Safe operating mode selection with PSS 4000, PITreader and PMI (PSSu PITmode flex visu)

PILZ
THE SPIRIT OF SAFETY

Product

Type:	PITreaderAccess, FS_MSO_PITreader_Visu
Name:	PSS 4000, PITreader, PMI
Manufacturer:	Pilz GmbH & Co. KG, Safe Automation

Document

Release Number:	01
Release Date:	14 February 2022

Application Note – 1005823-EN-01

Document Revision History

Release	Date	Changes	Chapter
01	2022-02-14	Creation	all

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.

February 2022

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
PSSu	**PSSu**niversal	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	
MSO	**M**ode of **S**afe **O**peration	
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 operating mode selection and access permission system “PITmode flex visu”.

“PITmode flex visu” includes the access permission system PITreader and safe operating mode selection via a Pilz visualisation system with a Pilz programmable safety system, in this case a PSSu PLC from the automation system PSS 4000.

The general procedure for a successful basic configuration is shown.

NOTICE

A detailed explanation of safety functions used in the failsafe application and its evaluation regarding functional safety are not a 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 PITmode flex visu	1005364-EN-xx
3	System Description PSS 4000	1001467-EN-xx
4	Safety Manual PSS 4000	1001468-EN-xx
5	Operating Manual PITreader	1004806-EN-xx
6	Operating Manual PMI v707e	1003980-EN-xx
7	Operating Manual PSSu H PLC1 FS SN SD	21939-EN-xx
8	Operating Manual PSSu E F 4DI	21310-EN-xx
9	Operating Manual PSSu E F 4DO 0.5	21316-EN-xx
10	Operating Manual PSSu E S 4DI	21340-EN-xx
11	PAS4000 Online Help	-
12	PASvisu Builder Online Help	-

2.2 Documentation from other sources of information

No.	Description	Item No. / Download
1	EN ISO 16090-1:2018 Machine tools safety – Machining centres, Milling machines, Transfer machines – Part 1: Safety requirements	European standard
2	EN ISO 13849-1:2015 Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	European standard
3	EN ISO 12100:2010 Safety of machinery – General principles for design – Risk assessment and risk reduction	European standard
4	EN 60204-1:2018 Safety of machinery – Electrical equipment of machines – Part 1: General requirements	European standard

3 Used hardware and software

3.1 Pilz products

No.	Descriptions	Order number	Version	Number
1	PSSu H PLC1 FS SN SD	312070	FW 1.23	1
2	PSSu E F 4DI	312200	-	2
3	PSSu E F 4DO 0.5	312210	-	1
4	PSSu E S 4DI	312400	-	1
5	PSSu A Con 2/8 C (connector set, spring-loaded connection)	313111	-	1
6	PSSu BP 1/8C	312601	-	4
7	PITreader base unit	402255	-	1
8	PITreader key adapter h	402308	-	1
9	PITreader key ye 1	402261	-	1
10	PITreader key ye 3	402263	-	1
11	PITreader key ye 5 service	402269	-	1
12	PMI v707e	266707	-	1
13	PASvisu Builder	-	V 1.11	1
14	Software-Plattform PAS4000	-	V 1.23	1

The Pilz product portfolio also includes safety switches for safety gates, safe rotary encoders, enabling switches, servo amplifiers and drives. However, these are not described in detail here as they are not at the core of this Application Note.

3.2 Structure of the application (schematic)

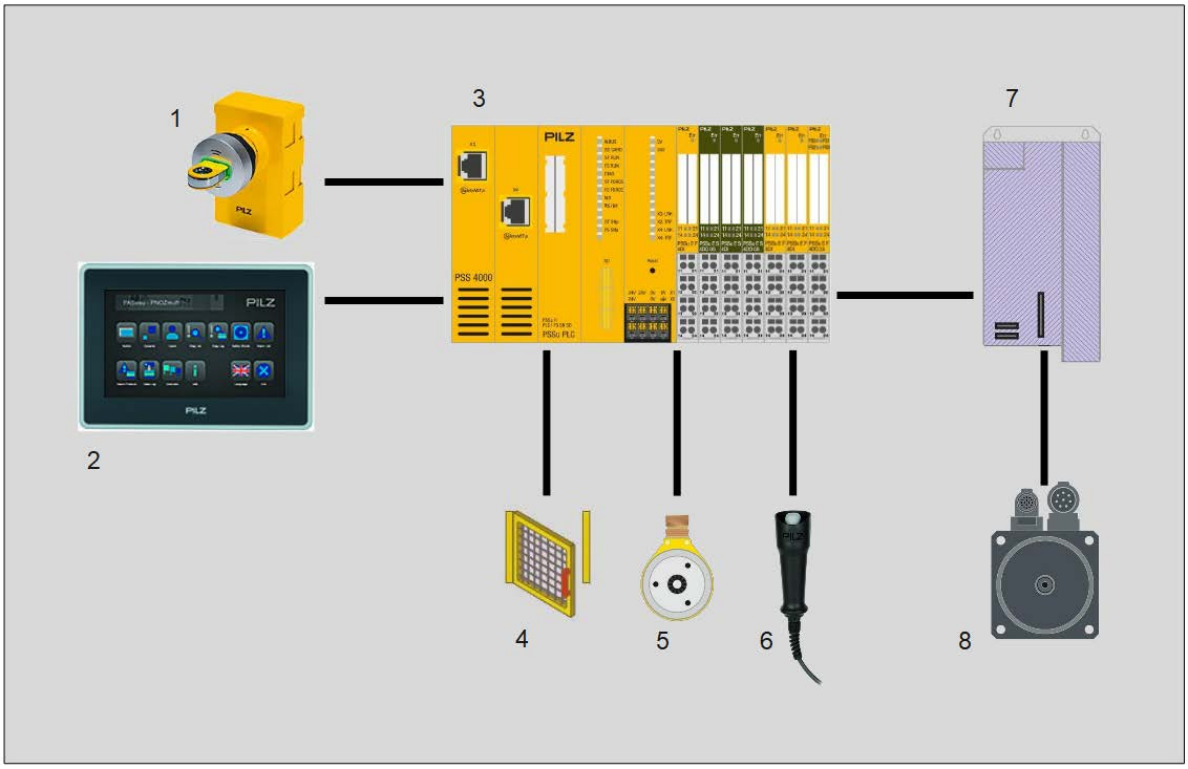


Figure 1: Application – Structure of the hardware (schematic)

1. Access permission system PITreader
2. Display unit PMI v707e
3. Failsafe controller PSSu PLC1
4. Safety gate (safeguard to be activated)
5. Speed sensor (safeguard to be activated)
6. Enabling switch (safeguard to be activated)
7. Servo amplifier (actuator technology)
8. Drive (actuator technology)

4 Application description

4.1 Task

A typical, popular starting point is outlined in order to illustrate the use of the system "PITmode flex visu" in a practical situation.

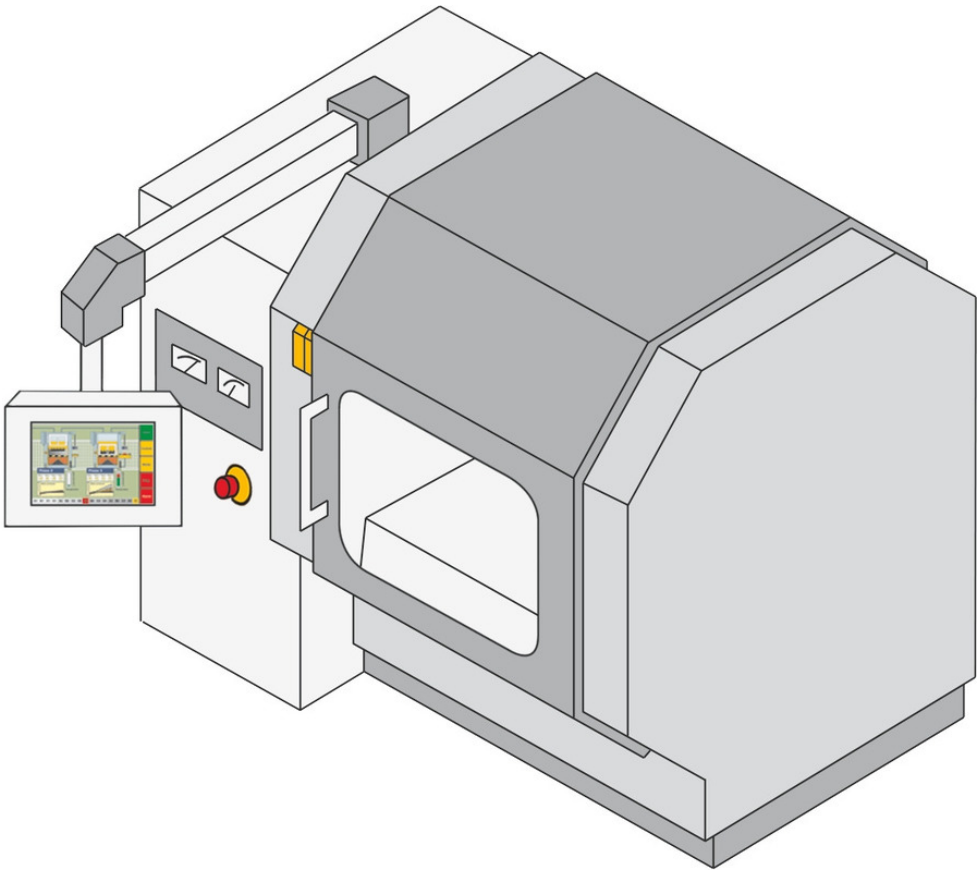


Figure 2: Machine tool

5 modes of safe operation are provided for a new Type 3 machine tool in accordance with EN ISO 16090-1 [2018]:

- MSO 1 - Automatic mode
- MSO 2 - Setup mode
- MSO 3 - Mode for manual access under restricted operating conditions
- MSO 4 - Special mode (process monitoring)
- MSO 5 - Service mode

The machine operator should only be able to select MSO 1, the tool setter MSO 1 to MSO 3 and appropriately trained service personnel MSO 1 to MSO 5.

Activation of the required safeguards is a prerequisite for operating the machine in a selected mode of safe operation. In this case the risk analysis showed the following:

- Automatic mode: Monitoring of the closed safety gate
- Set-up mode: Monitoring of the limited speed of linear and rotational axes plus the enabling device
- Mode for manual access: Monitoring of the restricted operating conditions (axis vector speed, spindle speed) plus the enabling device

- Special mode (process mon.) Monitoring of the limited speed of linear and rotational axes, monitoring of limited travel, shutdown of unnecessary function units (e.g. tool change)
- Service mode: Monitoring of the removable service equipment, monitoring of the limited speed of linear and rotational axes and the hold-to-run control device

The higher level E-STOP device must be effective in all modes of safe operation.

CAUTION!

A risk analysis in accordance with EN ISO 12100 [2010] must be carried out to establish the safeguards precisely.
For this example, reference is also made to compliance with the requirements specified in the standard EN ISO 16090-1 [2018].

4.2 Selection system for modes of safe operation (MSO)

The selection system for modes of safe operation is generally divided into the following subfunctions:

- Access device
- Selection device
- Activation device

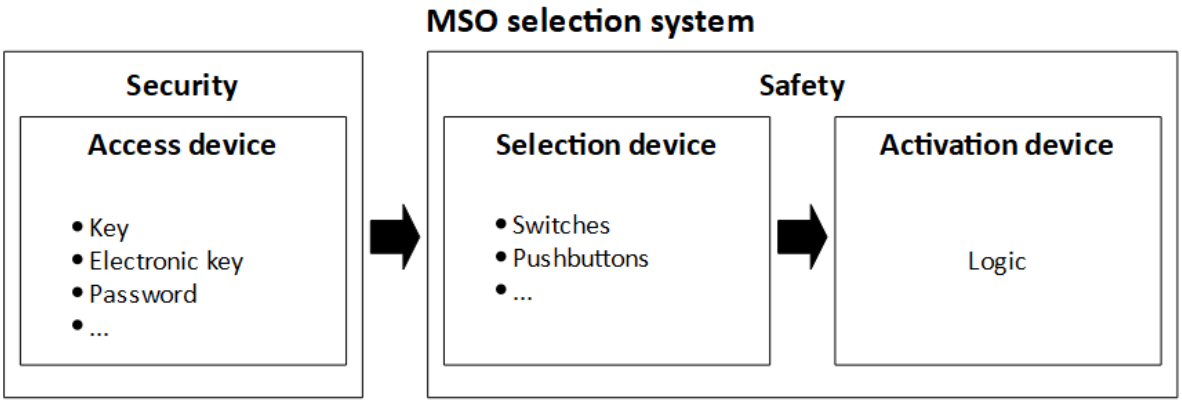


Figure 3: Selection system for modes of safe operation

"PITmode flex visu" uses an electronic modular system to replace the key switch that used to be used previously to select the modes of safe operation.

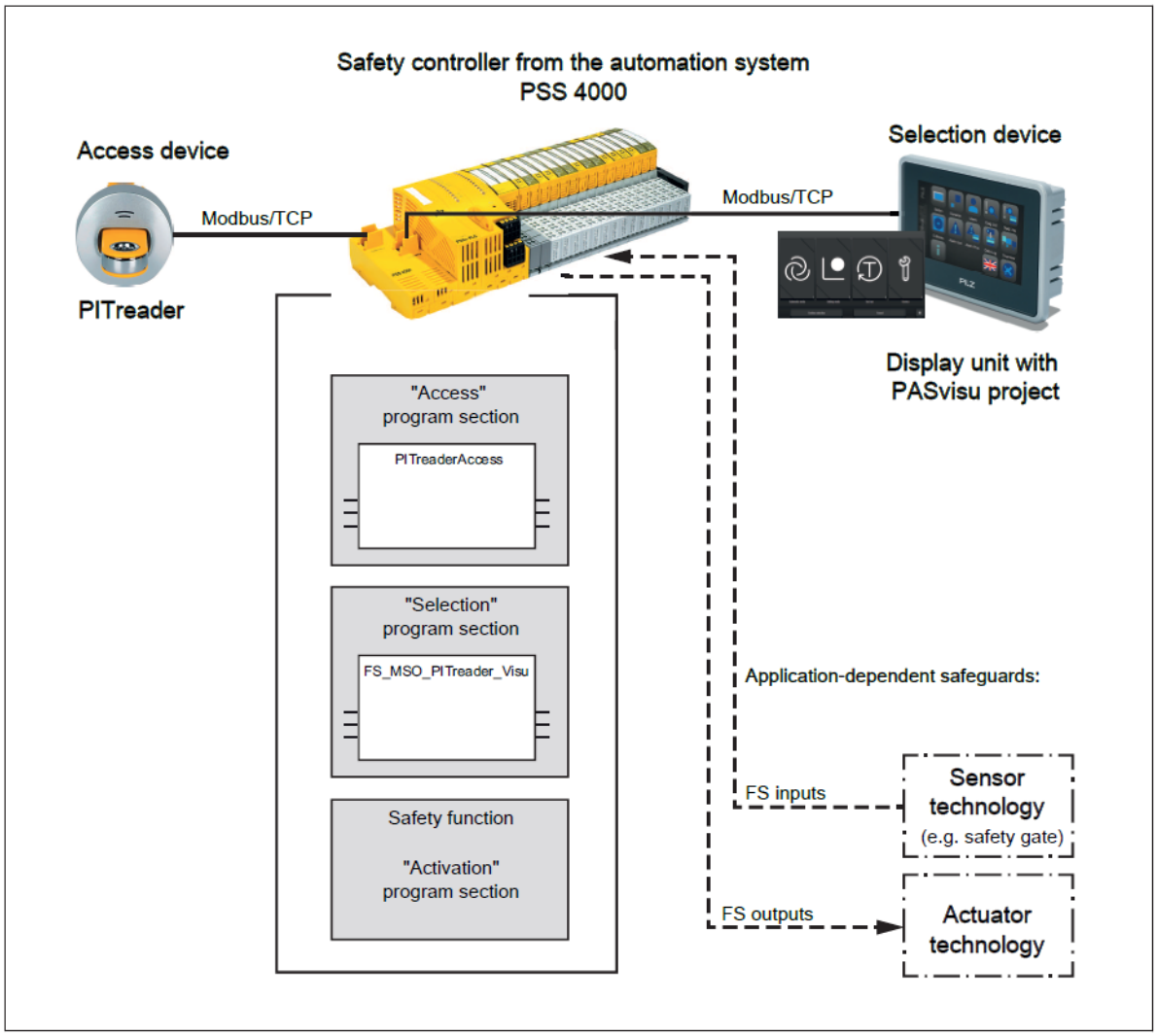


Figure 4: System overview "PITmode flex visu"

- Access device
  The access device consists of the access permission system PITreader and transponder keys. A user can authenticate himself on the safety controller by inserting a transponder key into the PITreader. He will then be authorised for certain actions. The permission on the transponder key must be greater than or equal to the selection (MSO number) made on the operating mode selector switch. The function block "PITreaderAccess" is available on the safety controller to evaluate the access device.

- Selection device
  Operating modes are selected using a display unit (Visu panel). A project from the visualisation system PASvisu is operated on the display unit. The "MSO flex visu" tile is used in the process. The operating mode is selected on the tile; the status of the operating mode selection is also displayed. The selection device must be evaluated on the safety controller using the function block "FS_MSO_PITreader_Visu".

- Activation device
  The required safeguards are activated in the activation device, depending on the selected mode of safe operation.

The hardware and software configuration for access permission and selection of the mode of safe operation for this machine are described below.

NOTICE

Implementation of the safeguards (such as E-STOP, safety gate, enabling switch, monitoring of limited speed etc.) and activation of the modes of safe operation are not part of this Application Note.

4.3 Access permission with PITreader

The PITreader is connected to the safety controller via a Modbus/TCP connection. Monitoring of the PITreader and provision of the data stored on the transponder keys occurs in the user program via an instance of the block "PITreaderAccess". There are no settings to make on the block.

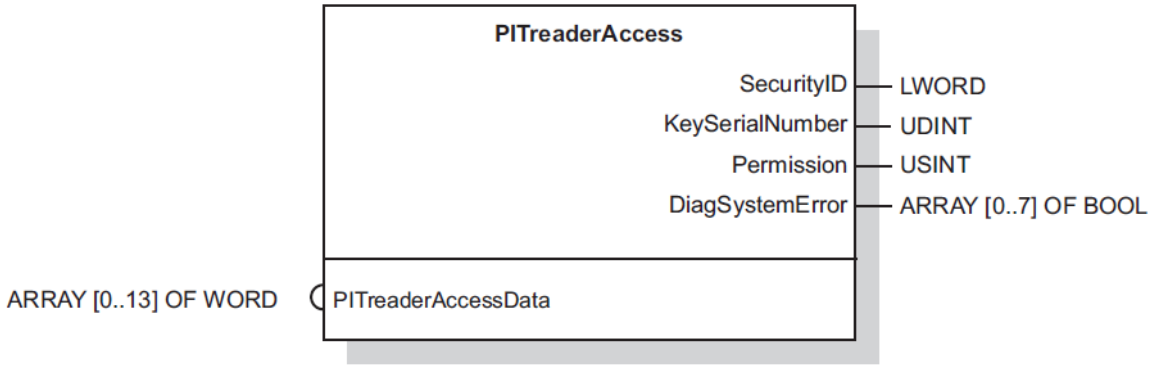


Figure 5: Block header „PITreaderAccess“

The block "PITreaderAccess" outputs the following data via O-variables:

- Security ID of the transponder key (SecurityID)
- Serial number of the transponder key (KeySerialNumber)
- Permission of the transponder key (Permission)
- Diagnostic information (DiagSystemError)

Operating mode selection is locked if the permission is 0. The block outputs permission 0 when:

- No transponder key is inserted
- No permission is stored on the transponder key
- An error occurred when reading the transponder key (invalid data)

When the permission is greater than 0, the modes of safe operation are enabled for selection in accordance with the permission.

Transponder keys with different permissions are used to guarantee that only authorised personnel with appropriate qualifications can select the modes of safe operation.

- Transponder key for machine operators: Permission 1 – MSO 1
- Transponder key for tool setters: Permission 3 – MSO 1...MSO 3
- Transponder key for service personnel: Permission 5 – MSO 1...MSO 5

4.4 Operating mode selection via display unit PMI

The PMI is connected via a Modbus/TCP connection to the programmable safety system.

The display and operator elements on the visualisation system are controlled and monitored in the user program by means of an instance of the block “FS_MSO_PITreader_Visu”.

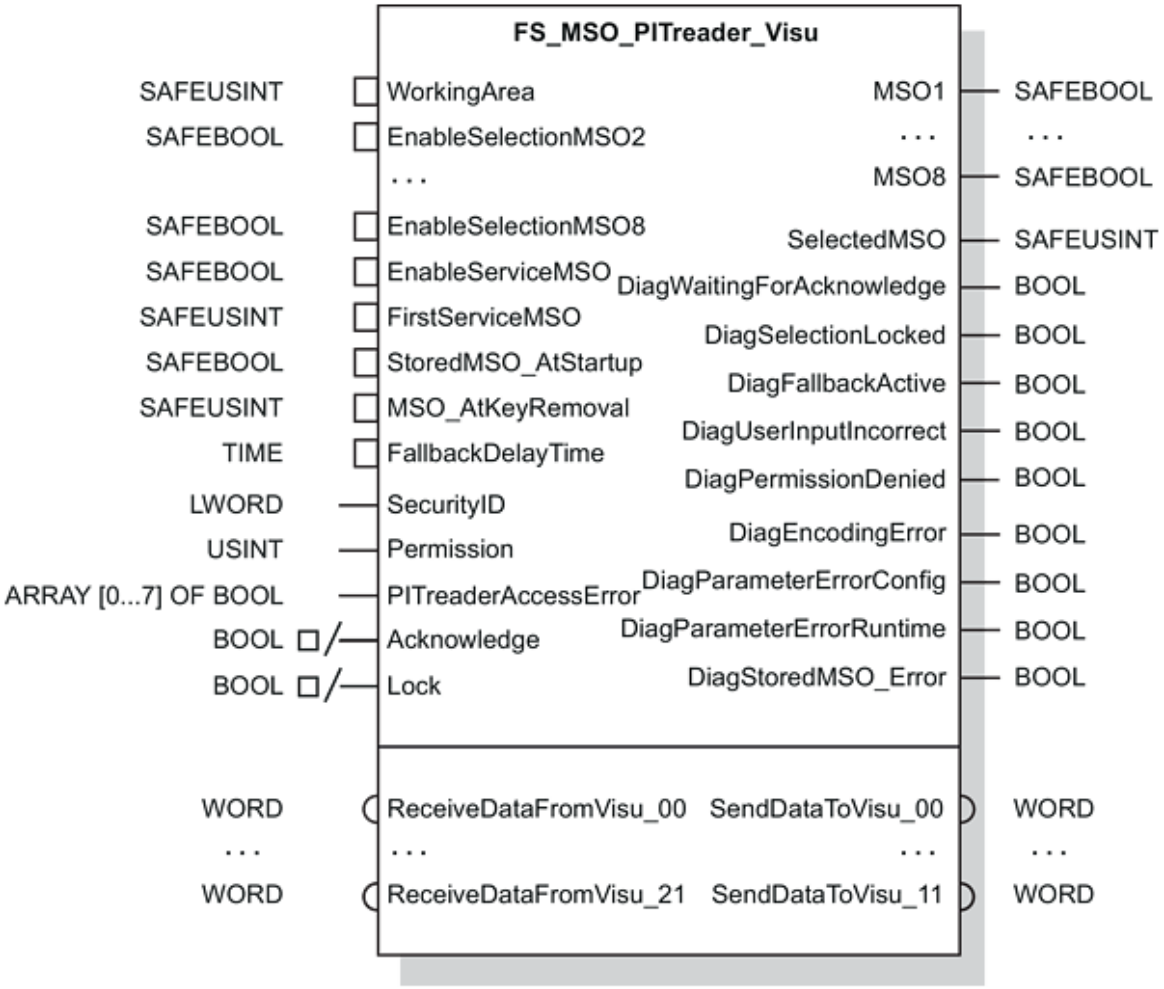


Figure 6: Block header „FS_MSO_PITreader_Visu“

The parameters of the block are set as follows for the example given here, see Section 6.1.1 Multi programming [🕮 23] or Section 6.1.2 IEC 61131 programming (programming language STL: Structured Text) [🕮 25].

- Working area (WorkingArea): 1
- Enable selection of MSO2 (EnableSelectionMSO2): Yes/TRUE
- Enable selection of MSO3 (EnableSelectionMSO3): Yes/TRUE
- Enable selection of MSO4 (EnableSelectionMSO4): Yes/TRUE
- Enable selection of MSO5 (EnableSelectionMSO5): Yes/TRUE
- Enable selection of MSO6 (EnableSelectionMSO6): No/FALSE
- Enable selection of MSO7 (EnableSelectionMSO7): No/FALSE
- Enable selection of MSO8 (EnableSelectionMSO8): No/FALSE
- Enable service operating mode (EnableServiceMSO): Yes/TRUE
- Start of service operating modes (FirstServiceMSO): 5
- Startup with stored operating mode (StoredMSO_AtStartup): No/FALSE
  (meaning MSO1 is selected after PSS restart)

- Behaviour after removal of the transponder key (MSO_AtKeyRemoval): 2
  ("2" = return to operating mode 1 if service operating mode is selected, in all other cases the selected operating mode is retained when the transponder key is removed)
- Delay-on de-energisation time after removal of the transponder key: 15 seconds
  (FallbackDelayTime)

The I variable *SecurityID* is assigned the O variable *SecurityID* of the block "PITreaderAccess".

The I variable *Permission* is assigned the O variable *Permission* of the block "PITreaderAccess".

The I variable *PITreaderAccessError* is assigned the O variable *DiagSystemError* of the block "PITreaderAccess".

The I variable *Acknowledge* is assigned a signal (e.g. from the CNC) that provides information about when the machine is ready for a change of the operating mode, e.g. when a machining operation is completed.

The I variable *Lock* is not used in this example. This is permanently assigned FALSE.

Except for *MSO1* to *MSO5*, the remaining I and O variables are not used in this example.

The I-PI variable *ReceiveDataFromVisu_xx* and the O-PI variable *SendDataToVisu_xx* are assigned by means of I/O mapping (Modbus/TCP connection).

The block ensures that only one operating mode is selected at one time, meaning that only one of the outputs *MSO1* – *MSO8* is TRUE.

More detailed information about the I and O variables for the block can be found in the PAS4000 online help.

The configuration of the operating mode selection in the programmable safety system and in the display unit must be the same, see chap. 6.2 PMI [🕮 29]. If the configurations are different, no operating mode selection is possible.

The working area cannot be assigned twice. If additional operating mode selections are to be used in the same PSS project, the I variable *WorkingArea* must be assigned different values. In a Modbus/TCP network, max. 10 working areas can be used.

4.5 Activating the modes of safe operation

In the safety controller, the modes of safe operation must be activated by linking the O-variables *MSO1* to *MSO5* of the block "FS_MSO_PITreader_Visu" to the necessary safeguards.

The following must be noted for implementation:

- In all operating modes, triggering of the emergency stop function must lead to the removal of power to the drives.
- The safeguards activated in the individual operating modes must lead to the removal of power to the drives if the safety function is triggered on any of the active safeguards (e.g. safety gate opened, limit value for permitted speed exceeded, 3-stage enabling switch fully depressed),
- A change of operating mode must lead to the removal of power to the drives.
- A reset of the safety function after it has been triggered must never cause the drives to start up automatically. (The requirements for the execution of the reset are not covered in this Application Note.)

The removal of power to the drives (STO) can be executed as a stop category 0 or 1 in accordance with EN 60204:2018, clause 9.2.2.

4.6 Safety considerations

4.6.1 PITreader

Access permission with PITreader does not contribute to functional safety and so is not safety-related in design. This classification results from a comparison with the conventional "key switch" system: key and lock are similar in not contributing to functional safety.

Any errors detected by the PITreader or the evaluation block "PITreaderAccess" mean that the permission will be 0 (O-variable *Permission* on the block "PITreaderAccess"). As a result, operating mode selection is locked.

Potential errors are:

- Transponder key defective
- Transponder key without permission
- PITreader defective
- Connection between PITreader and safety controller interrupted

4.6.2 Operating mode selection

The "FS_MSO_PITreader_Visu" block meets the following safety requirements:

- The block prevents unintentional changeover.
  Changing to another safe operating mode is – if the relevant authorisation is present – initiated by a deliberate operator action. For this, a button on the visualisation system (selection equipment) must be pressed and released again within a defined time period.
  The visualisation system reports the selection to the block. The block first reports the selection back to the visualisation system. On the visualisation system, the user must check the reported selection and confirm this by pressing a separate button within a defined time period. The block only transmits the selection to the activation equipment following confirmation.
- The block detects simultaneous operation of several buttons as an error.
  A new selection is only possible after all buttons have been released.
- The block ensures that only one safe operating mode is selected at all times, in that only one of the outputs MSO1 – MSO8 is TRUE.
- The block ensures that after restarting the programmable safety system – depending on the configuration – either the safe operating mode 1 (MSO1) or the last selected safe operating mode is output.

The parameters of the block are monitored for the permitted value range. The parameters are read in when the programmable safety system is restarted and can no longer be changed during operation.

Errors that are detected during configuration, operation or authorisation are reported.

4.6.3 Safeguards

An examination of the individual safeguards activated in the various operating modes would exceed the scope of this Application Note. At this point, therefore, we shall only refer to some of the key points:

- Energising a safeguard (e.g. opening a safety gate, exceeding the permitted speed), forces power to be removed (activation of STO). As a result, the drive cannot generate any torque, including any braking torque.
  - Consequently further hazards may arise, which need to be examined, such as:
  - Taking longer to reach standstill (overrun)
  - Uncontrolled falling (e.g. on vertical axes)

- Positional change due to mass, pressure or voltage,
- Etc.

If it is possible for the operator to encroach into the danger zone, whether fully or partially, a risk analysis should clarify whether a separate, additional "manual reset function" is required.

4.7 Functional Safety

4.7.1 Introduction

Operating mode selection is treated as a separate safety function. If operating mode selection should fail, in a worst case scenario the machine might be operated without safety functions without anyone noticing. For this reason, the highest PL_r of all the safety functions that can be activated on the machine should generally be applied for operating mode selection. The system "PITmode flex visu" can be used for applications up to Category 3 PL d of EN ISO 13849-1 or SIL CL 2 of EN 62061.

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

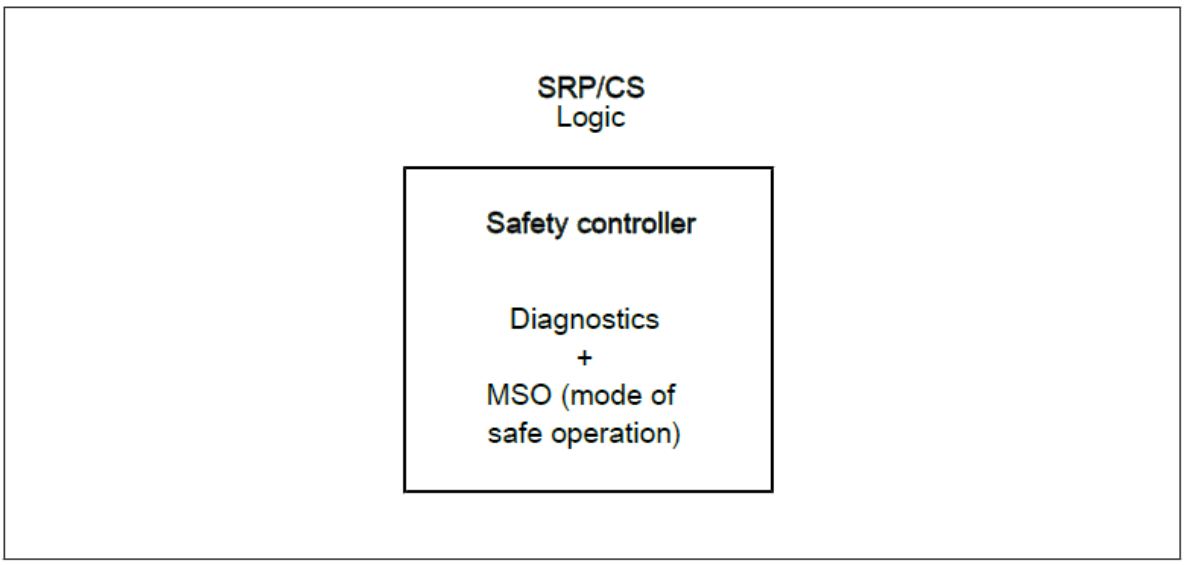


Figure 7: Safety-related architecture, "Access and operating mode selection" subsystem

INFORMATION

As the residual error rate Λ of the communication system (Modbus/TCP) contributes to no more than 1 % of the safety function's total probability of failure, it can be ignored when calculating the safety characteristic data for the "operating mode selection" safety function and does not need to be added to the SRP/CS.

The probability of failure of the access device and the visual selection device does not need to be included in the calculation of the safety function's probability of failure.

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

No.	Safety function	Performance level	Safety-related parts of the control system
1	Activation of the safety functions required for the selected operating mode	PL d	Logic (PSSu H PLC1 FS SN)

No.	Description	Identifier
1	Mission time	20 years

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

4.7.3 Safety-related characteristic data in accordance with EN 62061

No.	Safety-related control function (SRCF)	Safety integrity level	Subsystems
1	Activation of the safety functions required for the selected operating mode	SIL 2	Logic (PSSu H PLC1 FS SN)

No.	Description	Identification
1	Proof test interval	20 years

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

5 Hardware configuration

5.1 PITreader

Upon delivery the PITreader has the IP address 192.168.0.12. If this IP address is free in the network and is therefore usable, no configuration is required on the PITreader.

The PITreader is configured via a web application, which is called up via a standard browser. The web application can be used generally to make the settings on the PITreader and to make changes on transponder keys. The PITreader operating manual contains a detailed description.

This example uses transponder keys that are pre-configured and cannot be changed. The permissions are permanently set and apply to all device groups.

5.2 PMI

The configuration of the PMI is limited to assigning the device a network address. Using the PMI Manager, the IP address 192.168.0.2 is set on the display unit.

A detailed description of the PMI manager can be found in the PMI v704e/v707e operating manual.

5.3 PSSu PLC

5.3.1 Overview

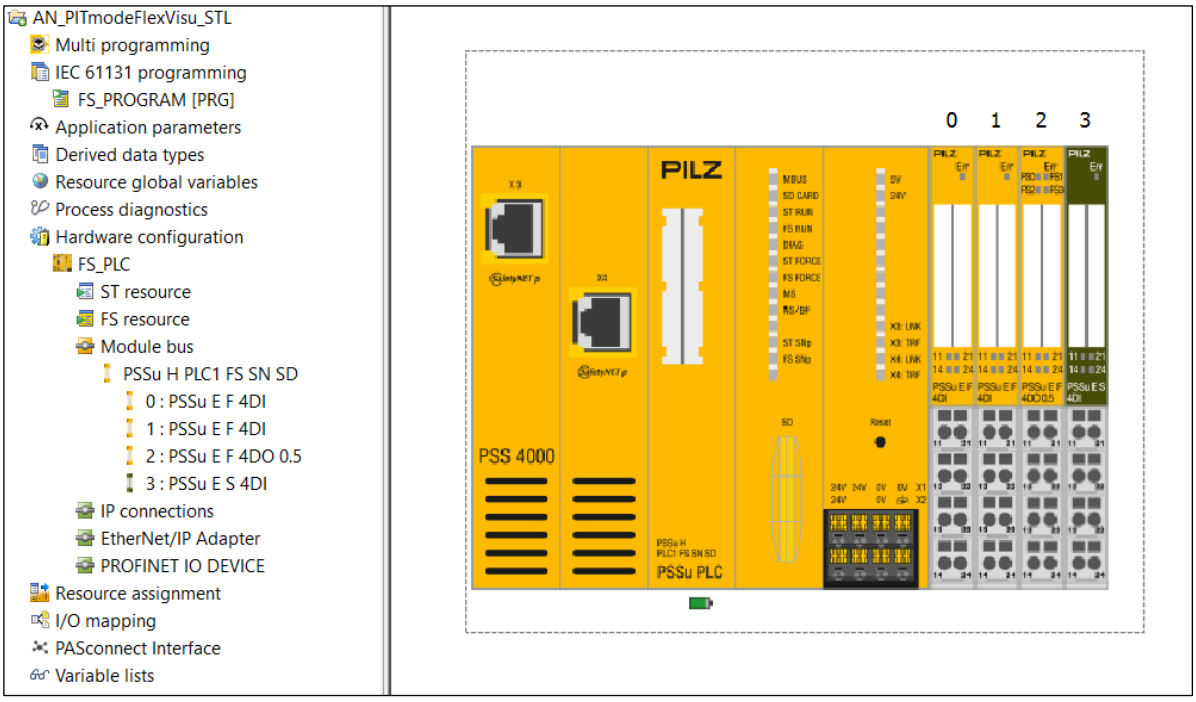


Figure 8: PSS 4000 hardware configuration

The PSSu PLC is assigned the IP address 192.168.0.22.

The default settings from the I-modules are adopted.

5.3.2 IP connection

For connection of the PITreader and the PMI, two IP connections must be configured on the PSSu PLC.

A Modbus/TCP client connection must be created for the data from the PITreader.

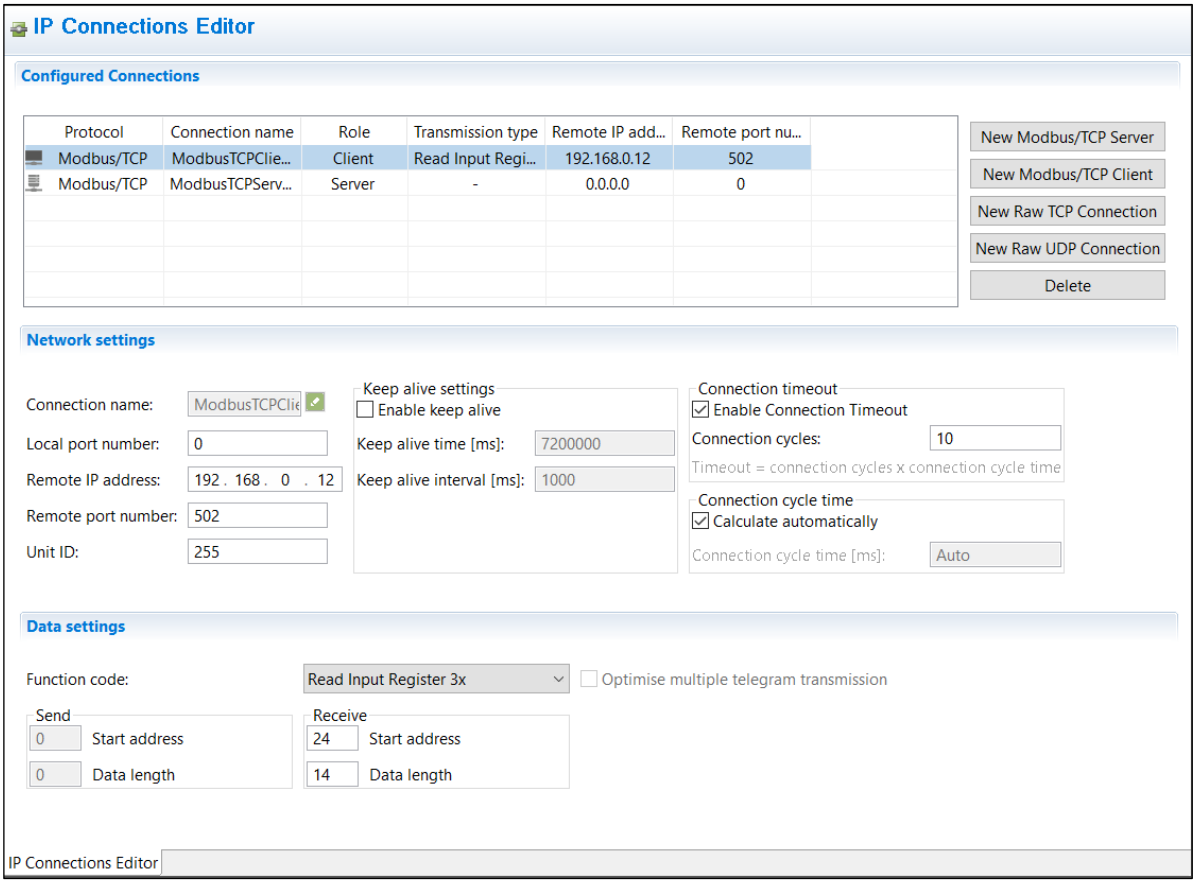


Figure 9: Modbus/TCP client connection

Data exchange with the PMI requires a Modbus/TCP server connection.

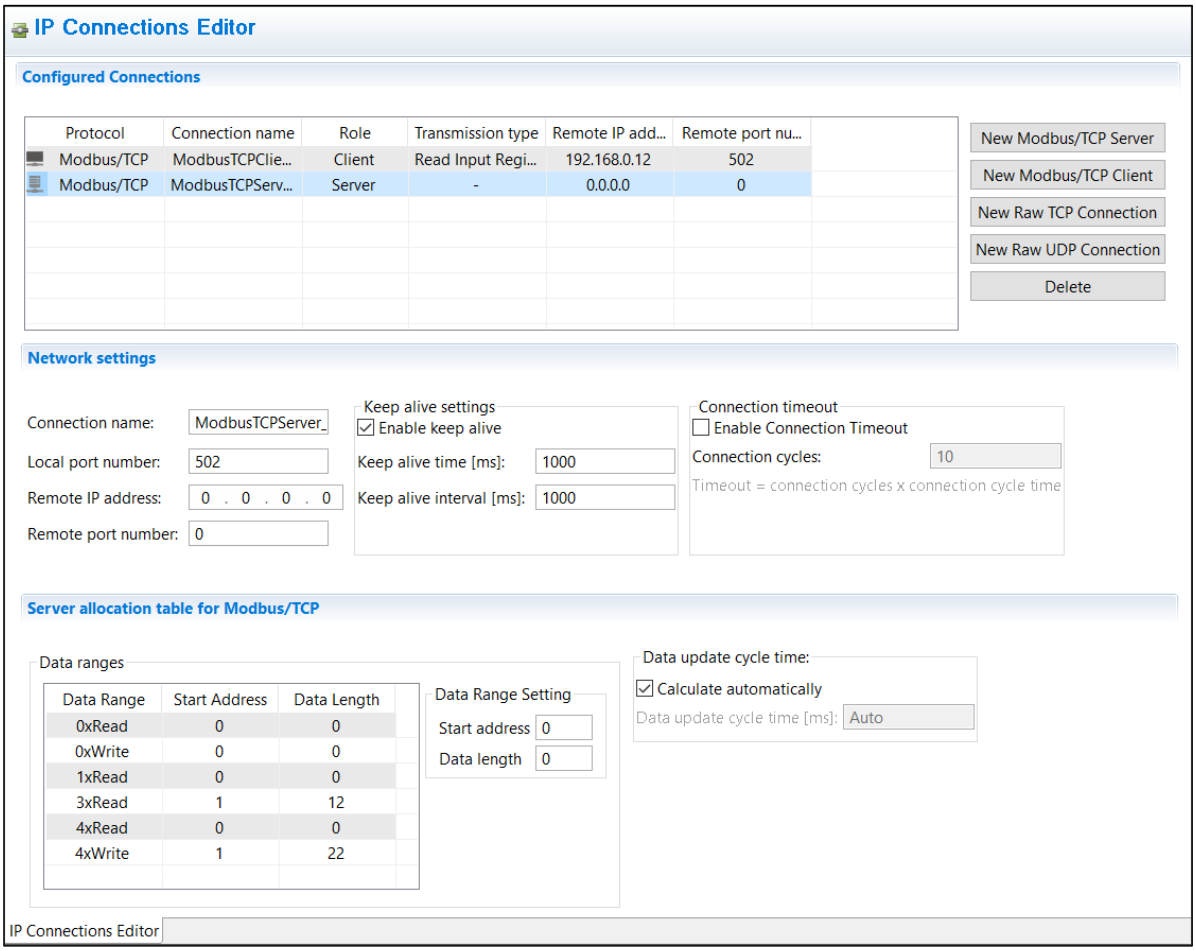


Figure 10: Modbus/TCP server connection

5.3.3 Connection diagram

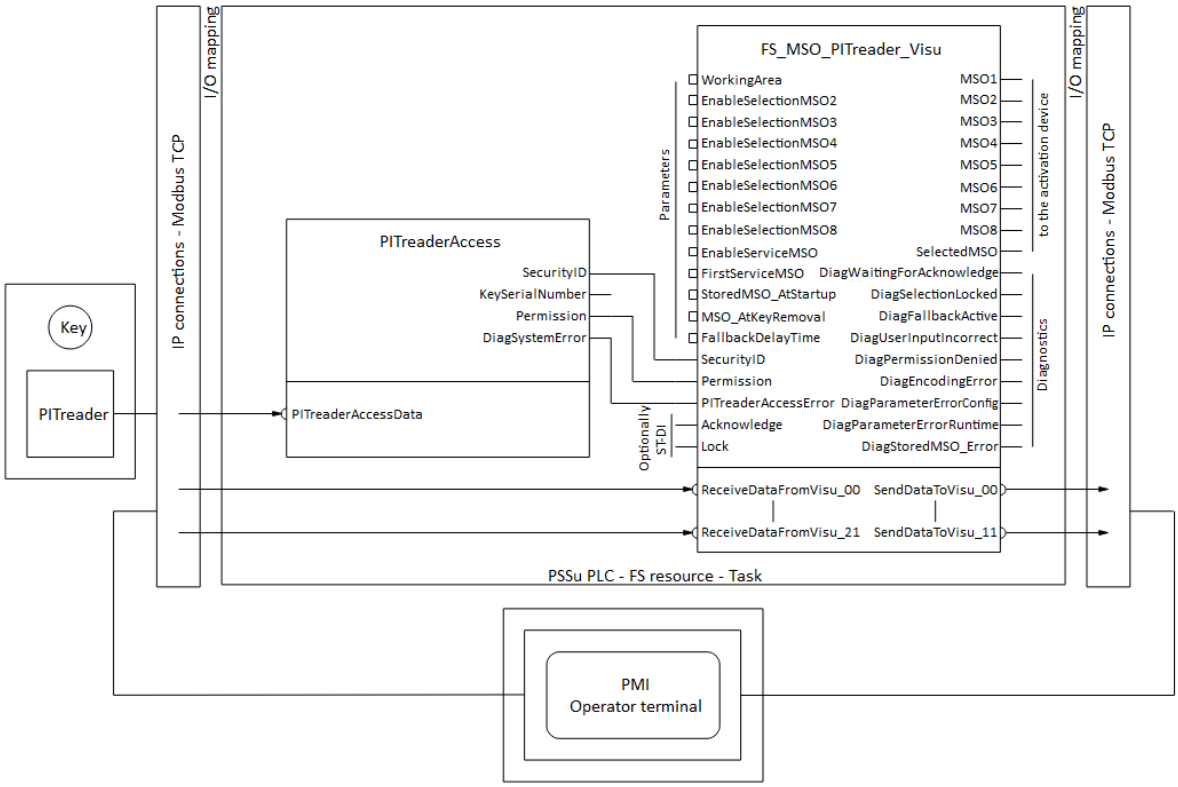


Figure 11: Basic wiring of PITreader, PMI and PSS blocks

The detailed wiring of the example used here can be found in the circuit diagram in the appendix, see chap. 8.1 Wiring diagram [📖 38].

6 Software configuration

6.1 PSSu PLC

The creation of the software is displayed in the alternative programming types: "Multi-programming" and "IEC 61131 programming".

6.1.1 Multi programming

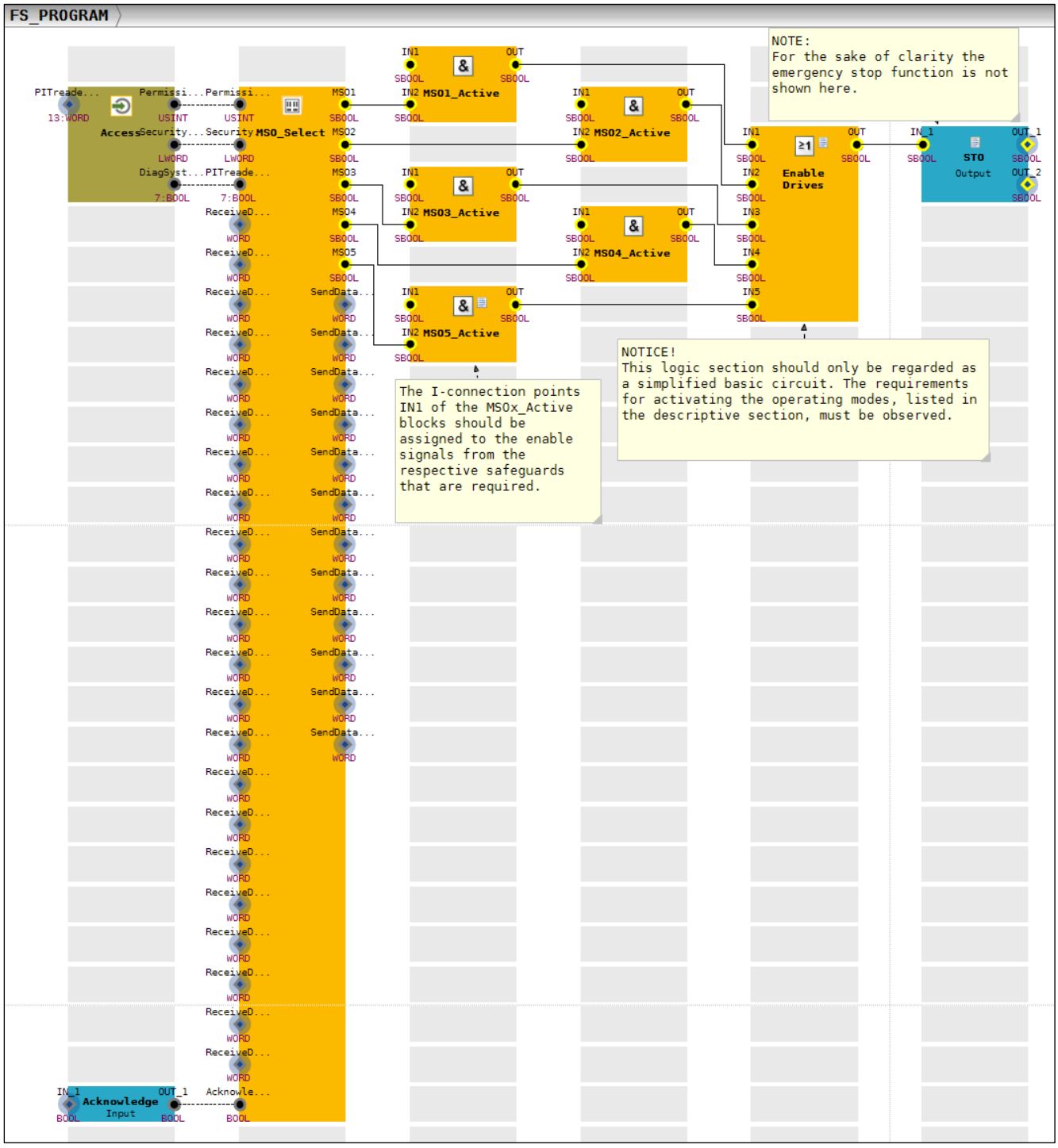


Figure 12: Multi program „FS_PROGRAM“

The instance of the “PITreaderAccess” block was named “Access”, while the instance of the “FS_MSO_PITreader_Visu” block was assigned the name “MSO_Select”.

The “Acknowledge” and “STO” elements are used to provide I-PI or O-PI variables for the assignment to hardware.

The logic section with the elements “MSOx_Active” and “EnableDrives” should only be regarded as a simplified basic circuit. The requirements listed in the descriptive section for activating the operating modes must be observed, see Section 4.1 Task [🕮 10], Section 4.5 Activating the modes of safe operation [🕮 15] and Section 4.6.3 Safeguards [🕮 16].

The properties of the block instance “MSO_Select” is shown below, see Section 4.4 Operating mode selection via display unit PMI [🕮 14].

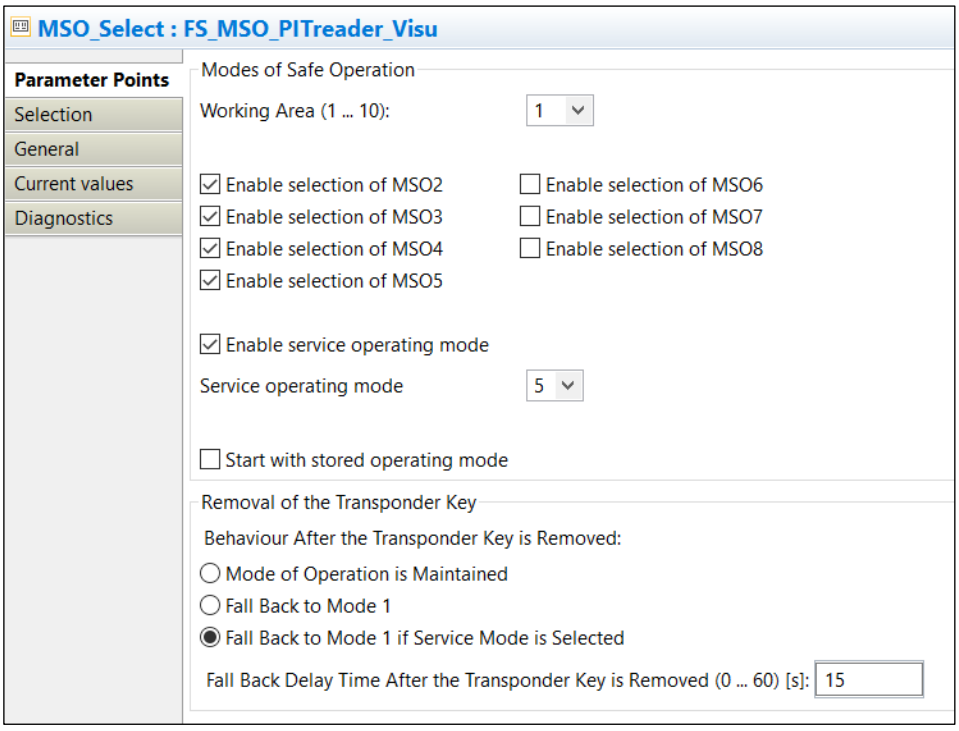


Figure 13: Parameter settings (MSO_Select)

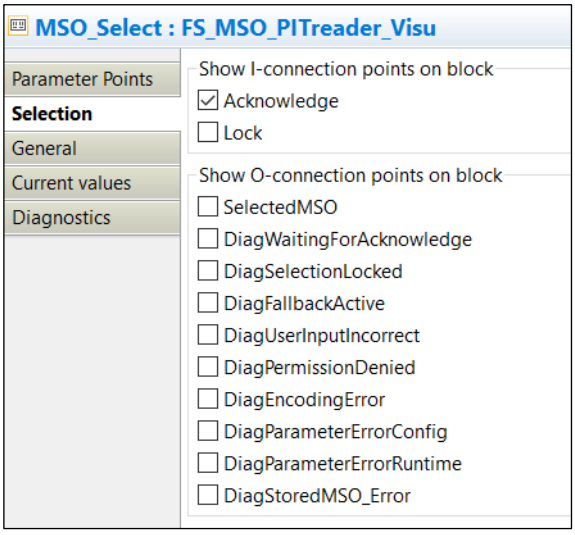


Figure 14: Selection of connection points (MSO_Select)

MSO_Select : FS_MSO_PITreader_Visu

Parameter Points
Selection
General
Current values
Diagnostics

Variable	Configured Value	Current Value
WorkingArea	1	USINT#1
EnableSelectionMSO2	true	true
EnableSelectionMSO3	true	true
EnableSelectionMSO4	true	true
EnableSelectionMSO5	true	true
EnableSelectionMSO6	false	false
EnableSelectionMSO7	false	false
EnableSelectionMSO8	false	false
EnableServiceMSO	true	true
FirstServiceMSO	5	USINT#5
StoredMSO_AtStartup	false	false
MSO_AtKeyRemoval	2	USINT#2
FallbackDelayTime	15	T#15s
Lock	false	false

Figure 15: Values currently valid in the Multi program (MSO_Select)

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

6.1.2.1 Declaration part

```
01  PROGRAM FS_PROGRAM
02  VAR
03      // Authorisation and access
04      Access                  : PITreaderAccess;
05
06      // MSO operating mode selection
07      MSO_Select              : FS_MSO_PITreader_Visu;
08      Acknowledge       AT %I*  : BOOL;      // PI variable for acknowledgement of selection
09      MSO1_Selected           : SAFEBOOL; // MSO1 selected
10      MSO2_Selected           : SAFEBOOL; // MSO2 selected
11      MSO3_Selected           : SAFEBOOL; // MSO3 selected
12      MSO4_Selected           : SAFEBOOL; // MSO4 selected
13      MSO5_Selected           : SAFEBOOL; // MSO5 selected
14
15      // MSO Aktivierung
16      MSO1_Active             : SAFEBOOL; // MSO1 activated
17      MSO2_Active             : SAFEBOOL; // MSO2 activated
18      MSO3_Active             : SAFEBOOL; // MSO3 activated
19      MSO4_Active             : SAFEBOOL; // MSO4 activated
20      MSO5_Active             : SAFEBOOL; // MSO5 activated
21      SafetyMSO1_Enable       : SAFEBOOL; // Enable of safeguards for MSO1
22      SafetyMSO2_Enable       : SAFEBOOL; // Enable of safeguards for MSO2
23      SafetyMSO3_Enable       : SAFEBOOL; // Enable of safeguards for MSO3
24      SafetyMSO4_Enable       : SAFEBOOL; // Enable of safeguards for MSO4
25      SafetyMSO5_Enable       : SAFEBOOL; // Enable of safeguards for MSO5
26      EnableDrives      AT %Q*  : SAFEBOOL; // PI variable for enabling the drives
27  END_VAR
```

6.1.2.2 Instruction part

Note: For the sake of clarity the emergency stop function is not shown here.

```
28  //-- Authorisation and access-----------------------------------------------------
29  Access();
30
31  //--MSO operating mode selection----------------------------------------------
32  MSO_Select(
33      WorkingArea              := USINT#1,           // Working Area 1
34      EnableSelectionMSO2      := TRUE,              // Enable MSO2 for selection
35      EnableSelectionMSO3      := TRUE,              // Enable MSO3 for selection
36      EnableSelectionMSO4      := TRUE,              // Enable MSO4 for selection
37      EnableSelectionMSO5      := TRUE,              // Enable MSO5 for selection
38      EnableSelectionMSO6      := FALSE,             // MSO6 not used
39      EnableSelectionMSO7      := FALSE,             // MSO7 not used
40      EnableSelectionMSO8      := FALSE,             // MSO8 not used
41      EnableServiceMSO         := TRUE,              // with service mode
42      FirstServiceMSO          := USINT#5,           // MSO5 as first service mode
43      StoredMSO_AtStartup      := FALSE,             // Start-up with MSO1
44      MSO_AtKeyRemoval         := USINT#2,  // Fall back to MSO1, when in service mode
45      FallbackDelayTime        := T#15s,             // Fallback delay 15 seconds
46      SecurityID               := Access.SecurityID, // SecurityID from access block
47      Permission               := Access.Permission, // Permission from access block
48      PITreaderAccessError     := Access.DiagSystemError, // Diagnostics from access block
49      Acknowledge              := Acknowledge,       // Acknowledgement of selection
50      Lock                     := FALSE,             // Lock input not active
51      MSO1                     => MSO1_Selected,     // MSO1 selected
52      MSO2                     => MSO2_Selected,     // MSO2 selected
53      MSO3                     => MSO3_Selected,     // MSO3 selected
54      MSO4                     => MSO4_Selected,     // MSO4 selected
55      MSO5                     => MSO5_Selected      // MSO5 selected
56      );
57
58  //--MSO activation and enable of the drives-----------------------------------
59  (*************************************************************************
60   * NOTICE!                                                               *
61   * This logic section should only be regarded as a simplified basic circuit.  *
62   * The requirements for activating the operating modes, listed in the    *
63   * descriptive section, must be observed!                                *
64   * The variables SafetyMSOx_Enable should be assigned to the enable signals   *
65   * from the respective safeguards that are required.                     *
66   *************************************************************************)
67  MSO1_Active := MSO1_Selected AND SafetyMSO1_Enable;
68  MSO2_Active := MSO2_Selected AND SafetyMSO2_Enable;
69  MSO3_Active := MSO3_Selected AND SafetyMSO3_Enable;
70  MSO4_Active := MSO4_Selected AND SafetyMSO4_Enable;
71  MSO5_Active := MSO5_Selected AND SafetyMSO5_Enable;
72  EnableDrives := MSO1_Active OR MSO2_Active OR MSO3_Active OR MSO4_Active OR MSO5_Active;
73
74  END_PROGRAM
```

The logic section "MSO activation and enable of the drives“ should only be regarded as a simplified basic circuit. The requirements for activating the operating modes, listed in the descriptive section, must be observed, see Section 4.1 Task [📖 10], Section 4.5 Activating the modes of safe operation [📖 15] and Section 4.6.3 Safeguards [📖 16].

6.1.3 Resource assignment

The program "FS_PROGRAM" must be assigned to a task on the FS resource.

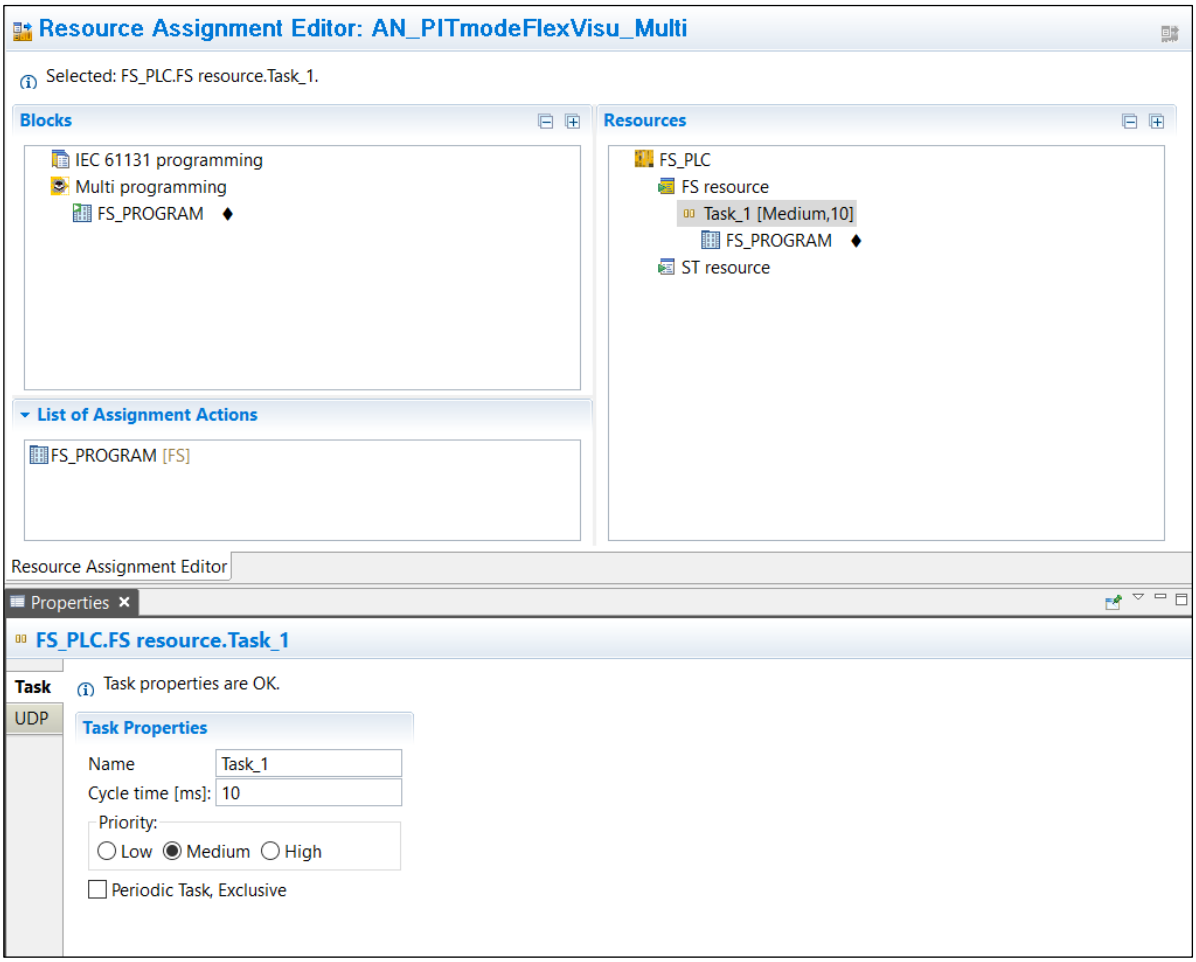


Figure 16: FS resource assignment

6.1.4 I/O mapping

The PI variables available in the user program can be mapped to the hardware configuration in the I/O mapping editor. The following diagrams refer to IEC 61131 programming.

The following I/O mappings should be made using the filter "PI variables <-> Module bus":

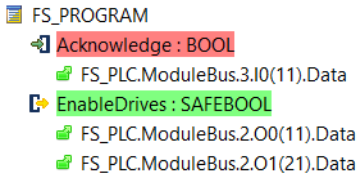


Figure 17: I/O mapping PI-variables <-> Module bus

The following I/O mappings should be made using the filter "PI variables <-> IP connections“:

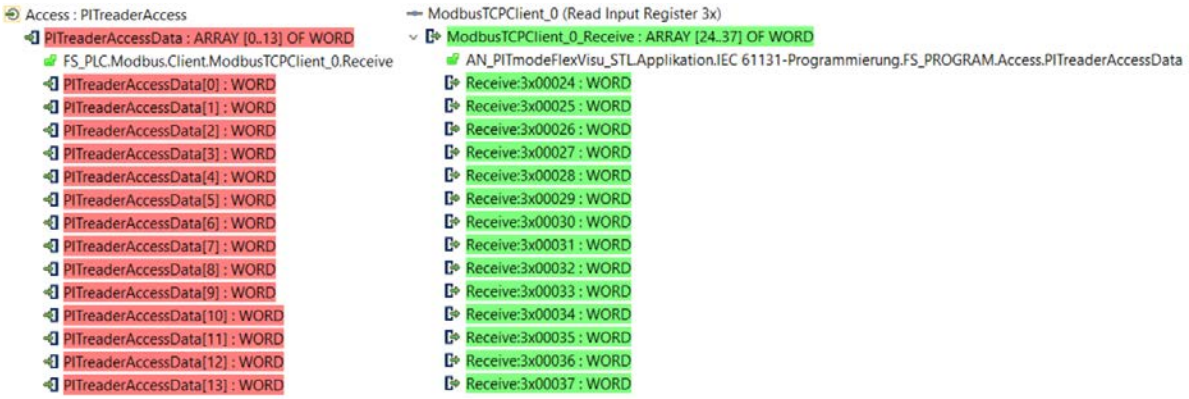


Figure 18: I/O mapping PI variables <-> IP connections: Modbus/TCP Client

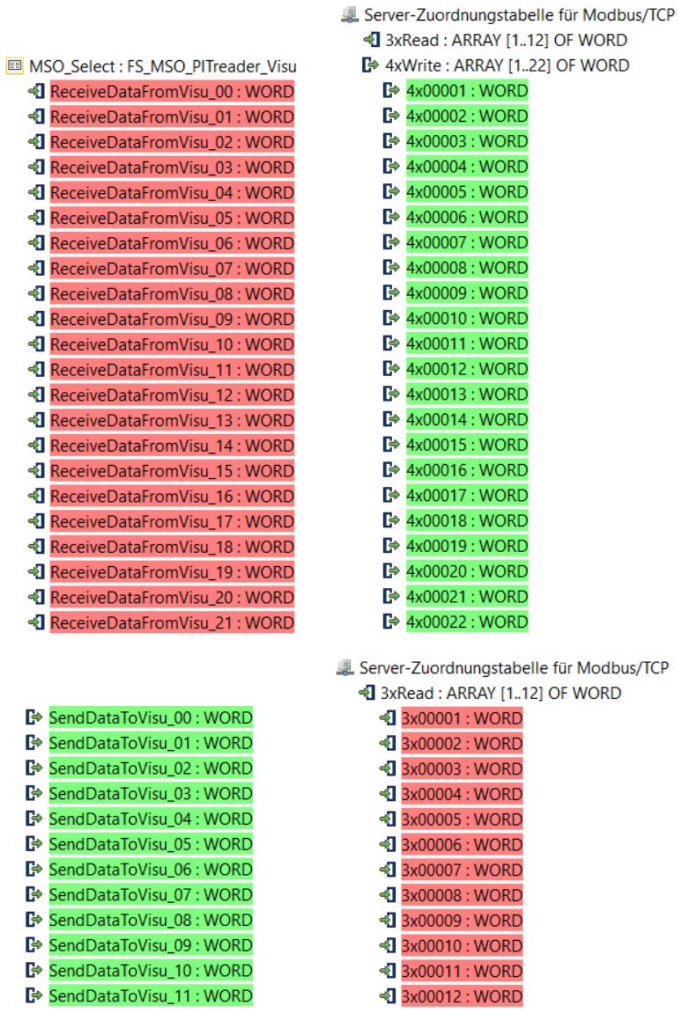


Figure 19: I/O mapping PI variables <-> IP connections: Modbus/TCP Server

6.2 PMI

The configuration for display and operation on the PMI is performed with the software tool PASvisu Builder.

A PASvisu project is created for the intended display unit here (project language English). Specification of a data source is not required for the "MSO flex visu" tile alone (default data source can be deleted).

In the page editor, the "MSO flex visu" tile is added to the project for the operating mode selection from the "Hardware-related tiles" area.

The tile is configured as follows in line with the PSS 4000 project:

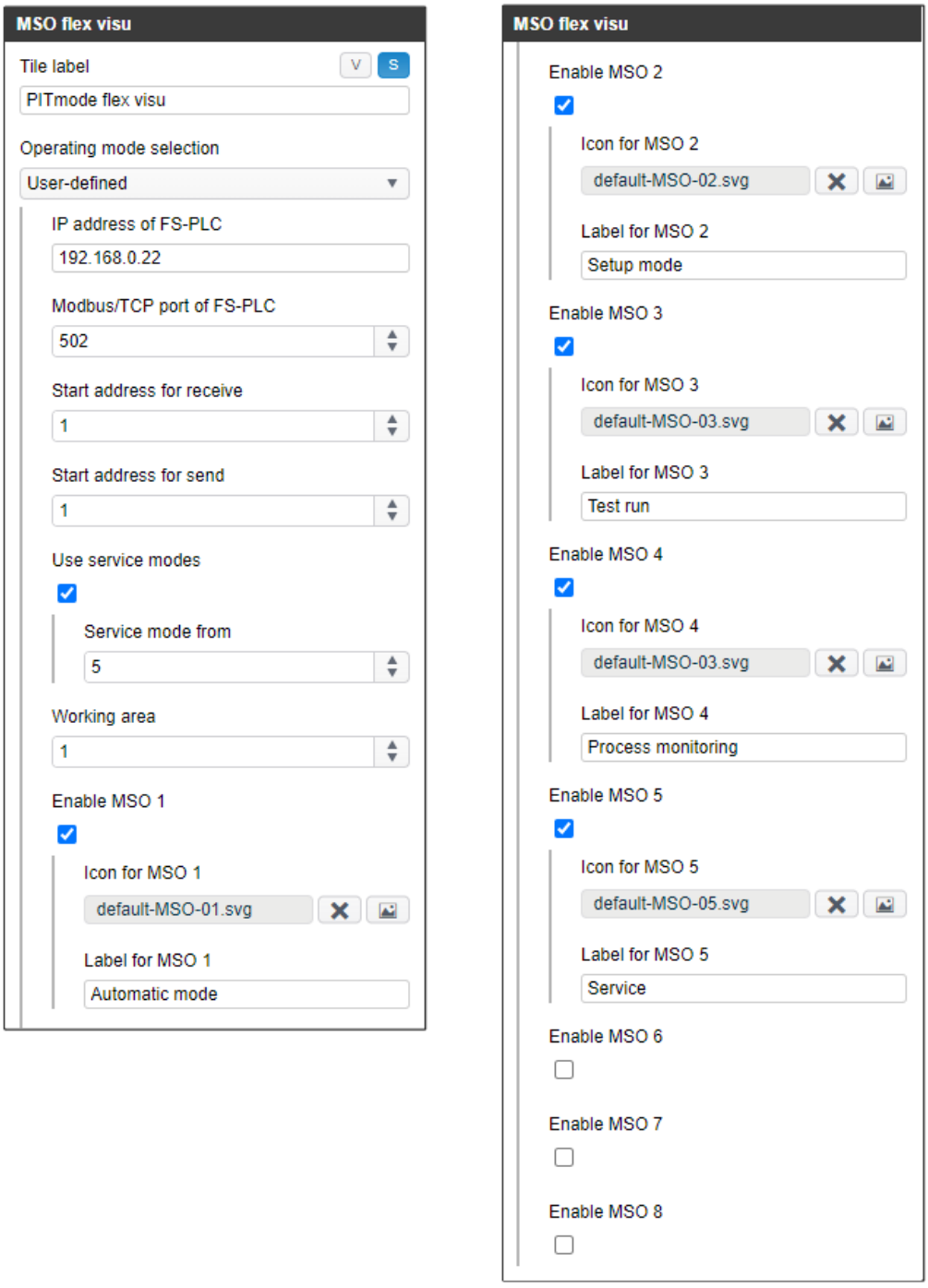


Figure 20: Configuration of the "MSO flex visu" tile

The same icon is used for MSO4 as for MSO3 in this example.

The tile contains the buttons for selection of the operating modes.

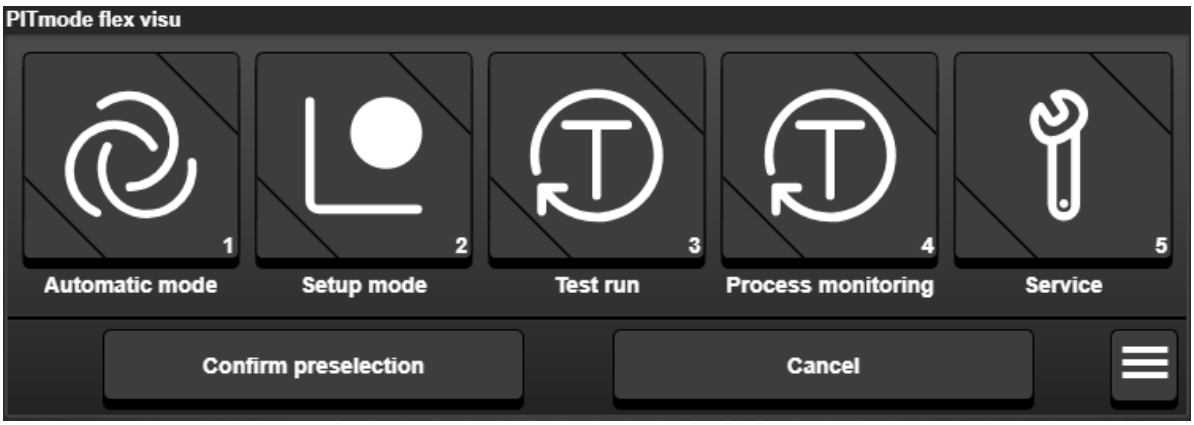


Figure 21: "MSO flex visu" tile configured in PASvisu Builder

Notes:

- Positioning of the tiles
  Make sure that no "MSO flex visu" tile is covered by other tiles. The operator must be able to see the entire tile.
- Consistent configuration of the operating mode selection
  The configuration of the operating mode selection in the programmable safety system and in the PASvisu project must be the same. This is checked in the runtime of the PASvisu project. If the configurations are not the same, the tile is marked as incorrect and operating mode selection is not possible.
- One tile per working area
  It is the user's responsibility to ensure that there is no more than one "MSO flex visu" tile per working area and that this tile is displayed on exactly one display unit.

After completing the configuration, the PASvisu project must be sent to the PMI.

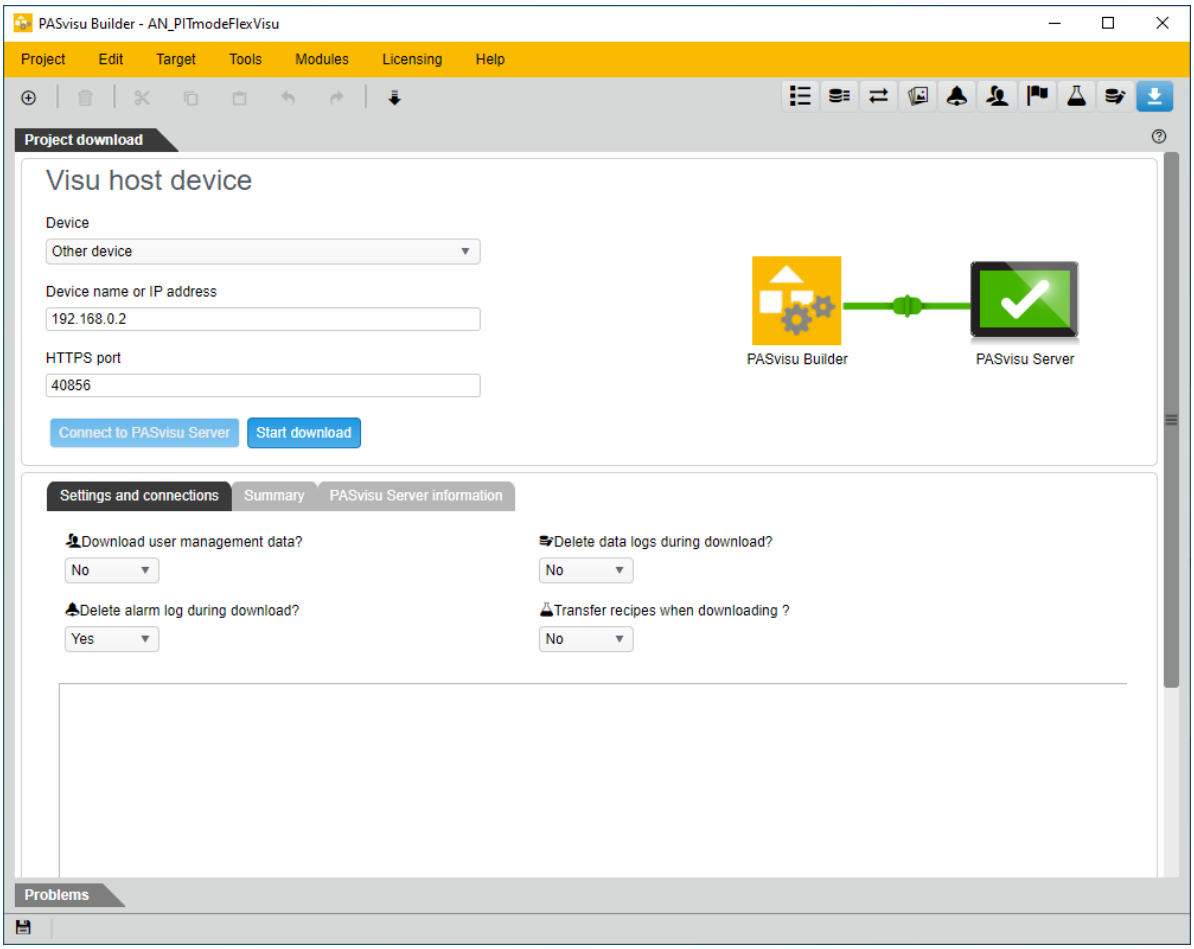


Figure 22: Download of the PASvisu project in PASvisu Builder

If the configuration has been changed, a warning note first appears that must be confirmed.

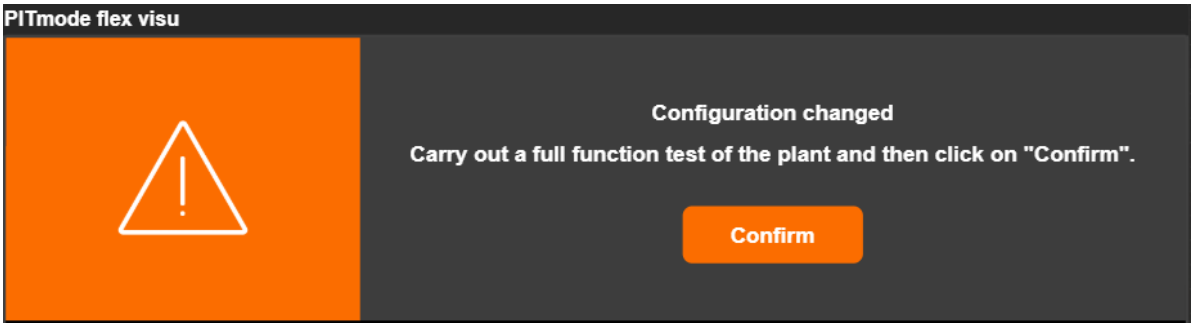


Figure 23: Warning note after changing the configuration

7 Operating

7.1 Application conditions

NOTICE

The following activities are the responsibility of the user and must be given consideration:

- Comply with the regulations of the Type C standards (machinery safety standards) for the respective application with regard to operating mode selection, such as EN ISO 16090-1 for example.
- Design your system so that MSO1 is the safest mode of operation.
- Carry out a full function test of the machine after installation (and each time the configuration is changed). The test may only be carried out by qualified personnel.

Ensure the following:

- The operator must always be able to see which operating mode is active.
- The operating mode displayed following selection must match the operating mode selected by the operator.

Note:

- The operator must have adequate training for the operating mode he has selected.
- Before each machine start, a check must be carried out to see that the desired operating mode is selected.
- The operator must always ensure that the operating mode he requires is the one actually selected. If the required operating mode is not selected, the machine must be shut down immediately.

CAUTION!

Please note the following:

- The operating mode may only be selected from outside of the danger zone.
- Selecting an operating mode must not in itself cause the machine to start up.
- The operating mode must not be selected as the machine is running.

7.2 Select mode of safe operation

The buttons for the service operating modes are only visible on the display unit if a transponder key with permission for the service operating modes is inserted and the selection block is not activated. The button with the selected operating mode is always visible.

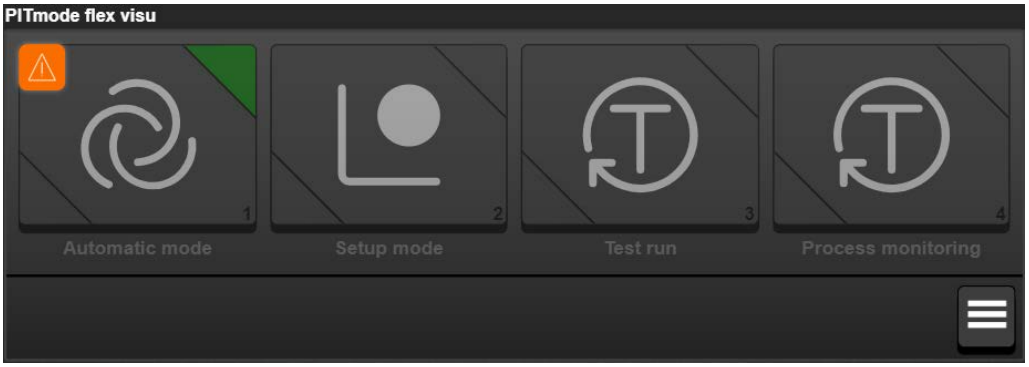


Figure 24: View of the tile with the transponder key removed ("Automatic mode" selected)

- Insert a transponder key with the corresponding permission in the PITreader. The colour of the illuminated ring around the key adapter changes from blue to green if the transponder key has been recognised as valid.

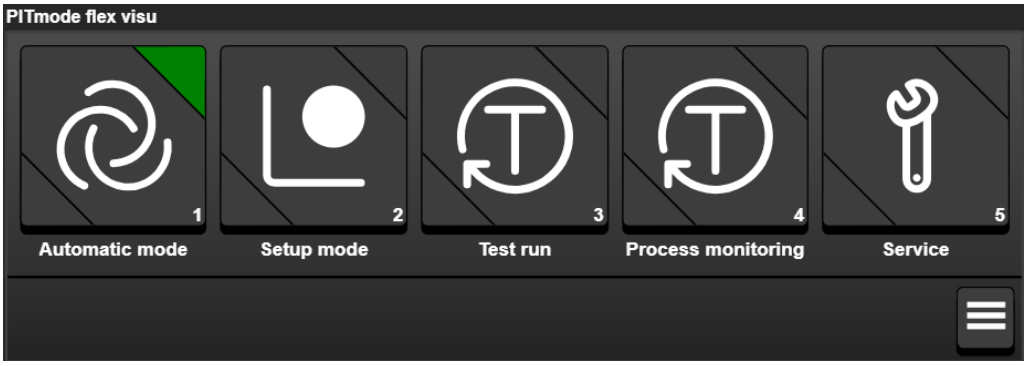


Figure 25: View of the tile with the transponder key inserted (permission 5)

- Select the desired operating mode by pressing the corresponding button on the tile. The button must be pressed between 500 ms and 5 000 ms. The button lights up yellow when released.

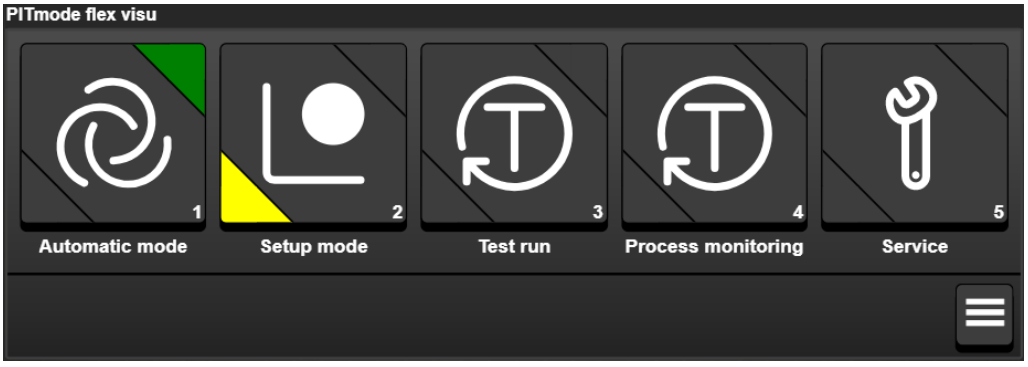


Figure 26: View of the tile after preselection of MSO2 ("Setup mode")

- After 2 seconds, the buttons “Confirm preselection” and “Cancel” are shown.

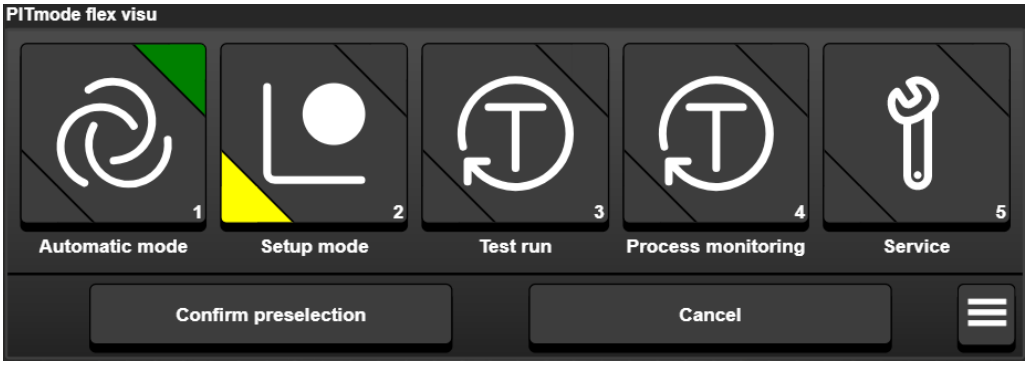


Figure 27: View of the tile 2 seconds after preselection of MSO2 (“Setup mode”)

- Confirm the selection by pressing the “Confirm preselection” button. The button must be pressed between 500 ms and 5 000 ms. The button for MSO2 (“Setup mode”) flashes green when this is released.
  The preselection is now confirmed, but not yet acknowledged. The safe operating mode is only adopted if the selection is acknowledged using the I variable *Acknowledge*.

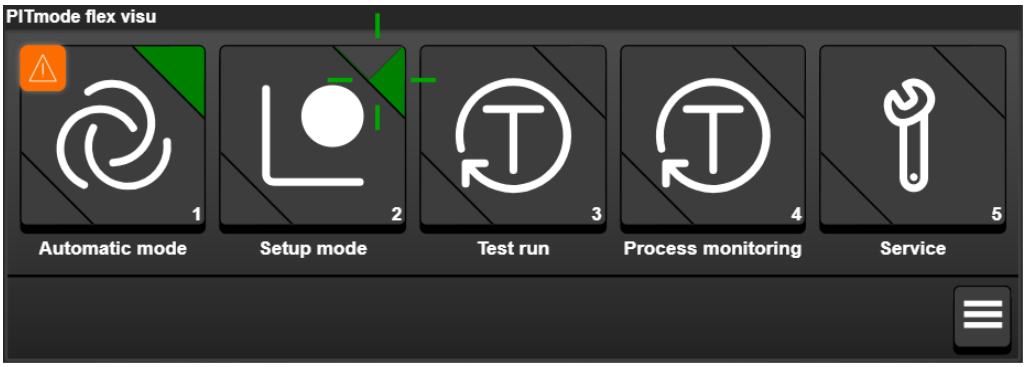


Figure 28: View of the tile after pressing the “Confirm preselection” button (MSO2 flashes)

- If the *Acknowledge* signal is TRUE, the O variable MSO1 for the previous operating mode is switched off and the O variable MSO2 for the newly selected operating mode is switched on. At the same time, the button of the newly selected operating mode lights up green and the button of the previous operating mode is off.

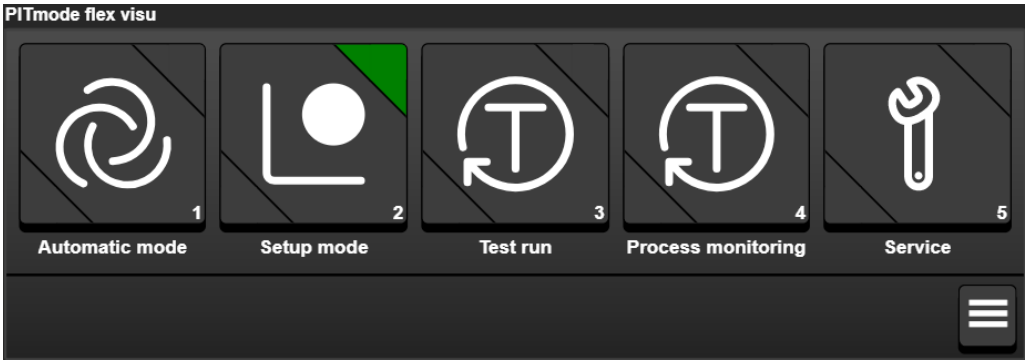


Figure 29: View of the tile if Acknowledge is set to TRUE

- Remove the transponder key from the PITreader. The ring around the key adapter lights up blue.

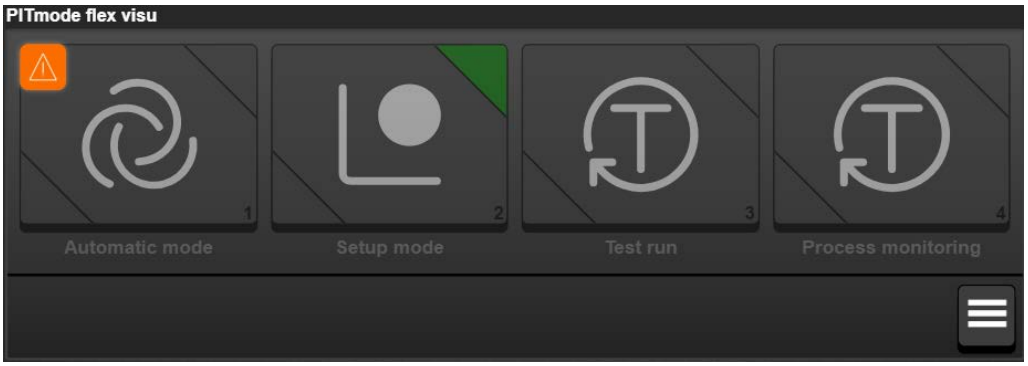
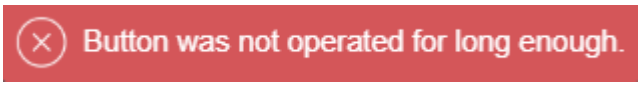


Figure 30: View of the tile with the transponder key removed ("Setup mode" selected)

The FS_MSO_PITreader_Visu block sends various user errors, system information and system errors to the PMI. On the PMI, this information is displayed directly at the associated tile via the ⚠ or ⊗ icon. Pressing the respective icon shows the diagnostic text, e.g.:

or



The displays are deleted when the user reacts accordingly (in this example, *Acknowledge* was set to TRUE or a button was pressed correctly).

Diagnostic information is also output via the diagnostic list of PAS4000 and via the O variable *Diag*... ("FS_MSO_PITreader_Visu" block).

7.3 Select mode of safe service operation

The selection of a service operating mode is performed in the same manner as the selection of a safe operating mode.

A transponder key with permission 5 must be inserted in the existing configuration. Selection of the MSO5 button ("Service") is thereby enabled.

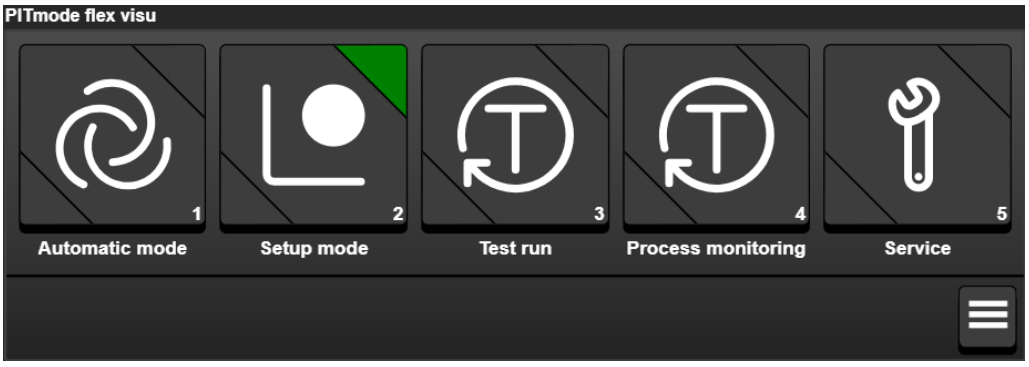


Figure 31: View of the tile with the transponder key inserted (permission 5)

Pressing the MSO5 button (“Service”) and then the “Confirm preselection” button selects the service operating mode. The service operating mode is also only adopted if the selection is acknowledged via the I variable *Acknowledge* = TRUE. The O variable *MSO2* of the previous operating mode is switched off and the O variable *MSO5* for the newly selected service operating mode is switched on (“FS_MSO_PITreader_Visu” block).

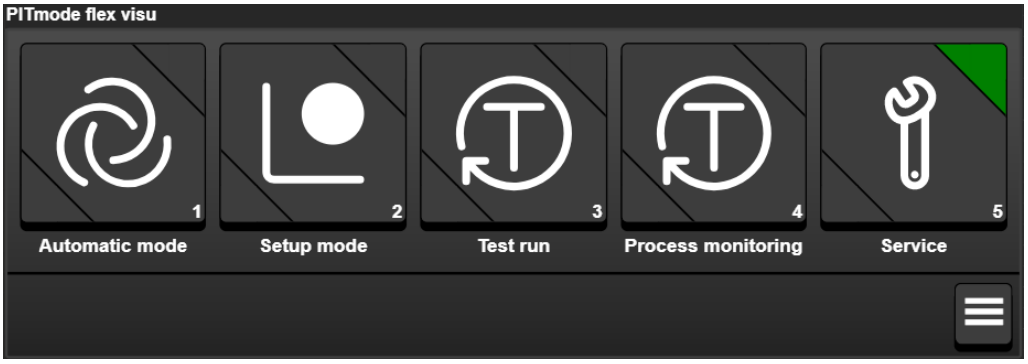


Figure 32: View of the tile after successful selection of the service operating mode

The service operating mode remains selected as long as the transponder key is inserted.

This example is configured to change to operating mode MSO1 when the transponder key is removed in service operating mode:

- Remove the transponder key from the PITreader. The ring around the key adapter lights up blue. The tile shows that in a few seconds (15 s) it will change to operating mode MSO1. By inserting a transponder key with the corresponding permission, this change can be prevented. In this case, the service operating mode remains selected.

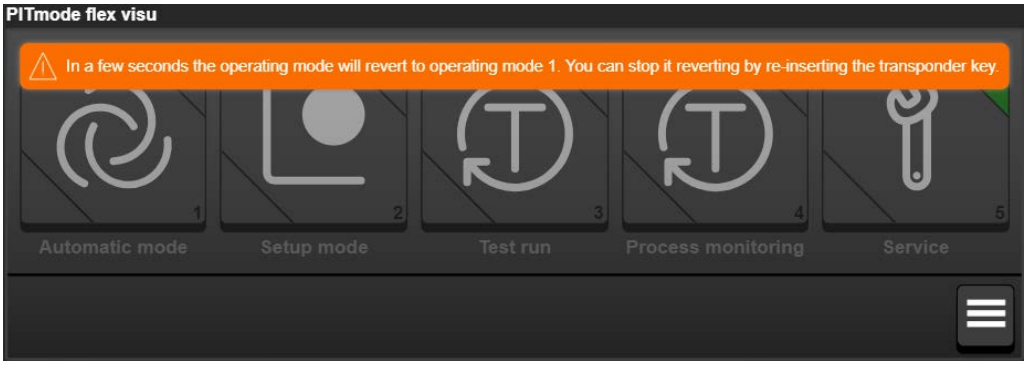


Figure 33: View of the tile after removing the transponder key

- If no transponder key is inserted, after the delay-on de-energisation time expires the system changes to operating mode MSO1. If *Acknowledge* = TRUE, the MSO1 button (“Automatic mode”) lights up green and the MSO5 button (“Service”) is off. The O variable *MSO5* is switched off and the O variable *MSO1* is switched on (“FS_MSO_PITreader_Visu” block).

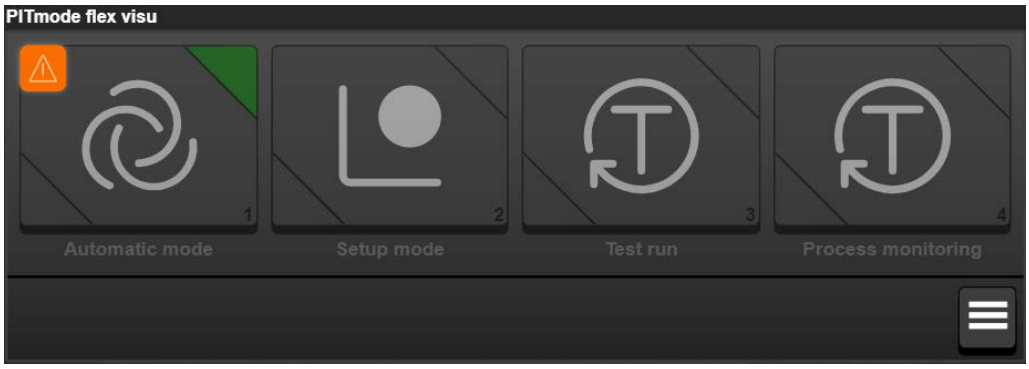
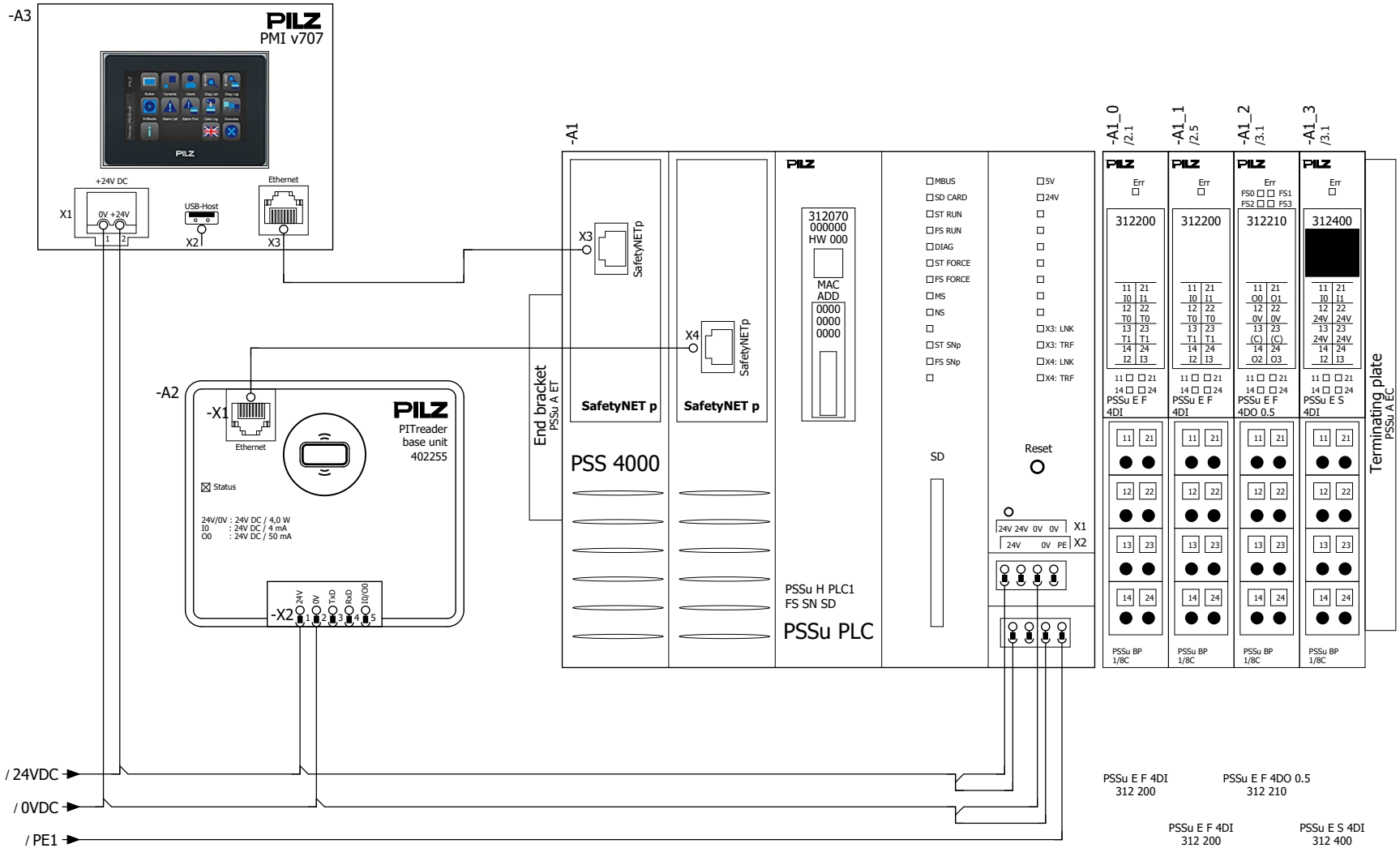
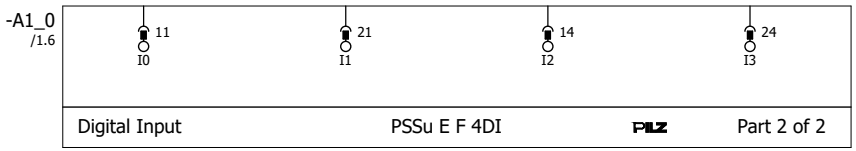


Figure 34: View of the tile after the delay-on de-energisation time expires and Acknowledge = TRUE



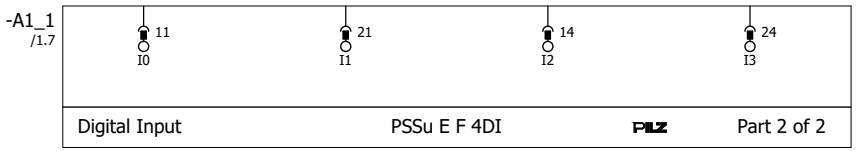
Revision	03.09.2021	Date	27.08.2021	EN ISO 13849-1	PL d	Pilz GmbH & Co. KG Felix-Wankel-Strasse 2 D-73760 Ostfildern	Safety-related Operating Mode Selection PSSu PITmode flex visu PSS 4000 and PITreader and PMI	Mounting place + AN_1005823_01
Name	Pilz	Name	Pilz					Page: 1 / 3
				EN 62061	SIL 2			
		Dep.	CSI					

For further safety functions (e.g. E-Stop, S-gate, ...)



none none none none

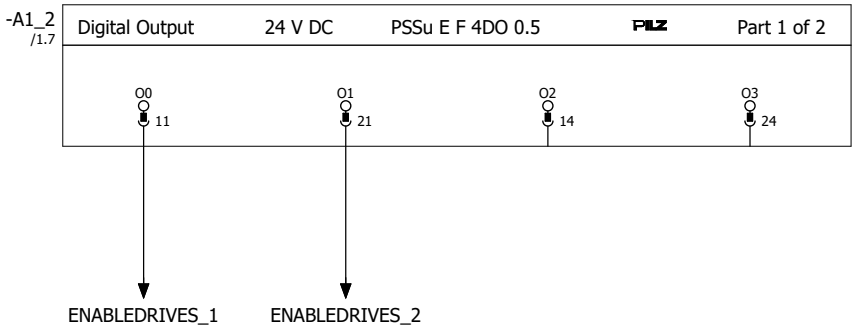
For further safety functions (e.g. E-Stop, S-gate, ...)

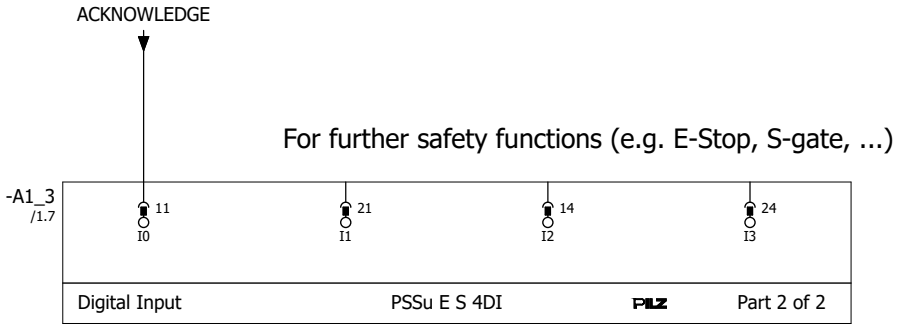


none none none none

0	1	2	3	4	5	6	7	8	9

Enable Drives	Enable Drives	none	none





Acknowledge	none	none	none

Revision	03.09.2021	Date	27.08.2021	EN ISO 13849-1	PL d	Mounting place + AN_1005823_01
Name	Pilz	Name	Pilz			
				EN 62061	SIL 2	Page: 3 / 3
		Dep.	CSI			

Pilz GmbH & Co. KG
Felix-Wankel-Strasse 2
D-73760 Ostfildern

Safety-related Operating Mode Selection
PSSu PITmode flex visu
Control

9 Table of figures

Support

Technical support is available from Pilz round the clock.

Americas
Brazil
+55 11 97569-2804
Canada
+1 888 315 7459
Mexico
+52 55 5572 1300
USA (toll-free)
+1 877-PILZUSA (745-9872)

Asia
China
+86 21 60880878-216
Japan
+81 45 471-2281
South Korea
+82 31 778 3300

Australia
+61 3 95600621

Europe
Austria
+43 1 7986263-0
Belgium, Luxembourg
+32 9 3217570
France
+33 3 88104003
Germany
+49 711 3409-444
Ireland
+353 21 4804983
Italy, Malta
+39 0362 1826711
Scandinavia
+45 74436332
Spain
+34 938497433
Switzerland
+41 62 88979-32
The Netherlands
+31 347 320477
Turkey
+90 216 5775552
United Kingdom
+44 1536 462203

You can reach our international hotline on:
support@pilz.com

Pilz develops environmentally-friendly products using ecological materials and energy-saving technologies. Offices and production facilities are ecologically designed, environmentally-aware and energy-saving. So Pilz offers sustainability, plus the security of using energy-efficient products and environmentally-friendly solutions.

Energy saving by Pilz

BLUECOMPETENCE Alliance Member
Partner of the Engineering Industry Sustainability Initiative

pilz
Partner of:
The Best of German Engineering

1005173-EN-01 Draft 01, 2019-06 Printed in Germany

We are represented internationally. Please refer to our homepage www.pilz.com for further details or contact our headquarters.

Headquarters: Pilz GmbH & Co. KG, Felix-Wankel-Straße 2, 73760 Ostfildern, Germany
Telephone: +49 711 3409-0, Telefax: +49 711 3409-133, E-Mail: info@pilz.com, Internet: www.pilz.com

PILZ
THE SPIRIT OF SAFETY