

**Safe operating mode selection with PSS 4000,
PITreader and keypad PIT oe 4S
(PSSu PITmode flex)**



Product

Type: PITreaderAccess, FS_MSO_PITreader_Keypad(_PLC)
Name: PSS 4000, PITreader, PIT oe 4S
Manufacturer: Pilz GmbH & Co. KG, Safe Automation

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

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February 2022

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Industrial Security

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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	Application Note	 AN.content (1002400)">www.pilz.com > AN.content (1002400)
PNOZ	Pilz E-STOP positive-guided (DE: Pilz NOT -AUS-Zwangsgeführt)	 PNOZ">www.pilz.com > PNOZ
PSS	Programmable control system (DE: Programmierbares Steuerungssystem)	 PSS">www.pilz.com > PSS
PSSu	PSS universal	 PSS">www.pilz.com > PSS
PSS u2	PSS universal, 2 nd generation	 PSS u2">www.pilz.com > PSS u2
POU	Program Organisation Unit	
NC	Normally Closed	
NO	Normally Open	
MSO	Mode of Safe Operation	
STO	Safe Torque Off	

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.

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1 Preface

This Application Note basically describes the commissioning of the operating mode selection and access permission system "PITmode flex".

"PITmode flex" consists of the access permission system PITreader and safe operating mode selection with a Pilz safety controller, in this case a PSSu PLC from the automation system PSS 4000.

It illustrates the basic workflow for a successful basic configuration.



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	1005276-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 PIT oe 4S	1005257-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	Operating Manual PSSu E S 4DO 0.5	21346-EN-xx
12	PAS4000 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 1.22	1
2	PSSu E F 4DI	312200	-	3
3	PSSu E F 4DO 0.5	312210	-	1
4	PSSu E S 4DI	312400	-	1
5	PSSu E S 4DO 0.5	312405	-	2
6	PSSu A Con 2/8 C (connector set, spring-loaded connection)	313111	-	1
7	PSSu BP 1/8C	312601	-	7
8	PITreader base unit	402255	-	1
9	PITreader key adapter h	402308	-	1
10	PITreader key ye 1	402261	-	1
11	PITreader key ye 3	402263	-	1
12	PITreader key ye 5 service	402269	-	1
13	PIT oe 4S	402311	-	1
14	Software platform PAS4000	-	V 1.22	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)

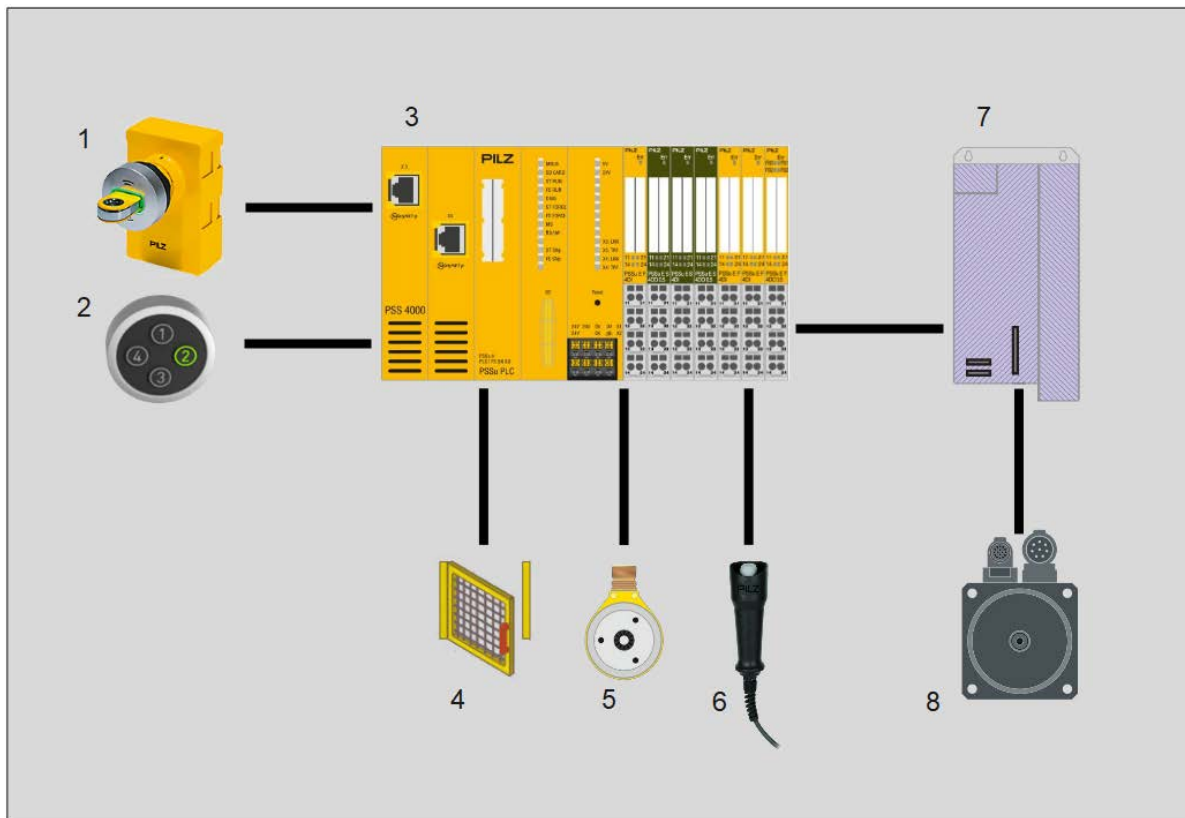


Figure 1: Application – Structure of the hardware (schematic)

1. Access permission system PITreader
2. Keypad with display elements PIT or 4S
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" in a practical situation.

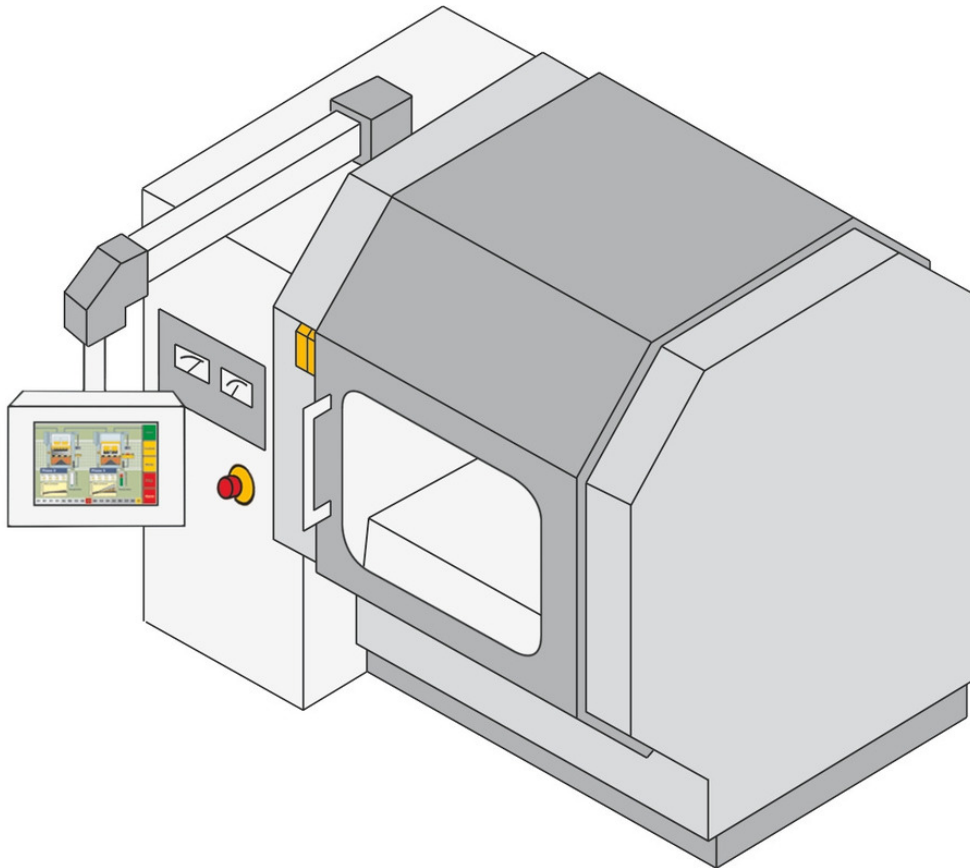


Figure 2: Machine tool

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

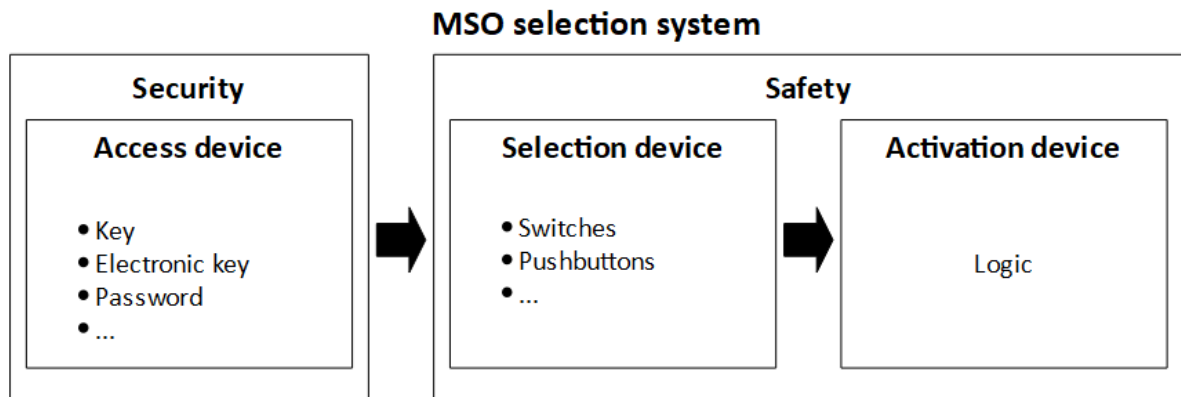


Figure 3: Selection system for modes of safe operation

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

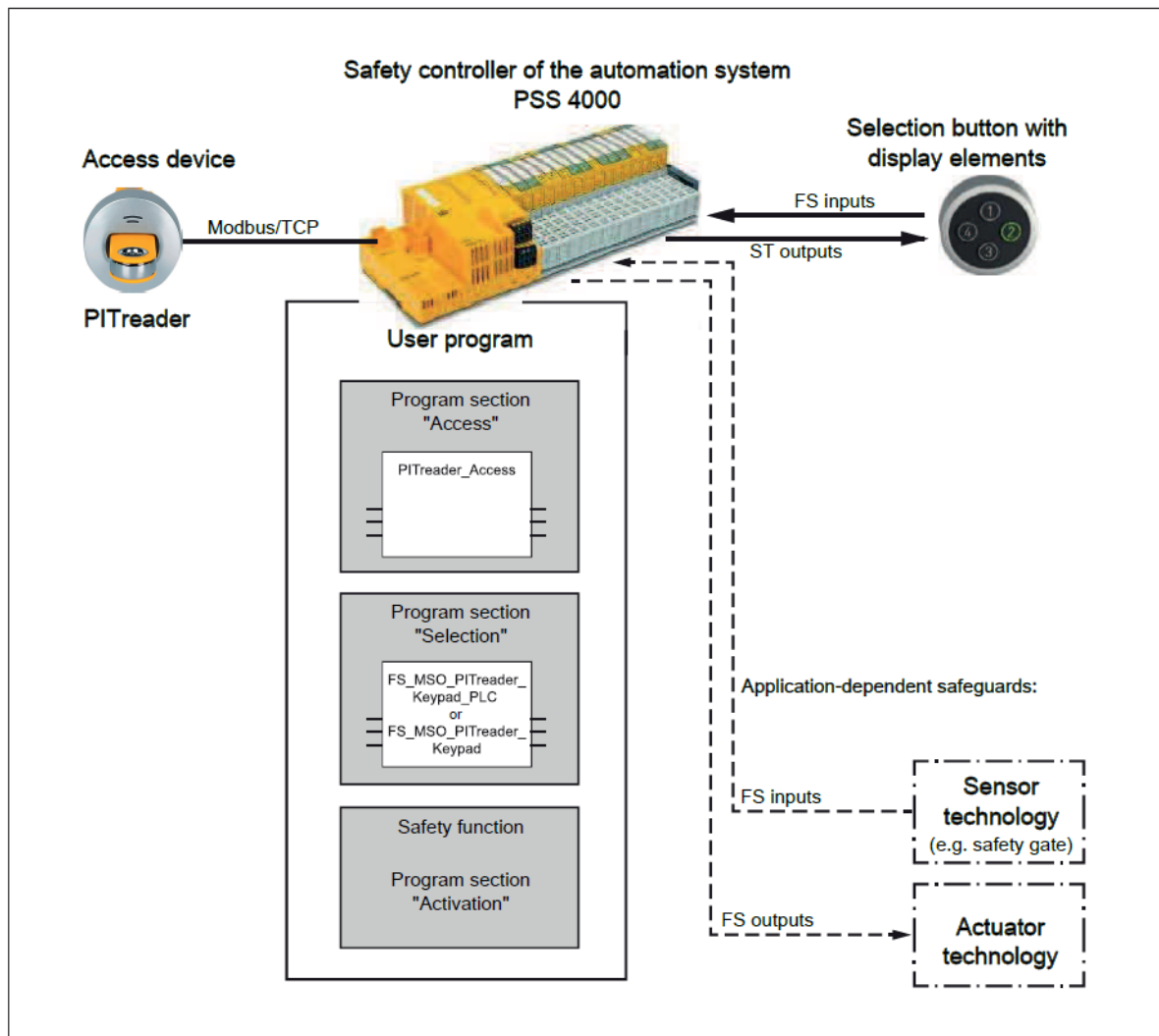


Figure 4: System overview "PITmode flex"

- ▶ 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
The selection device consists of a keypad with display elements PIT or 4S. Individual buttons and display elements may also be used as an alternative. The display elements are used to display the selected mode of safe operation. The selection device must be evaluated on the safety controller using the function block "FS_MSO_PITreader_Keypad(PLC)".
- ▶ 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.

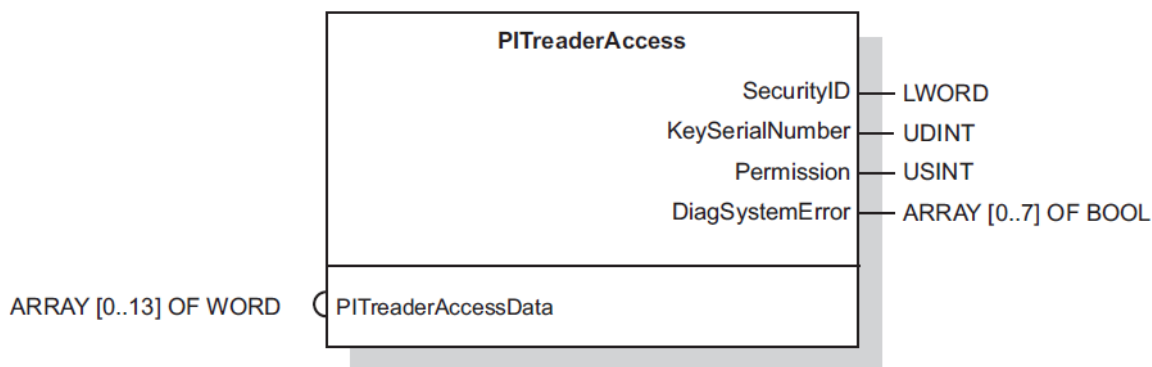


Figure 5: Block header „PITreaderAccess“

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*)

Only the transponder key's permission (*Permission*), output by the block, is used to select the modes of safe operation.

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

The I-variable *Permission* is assigned to the O-variable *Permission* on the block "PITreaderAccess".

The I-variable *Acknowledge* is not used in this example, so it is permanently assigned the value TRUE.

The I-variable *Lock* is assigned to a signal (e.g. from the CNC), which provides information about a machining process that is currently active. Operating mode selection is locked while *Lock* is TRUE.

The I-variables *Input1* to *Input4* are assigned to the inputs on the module to which the keys of the PIT or 4S are connected.

The O-variables *Output1_PI* to *Output4_PI* are assigned to the outputs on the module to which the display elements of the PIT or 4S are connected.

The O-variables *DiagSelectionLocked* and *DiagFallbackActive* are assigned 2 outputs on a PSS E S 4DO 0.5 module. Display elements can be connected to the outputs, for example, so that the lock input and fall back to MSO 1 can be signalled separately when the transponder key is removed.

Other than *MSO1* to *MSO5*, further I- and O-variables are not used in this example.

The block ensures that only ever one operating mode is selected at a time, i.e. only one of the outputs *MSO1* ... *MSO8* is TRUE.

Detailed information on the block's I- and O-variables can be found in the PAS4000 online help.

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_MSOPITreader_Keypad(_PLC)" 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 block "FS_MS0_PITreader_Keypad(_PLC)" meets the following safety requirements:

- ▶ The block prevents any unintended switching.
Switching to a different mode of safe operation – when the appropriate permission is present - is initiated by deliberate operator action. A button must be operated and then released within a defined time window.
Through this action, a short circuit is also detected between 24 VDC and an input on the PSSu module.
- ▶ The block detects the simultaneous operation of multiple buttons as an error.
Shorts between the inputs of the PSSu module are also detected.
A new selection cannot be made until all the block's inputs are FALSE.
- ▶ The block ensures that only one mode of safe operation is selected at any one time, by only ever having one of the outputs *MSO1* ... *MSO8* TRUE at a time.
- ▶ After the safety controller is restarted, the block ensures that – depending on the configuration – either the mode of safe operation 1 (MSO 1) or the last mode of safe operation to be selected is output.

The block's parameters are monitored to ensure they are within the permitted value ranges. The parameters are read in when the safety controller is restarted and cannot be changed during operation.

Any errors detected with the configuration, operation or permission 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" 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.

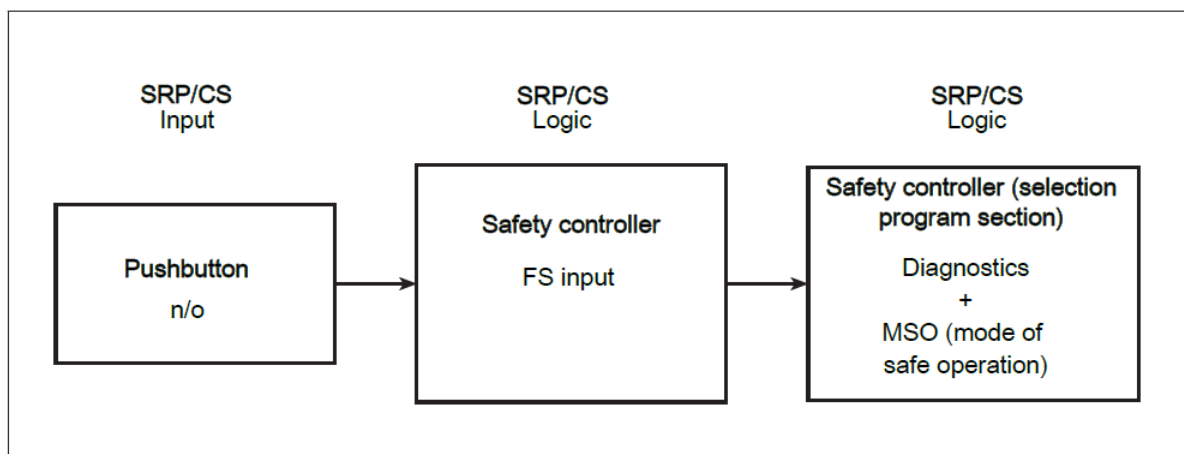


Figure 7: Safety-related architecture, "Pushbutton" subsystem and "Selection" program section

In accordance with EN ISO 13849-1, the external pushbuttons with N/O contacts can be treated as follows:

- ▶ For the "operating mode selection" safety function it is sufficient for a safety level to be calculated for just one pushbutton.
- ▶ Cat. 2 can be estimated for the pushbutton subsystem; the following conditions are met:
 - Demand rate = Test rate (1 to 1) – Testing occurs immediately upon demand of the safety function and the overall time to detect the fault and to bring the machine to a non-hazardous condition is shorter than the time to reach the hazard.
 - $MTTF_{D, TE} \text{ (Test equipment)} > 0.5 * MTTF_{D, L} \text{ (Logic)}$
- ▶ DC 90 % (shorts between contacts in the wiring are also detected)
- ▶ Measures against CCF (min. score of 65 in accordance with Table F.1 (EN ISO 13849-1) can be considered to have been fulfilled if the user can confirm that the following measures against CCF have been fulfilled:
 - Protection against over-voltage, over-pressure, over-current, overtemperature, etc. (score of 15)
 - Other influences: Consideration of the requirements for immunity to all relevant environmental influences such as, temperature, shock, vibration, humidity (e.g. as specified in relevant standards) (score of 10)

All the requirements for calculating the safety-related characteristic data can be regarded as met for the pushbuttons used on the PIT oe 4S.

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	Sensor (PIT oe 4S) Input (PSSu E F DI) Logic (PSSu H PLC1 FS SN)

Requirements:

No.	Description	Identifier
1	Common cause failure (CCF)	Requirements are considered to be met (must be checked when implemented)
2	Mission time	20 years
3.1	Operation interval (electromechanical components) (according to application-related assumption from this example)	Sensor 1 operation per hour
3.2	Operation interval (electromechanical components) (according to typical demand rates from ISO 16090-1 Table I.1)	Sensor 4 operations per hour Sensor must be replaced after $T_{10D}=5.2$ 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	Sensor (PIT oe 4S) Input (PSSu E F DI) Logic (PSSu H PLC1 FS SN)

Requirements:

No.	Description	Identification
1	Common cause failure (CCF)	$\beta = 2\%$ (must be checked when implemented)
2	Proof test interval	20 years
3.1	Operation interval (electromechanical components) (according to application-related assumption from this example)	Sensor 1 operation per hour
3.2	Operation interval (electromechanical components) (according to typical demand rates from ISO 16090-1 Table I.1)	Sensor 4 operations per hour Sensor must be replaced after $T_{10D}=5.2$ 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 PSSu PLC

5.2.1 Overview

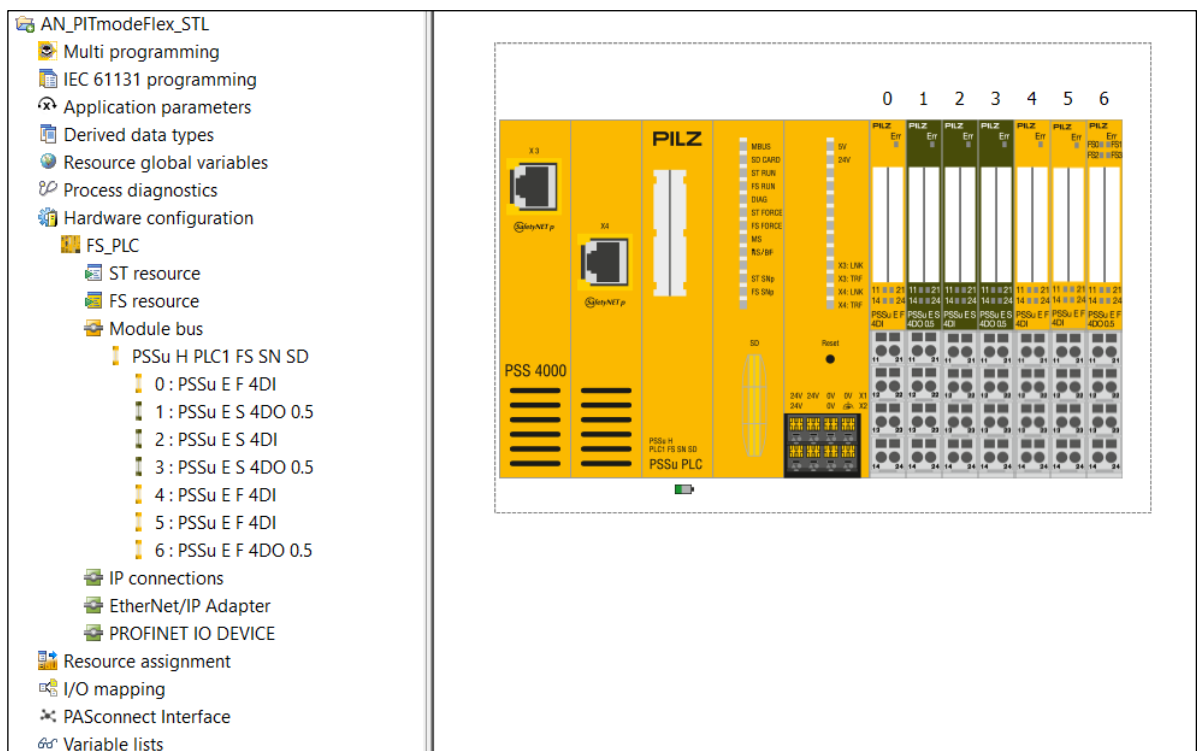


Figure 8: PSS 4000 hardware configuration

The PSSu PLC is assigned the IP address 192.168.0.11.

The inputs on the I-module PSSu E F DI, to which the keypad PIT or 4S is connected, must be reconfigured from test pulses to 24 V.

The default settings from the other I-modules are adopted.

5.2.2 IP connection

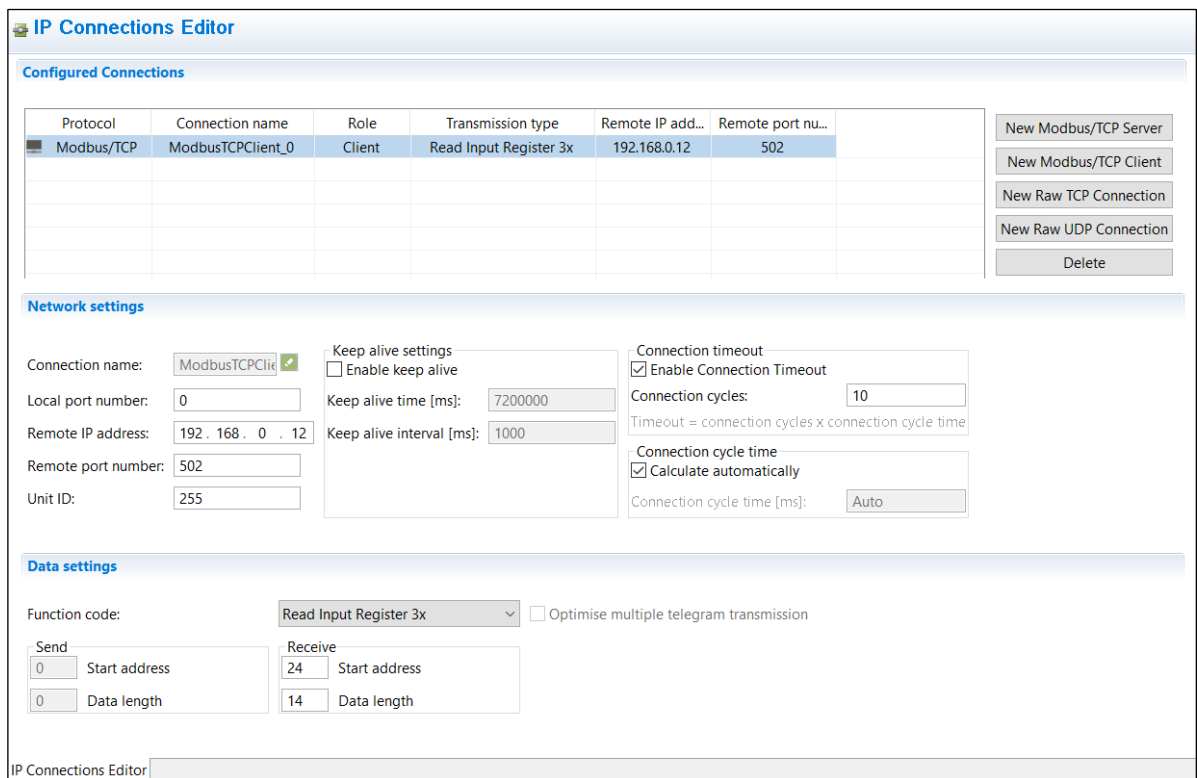


Figure 9: Modbus/TCP Client connection

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

5.2.3 Connection diagram

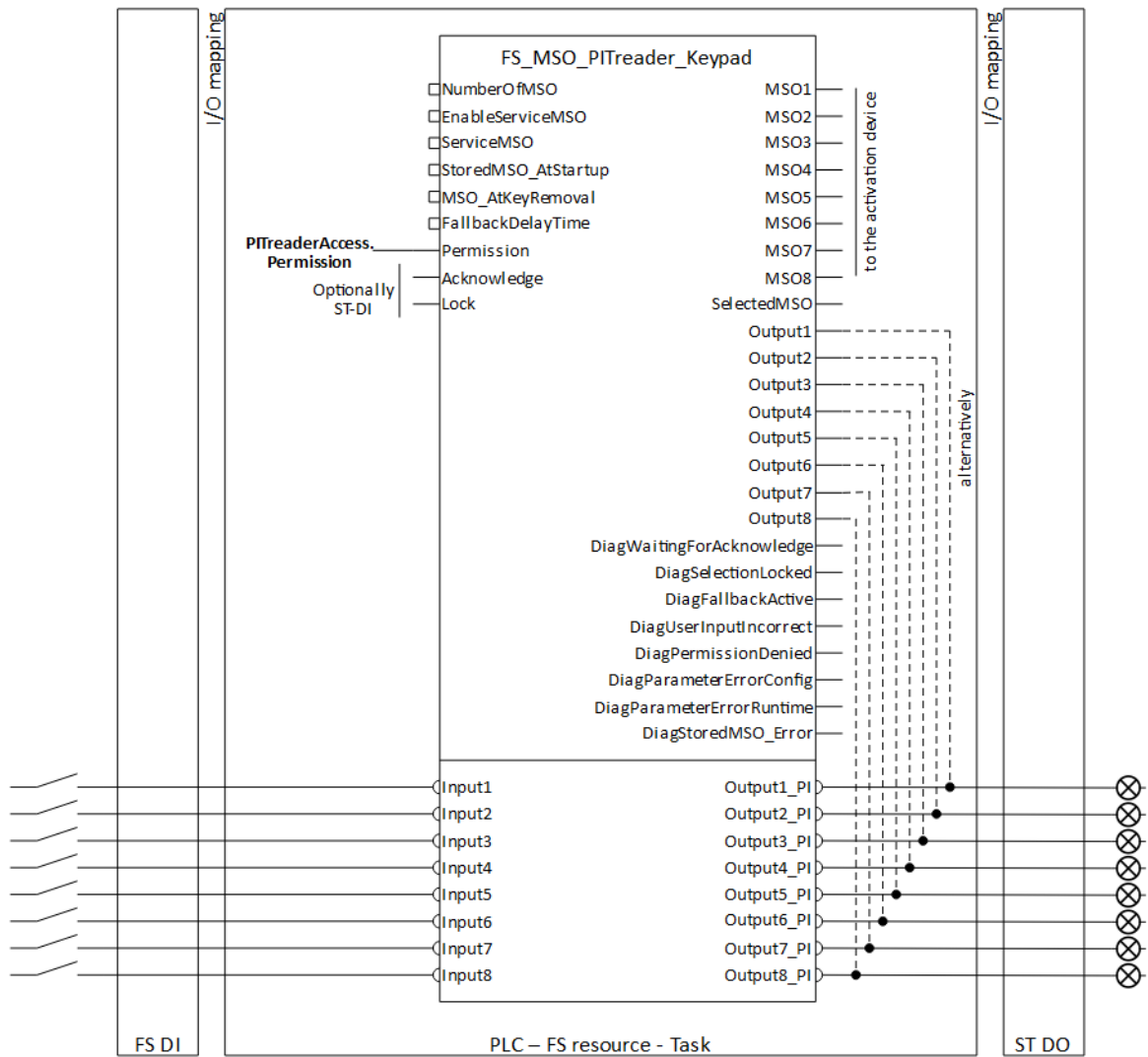


Figure 10: Basic wiring of the block "FS_MSO_PITreader_Keypad"

Detailed wiring of this example can be found in the wiring diagram in the Appendix, see [Section 8.1 Electrical circuit \[29\]](#).

6 Software configuration

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

6.1 Multi programming

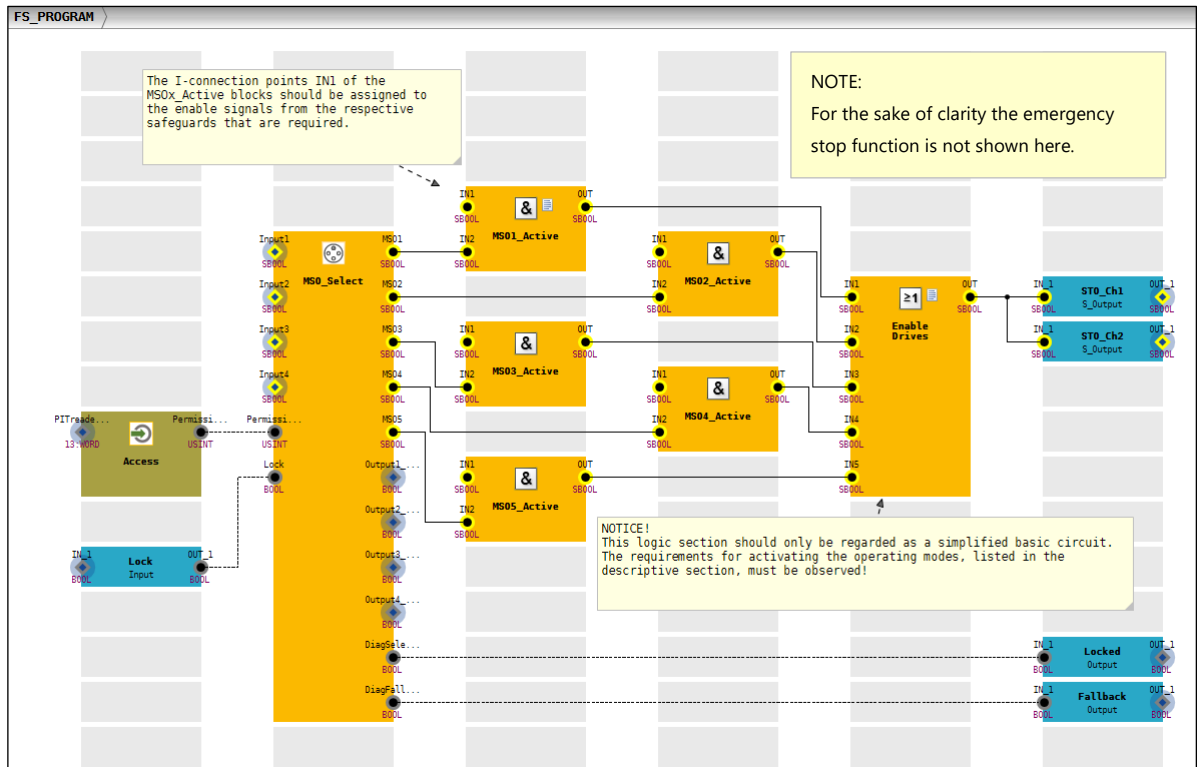


Figure 11: Multi program „FS_PROGRAM“

The instance of the block "PITreaderAccess" was called "Access"; "MSO_Select" was assigned as the name for the instance of the block "FS_MSO_PITreader_Keypad".

The elements "Lock", "STO_Ch1", "STO_Ch2", "Locked" and "Fallback" provide I-PI and O-PI variables for mapping the hardware.

The logic section with the elements "MSOx_Active" and "EnableDrives" 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 \[16\]](#).

The properties of the block instance "MSO_Select" are shown below, see [Section 4.4 Operating mode selection via keypad with display elements PIT or 4S \[14\]](#).

MSO_Select : FS_MSOPITreader_Keypad

Parameter Points

Modes of Safe Operation

Number of Modes of Safe Operation: 5

Enable Service Mode

Service Mode: 5

Start-Up with Stored Mode of Safe Operation

Removal of the Transponder Key

Behaviour After the Transponder Key is Removed:

Mode of Operation is Maintained

Fall Back to Mode 1

Fall Back to Mode 1 if Service Mode is Selected

Fall Back Delay Time After the Transponder Key is Removed (0 ... 60) [s]: 15

Figure 12: Parameter settings (MSO_Select)

MSO_Select : FS_MSOPITreader_Keypad

Parameter Points

Show I-connection points on block

Acknowledge

Lock

Show O-connection points on block

SelectedMSO

Output1

Output2

Output3

Output4

Output5

Output6

Output7

Output8

DiagWaitingForAcknowledge

DiagSelectionLocked

DiagFallbackActive

DiagUserInputIncorrect

DiagPermissionDenied

DiagParameterErrorConfig

DiagParameterErrorRuntime

DiagStoredMSO_Error

Figure 13: Selection of connection points (MSO_Select)

Parameter Points	Variable	Configured Value	Current Value
Selection	NumberOfMSO	5	USINT#5
General	EnableServiceMSO	true	true
Current values	ServiceMSO	5	USINT#5
Diagnostics	StoredMSO_AtStartup	false	false
	MSO_AtKeyRemoval	2	USINT#2
	FallbackDelayTime	15	T#15s
	Acknowledge	true	true

Figure 14: Values currently valid in the Multi program (MSO_Select)

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

6.2.1 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_Keypad_PLC;
08     MSO1_5_Button        AT %I* : SAFEBOOL; //PI variable for selection button MSO1/MSO5
09     MSO2_Button          AT %I* : SAFEBOOL; // PI variable for selection button MSO2
10     MSO3_Button          AT %I* : SAFEBOOL; // PI variable for selection button MSO3
11     MSO4_Button          AT %I* : SAFEBOOL; // PI variable for selection button MSO4
12     Lock                  AT %I* : BOOL; // PI variable for lock input
13     MSO1_Selected        : SAFEBOOL; // MSO1 selected
14     MSO2_Selected        : SAFEBOOL; // MSO2 selected
15     MSO3_Selected        : SAFEBOOL; // MSO3 selected
16     MSO4_Selected        : SAFEBOOL; // MSO4 selected
17     MSO5_Selected        : SAFEBOOL; // MSO5 selected
18     Display1             AT %Q* : BOOL; // PI variable for display element 1
19     Display2             AT %Q* : BOOL; // PI variable for display element 2
20     Display3             AT %Q* : BOOL; // PI variable for display element 3
21     Display4             AT %Q* : BOOL; // PI variable for display element 4
22     SelectionLocked      AT %Q* : BOOL; // PI variable for "Lock input" display
23     FallbackActive       AT %Q* : BOOL; // PI variable for "Fallback active" display
24
25     // MSO activation
26     MSO1_Active          : SAFEBOOL; // MSO1 activated
27     MSO2_Active          : SAFEBOOL; // MSO2 activated
28     MSO3_Active          : SAFEBOOL; // MSO3 activated
29     MSO4_Active          : SAFEBOOL; // MSO4 activated
30     MSO5_Active          : SAFEBOOL; // MSO5 activated
31     SafetyMSO1_Enable    : SAFEBOOL; // Enable of safeguards for MSO1
32     SafetyMSO2_Enable    : SAFEBOOL; // Enable of safeguards for MSO2
33     SafetyMSO3_Enable    : SAFEBOOL; // Enable of safeguards for MSO3
34     SafetyMSO4_Enable    : SAFEBOOL; // Enable of safeguards for MSO4
35     SafetyMSO5_Enable    : SAFEBOOL; // Enable of safeguards for MSO5
36     EnableDrives         AT %Q* : SAFEBOOL; // PI variable for enabling the drives
37 END_VAR

```

6.2.2 Instruction part

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

```

38 //--Authorisation and access-----
39 Access();
40
41 //--MSO operating mode selection-----
42 MSO_Select(
43     Input1                := MSO1_5_Button, // Selection button MSO1 and MSO5
44     Input2                := MSO2_Button, // Selection button MSO2
45     Input3                := MSO3_Button, // Selection button MSO3
46     Input4                := MSO4_Button, // Selection button MSO4
47     Input5                := FALSE, // Not used
48     Input6                := FALSE, // Not used
49     Input7                := FALSE, // Not used
50     Input8                := FALSE, // Not used
51     NumberOfMSO           := USINT#5, // 5 operating modes
52     EnableServiceMSO      := TRUE, // With service mode
53     ServiceMSO            := USINT#5, // MSO5 as service mode
54     StoredMSO_AtStartup   := FALSE, // Start-up with MSO1
55     MSO_AtKeyRemoval      := USINT#2, // Fall back to MSO1, when in service mode
56     FallbackDelayTime     := T#15s, // Fallback delay 15 seconds
57     Permission            := Access.Permission, // Permission from access block
58     Acknowledge           := TRUE, // No acknowledgement required
59     Lock                  := Lock, // Lock input
60     MSO1                  => MSO1_Selected, // MSO1 selected
61     MSO2                  => MSO2_Selected, // MSO2 selected
62     MSO3                  => MSO3_Selected, // MSO3 selected
63     MSO4                  => MSO4_Selected, // MSO4 selected
64     MSO5                  => MSO5_Selected, // MSO5 selected
65     Output1               => Display1, // Display element 1
66     Output2               => Display2, // Display element 2

```



```

67     Output3           => Display3,           // Display element 3
68     Output4           => Display4,           // Display element 4
69     DiagSelectionLocked => SelectionLocked,  // Display for "Lock input"
70     DiagFallbackActive => FallbackActive     // Display for "Fallback active"
71   );
72
73   //--MSO activation and enable of the drives-----
74   (*****
75   * NOTICE! *
76   * This logic section should only be regarded as a simplified basic circuit. *
77   * The requirements for activating the operating modes, listed in the *
78   * descriptive section, must be observed! *
79   * The variables SafetyMSOx_Enable should be assigned to the enable signals *
80   * from the respective safeguards that are required. *
81   *****)
82   MSO1_Active := MSO1_Selected AND SafetyMSO1_Enable;
83   MSO2_Active := MSO2_Selected AND SafetyMSO2_Enable;
84   MSO3_Active := MSO3_Selected AND SafetyMSO3_Enable;
85   MSO4_Active := MSO4_Selected AND SafetyMSO4_Enable;
86   MSO5_Active := MSO5_Selected AND SafetyMSO5_Enable;
87   EnableDrives := MSO1_Active OR MSO2_Active OR MSO3_Active OR MSO4_Active OR MSO5_Active;
88
89   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 \[16\]](#).

6.3 Resource assignment

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

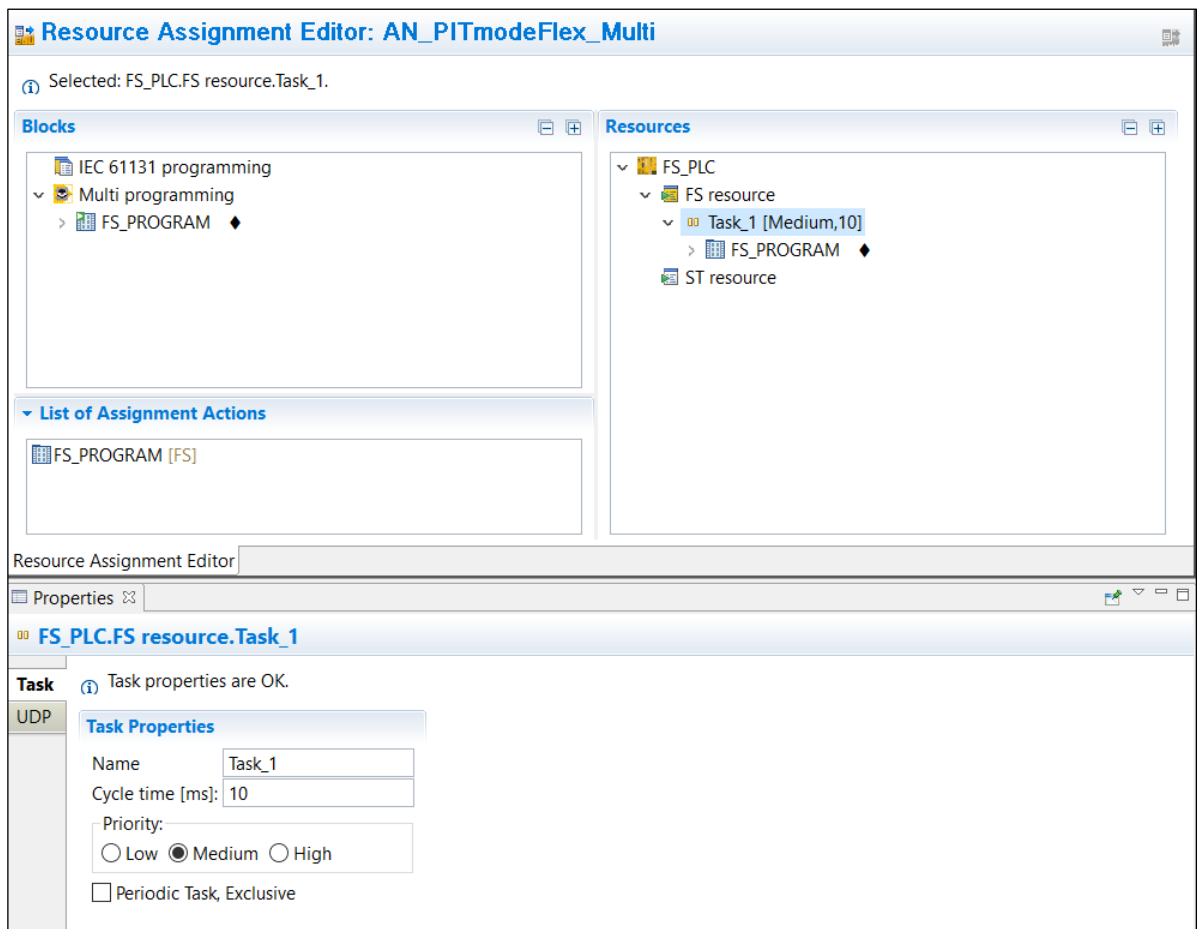


Figure 15: FS resource assignment

6.4 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":

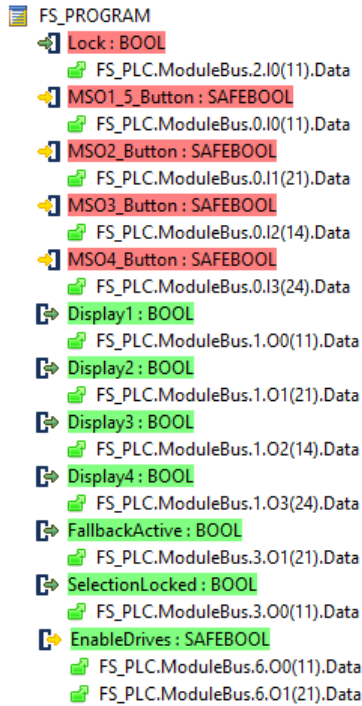


Figure 16: I/O mapping PI-variables <-> Module bus

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

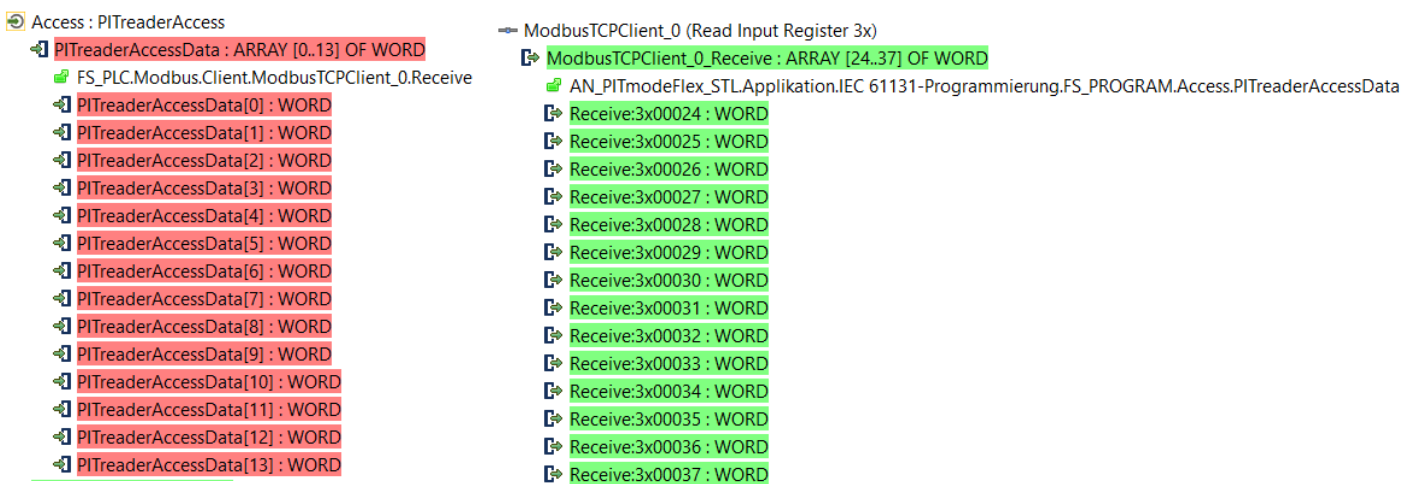


Figure 17: I/O mapping PI variables <-> IP connections

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

- ▶ Insert a transponder key with the relevant permission into the PITreader. The colour of the illuminated ring around the key adapter switches from blue to green when the transponder key has been recognised as valid.
- ▶ Select the required operating mode by pressing the relevant button (number 1 to 4 on the keypad PIT oe 4S). The button must be pressed for a minimum of 50 ms and a maximum of 5 s. The display element for the previous operating mode is switched off and the display element for the newly selected operating mode is switched on. The O-variable *MSO_x* from the previous operating mode is switched off; the O-variable *MSO_x* from the newly selected operating mode is switched on (block "FS_MS0_PITreader_Keypad").
- ▶ Remove the transponder key from the PITreader. The ring around the key adapter lights up blue.

Should the selection be locked (*Lock = TRUE*) or the permission not be sufficient, this will be signalled by the display element for the operated button flashing repeatedly.

If several buttons are operated simultaneously or a button is operated for too long (> 5 seconds), this will also be signalled by the display elements for the operated buttons flashing repeatedly.

Diagnostic information will be displayed in the event of an error. The information is displayed via the diagnostic list from PAS4000 and via the O-variables *DiagSelectionLocked*, *DiagUserInputIncorrect* or *DiagPermissionDenied* (block "FS_MSO_PITreader_Keypad").

7.3 Select mode of safe service operation

- ▶ Insert a transponder key with the relevant permission (5 minimum) into the PITreader. The colour of the illuminated ring around the key adapter switches from blue to green when the transponder key has been recognised as valid.
- ▶ Select the service operating mode by pressing button 1 on the keypad PIT oe 4S. The button must be pressed for a minimum of 5 s and a maximum of 10 s. The display element for the previous operating mode is switched off and all display elements on the PIT oe 4S are switched to a flashing mode. The O-variable *MSOx* from the previous operating mode is switched off; the O-variable *MSO5* from the newly selected service operating mode is switched on (block "FS_MSO_PITreader_Keypad").
- ▶ Service operating mode remains selected for as long as the transponder key is inserted.
- ▶ Remove the transponder key from the PITreader. The ring around the key adapter lights up blue. The O-variable *DiagFallbackActive* and an entry in the PAS4000 diagnostic list are used to indicate that a switch to operating mode MSO 1 will occur in just a few seconds (15 s). This switch can be prevented by inserting a transponder key with the relevant permission. In this case service mode will continue to be selected.
- ▶ If no transponder key is inserted, the switch to operating mode MSO 1 will occur after the fallback delay time has elapsed. The flashing on the display elements is switched off and the display element for MSO 1 is switched on and is static. The O-variable *MSO5* is switched off and the O-variable *MSO1* is switched on (block "FS_MSO_PITreader_Keypad").

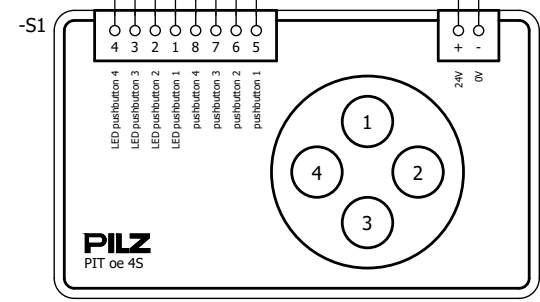
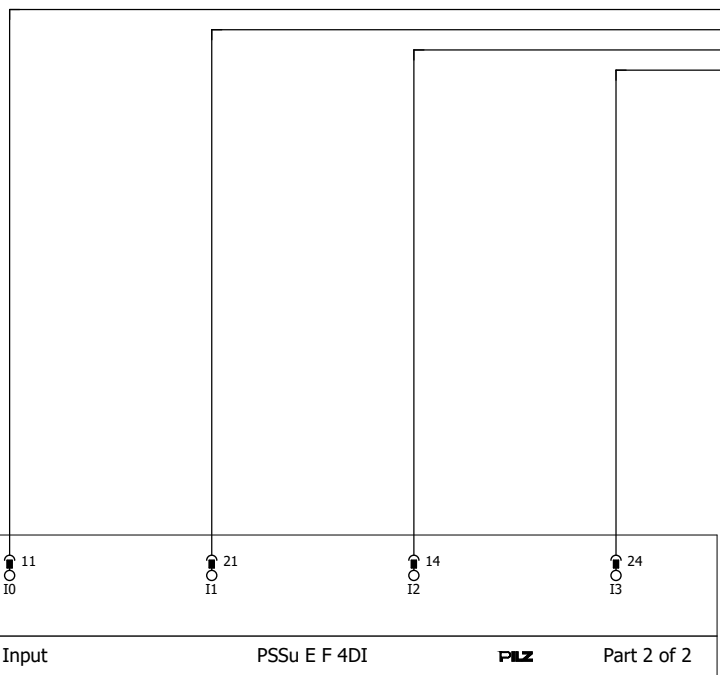
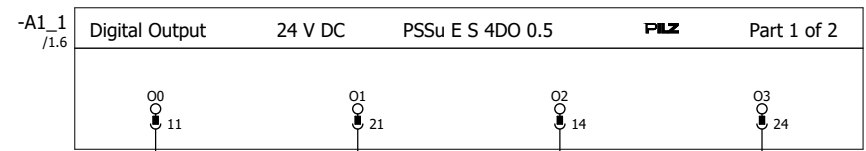
Should the selection be locked (*Lock = TRUE*) or the permission not be sufficient, this will be signalled by the display element for the operated button flashing repeatedly.

If several buttons are operated simultaneously or button 1 is operated for too long (> 10 seconds), this will also be signalled by the display elements for the operated buttons flashing repeatedly.

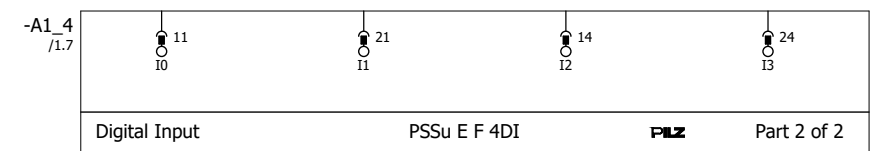
Diagnostic information will be displayed in the event of an error. The information is displayed via the diagnostic list from PAS4000 and via the O-variables *DiagSelectionLocked*, *DiagUserInputIncorrect* or *DiagPermissionDenied* (block "FS_MSO_PITreader_Keypad").

/ 24VDC
/ -0VDC

Display1 Display2 Display3 Display4



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



MSO1_5 MSO2 MSO3 MSO4
_Button _Button _Button _Button

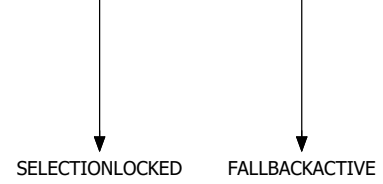
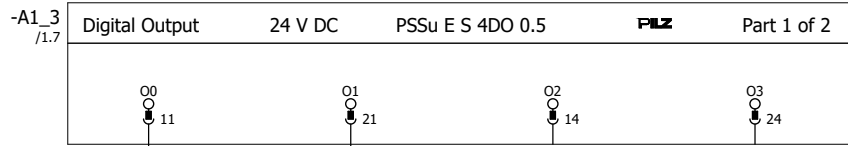
none none none none

Revision	31.08.2021	Date	24.08.2021	EN ISO 13849-1	PL d
Name	Pilz	Name	Pilz	EN 62061	SIL 2
		Dep.	CSI		

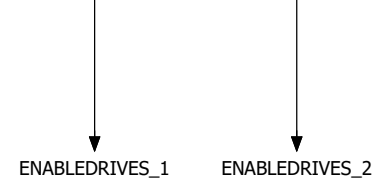
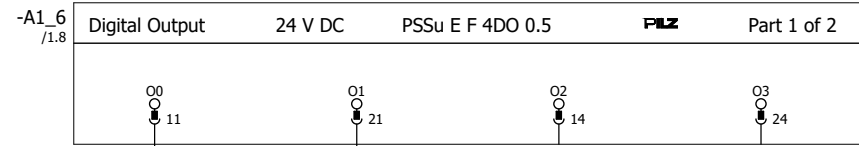


Safety-related Operating Mode Selection
PSSu PITmode flex
PIT oe 4S

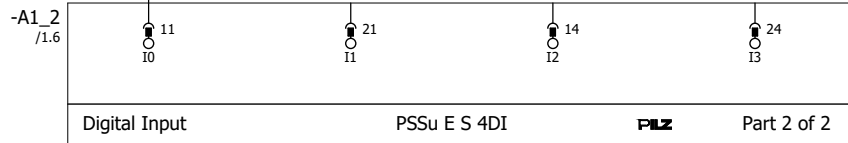
Selection Locked Fallback Active none none



Enable Drives Enable Drives none none

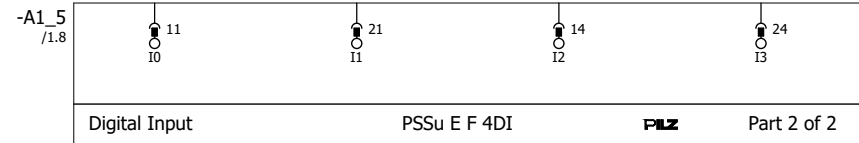


LOCK



Lock none none none

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



none none none none

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