PSS 4000 Safety Gate with PSENmech (me2) PASmulti

pilz

Product

Type:	FS_SafetyGate, FS_OutputFBL
Name:	PSS 4000, Blocks, PAS4000, PLC, PASmulti
Manufacturer:	Pilz GmbH & Co. KG, Safe Automation

Document

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the spirit of safety

Document Revision History

Release	Date	Changes	Chapter
01	2011-07-27	Creation	all
02	2012-04-23	Revision of the Application Note	all

Exclusion of liability

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However, we cannot accept liability for the accuracy and entirety of the information provided, except in the case of gross negligence. In particular it should be noted that statements do not have the legal quality of assurances or assured properties.
We are grateful for any feedback on the contents.

April 2012

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Contents

Abbreviations

PAS	**P**ilz **A**utomation **S**uite (software platform)
PSS	Programmable Control System (DE: **P**rogrammierbares **S**teuerungs**s**ystem)
PNOZ	Pilz E-STOP Positive-Guided (DE: **P**ilz **NO**T-AUS-**Z**wangsgeführt)
POU	**P**rogram **O**rganisation **U**nit
PRG	**Pr**o**g**ram
FB	**F**unction **B**lock
FUN	**Fun**ction
MB	**M**ulti **B**lock
CB	**C**omponent **B**lock
BB	**B**asic **B**lock
PI	**P**rocess **I**mage
PIP	**PI P**oint

1. Useful documentation

Reading the documentation listed below is necessary for understanding this application note. The availability of the indicated tools and safe handling are also presupposed with the user.

1.1. Documentation from Pilz GmbH & Co. KG

No.	Description	Item No.
1	Pilz international homepage, download section	www.pilz.com
2	Operating ManualPSSu H PLC1 FS SN SD	21939-EN-xx
3	Operating Manual PSSu E F 4DI	21 311-xx
4	Operating Manual PSSu E F DI OZ 2	21 329-xx
5	Operating Manual PSSu E F 4DO 0.5	21 317-xx
6	Operating Manual PSSu E S 4DI	21 340-EN-xx
7	Operating Manual PSSu E S 4DO 0.5	21 346-EN-xx
8	System Description Programmable safety and control system PSS 4000	1001467-EN-xx
9	Safety Manual Programmable safety and control system PSS 4000	1001468-EN-xx
10	PAS4000 online help	-
11	Operating Manual PSEN me2S/2AS	0800000423_en

1.2. Documentation from other sources of information

No.	Description	Item No.
1		
2		

Note
The present example (PSS 4000 Safety Gate with PSENmech) is also available in the programming languages Instruction list and Structured text.

2. Hardware configuration

2.1. Pilz products

No.	Description	Order number	Version	Number
1	PSSu H PLC1 FS SN SD	312 070	001	1
2	PSSu E F 4DI	312 200	-	1
3	PSSu E F DI OZ 2	312 220	-	1
4	PSSu E F 4DO 0.5	312 210	-	2
5	PSSu E S 4DI	312 400	-	1
6	PSSu E S 4DO 0.5	312 405	-	1
7	PSSu BP 1/8 C	312 601	-	6
8	PSENme 2S/2AS	570 200	-	2
9	PAS4000	-	v1.5.0	1

2.2. Hardware configuration

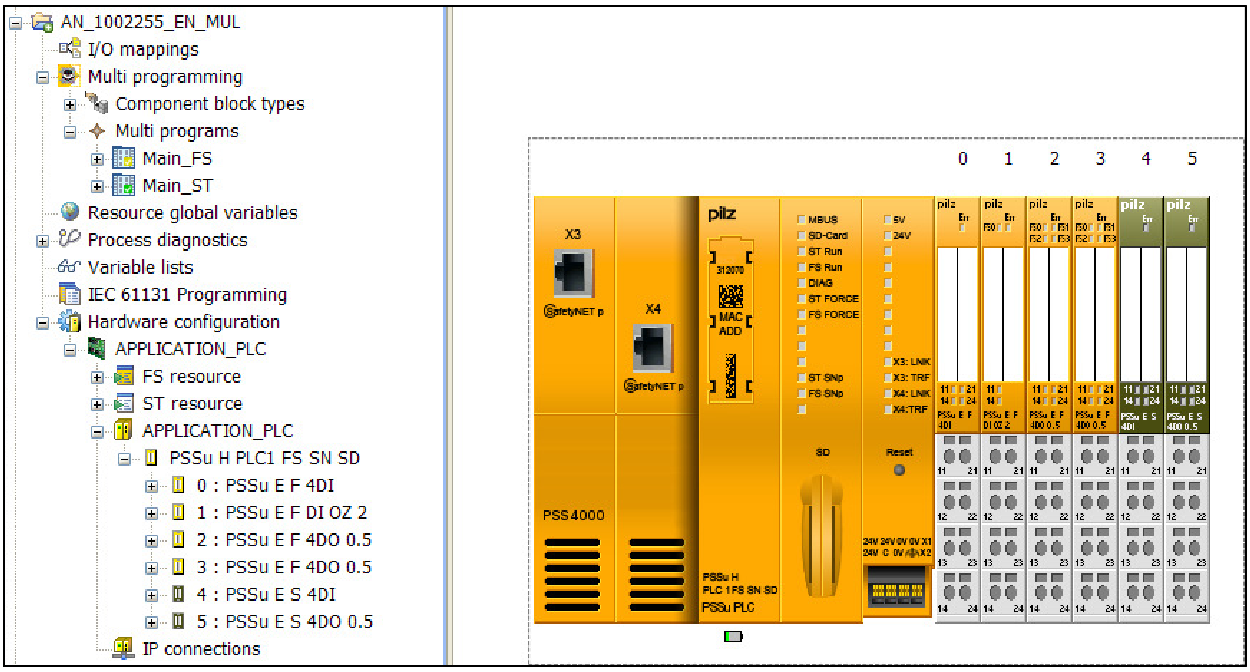


Fig. 1: Hardware configuration

3. Application Task

3.1. Description

The example shows the implementation of a safety gate application with a PSS 4000 PLC.
The safe control and evaluation of the signals is taken over by two Pilz Function blocks (FS-FB) from the library.

- FS_SafetyGate
  CRC ADDB

- FS_OutputFBL
  CRC B3A7

The workflow is divided into the following two main functions:
- Safety Gate and
- Feedback Loop Monitoring

3.1.1. Safety gate monitoring function

The control system monitors the two safety gate switches (S1, S2) via the user program.
An instance of the Pilz function block "FS_SafetyGate" is assigned to them. This FS-FB detects whether the assigned safety gate switch has been operated, as well as detecting incorrect input signals and whether the contact synchronization time has been exceeded, etc.

If the safety gate switches are operated or an error occurs, the enable output "Enable" on the FS-FB will immediately be reset.
The enable output "Enable" is also reset when the PSS is stopped and when the PSS is switched on. The signal from the enable output "Enable" must be evaluated by the user program and trigger an appropriate reaction.

Based on the diagnostic outputs ("DiagSwitchError", "DiagInputNotValid") it can be determined why "Enable" was reset.
The outputs "DiagOperated", "DiagReadyForReset" and "DiagReadyForTest" are used as status messages.

A "valid bit" is formed by the system for the respective hardware input to determine whether a process value received from a sensor is valid.
The valid bit is queried in the Function block and indicates whether an error has occurred in the signal transmission between hardware input and processor (such as test clock error, module overheats, etc.).
If the valid bit is FALSE, the process value is invalid and the Pilz function block provides an appropriate diagnostic message. The error signal reset enable.
(For more information, see "Validity process data" in PAS4000 *online help*)

The way in which the error is reset will depend on the operating mode set on the FS-FB.
In this application example, parameters for FS-FB have been set in such a way that "Reset" (S3) is required in order to reset output parameter "Enable" when:

- the PSS is cold started (PSS switched from off to on),
- warm started (PSS transferring from STOP to RUN) or
- when the safety gate switches are released.

Although the safety gate functions are configured to reset themselves, a PSS cold start or the closing of the safety gate may not directly enable a machine to start up without further conditions being met.

Input circuit safety assessment

- If a contact on the safety gate switch is overridden, the Pilz function block will detect this as an error at the next operation.
- A short between the input circuits within a multicore cable will be detected as an error by the programmable control system.
- A short between 24 VDC and an input circuit will be detected as an error by the programmable control system.
- The highest category can only be achieved when the contacts on the safety gate switch are supplied with test pulses and the contacts on the safety gate switch have dual-channel wiring.
- If an operator completely (or even maybe partly) is able to access the dangerous area, a risk analysis should clarify whether an additional, separate "manual reset function" is required.

3.1.2. Feedback loop monitoring function

The control system monitors the feedback circuits (NC contacts) of the motor contactors KM1 and KM2 via the user program.
An instance of the Pilz function block “FS_OutputFBL” is assigned to them.
The FS_FB drives the contactors as well as monitoring the feedback loop.
A 1-signal at input parameter “Input” of the FS-FB sets the outputs that drive the contactors, “Output1” and “Output2”, to “1”; a 0-signal sets it to “0”.
If an error occurs, the outputs “Output1” and “Output2” that drive the contactors on FS-FB will immediately be reset. Both outputs are also reset when the PSS is stopped and when the PSS is switched on.

Based on the diagnostic outputs (“DiagFeedbackLoopError”, “DiagFeedbackLoopNotValid”) it can be determined why the outputs were reset.

A “valid bit” is formed by the system for the respective hardware input to determine whether a process value received from a sensor is valid.
The valid bit is queried in the Function block and indicates whether an error has occurred in the signal transmission between hardware input and processor (such as test clock error, module overheats, etc.).
If the valid bit is FALSE, the process value is invalid and the Pilz function block provides an appropriate diagnostic message. The error signal reset enable.
(For more information, see “Validity process data” in PAS4000 *online help*)

If an error occurs, a new activity has to take place at the input “Input” of the FS-FB once the error has been rectified, so that the outputs “Output1” and “Output2” will be set again.

Feedback loop monitoring safety assessment

- A short between 24 VDC and a safety output or a feedback loop input will be detected as an error by the programmable safety system. The load can be switched off via the second shutdown route.
- The feedback loop contacts must be installed in a single mounting area (control cabinet).
- To achieve a higher level of safety, 2 actuators must be used.

3.2. Functional safety

3.2.1. Safety-related characteristics in accordance with EN ISO 13849-1

No.	Safety function	PL	Safety-related parts of the control system
1	Machine shut down when a safety gate is opened	PL e	Sensor (PSEN me 2S/2AS S1, S2) Input (PSSu E F 4DI) Logic (PSSu H PLC1 FS SN) Output (PSSu E F DI OZ 2) Actuator (contactors KM1, KM2)

Prerequisites

No.	Description		Identification
1	Common cause failure (CCF)		Requirements are considered to be met (must be tested on implementation)
2	Mission time		20 years
3	Operating interval (electromechanical components)	Sensor	two operations per hour
		Actuator	two operations per hour
4	Characteristic data of contactors KM1/KM2	B10d	2,000,000

Please note the further requirements of EN ISO 13849-1, e.g. requirements for avoiding systematic faults.

3.2.2. Safety-related characteristics in accordance with EN 62061

No.	Safety-related control function (SFCF)	Safety Integrity Level	Subsystems
1	Machine shut down when a safety gate is opened	SIL 3	Sensor (PSEN me 2S/2AS S1, S2) Input (PSSu E F 4DI) Logic (PSSu H PLC1 FS SN) Output (PSSu E F DI OZ 2) Actuator (contactors KM1, KM2)

Prerequisites

No.	Description		Identification
1	Common cause failure (CCF)		ß = 2% (must be tested on implementation)
2	Proof test interval		20 years
3	Operating interval (electromechanical components)	Sensor	two operations per hour
		Actuator	two operations per hour
4	Characteristic data of contactors KM1/KM2	B10d	2,000,000
		Dangerous failure rate	65%

Please note the further requirements of EN 62061, e.g. requirements for systematic safety integrity.

3.3. PAS-Project

To operate a plant with one or more programmable control systems PSS 4000, a project must be created in PAS4000.
A project consists of the hardware configuration and the user program.

3.3.1. Multi Programming

Multi programming is performed in accordance with the component model in the graphics Multi Editor. Three types of blocks are available for structuring the user program.

- Multi program
  A Multi program is used exclusively to structure the user program. Multi blocks can be called up in a Multi program. Multi blocks are component blocks and basic blocks.
- Component block (CB)
  Component blocks are used to combine multi blocks. Several separate sub-solutions for automation functions can be combined in this way. Component blocks can be used to reproduce plant and machine structures. Component blocks are self-contained units, which can be easily reused.
- Basic block (BB)
  Basic blocks are used to implement any complex automation solutions.

(For more information about programming with PAS4000, look at PAS4000 online help)

3.3.1.1. PASmulti-Editor

The program for the cyclic process is created in a “Multi Program”.
The assignment of inputs and outputs is implemented within a component block. For the creation of a component block, there are different ways, one of which is shown below exemplary.

Create empty CB in an other block
Drag the element “Empty component block” from the Palette in an existing component block or a multi program.

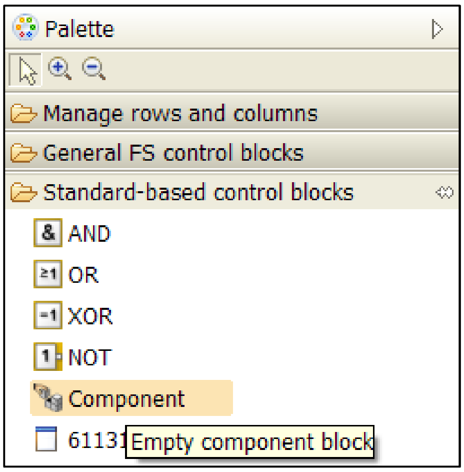


Fig. 2: Create empty component block

The window for entering the required data is opened.
Enter at least a type name and an instance name.

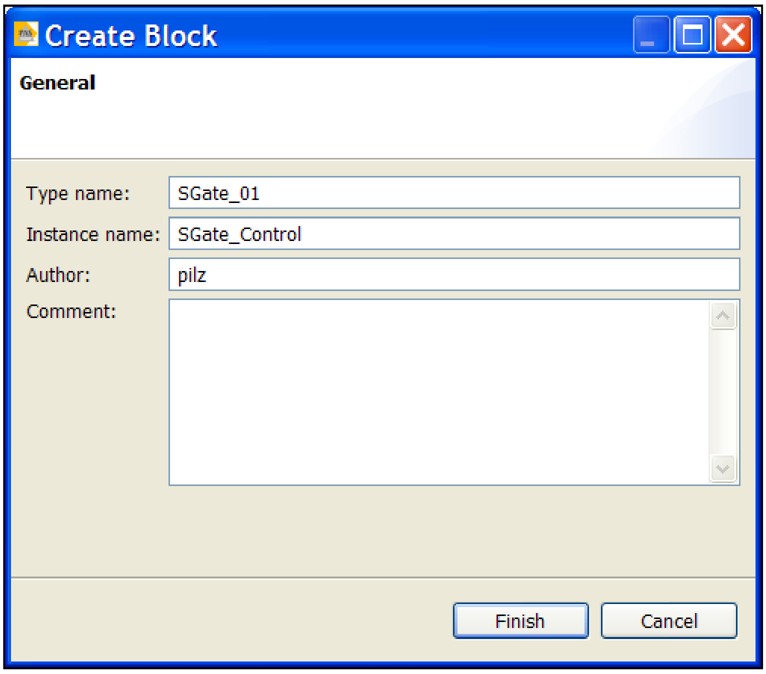


Fig. 3: Create block

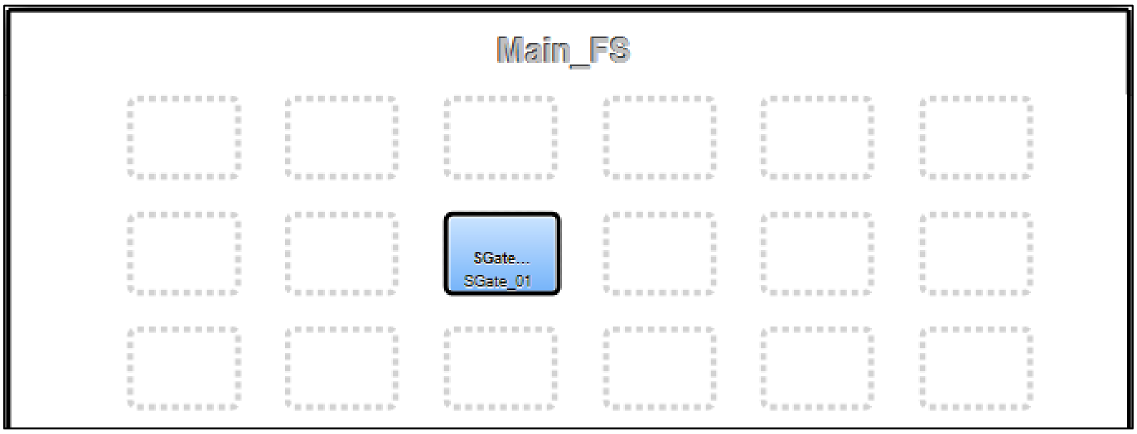


Fig. 4: Program Component block

With a double click on the created component one enters into the component block.

Within the component block, the PI points are linked with the inputs and outputs. The instances of the Pilz function blocks (basic blocks) for safety gate and feedback loop are added with drag and drop from the palette (library).

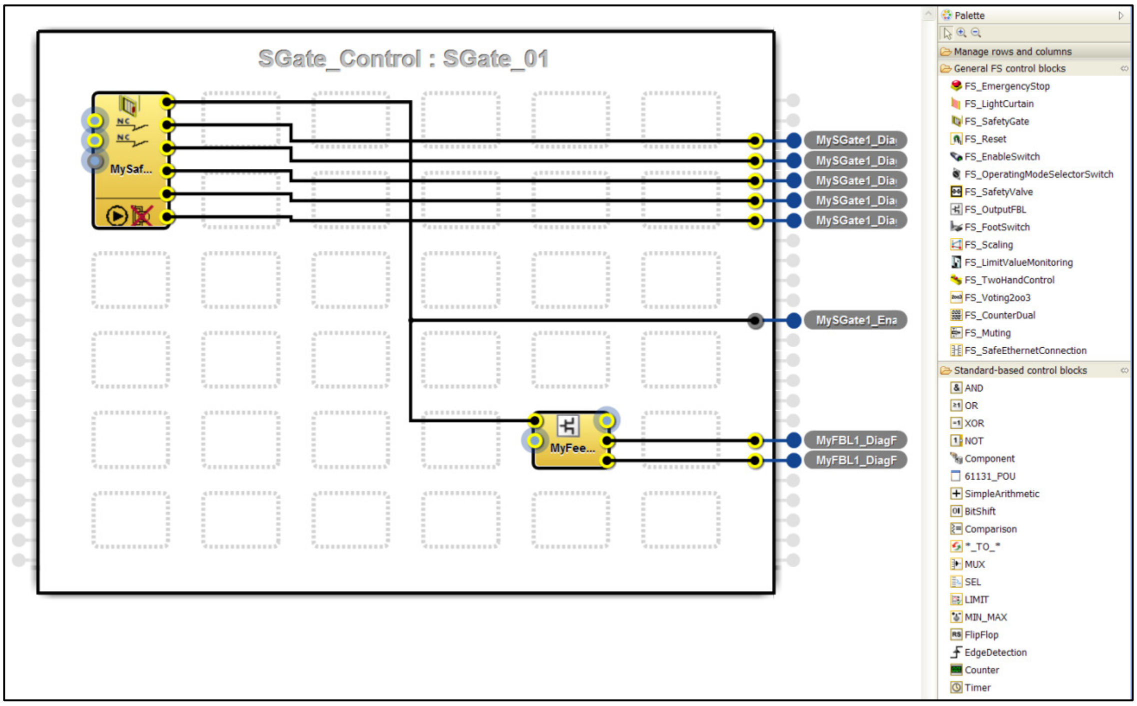


Fig. 5: Element selection

With a right click on an interface point in the point rail, the point type can be selected.
The connection from the component block to the program can realised by PI points (PIP).

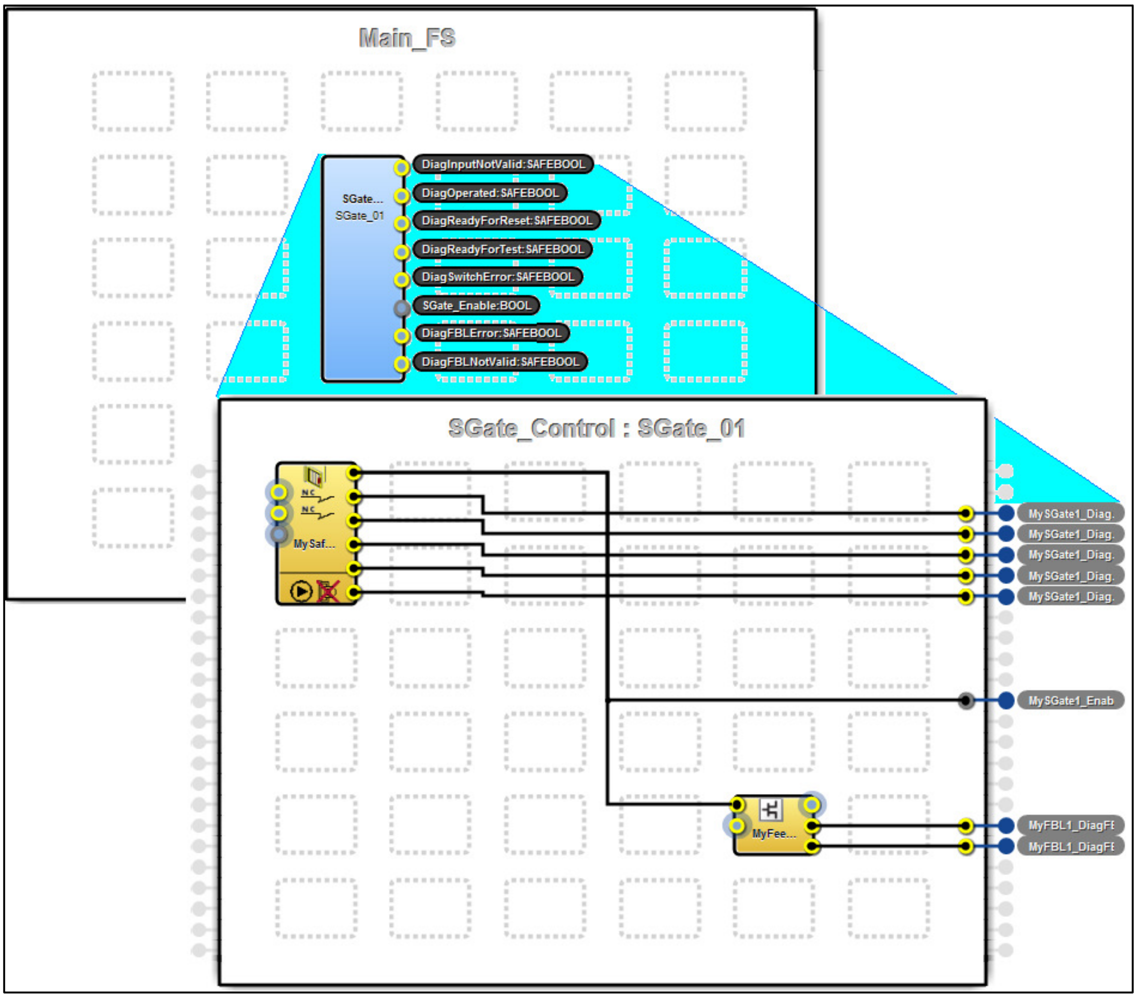
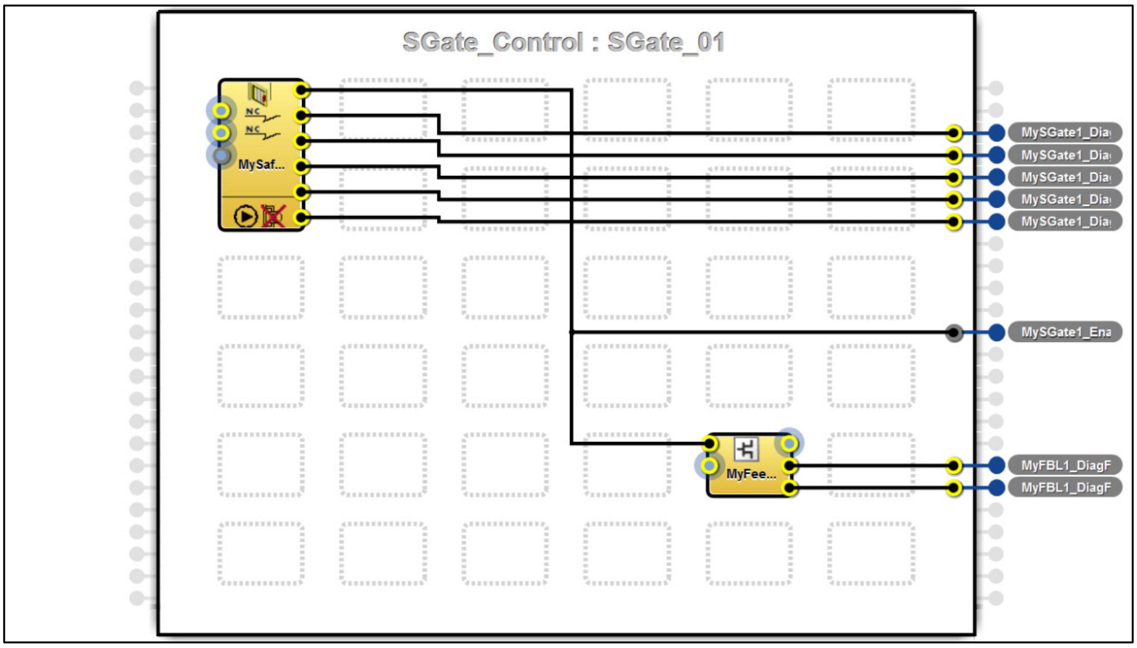


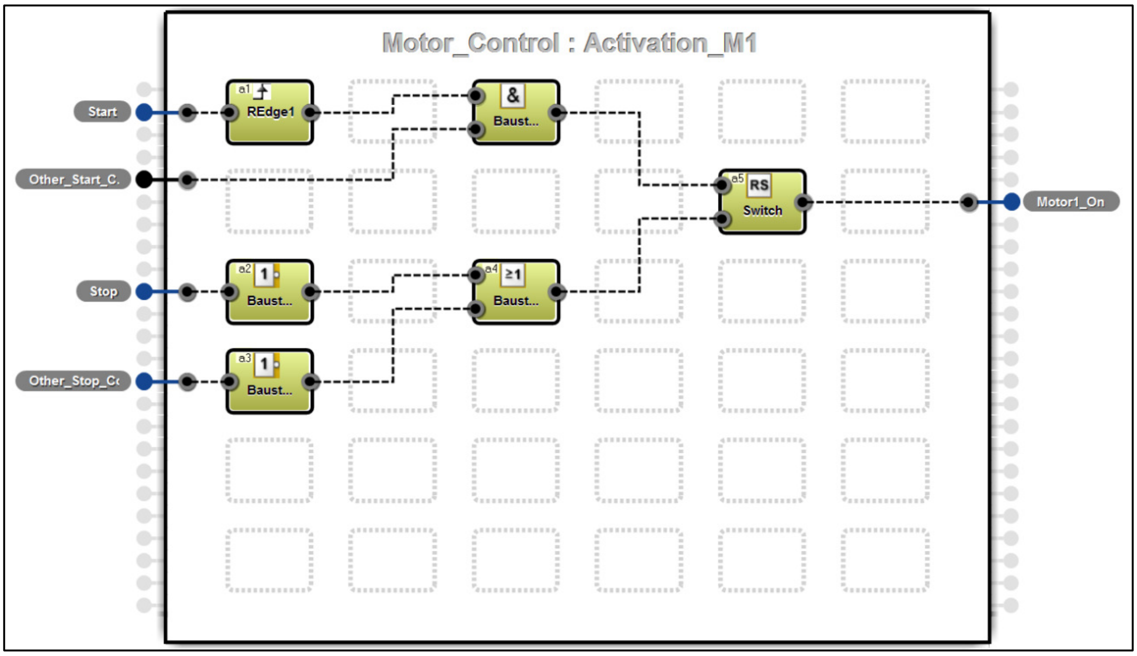
Fig. 6: Layer perspective

Failsafe program



Standard program

The signals from the start- and stop switch are imported from a standard module PSSu E S 4DI (1A4). These signals belong to the motor control and thus to the standard control functions of the machine.
The program code for the evaluation and processing of these signals is not processed within the FS resource (safety-related part) of the control, but in a ST resource in a separate task as independent application (additional Multi Program).



3.3.2. I/O Mapping

In PAS4000, variables can be created and the user program can be programmed without the need of the mapping to the hardware being present at the beginning of the project.
After identification of the used I/O from the variable declaration, the required hardware can be determined.
The I/O mapping editor forms the connecting between the user program and the hardware and coordinates the available I/O and existing PI-variables.

3.3.2.1. I/O Mapping Editor

The PI variables declared in the user-program can be assigned in the I/O mapping editor to the hardware configuration.

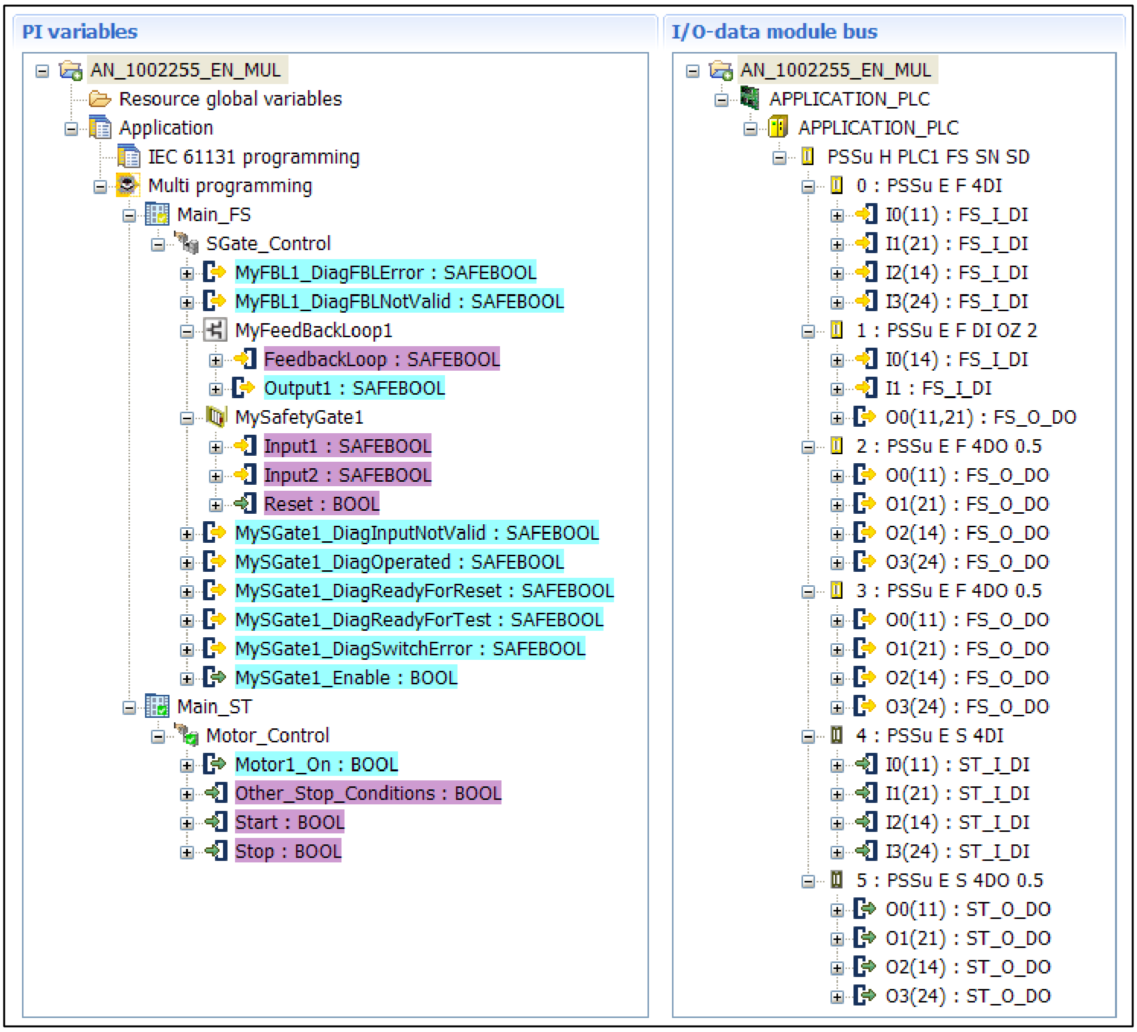


Fig. 7: Mapping Editor – Multi program

3.3.3. Process PAS Project

- Step 1: In the Multi editor, PI variables and the logical sequence will be generated as a program.

Fig. 8: PI variables

- Step 2: The design of the hardware (control, I/O, sensor, actor) will created as a circuit diagram. (parallel possible to Step 1)

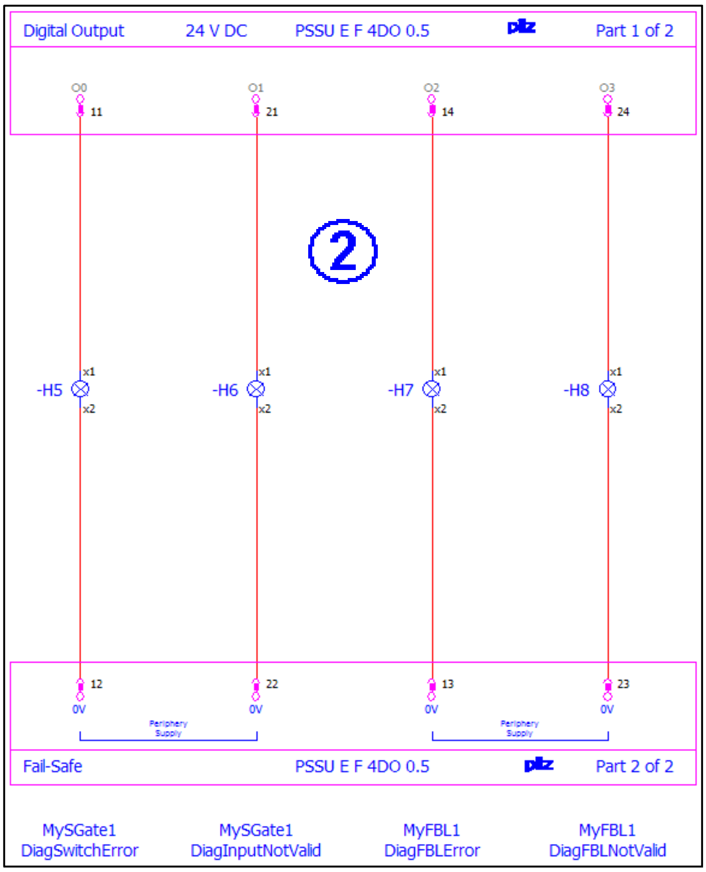


Fig. 9: Circuit diagram (extract)

- Step 3: Based on the PI variables (I/O), the required power of control (PLC, Multi) is selected. The implementation of the I/O modules in the PAS system occurs in the PSSu module editor.

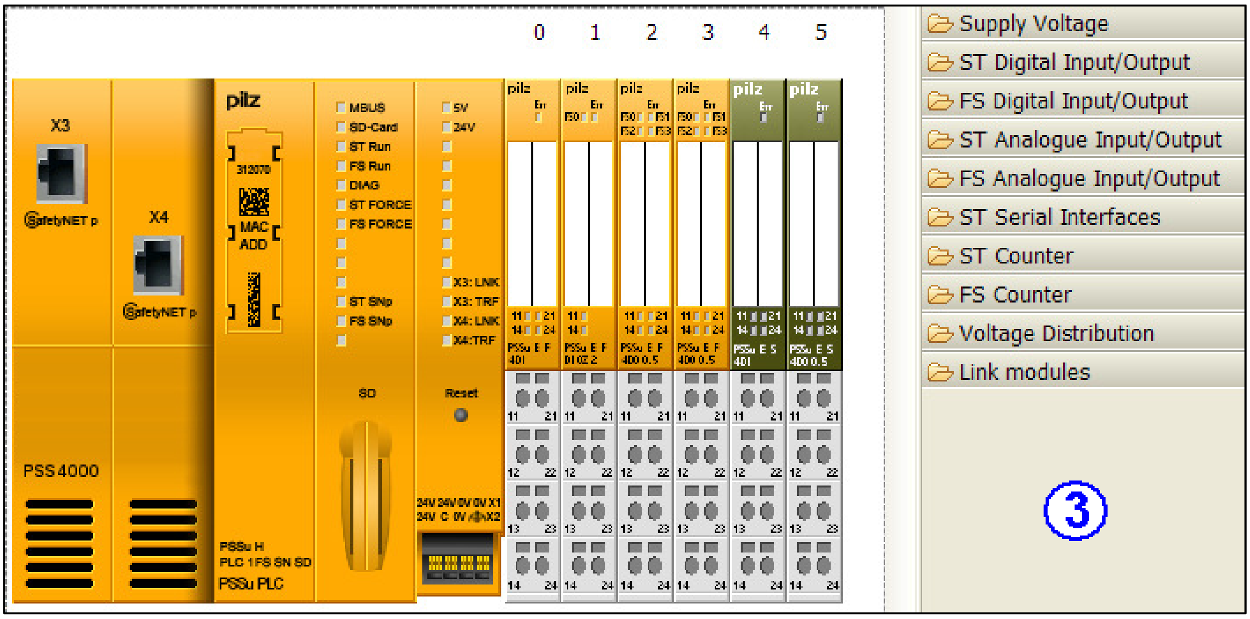


Fig. 10: PSSu Module Editor

- Step 4: Assignment of the PI variables in the I/O Mapping Editor.

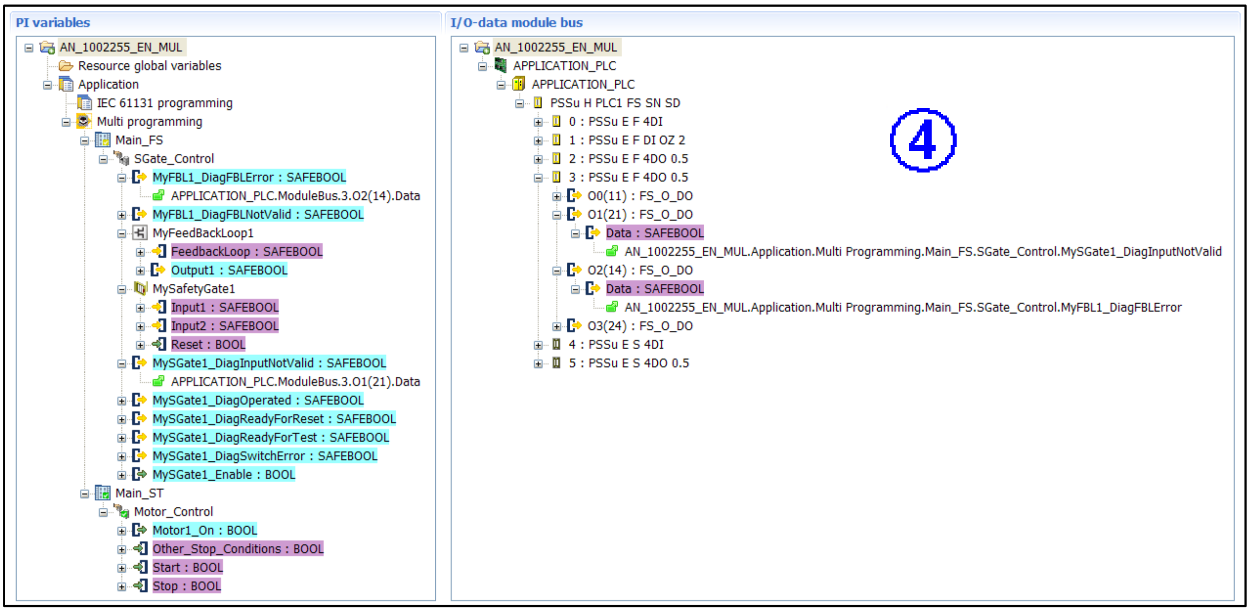


Fig. 11: I/O Mapping Editor

- Overview process PAS Project (Steps 1-4)

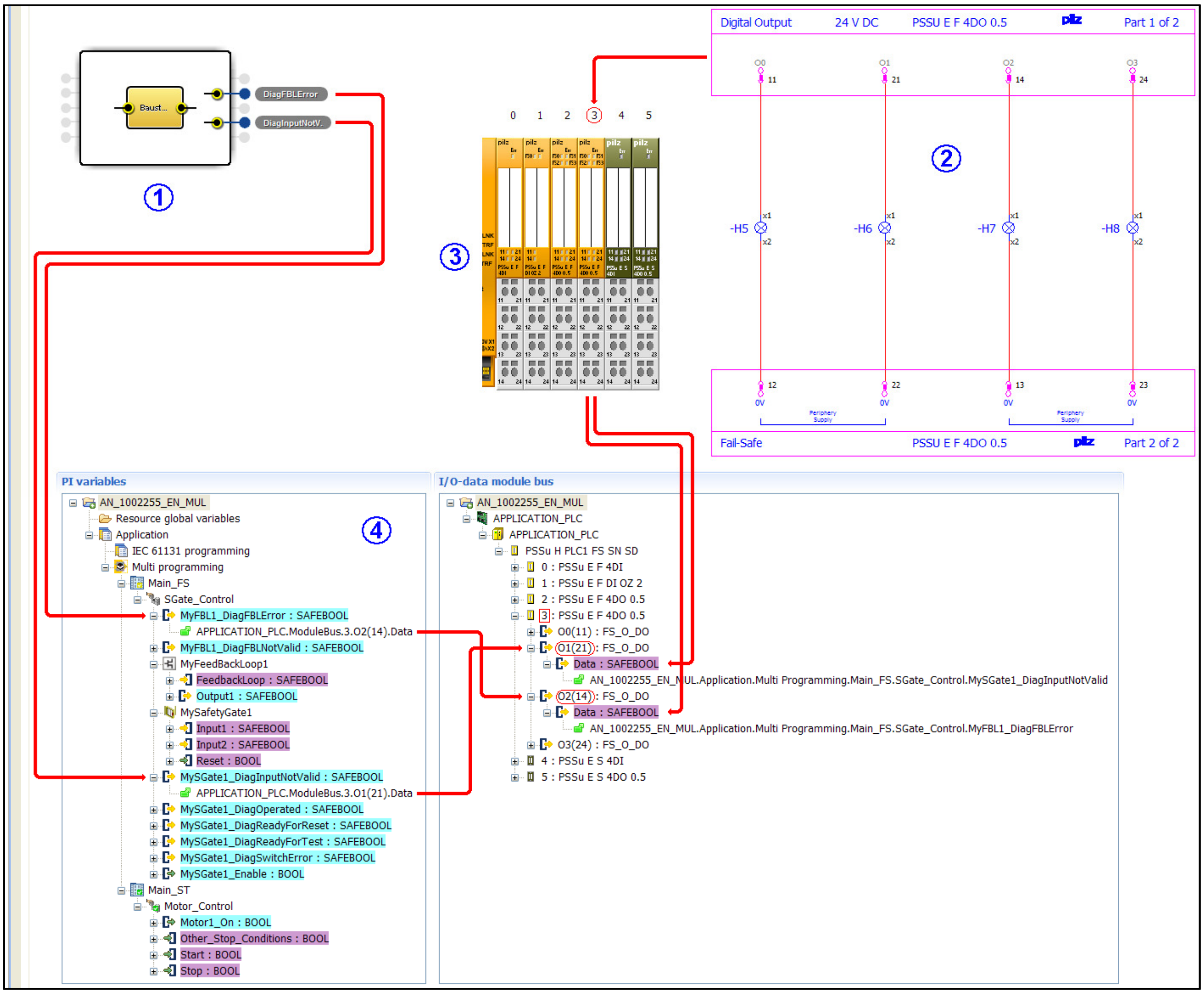
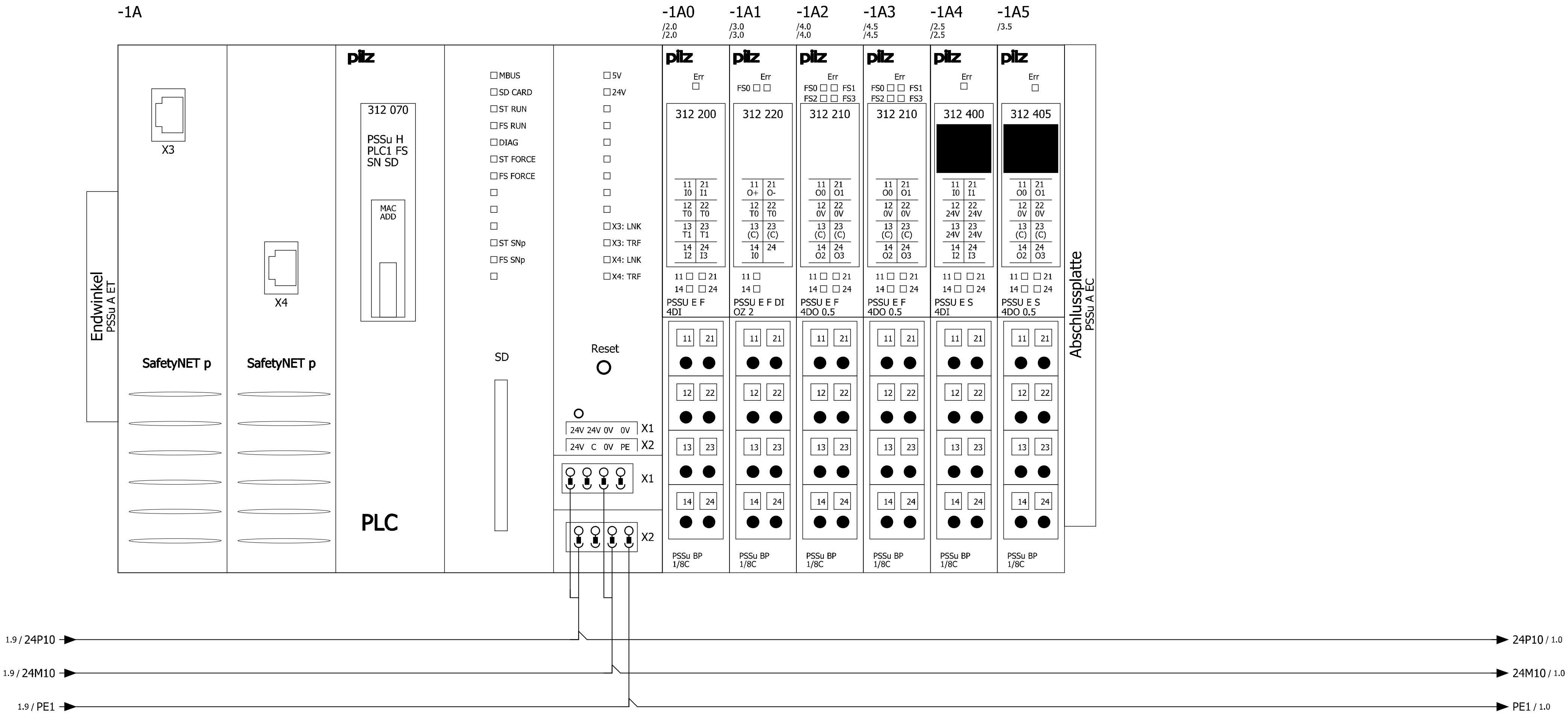


Fig. 12: Process PAS Project



PSSu E F 4DI
312 200

PSSu E S 4DI 0.5
312 400

PSSu E S 4DI 0.5
312 400

PSSu E F DI OZ 2
312 220

PSSu E S 4DO 0.5
312 405

PSSu E S 4DO 0.5
312 405

PSSu BP 1/8C
312 601

PSSu BP 1/8C
312 601

PSSu BP 1/8C
312 601

PSSu BP 1/8C
312 601

PSSu BP 1/8C
312 601

PSSu BP 1/8C
312 601

Revision	08.03.2012	Date	19.01.2005	EN ISO 13849-1:2006 PL e	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	PSS 4000 - Safety Gate with PSENmech	Mounting place + AN_1002024_02
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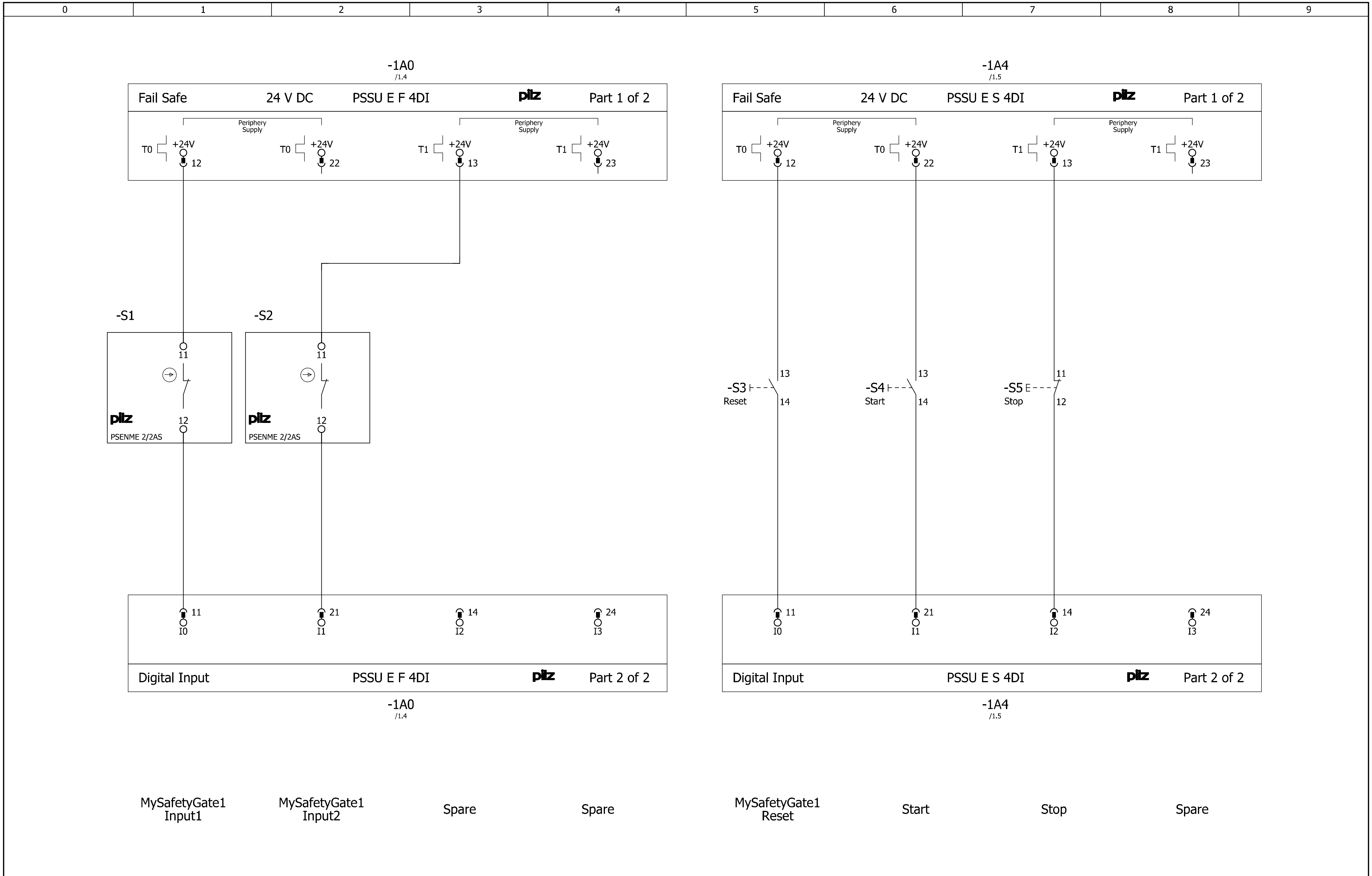
				EN 62061:2005 SIL 3		Power supply PSS 4000	Page: 1 / 4
		Dep.	CS				



Revision	08.03.2012	Date	19.01.2005	EN ISO 13849-1:2006 PL e	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	PSS 4000 - Safety Gate with PSENmech	Mounting place + AN_1002024_02
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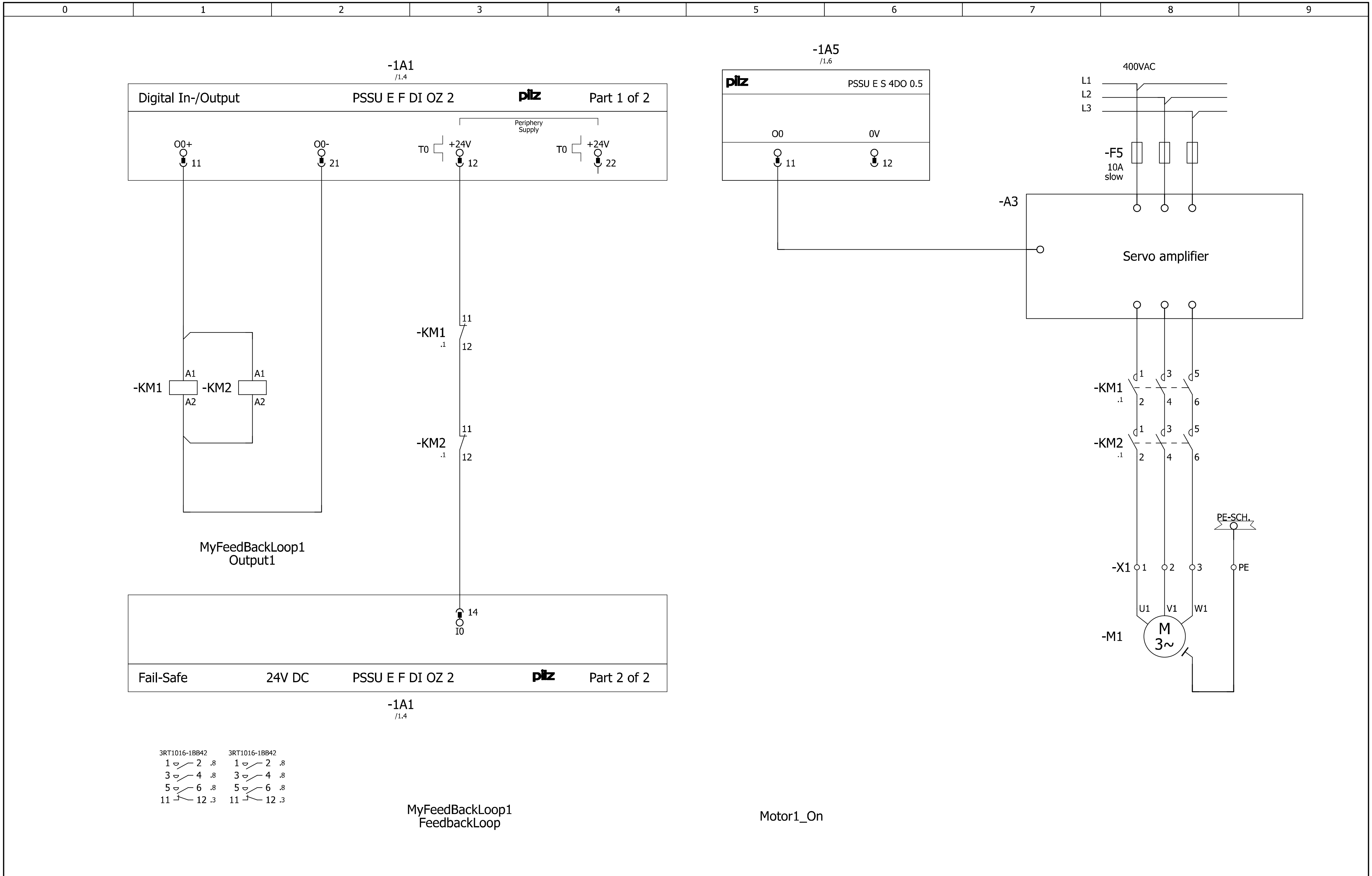
				EN 62061:2005 SIL 3		Inputs	Page: 2 / 4
		Dep.	CS				



Revision	08.03.2012	Date	19.01.2005	EN ISO 13849-1:2006	PL e	pilz Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	PSS 4000 - Safety Gate with PSENmech	Mounting place + AN_1002024_02
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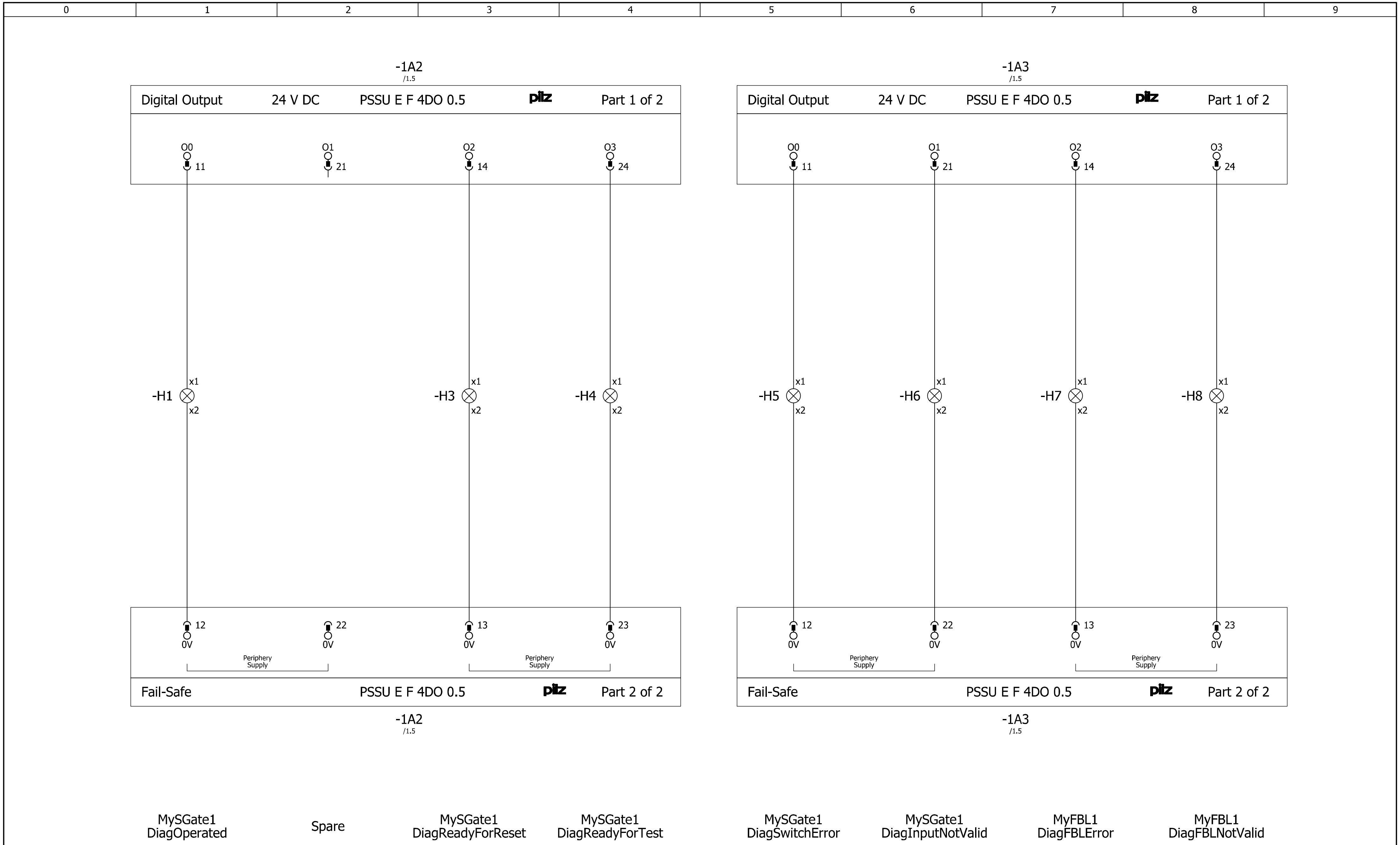
		Dep.	CS					



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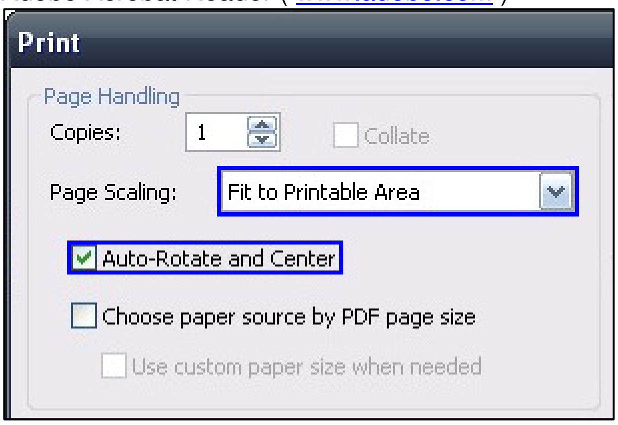
Name	RDS	Name	RDS					
		Dep.	CS	EN 62061:2005	SIL 3		Status/Error message	Page: 4 / 4

4. Table of figures

Recommended printer settings

Adobe Acrobat Reader (www.adobe.com)



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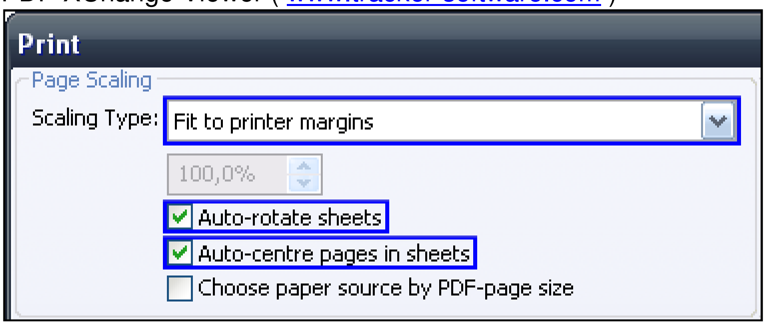

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Please refer to our homepage for further details or contact our headquarters.

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