PSSu Key-in-Pocket Basic

THE SPIRIT OF SAFETY

Product

Type:	FS_KeyInPocket_SignInOut, FS_KeyInPocket_Manager
Name:	PSS 4000, PITreader, PITgatebox, PSENmlock
Manufacturer:	Pilz GmbH & Co. KG, Safe Automation

Document

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Validity of Application Note

This present Application Note is valid until a new version of the document is published.
This and other Application Notes can be downloaded in the latest version and for free from www.pilz.com. For a simple search, use our content document (1002400) or the direct search function in the download area.

The Pilz newsletter is free of charge and keeps you up-to-date on all the latest issues and trends in safe automation.

Exclusion of Liability

We have taken great care in compiling our application note. It contains information about our company and our products. All statements are made in accordance with the current status of technology and to the best of our knowledge and belief.
While every effort has been made to ensure the information provided is accurate, we cannot accept liability for the accuracy and entirety of the information provided, except in the case of gross negligence. In particular, all information on applicable standards, safety-related classifications and time characteristics should be viewed as provisional. 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.

May 2023

Industrial Security

To secure plants, systems, machines and networks against cyberthreats it is necessary to implement (and continuously maintain) an overall Industrial Security concept that is state of the art.
Perform a risk assessment in accordance with VDI/VDE 2182 or IEC 62443-3-2 and plan the security measures with care. If necessary, seek advice from Pilz Customer Support.

Abbreviations

Abbreviation / term	Description	Source
AN	**A**pplication **N**ote	www.pilz.com > AN content (1002400)
PNOZ	Pilz E-STOP positive-guided (DE: **P**ilz **NO**T-AUS-**Z**wangsgeführt)	www.pilz.com > PNOZ
PSS	Programmable control system (DE: **P**rogrammierbares **S**teuerungs**s**ystem)	www.pilz.com > PSS
PSS u2	**PSSu**niversal, **2**nd generation	www.pilz.com > PSS u2
POU	**P**rogram **O**rganisation **U**nit	
NC	**N**ormally **C**losed	
NO	**N**ormally **O**pen	
STO	**S**afe **T**orque **O**ff	

Definition of Symbols

Information that is particularly important is identified as follows:

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.

Contents

1 Preface

This Application Note provides a basic description of the commissioning of the key-in-pocket system from Pilz, using as an example a manufacturing cell with one access point.

With the help of the access permission system PITreader and a Pilz safety controller, the key-in-pocket system from Pilz guarantees that a plant cannot (re-)start until the last person has left the danger zone. A PSSu PLC from the automation system PSS 4000 is used as the safety controller.

The general procedure for a successful basic configuration is shown.

NOTICE

A detailed explanation of the safety functions employed in the failsafe application and their evaluation in terms of functional safety are not part of this document.

2 Useful documentation

Reading the documentation listed below is necessary for understanding this Application Note. The availability of the software used and its safe handling are also presupposed for the user.

2.1 Documentation from Pilz GmbH & Co. KG

No.	Description	Item No. /Download
1	Pilz international homepage, download section	www.pilz.com
2	System description Key-in-Pocket	1006613-EN-xx
3	System description PSS 4000	1001467-EN-xx
4	Safety manual PSS 4000	1001468-EN-xx
5	Operating manual PSSu H PLC2 FS SN SD	1005195-EN-xx
6	Operating manual PSSu E F 4DI	21310-EN-xx
7	Operating manual PSSu E F 4DO 0.5	21316-EN-xx
8	Operating manual PITreader	1004806-EN-xx
9	Operating manual PIT gb RLLE y ETH	1005249-EN-xx
10	Operating manual PSEN ml b 1.1/2.1/2.2 / PSEN ml DHM	1005444-EN-xx
11	PAS4000 Online help	-

2.2 Documentation from other sources of information

No.	Description	Item No. / Download
1	EN ISO 13849-1:2015 Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	European standard
2		
3		
4		

3 Used hardware and software

3.1 Pilz products

No.	Descriptions	Order number	Version	Number
1	PSSu H PLC2 FS SN SD	312077	FW 1.25	1
2	PSSu E F 4DI	312200	-	3
3	PSSu E F 4DO 0.5	312210	-	3
4	PSSu BP 1/8C	312601	-	6
5	PSSu A Con 2/8 C (connector set, spring-loaded connection)	313111	-	1
6	PIT gb RLLE y up ETH (PITgatebox – pushbutton unit)	G1000020	-	1
7	PITreader key ye g (Transponder key, authorisations freely configurable)	402260	-	1 (min.)
8	PSEN ml b 2.1 switch (Safety gate system with mechanical guard locking, basic version with power reset, fully coded)	570403	-	1
9	PSEN ml DHM down l 2.1 (Door handle module for fully coded PSENmlock switches, left-hand gate end stop)	6O000006	-	1
10	Software platform PAS4000	-	V 1.25	1

The Pilz product portfolio also includes servo amplifiers and drives. However, they are not described in detail here, as they are not central to this Application Note.

3.2 Structure of the application (schematic)

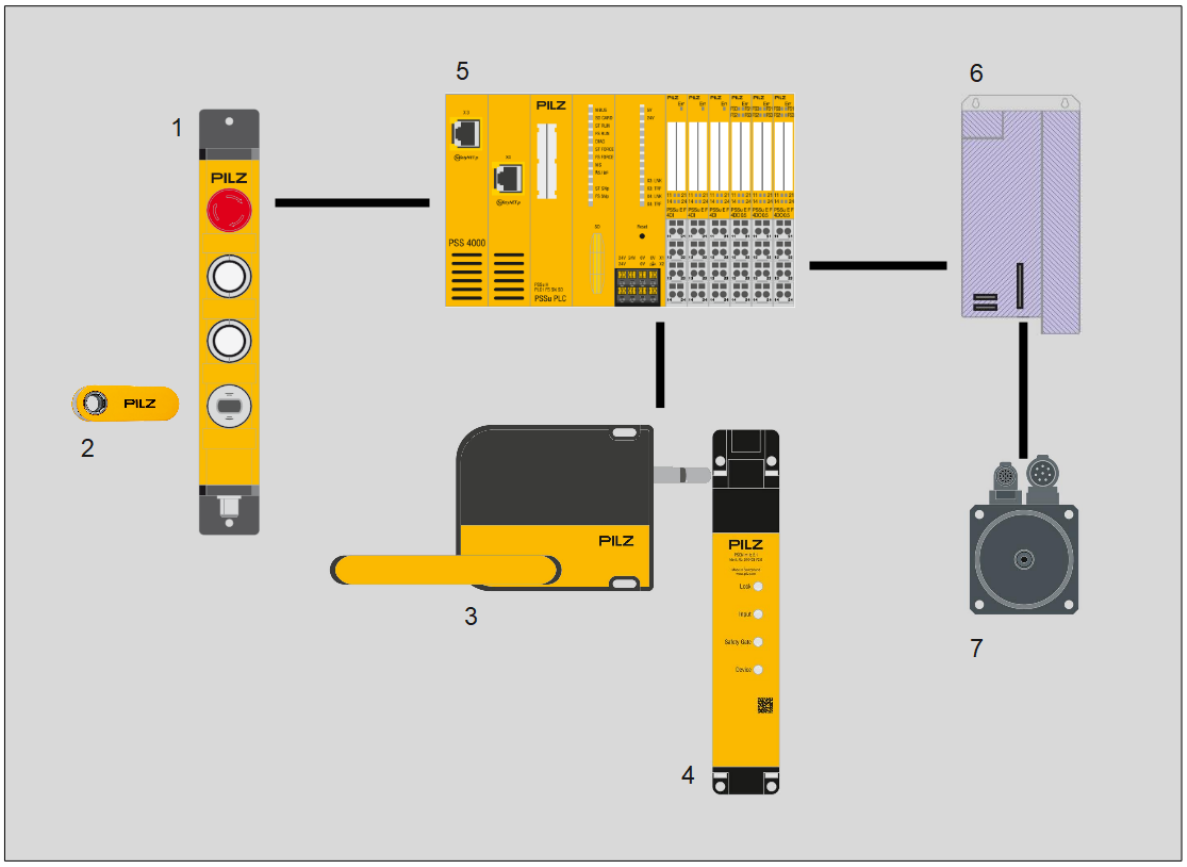


Figure 1: Application – Structure of the hardware (schematic)

1. PITgatebox – pushbutton unit with PITreader
2. Transponder key
3. Door handle module for PSENmlock
4. Safety gate system PSENmlock
5. Failsafe controller PSSu PLC
6. Servo amplifier
7. Drive

4 Application description

4.1 Introduction

On a plant in which the danger zone is accessible via safety gates, "key-in-pocket" is a system that guarantees that the plant cannot (re-)start until the last person has left the danger zone. Each person who accesses the danger zone has to sign in to the key-in-pocket system's internal sign in list. When leaving the danger zone, each person must sign out of the internal sign in list. Transponders from the authentication system PITreader from Pilz are used to sign in and out.

The example shows the application of the key-in-pocket system on a machine that executes hazardous movements within a protective enclosure (protective grille and safety gate).

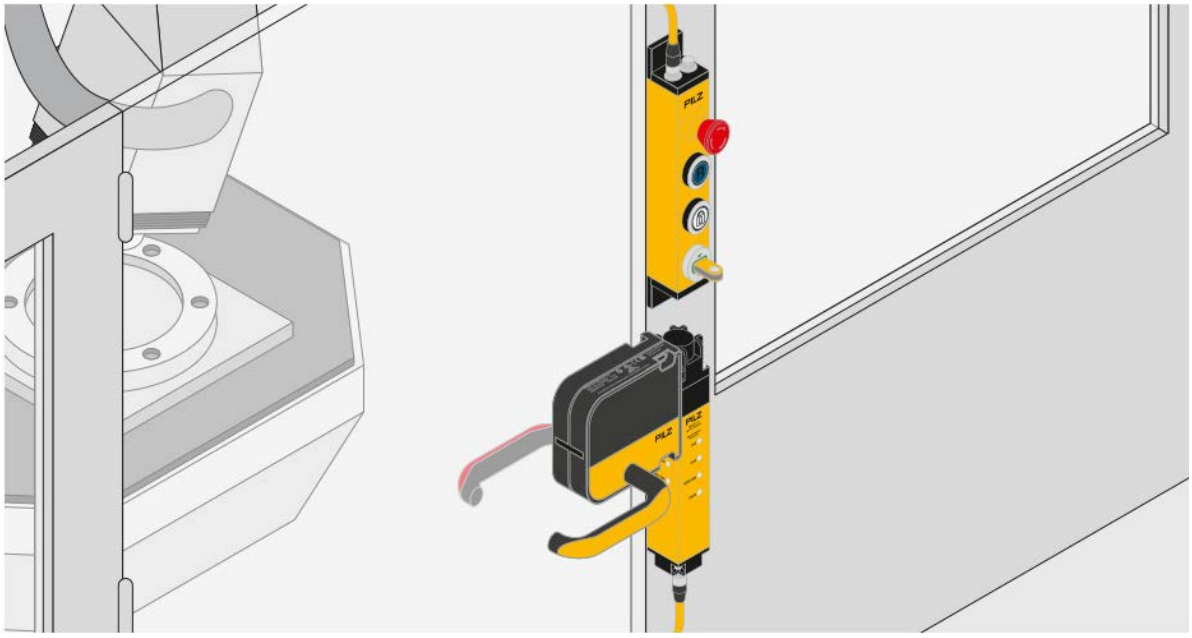


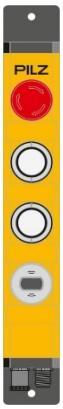
Figure 2: Access to the danger zone

It is only possible to enter the danger zone if:
- An operator has used his personal transponder to sign in to the key-in-pocket system's sign in list via the PITreader integrated within the PITgatebox
- All hazardous machine movements are stopped
- The guard locking on the safety gate has been deactivated.

The operator carries his transponder with him while he is in the danger zone.

It is only possible to restart the machine if:
- The operator has closed the safety gate and activated guard locking
- The operator has used his transponder to sign out of the key-in-pocket system's sign in list and nobody else is signed in to the sign in list.

To operate the key-in-pocket system a PITgatebox is used, which has two illuminated pushbuttons in addition to an E-STOP and the PITreader. Two further pushbuttons are required to start and stop the machine.



Lock/Unlock

Sign-In/Sign-Out

Figure 3: PITgatebox with pushbutton assignment

Activation (lock) and deactivation (unlock) of guard locking are assigned to the upper pushbutton. The status of guard locking (activated/deactivated) is displayed via the integrated indicator lamp.

The lower pushbutton is used to sign a transponder in to the sign in list and to sign a transponder out of the sign in list. The status of a transponder (signed in/signed out) is displayed via the integrated indicator lamp.

A *PSEN ml b 2.1* (PSENmlock) is used in conjunction with a handle module *PSEN ml DHM down l 2.1* for safety gate monitoring and guard locking.

4.2 Key-in-pocket

The basic function of the key-in-pocket system in this application is described below, based on the machine in operation.

The operator wishes to enter the danger zone. To do this, he positions his transponder in the PITreader, presses the lower pushbutton (sign in/sign out) and then releases it (0.5 … 5 seconds).

The operator ensures that the indicator lamp on the lower pushbutton switches to a continuous light; i.e. the transponder is signed in to the sign in list.

By signing in to the sign in list, a machine stop is requested automatically. Also, signing in to the sign in list activates the display for the status of guard locking.

While the machine is not yet at standstill, the indicator lamp on the upper pushbutton (lock/unlock) will flash. When the machine is at standstill, the indicator lamp switches to continuous light, so indicating that guard locking is activated.

The operator can now deactivate guard locking by pressing the upper pushbutton (lock/unlock). The indicator lamp goes out, so indicating that the gate can be opened.

The operator removes his transponder (the indicator lamp (sign in/sign out) goes out), opens the gate and enters the danger zone.

After leaving the danger zone, the operator closes the gate and positions his transponder in the PITreader. The indicator lamp in the lower pushbutton (sign in/sign out) switches to a continuous light.

Pressing the upper pushbutton (lock/unlock) activates guard locking. The activated status is displayed via the indicator lamp staying continuously lit.

The operator presses the lower pushbutton (sign in/sign out) and then releases it (0.5 … 5 seconds). The indicator lamp goes out, so indicating that the transponder has been signed out of the sign in list. The operator removes his transponder from the PITreader.

If nobody else has signed in to the sign in list in the meantime, then the enable to start the machine is now present (separate Start button). Signing out the last transponder from the sign in list resets the restart interlock.

Any person who enters the danger zone must use their transponder to sign in to the sign in list and then sign out again after leaving the danger zone. A maximum of 21 people can sign in to the sign in list.

The following blocks are used for the key-in-pocket system: “FS_KeyInPocket_SignInOut” and “FS_KeyInPocket_Manager”.

Where people have signed in to the sign in list before entering the danger zone but have not signed out of the sign in list after leaving the danger zone and are also no longer available, the block “FS_KeyInPocket_Manager” has the option to delete the list using a transponder with a higher permission and a separate pushbutton (“Delete”). The data on the signed in transponder (security ID and serial number) can be read on the block "FS_KeyInPocket_Manager".

4.3 Monitoring of safety gate and guard locking

The safety gate system PSENmlock signals the status of the safety gate and guard locking via 2 OSSD outputs.

A block with automatic reset, “FS_SafetyGate”, is used to evaluate the OSSD outputs.

Guard locking can only be activated/de-activated when the transponder is positioned and signed in.

Guard locking can only be deactivated once the hazardous movement has ended (safe standstill monitoring).

The functional state of guard locking (locked/unlocked) remains active even after the supply voltage is removed.

4.4 Drive

With the request to stop the machine (sign in to the sign in list, stop button), the motor is stopped and shut down via the servo amplifier, via a preset ramp.

To ensure that the operator does not access the danger zone until the danger has passed, a delay device is started when the machine is stopped. This ensures that any movement has come to a standstill before guard locking on the safety gate can be opened (delay time > maximum stopping time of the motor).

Once the set delay time has elapsed, two safe outputs are shut down, whereby the servo amplifier’s pulse inhibitor safely removes the power to the motor (STO).

The safe standstill monitoring implemented here in the form of a delay time is only one example and should be defined and implemented by the user to suit the specific application.

This example does not describe the design and functionality of the servo amplifier in any detail. The user must select an appropriate drive to suit their application and the safety level it requires.

4.5 Safety assessments

4.5.1 Key-in-pocket system

The system provides protection against an unintended and unauthorised restart. The restart interlock is set (“Enable” = FALSE on the block “FS_KeyInPocket_Manager”), as soon as one person uses their transponder to sign in to the sign in list, and reset (“Enable” = TRUE), when a person has signed out the list’s last remaining transponder from the list.

The safety concept is based on each action (signing in/signing out of the sign in list) requiring operator action on two logically, technologically and physically independent components:

- PITreader with transponders and transfer via network protocol
- Pushbutton on a safe hardware input

Both function elements are considered as independent channels.
Measures to detect and manage single errors are implemented in both channels.

The following measures are used in the channel with the PITreader:
- Data transfer is monitored through data dynamisation
- Data is secured via CRC
- Data on a positioned transponder is valid for a limited time
- Limited to one action while a transponder is positioned
- Data connection is monitored

The following measures are used in the channel with the pushbutton:
- A rising and falling edge must be detected to trigger an action.
- An operation is classed as valid if the falling edge occurs between 500 ms and 5 s after the rising edge.

When deleting the list via the block “FS_KeyInPocket_Manager”, the transponder used for deletion remains in the sign in list, so that the delete operation does not reset the restart interlock.

The sign in list is empty when the safety controller starts up (no non-volatile memory). In order to set the enable for the restart, a transponder must be signed in once to the sign in list and then signed out again.

For safe application of the key-in-pocket system, please note the guidelines stated in chapter 7 Application conditions [📖 28].

4.5.2 Safety gate system

The safety gate system PSENmlock meets the following safety requirements:

- Safe guard locking for swing gates and sliding gates
  (the safety switch may only be used with the corresponding actuator.)
- Errors on the OSSD signals (no synchronous switching, OSSD failing to switch from TRUE to FALSE when guard locking is deactivated) are detected by the block “FS_SafetyGate”. A short or cross-short between the OSSDs is detected by the PSENmlock and leads to the OSSDs being shut down. (The safety outputs (OSSDs) must not be connected to 24V.)
- Errors on the 2-channel operation of the guard locking device or servo amplifier (stuck-at-high, cross-short) are detected by the safety controller (on and off test). In the event of an error, guard locking is still guaranteed.
- After the drive has stopped or when the safety gate is opened, the energy supply to the motor is forcibly removed (activation of STO). As a result, the drive can no longer generate a rotational torque and therefore no braking torque either.
  Additional hazards may therefore arise, which must be taken into consideration. For example:
  - Increased time to standstill (overrun)
  - Uncontrolled falling (e.g. on vertical axes)
  - Positional change due to mass, pressure or voltage

Please comply with the safety guidelines and installation and wiring instructions in the PSENmlock operating manual.

4.5.3 Drive system

Please comply with the safety guidelines stated in the operating manual for the relevant servo amplifier.

4.6 Functional safety

4.6.1 Introduction

The restart interlock implemented through the key-in-pocket system is treated as a separate safety function. The safety function depends equally on both input functions (pushbutton und PITreader). PITreader and pushbutton can therefore be regarded as channels of the "Input" subsystem. The key-in-pocket system can be used for applications up to Category 3 PL d of EN ISO 13849-1 or up to SIL 2 of EN 62061.

The safety gate system PSENmlock achieves classification to PL e of EN ISO 13849-1 and SIL 3 of EN 62061, both for safety gate monitoring and mechanical guard locking.
Fault exclusion is assumed for the single-channel mechanical actuator (F_{max} = 2x F_{ZH}).

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

4.6.2 Safety-related characteristic data in accordance with EN ISO 13849-1

No.	Safety function	Performance level	Safety-related parts of the control system
1	Restart is prevented as long as one person is signed in to the sign in list with their transponder. (KEY-IN-POCKET).	PL d	Sensor (Pushbutton/PITreader PITgatebox) Input (PSSu E F 4DI) Logic (PSSu H PLC2 FS SN SD) Output (PSSu E F 4DO 0.5) Actuator (Servo amplifier)
2	Hazardous movements are shut down when the safety gate is opened; a restart is prevented while the safety gate is open. (SAFETY GATE)	PL e	Sensor (PSENmlock (OSSD)) Input (PSSu E F 4DI) Logic (PSSu H PLC2 FS SN SD) Output (PSSu E F 4DO 0.5) Actuator (Servo amplifier)
3	Restart is prevented if guard locking is not activated. (GUARD LOCKING – start-up)	PL e	Sensor (PSENmlock (OSSD)) Input (PSSu E F 4DI) Logic (PSSu H PLC2 FS SN SD) Output (PSSu E F 4DO 0.5) Actuator (Servo amplifier)
4	Guard locking cannot be deactivated until a safe state is achieved. (GUARD LOCKING – standstill)	PL e	Logic (PSSu H PLC2 FS SN SD) Output (PSSu E F 4DO 0.5) Actuator (PSENmlock (Guard locking))

Requirements:

No.	Description		Identification
1	Common cause failure (CCF)		Requirements are considered to be met (must be checked when implemented)
2	Mission time		20 years
3	Operation interval (electromechanical components) (according to application-related assumption from this example)	Sensor	4 operations per hour
4	Characteristic data of servo amplifier - STO (assuming):	Actuator	PFH_D = 5E-09
			PL e

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

4.6.3 Safety-related characteristic data in accordance with EN 62061

No.	Safety-related control function (SRCF)	Safety Integrity Level	Subsystems
1	Restart is prevented as long as one person is signed in to the sign in list with their transponder. (KEY-IN-POCKET).	SIL 2	Sensor (Pushbutton/PITreader PITgatebox) Input (PSSu E F 4DI) Logic (PSSu H PLC2 FS SN SD) Output (PSSu E F 4DO 0.5) Actuator (Servo amplifier)
2	Hazardous movements are shut down when the safety gate is opened; a restart is prevented while the safety gate is open. (SAFETY GATE)	SIL 3	Sensor (PSENmlock (OSSD)) Input (PSSu E F 4DI) Logic (PSSu H PLC2 FS SN SD) Output (PSSu E F 4DO 0.5) Actuator (Servo amplifier)
3	Restart is prevented if guard locking is not activated. (GUARD LOCKING – start-up)	SIL 3	Sensor (PSENmlock (OSSD)) Input (PSSu E F 4DI) Logic (PSSu H PLC2 FS SN SD) Output (PSSu E F 4DO 0.5) Actuator (Servo amplifier)
4	Guard locking cannot be deactivated until a safe state is achieved. (GUARD LOCKING – standstill)	SIL 3	Logic (PSSu H PLC2 FS SN SD) Output (PSSu E F 4DO 0.5) Actuator (PSENmlock (Guard locking))

Requirements:

No.	Description		Identification
1	Common cause failure (CCF)		ß = 2 % (must be checked when implemented)
2	Proof test interval		20 years
3	Operation interval (electromechanical components) (according to application-related assumption from this example)	Sensor	4 operations per hour
4	Characteristic data of servo amplifier - STO (assuming):	Actuator	PFH_D = 5E-09
			SIL 3

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

5 Hardware configuration

5.1 PITgatebox with PITreader

The PITreader is configured via a web application, which is called up via a standard browser. Settings on the PITreader as well as changes to transponders can generally be made via the web application. A detailed description can be found in the operating manual PITreader.

When delivered, the PITreader in the PITgatebox has the IP address 192.168.0.12.

This example uses transponders that are freely configurable. Before use, they must be assigned a permission via the web application.

5.2 PSSu PLC

5.2.1 Overview

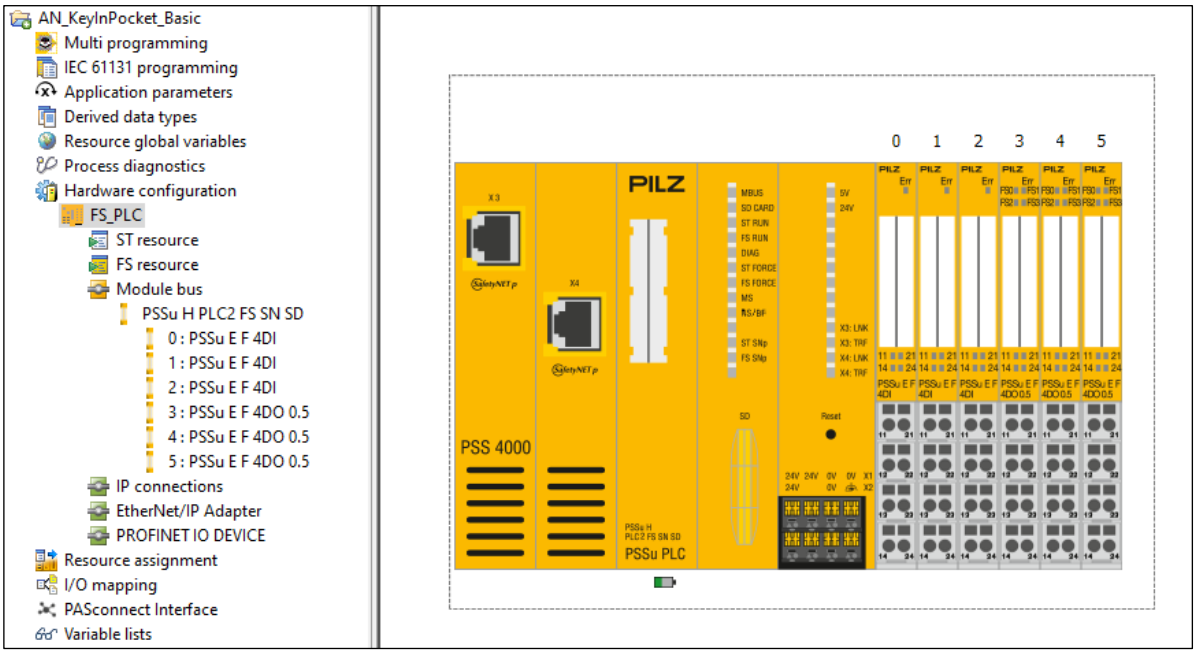


Figure 4: PSS 4000 hardware configuration

The PSSu PLC is assigned the IP address 192.168.0.11.

With the E-modules PSSu E F 4DO 0.5, the off tests must be activated (default setting). The on tests for the outputs that activate guard locking and the servo amplifier must also be activated.

All inputs are configured for a 24 V supply, with the exception of the emergency stop inputs, which are supplied via pulse signals.

5.2.2 IP connection

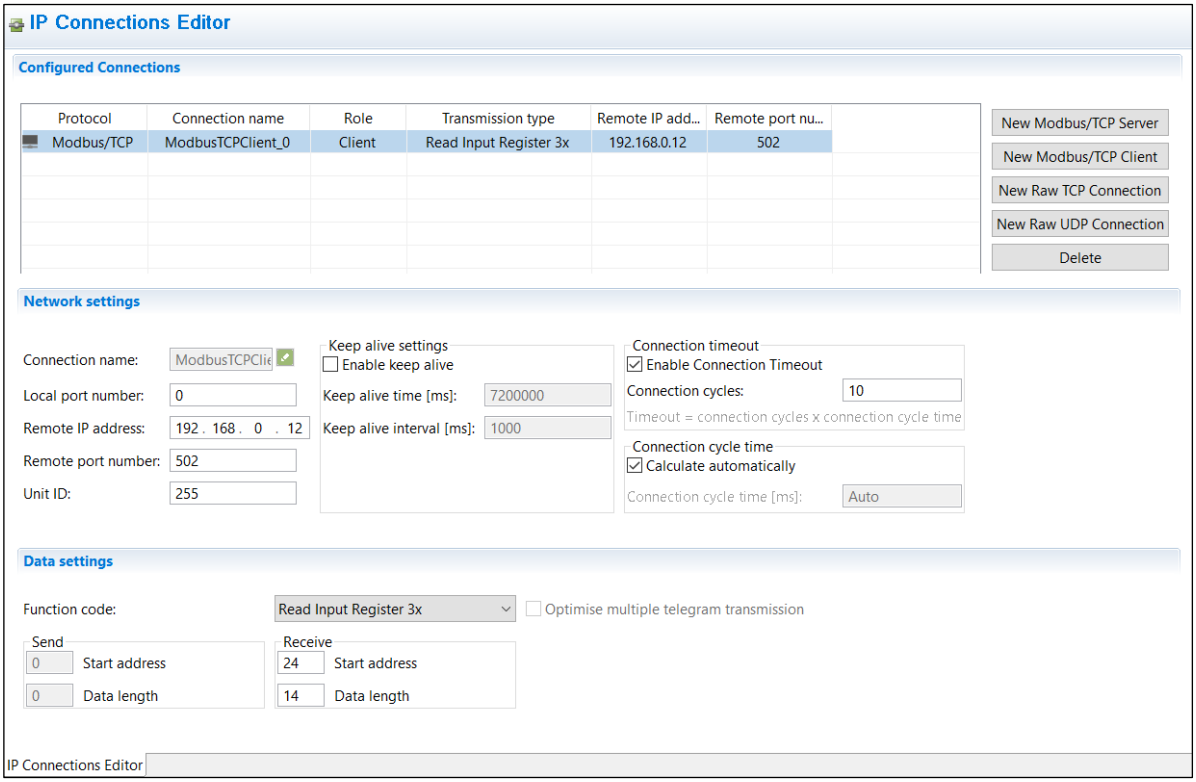


Figure 5: Modbus/TCP client connection

The PITreader supplies data to the PSSu PLC via the IP connection configured above.

6 Software configuration

The software development is shown in the alternative programming types “Multi programming” and “IEC 61131 programming”.

6.1 Multi programming

The program can be divided into 3 functional areas:

- Key-in-pocket system
- Activation and monitoring of the safety gate with guard locking
- Activation of the machine

To keep the illustration understandable, some internal signals have been assigned to PI points and have been connected via PI-PI mapping. These connections can also be created directly without PI points, of course, via lines.

The blue elements are simple component blocks for converting connection points into PI points and vice-versa. The “Button” type elements also supply the valid information from the input signal.

Note: For reasons of clarity, the emergency stop function is not represented here.

6.1.1 Key-in-Pocket

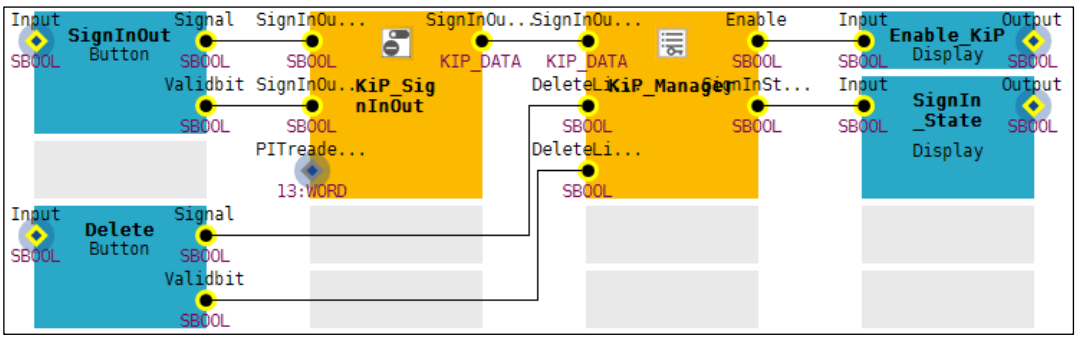


Figure 6: Multi program part “Key-in-Pocket”

The following blocks are used for the key-in-pocket system: “FS_KeyInPocket_SignInOut” (instance “KiP_SignInOut”) and “FS_KeyInPocket_Manager” (instance “KiP_Manager”).

“KiP_SignInOut” processes the data from the PITreader and the commands from the “SignInOut” pushbutton, for signing in and out of the sign in list. The parameter settings are used to activate sign in/sign out and to specify a minimum permission for the transponders:

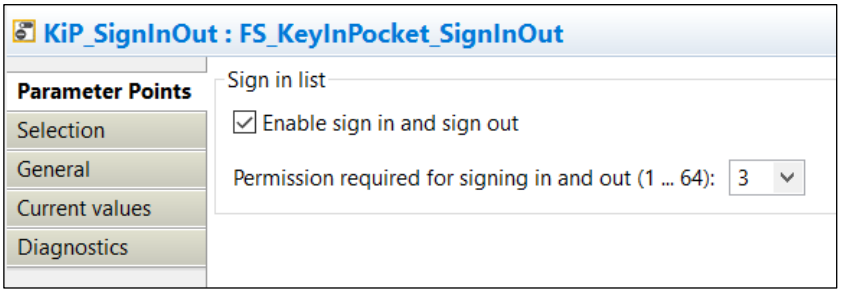


Figure 7: Parameter settings "KiP_SignInOut”

"KiP_Manager" manages the sign in list. The block receives data from "KiP_SignInOut" and signs this in or out of the internal sign in list. Using a signed-in transponder with a higher permission, the internal list can be deleted apart from one entry, via the "Delete" button. The parameter settings are used to deselect the blind spot check and to specify the number of channels to be processed, along with the channel and the permission to delete:

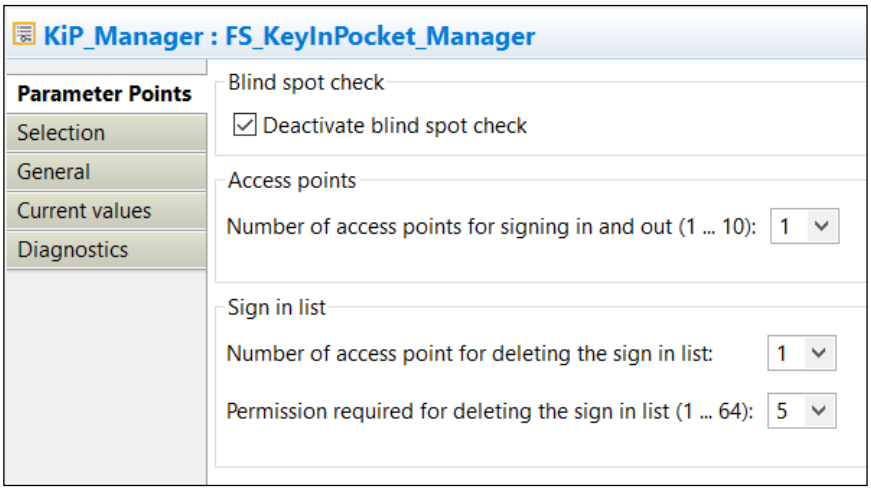


Figure 8: Parameter settings "KiP_Manager"

The status of a positioned transponder (signed in/signed out) is displayed via the output "SignInState".

The key-in-pocket system's enable output "Enable_KiP" is subsequently incorporated into the machine's start and stop conditions.

Via additional outputs, "KiP_SignInOut" and "KiP_Manager" provide information such as diagnostic messages, a counter for the entries in the sign in list or a list of the signed in transponders. For greater clarity, these outputs are deselected in the current example:

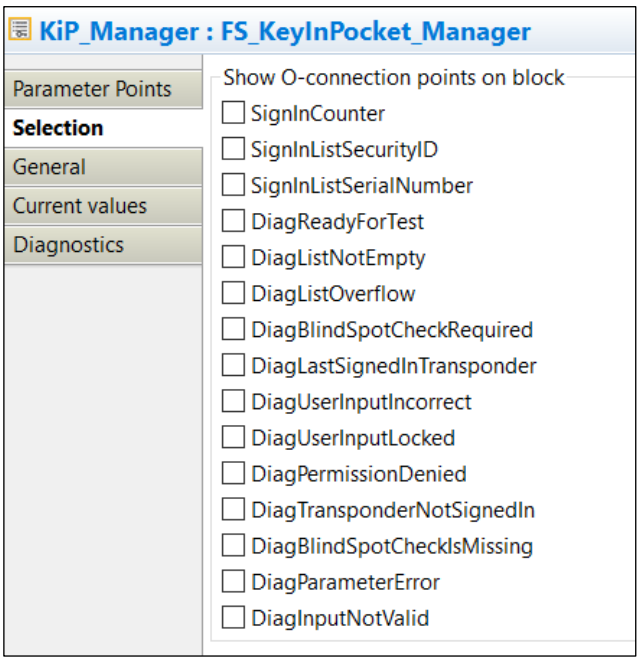


Figure 9: Selection settings "KiP_Manager"

6.1.2 Activation and monitoring of the safety gate with guard locking

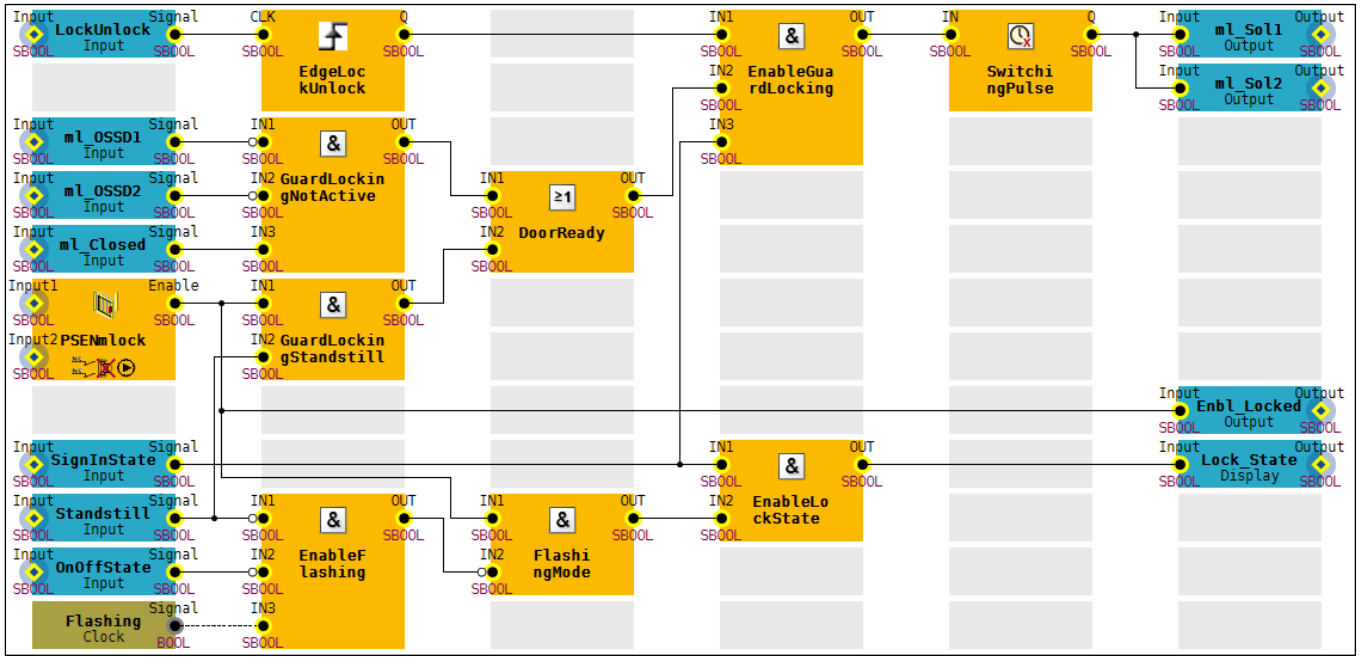


Figure 10: Multi program part "Activating and monitoring the safety gate with guard locking"

With a rising edge at the pushbutton "LockUnlock", guard locking on the PSENmlock is activated or deactivated with a pulse at the outputs "ml_Sol1" and "ml_Sol2". "Switching_Pulse" is a switch-off delay "TOF" of 400 ms.

To **activate** guard locking, the following conditions must be met:

- Safety gate closed, guard locking deactivated: "ml_Closed" = TRUE, "ml_OSSD1" = FALSE, "ml_OSSD2" = FALSE (block "GuardLockingNotActive")
- Transponder positioned and signed in to the sign in list: "SignInState" = TRUE (block "EnableGuardLocking")

To **deactivate** guard locking, the following conditions must be met:

- Safety gate closed, guard locking activated: "Enable" = TRUE ("FS_SafetyGate" block "PSENmlock")
- Machine standstill: "Standstill" = TRUE (block "GuardLockingStandstill")
- Transponder positioned and signed in to the sign in list: "SignInState" = TRUE (block "EnableGuardLocking")

The OSSDs of the PSENmlock are monitored using the block "FS_SafetyGate" ("PSENmlock"). The parameter settings are used to configure simultaneity monitoring of the OSSDs and the reset behaviour:

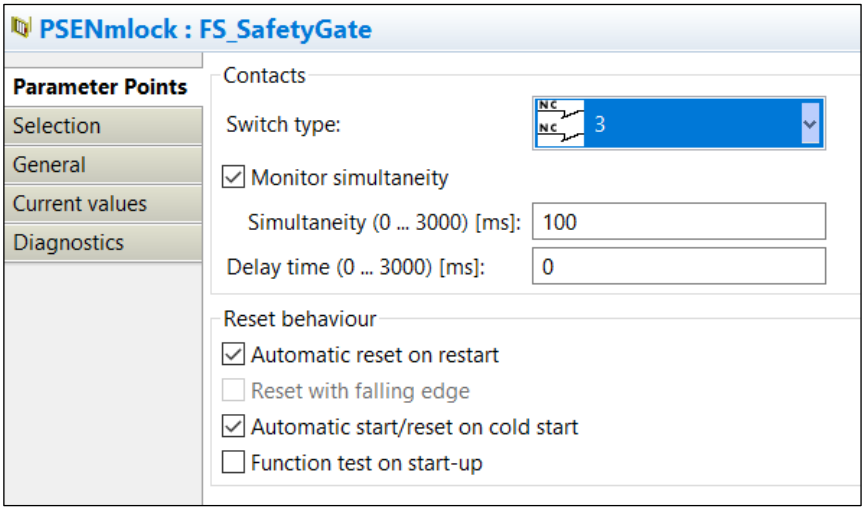


Figure 11: Parameter settings "PSENmlock"

The status of guard locking is forwarded via the output "Enbl_Locked" and signalled via the output "Lock_State".

"Lock_State" = TRUE is output when the following conditions are present:

- Safety gate closed, guard locking activated: "Enable" = TRUE ("FS_SafetyGate" block "PSENmlock")
- Machine stop requested: "OnOffState" = FALSE (blocks "EnableFlashing" and "FlashingMode")
- Machine standstill: "Standstill" = TRUE (blocks "EnableFlashing" and "FlashingMode")
- Transponder positioned and signed in to the sign in list: "SignInState" = TRUE (block "EnableLockState")

The block "Flashing" supplies a flashing signal, which is output at "Lock_State", when a machine stop is requested ("OnOffState" = FALSE), but a machine standstill has not yet been achieved ("Standstill" = FALSE). Guard locking must also still be activated ("Enable" = TRUE from the "FS_SafetyGate" block "PSENmlock") and a transponder must be positioned and signed in to the sign in list ("SignInState" = TRUE).

If the conditions stated above are not met, then "Lock_State" = FALSE.

6.1.3 Activating the machine

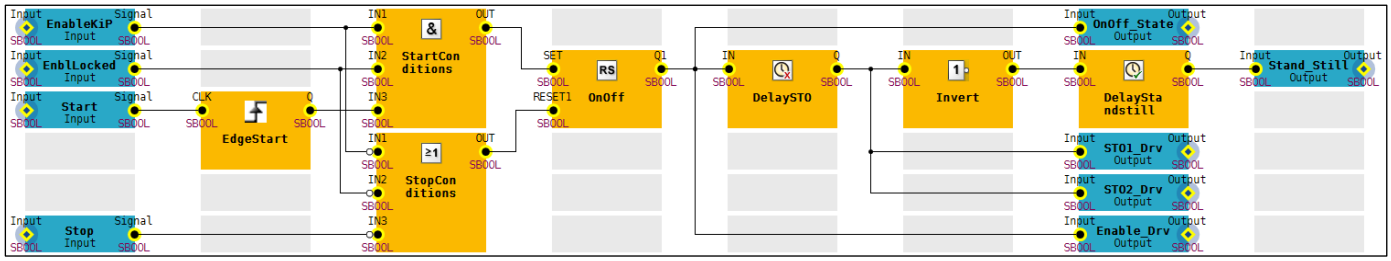


Figure 12: Multi program part "Activating the machine"

With a rising edge at the "Start" button, the machine can be started under the following conditions (block "StartConditions"):

- The sign in list is empty, the key-in-pocket system gives the enable: "EnableKiP" = TRUE
- The safety gate is closed and guard locking is activated: "EnblLocked" = TRUE

With the start signal, the RS-FlipFlop "OnOff" is set and the outputs "OnOff_State", "Enable_Drv", "STO1_Drv" and "STO2_Drv" are set to TRUE.

A machine stop is requested when either (block “StopConditions”):

- A person signs in to the key-in-pocket system’s sign in list: “EnableKiP” = FALSE

or

- The safety gate with guard locking does not supply an enable: “EnblLocked” = FALSE

or

- The stop button is operated: “Stop” = FALSE

If a machine stop is triggered (RS-FlipFlop “OnOff” = FALSE, “OnOff_State” = FALSE), the “Enable_Drv” output for the servo amplifier is switched off immediately, activating the set deceleration ramp in the servo amplifier. Both outputs “STO1_Drv” and “STO2_Drv” are switched off with a time delay, triggering the STO function in the servo amplifier once the drive has come to a standstill. In this case, “DelaySTO” is a switch-off delay “TOF” of 1000 ms.

In this example, standstill detection is implemented via a time delay. By switching off the STO outputs, the switch-on delay “TON” “DelayStandStill” is started via the negation “Invert”. The output “Stand_Still” = TRUE is issued once 5000 ms have elapsed.

6.2 IEC 61131 programming (programming language STL: Structured Text)

6.2.1 Declaration part

```
001  PROGRAM FS_Program
002  VAR
003     // Blocks
004     KiP_SignInOut                                  : FS_KeyInPocket_SignInOut;
005     KiP_Manager                                    : FS_KeyInPocket_Manager;
006     PSENmlock                                      : FS_SafetyGate_PLC;
007     SwitchingPulse                                 : TOF;
008     LockUnlockEdge                                 : R_TRIG;
009     Flashing                                       : Clock;
010     StartEdge                                      : R_TRIG;
011     OnOff                                          : RS;
012     DelaySTO                                       : TOF;
013     DelayStandstill                                : TON;
014
015  // PI variables for pushbuttons, display elements and actuator
016     SignInOut WITH VALID                        AT %I*  : SAFEBOOL;
017     SignInOut_Valid EXTENSION VALID OF SignInOut    : SAFEBOOL;
018     DeleteList WITH VALID                       AT %I*  : SAFEBOOL;
019     DeleteList_Valid EXTENSION VALID OF DeleteList  : SAFEBOOL;
020     SignInState                                 AT %Q*  : SAFEBOOL;
021     LockUnlock                                  AT %I*  : SAFEBOOL;
022     ml_Closed                                   AT %I*  : SAFEBOOL;
023     ml_OSSD1 WITH VALID                         AT %I*  : SAFEBOOL;
024     ml_OSSD1_Valid EXTENSION VALID OF ml_OSSD1      : SAFEBOOL;
025     ml_OSSD2 WITH VALID                         AT %I*  : SAFEBOOL;
026     ml_OSSD2_Valid EXTENSION VALID OF ml_OSSD2      : SAFEBOOL;
027     ml_Solenoid1                                AT %Q*  : SAFEBOOL;
028     ml_Solenoid2                                AT %Q*  : SAFEBOOL;
029     LockState                                   AT %Q*  : SAFEBOOL;
030     Start                                       AT %I*  : SAFEBOOL;
031     Stop                                        AT %I*  : SAFEBOOL;
032     Enable_Drv                                  AT %Q*  : SAFEBOOL;
033     STO1_Drv                                    AT %Q*  : SAFEBOOL;
034     STO2_Drv                                    AT %Q*  : SAFEBOOL;
035
036  // Internal variables
037     Enable_KiP                                     : SAFEBOOL;
038     Enable_Locked                                  : SAFEBOOL;
039     EnableGuardLocking                             : SAFEBOOL;
040     FlashingMode                                   : SAFEBOOL;
041     OnOffState                                     : SAFEBOOL;
042     Standstill                                     : SAFEBOOL;
043     StartConditions                                : SAFEBOOL;
044     StopConditions                                 : SAFEBOOL;
045  END_VAR
```

6.2.2 Instruction part

Note: For reasons of clarity, the emergency stop function is not represented here.

For program description see chapter 6.1 Multi programming [🕮 18].

```
// Key in Pocket - Access point for signing in/out of the sign in list
KiP_SignInOut(
   ActivateSignInOut                := TRUE,
   SignInOutPermission              := USINT#3,
   SignInOut                        := SignInOut,
   SignInOut_Valid                  := SignInOut_Valid
   );

// Key in Pocket - Management of sign in list
KiP_Manager(
   NumberOfChannels                 := USINT#1,
   SignInOutData                    := KiP_SignInOut.SignInOutData,
   DeactivateBlindSpotCheck         := TRUE,
   BlindSpotCheckOK                 := FALSE,
   ChannelDeleteList                := USINT#1,
   PermissionDeleteList             := USINT#5,
   DeleteList                       := DeleteList,
   DeleteList_Valid                 := DeleteList_Valid,
   Enable                           => Enable_KiP,
   SignInStatus1                    => SignInState
   );

// Safety gate system PSENmlock - Monitoring of safety gate
PSENmlock(
   SwitchType                       := USINT#3,
   Input1                           := ml_OSSD1,
   Input1_Valid                     := ml_OSSD1_Valid,
   Input2                           := ml_OSSD2,
   Input2_Valid                     := ml_OSSD2_Valid,
   AutoStart                        := TRUE,
   AutoReset                        := TRUE,
   MonitoredReset                   := FALSE,
   StartupTest                      := FALSE,
   SimultaneityTime                 := T#100ms,
   DelayTime                        := T#0ms,
   Reset                            := FALSE,
   Enable                           => Enable_Locked
   );

// Safety gate system PSENmlock - Activate/deactivate guard locking via edge
LockUnlockEdge(
   CLK := LockUnlock
   );

// Conditions for activating/deactivating guard locking
EnableGuardLocking :=
   SignInState AND LockUnlockEdge.Q AND
   ((ml_Closed AND NOT ml_OSSD1 AND NOT ml_OSSD2)
    OR
   (Enable_Locked AND Standstill));

// Safety gate system PSENmlock - Control pulse for guard locking
SwitchingPulse(
   IN := EnableGuardLocking,
   PT := T#400ms
   );
ml_Solenoid1 := SwitchingPulse.Q;
ml_Solenoid2 := SwitchingPulse.Q;

// Flash signal to display overrun when machine stop is requested
Flashing();
FlashingMode :=
   Enable_Locked AND
   NOT(NOT Standstill AND NOT OnOffState AND Flashing.Signal);

// Safety gate system PSENmlock - Display of guard locking status
LockState := SignInState AND FlashingMode;

// Drive started via edge (start button normally open)
StartEdge(
        CLK := Start
```

```
117         );
118
119  // Start conditions
120  StartConditions := StartEdge.Q AND Enable_Locked AND Enable_KiP;
121
122  // Criteria for stopping the drive (stop button normally closed)
123  StopConditions := NOT Stop OR NOT Enable_Locked OR NOT Enable_KiP;
124
125  // RS-Flipflop for storing the status of the drive
126  OnOff(
127     SET    := StartConditions,
128     RESET1 := StopConditions,
129     Q1     => OnOffState
130     );
131
132  // Switch off delay for shutting down via STO
133  DelaySTO(
134     IN := OnOffState,
135     PT := T#1000ms
136     );
137
138  // Activating the drive
139  Enable_Drv := OnOffState;
140  STO1_Drv   := DelaySTO.Q;
141  STO2_Drv   := DelaySTO.Q;
142
143  // Standstill detection via switch on delay after overrun ends
144  DelayStandstill(
145     IN := NOT DelaySTO.Q,
146     PT := T#5000ms,
147     Q => Standstill
148     );
149
150  END_PROGRAM
```

6.3 Resource assignment

The program “FS_Program” must be assigned to a task on the FS resource.

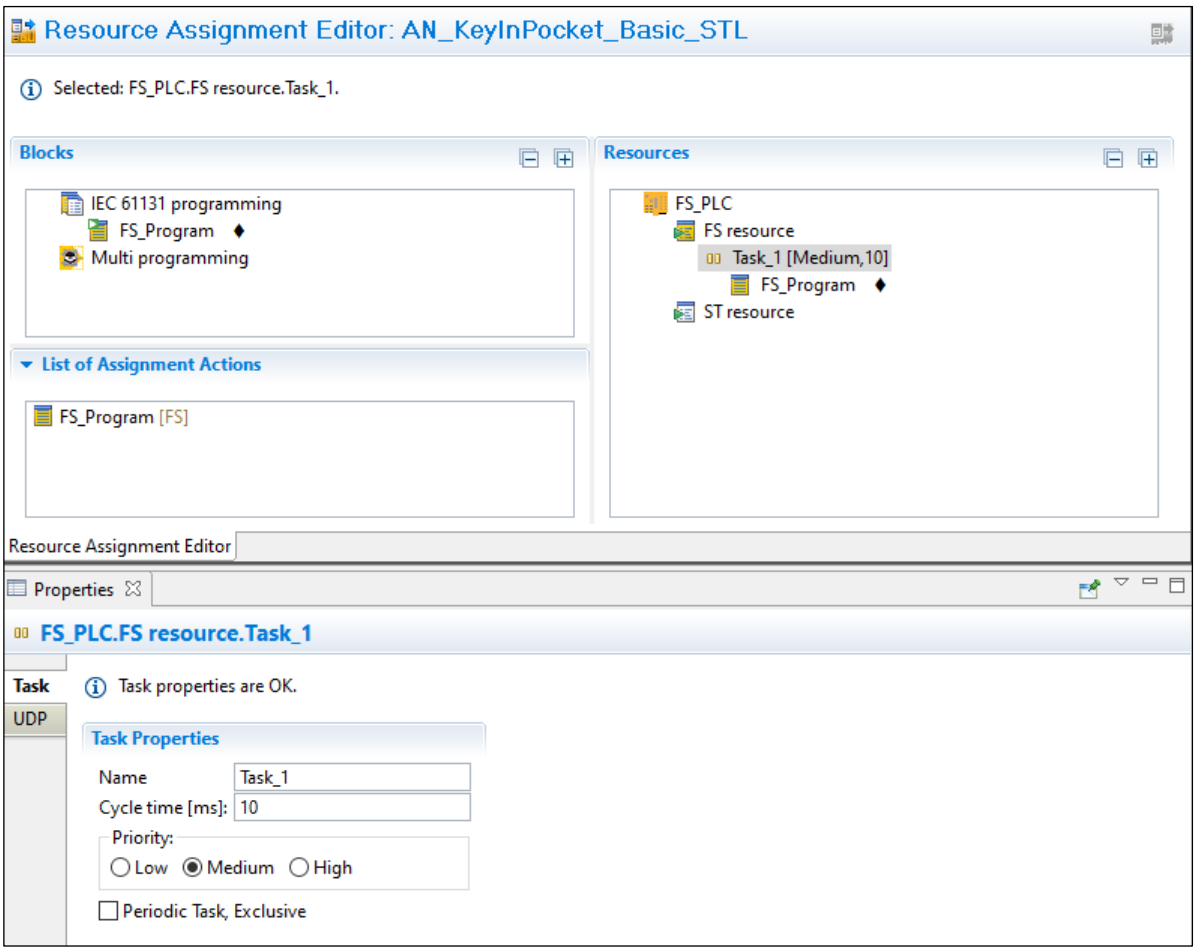


Figure 13: FS resource assignment

6.4 I/O mapping

The PI variables available in the user program can be mapped in the hardware configuration's I/O Mapping Editor. The following illustrations refer to IEC 61131 programming.

The following I/O mappings are to be made with the filter "PI variables <-> Module bus":

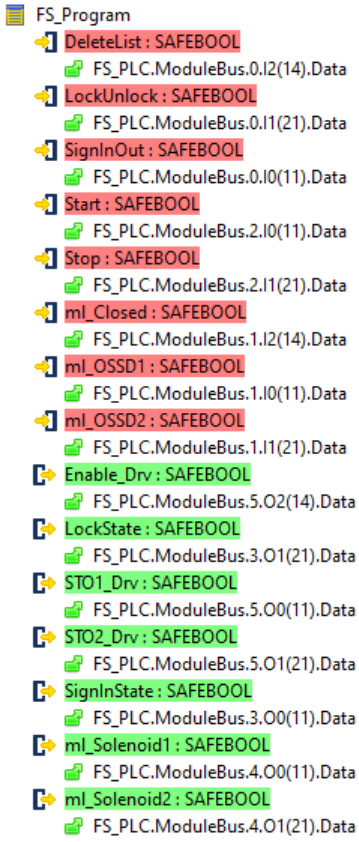
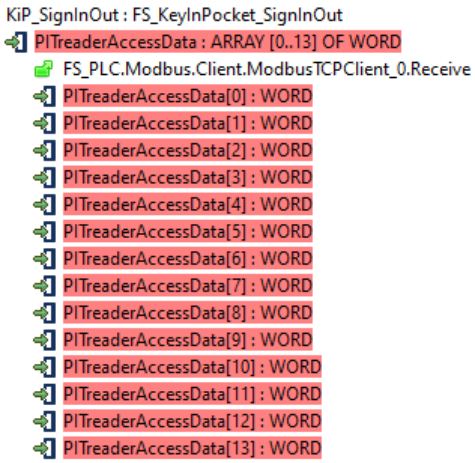


Figure 14: I/O mapping PI variables <-> Module bus

The following I/O mappings are to be made with the filter "PI variables <-> IP connections":



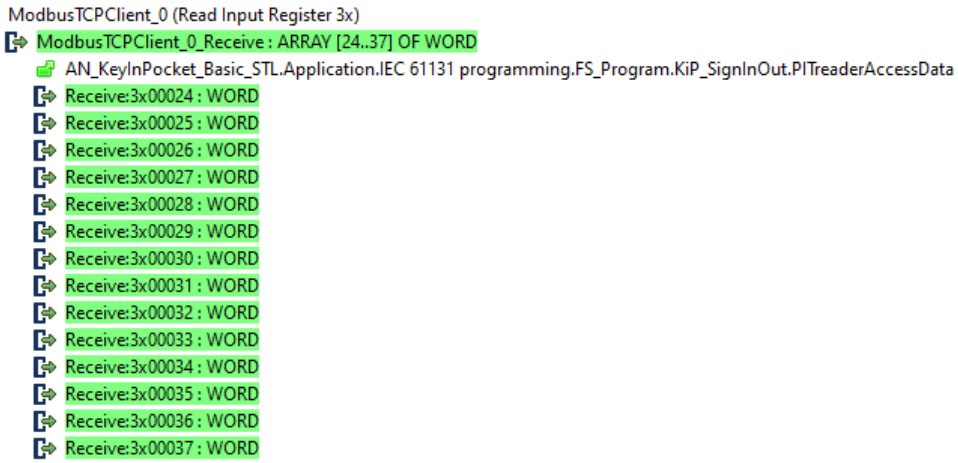


Figure 15: I/O mapping PI variables <-> IP connections

7 Application conditions

NOTICE

When using the key-in-pocket system, make sure that the following training takes place:

- Each person who comes into contact with the plant must be trained to know that they may only access the danger zone if they have previously signed in to the key-in-pocket system's internal sign in list.

- Each user must have an expectation regarding the dynamics of the signal lamp that displays the sign in status. This expectation must be provided through training:

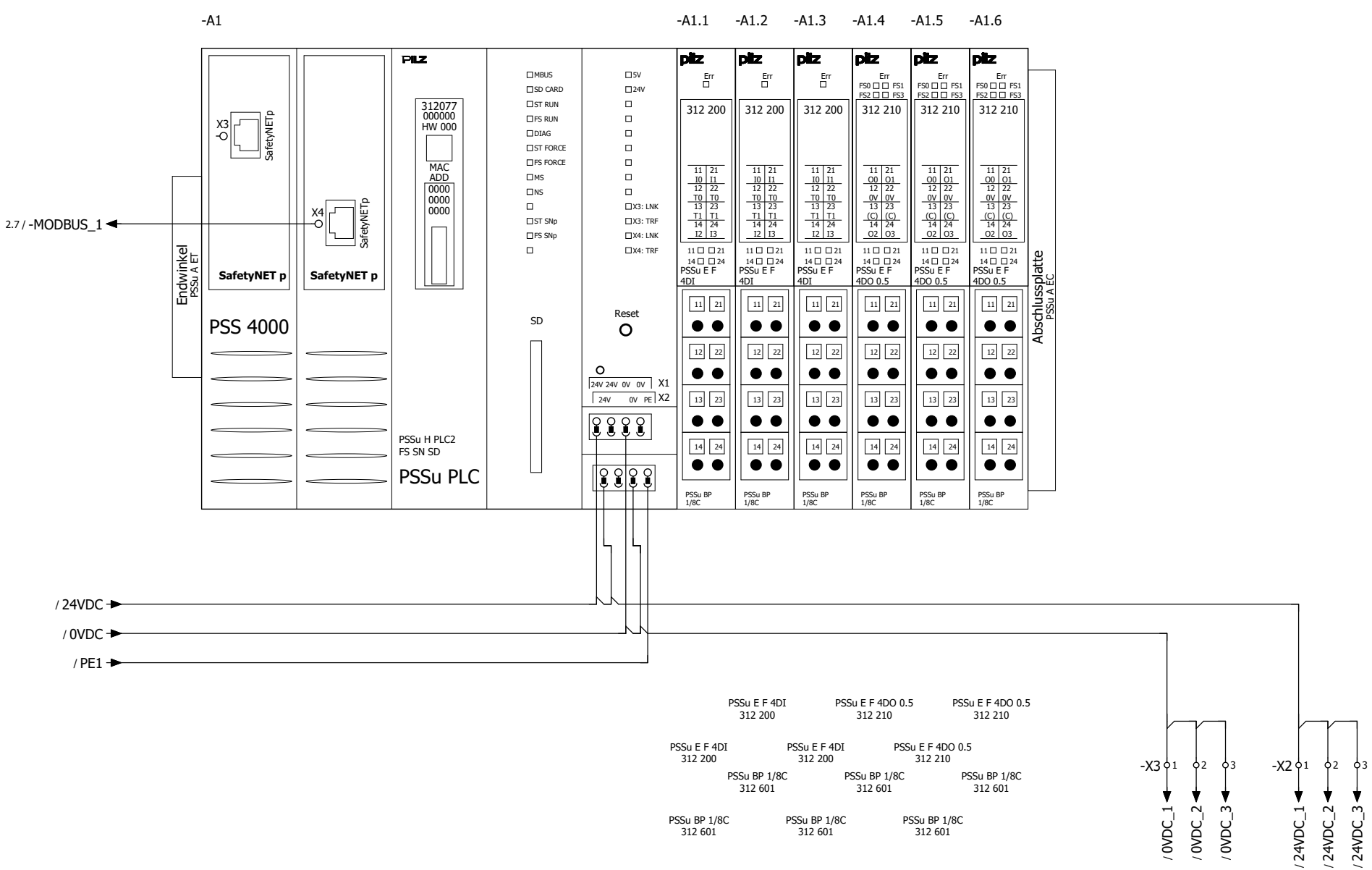
  - If the display element comes on when the transponder is positioned, the transponder is signed in to the sign in list. The display element goes off when the transponder is removed. The plant can be accessed if the person carries the transponder with them.
  - If the display element does not come on when the transponder is positioned, the transponder is not signed in to the sign in list. The plant may not be accessed. Before accessing the plant, the transponder must be signed in to the sign in list.
  - When signing in to the sign in list (transponder is positioned -> display element remains off -> press and release pushbutton), the display element must come on. If the display element does not come on, there is an error (evaluate diagnostic messages). The plant may not be accessed.
  - When signing out of the sign in list (transponder is positioned -> display element comes on -> press and release pushbutton), the display element must go off. If the display element does not go off, there is an error (evaluate diagnostic messages). The plant cannot be put into service.

NOTICE

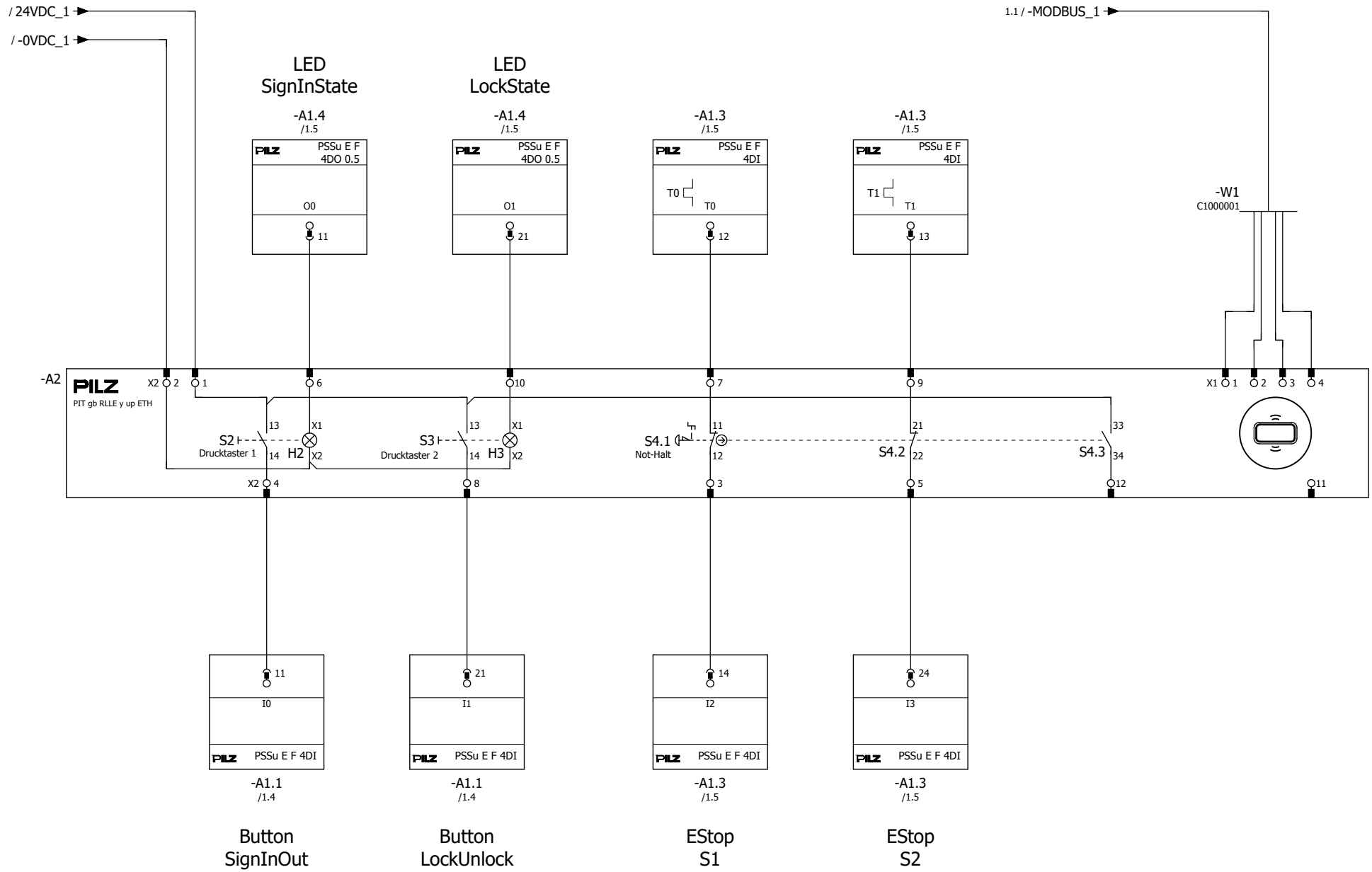
When using the key-in-pocket system, make sure that the following requirements are met:

- Where there is a movable guard that prevents access to the danger zone, a person may only open it if they have already signed in successfully to the key-in-pocket system's internal sign in list.
- FS outputs (off tests) must be used to control the display elements that signal the sign in status.
- The operator must use appropriate measures to ensure that the manual deletion of entries from the internal sign in list is restricted to those with appropriate training and is not regarded as a routine operation. This can be supported, for example, by restricting a transponder to certain permissions or by using a dedicated PITreader.
- After intervening in the internal sign in list (deleting entries), appropriate checks in the form of organisational measures must be used to ensure that nobody whose transponder is not included in the internal sign in list is left in the danger zone.
- After the power has failed and then been restored, in addition to the required function test, appropriate checks in the form of organisational measures must be used to ensure that nobody whose transponder is not included in the internal sign in list is left in the danger zone.
- In the following cases, PITreader units may only be used in areas that are accessible after signing into the key-in-pocket system's internal sign in list:
  - If used to check the sign in status of persons in the internal sign in list, with the objective of locking further processes
  - If used on stations for checking blind spots
- If additional functions are to be carried out depending on a transponder's sign in status, then these operations must be confirmed through an additional control element and may not be initiated purely as a result of checking the sign in status.

Please comply with the instructions for installation, wiring, commissioning and operation in the operating manuals for the individual components and in the system descriptions.



Revision	09.01.2023	Date	06.12.2022	EN ISO 13849-1	PL d	PILZ Pilz GmbH & Co. KG Felix-Wankel-Strasse 2 D-73760 Ostfildern	PSSu Basic	Mounting place + AN_1006504_01
Name	Pilz	Name	Pilz					
				EN 62061	SIL 2			Page: 1 / 4
		Dep.	CSI					



Revision	09.01.2023	Date	06.12.2022	EN ISO 13849-1	PL d	Pilz GmbH & Co. KG Felix-Wankel-Strasse 2 D-73760 Ostfildern	PSSu PIT gb RLLE
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		Dep.	CSI				

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+ AN_1006504_01

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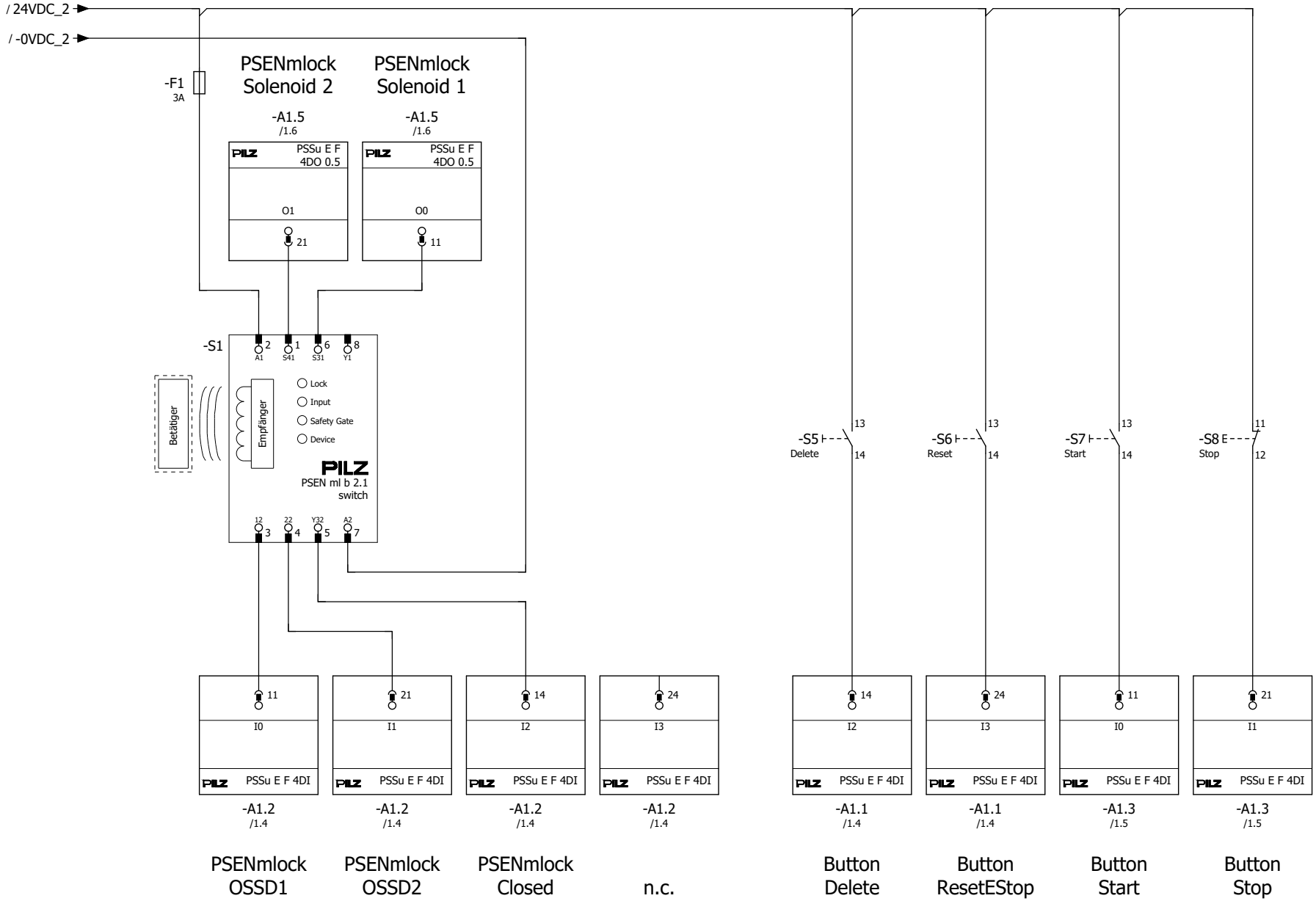
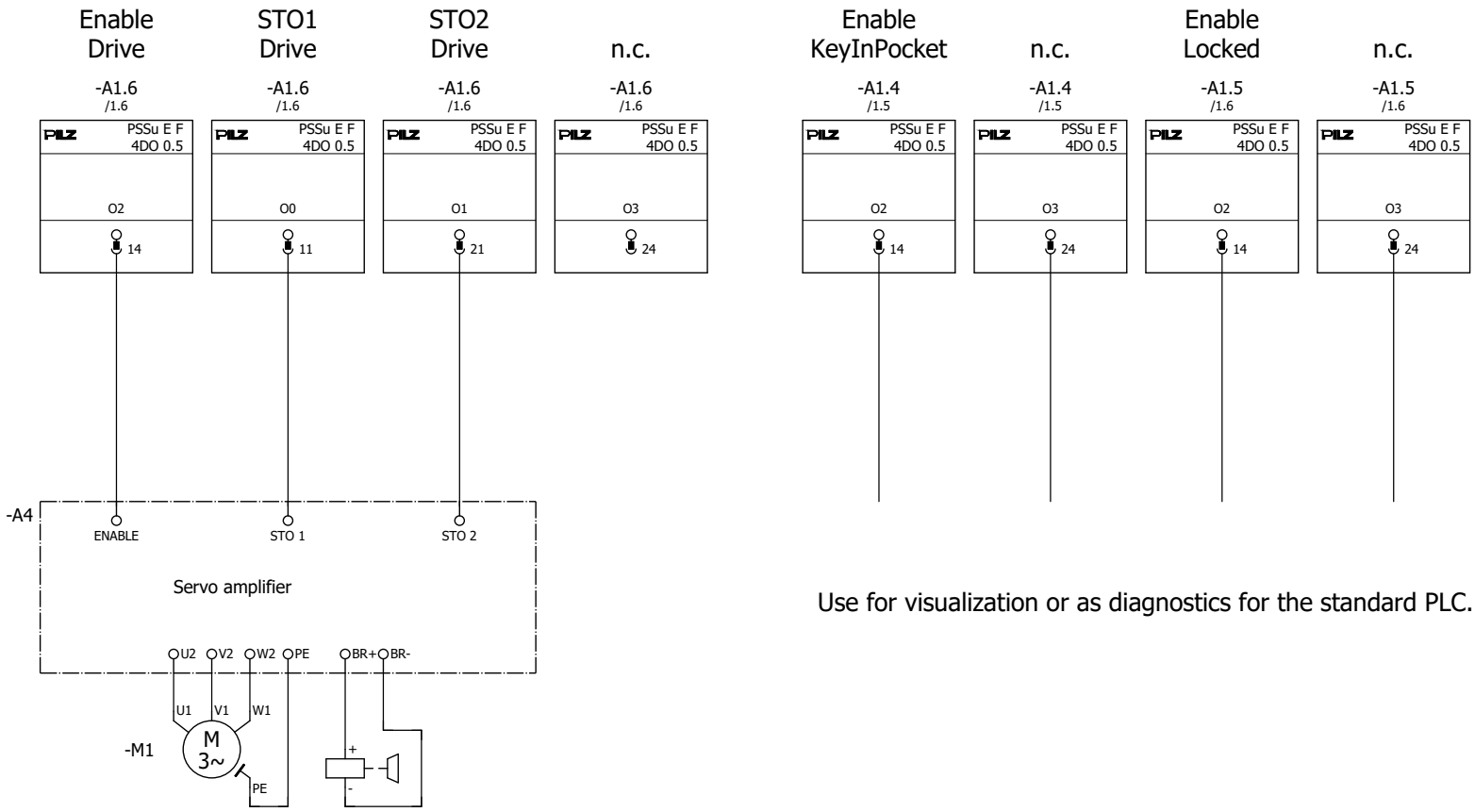


Revision	09.01.2023	Date	06.12.2022	EN ISO 13849-1	PL d	PILZ Pilz GmbH & Co. KG Felix-Wankel-Strasse 2 D-73760 Ostfildern	PSSu PSEN ml b 2.1	Mounting place + AN_1006504_01
Name	Pilz	Name	Pilz					
				EN 62061	SIL 2			Page: 3 / 4
		Dep.	CSI					



Use for visualization or as diagnostics for the standard PLC.

Revision	09.01.2023	Date	06.12.2022	EN ISO 13849-1	PL d	PILZ Pilz GmbH & Co. KG Felix-Wankel-Strasse 2 D-73760 Ostfildern	PSSu Drive	Mounting place + AN_1006504_01
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				EN 62061	SIL 2			Page: 4 / 4
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