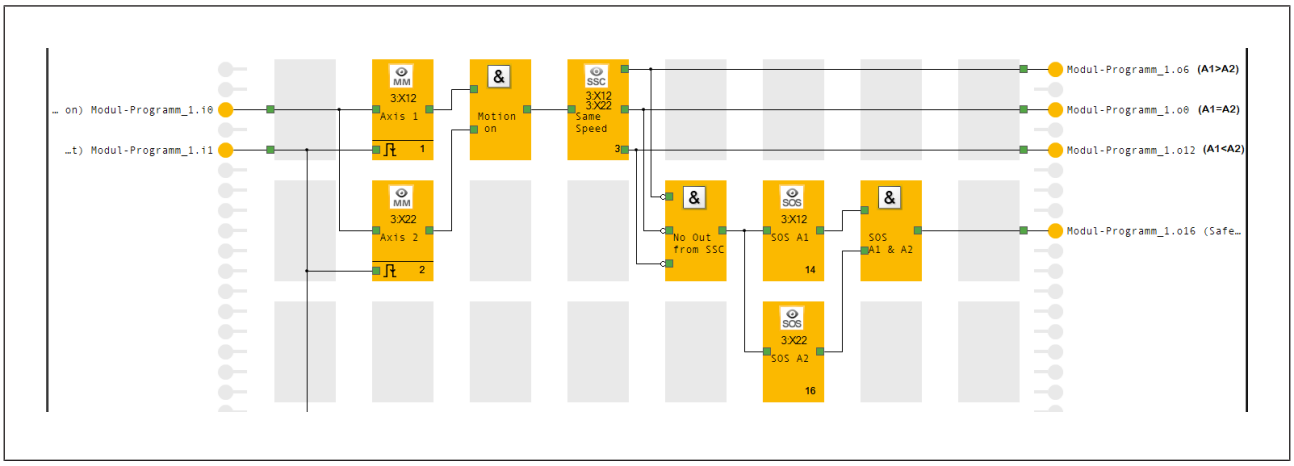
CAUTION!

The exact recording of the curve (circle radius) cannot be determined from these output signals. For cornering, therefore, the laser scanner's safety zone must be large enough to monitor all possible radii.

2 ***motion monitoring*** elements must be configured per ***safe speed comparison*** element. Use of a motion monitoring module PNOZ m EF 2MM is a prerequisite.

The two ***motion monitoring*** elements record the signals from the sensors connected to the axes and convert them into speed values.
The ***safe speed comparison*** element then uses these for speed comparison.

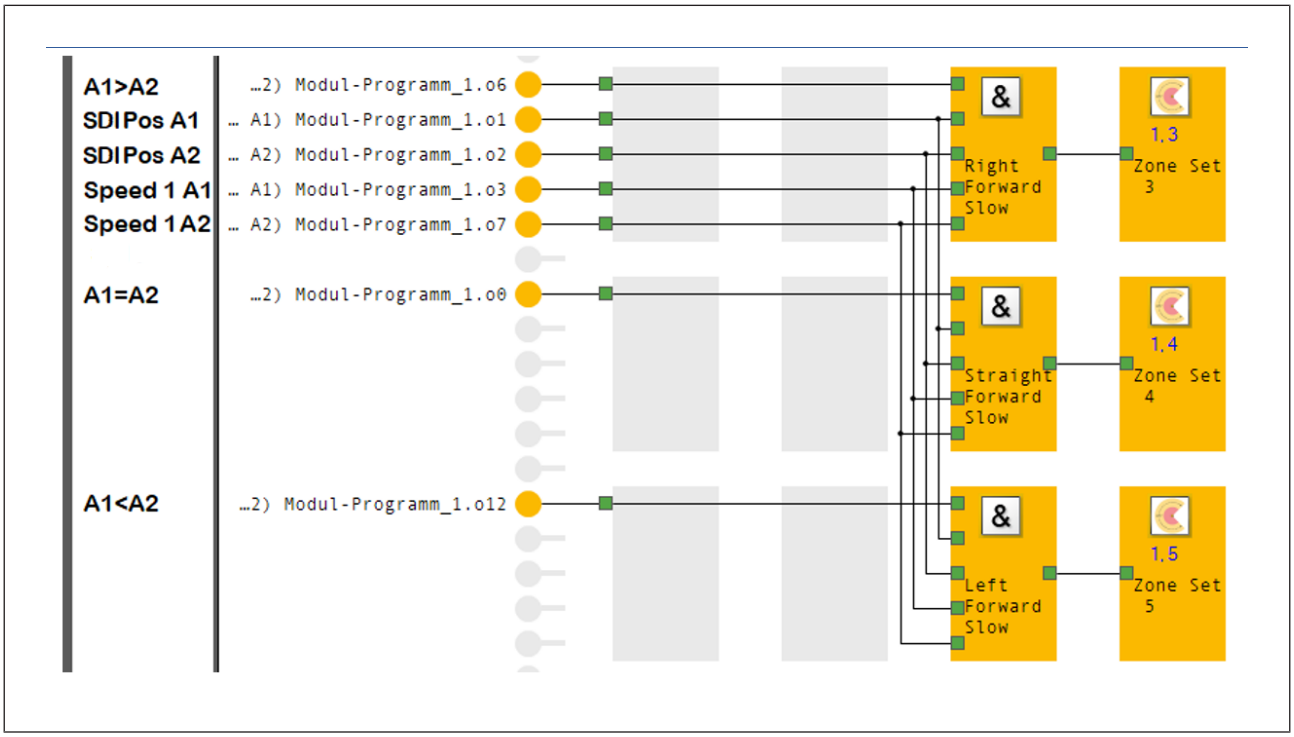
Control and evaluation of the safe speed comparison element



In combination with the signals from direction of rotation and speed monitoring, for example, the three direction signals (A1>A2, A1=A2, A1<A2) can be used to control zone selection (zone set element) for a safety laser scanner PSENscan.

To clearly control the zones, the control signals for zone selection must be masked out.

Example configuration – Masking the control signals for zone selection



If the direction of rotation is also taken into account, three backward directions can be recorded in addition to the three forward directions.
If additional speeds are defined, such as docking speed, slow speed, or fast speed for example, then you already have 18 safety zones that can be controlled using the ***zone set*** elements.
These must also be masked out beforehand.

Another potential movement for the automated guided vehicle is turning on the spot.

The two axes are rotated simultaneously at the same speed in the opposite direction, thus achieving a rotation around the vertical axis to the left or right.

To prevent this movement from being recorded as a curve, despite the different directions of rotation of axes A1 and A2, the SSC element should be monitored for synchronism (axis 1 = axis 2). To ensure that the SSC element does not recognise the reverse movement of one axis as a negative value, the ***Ignore direction of rotation*** option is selected in the element's configuration window. This means that the direction of rotation for both axes is always assumed to be positive.

To still enable the direction of rotation to be recognised, the direction of rotation of each individual axis is additionally monitored using the ***safe direction monitoring*** (SDI) element. The difference to normal straight-ahead travel, therefore, lies in the masking of the direction signals from the SDI elements.

Control of the drive

The speed of the two drive axes is not controlled by the safety controller, but by a separate drive controller. This controls the speeds of the axes and therefore the direction, speed and positioning of the automated guided vehicle.

In the example, the current speeds of axes A1 and A2 are safely recorded, without any direct influence on the drive. Based on the measurement results from the sensors on the axes, the safety zones and other safety functions are controlled and monitored in accordance with their configured parameters. The drive controller must have at least one option for STO control so that the drive can be shut down safely by the PNOZmulti.

WARNING!

Hazard due to loss of the safety function

The safety functions should be checked after initial commissioning and each time the plant/machine is changed. The safety functions may only be checked by qualified personnel.

7 Safe Ethernet Connection 2

7.1 Overview

The Safe Ethernet Connection 2 enables a point-to-point connection between a PNOZmulti base unit and a PSS 4000 device. Up to 64 safe virtual inputs and outputs can be transmitted via this connection.

7.2 System requirements

- PNOZmulti Configurator: from Version 11.6.0
- Base unit PNOZ m B1 from Firmware Version 1.12 of the configurable safe small controllers PNOZmulti 2

Please contact Pilz if you have an older version.

7.3 Function description

Safe Ethernet Connection 2 is used for safe communication between a PNOZmulti base unit PNOZ m B1 and a PSS 4000 device based on Industrial Ethernet. The underlying protocol is Modbus/TCP.

A point-to-point connection (1:1 communication relationship) can be implemented via the Safe Ethernet Connection 2. The information can be exchanged between a PNOZ m B1 and a PSS 4000 device via 64 safe virtual inputs and 64 safe virtual outputs.

Data exchange via the non-safety-related communication medium (Ethernet, Modbus/TCP) achieves safety in two ways: by using safety-related blocks/elements in both communication partners and by the fact that the blocks are executed in the safety-related part of the control system.

This procedure corresponds to the black channel principle in accordance with EN/IEC 61784-3. Depending on the application area and its respective regulations, the element can be used up to SIL3 in accordance with EN/IEC 61508 and up to PLe (Cat.4) in accordance with EN ISO 13849-1.

A safe Ethernet connection between a PNOZ m B1 and a PSS 4000 device can be regarded as a connection that provides communication in both directions. The communication partners continually try to send, even if the connection is broken. If the connection is error-free, it can be restored by a reset on the receiver side.
To establish a complete connection in both communication directions, the connection must be reset on both sides.

7.4 Configuration in the PNOZmulti Configurator

The connection settings for the PNOZmulti are made in the PNOZmulti Configurator in the element ***Safe Ethernet Connection 2 Status***. This is where the local address, remote address and timeout are set. For details of the configuration please refer to the online help for the PNOZmulti Configurator.

Local address

Own connection address, must be unique in the entire network.

Remote address

Connection address of the communication partner, must be unique in the entire network (local address of the communication partner).

Timeout

The timeout is the monitoring time for a telegram's runtime. The monitoring time is jointly responsible for the safety function's reaction time and should therefore be set as low as possible. However, if the rated monitoring time is too short, frequent connection failures may result.

Recommended configuration for a connection between PSS 4000 and PNOZmulti 2

Formula:

$t_{SEC2Timeout} \geq (2 \times t_{ProcessingTimePNOZmulti}) + (2 \times t_{ModbusCycleTime)} + (4 \times t_{PssTask})$

The processing time of the PNOZmulti $t_{ProcessingTimePNOZmulti}$ can be found in the operating manual for the PNOZ m B1.

The cycle time of the Modbus connection $t_{ModbusCycleTime}$ is the cycle time configured in PAS 4000 for the Modbus connection that transports the data of the FS_SafeEthernetConnection2.

The task cycle time $t_{PssTask}$ is the cycle time configured in PAS 4000 for the task in which the FS_SafeEthernetConnection2 function block is called in the PSS 4000.

The same value should be configured as the timeout value $t_{SEC2Timeout}$ for both communication partners.

Example:
Connection PNOZ m B1 to PSS 4000

- PNOZ m B1 $t_{ProcessingTimePNOZmulti}$ = 30ms
- $t_{ModbusCycleTime}$ configured in PSS 4000 = 10ms
- $t_{PssTask}$ configured in PSS 4000 = 15ms

$t_{SEC2Timeout} \geq (2 \times t_{ProcessingTimePNOZmulti}) + (2 \times t_{ModbusCycleTime)} + (4 \times t_{PssTask})$

$t_{SEC2Timeout} \geq (2 \times 30ms) + (2 \times 10ms) + (4 \times 15ms) = 140ms$

WARNING!

Loss of safety function due to brevity of signals!

The payload must be present for at least the monitoring time Timeout, otherwise certain communication errors in the receiver cannot be detected. Make sure that the payload is available in the transmitter for at least the monitoring time $t_{SecTimeout}$ to enable the receiver to evaluate it safely.

7.5 Modbus configuration

Data exchange is based on Ethernet. The underlying protocol is Modbus/TCP.

The PNOZmulti is always a Server for the Modbus/TCP with settings for the Safe Ethernet Connection 2 specified by the configuration.

Information regarding the configuration of Modbus/TCP for PSS 4000

Data exchange is defined by the possibilities and requirements of Modbus/TCP. The blocks uses the holding registers (4x) for data exchange. FC 23 (Read/Write Multiple Registers) must be configured as the function code (FC) for Client connections.

For communication between two devices, a Modbus/TCP connection must be configured for each device. Modbus/TCP requires that one of the communication partners is configured as the Client connection and the other as the Server connection. The PNOZmulti can only act as Server. The PSS 4000 must be configured as a Client.

The Modbus address at which the PNOZmulti 2 makes the send and receive data available as Server cannot be freely configured in PNOZmulti 2, but is specified by the PNOZmulti Configurator. 22 registers each must be configured for send and receive data.

The addresses must be read from the configuration.

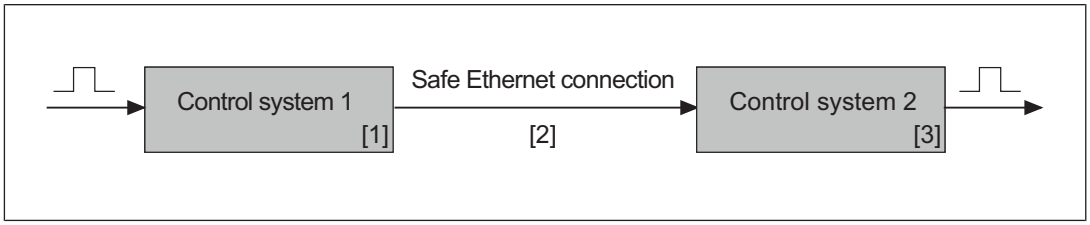
These addresses must be configured accordingly in the PSS 4000.

7.6 Reaction time

The safety function's safe reaction time is composed of the control systems' reaction times and the monitoring time for a telegram's runtime.

Formation of the overall data path

The overall data path is composed of the data subpaths of a control system 1, the Safe Ethernet Connection 2 and the data subpaths of a control system 2.



Data path 1: Control system 1 (transmitter)

Data path 1 describes the time between the signal changing at the input of control system 1 and the signal being present in the output area ***Safe Ethernet Connection 2*** of control system 1.

If control system 1 (transmitting system) is an automation system PSS 4000, you can calculate the reaction time of this data path as described in the online help for PAS4000.

If control system 1 (transmitting system) is a control system PNOZmulti, you can calculate the reaction time as follows:

- Max. input delay (see Technical details in the operating instructions for the respective input) + Max. processing time of the base unit (see base unit's operating manual)

Data link 2: Safety Ethernet Connection 2 (transmission)

Data path 2 describes the time between the signal being present in the output area ***Safe Ethernet Connection 2*** of control system 1 and the signal being present in the input area ***Safe Ethernet Connection 2*** of control system 2.

The reaction time of data path 2 corresponds to the configured timeout time $t_{SEC2Timeout}$ of the receiver system.

Data path 3: Control system 2 (receiver)

Data path 3 describes the time between the signal being present in the output area ***Safe Ethernet Connection 2*** of control system 2 and the output switching in control system 2.

If control system 2 (receiving system) is an automation system PSS 4000, you can calculate the reaction time of this data path as described in the online help for PAS4000.

If control system 2 (receiving system) is a control system PNOZmulti 2, you can calculate the reaction time as follows:

- Max. switch-off delay of the output (see Technical details in the operating instructions for the respective output)

Overall reaction time

The reaction time t_{React_max} from the signal changing at the input on control system 1 to the output switching on control system 2 is calculated by adding the reaction times of the three individual data paths.

Series connection

If several control systems are connected in series and information is channelled via several ***Safe Ethernet Connections 2***, each transmission must be calculated as a standalone connection (consisting of the three data subpaths) and the reaction times are added together.

Example: Input PNOZmulti – Output PSS 4000 PLC

Data path	Control system 1 PNOZmulti	Control system 2 PSS 4000
1	Max. input delay + Max. processing time of base unit	
2	Set timeout time $t_{SEC2Timeout}$: ($t_{SEC2Timeout} \geq (2 \times t_{ProcessingTimePNOZmulti}) + (2 \times t_{ModbusCycleTime}) + (4 \times t_{PssTask})$)	
3		Cycle time with ext. communication $t_{extCo\_Task2\_max}$ + Reaction time of module bus $t_{Task2\_MBUS\_max}$

Max. input delay of PNOZ m EF 8DI4DO (see operating manual)	8 ms
Max. processing time of base unit (see base unit's operating manual)	30 ms
Set timeout time (see Configuration in the PNOZmulti Configurator [📖 59])	150 ms
$t_{extCo\_Task2\_max}$ (see example in the online help for PAS4000)	100 ms
$t_{Task2\_MBUS\_max}$ (see example in the online help for PAS4000)	15 ms

Reaction time t_{React_max} = 8 ms + 30 ms + 150 ms + 100 ms + 15 ms

Reaction time t_{React_max} = 303 ms

7.7 Application guidelines

Connection status

The output on the element ***Safe Ethernet Connection 2 Status*** in the user program indicates whether the data is received without error and whether there is a connection for receiving data (error-free data receipt).

If the output = "0", the connection is broken. All virtual inputs on the ***Safe Ethernet Connection 2*** are switched to "0". The base unit remains in a RUN condition.

When the PNOZmulti is restarted or started automatically, communication is started with a falling edge on the element's input.

The cause of the error can be evaluated via the expanded PVIS diagnostic configuration (see section entitled Diagnostic word).

A break in the connection for receiving data has no direct effect on the connection for sending data.

Connection addresses

The connection authenticity of a point-to-point connection is tested using the connection addresses that are configured on the respective status - block/element as ***Local address*** and ***Remote address***.

Make sure that the connection addresses in a point-to-point connection is only used on precisely this connection within a network.

WARNING!

Loss of safety function due to the use of a connection address for more than one point-to-point connection in a network!

If a connection address is used in a network for more than one point-to-point connection, an unintended connection to a communication partner may result. This cannot be detected. Make sure that the connection addresses in a point-to-point connection is only used on precisely this connection within a network. Be sure to use the **Check list for connection addresses**.

Example 1: Connection addresses on a point-to-point connection with Safe Ethernet Connection 2

- Two different connection addresses are needed per point-to-point connection. In the example, connection addresses 20 and 21 are to be used.
- Other potential connections in the network may no longer use connection addresses 20 and 21.

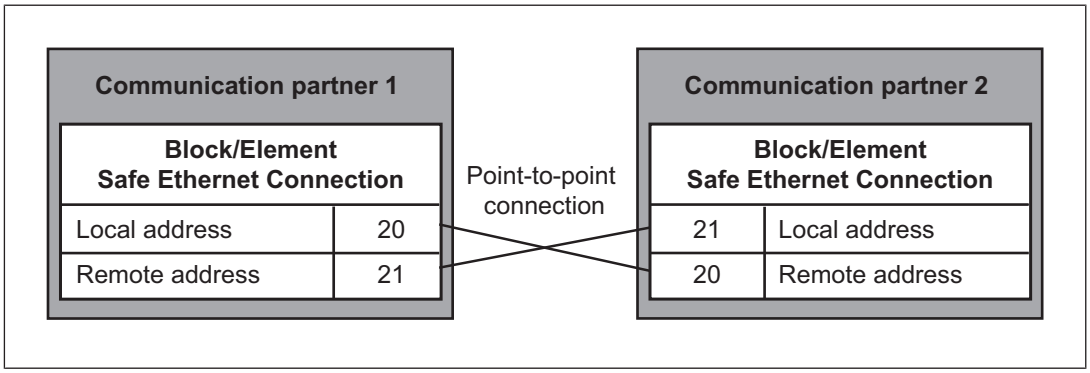


Fig.: Connection addresses on a point-to-point connection

Example 2: Connection addresses on multiple point-to-point connections with Safe Ethernet Connection

- Communication partner 1 maintains a point-to-point connection with each of the communication partners 2 and 3. A total of four different connection addresses are required for the two point-to-point connections. In the example, connection addresses 30 and 31 are to be used for point-to-point connection 1 and addresses 40 and 41 for point-to-point connection 2.
- Other potential connections in the network may no longer use connection addresses 30, 31, 40 and 41.

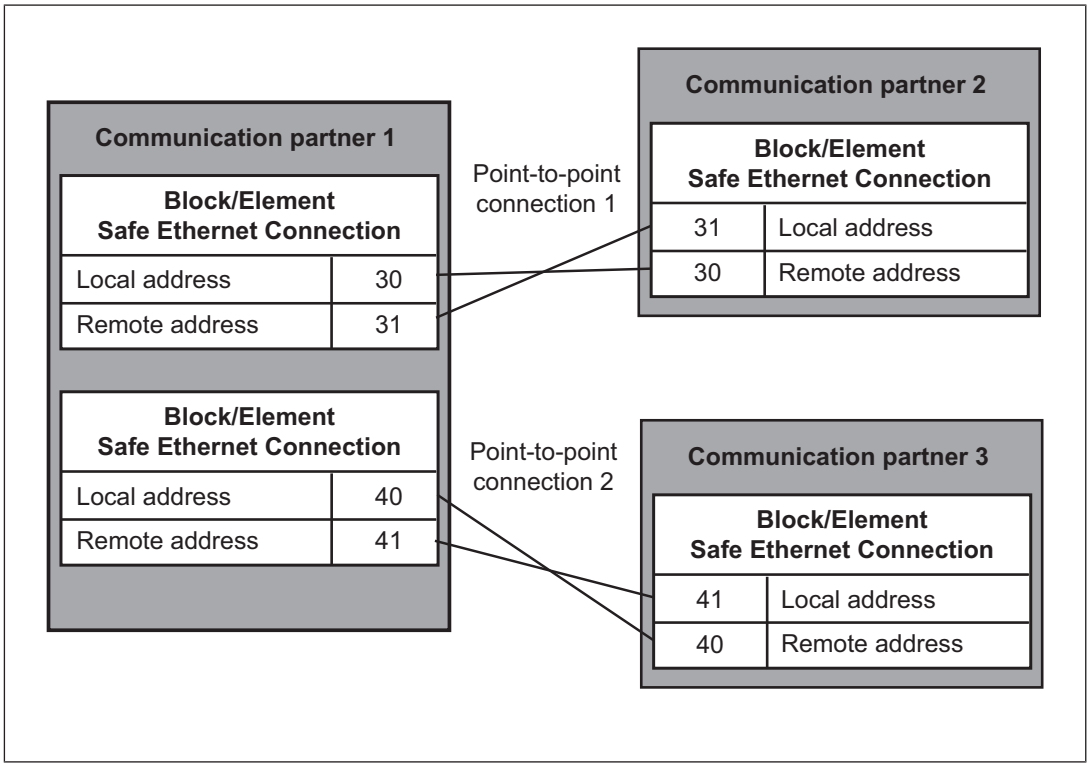


Fig.: Connection addresses on two point-to-point connections

Using the check list to check the connection addresses

As the multiple use of connection addresses cannot be avoided by technical measures, this must be achieved using organisational measures, implemented by the user.
The procedure is described using the example above.

- **Calculate the number of all block calls**

  For each individual device in the overall network, calculate the number of block calls with ***Safe Ethernet Connection 2***. We recommend using a table as shown in the following example:

Number of device	Number of block calls
1	2
2	1
3	1
4	-
Total number of block calls	**4**

Calculate connection addresses

Calculate the connection addresses for all point-to-point connections. You should also calculate how often a connection address has been configured. We recommend using a table as shown in the following example:

Connection address	Configuration as local address	Configuration as remote address
1 … 29	Unused	
30	I	I
31	I	I
32 … 39	Unused	
40	I	I
41	I	I
42 … 255	Unused	
Total number of configured connection addresses	**8**	

Complete check list

The following check list must be completed and the results documented:

Question	Yes	No
Have all devices in the network been recorded?	x	
Have all the block calls on all devices in the network been recorded?	x	
Does each configured connection address occur 1x only as a "local address"?	x	
Does each configured connection address occur 1x only as a "remote address"?	x	
Does the total number of block calls calculated from step 1 and the total number of configured connection addresses calculated from step 2 correspond to the following equation? (total number of configured connection addresses) = 2 x (total number of block calls)	x	

NOTICE

Note:
All questions in the check list must be answered with "Yes". If you **cannot** answer "Yes" to one of the questions, the relevant situation must be rectified. Then repeat all the steps documented here.

Check list template

As the multiple use of connection addresses cannot be avoided by technical measures, this must be achieved using organisational measures, implemented by the user.

Follow the instructions below:

- **Calculate the number of all block calls**

  For each individual device in the overall network, calculate the number of block calls with ***Safe Ethernet Connection 2***. We recommend using a table as shown in the following example:

Number of device	Number of block calls
Total number of block calls	

- **Calculate connection addresses**

  Calculate the connection addresses for all point-to-point connections. You should also calculate how often a connection address has been configured. We recommend using a table as shown in the following example:

Connection address	Configuration as local address	Configuration as remote address
Total number of configured connection addresses		

- **Complete check list**

  The following check list must be completed and the results documented:

Question	Yes	No
Have all devices in the network been recorded?	☐	☐
Have all the block calls on all devices in the network been recorded?	☐	☐
Does each configured connection address occur 1x only as a "local address"?	☐	☐
Does each configured connection address occur 1x only as a "remote address"?	☐	☐
Does the total number of block calls calculated from step 1 and the total number of configured connection addresses calculated from step 2 correspond to the following equation? (total number of configured connection addresses) = 2 x (total number of block calls)	☐	☐

Date ……..……	Signature ……

NOTICE

Note:
All questions in the check list must be answered with "Yes". If you **cannot** answer "Yes" to one of the questions, the relevant situation must be rectified. Then repeat all the steps documented here.

8 Cascading PNOZ m C0

8.1 Overview

The cascading function enables base units PNOZ m C0 to be networked with each other and with safety relays PNOZelog and base units PNOZmulti Classic.

8.2 System requirements

PNOZmulti Configurator: from Version 11.7.0

PNOZ m C0 from Hardware Version:02, Firmware:01.02

Please contact Pilz if you have an older version.

8.3 Function description

PNOZ m C0 base units can be networked together by cascading. Safe inputs i2 ... i7 can be configured to evaluate the cascading signal. The safety outputs o0 ... o3 can be configured to output the cascading signal.

Several base units PNOZ m C0 or compatible safety relays can be connected to an output with cascading signal belonging to the base unit PNOZ m C0 in order to evaluate the cascading signal.

- Cascading can be used to connect an emergency stop request or an enable signal across several devices within an overall application.
- PNOZ m C0 base units, PNOZmulti Classic base units and PNOZelog safety relays can be integrated into the network.
- A safety output with cascaded enable signal can be used in parallel to control an actuator.
- When the devices are networked, the switch-on and switch-off delay times of the individual devices are added together (see technical details of the networked devices).
- If necessary, a reset lock must be provided on each cascaded unit.
- Max. Number of downstream safety relays per cascading output:
  - 50 without parallel controlled actuator
  - 4 with parallel controlled actuator

WARNING!

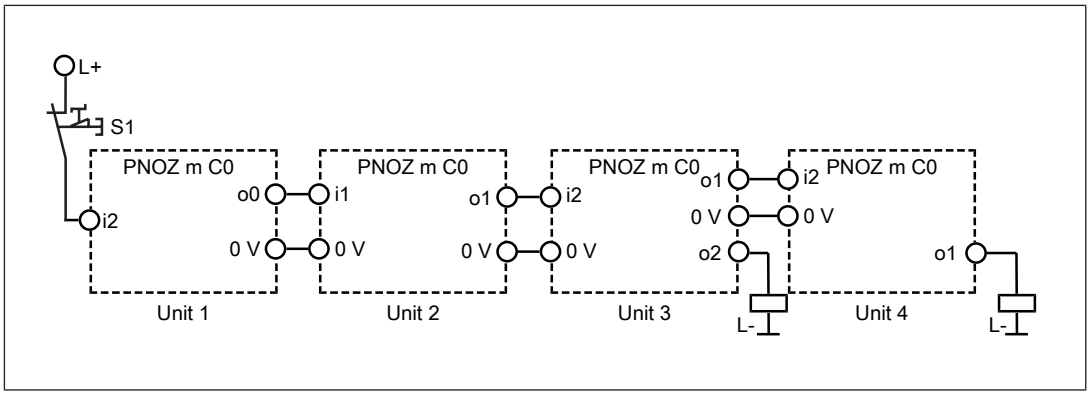
Hazard due to loss of the safety function

When cascading safety relays, the inputs for cascading must be tested for correct error response each time the configuration is changed and the results logged.
The following tests must be carried out:

- Detection of a cross-circuit of the cascading signal at the input against 24 V
- Detection of a wire break of the cascading signal at the input

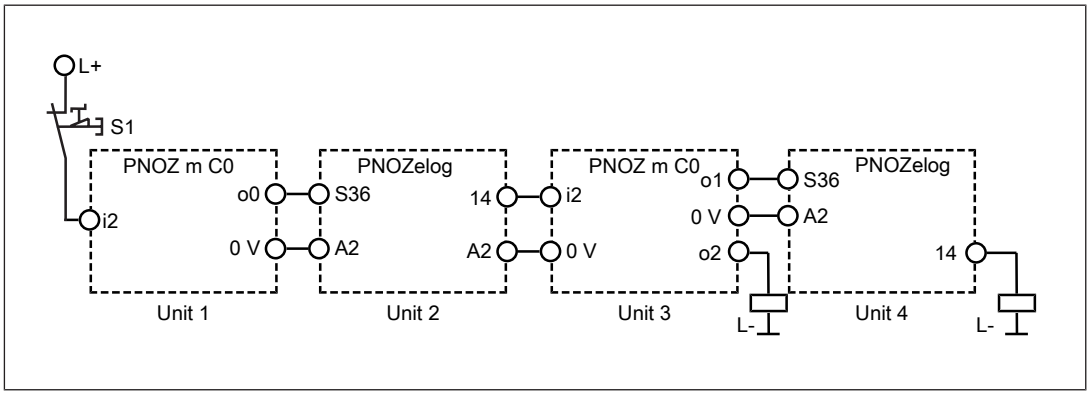
Example delay time:

- Delay input i2 – cascading output o0 Unit 1: 29 ms
- Delay input i2 – cascading output o1 Unit 2: 20 ms + 20 ms
- Delay input i2 – semiconductor output o1 Unit 3: 20 ms + 20 ms + 20 ms
- Delay input i2 – semiconductor output o1 Unit 4: 20 ms + 20 ms + 20 ms + 20 ms



Incorporating PNOZelog units:

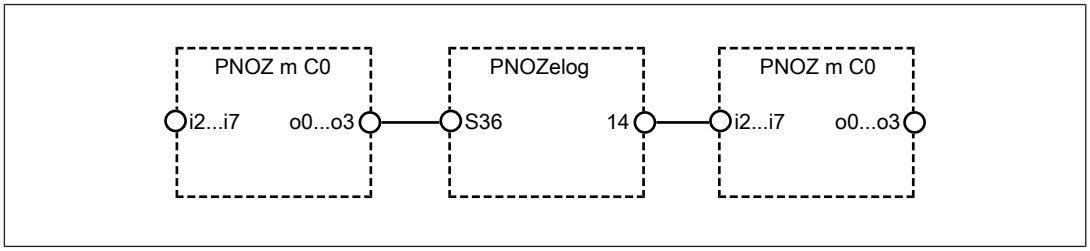
- PNOZelog units may also be included in the series connection. The delay times on the individual units are also added together with this type of cascading.
- Remember to consider the switch-on delay and any potential delay time for the outputs on the PNOZelog units (see operating manual PNOZelog).



8.4 Networking structures

Series connection

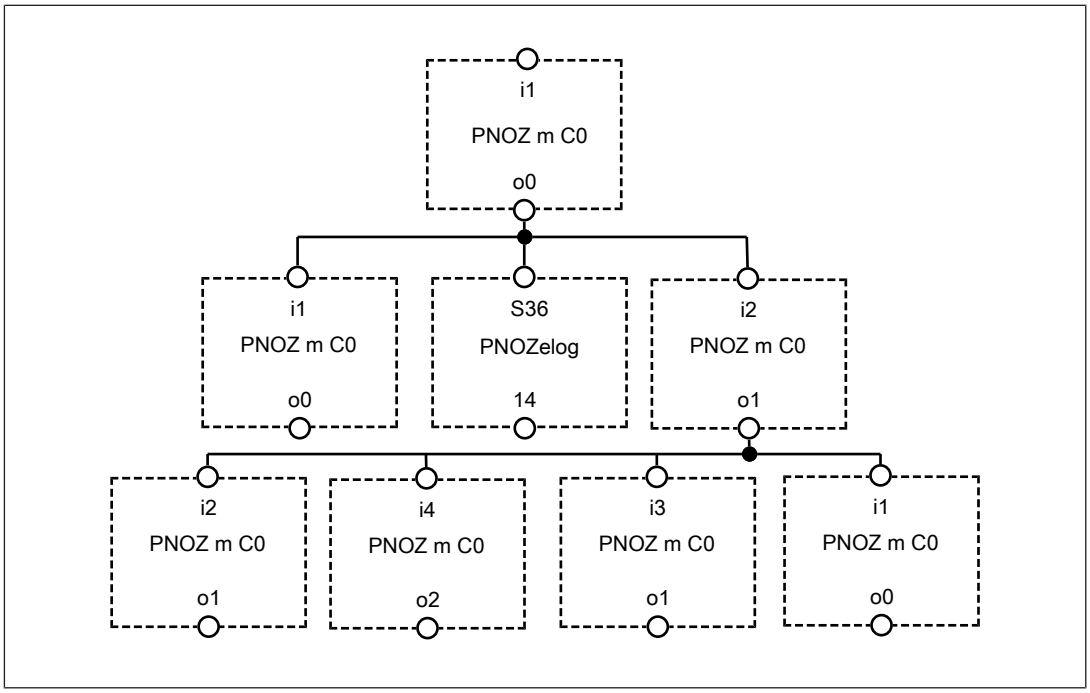
Any number of base units PNOZ m C0 and safety relays PNOZelog may be connected in series. The number of units connected in succession will depend only on the reaction time required by the application. As the delay times on the individual units are added together, the reaction time increases with each unit.



Tree structure

Tree structures may be designed with as many levels as necessary.

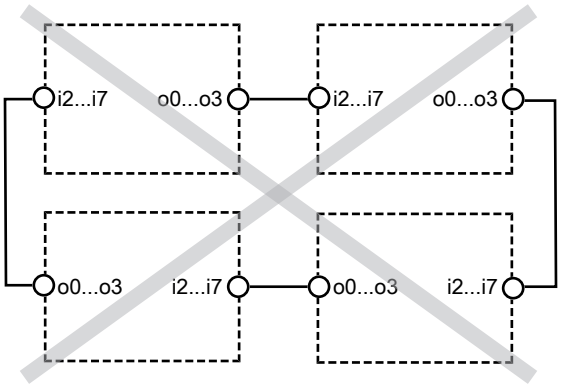
A maximum of 50 safety relays can be integrated in parallel on each level.



Ring structure

CAUTION!

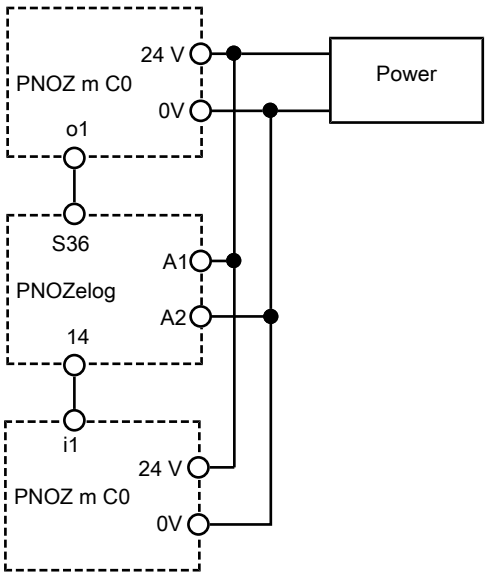
It is not permitted to connect devices in a ring-shaped structure.



8.5 Supply voltage for the cascaded units

NOTICE

All networked base units must be connected to a common 0 V supply. When cascading with a differential signal, GND of the device must be connected accordingly to CO- or CI- of the other safety relay.



8.6 Wiring

Please observe the following when wiring:

- Cable length between 2 PNOZmulti units: max. 100 m
- Cable materials: see technical details in the units' operating manual

WARNING!

Hazard due to loss of the safety function

When cascading safety relays, cross-circuiting of the cascading signals must be excluded by using separate sheathed cables or other measures.

Support

Technical support is available from Pilz round the clock.

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