PSS 4000 Light Curtain with PSENopt Instruction List

pilz

Product
Type: FS_LightCurtain, FS_OutputFBL
Name: PSS 4000, Blocks, PAS4000, PLC, IL
Manufacturer: Pilz GmbH & Co. KG, Safe Automation

Document
Release Number: 04
Release Date: 27 July 2011

Application Note - No. 1002025_EN_04

the spirit of safety

Document Revision History

Release	Date	Changes	Chapter
01	2010-04-08	Creation	all
02	2010-09-28	Adjustments for publication on Pilz website, New Function block library, Valid bit	only editorial 2 + 3
03	2010-12-10	Adjustments for publication on Pilz website	only editorial
04	2011-07-27	Revision for Pilz Automation Suite	all

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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.

July 2011

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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	**Pro**g**g**ram
FB	**F**unction **B**lock
FUN	**Fun**ction

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 Manual PSSu 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	System Description Programmable safety and control system PSS 4000	1001 467-EN-xx
7	Safety Manual Programmable safety and control system PSS 4000	1001 468-EN-xx
8	PAS4000 online help	-
9	Operating Manual PSEN op4F/H-s-.../1	1001 422-EN-xx

1.2. Documentation from other sources of information

No.	Description	Item No.
1		
2		

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	-	2
3	PSSu E F DI OZ 2	312 220	-	1
4	PSSu E F 4DO 0.5	312 210	-	2
5	PSSu BP 1/8 C	312 601	-	5
6	PSEN op4F-s-14-090/1	630 745	-	1
7	PAS4000	-	v1.3.2	1

2.2. Hardware configuration

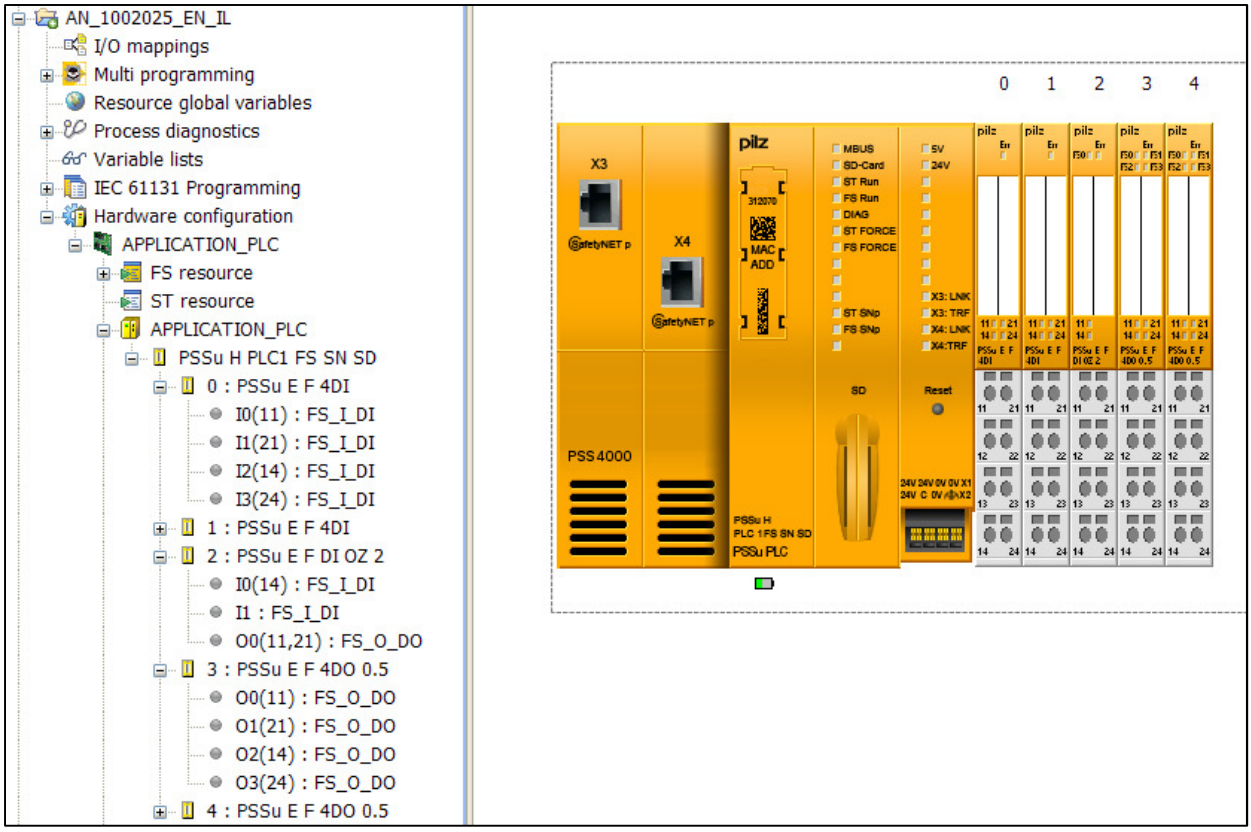


Fig. 1: Hardware configuration

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_LightCurtain
  CRC 5963

- FS_OutputFBL
  CRC B3A7

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

3.1.1. Light curtain monitoring function

The control system monitors the light curtain (B1, B2) via the user program.
An instance of the Pilz function block *“FS_LightCurtain”* is assigned to them. This FS-FB detects whether the assigned light curtain has been operated, as well as detecting incorrect input signals and whether the contact synchronization time has been exceeded, etc.

If the light curtain are interrupted 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 Funktion 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 light curtain are released.

Although the light curtain and the light curtain function are configured to reset themselves, a PSS cold start or the release of the light curtain may not directly enable a machine to start up without further conditions being met.

Input circuit safety assessment

- A short between 24 VDC and an input circuit on the PSSu module will be detected as an error by the AOPD; the AOPD outputs are shut down.
- A short between the input circuits on the PSSu module will be detected as an error by the AOPD; the AOPD outputs are shut down.

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 Funktion 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 the safety light curtain is interrupted	PL e	Sensor (PSEN op4F-s…/1 A1, A2) 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 the safety light curtain is interrupted	SIL 3	Sensor (PSEN op4F-s…/1 A1, A2) 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.

3.2.3. Classification in accordance with EN 954-1

Depending on the application area and its respective regulations, this connection example is suitable for applications up to Category 4 of EN 954-1.

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. IEC 61131 Programming

When programming in accordance with IEC 61131, the user program is structured by three types of program organisation units (POUs):

- Programs (PRG)
- Function blocks (FB)
- Functions (FUN)

The program forms the higher structural level. Functions and function blocks may be called up within a program.
Function blocks and functions undertake specific individual tasks within the program.

Each POU consists of a declaration part and an instruction part.

The variables and type declarations are made in the declaration part, which is shown in text format, irrespective of the programming language.

The instruction part contains the instructions. The instructions can be formulated in one of the IEC 61131 programming languages.

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

3.3.1.1. IL-Editor

The program for the cyclic process is created in a POU of the type “Program”.
The Pilz function blocks for emergency stop and feedback loop and the standardized function block of the rising edge monitoring (from IEC 61131-3) were added from the library. (Right-click in the declaration part of the POU “Add from library”)

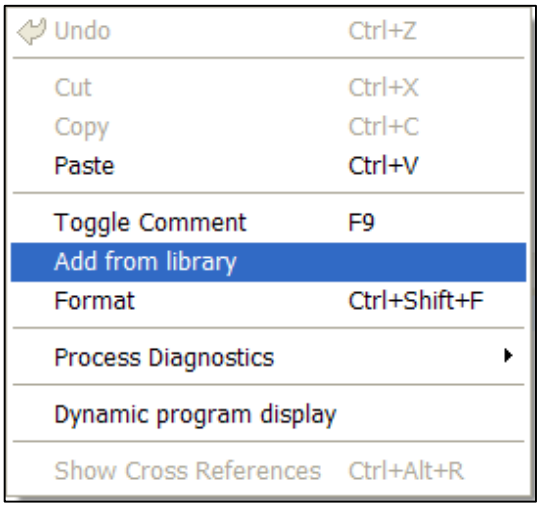


Fig. 2: Add from library

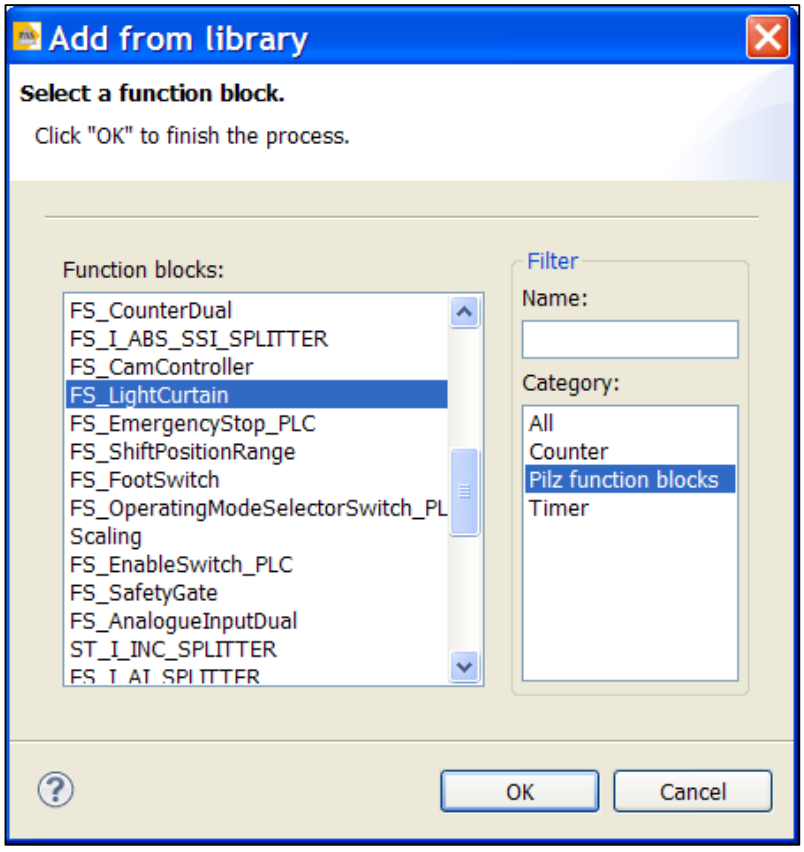


Fig. 3: Selection library

Declaration part

```
001 PROGRAM LCurt_01
002 VAR
003       MyLightCurtain1                    : FS_LightCurtain;
004       MyFeedBackLoop1                    : FS_OutputFBL;
005       MyRisingEdge1                      : R_TRIG;
006
007 // My LCurtain 1
008       MyLCurt1_Enable                    : SAFEBOOL;
009       MyLCurt1_DiagOperated       AT %Q* : SAFEBOOL;
010       MyLCurt1_DiagReadyForReset  AT %Q* : SAFEBOOL;
011       MyLCurt1_DiagReadyForTest   AT %Q* : SAFEBOOL;
012       MyLCurt1_DiagSwitchError    AT %Q* : SAFEBOOL;
013       MyLCurt1_DiagInputNotValid  AT %Q* : SAFEBOOL;
014
015 // My FBL
016       MyFBL1_DiagFblError         AT %Q* : SAFEBOOL;
017       MyFBL1_DiagFblNotValid      AT %Q* : SAFEBOOL;
018       MyFBL1_Switch_On                   : SAFEBOOL;
019
020 // COMMON
021       Start                       AT %I* : SAFEBOOL;
022       Stop                        AT %I* : SAFEBOOL;
023       Start_FLR                          : SAFEBOOL;
024 END_VAR
025
026 VAR CONSTANT
027 // Declaration SwitchType 3 (NCNC)
028       MyLCURT1_DOUBLE_CH                 : USINT := USINT#3;
029 END_VAR
```

Instruction part

```
030 // Safety-Block Light-Curtain1
031       CAL   MyLightCurtain1(
032       SwitchType         := MyLCURT1_DOUBLE_CH,
033       AutoStart          := FALSE,
034       AutoReset          := FALSE,
035       MonitoredReset     := TRUE,
036       StartupTest        := FALSE,
037       SimultaneityTime   := T#100ms,
038       DelayTime          := T#40ms,
039       Enable             => MyLCurt1_Enable,
040       DiagOperated       => MyLCurt1_DiagOperated,
041       DiagReadyForReset  => MyLCurt1_DiagReadyForReset,
042       DiagReadyForTest   => MyLCurt1_DiagReadyForTest,
043       DiagSwitchError    => MyLCurt1_DiagSwitchError,
044       DiagInputNotValid  => MyLCurt1_DiagInputNotValid
045       )
046
047 // Rising edge monitoring1 --> Start
048       CAL   MyRisingEdge1(
049       clk := Start,
050       q   => Start_FLR
051       )
052
053 // Start analysis
054       LD    MyLCurt1_Enable
055       AND   Start_FLR
056       S     MyFBL1_Switch_On
057
058 // Stop analysis
059       LDN   MyLCurt1_Enable
060       ORN   Stop
061       R     MyFBL1_Switch_On
062
063 // Safety-Block FBL1
064       CAL   MyFeedBackLoop1(
065       Input                   := MyFBL1_Switch_On,
066       FeedbackLoopTime        := T#200ms,
067       DiagFeedbackLoopError   => MyFBL1_DiagFblError,
068       DiagFeedbackLoopNotValid => MyFBL1_DiagFblNotValid
069       )
070
071       END_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.

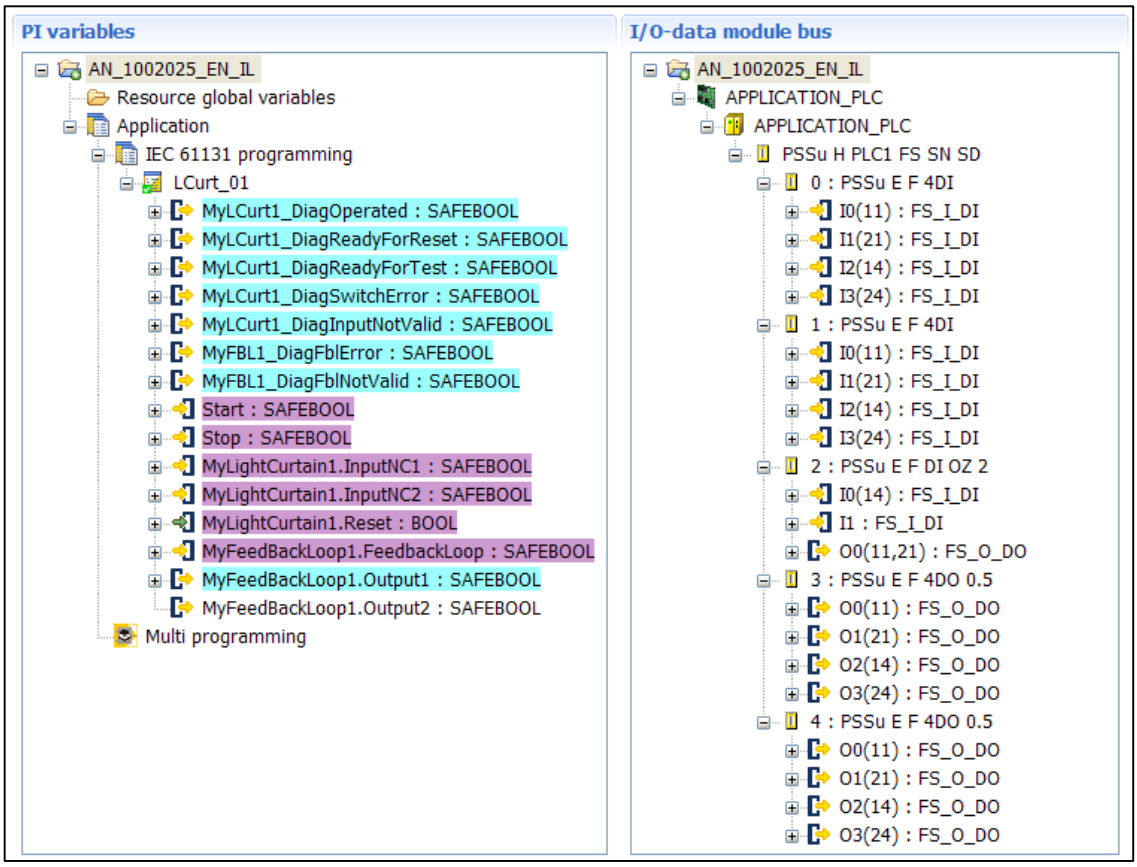


Fig. 4: Mapping Editor – IL-program

3.3.3. Process PAS Project

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

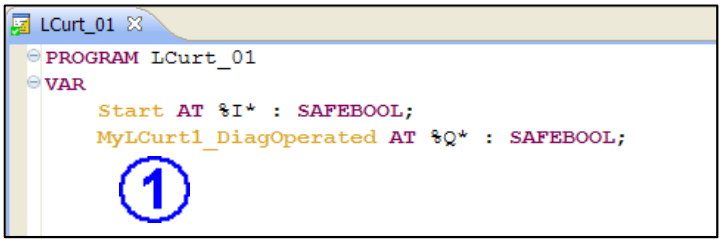


Fig. 5: PI variables

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

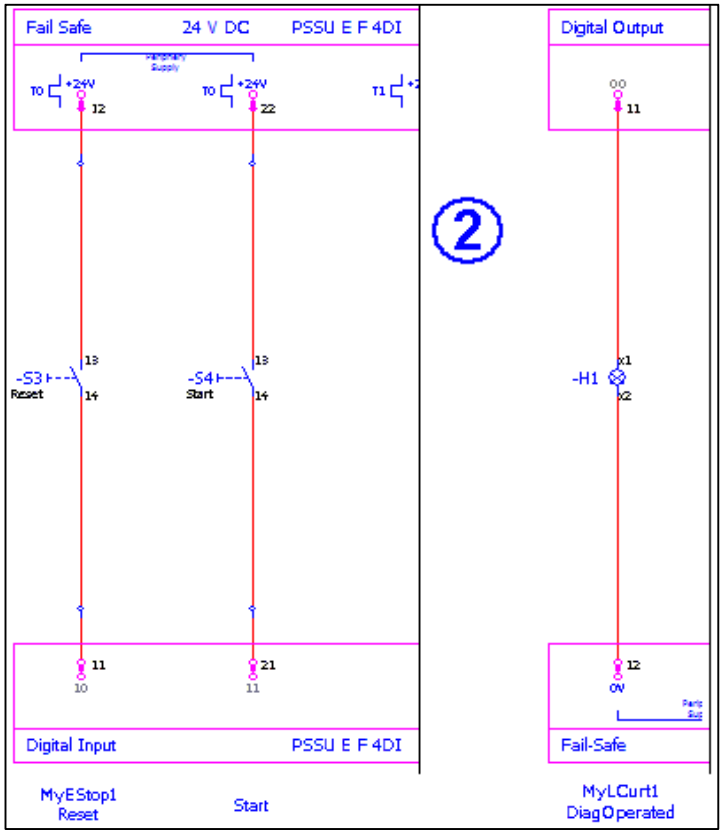


Fig. 6: Circuit diagram (extract)

- 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.

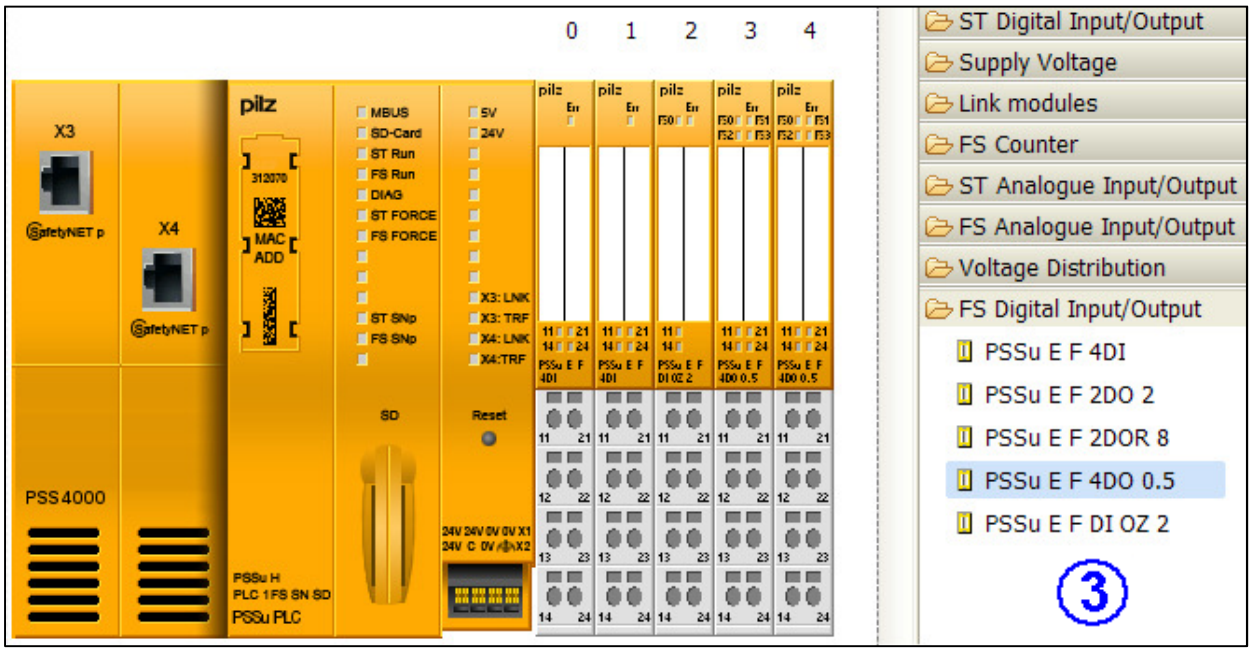


Fig. 7: PSSu Module Editor

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

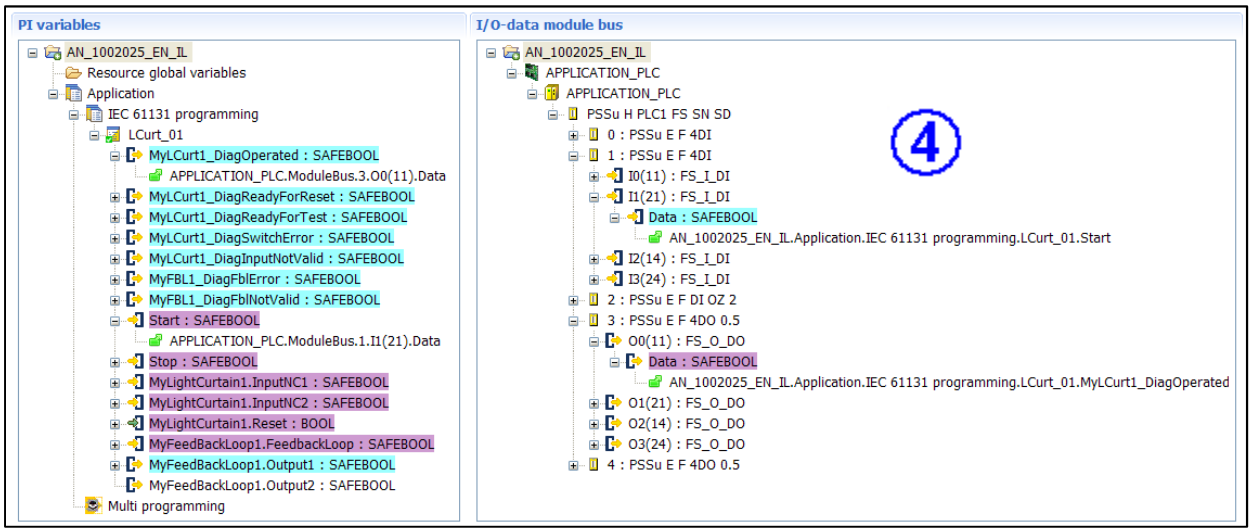


Fig. 8: I/O Mapping Editor

- Overview process I/O Mapping (Steps 1-4)

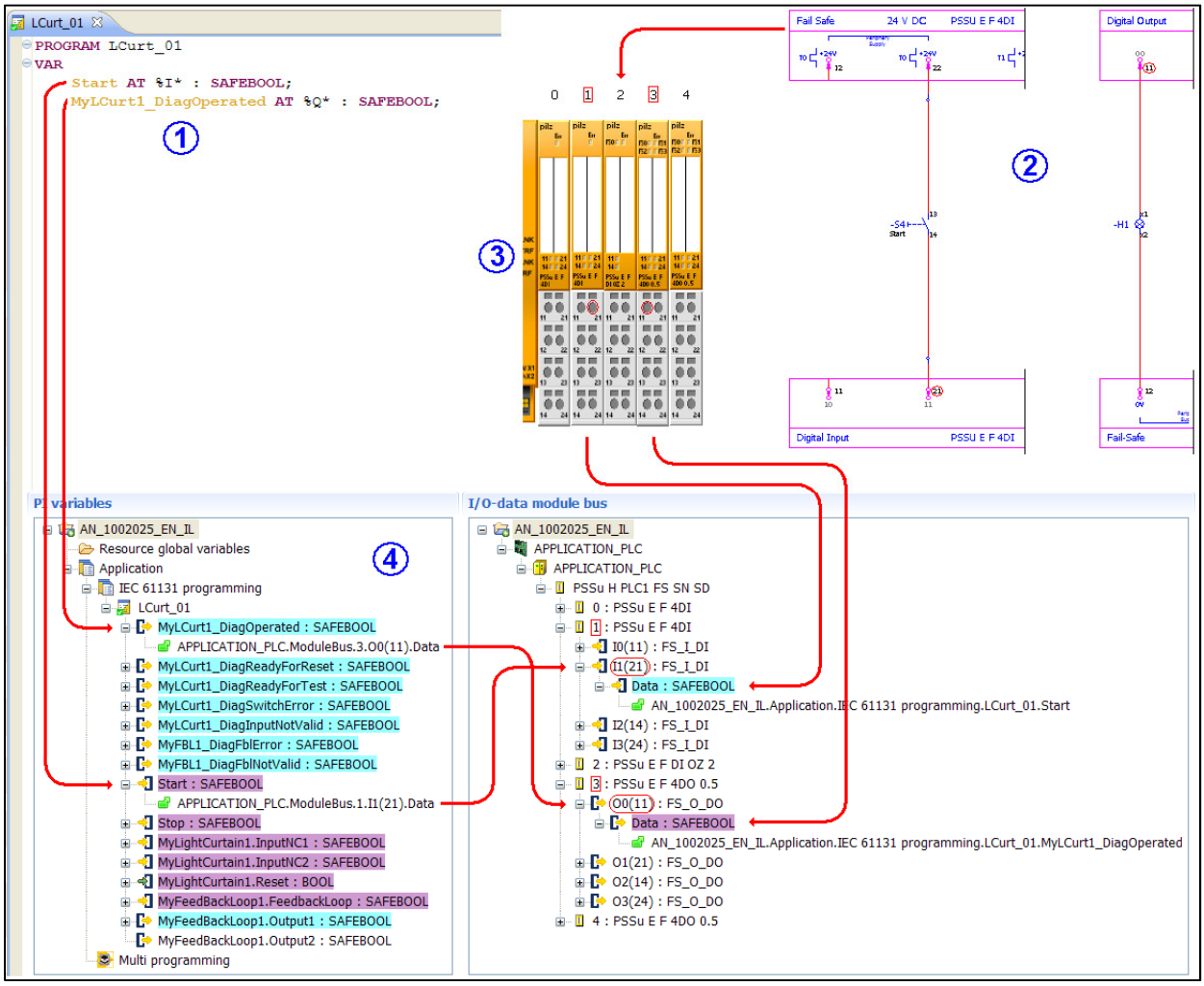
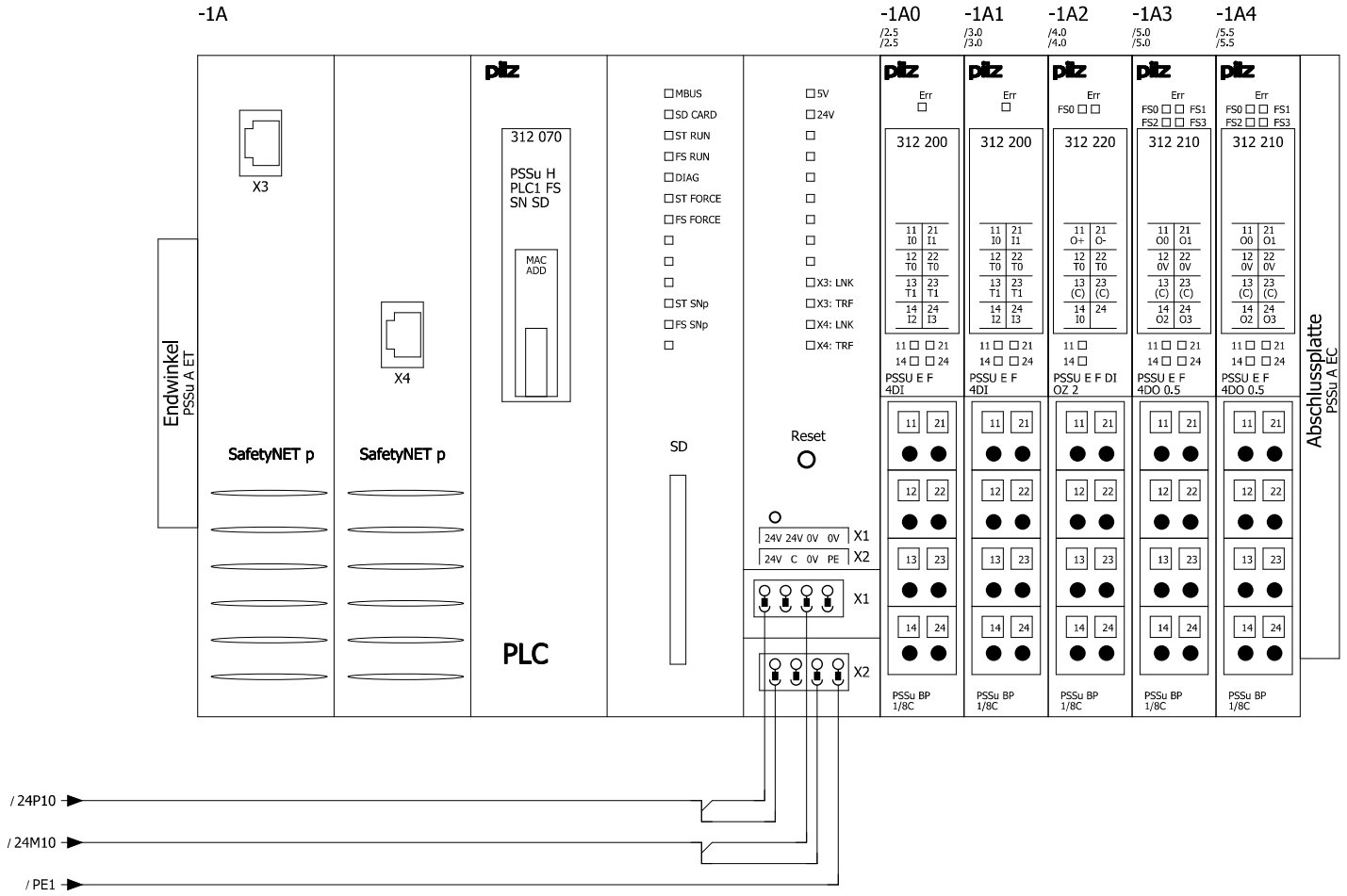


Fig. 9: Process I/O Mapping



PSSu E F 4DI
312 200

PSSu E F DI OZ 2
312 220

PSSu E F 4DO 0.5
312 210

PSSu E F 4DI
312 200

PSSu E F 4DO 0.5
312 210

PSSu BP 1/8C
312 601

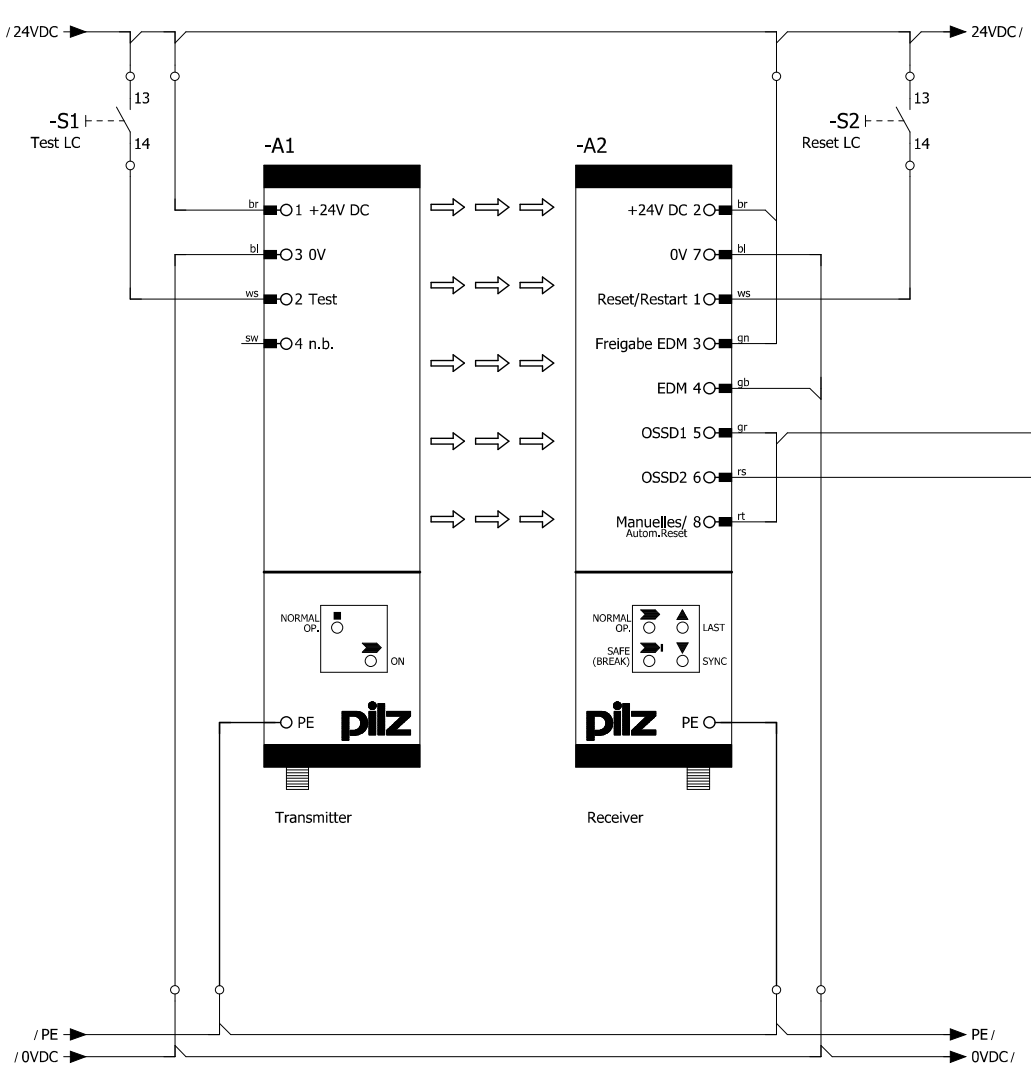
PSSu BP 1/8C
312 601

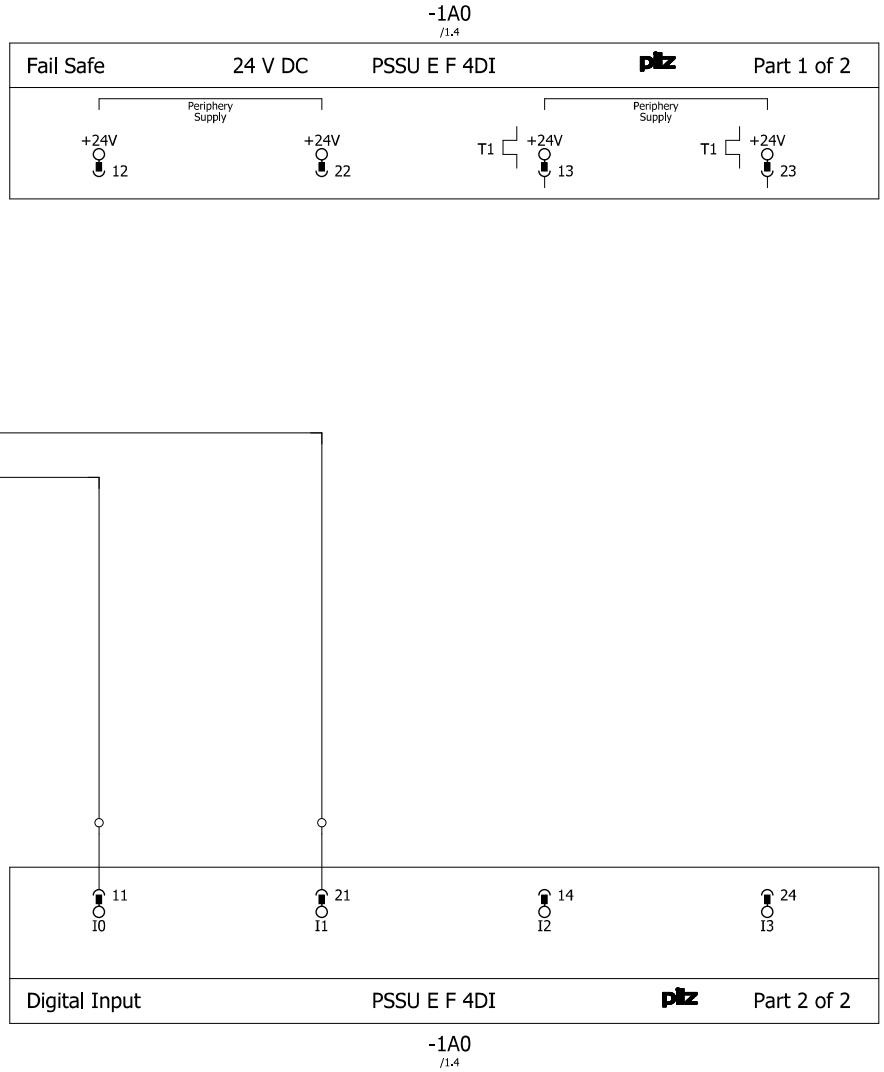
PSSu BP 1/8C
312 601

PSSu BP 1/8C
312 601

PSSu BP 1/8C
312 601

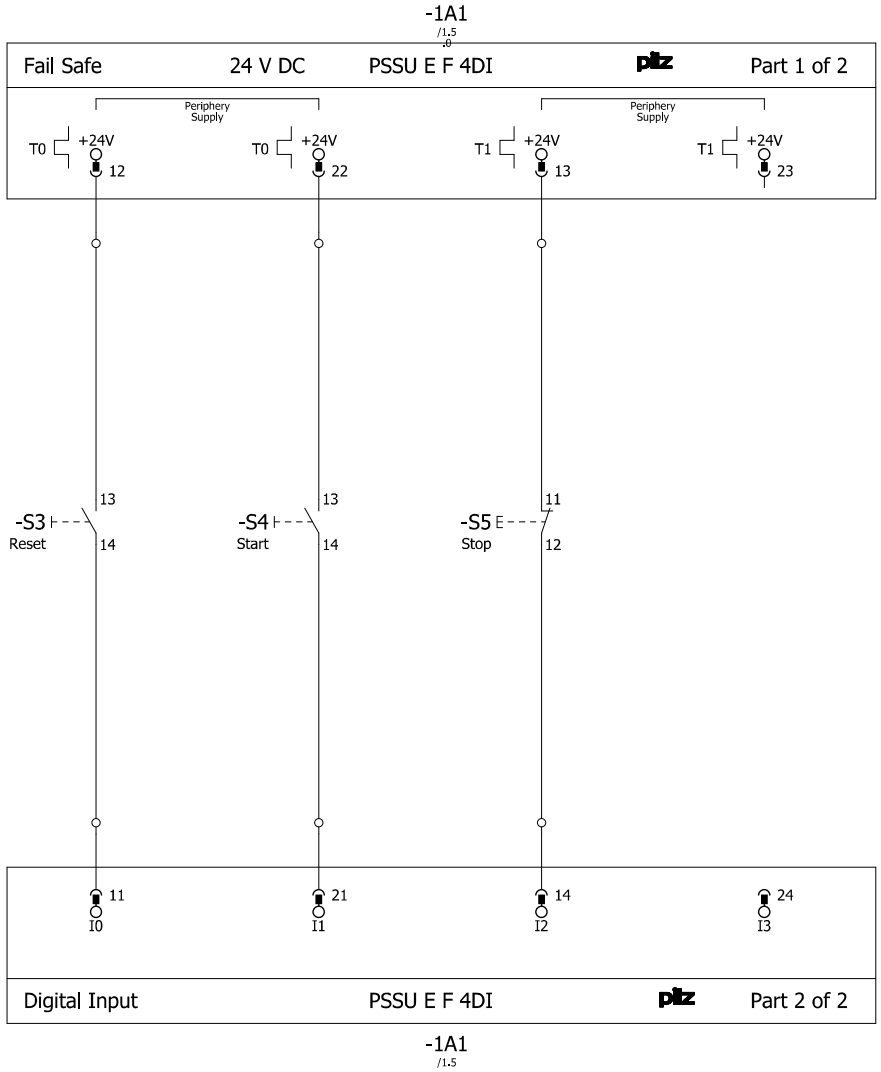
Revision	26.07.2011	Date	19.01.2005	EN ISO 13849-1:2006 PL e	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	PSS 4000 - Light curtain with PSENopt	Mounting place + AN_1002025_02
Name	RDS	Name	RDS				
				EN 62061:2005 SIL 3		Power supply PSS 4000	Page: 1 / 5
		Dep.	CS				





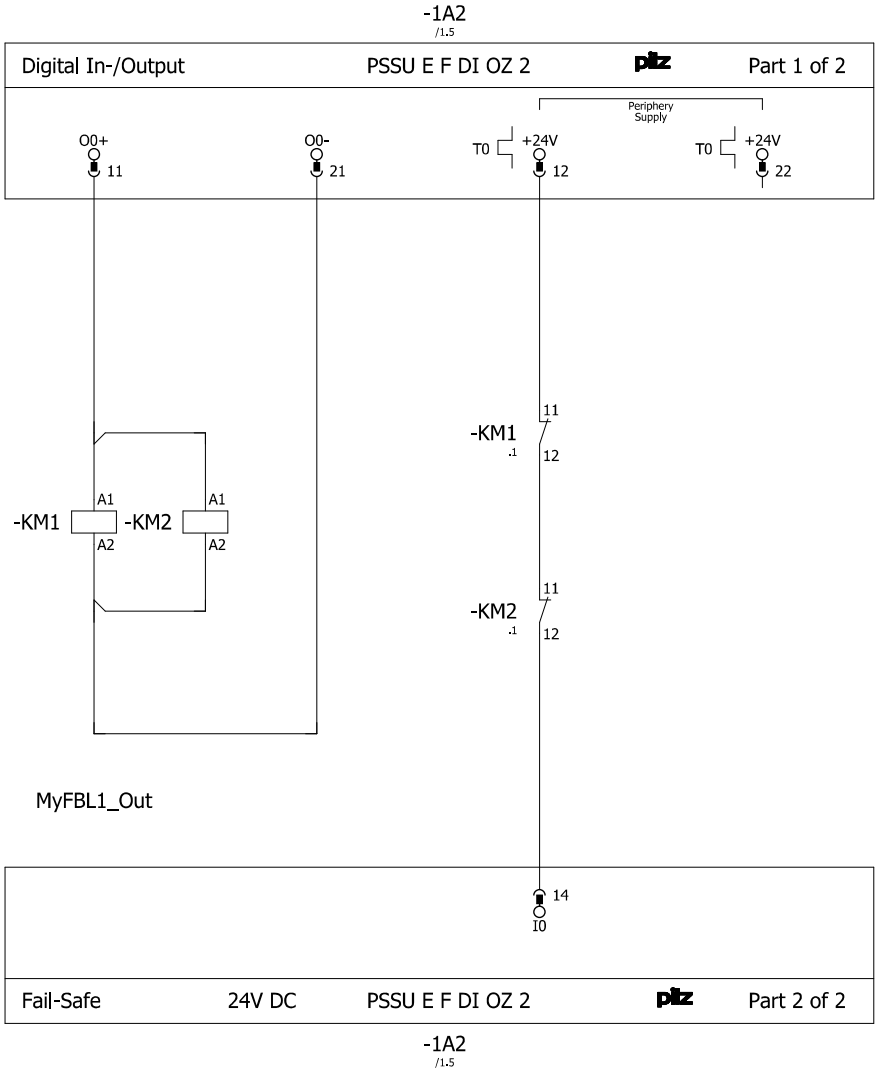
MyLCurt1 In1 | MyLCurt1 In2 | Spare | Spare

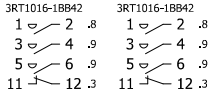
Revision	26.07.2011	Date	19.01.2005	EN ISO 13849-1:2006 PL e	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	PSS 4000 - Light curtain with PSENopt	Mounting place + AN_1002025_02
Name	RDS	Name	RDS				
				EN 62061:2005 SIL 3		Inputs	Page: 2 / 5
		Dep.	CS				



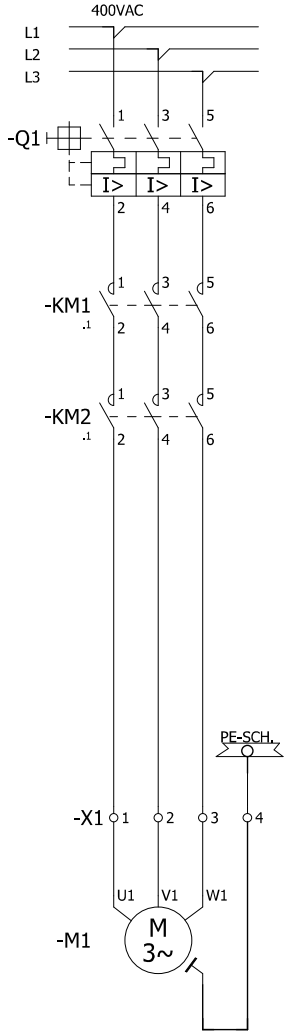
MyLCurt1 Reset | Start | Stop | Spare

Revision	26.07.2011	Date	19.01.2005	EN ISO 13849-1:2006 PL e	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	PSS 4000 - Light curtain with PSENopt	Mounting place + AN_1002025_02
Name	RDS	Name	RDS				
				EN 62061:2005 SIL 3		Inputs 2	Page: 3 / 5
		Dep.	CS				





MyFBL1



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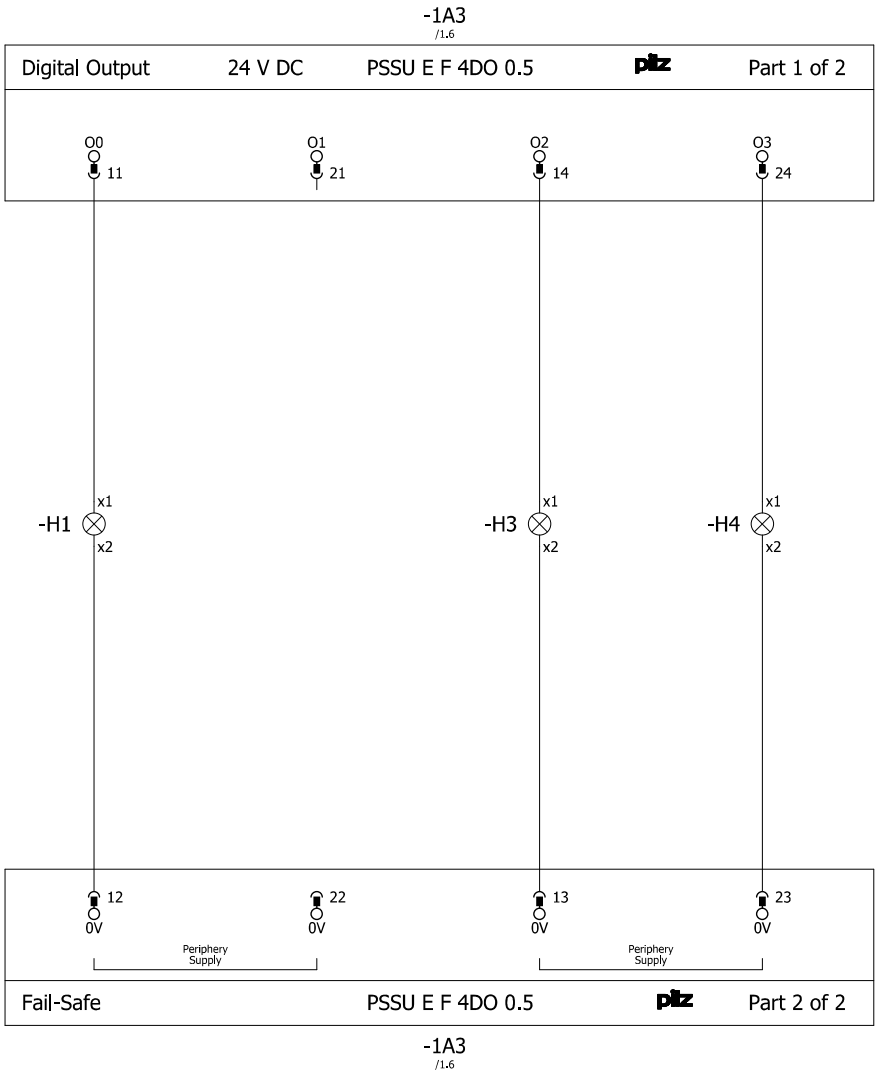
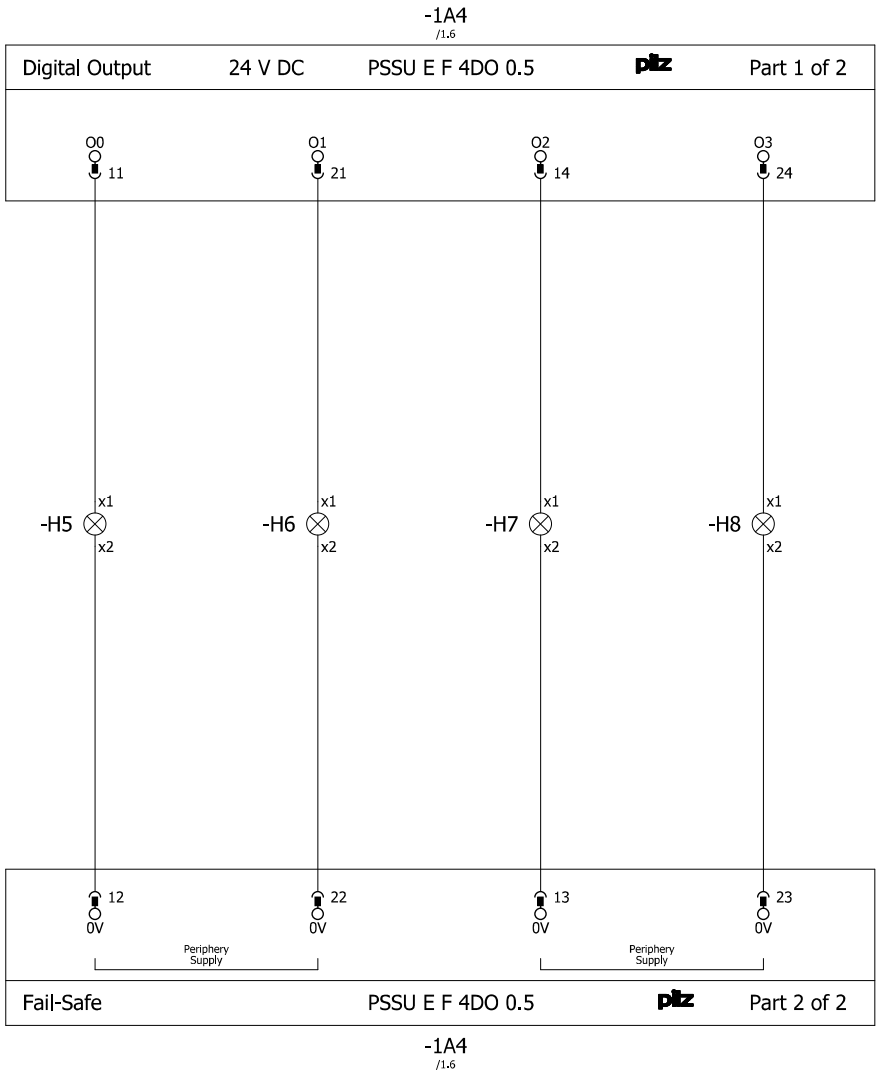
Name	RDS	Name	RDS				
				EN 62061:2005 SIL 3		Drive	Page: 4 / 5
		Dep.	CS				





MyLCurt1 DiagOperated	Spare	MyLCurt1 DiagReadyForReset	MyLCurt1 DiagReadyForTest	MyLCurt1 DiagSwitchError	MyLCurt1 DiagInputNotValid	MyFBL1 DiagFBLError	MyFBL1 DiagFBLNotValid

Revision	26.07.2011	Date	19.01.2005	EN ISO 13849-1:2006 PL e	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	PSS 4000 - Light curtain with PSENopt	Mounting place + AN_1002025_02
Name	RDS	Name	RDS				
				EN 62061:2005 SIL 3		Status/Error message	Page: 5 / 5
		Dep.	CS				

Table of figures

Recommended printer settings

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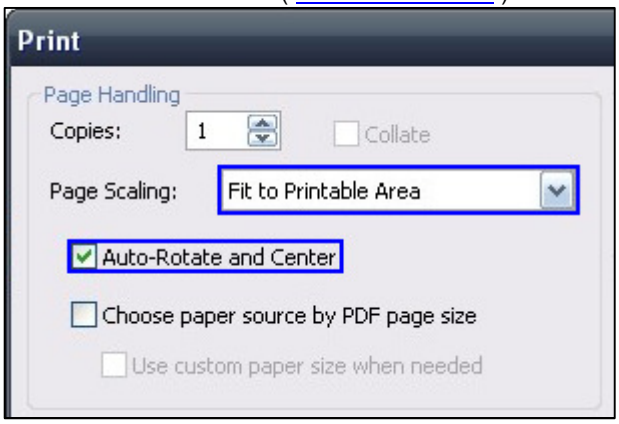
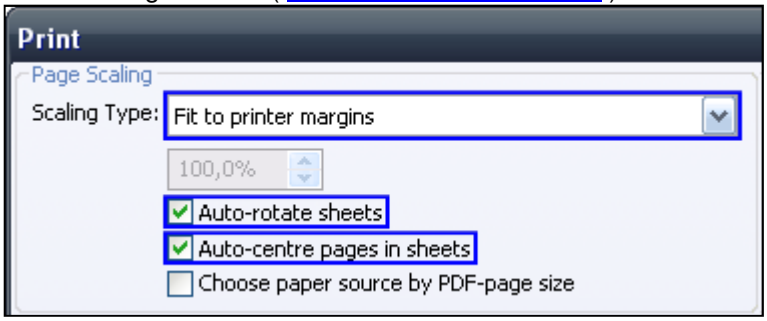


PDF-XChange Viewer (www.tracker-software.com)



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