Automation System PSS 4000

System Description – No. 1001467-EN-10

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SD means Secure Digital.

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1.1 Validity of the documentation

This documentation is valid for the automation system PSS 4000. It is valid until new documentation is published.

The latest documentation is always enclosed with the product.

This document often uses the term "PSS 4000" as an abbreviation of "Automation system PSS 4000".

1.2 Overview of documentation

1 Introduction to the Documentation

The introduction is designed to familiarise you with the contents, structure and specific order of this system description.

2 Automation System PSS 4000

This chapter contains an introduction to the automation system PSS 4000.

3 Safety

This chapter must be read as it contains important information on safety regulations.

4 PSSu System Basics

This chapter contains essential information on the design and power supply of a PSSu system, including the system limits and factory-set defaults.

5 Ethernet Interface

This chapter contains essential information on the Ethernet interface on PSS 4000 devices.

6 SafetyNET p

This chapter contains an introduction to SafetyNET p, usable components and network subscribers.

7 External Communication

This chapter contains information on data exchange via Ethernet-based communication modes such as Modbus/TCP and on data exchange via fieldbus systems such as PROFIBUS-DP Slave.

8 Project

This chapter contains essential information on the programming model, device naming, project download and access protection for blocks.

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1.2 Overview of documentation

9 Mode of Operation

This chapter explains the operating states of a PSSu system, options for user intervention, special procedures and modes of operation.

10 Commissioning

This chapter describes the requirements during commissioning.

11 Maintenance and Repair, Decommissioning

This chapter describes the requirements during maintenance, repair and decommissioning.

12 OPC Server

This chapter describes the Pilz PSS 4000 OPC Server.

13 Diagnostics

This chapter contains an overview and introduction to diagnostics on the PSS 4000.

14 Appendix

The appendix documents various factory-set defaults.

15 List of Abbreviations

16 Glossary

1.3 Definition of symbols

Information that is particularly important is identified as follows:

DANGER!
This warning must be heeded! It warns of a hazardous situation that poses an immediate threat of serious injury and death and indicates preventive measures that can be taken.

WARNING!
This warning must be heeded! It warns of a hazardous situation that could lead to serious injury and death and indicates preventive measures that can be taken.

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 unit(s) 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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In development
This function or description is not yet available.
It will not concern safety-related functions or descriptions.

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2.1 Introduction to PSS 4000

2.1.1 General

PSS 4000 is an automation system that can be used to tackle the widest range of automation functions. These include requirements from the fields of control technology (PLC), motion control and visualisation.

PSS 4000 can be used at every stage of automation, ranging from a small, decentralised automation terminal to a complex network at control level.

The automation system PSS 4000 handles non-safety-related functions (ST functions) as well as safety-related functions (FS functions) for control, motion control and visualisation tasks.

2.1 Introduction to PSS 4000

2.1.2 SafetyNET p

SafetyNET p is used for networked automation functions. SafetyNET p is an Ethernet-based multi-master bus system suitable for industrial use.

The SafetyNET p protocol contains a safe data channel for safety-related data. This channel is certified for data transfer in accordance with SIL 3 of IEC 61508. On SafetyNET p, safety and non-safety-related data is transferred via different data channels, but using the same connection cable.

In terms of the topology, SafetyNET p supports various familiar Ethernet architectures. So modular system architectures and individual subnetworks can be implemented. If necessary, this method can be used to divide automation functions into decentralised and largely independent function units. The main benefits of this type of architecture lie in the reusability, modification and availability of function units.

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2.1 Introduction to PSS 4000

2.1.3 Devices in the automation system PSS 4000

2.1.3.1 System overview

Devices in the automation system PSS 4000 are divided into **PSS 4000 devices** and **PSS 4000 periphery devices**. The diagram below provides an overview of how the devices are divided and subdivided:

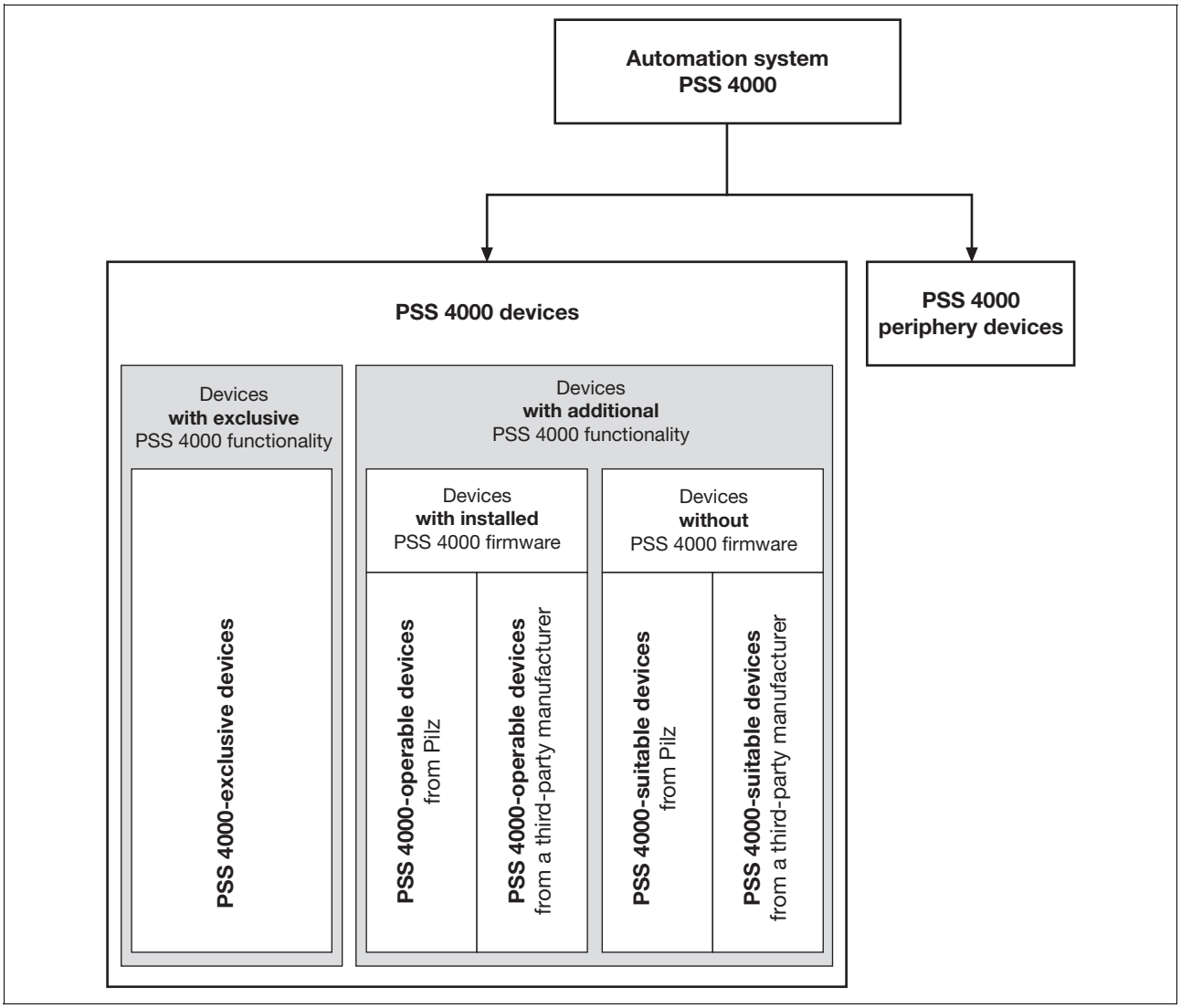

Fig. 2-1: Devices of the automation system PSS 4000

2.1 Introduction to PSS 4000

PSS 4000 devices

PSS 4000 devices are devices on which the PSS 4000 firmware is installed or on which the PSS 4000 firmware can be installed. As such, these devices have the basic properties of the automation system PSS 4000. The most important basic properties include:

- Ability to find the devices via PAS4000 using "Scan PSS 4000 Network"
- Incorporation into the PSS 4000 diagnostic system
- Respective configuration obtained via the PSS 4000 project download
- Respective device project obtained via the PSS 4000 project download

A further subdivision of the PSS 4000 devices is as follows:

- Devices which exclusively have PSS 4000 functionality (e.g. PSSu system head modules) are called **PSS 4000-exclusive devices**.
- Devices which have PSS 4000 functionality as an additional feature are subdivided as follows:
  - **PSS 4000-operable devices**
    These are devices on which the PSS 4000 firmware is installed. They may be Pilz devices or devices from a third party manufacturer. If they are Pilz devices, they will be called "PSS 4000-operable devices from Pilz", otherwise they will be called "PSS 4000-operable devices from a third-party manufacturer".
  - **PSS 4000-suitable devices**
    These are devices on which the PSS 4000 firmware is not installed, (e.g. PMI operator terminals, PC), but on which the PSS 4000 firmware can be installed. They may be Pilz devices or devices from a third party manufacturer. If they are Pilz devices, they will be called "PSS 4000-suitable devices from Pilz", otherwise they will be called "PSS 4000-suitable devices from a third-party manufacturer".
    If the PSS 4000 firmware is installed on a PSS 4000-suitable device, that device then becomes a PSS 4000-operable device.

PSS 4000 periphery devices

PSS 4000 periphery devices are devices that can be used with the automation system PSS 4000. They are subdivided as follows:

- Devices on which the PSS 4000 firmware cannot be installed (e.g. sensors, devices for external communication such as PROFIBUS-DP Master)

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2.1 Introduction to PSS 4000

- Devices on which the PSS 4000 firmware can be installed, but is not installed (e.g. PSS 4000-suitable devices such as PMI operator terminals with exclusive PSS 4000 Diag Control)

2.1 Introduction to PSS 4000

2.1.3.2 System sections

A system section is a defined unit of functionalities, which provides utilities on a device, which are visible to the user. To ensure that a system section can run on a PSS 4000-exclusive device or PSS 4000-operable device, the corresponding hardware requirements must be met.

The system sections that are available on a PSS 4000-exclusive device or PSS 4000-operable device depend on the device. Details of the PSS 4000-exclusive devices and PSS 4000-operable devices from Pilz are available in the operating manual for the relevant unit.

Overview of available system sections

- Resources
  - FS resource system section
    Execution unit for safety-related control programs
  - ST resource system section
    Execution unit for non-safety-related control programs
- Module bus
  - FS module bus system section
    Unit for data exchange between FS electronic modules/FS compact modules and other system sections on this device
  - ST module bus system section
    Unit for data exchange between ST electronic modules/ST compact modules and other system sections on this device
- SafetyNET p RTFN
  - FS SafetyNET p RTFN system section
    Unit for transporting FS-I/O-data via SafetyNET p RTFN
  - ST SafetyNET p RTFN system section
    Unit for transporting ST-I/O-data via SafetyNET p RTFN
- External communication
  - IP connections system section
    Unit for transporting external I/O data via IP connections (e.g. Modbus/TCP, Raw UDP)
  - PROFIBUS-DP Slave system section
    Unit for transporting external I/O data as PROFIBUS-DP Slave
- Server
  - Diagnostic Server system section
    Unit for providing diagnostic data
  - OPC Server system section
    Unit with standardised software interface for providing visualisation data

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2.1 Introduction to PSS 4000

Overview of the system sections of PSS 4000-exclusive/operable devices

Product	FS resource	ST resource	FS module bus	ST module bus	FS SafetyNET p RTFN	ST SafetyNET p RTFN	IP connections	PROFIBUS-DP Slave	OPC Server	Diagnostic Server
PSSu H PLC1 FS DP SN SD	◆	◆	◆	◆	◆	◆	◆	◆	---	---
PSSu H PLC1 FS SN SD	◆	◆	◆	◆	◆	◆	◆	---	---	---
PSSu H m F DP SN SD	◆	---	◆	◆	◆	◆	---	◆	---	---
PSSu H m F DP ETH SD	◆	---	◆	◆	---	---	---	◆	---	---
PSSu H FS SN SD	---	---	◆	◆	◆	◆	---	---	---	---
PSS 4000 firmware for PMI 4 series	---	---	---	---	---	---	---	---	◆	◆
PSS 4000 firmware for PMI 5 series	---	---	---	---	---	---	---	---	◆	◆
PSS 4000 firmware for PC	---	---	---	---	---	---	---	---	◆	◆

2.1 Introduction to PSS 4000

2.1.3.3 PSS 4000-exclusive devices: PSSu systems

PSSu systems are PSS 4000-exclusive devices. The system sections that are available on a PSSu system depend on the device (see System sections, page 2-6) . Details can also be found in the operating manual of the relevant device.

A PSSu system is assembled from a variety of modules, to suit the functions required. The modular structure makes it easier to react to modifications and adjustments. With a PSSu system, not only is it possible to adapt the scope retrospectively (e.g. extend the number of I/Os, extend/ modify the I/O technology, such as using relay outputs, adding I/O functions such as analogue evaluation, counter functions, temperature evaluation), it's also possible to convert a PSSu system with a lower performance rating (e.g. decentralised system PSSuniversal I/O) into a PSSu system with a higher performance rating (e.g. control system PSSuniversal PLC).
A PSSu system is configured in the PSSu Module Editor of the PAS4000.

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2.1 Introduction to PSS 4000

2.1.3.4 PSS 4000-operable devices from Pilz PMI

Various Pilz PMI operator terminals can be made into "PSS 4000-operable devices from Pilz" by installing the PSS 4000 firmware (see System requirements, page 12-5) . When the PSS 4000 firmware is installed, the PMI obtains various system sections, as e.g the OPC Server and Diagnostic Server (see Overview of the system sections of PSS 4000-exclusive/operable devices, page 2-7) .

2.1 Introduction to PSS 4000

2.1.3.5 PSS 4000-operable devices from a third-party manufacturer: PC

A PC with the corresponding system requirements can be made into a "PSS 4000-operable device from a third-party manufacturer" by installing the PSS 4000 firmware (see System requirements, page 12-5) . In this case the PC will also be known as a PSS 4000-PC. When the PSS 4000 firmware is installed, the PC obtains e.g. the OPC Server system section and the Diagnostic Server system section (see System sections available, page 2-7) .

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2.1 Introduction to PSS 4000

2.1.3.6 PSS 4000-suitable devices

A PSS 4000-suitable device must meet certain system requirements in order for the PSS 4000 firmware to be installed. These system requirements are defined through the PSS 4000 firmware that is to be installed on the PSS 4000-suitable device.

Example for PSS 4000 OPC Server

- The PSS 4000 OPC Server can be installed on a PC with various Microsoft Windows operating systems (see System requirements, page 12-5) .
- The PSS 4000 OPC Server can be installed on various generations of Pilz PMI operator terminals (see System requirements, page 12-5) .

2.1 Introduction to PSS 4000

2.1.4 PAS4000

Design, configuration, programming, commissioning and diagnostics take place centrally via PAS4000 (Pilz Automation Suite 4000).

PAS4000 is a collection of various tools which can be used to create and edit a project, e.g.:

- PSSu Module Editor
  The required PSSu systems are assembled and configured in the PSSu Module Editor.
- I/O Mapping Editor
  The connection between the user program and hardware is established in the I/O Mapping Editor.
- IL Editor
  In the IL Editor, the user program is programmed in the instruction list (IL) programming language.

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2.1 Introduction to PSS 4000

2.1.5 Diagnostics

Effective diagnostics are required in order to keep machine downtimes to a minimum. Diagnostics must provide all the information necessary to rectify faults quickly, prevent faults and analyse machine conditions.

The PSS 4000 distinguishes between system diagnostics and process diagnostics.

- System diagnostics
  Diagnostics on hardware and firmware, including errors in the hardware configuration or user program.
  The system diagnostics are provided by Pilz in full. Only a few adjustments can be made by the user, e.g. switch off mandatory acknowledgement.
- Process Diagnostics
  Diagnostics on procedures and conditions. The process diagnostics are created by the user within the user program. Pilz component blocks are supplied with process diagnostics, which users can adapt to suit their own requirements.

A diagnostic server is required if you wish to display a project's diagnostic data (see Diagnostic Server, page 13-25) . A project may only contain one Diagnostic Server.
If the project contains an OPC Server (PSS 4000 OPC Server), the PSS 4000 device on which the OPC Server is installed will provide the Diagnostic Server. If there is no OPC Server, PAS4000 will start up its own Diagnostic Server if the diagnostic list or diagnostic log is to be displayed in PAS4000.

2.1 Introduction to PSS 4000

2.1.6 OPC Server

OPC is a standardised software interface, through which PC-based software from a range of manufacturers can exchange data. The OPC Foundation is responsible for maintaining and propagating the standard.

On networked plants, an OPC Server will typically collect diagnostic data, process data etc. and display it in the defined namespace. OPC Clients access and process the data provided by the OPC Server for process visualisation purposes and/or to record operating data.

In the PSS 4000 automation system a PC or a PMI operator terminal obtains the OPC Server system section as part of the installation of PSS 4000 firmware. By installing the PSS 4000 Firmware a PC becomes a "PSS 4000-operable device from a third-party manufacturer" and a PMI operator terminal PMI becomes a "PSS 4000-operable device from Pilz" (see System Overview, page 2-3) .

The following boundary conditions apply to the OPC Server:

- The OPC Server supports various OPC properties for the access of OPC Clients (see OPC properties of the OPC Server, page 12-4) .
- The OPC Server can be installed on a PC or Pilz PMI operator terminal (see System requirements, page 12-5) .
- An OPC Server can collect the data of exactly one project that has been created with PAS4000 and provide it for the OPC Clients.
- Each project created with PAS4000 may contain precisely one OPC Server.
- It is possible to access the OPC Server with more than one Client.
- All project-based settings for the OPC Server are made in PAS4000 and are transferred to the OPC Server as an OPC device project when the project is downloaded.

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2.2 Modularity with PSS 4000

2.2.1 Centralised view of a networked system

PSS 4000 combines the benefits of a centralised control system at the highest automation level with the benefits of small, decentralised control units.

- Benefits at the highest automation level:
  - Software tool PAS4000, which can be used from a central location
  - Centralised configuration, even of decentralised PSSu systems
  - User program that has been created centrally can be distributed to decentralised PSSu systems
  - Rapid overview of the entire plant during troubleshooting, commissioning/re-commissioning and modification
- Benefits at the lowest automation level:
  - Decentralised function units can be commissioned independently
  - Increased availability (no “Single Point of Failure”)

2.2 Modularity with PSS 4000

2.2.2 Scalability of the devices

The term “scalability” is used for a device when it has a certain degree of adaptability to changing requirements.

A distinction can be made between “horizontal” and “vertical” scalability:

- Horizontal scaling
  Functions are distributed to other or additional devices. On PSS 4000 for example, horizontal scaling can be used to:
  – Distribute the control power to various PSSu systems on a networked plant, to increase the processing power, for example
  – Divide the user program into independent subfunctions in order to distribute it to the project devices
  – Divide the project into reusable parts
- Vertical scaling
  A device or parts of a device are replaced by a more powerful alternative. On PSS 4000 for example, vertical scaling can be used to:
  – Adapt the performance class of a PSSu system retrospectively by using a head module of a different performance class
  – Expand and adapt a PSSu system retrospectively using I/O modules

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2.2 Modularity with PSS 4000

2.2.3 Modularisation within programming

On PSS 4000, control functions can be distributed across an entire plant. As a result, the plant architecture can be modularised in line with the task assignment. This modularisation applies not only to the modular structure of the PSSu systems and network but also to the user program. With component-oriented programming, the plant can be completely divided into functionalities. The aim is to achieve the highest possible level of standardisation and reusability while maintaining maximum flexibility and adaptability.

The following can be achieved with a modularised user program on PSS 4000 for example:

- Modifications will only impact locally
- Control functions can be standardised
  A user program can be adopted for all functions with an identical structure; and once a modification has been made, it can be transferred to all the relevant PSSu systems.
- Availability is increased, as error reactions are restricted locally

6.3 Selecting SafetyNET p components

6.3.2 Selecting components for RTFN

For RTFL generally those components must be used that have a conformity test in accordance with Safety Network International e.V. and that correspond to the respective SafetyNET p specification in its current form. This is the case for components from the Pilz range, for example.

In principle it is possible to use non-certified components, provided they are designated for use in an industrial environment and the requirements of Safety Network International e.V. have been met.

INFORMATION
If you assemble the connection cable yourself we recommended that you use connector and cable made by the same manufacturer. This is because considerable variances may arise regarding connector dimensions and cable cross sections, due to the permitted tolerances.

6.4 SafetyNET p interface

The physical connection for data exchange via SafetyNET p is provided via an Ethernet interface (see Ethernet interface, page 5-2) .

NOTICE
Only use SafetyNET p subscribers (e.g. switches, hubs) that support the autosensing/autonegotiation function, otherwise a duplex conflict (duplex mismatch) may arise, which can cause considerable delays or sporadic data transmission errors.

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6.5 Process data exchange via SafetyNET p RTFN

For process data exchange via SafetyNET p RTFN, PSS 4000 devices must have the system sections "FS-SafetyNET p RTFN" and/or "ST-SafetyNET p RTFN".

Process data exchange on SafetyNET p RTFN occurs via so-called connections. The FS/ST SafetyNET p RTFN system section of a PSS 4000 device sends process data from its send data area via a transmit connection (Tx connection) and receives process data in its receive data area.

Safety-related process data (FS process data) is sent via secure Tx connections (FS-Tx connections) on SafetyNET p's secure data channel. Non-safety-related process data (ST process data) is sent via non-secure Tx connections (ST-Tx connections) on SafetyNET p's non-secure data channel.

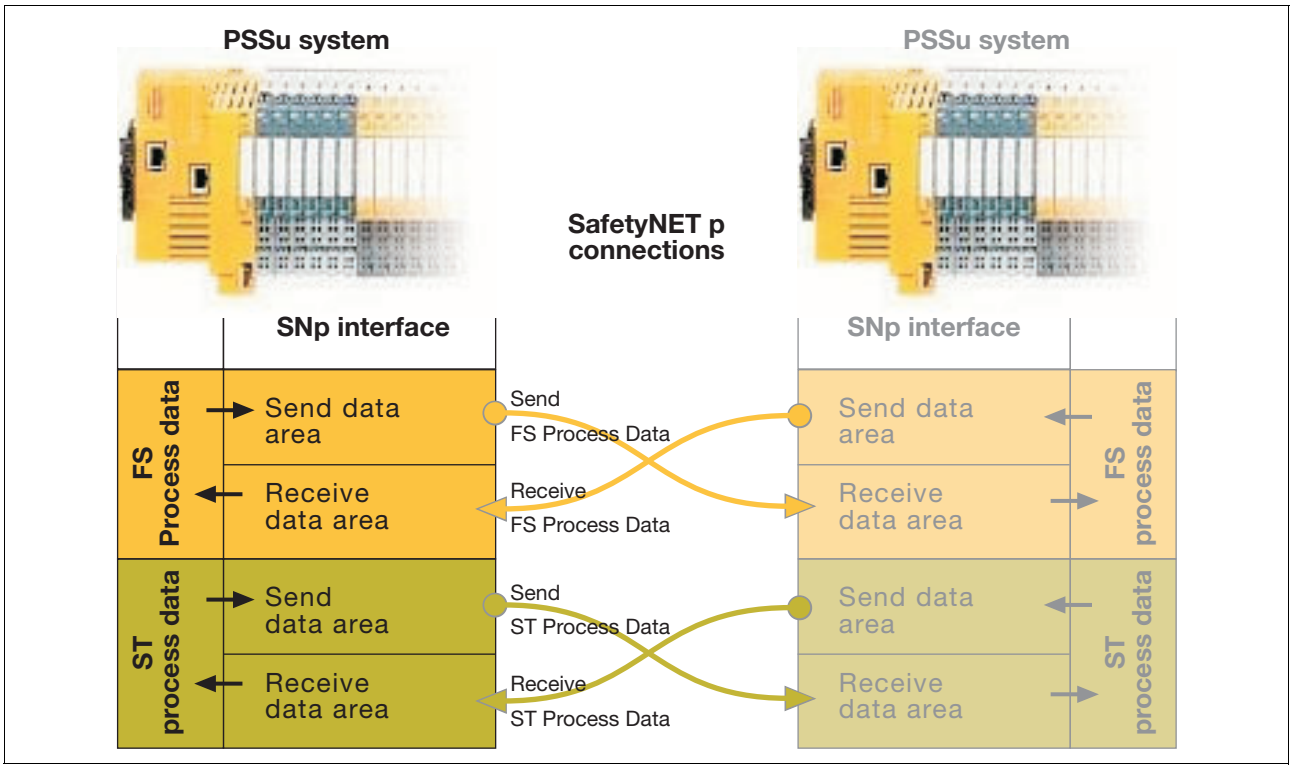

Fig. 6-4: Process data exchange principle (e.g. PSSu systems)

6.5 Process data exchange via SafetyNET p RTFN

Each Tx-connection consists of a transmit part and a receive part. The transmit part corresponds to an area in the send data area (Tx data area) of the transmitting PSS 4000 device. The receive part corresponds to an area in the receive data area (Rx data area) of the receiving PSS 4000 device.

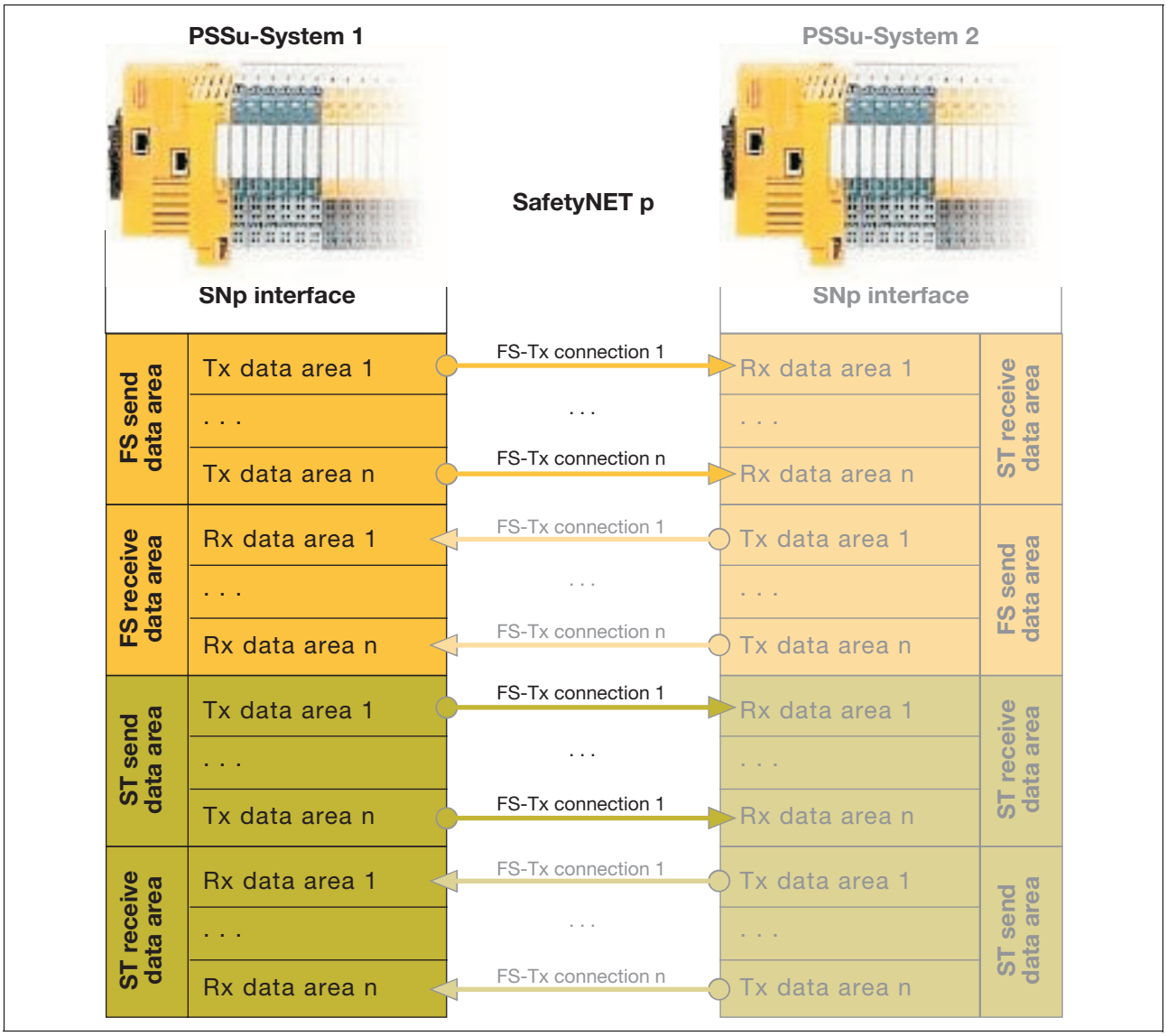

Fig. 6-5: Connection principle (e.g. PSSu systems)

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6.5 Process data exchange via SafetyNET p RTFN

6.5.1 Cyclical processing of connections

The FS/ST SafetyNET p RTFN system section on the transmitting PSS 4000 device starts a Tx connection cyclically with the cycle time $t_{SNp\ RTFN}$ and sends the process data via SafetyNET p (see Reaction times, page 9-140) .
In the FS/ST SafetyNET p RTFN system section of the receiving PSS 4000 device, event-driven tests check whether new process data has arrived via the Rx connection that belongs to the Tx connection.

After the TX connection is started, the process data must be available in the corresponding receive data area within the transmission delay time $t_{DelaySNp\ RTFN}$ (see Reaction times, page 9-140) .

6.5 Process data exchange via SafetyNET p RTFN

6.5.2 Data transfer limits

The data transfer limits are determined by the following data:

- **Maximum number of ST connections per ST SafetyNET p RTFN system section**

  The maximum number of ST-Tx connections is limited by the number of ST send data areas that an ST SafetyNET p RTFN system section can manage. The number of ST send data areas always corresponds to the number of ST receive data areas.

  The number of send and receive data areas that an ST SafetyNET p RTFN system section can manage depends on the PSS 4000 device that is used (e.g. head module for control systems PSSu PLC, control systems PSSu multi, decentralised system PSSu I/O). Details can be found in the operating manual of the relevant device.

  The ST-Tx connections can either be established to a single PSS 4000 device or to the SafetyNET p RTFN system sections of various PSS 4000 devices.

  Example: Control system PSSu PLC:

  The ST SafetyNET p RTFN system section of a control system PSSu PLC can manage the send data areas for a max. 64 ST-Tx connections; consequently it can also manage the receive data areas for a max. 64 ST-Tx connections.

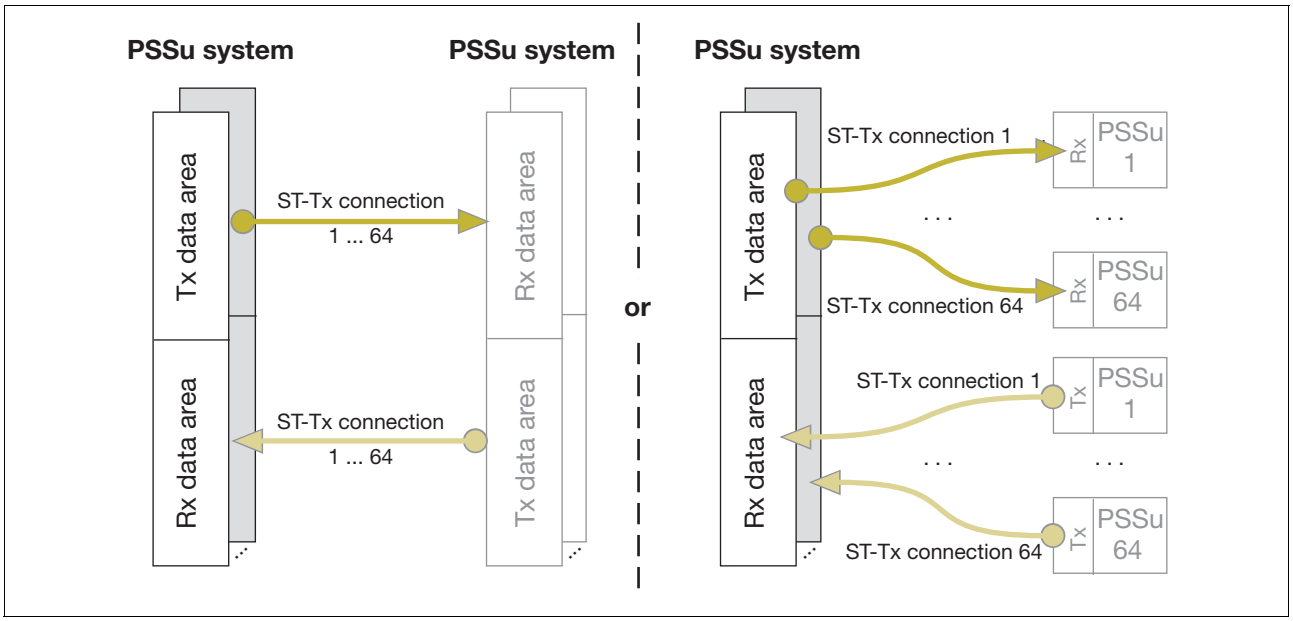

Fig. 6-6: Max. number of ST-Tx connections on control systems PSSu PLC

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6.5 Process data exchange via SafetyNET p RTFN

- **Maximum number of FS connections per FS SafetyNET p RTFN system section**

  The maximum number of FS-Tx connections is limited by the number of FS send data areas that an FS SafetyNET p RTFN system section can manage. The number of FS send data areas always corresponds to the number of FS receive data areas.

  The number of send and receive data areas that an FS SafetyNET p RTFN system section can manage depends on the PSS 4000 device that is used (e.g. head module for control systems PSSu PLC, control systems PSSu multi, decentralised system PSSu I/O). Details can be found in the operating manual of the relevant device.

  The FS-Tx connections can either be established to a single PSS 4000 device or to the FS SafetyNET p RTFN system sections of various PSS 4000 devices.

  Example: Control system PSSu PLC:

  The FS SafetyNET p RTFN system section of a control system PSSu PLC can manage the send data areas for a max. 64 FS-Tx connections; consequently it can also manage the receive data areas for a max. 64 FS-Tx connections.

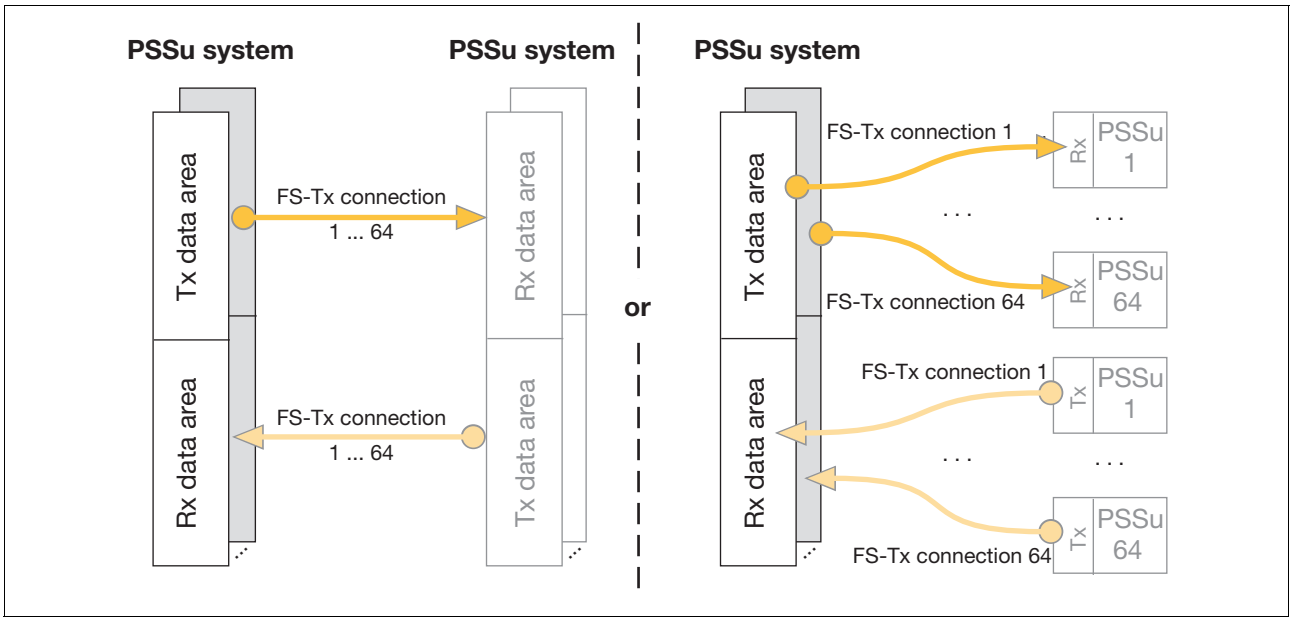

Fig. 6-7: Max. number of FS-Tx connections on control systems PSSu PLC

6.5 Process data exchange via SafetyNET p RTFN

- **Max. number of variables per PSS 4000 device**
  The number of variables that can be managed depends on which PSS 4000 device is used (e.g. head module for control systems PSSu PLC, control systems PSSu multi or decentralised system PSSu I/O). Details can be found in the operating manual of the relevant PSS 4000 device.
  Examples:
  - **Control system PSSu PLC:**
    - 5000 variables with elementary ST data types
    - 4000 variables with elementary FS data types
  - **Control system PSSu multi:**
    - 2500 variables with elementary ST data types
    - 2000 variables with elementary FS data types
- **Max. number of bytes per connection**
  The number of bytes per connection depends on the PSS 4000 device you are using.
  - ST process data sends from the Tx data area:
    246 Bytes per ST-Tx connection
  - ST process data receives in the Rx data area:
    246 Bytes per ST-Tx connection
  - FS process data sends from the Tx data area:
    115 Bytes per FS-Tx connection
  - FS process data receives in the Rx data area:
    115 Bytes per FS-Tx connection
- **Max. number of variables per connection**
  The number of variables that can be transmitted in a connection depends on their bit requirement. A variable's bit requirement depends on its data type and any possible expansion (valid bit).
  If the variables to be transmitted exceed the max. number of bytes that can be transmitted with a connection, the variables are automatically split over additional connections. Please note that this may affect data consistency (see Data consistency, page 8-18) .
  - **Variables with elementary data type**
    The bit requirement depends on the variables' data type (e.g. BOOL/SAFEBOOL: 1 Bit, WORD/SAFEWORD: 16 Bits).
  - **Variables with directly derived data type**
    The bit requirement corresponds to the bit requirement of the elementary data type from which the variable was derived.
  - **Variables of ARRAY data type**
    The bit requirement corresponds to the sum of bits needed for each element. For example, the bit requirement of a one-dimensional array can be calculated by multiplying an element's bit requirement by the number of elements.

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6.5 Process data exchange via SafetyNET p RTFN

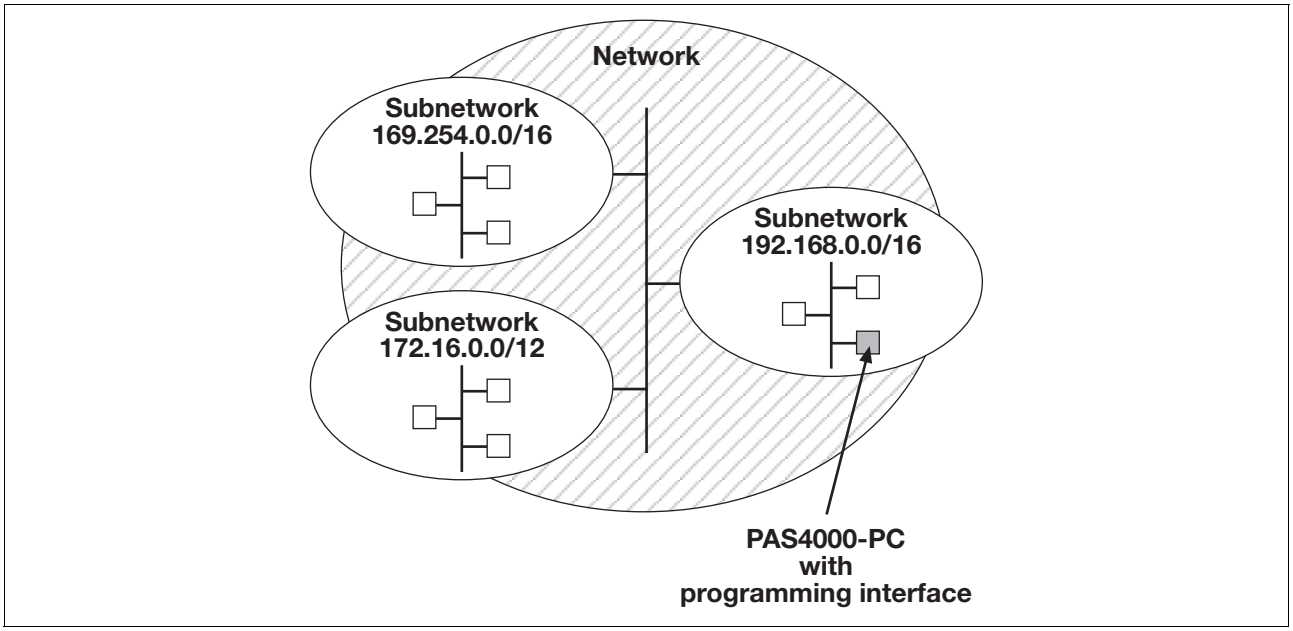
In terms of data consistency, the system ensures that the elements of an array are not split over different connections.

– **Variables of STRUCT data type**
The bit requirement corresponds to the sum of bits needed for each element.
In terms of data consistency, the system ensures that the elements of a structure are not split over several connections.

– **Variables with VALID extension**
The variables' bit requirement is increased by 1 Bit. The valid bit is transmitted once only. This also applies for a variable of an I/O data type.

6.6 Network without Routers

There are a number of rules to be observed when designing a SafetyNET p network for a project. If you are not using Routers, the following applies:



- Scan
  In PAS4000 there are various options for finding SafetyNET p subscribers (e.g. scan network, scan project).
  - The "Scan network" process finds all the PSS 4000-exclusive/operable devices in a network connected to the same network adapter as the programming interface
  - The "Scan project" process finds all the PSS 4000-exclusive/operable devices that have been configured within the project and are located in a network connected to the same network adapter as the programming interface
- Device naming via PAS4000
  Device naming can be performed on devices found during the scanning process.
- Process data exchange
  To enable process data exchange between the PSS 4000 devices within a project, the devices must be in the same subnetwork. Switches and hubs can be interconnected.

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6.6 Network without Routers

- Other online actions
  Other online actions include all online actions with the exception of scanning and device naming, e.g.:
  – Project download
  – Diagnostics (diagnostic list, diagnostic log)
  – Debugging (show, control, force variables; dynamic program display, etc.)

  To enable these online actions to be performed, the programming interface on the PAS4000-PC must be in the same subnetwork as the project's PSS 4000 devices. Switches and hubs can be interconnected.

6.7 Network with Routers

On Ethernet, a Router connects two different Ethernet networks. As an Ethernet network is identified by the Net-ID (= part of the IP address), the Net-ID can be used to decide whether the subscriber is in the same network or whether data packets must be transferred to a Router to be forwarded.

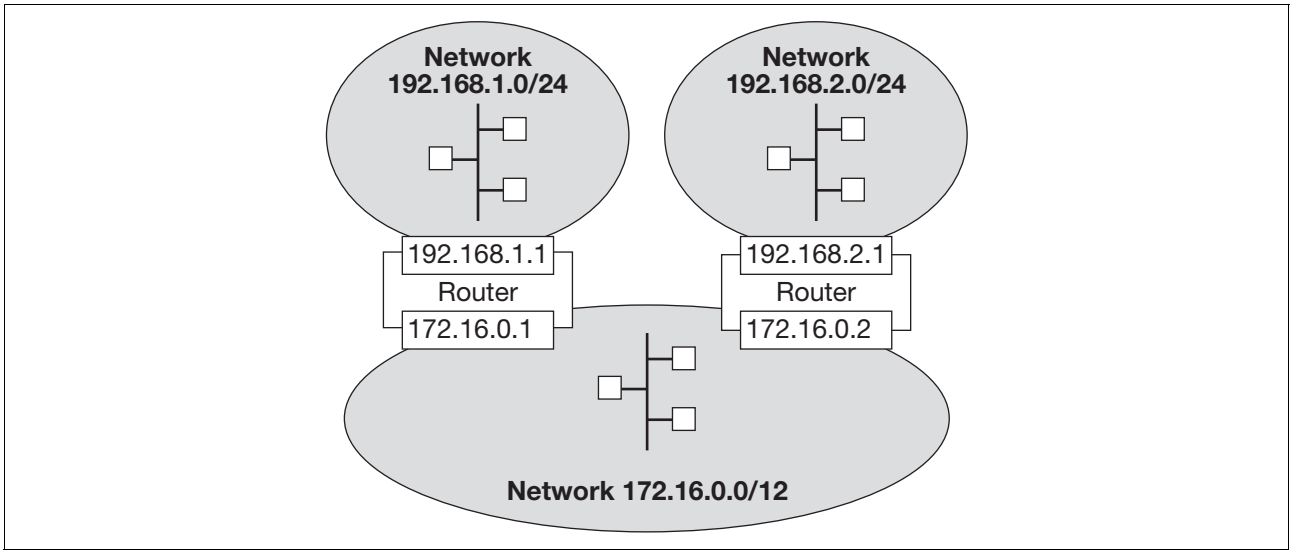

Fig. 6-8: Example for connecting Ethernet networks using Routers

If Routers are used in a SafetyNET p network, please note the following:

- Requirements of Routers
  Only Routers that support a maximum transmission unit (MTU) of min. 296 Bytes can be used in a SafetyNET p network.
- Scan
  In PAS4000 there are various options for finding SafetyNET p subscribers (e.g. scan network, scan project).
  To prevent the system searching for all potential PSS 4000 devices worldwide, the scan function on PAS4000 works on the basis of an IP broadcast. The default setting for "Time To Live" (TTL = 1) prevents scanning across Routers with PAS4000 (see System variable PILZ_SNP_MULTICAST_TTL, page 6-24) .
- Device naming via PAS4000
  If networks are connected via Routers, the default setting for "Time To Live" (TTL = 1) must have device naming performed directly from the respective network and not performed centrally (see System variable PILZ_SNP_MULTICAST_TTL, page 6-24) .
- Process data exchange
  Provided a Router is configured correctly (e.g. Routing table), process

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6.7 Network with Routers

data exchange will also work with PSS 4000-exclusive/operable devices which, from the perspective of the PAS4000-PC, are in a network behind a Router.

- Other online actions
  Provided a Router is configured correctly (e.g. Routing table), the other online actions will also work for PSS 4000-exclusive/operable devices which, from the perspective of the PAS4000-PC, are in a network behind a Router. Other online actions include all online actions with the exception of scanning and device naming, e.g.:
  – Project download
  – Diagnostics (diagnostic list, diagnostic log)
  – Debugging (show, control, force variables; dynamic program display, etc.)

6.8 System variable PILZ_SNP_MULTICAST_TTL

Time To Live (TTL) is a property of the Internet Protocol (IP). TTL can be used to restrict the routing of IP packets to other networks.
Each router that passes an IP packet on the way from the sender to the transmitter to the address reduces the TTL value of the IP packet by 1. An IP packet whose value falls to 0 is not transmitted by a router and it is discarded.

Scanning and device naming are performed depending on the settings of the relevant TTL. The TTL value for these two actions can be configured on the PAS4000 PV via the system variable PILZ_SNP_MULTICAST_TTL.
Beside the correct configuration of a router, the setting for PILZ_SNP_MULTICAST_TTL is the key factor for reaching the PSS 4000 devices that are behind a router, as seen from the PAS4000 PC, when scanning and naming devices.

NOTICE
Please note that if PILZ_SNP_MULTICAST_TTL > 1 it is possible to intervene across all routers in other networks. This may jeopardise network safety.

With the configuration of the system variable PILZ_SNP_MULTICAST_TTL:

- Default TTL when system variable PILZ_SNP_MULTICAST_TTL is not available: 1
  To prevent the system searching for all PSS 4000 devices worldwide, the default setting prevents scanning across Routers and device naming across Routers.
  It is not necessary to create and to configure the system variable PILZ_SNP_MULTICAST_TTL when PAS4000 is to use the default setting. PAS4000 automatically uses the default setting when the system variable is not found at startup.
- System variables are configured in the system environment with the Windows operating systems (e. g. Windows XP, Windows Vista, Windows 7)
  Example for Windows XP:
  Start -> Control Panel -> System -> Advanced tab -> ***Environment Variables*** button

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6.8 System variable PILZ_SNP_MULTICAST_TTL

- valid configuration for PILZ_SNP_MULTICAST_TTL: integer value in the range of 1 … 64
  - When the configuration is invalid (e. g. letters, value is not an integer) the default setting is used for PILZ_SNP_MULTICAST_TTL.
  - If a value > 64 is configured, the value 64 is used for PILZ_SNP_MULTICAST_TTL.
- The creation/change of the system variables PILZ_SNP_MULTICAST_TTL will not become effective until the PAS4000 PC is restarted.

NOTICE
If the OPC Server is installed on the same PC as PAS4000, the OPC server sets the system variable PILZ_SNP_MULTICAST_TTL to 64 during installation.

6.9 Prevent data exchange with projects with identical project name

Data exchange between projects is not permitted and it is prevented by PSS 4000 for FS data. However, it can happen that projects in which FS data are processed have identical project names. If such projects are operated in the same SafetyNET p network, PSS 4000 cannot prevent cross-connections in the data exchange without additional measures.

Operate projects with identical project name and processing of FS data in closed SafetyNET p networks. A SafetyNET p network will be deemed as "closed" when it is ensures that no SafetyNET p data traffic takes place beyond network limits.

INFORMATION
If you can **not** ensure that the projects are in closed SafetyNET p networks, the projects may not have identical project names. Rename the projects.

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7.1 Communication modes for external communication

External communication refers to data exchange in which output data (external O-data) leaves the automation system PSS 4000 and input data (external I-data) enters the system. This is achieved with the help of various communication modes. The communication mode supported by a PSS 4000 device depends on the device. Details can be found in the operating manual of the relevant PSS 4000 device.

Communication modes for external communication are divided into "Fieldbuses" and "IP connections".

Fieldbuses

The term "Fieldbuses" embraces industrial fieldbuses with a standardised protocol (e.g. PROFIBUS-DP). For external communication via a fieldbus, a PSS 4000 device must have the corresponding system section (e.g. PROFIBUS-DP Slave system section). The physical connection is established via defined interfaces, depending on the fieldbus.

IP connections

The term "IP connections" embraces all protocols and communication links that are addressed via IP addresses (Modbus/TCP, Raw UDP). For this type of external communication a PSS 4000 device must have the "IP connections" system section. The physical connection is established via an Ethernet interface.

NOTICE

The following applies for the **max. number of IP connections**: The "IP connections" system section on a PSS 4000 device can manage a maximum of 32 IP connections in total. This upper limit also applies if you are operating the "IP connections" system section of a PSS 4000 device with a variety of protocols or communication links.
SafetyNET p connections are **not** managed by the "IP connections" system section and so do not affect this upper limit.

7.2 Modbus/TCP

Modbus is an open fieldbus standard published by the User Group MODBUS-IDA (see www.Modbus-IDA.org).

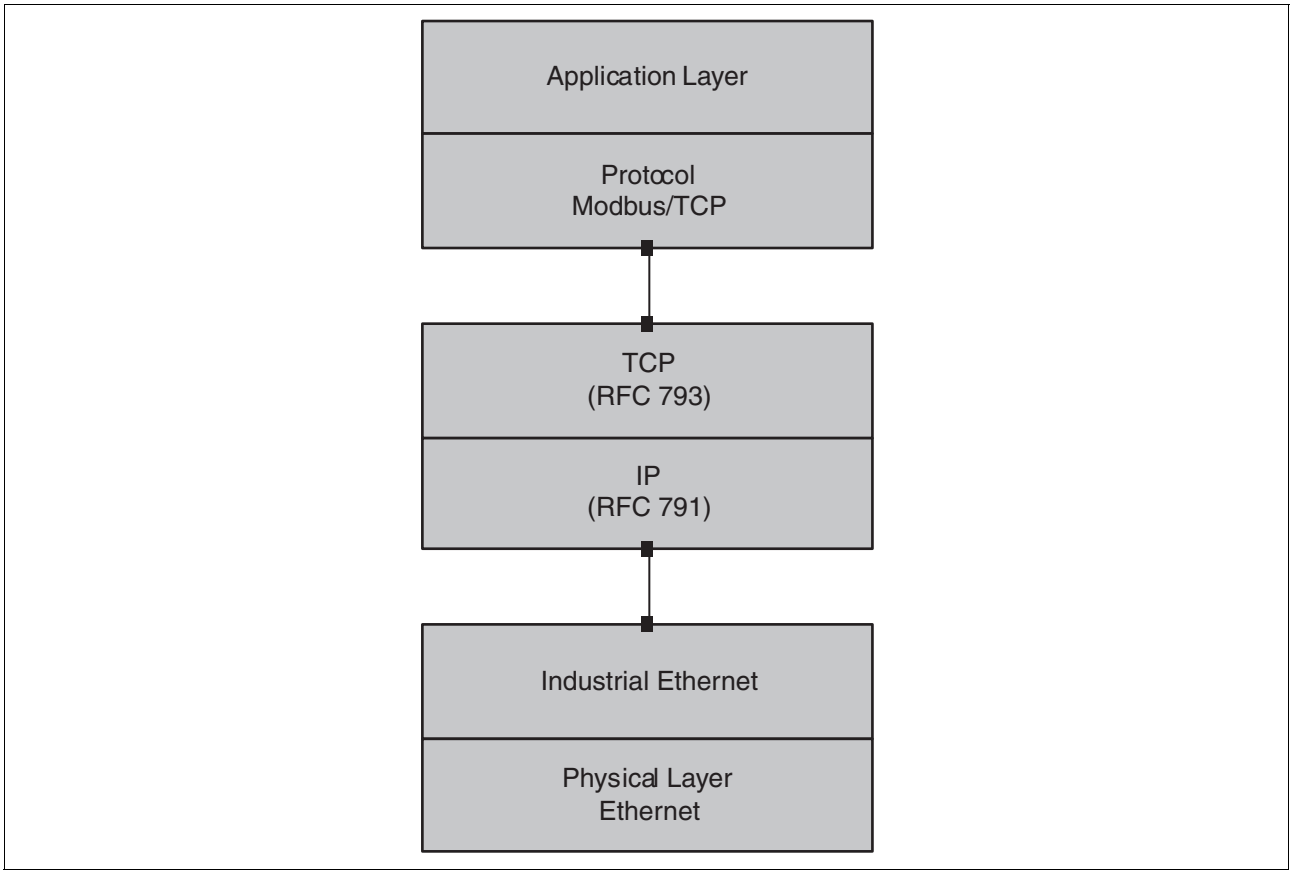

Fig. 7-1: Communication of a PSS 4000 device via Modbus/TCP

Modbus/TCP is a protocol based on Industrial Ethernet (TCP/IP over Ethernet). It is one of the protocols with Client/Server communication. Data is transferred via a request/response mechanism using function codes (FC).

Modbus/TCP is connection-oriented, i.e. before usable data is transferred via Modbus/TCP, a connection must first be established between two Modbus/TCP interfaces. The initiator of the connection is called the "Client". The communications partner with which the Client establishes the connection is called the "Server". Whether a connection on a device assumes the role of Client or Server is defined when a connection is con-

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7.2 Modbus/TCP

figured. As a result, the Server/Client role only applies for that specific connection.

Data exchange via Modbus/TCP can be used on the automation system PSS 4000 for non-safety-related applications.

7.2 Modbus/TCP

7.2.1 "IP connections" system section

In the automation system PSS 4000, external communication via Modbus/TCP is possible with all PSS 4000 devices that have the "IP connections" system section (see Communication modes for external communication, page 7-1) . In this case, the "IP connections" system section of a PSS 4000 device performs all the tasks required for communication. For example, these include:

- Management of the Modbus/TCP connections(see Modbus/TCP connections, page 7-5)
- Management of the Modbus/TCP data areas(see Modbus/TCP data areas, page 7-7)
- Support for function codes (see Function codes, page 7-8)
- Data exchange (see Data exchange via Modbus/TCP, page 7-12)

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7.2 Modbus/TCP

7.2.2 Modbus/TCP connections

The "IP connections" system section of a PSS 4000 device manages the Modbus/TCP connections that are configured for the device. The connection is configured in the PAS4000's IP Connections Editor.

Several Modbus/TCP connections can be configured for a PSS 4000 device (see Data transfer limits, page 7-10) . When a connection is configured you have the option to configure the connection for the role of Client or Server. If a Client role is configured for a connection, this is called a "Client connection" from the perspective of the PSS 4000 device, otherwise it is called a "Server connection" from the perspective of the PSS 4000 device.

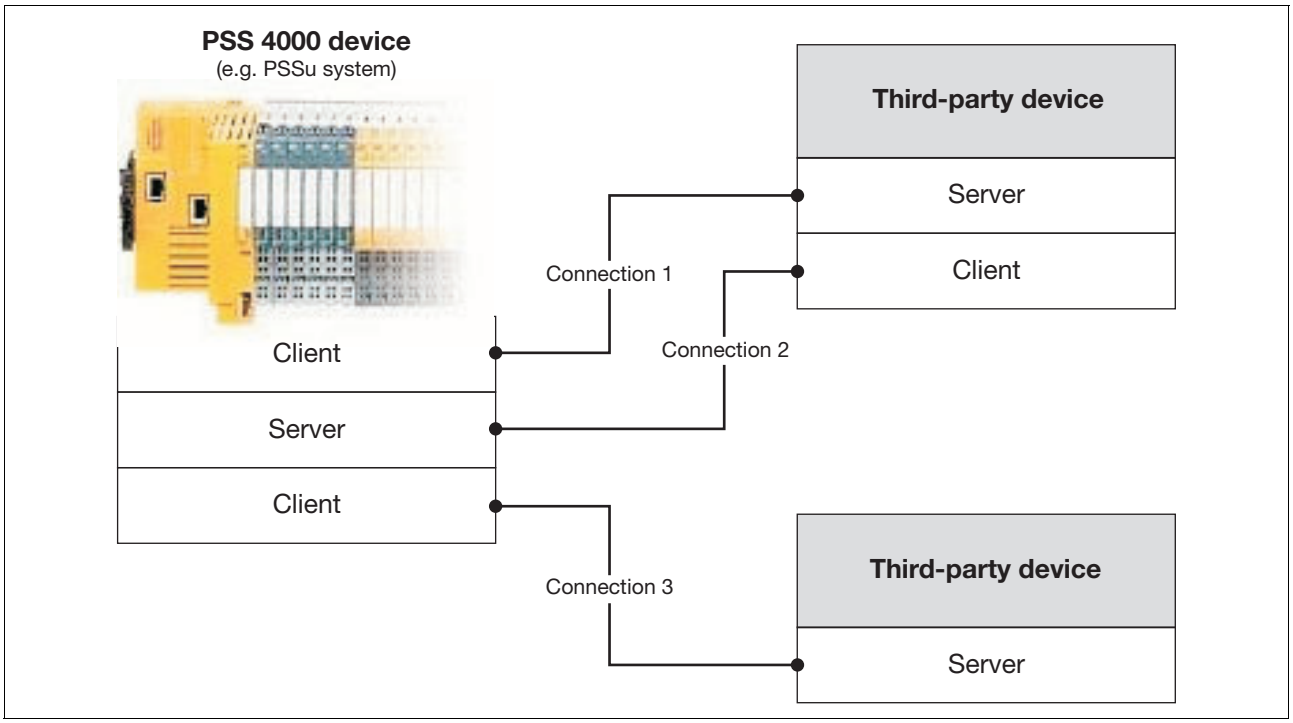

Fig. 7-2: Role assignment on Modbus/TCP connections (example)

Port numbers must be defined for data exchange via a Modbus/TCP connection. Server connections on a PSS 4000-exclusive device use Port 502 as a default setting. However, a different port number may be configured.

7.2 Modbus/TCP

INFORMATION
Known applications (e.g. Telnet) are assigned fixed port numbers, to which each application can refer during data transfer. The range 0 ... 1023 contains reserved port numbers. Under no circumstances should these be used for your own applications. The complete list of reserved port numbers and their utilities are listed in RFC 1700.

Send and receive data is transferred cyclically on PSS 4000-exclusive devices. With cyclical transfer, a permanent connection is maintained between the connection Client and Server.

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7.2 Modbus/TCP

7.2.3 Modbus/TCP Server connection (server connections)

The "IP connections" system section of a PSS 4000 device supports the following Modbus/TCP data areas for connections with a Server role:

Data area	Modbus syntax	Example
Coils (Bit) 0x00000 … 0x65535 [read/write]	0x[xxxxx]	0x05888
Discrete Inputs (Bit) 1x00000 … 1x65535 [read only]	1x[xxxxx]	1x05888
Input Register (Wort/16 Bits) 3x00000 … 3x65535 [read only]	3x[xxxxx]	3x05888
Holding Register (Wort/16 Bits) 4x00000 … 4x65535 [read/write]	4x[xxxxx]	4x05888

INFORMATION

The "IP connections" system section of a PSS 4000 device starts the addressing for Modbus/TCP data areas at "0". On devices from other manufacturers, addressing may start at "1". Please refer to the operating manual provided by the relevant manufacturer.

7.2 Modbus/TCP

7.2.4 Function Codes (Client connections)

The "IP connections" system section of a PSS 4000 device supports the following function codes (FC) for connections with a Client role:

Function code	Function	
FC 01	Read Coils	The connection Client reads bit data from the connection Server, data length ≥ 1 Bit, e.g. digital inputs (receive data from 0x)
FC 02	Read Discrete Input	The connection Client reads bit data from the connection Server, data length ≥ 1 Bit, e.g. digital inputs (receive data from 1x)
FC 03	Read Holding Register	The connection Client reads word data from the connection Server, data length ≥ 1 Word, e.g. analogue inputs, counter inputs (receive data from 4x)
FC 04	Read Input Register	The connection Client reads word data from the connection Server, data length ≥ 1 Word, e.g. analogue inputs, counter inputs (receive data from 3x)
FC 05	Write Single Coil	The connection Client writes to one bit datum in the connection Server, data length = 1 Bit, e.g. digital input (send data to 0x)
FC 06	Write Single Register	The connection Client writes to one word datum in the connection Server, data length = 1 Word, e.g. analogue output, counter output (send data to 4x)
FC 15	Write Multiple Coils	The connection Client writes to multiple bit data in the connection Server, data length > 1 Bit, e.g. digital outputs (send data to 0x)
FC 16	Write Multiple Registers	The connection Client writes to multiple word data in the connection Server, data length > 1 Word, e.g. analogue inputs, counter inputs (send data to 4x)
FC 23	Read/Write Multiple Registers	The connection Client reads and writes multiple word data within a telegram (receive data from 4x and send data to 4x)

INFORMATION

A function code must be configured for each Client connection. This can be done in the PAS4000's IP Connections Editor.

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7.2 Modbus/TCP

7.2.5 Relationship between function codes and Modbus/TCP data areas

For Client connections, the following relationship exists between function codes and Modbus/TCP data areas:

Data area (Remote Address)	**Send (Client)**		**Receive (Client)**
0x Coils (Bit)	Data Length	Function code	Function code
	= 1Bit	FC = 05 (Write Single Coil)	FC = 01 (Read Coils)
	> 1 Bit	FC = 15 (Write Multiple Coils)	
1x Discrete Inputs (Bit)	- - -		FC = 02 (Read Discrete Inputs)
3x Input Register (Wort)	- - -		FC = 04 (Read Input Register)
4x Holding Register (Word)	Data Length	Function code	FC = 03 (Read Holding Registers)
	= 1 Wort	FC = 06 (Write Single Register)	
	> 1 Wort	FC = 16 (Write Multiple Registers)	
	If there is an entry for both send and receive data, function code FC = 23 is used (Read/Write Multiple Registers).		

7.2 Modbus/TCP

7.2.6 Data transfer limits

Max. number of Modbus/TCP connections

The max. number of Modbus/TCP connections (Client connections and/or Server connections) depends on the device. Details can be found in the operating manual of the relevant PSS 4000 device.
Please also note the general upper limit of 32 IP connections for one PSS 4000 device(see Communication modes for external communication, page 7-1) .

Limits on Client connections

On Client connections, the maximum data length per telegram is restricted. The following table contains information on the maximum data length per telegram that is supported:

Data transfer		Data length per telegram
Read data (Bit)	FC 01 (Read Coils)	1 … max. 2000
	FC 02 (Read Discrete Inputs)	
Read data (Bit)	FC 05 (Write Single Coil)	1 Bit
	FC 15 (Write Multiple Coils)	1 … max. 1968
Read data (Word)	FC 03 (Read Holding Registers)	1 … max. 125
	FC 04 (Read Input Register)	
Write data (Word)	FC 06 (Write Single Register)	1 Word
	FC 16 (Write Multiple Registers)	1 … max. 123 Words
Read and write data (Word)	FC23 (Read/Write Multiple Registers)	Read 1 … max. 125 Words Write 1 … max. 121 Words

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7.2 Modbus/TCP

FC 03, FC 04 and FC 16 support data transfer with multiple telegrams. If the max. supported data length per telegram is exceeded when transferring data with FC 03, FC 04 or FC 16, the data will be spread over multiple telegrams. The following table contains details of the data length when transferring data with multiple telegrams:

Data transfer with multiple telegrams		Data length
Read data (Word)	FC 03 (Read Holding Registers)	From 126 … max. 2000 Words
	FC 04 (Read Input Register)	
Write data (Word)	FC 16 (Write Multiple Registers)	From 124 … max. 2000 Words

When a Client connection is configured in PAS4000 it is possible to influence the transfer of multiple telegrams. If multiple telegrams are to be transferred, you can configure whether it is necessary to wait for a response to one (sub)telegram before sending the next (sub)telegram or whether to send all (sub)telegrams one after the other, without waiting for a response. The responses to the (sub)telegrams will only be collected once the transfer is complete, which optimises data transfer.

INFORMATION
When devices from a third-party manufacturer are used as communication partners, limits regarding data lengths may vary. Please refer to the information stated in the operating manual of the relevant unit.

7.2 Modbus/TCP

7.2.7 Data exchange via Modbus/TCP

It is always the connection Client that initiates data transfer. For a Client connection, the direction of the data flow (send/receive) and data area (Coils, Discrete Inputs, Input Registers, Holding Register) is established by defining the function code when the connection is configured. The data length is also defined when the connection is configured.

7.2.7.1 Send data and receive data

When sending, the connection Client sends data to a data range belonging to the connection Server. This is also known as "Writing data". For this to work, the target data destination must be configured on the device with the role of Client.

When receiving, the connection Client requests and receives data located in a data range belonging to the connection Server. This is also known as "Reading data". For this to work, the data source must be configured on the device with the role of Client.

From the perspective of the automation system PSS 4000, receive data is called external I-data, and send data is called external O-data (see Validity of process data, page 8-4) .

Please ensure that the relevant data area (data destination, data source) is available on the Server (see Server allocation table, page 7-14) .

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7.2 Modbus/TCP

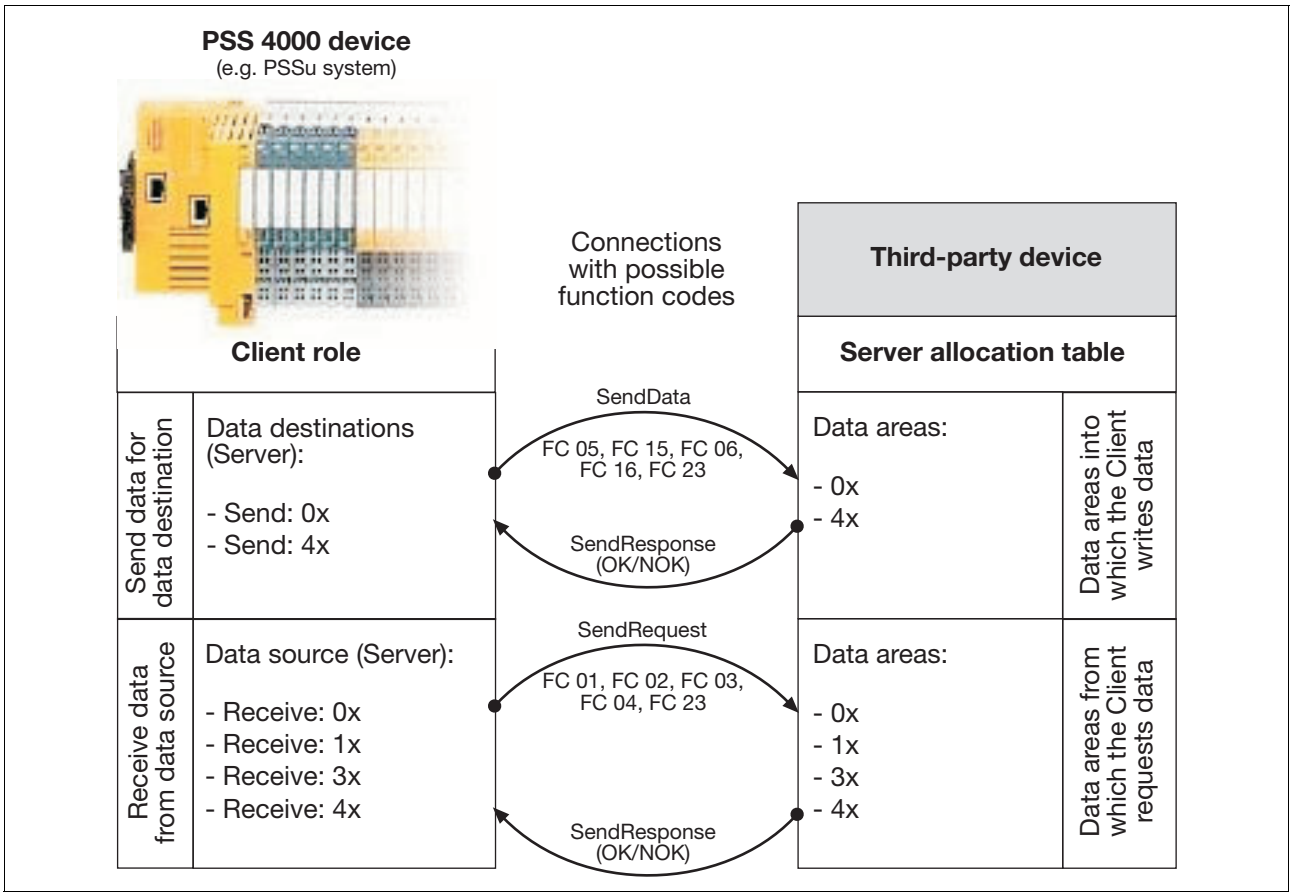

Fig. 7-3: PSS 4000 device with "IP connections" system section and Client role for connections (principle)

7.2 Modbus/TCP

7.2.7.2 Server allocation table

To ensure that the connection Client can send data to the connection Server and receive data requested from the connection Server, the relevant data areas must be configured on the Server.
With Server connections this is achieved by configuring a Server allocation table when the connection is configured.

The following applies:

- The connection Client writes data to the Server allocation table's write data area (0xWrite, 4xWrite).
- The connection Client requests data from the Server allocation table's read data area (0xRead, 1x, 3x, 4xRead).

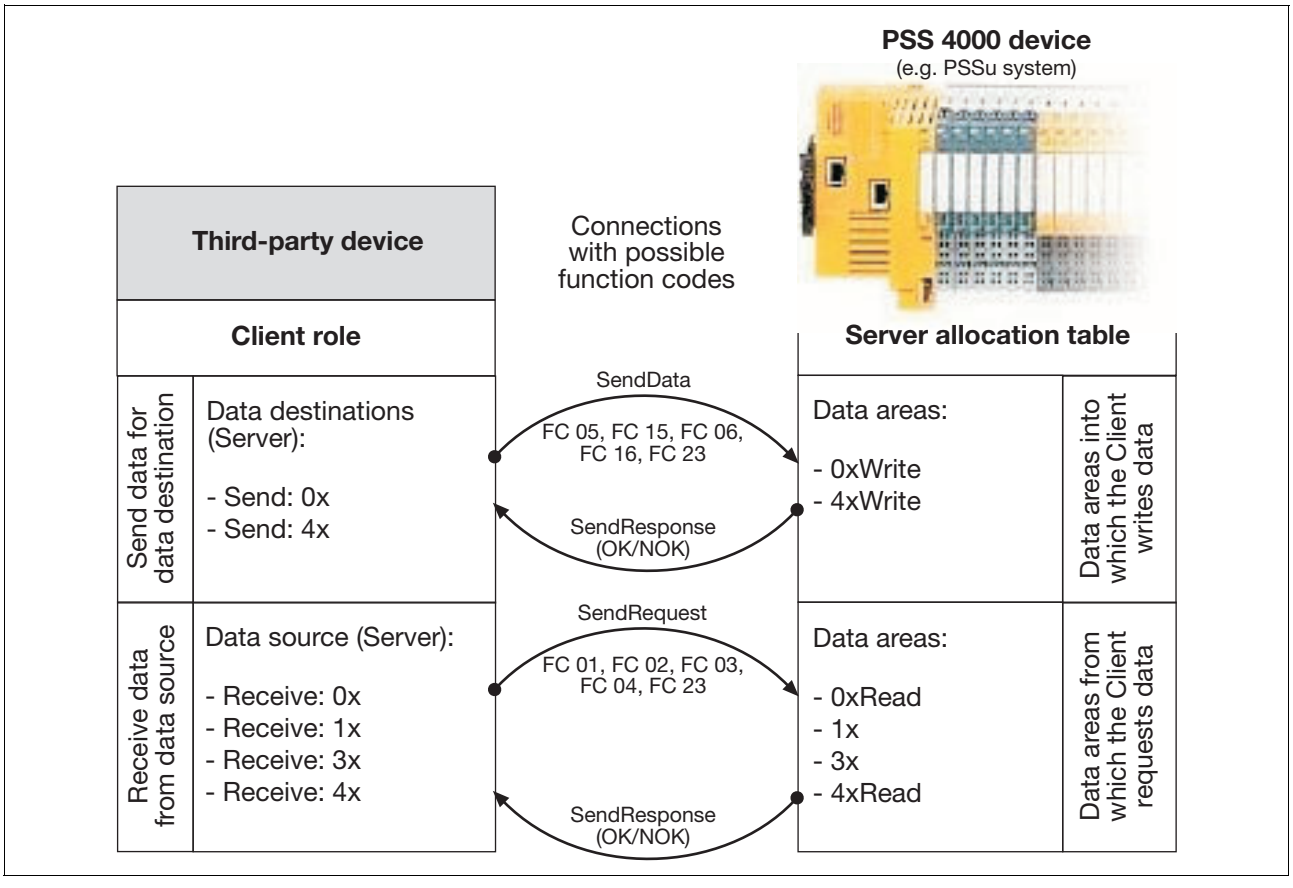

Fig. 7-4: PSS 4000 device with "IP connections" system section and Server role for connections (principle)

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7.2 Modbus/TCP

Limits when configuring a server allocation table in PAS4000

Each data range can have a start address in the range 0 … (65535 – data length) and a maximum data length of 8000:

Data range	Start address	Max. data length
0xRead	0 … (65535 – data length)	8000
0xWrite		
1x		
3x		
4xRead		
4xWrite		

Example structure of a server allocation table in PAS4000:

Data range	Start address	Data length
0xRead	0	4
0xWrite	100	4
1x	0	0
3x	0	0
4xRead	0	2
4xWrite	100	2

7.2 Modbus/TCP

7.2.8 Modbus/TCP I/O data

The "IP connections" system section enables a PSS 4000 device to exchange I/O data with third-party devices via Modbus/TCP. For this to work it is necessary for the I/O data in PAS4000's I/O Mapping Editor to be mapped to the corresponding Modbus/TCP data areas.

I/O mapping of Modbus/TCP data areas

I/O mapping is used to define which data source supplies data to which data sink.

Possible I/O mapping for Modbus/TCP data areas:

		Modbus/TCP			
		Client role		Server role (Server allocation table)	
		Send data areas (0x, 4x)	Receive data areas (0x, 1x, 3x, 4x)	Read data areas (0x, 1x, 3x, 4x)	Write data areas (0x, 4x)
Module bus	I-datum (e.g. HW input)	◆	- - -	◆	- - -
	O-datum (e.g. HW output)	- - -	◆	- - -	◆
PI variables	I-PI variable	- - -	◆	- - -	◆
	O-PI variable	◆	- - -	◆	- - -

◆ I/O mapping possible

- - - I/O mapping impossible

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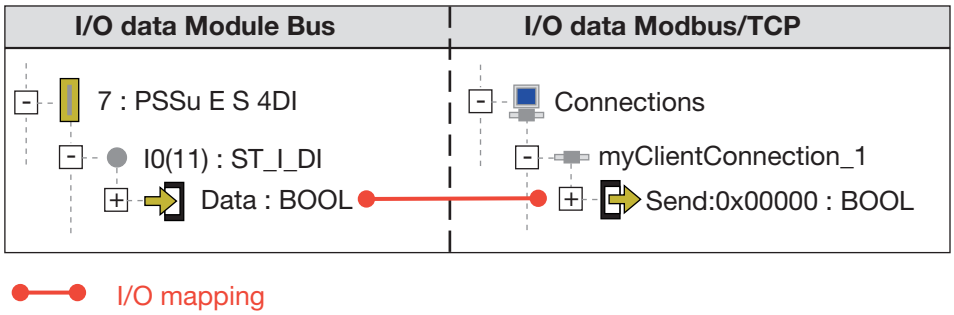
7.2 Modbus/TCP

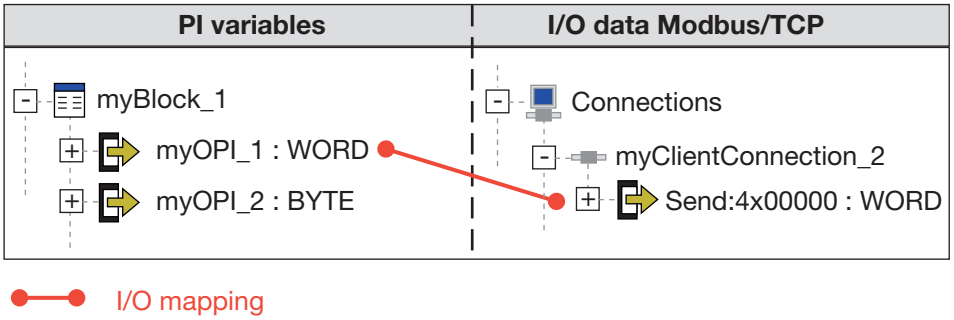
Examples:

I/O mapping for Client roles

- The input signal at a hardware input is to be sent to a device from another manufacturer via a Modbus/TCP connection.
  - Direction of data flow: Hardware input -> Modbus/TCP
  - Function code used: FC05/FC15 (send)
  - Possible I/O mapping (example):

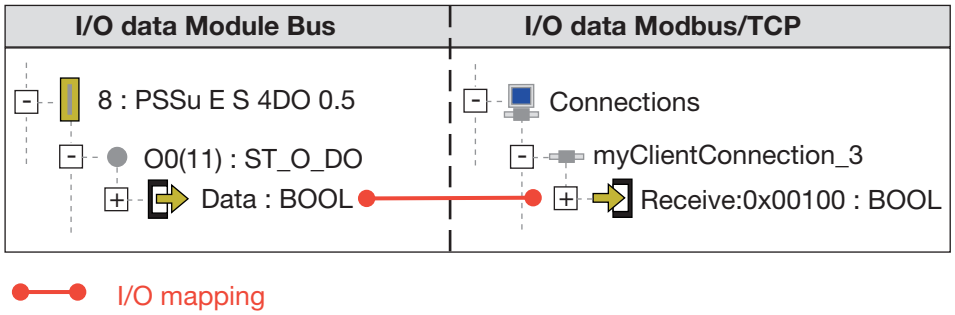


- The content of an O-PI variable from the user program is to be sent to a device from another manufacturer via a Modbus/TCP connection.
  - Direction of data flow: O-PI variable -> Modbus/TCP
  - Function code used: FC06/FC16/FC23 (send)
  - Possible I/O mapping (example):

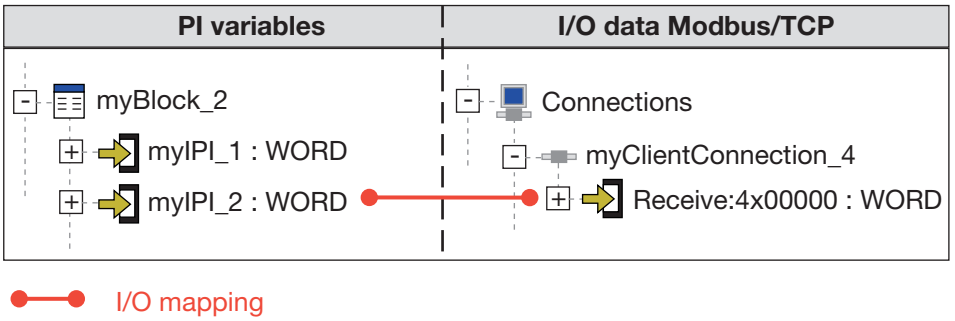


7.2 Modbus/TCP

- The hardware output on a PSSu system is to be controlled by a device from another manufacturer via a Modbus/TCP connection.
  - Direction of data flow: Modbus/TCP -> Hardware output
  - Function code used: FC01 (receive)
  - Possible I/O mapping (example):



- A piece of data is to be requested by a device from another manufacturer via a Modbus/TCP connection. Once the data has been received it is to be made available for further processing within the user program.
  - Direction of data flow: Modbus/TCP -> I-PI variable
  - Function code used: FC03/FC23 (receive)
  - Possible I/O mapping (example):



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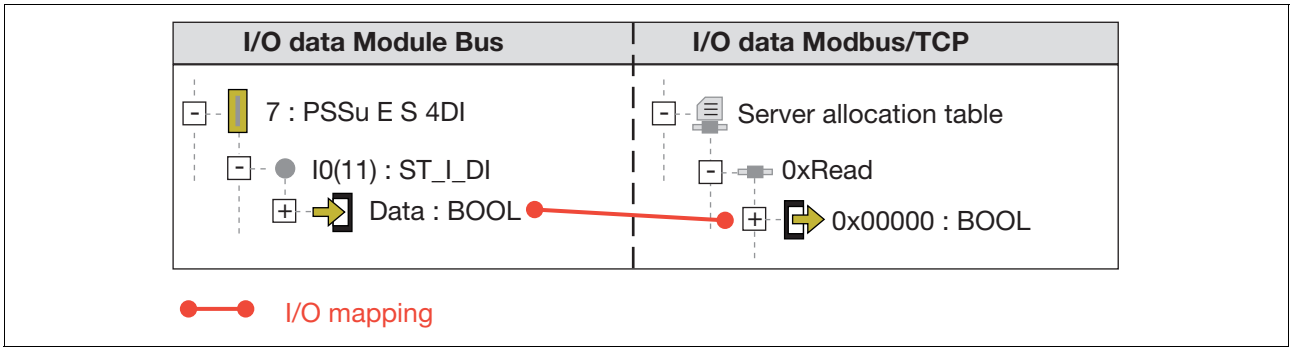
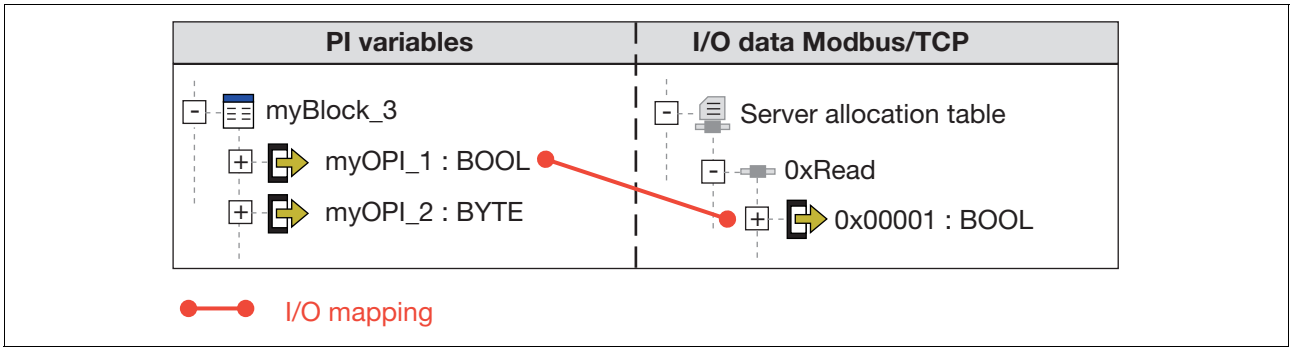
7.2 Modbus/TCP

I/O mapping for Server roles (Server allocation table)

- The signal from a hardware input is made available in the Server allocation table's read data area. The piece of data can be read by a device from another manufacturer via a Modbus/TCP connection.
  - Direction of data flow: Hardware input -> Modbus/TCP
  - Possible I/O mapping:

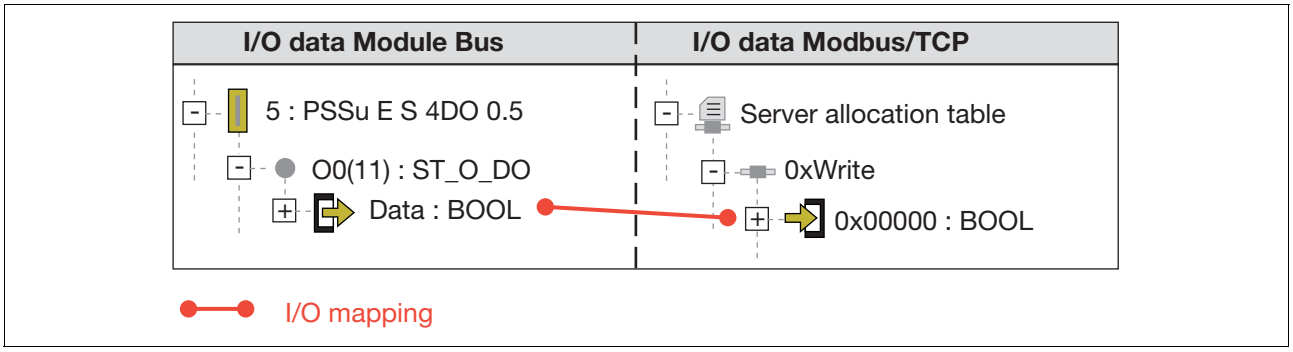


- The content of an O-PI variable is made available in the Server allocation table's read data area. The piece of data can be read by a device from another manufacturer via a Modbus/TCP connection.
  - Direction of data flow: O-PI variable -> Modbus/TCP
  - Possible I/O mapping:

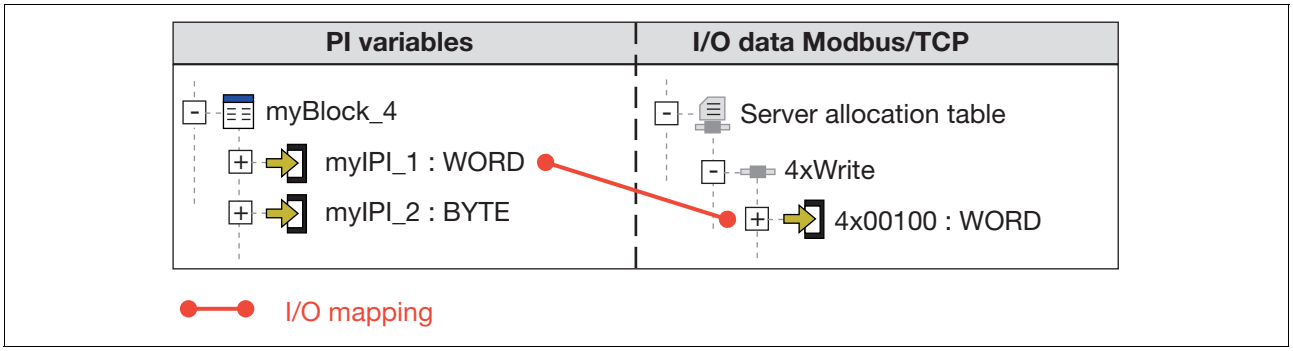


7.2 Modbus/TCP

- The hardware output on a PSSu system is to be controlled by a device from another manufacturer via a Modbus/TCP connection. The device from another manufacturer writes to the Server allocation table's write data area.
  - Direction of data flow: Modbus/TCP -> Hardware output
  - Possible I/O mapping:



- A piece of data is to be written to the Server allocation table's write data area by a device from another manufacturer via a Modbus/TCP connection. The data is to be processed further within the user program.
  - Direction of data flow: Modbus/TCP -> I-PI variable
  - Possible I/O mapping:



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7.2 Modbus/TCP

7.2.9 Address display of Modbus/TCP addresses

The addresses for the I/O data of a PSS 4000 device are displayed at several points, e.g. in PAS4000 and in the diagnostics.

7.2.9.1 Address display of send data

The addresses of Modbus/TCP send data (Client role) are structured as follows:

<Device name>.Modbus.Client.*<Connection name>*.Send.*<Start address>*

Examples:
myDevice_1.Modbus.Client.myConnection1.Send.0x00000
myDevice_1.Modbus.Client.myConnection2.Send.4x00005

7.2.9.2 Address display of receive data

The addresses of Modbus/TCP receive data (Client role) are structured as follows:

<Device name>.Modbus.Client.*<Connection name>*.Receive.*<Start address>*

Examples:
myDevice_1.Modbus.Client.myConnection3.Receive.0x00000
myDevice_1.Modbus.Client.myConnection4.Receive.1x00010
myDevice_1.Modbus.Client.myConnection5.Receive.3x00000
myDevice_1.Modbus.Client.myConnection6.Receive.4x00005

7.2 Modbus/TCP

7.2.9.3 Address display in the Server allocation table

The addresses of the Modbus/TCP Server allocation table (Server role) are structured as follows:

<Device name>.Modbus.Server.*<Selectable data area in the Server allocation table>*.*<Start address>*

Examples:
myDevice_2.Modbus.Server.0xRead.0x00000
myDevice_2.Modbus.Server.0xWrite.0x00100
myDevice_2.Modbus.Server.1x.1x00010
myDevice_2.Modbus.Server.3x.3x00000
myDevice_2.Modbus.Server.4xRead.4x00005
myDevice_2.Modbus.Server.4xWrite.4x00005

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7.2 Modbus/TCP

7.2.10 Data consistency on Modbus/TCP

The data consistency of data sent (Client role) or provided (Server role) by third party devices is the responsibility of those devices. From the PSS 4000's perspective, no statement can be made regarding the data consistency of those devices.

Data consistency on receive data from a Client connection

If a PSS 4000-exclusive/operable device is the connection Client, from the device's perspective, the receive data from this connection (FC 01, FC 02, FC 03, FC 04, FC 23) is external I-data.
The external I-data from a Client connection is treated as consistent data in PSS 4000,(see Data consistency, page 8-18) provided it is transferred in a single telegram (see Data transfer limits (Client connections), page 7-10) .
The external I-data from a Client connection forms a consistency range of the consistency range type "ST-I data of an external communication connection". The exact description is consistency range "ST-I data of a Modbus/TCP Server connection" (see Consistency ranges, page 8-19) .

Data consistency on receive data from a Server connection

If a PSS 4000-exclusive/operable device is the connection Server, from the device's perspective, the receive data from this connection (data areas 0xWrite or 4xWrite) is external I-data.
The external I-data from a Server connection is treated as consistent data in PSS 4000,(see Data consistency, page 8-18) provided it is transferred in a single telegram (see Data transfer limits (Client connections), page 7-10) .
The external I-data from a Server connection forms a consistency range of the consistency range type "ST-I data of an external communication connection". The exact description is consistency range "ST-I data of a Modbus/TCP Server connection" (see Consistency ranges, page 8-19) .

7.2 Modbus/TCP

Data consistency on a Client connection's send data

If a PSS 4000-exclusive/operable device is the connection Client, from the device's perspective, the send data from this connection is external O-data.
The external O-data of a Client connection (FC 05, FC 15, FC 06, FC 16, FC 23) is consistent if it comes from the same consistency range on a data source (see Data consistency, page 8-18) .

Data consistency on a Server connection's send data

If a PSS 4000-exclusive/operable device is the connection Server, from the device's perspective, the send data (data areas 0xRead, 1x, 3x, 4xRead) is external O-data. The external O-data of a Server connection is consistent if it comes from the same consistency range on a data source (see Data consistency, page 8-18) .

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7.2 Modbus/TCP

7.2.11 Special features when using the data areas 0x and 4x

On some devices (e.g. operator terminals such as Pilz PMI), Client connections are used to write data to the data areas (0x, 4x) of the Server allocation table and then automatically request the data back immediately, to show on the display for example.

If the connection's Server is a PSS 4000-exclusive/operable device, this "data mirroring" will only work if additional measures are taken for the device: There are minor differences in handling for IEC 61131 programming and Multi programming.

Procedure for IEC 61131 programming:

- Create a block
  e.g. program-type POU
- Declare the required I-PI variables in the block
  Via the I-PI variables, I/O-mapping is used to access the write data areas (0xWrite, 4xWrite) of the Server allocation table.
  e.g. myIPI_1 AT %I* : WORD
- Declare the corresponding O-PI variables in the block
  The O-PI variables are needed in order to restore the I-PI variables in the block. This is a condition for "data mirroring" the I-data to the Read data areas (0xRead, 4xRead) of the Server allocation table.
  e.g. myOPI_1 AT %Q* : WORD
- "Mirror data" by restoring the I-PI variables to the O-PI variables in the block
  Example (programming in IL):

```
RESTORE:    LD      myIPI_1
            ST      myOPI_1
```

- I/O-map the I-PI variables to the write data areas (0xWrite, 4xWrite) of the Server allocation table (I/O Mapping Editor of PAS4000)
- I/O-map the O-PI variables to the read data areas (0xRead, 4xRead) of the Server allocation table (I/O Mapping Editor of PAS4000)
- Assign the block to a resource from a PSS 4000-exclusive/operable device
  e.g. ST resource from myDevice_1

7.2 Modbus/TCP

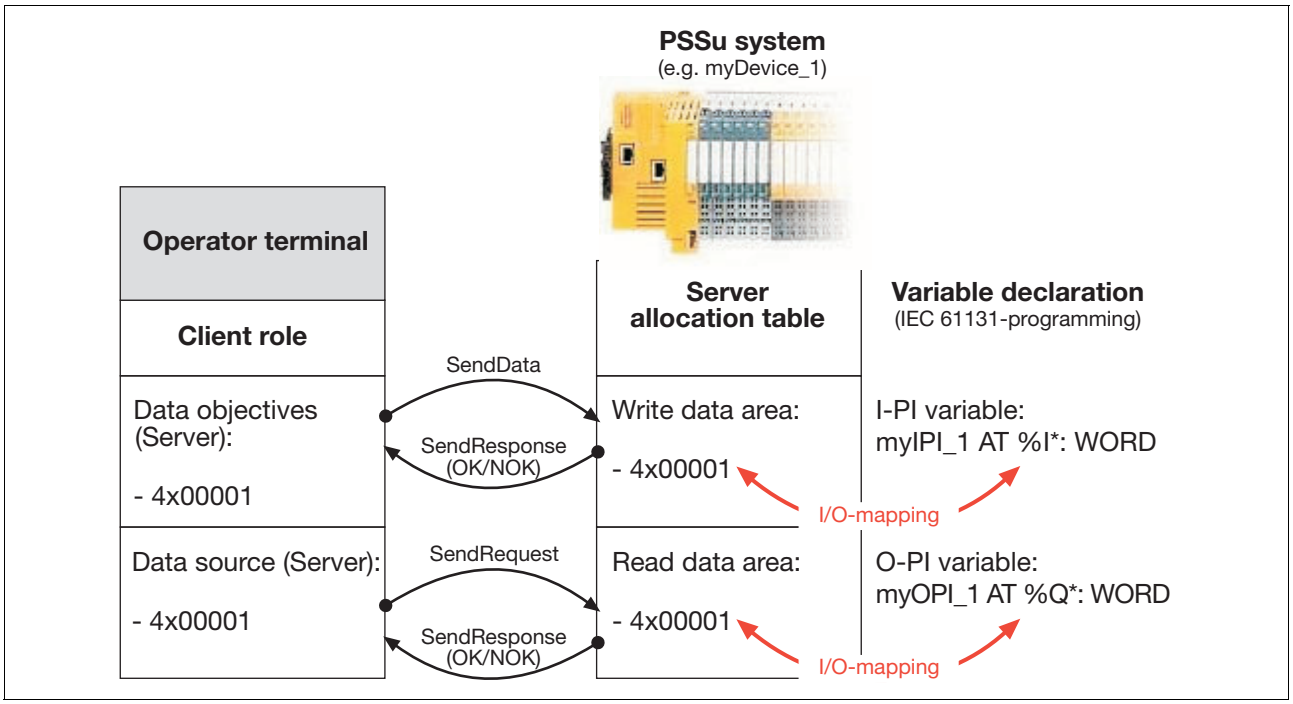

Fig. 7-5: Data mirroring in IEC 61131 programming (example)

Procedure for Multi programming:

Option 1:

- Create an IEC 61131 basic block in the Multi program
- Declare the required PI variables in the IEC 61131 basic block and program "data mirroring"
  This procedure is identical to the procedure for IEC-61131 programming (see above).
- I/O-map the I-PI variables to the write data areas (0xWrite, 4xWrite) of the Server allocation table
- I/O-map the O-PI variables to the read data areas (0xRead, 4xRead) of the Server allocation table
- Assign the block to a resource from a PSS 4000-exclusive/operable device
  e.g. ST resource from myDevice_1

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7.2 Modbus/TCP

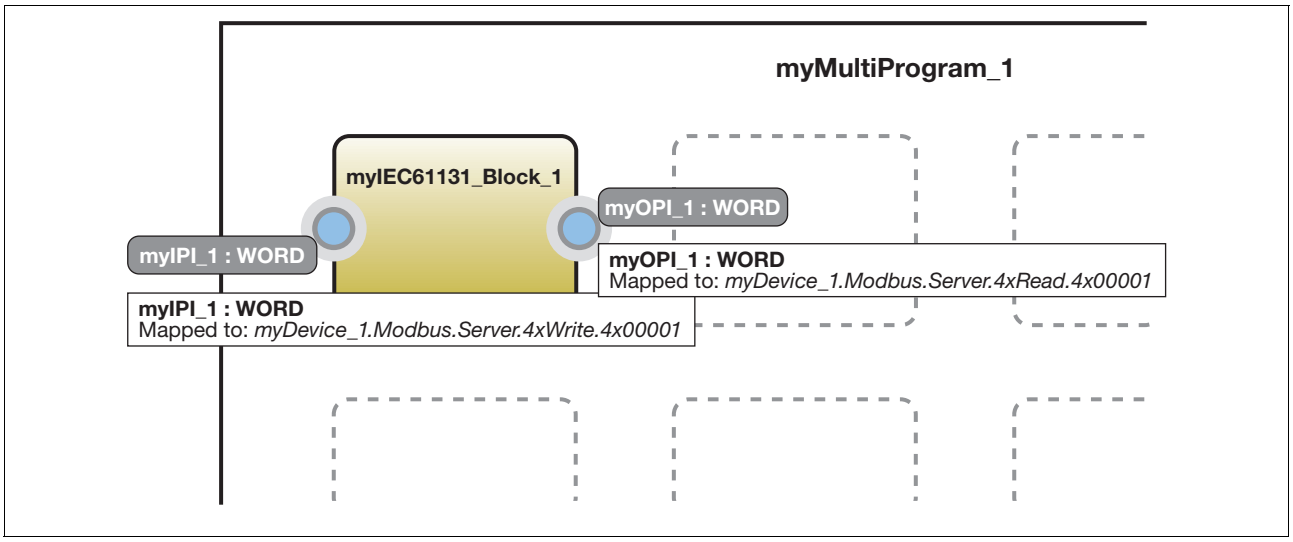


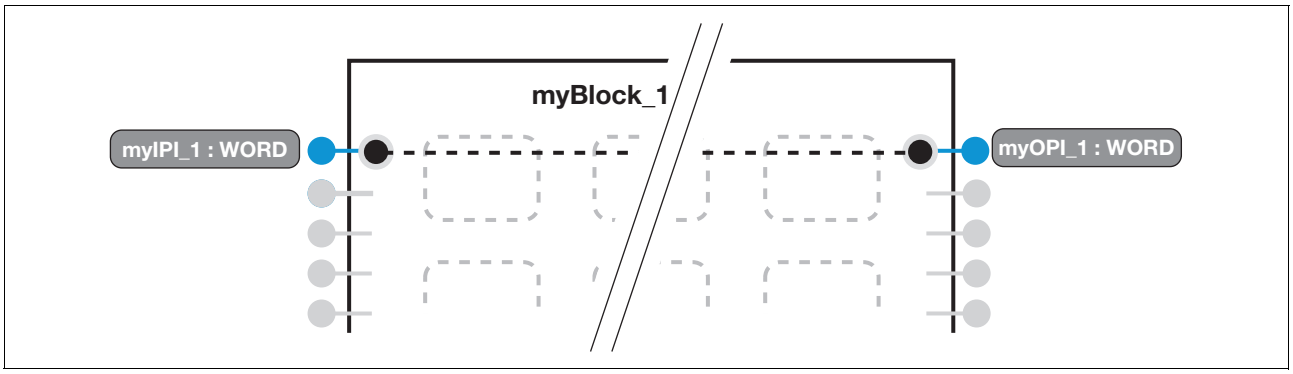
Fig. 7-6: I/O-mapping in Multi programming – IEC 61131 basic block (example)

7.2 Modbus/TCP

Option 2:

- Create a component block (CB) in the Multi program
- Configure the block interface to
  - Configure the required I-PI points, which represent the I-PI variables
    Via the I-PI points, I/O-mapping is used to access the write data areas (0xWrite, 4xWrite) of the Server allocation table.
    e.g. myIPI_1: WORD
  - Configure the corresponding O-PI points, which represent the O-PI variables
    Th O-PI points are needed in order to connect the I-PI points to the O-PI points within the block. This is a condition for "data mirroring" the I-data to the read data areas (0xRead, 4xRead) of the Server allocation table.
    e.g. myOPI_1: WORD
- "Mirror data" by connecting the I-PI points to the block's O-PI points

Example:



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7.2 Modbus/TCP

- Configure I/O mapping
  - I/O-map the I-PI points to the write data areas (0xWrite, 4xWrite) of the Server allocation table
  - I/O-map the O-PI points to the read data areas (0xRead, 4xRead) of the Server allocation table

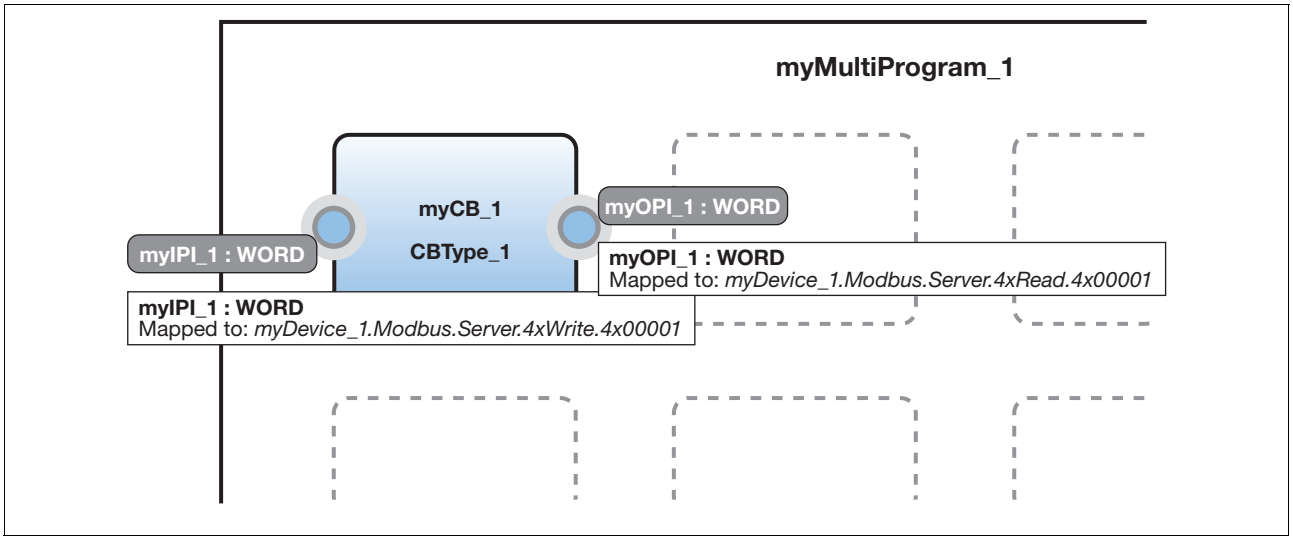

Fig. 7-7: I/O-mapping in Multi programming – Component block (example)

7.3 Raw UDP

The User Datagram Protocol (UDP) is implemented in accordance with RFC768. "Raw UDP" stands for data exchange via UDP, without an upper layer protocol.

UDP is used for communication between various communication partners. The communication service on a communication partner is identified via a port number. UDP uses the Internet Protocol (IP) for addressing, i.e. a UDP datagram is encapsulated in an IP frame and is sent to the communication partner as a data packet using the IP address.

UDP is a "non-connection-oriented" or "connectionless" protocol. This means:

- A connection to the communication partner is not established before starting transmission
- There is no guarantee that
  - Sent data packets arrive
  - Sent data packets arrive only once
  - Data packets arrive in the same order in which they were sent

As a result, UDP can only be used if the application is insensitive to lost and unsorted datagrams or if the application itself provides appropriate control and correction mechanisms on the communication partners.

Although UDP is a connectionless protocol, for simplicity's sake, the description below refers to the communication relationship between communication partners as a "connection".

Data exchange via Raw UDP can be used on the automation system PSS 4000 for non-safety-related applications.

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7.3 Raw UDP

7.3.1 "IP connections" system section

In the automation system PSS 4000, external communication via Raw UDP is possible with all PSS 4000 devices that have the "IP connections" system section (see Communication modes for external communication, page 7-1) . In this case, the "IP connections" system section of a PSS 4000 device performs all the tasks required for communication. These include:

- Managing the Raw UDP connections (see Raw UDP connections, page 7-32)
- Data exchange (see Data exchange via Raw UDP, page 7-33)

7.3 Raw UDP

7.3.2 Raw UDP connections

The "IP connections" system section of a PSS 4000 device manages the Raw UDP connections that are configured for the device. The connection is configured in the PAS4000's IP Connections Editor.

The following Raw UDP connections can be configured for a PSS 4000 device:

- **Send connections (role = transmitter)**
  - Unicast (1:1 connection)
  - Broadcast (1:"all" connection)
    Loopback is configurable
  - Multicast (1:n connection) in accordance with RFC 1112, IGMVP V1
- **Receive connections (role = receiver)**
  A FIFO memory can be enabled for receive data
  - Unicast (1:1 connection)
  - Broadcast (1:"all" connection)
  - Multicast (1:n connection) in accordance with RFC 1112, IGMVP V1
- **Send and receive connections (role = transmitter/receiver)**
  A FIFO memory can be enabled for receive data
  - Unicast (1:1 connection)
  - Broadcast (1:"all" connection)
    Loopback when sending is configurable
  - Multicast (1:n connection) in accordance with RFC 1112, IGMVP V1

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7.3 Raw UDP

7.3.3 Data exchange via Raw UDP

Raw UDP is not connection-oriented. Consequently Raw UDP does not have any mechanisms for establishing and ending a connection.

With connections that are configured in PAS4000 as send connections (role = transmitter), the PSS 4000 device sends data to one or more communication partners with a receiver role for this connection.

With connections that are configured in PAS4000 as receive connections (role = receiver), the connection waits for the communication partner with a transmitter role for this connection to send its data.

Connections that are configured in PAS4000 as send and receive connections (role = transmitter/receiver) are used to both send and receive data. A communication partner that opens communication, i.e. sends the first telegram via this connection, must be configured for send and receive connections. This communication partner is called the initiator. The communication partner without initiator functionality waits to receive the first telegram via this connection.

From the perspective of the automation system PSS 4000, receive data is called external I-data, and send data is called external O-data (see Validity of process data, page 8-4) .

A send and receive connection with initiator functionality is configured in PAS4000 according to the following rule of thumb:

Role	Network settings	
Transmitter/receiver	Remote port number	Does not equal 0
	Remote IP address	Does not equal 0.0.0.0

7.3 Raw UDP

INFORMATION

The initiator of a send and receive connection must meet the condition for both the remote port number and the remote IP address.

If just one of the conditions is **not** met, i.e. the remote port number is 0 and/or the remote IP address is 0.0.0.0, the send and receive connection will not have initiator functionality.

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7.3 Raw UDP

7.3.4 Data transfer limits

When transferring data via Raw UDP, the following limits apply for a PSS 4000 device:

- The max. number of Raw UDP connections depends on the device. Details can be found in the operating manual of the relevant PSS 4000 device.
  Please also note the general upper limit of 32 IP connections for one PSS 4000 device(see Communication modes for external communication, page 7-1) .
- A data length of 1 … max. 1024 Bytes (external I-data) can be configured for a receive connection.
- A data length of 1 … max. 1024 Bytes (external O-data) can be configured for a send connection.
- A data length of 1 … max. 1024 Bytes for each transmission direction can be configured for a send and receive connection.
- The maximum configurable data length is supported for each telegram; i.e. data from send connections will not be spread over multiple telegrams.
- The number of data bytes transmitted in a telegram must exactly equal the number that was configured for the connection:
  - If a telegram received by a PSS 4000 device contains more data bytes than were configured for the connection, the surplus data bytes will be rejected. A diagnostic message will not be displayed in the diagnostic list, as this is the defined behaviour for the PSS 4000.
  - If a telegram received by a PSS 4000 device contains fewer data bytes than were configured for the connection, a diagnostic message will be displayed in the diagnostic list.
- A FIFO memory can be enabled for receive data. The size of the FIFO memory depends on the device. Details can be found in the operating manual of the relevant PSS 4000 device. If the memory overflows, incoming data will be rejected and a diagnostic message will be displayed in the diagnostic list.

7.3 Raw UDP

7.3.5 Raw UDP I/O data

The "IP connections" system section enables a PSS 4000 device to exchange I/O data with third-party devices via Raw UDP. For this to work it is necessary for the I/O data in PAS4000's I/O Mapping Editor to be mapped to the corresponding Raw UDP data areas.

I/O mapping of Raw UDP data areas

I/O mapping is used to define which data source supplies data to which data sink.

Possible I/O mapping for Raw UDP data areas:

		Raw UDP	
		Receive data (= external I-data)	Send data (= external O-data)
Module bus	I-datum (e.g. HW input)	- - -	◆
	O-datum (e.g. HW output)	◆	- - -
PI variables	I-PI variable	◆	- - -
	O-PI variable	- - -	◆

◆ I/O mapping possible

- - - I/O mapping impossible

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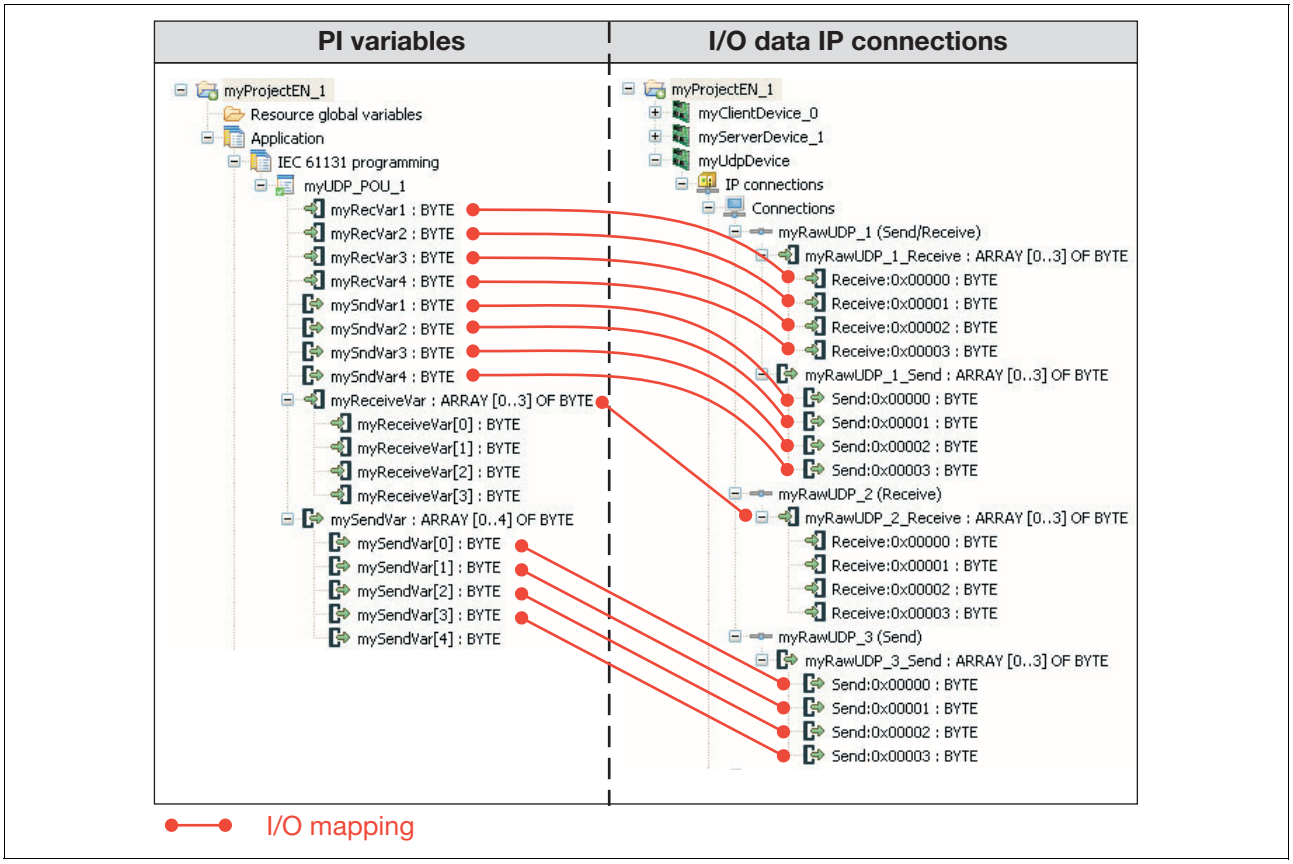
7.3 Raw UDP

Examples:

- **I/O mapping of I/O data**
  The receive data of the electronic module PSSu K S RS232 is to be transmitted to the communication partner and data received by the communication partner is to be output on the PSSu K S RS232.
  The send and receive connection "myRawUDP_1" is configured for this purpose:

  Possible I/O mapping (example):

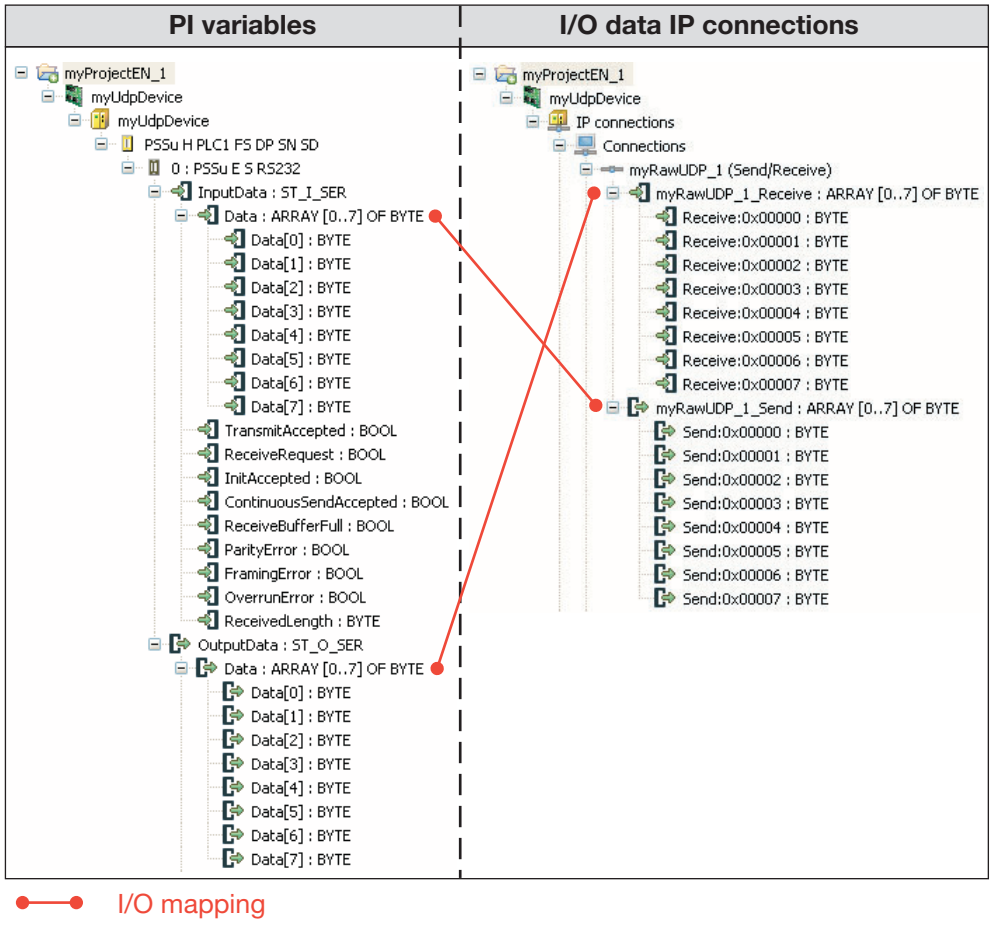


7.3 Raw UDP

I/O mapping of PI variables

The contents of a block's O-PI variables are to be transmitted to the communication partner and I-PI variables are to be assigned to the receive data. 3 connections are configured for this purpose:
- myRawUDP_1 (send and receive connection)
- myRawUDP_2 (send connection)
- myRawUDP_3 (receive connection)

Possible I/O mapping (example):



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7.3 Raw UDP

7.3.6 Address format of Raw UDP addresses

The addresses for the I/O data of a PSS 4000 device are displayed at several points, e.g. in PAS4000 and in the diagnostics.

7.3.6.1 Address format of send data

The addresses of Raw UDP send data are structured as follows:

<Device name>.UDP.*<Connection name>*.Send.Byte[*<Element number>*]

Example:

myDevice_1.UDP.myTxConnection_1.Send.Byte[0]
…
myDevice_1.UDP.myTxConnection_1.Send.Byte[1023]

7.3.6.2 Address format of receive data

The addresses of Raw UDP receive data are structured as follows:

<Device name>.UDP.*<Connection name>*.Receive.Byte.[*<Element number>*]

Example:

myDevice_1.UDP.myRxConnection_1.Receive.Byte[0]
…
myDevice_1.UDP.myRxConnection_1.Receive.Byte[1023]

7.3 Raw UDP

7.3.7 Data consistency on Raw UDP

Where receive data is sent by third-party devices, these devices are responsible for the data consistency of this data. From the PSS 4000's perspective, no statement can be made regarding the data consistency of those devices.

Data consistency on receive data of a Raw UDP connection

If a PSS 4000-exclusive/operable device is the recipient of data from a Raw UDP connection, from the perspective of the PSS 4000 device the receive data is external I-data.
External I-data from a Raw UDP connection is treated as consistent data in PSS 4000 (see Data consistency, page 8-18) .
The external I-data from a Raw UDP connection forms a consistency range of the consistency range type "ST-I data of an external communication connection". The exact description is consistency range "ST-I data of a Raw UDP connection" (see Consistency ranges, page 8-19) .

Data consistency on send data of a Raw UDP connection

If a PSS 4000-exclusive/operable device in a Raw UDP connection is the transmitter of data, from the perspective of the PSS 4000 device the send data is external O-data.
The external O-data of a Raw UDP connection is consistent if it comes from the same consistency range on a data source (see Data consistency, page 8-18) .

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7.4 PROFIBUS-DP slave

PROFIBUS is an open fieldbus standard whose communication is defined in the international standards IEC 61158 and IEC 61784. Further provisions have been defined in specifications published by the PROFIBUS User Group. These specifications are available from PROFIBUS International (see www.profibus.com).

For non-safety related applications, a PROFIBUS-DP enabled PSS 4000 device can be incorporated into PROFIBUS-DP as a Slave.

A PROFIBUS-DP enabled PSS 4000 device can be used with a Class 1 DP Master that supports the communication protocol PROFIBUS-DP with performance level DP-V0, DP-V1 or DP-V2.

As a PROFIBUS-DP Slave, a PROFIBUS-DP enabled PSS 4000 device has the following features:

- Uses the communication protocol PROFIBUS-DP with performance level DP-V0
- Devices addressed via DIP switches (e.g. on the head module of a PSSu system) or via the PROFIBUS-DP Master when using device address 126
- Selectable transmission rates (9.6 kBits/s … 12 MBits/s)
- Supports the mode for automatic detection of the transmission rate (auto baud mode)
- Supports sync mode
- Supports freeze mode
- Supports the PROFIBUS-DP diagnostic telegram

7.4 PROFIBUS-DP slave

7.4.1 "PROFIBUS-DP Slave" system section

In the automation system PSS 4000, external communication via PROFIBUS-DP is possible with all PSS 4000 devices that have the "PROFIBUS-DP Slave" system section (see Communication modes for external communication, page 7-1) . In this case, the "PROFIBUS-DP Slave" system section performs all the tasks required for communication. For example these include managing the send and receive data areas and data exchange (see Data exchange via PROFIBUS-DP, page 7-44) .

The connection is configured in the PAS4000's PROFIBUS-DP Slave Editor.

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7.4 PROFIBUS-DP slave

7.4.2 Data exchange via PROFIBUS-DP

PSS 4000 devices with the "PROFIBUS-DP Slave" system section operate as PROFIBUS-DP Slaves when exchanging data via PROFIBUS-DP. It is always the PROFIBUS-DP Master that initiates data transfer. From the perspective of the automation system PSS 4000, the PROFIBUS-DP Master is outside the system.

7.4 PROFIBUS-DP slave

7.4.2.1 Send data and receive data

The PROFIBUS-DP Master sends data from its send data area to the receive data area of the "PROFIBUS-DP Slave" system section of a PSS 4000 device and requests data from the "PROFIBUS-DP Slave" system section of a PSS 4000 device. The "PROFIBUS-DP Slave" system section of a PSS 4000 device sends the requested data from its send data area to the receive data area of the PROFIBUS-DP Master. In the automation system PSS 4000, the data areas are called "virtual PROFIBUS modules". Virtual PROFIBUS modules are available with a variety of data types.
For data exchange, corresponding virtual PROFIBUS modules must be configured for both the PROFIBUS-DP Master and "PROFIBUS-DP Slave" system section of a PSS 4000 device. The virtual PROFIBUS modules for send data are called O-modules. They have an "O" for "Output" in the module name (e.g. 8OX, OB, OW). The virtual PROFIBUS modules for receive data are called I-modules. They have an "I" for "Input" in the module name (e.g. 8IX, IB, IW).

The PROFIBUS DP Master obtains the required virtual PROFIBUS modules from the GSD file. This is supplied with PAS4000 and is also available in the download area of the Pilz homepage (www.pilz.de -> Downloads). "GSD" can be entered as the search term, for example. The software download is only available for registered users. Unregistered users can register free of charge.

The virtual PROFIBUS modules required for the "PROFIBUS-DP Slave" system section of a PSS 4000 device are configured during the PROFIBUS-DP Slave configuration in PAS4000. After configuration the virtual PROFIBUS modules are located on virtual slots (virtual slots 0 ... 79).

From the perspective of the automation system PSS 4000, the receive data is called external I-data, and the send data is called external O-data (see Validity of process data, page 8-4) .

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7.4 PROFIBUS-DP slave

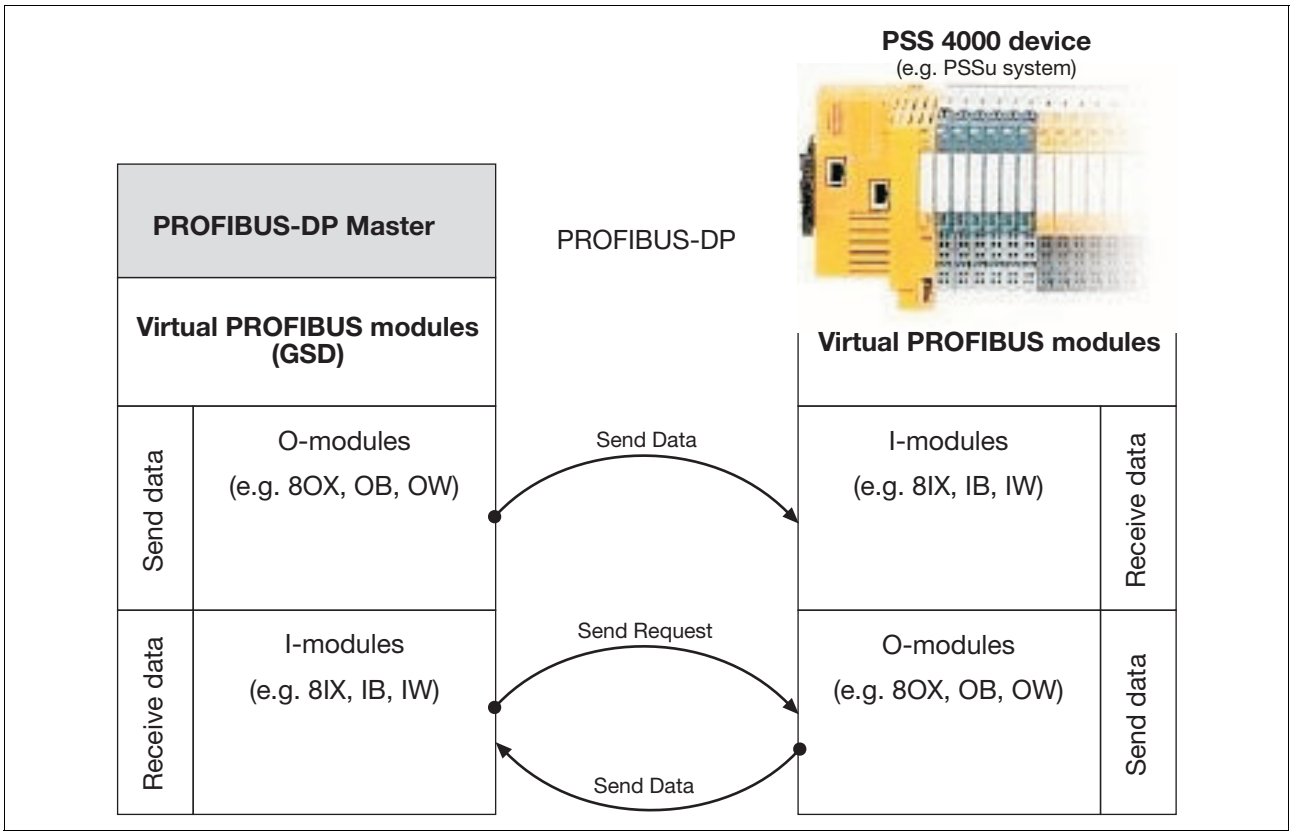

Fig. 7-8: Data exchange via virtual PROFIBUS modules (principle)

7.4 PROFIBUS-DP slave

7.4.2.2 Virtual PROFIBUS modules for receive data

The following virtual PROFIBUS modules (I-modules) can be configured in PAS4000 for the receive data of a "PROFIBUS-DP Slave" system section:

Virtual PROFIBUS module	Data type	Application
8IX	ARRAY [0..7] OF BOOL	Virtual PROFIBUS bit module To receive an array with 8 elements of data type BOOL
IB	BYTE	Virtual PROFIBUS byte module To receive data of data type BYTE
IW	WORD	Virtual PROFIBUS byte module To receive data of data type WORD
ID	DWORD	Virtual PROFIBUS byte module To receive data of data type DWORD
IBAn	ARRAY [0..(n-1)] OF BYTE	Virtual PROFIBUS byte module To receive an array with n elements of data type BYTE n = 2, 4, 8, 16, 32 or 64
IWAn	ARRAY [0..(n-1)] OF WORD	Virtual PROFIBUS byte module To receive an array with n elements of data type WORD n = 2, 4, 8, 16, 32 or 64

During data exchange, the PROFIBUS-DP Master transmits its send data to the I-modules in the automation system PSS 4000 via O-modules. Consequently, the O-modules on the PROFIBUS-DP Master must have corresponding I-modules in the automation system PSS 4000. Also, the data type of an I-module must correspond to the data type of the O-module in the PROFIBUS-DP Master.

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7.4 PROFIBUS-DP slave

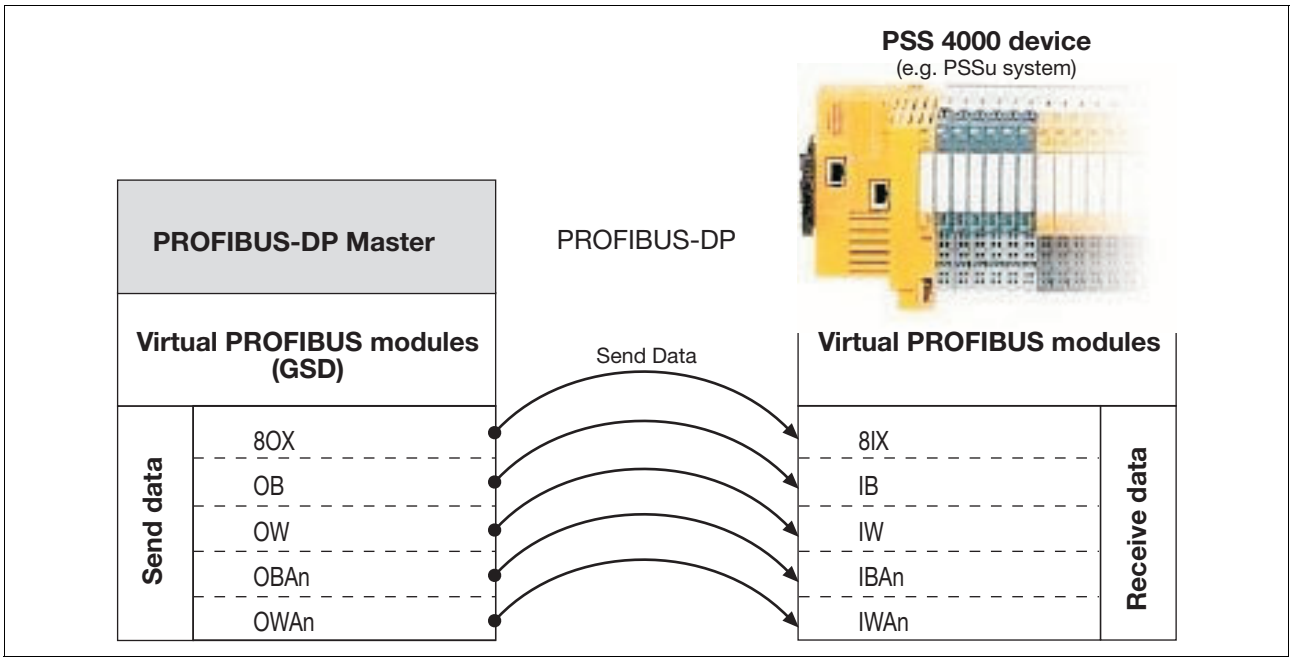

Fig. 7-9: Virtual PROFIBUS modules and their corresponding data types (receive data of a PSS 4000 device)

7.4 PROFIBUS-DP slave

7.4.2.3 Virtual PROFIBUS modules for send data

The following virtual PROFIBUS modules (O-modules) can be configured in PAS4000 for the send data of a "PROFIBUS-DP Slave" system section:

Virtual PROFIBUS module	Data type	Application
8OX	ARRAY [0..7] OF BOOL	Virtual PROFIBUS bit module To send an array with 8 elements of data type BOOL
OB	BYTE	Virtual PROFIBUS byte module To send data of data type BYTE
OW	WORD	Virtual PROFIBUS byte module To send data of data type WORD
OD	DWORD	Virtual PROFIBUS byte module To send data of data type DWORD
OBAn	ARRAY [0..(n-1)] OF BYTE	Virtual PROFIBUS byte module To send an array with n elements of data type BYTE n = 2, 4, 8, 16, 32 or 64
OWAn	ARRAY [0..(n-1)] OF WORD	Virtual PROFIBUS byte module To send an array with n elements of data type WORD n = 2, 4, 8, 16, 32 or 64

During data exchange, the PROFIBUS-DP Master requests data from O-modules on the automation system PSS 4000 and receives this data via its I-modules. Consequently, the O-modules on the automation system PSS 4000 must have corresponding I-modules in the PROFIBUS-DP Master. Also, the data type of an I-module in the PROFIBUS-DP Master must correspond to the data type of an O-module in the automation system PSS 4000.

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7.4 PROFIBUS-DP slave

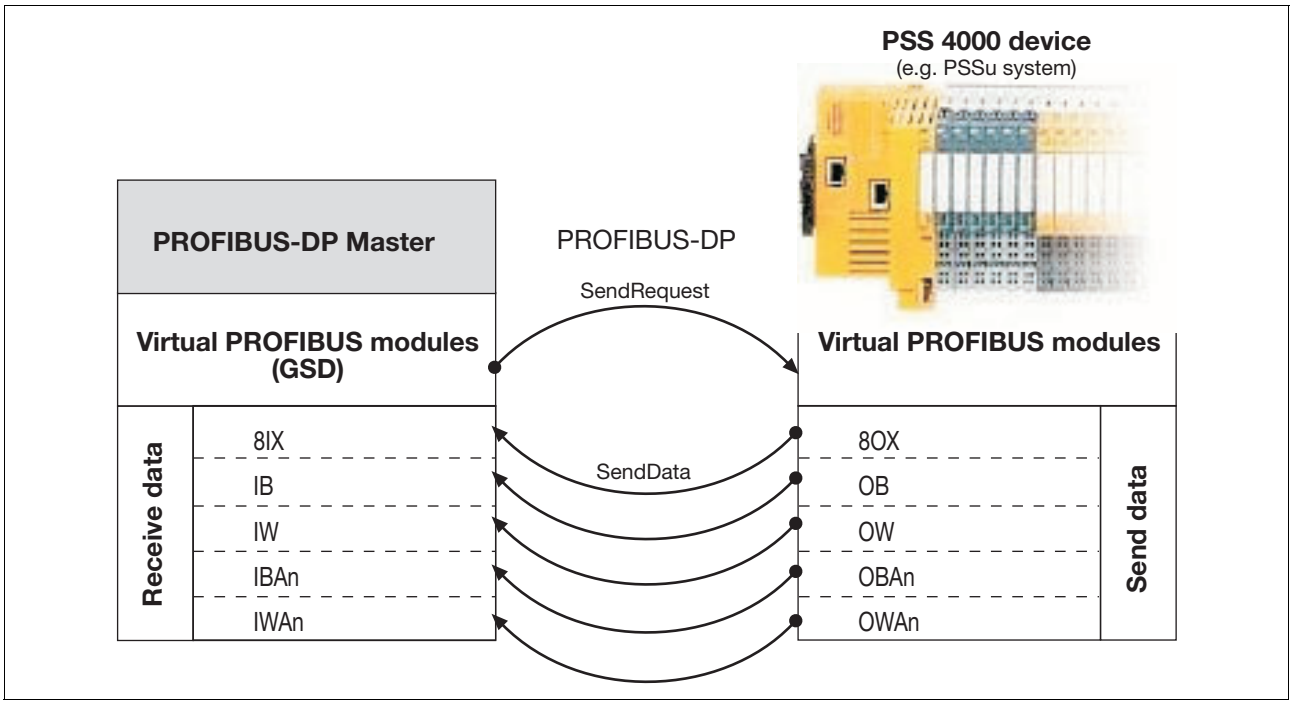

Fig. 7-10: Virtual PROFIBUS modules and their corresponding data types (send data of a PSS 4000 device)

7.4 PROFIBUS-DP slave

7.4.3 Data transfer limits

The following limits apply for data transfer via virtual PROFIBUS modules:

- A maximum of 80 virtual PROFIBUS modules with virtual slots 0 … 79 can be configured for the "PROFIBUS-DP Slave" system section of a PSS 4000 device.
- A maximum of 244 Bytes of receive data (= external I-data) can be configured for the "PROFIBUS-DP Slave" system section of a PSS 4000 device.
- A maximum of 244 Bytes of send data (= external O-data) can be configured for the "PROFIBUS-DP Slave" system section of a PSS 4000 device.

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7.4 PROFIBUS-DP slave

7.4.4 I/O data of PROFIBUS-DP slave

The "PROFIBUS-DP Slave" system section enables a PSS 4000 device to exchange I/O data with the PROFIBUS-DP Master via PROFIBUS-DP. For this to work it is necessary for the I/O data in PAS4000's I/O Mapping Editor to be mapped to the corresponding virtual PROFIBUS modules.

I/O-mapping of virtual PROFIBUS modules

I/O mapping is used to define which data source supplies data to which data sink.

Possible I/O-mapping for virtual PROFIBUS modules:

		Virtual PROFIBUS modules	
		Receive data (= external I-data of I modules as e.g B. 8IX, IB, IW, ID, IBAn, IWAn)	Send data (= external O-data of O-modules as e.g. 8OX, OB, OW, OD, OBAn, OWAn)
Module bus	I-datum (e.g. HW input)	- - -	◆
	O-datum (e.g. HW output)	◆	- - -
PI variables	I-PI variable	◆	- - -
	O-PI variable	- - -	◆

◆ I/O mapping possible

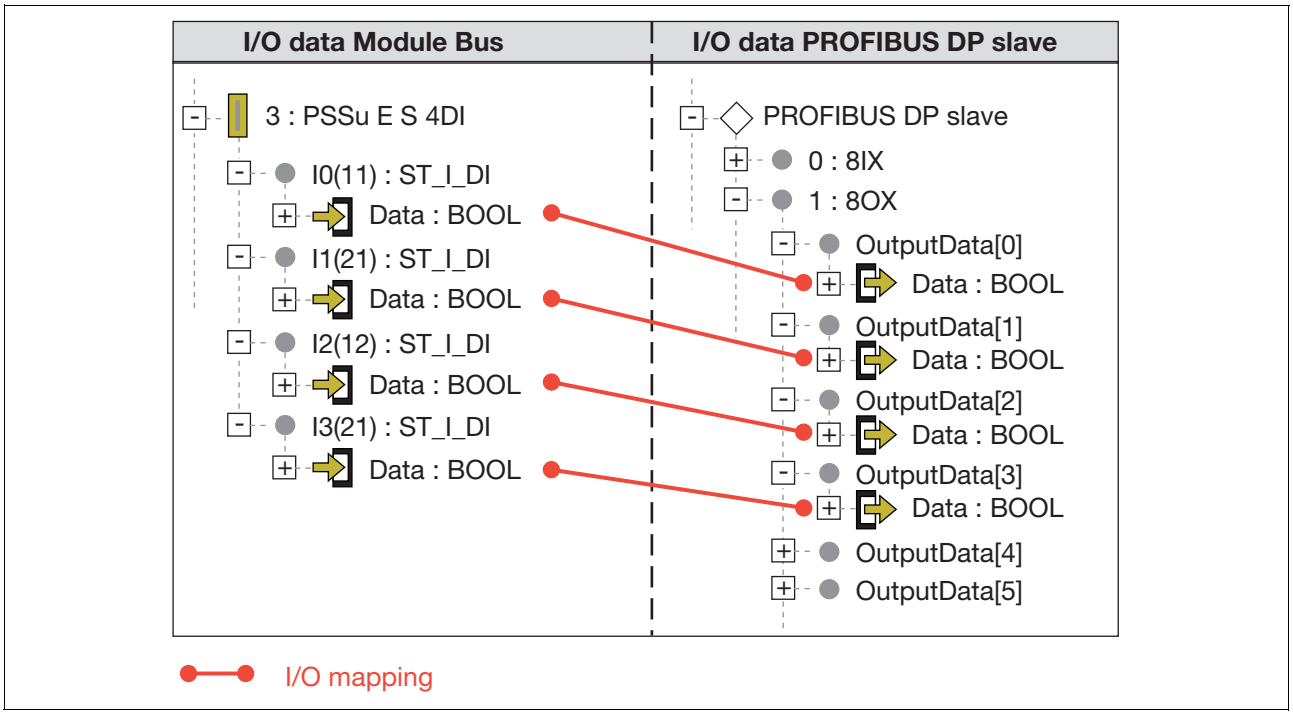
- - - I/O mapping impossible

7.4 PROFIBUS-DP slave

Examples:

I/O assignment for virtual PROFIBUS modules with send data

- The input signals of the hardware inputs of a PSSu E S 4DI are to be transferred to the PROFIBUS DP master.
  - Direction of data flow: Hardware input-> PROFIBUS DP
  - virtual PROFIBUS module used: 8OX
  - possible I/O mapping (example):



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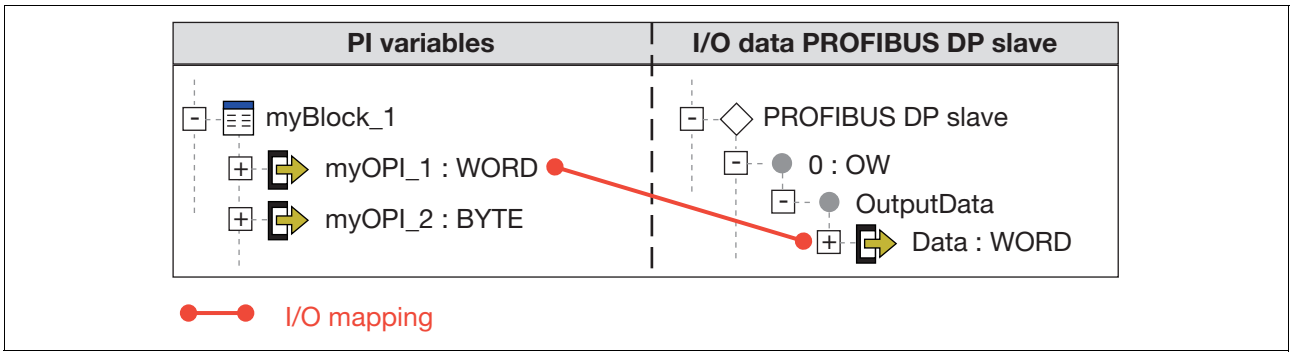
7.4 PROFIBUS-DP slave

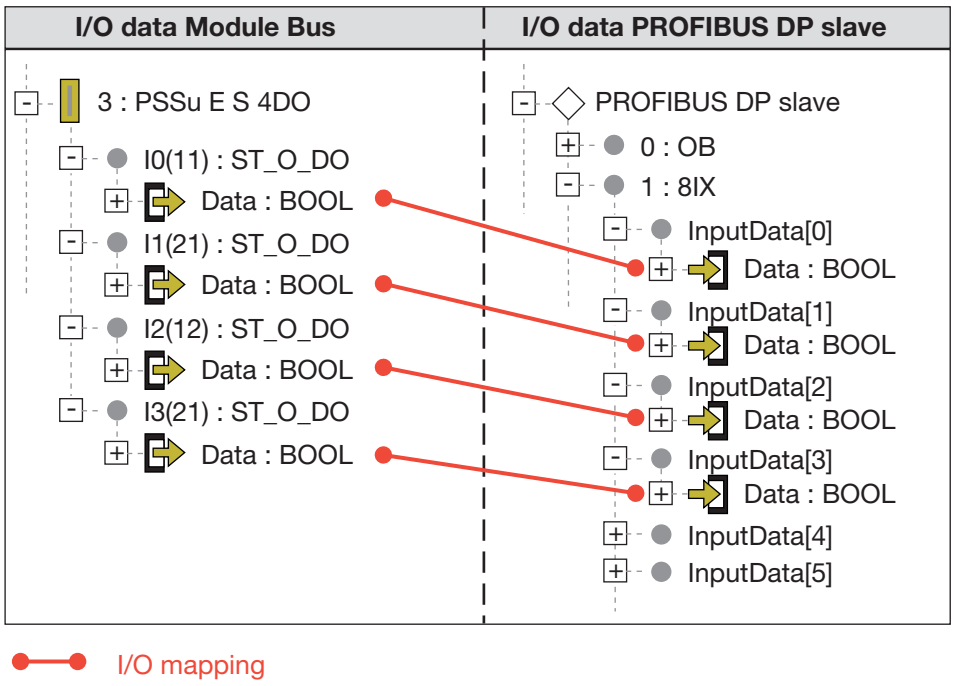
- The content of an O-PI variable of a block is to be transferred to the PROFIBUS DP master.
  - Direction of data flow: O-PI variable -> PROFIBUS DP
  - virtual PROFIBUS module used: OW
  - Possible I/O mapping (example):



7.4 PROFIBUS-DP slave

I/O assignment for virtual PROFIBUS modules with receive data

- The PROFIBUS-DP master is to control the hardware outputs of a PSSu E S 4DO 0.5.
  - Direction of data flow: PROFIBUS-DP -> Hardware outputs
  - virtual PROFIBUS module used: 8IX
  - Possible I/O mapping (example):



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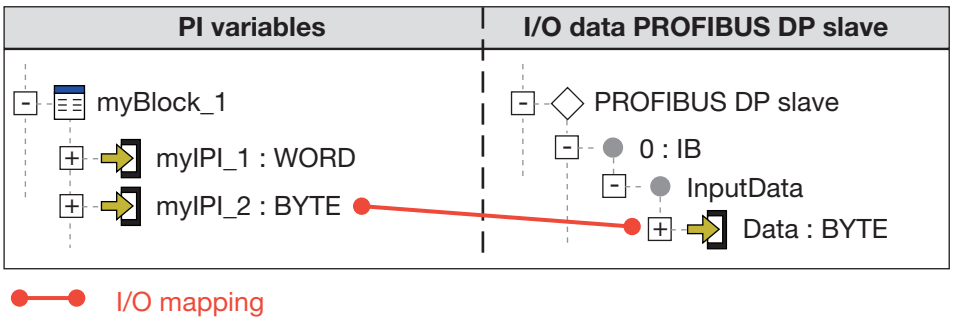
7.4 PROFIBUS-DP slave

- A date is to be transferred from the PROFIBUS-DP master to the PSSu system. Once the data has been received it is to be made available for further processing within a block.
  - Direction of data flow: PROFIBUS-DP -> I-PI variable
  - virtual PROFIBUS module used: IB
  - Possible I/O mapping (example):



7.4 PROFIBUS-DP slave

7.4.5 Address display of PROFIBUS-DP addresses

The addresses for the I/O data of a PSS 4000 device are displayed at several points, e.g. in PAS4000 and in the diagnostics.

7.4.5.1 Address display of send data

The addresses of PROFIBUS-DP send data (O-data of virtual PROFIBUS modules) are structured as follows:

<Device name>.ProfibusDP.<Virtual slot>.OutputData[<Element number>]

Examples:

- Address format for an 8OX:
  myDevice_1.ProfibusDP.2.OutputData[0]
  myDevice_1.ProfibusDP.2.OutputData[1]
  myDevice_1.ProfibusDP.2.OutputData[2]
  myDevice_1.ProfibusDP.2.OutputData[3]
  myDevice_1.ProfibusDP.2.OutputData[4]
  myDevice_1.ProfibusDP.2.OutputData[5]
  myDevice_1.ProfibusDP.2.OutputData[6]
  myDevice_1.ProfibusDP.2.OutputData[7]
- Address format for an OB:
  myDevice_1.ProfibusDP.3.OutputData
- Address format for an OW:
  myDevice_1.ProfibusDP.4.OutputData
- Address format for an OBA2:
  myDevice_1.ProfibusDP.5.OutputData[0]
  myDevice_1.ProfibusDP.5.OutputData[1]
- Address format for an OWA4:
  myDevice_1.ProfibusDP.6.OutputData[0]
  myDevice_1.ProfibusDP.6.OutputData[1]
  myDevice_1.ProfibusDP.6.OutputData[2]
  myDevice_1.ProfibusDP.6.OutputData[3]

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7.4 PROFIBUS-DP slave

7.4.5.2 Address display of receive data

The addresses of PROFIBUS-DP receive data (I-data of virtual PROFIBUS modules) are structured as follows:

<Device name>.ProfibusDP.<Virtual slot>.InputData[<Element number>]

Examples:

- Address format for an 8IX:
  myDevice_1.ProfibusDP.7.InputData[0]
  myDevice_1.ProfibusDP.7.InputData[1]
  myDevice_1.ProfibusDP.7.InputData[2]
  myDevice_1.ProfibusDP.7.InputData[3]
  myDevice_1.ProfibusDP.7.InputData[4]
  myDevice_1.ProfibusDP.7.InputData[5]
  myDevice_1.ProfibusDP.7.InputData[6]
  myDevice_1.ProfibusDP.7.InputData[7]
- Address format for an IB:
  myDevice_1.ProfibusDP.8.InputData
- Address format for an IW:
  myDevice_1.ProfibusDP.9.InputData
- Address format for an IBA4:
  myDevice_1.ProfibusDP.10.InputData[0]
  myDevice_1.ProfibusDP.10.InputData[1]
  myDevice_1.ProfibusDP.10.InputData[2]
  myDevice_1.ProfibusDP.10.InputData[3]
- Address format for an IWA2:
  myDevice_1.ProfibusDP.11.InputData[0]
  myDevice_1.ProfibusDP.11.InputData[1]

7.4 PROFIBUS-DP slave

7.4.6 PROFIBUS diagnostics

PROFIBUS-DP diagnostics can be performed via the PSS 4000 system diagnostics (see Diagnostic basics, page 13-1) .

However, the standard defines proprietary diagnostic options for PROFIBUS-DP. The current diagnostic information can be polled by a PROFIBUS-DP Master on the PROFIBUS-DP Slave via a diagnostic telegram.

The standard divides the diagnostic information in the diagnostic telegram into the following areas:

- System-internal diagnostics
- External diagnostics
  - Device-based diagnostics
  - ID-based diagnostics
  - Channel-based diagnostics

The system-internal diagnostic data is located in the first 6 Bytes of the diagnostic telegram and its meaning is firmly specified in the standard. These obligatory 6 Bytes may be followed by one block or several blocks containing external diagnostic data.

On PSS 4000 devices with a "PROFIBUS-DP Slave" system section, a PROFIBUS DP diagnostic telegram consists of a min. 6 Bytes of diagnostic data (obligatory diagnostic data) and a max. of 9 Bytes of diagnostic data (6 Bytes of obligatory diagnostic data + 3 Bytes of external diagnostic data).

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7.4 PROFIBUS-DP slave

7.4.6.1 System-internal diagnostics

Structure and content of the system-internal diagnostics data (Bytes 1 …6):

Byte No.	Bit No.	Meaning
1	0	Station_Non_Existent
	1	Station_Not_Ready
	2	Cfg_Fault
	3	Ext_Diag 0: no external diagnostics data present 1: external diagnostics data present
	4	Not_Supported
	5	Invalid_Slave_Response
	6	Prm_Fault
	7	Master_lock
2	0	Prm_req
	1	Stat_Diag
	2	Always "1"
	3	WD_on
	4	Freeze_Mode
	5	Sync_Mode
	6	Reserved
	7	Deactivated
3	6 ... 0	Reserved
	7	Ext_Diag_Overflow
4	7 … 0	Address of the PROFIBUS-DP master
5	7 … 0	Ident number of the PROFIBUS-DP slave: High-Byte PSSu systems: 0C
6	7 … 0	Ident number of the PROFIBUS-DP slave: Low-Byte PSSu systems: B0

INFORMATION
The exact meaning of the Bytes 1 … 6 can be found in the IEC 61158-6-3 (5.3.1) and IEC 61158-6-5 (6.2.3.3.1).

7.4 PROFIBUS-DP slave

7.4.6.2 External diagnostic data

In accordance with the standard, a diagnostic block starts with a Header Byte. This Header Byte determines the type and length of the diagnostic block. The standard defines three formats:

- Device-based diagnostics
- ID-based diagnostics
- Channel-based diagnostics

PSS 4000 supports device-based diagnostics. 3 Bytes including the Header Byte are required for device-based diagnostic data on a PSS 4000 device with "PROFIBUS-DP Slave" system section.

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7.4 PROFIBUS-DP slave

Structure and content of device-based diagnostic data of PSS 4000 devices with "PROFIBUS-DP Slave" system section

Byte No.	Bit No.	Value	Meaning
n	0 … 7	03h	Header Byte
			Bits 7 and 6: PSS 4000 device with "PROFIBUS-DP Slave" system section: Code for device-based diagnostics
			Bits 5 … 0: Number of bytes in the device-based diagnostics (including Header Byte) PSS 4000 device with "PROFIBUS-DP Slave" system section: 3 Bytes
n+1	0	0/1	Error message for the PSS 4000 device: 0: No message 1: A message of "Error" severity is present for at least one system section of the PSS 4000 device or A major FS fault is present for at least one FS system section of the PSS 4000 device (on a PSSu system, this corresponds to the status of the "DIAG" LED on the head module: "lights up red" or "flashes red")
	1	0/1	Fault in the FS/ST module bus system sections of the PSS 4000 device: The following applies for a PSSu system: 0: No message 1: Operating status "Safe condition of all FS outputs on the PSSu system" or At least one module cannot be accessed (e.g. a module has been removed during operation, set/actual hardware registry does not match) or Operating status "FS module bus in a STOP condition with fault: Major FS fault" (on a PSSu system, this corresponds to the status of the "MBUS" LED on the head module: "lights up red" or "flashes red")
	2	0/1	Fault in the "FS-SafetyNET p RTFN" system section of the PSS 4000 device: 0: No message 1: Operating status "FS SafetyNET p RTFN in STOP condition with fault: Major FS fault" or Operating status "FS SafetyNET p RTFN in STOP condition with fault: Major FS+ST fault" (on PSSu systems, this corresponds to the status of the "FS SNp" LED on the head module: "lights up red" or "flashes red")
	3	0/1	Fault in the "FS-SafetyNET p RTFN" system section of the PSS 4000 device: 0: No message 1: Operating status "ST SafetyNETp RTFN in STOP condition with fault": Major FS+ST fault" (on a PSSu system, this corresponds to the status of the "ST SNp" LED on the head module: "lights up red" or "flashes red")
	4	0	Reserved
	5	0	Reserved
	6	0	Reserved
	7	0	Reserved

7.4 PROFIBUS-DP slave

Byte No.	Bit No.	Value	Meaning
n + 2	0	0/1	Warning message for the PSS 4000 device 0: No message 1: A message of "Warning" severity is present for the PSS 4000 device (on PSSu systems, this corresponds to the status of the "DIAG" LED on the head module: lights up "orange")
	1	0/1	Forcing on the FS resource 0: No message 1: Forcing on the FS resource is active (on PSSu systems, corresponds to the status of the "FS FORCE" LED on the head module: "lights up yellow")
	2	0/1	Forcing on the ST resource 0: No message 1: Forcing on the ST resource is active (on PSSu systems, corresponds to the status of the "ST FORCE" LED on the head module: "lights up yellow")
	3 … 7	0	Reserved

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7.4 PROFIBUS-DP slave

7.4.7 Data consistency on PROFIBUS-DP

The data consistency of the data exchanged between the PROFIBUS-DP Master and PSS 4000 depends on the configuration of the PROFIBUS-DP Master.

PROFIBUS-DP supports three types of data consistency:

- Byte consistency
  Bytes are transmitted as whole units.
- Word consistency
  The two bytes in a word are always transmitted together.
- Buffer consistency
  The whole data buffer is transmitted as one unit without a break.
  From the perspective of the PSS 4000, the data buffer corresponds to the respective virtual PROFIBUS module for send data or receive data.

Data consistency of the receive data

From the perspective of the PSS 4000, the receive data of a virtual PROFIBUS module is external I-data.
As soon as external I-data is available in a virtual PROFIBUS module, it is treated as consistent data (see Data consistency, page 8-18) . The external I-data from a PROFIBUS module forms a consistency range of the consistency range type "ST-I data of an external communication connection". The exact description is consistency range "ST-I data of a PROFIBUS-DP connection" (see Consistency ranges, page 8-19) .

Data consistency of the send data

From the perspective of the PSS 4000, the send data of a virtual PROFIBUS module is external O-data.
The external O-data of a virtual PROFIBUS module is consistent if it comes from the same consistency range on a data source.
PSS 4000 always treats the external O data of a virtual PROFIBUS module as one unit. It is the task of the PROFIBUS-DP Master to guarantee the necessary data consistency.

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8.1 Project structure

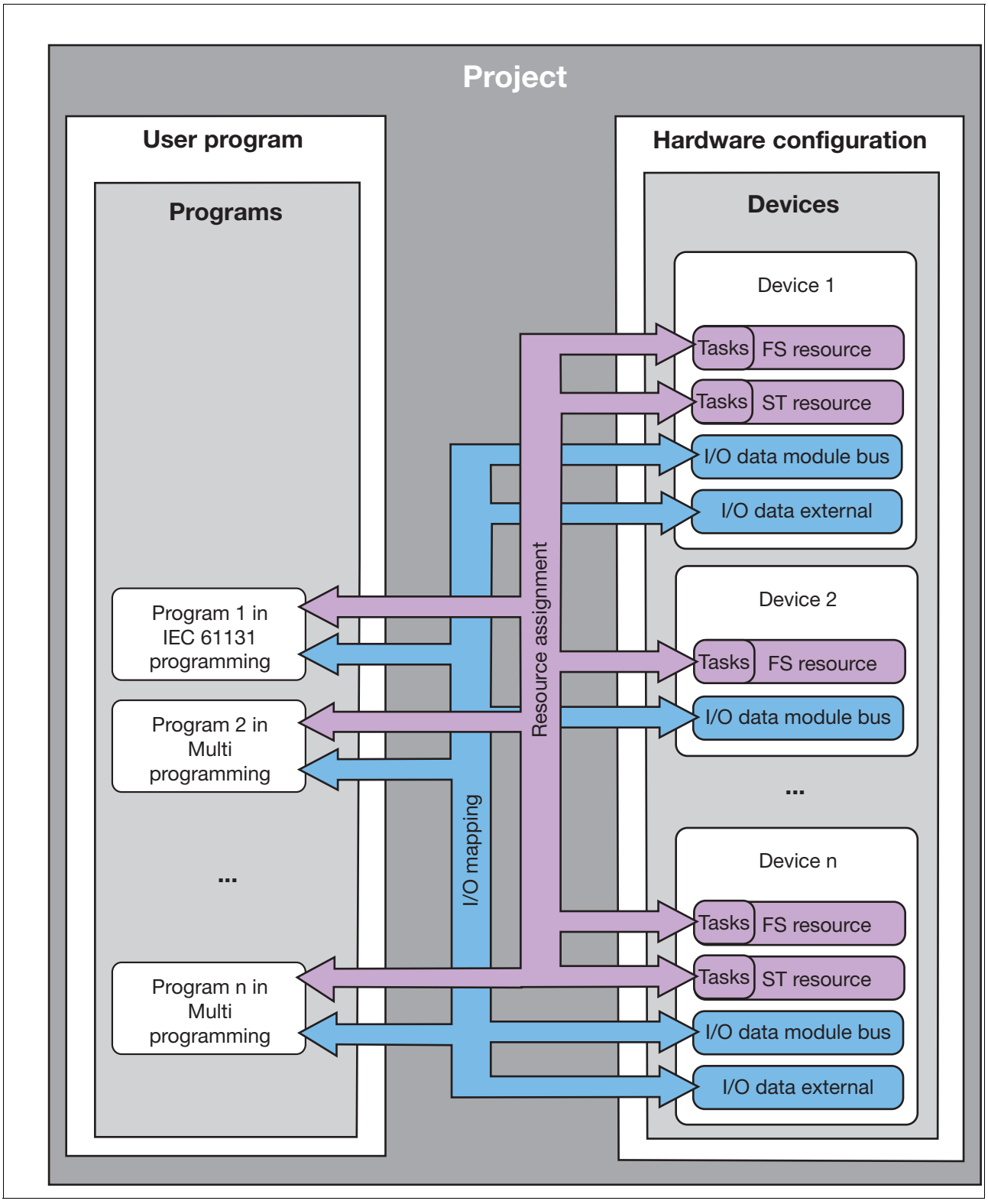

Fig. 8-1: Project structure

8.1 Project structure

To operate a plant with the automation system PSS 4000, a project must be created in PAS4000.

A project consists of the hardware configuration and the user program.

The hardware configuration defines the devices that will be used in the project and the settings with which the devices will be operated. The configuration is specified for each PSSu system, for example. The module bus I/O data, which is processed or provided by the PSSu system, is derived from the specification of the I/O modules. External communication can also be configured for PSS 4000 devices with external communication (e.g. PROFIBUS-DP-Slave). This produces the external I/O data, which is processed or provided by the device.

The user program consists of one or more programs. Programs for control systems PSSu PLC can be created in IEC 61131 programming and Multi programming. Programs for PSSu control systems may only be created in Multi programming.

IEC 61131 programming:

When programming in accordance with IEC 61131, three types of program organisation units (POUs) are available for structuring the user program:

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

The program forms the higher structural level. Functions and function blocks can be called up in a program.
Function blocks and functions perform specific individual tasks within the user program.

The POUs can be formulated in the IL (Instruction List) or STL (Structured Text) programming language as required.

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8.1 Project structure

Multi programming

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

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

INFORMATION
The term "block" is used as a generic term for Multi program, component block, basic block and program organisation unit of the type program, function block and function.

The connection between the blocks and the I/O hardware data is made via "PI variables". PI-variables can also be used for data exchange between blocks.

If no resource global variables are used, the user program can be created independently of the used hardware. Information on which section of the user program is to be executed on which resource under which task does not need to be defined in the resource assignment until programming is finished. The tasks determine the run-time properties of sections of the user program, i.e. the priority with which they are executed.

Once programming is finished, the connection between the PI variables and the automation system I/O data must be established. This is done in the I/O mapping.

8.2 Validity of process data

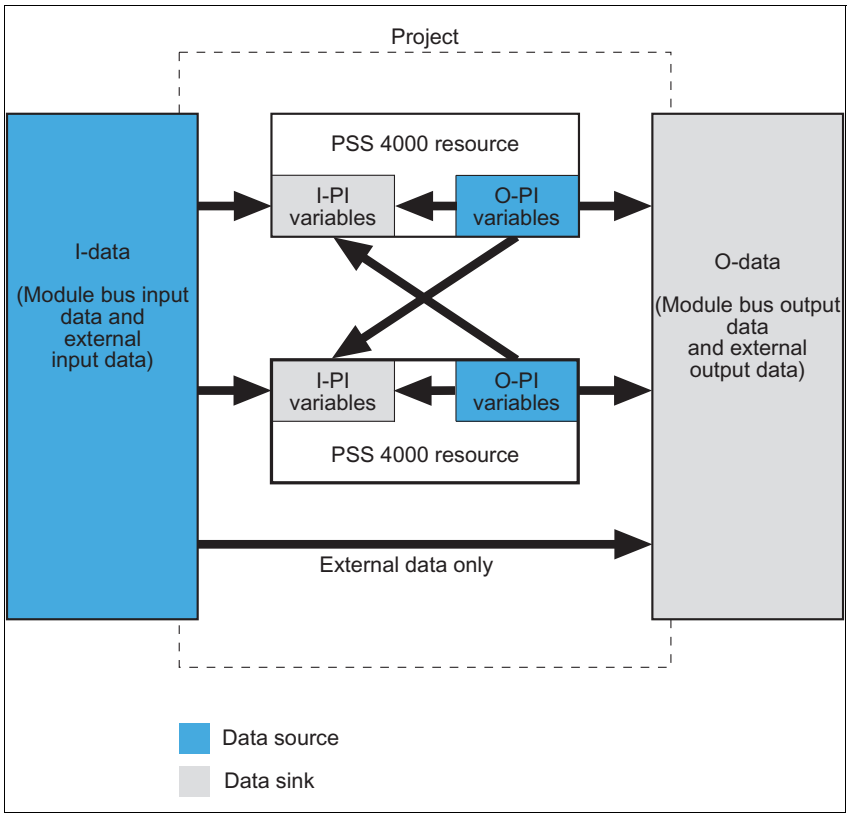

Fig. 8-2: Data flow within the project

Process data includes the I/O data and PI variables. Inside a project, process data is exchanged between data sources and data sinks.

Data sources are:

- Module bus I-data
  Input data that comes from the FS/ST module bus system section, e.g. from modules on the PSSu systems
- External I-data
  Input data that comes from the system sections for external communication, e.g. from the PROFIBUS-DP Slave.
- O-PI variables
  O-PI variables from PSS 4000 resources, e.g. from the FS resource or ST resource system sections; the resources may be on the same device or on different devices

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8.2 Validity of process data

Data sinks are:

- Module bus O-data
  Output data that is written to the FS/ST module bus system section, i.e. is downloaded to the modules on the PSSu systems
- External O-data
  Output data that goes out externally via system sections for external communication, e.g. via PROFIBUS-DP Slave.
- I-PI variables
  I-PI variables from PSS 4000 resources, e.g. from the FS resource or ST resource system sections

The data flow is shown in the diagram using arrows. I/O mapping defines which data source supplies data to which data sink.

During the data flow, either the data source or the communication channel between the data source and data sink may malfunction, so that the data sink fails to receive a valid process value from the data source. To enable the data sink to establish whether the process value it has received is valid, each process value in the data sink has what's termed a "valid bit".

The valid bit is FALSE if the process datum in the data source is marked invalid or if it's impossible to access the process datum in the data source.

If the valid bit is FALSE, the process value is invalid and may not be used. If this is the case, the data sink has a substitute value which is used instead of the process value.

Situations which set the valid bit to FALSE:

- On module bus I-data
  - Error on an input (e.g. test pulse error)
  - Error on an I/O module (e.g. module overheating)
  - Error on the module bus
  - Module bus starting
- On external I-data
  - Communication is stopped
  - Communication timeout
- On O-PI variables
  - Task is in a STOP condition
  - Resource is in a STOP condition

8.2 Validity of process data

Please note:

- Start-up behaviour

  On start-up, situations may occur in which the user program in a device's resource is already being run, although data sources (e.g. the local module bus) have not yet supplied any valid data. In this case, the user program will operate with the substitute values (see Substitute values, page 8-7) . As soon as the system section with the data source is up and running, the current data will be processed rather than the substitute values. The valid bits can be evaluated to ensure that this signal change does not provoke any unwanted reaction (see Evaluation of the valid bits in the user program, page 8-8) .

  A valid bit should be evaluated as a random sample from each system section from which data is processed in the user program (ST resource, FS resource, ST module bus, FS module bus, ST SafetyNET p RTFN, FS SafetyNET p RTFN, system section for external communication, e.g. PROFIBUS-DP Slave). For example, if an I-PI variable is assigned to an I-datum on the local FS module bus and the valid bit of that I-PI variable is TRUE, it's possible to conclude that the local FS module bus is running. At most some individual FS-I modules may be in a fault condition. If an I-PI variable is assigned to an I-datum on the ST module bus on another device and the valid bit of that I-PI variable is TRUE, it's possible to conclude that both the ST module bus on the other device and communication via ST-SafetyNET p RTFN are running. At most some individual ST-I modules on the other device may be in a fault condition.

- Online action: "Forcing"

  When forcing an I-PI variable for which a valid bit is declared, the valid bit is automatically forced with the value TRUE.

  Exceptions:

  – The user changes the force value for the valid bit to FALSE.
  – The user deactivates forcing for the valid bit.
  – The I-PI variable belongs to a read-protected block. In this case, it will not be possible to force the valid bit.

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8.2 Validity of process data

8.2.1 Substitute values

The substitute values for process data are fixed.

Substitute values may be:
- Zero (= safe condition)
- Last valid value

Process data	Substitute value
I-PI variable on an FS resource	Zero
Output from an FS bit module	Zero
O-datum from an FS byte module	Zero
I-PI variable from an ST resource	Zero
Output from an ST bit module	Zero
O-datum from an ST byte module	Zero
ST-O datum PROFIBUS-DP Slave	Zero
ST-O datum Modbus/TCP Server connection	Last valid value
ST-O datum Modbus/TCP Client connection	Zero
ST-O datum Raw UDP	Zero

8.2 Validity of process data

8.2.2 Evaluation of the valid bits in the user program

If a data source fails to supply a valid process datum, the valid bit in the data sink is set to FALSE and the data sink is assigned the substitute value. This process can be monitored by evaluating the valid bit.

The valid bit from an I-PI variable can be evaluated in the user program. It's not yet possible to monitor the valid bits from other data sinks.

If the I-PI variable is a multiple-element variable (e.g. a structure of the I/O data type ST_I_AI), the valid bit for the overall structure is identical to the valid bits of the structure's individual elements.

Evaluation of the valid bit in Multi programming

The PSS 4000 system block "VALID" is used to evaluate the valid bit.

Evaluation of the valid bit in IEC 61131 programming

The VALID extension must be declared for the I-PI variable in order to evaluate the valid bit.

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8.3 Task basics

Tasks determine the run-time properties of basic blocks (Multi programming) and of program-type program organisation units (IEC 61131 programming), i.e. the conditions under which they are executed, how often and with what priority.

One or more basic blocks and/or program-type POUs are assigned to a task.
A resource may contain a maximum of 9 tasks. The number of tasks depends on the device. Details can be found in the device's operating manual.
The system organises task execution. The tasks' properties influence when the tasks are executed and in which order.

INFORMATION
For many projects it's not necessary to configure task properties. The default configuration is sufficient (see Default configuration of tasks, page 8-15) . So you don't necessarily have to deal with the issue of "Tasks".

8.3 Task basics

8.3.1 Task properties

Task properties are defined in the task configuration:

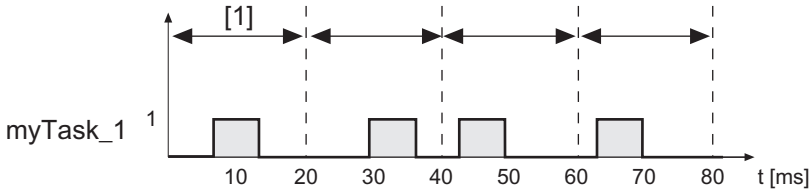
- Type

  The task type "periodic task" is currently available.

  The periodic task is executed once only within a definable task cycle time. The intervals between executions may vary.

  If the execution is not completed within the task cycle time, the operating status "Resource in RUN condition with task fault" will result.

  Example: Possible execution of periodic task "myTask_1" with a task cycle time of 20 ms



  [1] Task cycle time

- Priority

  The priority can be defined for each task. The priority determines the importance of a task in comparison with other tasks on a resource. As such it determines the order in which tasks on a resource are executed. The priorities are: high, medium and low. The number of times a priority may be assigned to a resource is specified. For example, a resource with 9 tasks may have 3 tasks with high priority, 3 with medium and 3 with low.

  If a lot of tasks are programmed with high priority, it can slow down the execution of certain online functions in PAS4000 (e.g. variable watch, dynamic program display) as well as access from the PSS 4000 OPC Server to data on the devices.

- Task cycle time (only on periodic tasks)

  The task cycle time defines the period within which the task must be executed.

  The task cycle time also serves as a subpriority. Where tasks have the same priority, the task with the shortest task cycle time is executed first.

- Exclusivity

  Exclusivity determines whether one or more basic blocks/program-type POUs can be assigned to a task.

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8.3 Task basics

8.3.2 Task execution

The PSS 4000 is a multi-tasking system with pre-emptive scheduling. Up to 9 tasks may be available on one resource. The number of tasks depends on the device. Details can be found in the device's operating manual.
The system organises task execution. The tasks' properties influence when the tasks are executed and in which order. The execution of lower priority tasks is interrupted if higher priority tasks are pending execution.

The following rules apply when executing tasks:

- Execution controlled per device
  Each device within the project independently controls task execution. A device can have a maximum of one FS resource and one ST resource. Each resource may contain a maximum of 9 tasks. The number of tasks depends on the device. Details can be found in the device's operating manual.
  The number of times a priority may be assigned to a resource is specified. For example, a resource with 9 tasks may have 3 tasks with high priority, 3 with medium and 3 with low.
- Order by priority
  Tasks are executed in accordance with their priority. High priority tasks are executed first, followed by medium and then low priority tasks. Where tasks have equal priority, the task cycle time decides. The task with the shortest task cycle time is executed first. If there are tasks with equal priority and task cycle time, the order is random.
- Interaction between FS and ST resource
  If a device has an FS and an ST resource, both are executed by the same CPU. The following order applies:
  1. FS tasks, high priority
  2. ST tasks, high priority
  3. FS tasks, medium priority
  4. ST tasks, medium priority
  5. FS tasks, low priority
  6. ST tasks, low priority

  Execution of the FS task with high priority always has precedence.
- Periodic check for pending tasks
  With each system clock pulse the system checks whether there are any tasks pending execution and redefines the order of execution. If a task is being executed, it will be interrupted if a higher priority task is pending.
- Execution order
  If several programs have to be run within a task, the programs are executed in alphabetical order, based on the program names.

8.3 Task basics

Multi programming: The execution order for the basic blocks within a Multi program is defined by PAS4000.

- Reading and outputting the process image and resource global variables

  When task execution begins, a copy is created of the section of the process image (I-PI and O-PI) needed by the blocks (basic blocks/ program-type POUs) in the task. The necessary resource global variables are also copied.

  When the task is executed, only the values from the copies are read and written.

  Not until the task is complete, in other words, when all the task's blocks have been executed, is the data from the copies transferred to the resource global variables and the process image of outputs (O-PI).

  By using this procedure, data cannot be modified externally while the task is being executed. Even if a task is interrupted during execution, it will subsequently continue working with the data in its copies.

- Task interruption

  A higher priority task is not the only event that can interrupt a task. A task will also be interrupted, for example, if a block is waiting for a system function to be executed. As a result, when a block is executed, it is not certain whether a block has been executed previously in a higher priority task and whether its current data is available in the PI. If one task is to process data from another task, the user must ensure that the necessary data from the other task has already been executed, by evaluating a counter for example.

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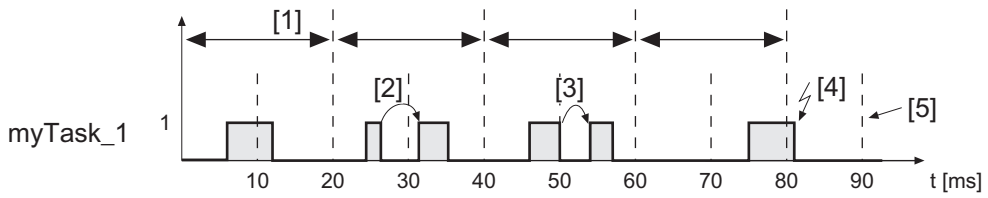
8.3 Task basics

Example 1
Execution of periodic task "myTask_1", with a task cycle time of 20 ms and a system clock pulse of 10 ms



[1] Task cycle time

[2], [3] Interruption

[4] Error

[5] System clock pulse

With each system clock pulse the system checks whether any tasks are pending execution. The task "myTask_1" is available for execution every 20 ms. However, it is not always executed immediately because higher priority tasks are executed first. The task may also be interrupted because the program is waiting for a system function to be executed for example [2], or because a higher priority task is present on the system clock pulse [3]. If the task execution is not completed within the task cycle time, an error is triggered [4].

Example 2
A medium priority task is being executed. A high priority task is present on the system clock pulse. The first task is interrupted and the high priority task is executed. Execution of the first task is then resumed.

Example 3
A high priority task with a task cycle time of 20 ms is being executed. A high priority task with a task cycle time of 10 ms is present on the system clock pulse. The first task is interrupted and the task with the shorter task cycle time is executed.

8.3 Task basics

Example 4
A medium priority ST task is being executed. A medium priority FS task is present on the system clock pulse. The ST task is interrupted and the FS task is executed first.

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8.3 Task basics

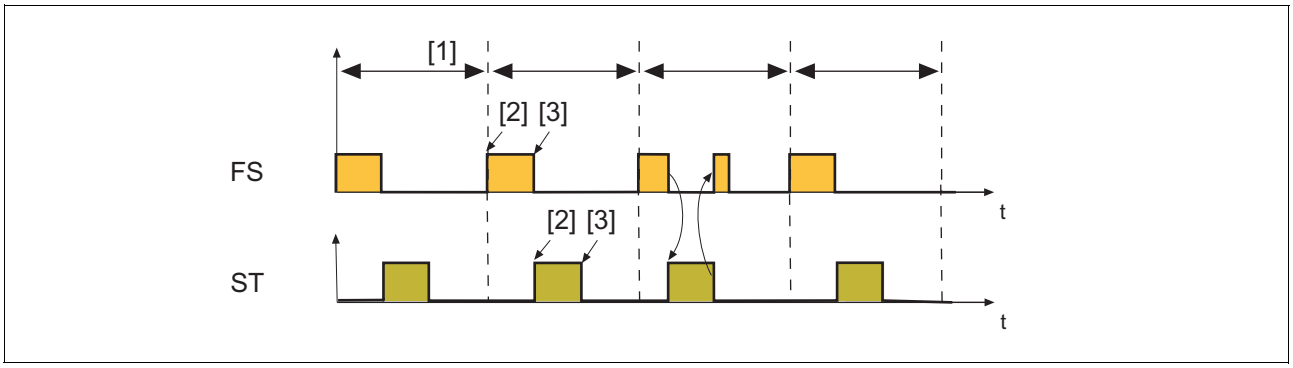
8.3.3 Default configuration of tasks

For many projects it's not necessary to configure task properties. The default configuration is sufficient.

The default configuration is designed so that the FS task is executed first on a device, followed by the ST task. The circumstance may arise where an FS block, for example, is waiting for a system function to be executed. In this case, execution of the FS task is interrupted and the ST task is executed.

If several programs have to be run within a task, the programs are executed in alphabetical order, based on the program names.
Multi programming: The execution order for the basic blocks within a Multi program is defined by PAS4000.

The FS task and ST task are executed once within the task cycle time of 100 ms.



[1] Task cycle time

[2] Resource global variables and process image of inputs (I-PI) and outputs (O-PI) are read in

[3] Output of resource global variables and process image of outputs (O-PI)

8.4 Data exchange between FS resource and ST resource

All the PI variables declared in the user program must be mapped to an I/O datum or another PI variable in the I/O Mapping Editor. It is also possible to map I-data directly to O-data.

The overview shows which I/O mappings are permitted.

Module bus data is data from the PSSu modules (e.g. hardware inputs/ hardware outputs). External data is data from external communication (e.g. Modbus/TCP, fieldbuses); this does not include data transmitted via SafetyNET p.

I/O mapping		**To (data sink)**					
		Module bus ST-O datum	Module bus FS-O datum	ST-I-PI variable	FS-I-PI variable	External ST-O datum	External FS-O datum
From (data source)	Module bus ST-I datum	---	---	◆	---	◆	---
	Module bus FS-I datum	---	---	+	◆	+	◆
	ST-O-PI variable	◆	+	◆	---	◆	---
	FS-O-PI variable	+	◆	+	◆	+	◆
	External ST-I datum	◆	+	◆	---	◆	---
	External FS-I datum	+	◆	+	◆	+	◆

Legend:

---	Not permitted (prevented by PAS4000)
◆	Permitted
+	Permitted, but the FS datum may only be used for **non-safety-related** tasks.

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8.4 Data exchange between FS resource and ST resource

Please note the following when I/O mapping:

- **I/O mappings between FS and ST**
  Even if ST output data (e.g. ST hardware outputs, ST-O data for external communication) is controlled via the FS resource, this output data may only be used for **non-safety-related** tasks. PAS4000 will warn you of such I/O mappings. This will include, for example, the I/O mapping of:
  – Module bus FS-I datum to external ST-O datum
  – FS-O-PI variable to module bus ST-O datum
  With this procedure, appropriate measures must be put in place to verify safety, e.g. by means of
  – A separate risk analysis and
  – Appropriate commissioning tests, feasibility tests
  The user is responsible for the correct implementation.
- **I/O mapping between PI variable and PI variable in the same task**
  After writing the O-PI variables, the value will not be available to read in to the mapped I-PI variable until the start of the next task cycle.

8.5 Data consistency

With PSS 4000, data consistency is generally understood as keeping together data that is recorded at a certain time and is considered current and related during a defined period.

Data consistency of a data source

In terms of data consistency, data sources (see Validity of process data, page 8-4) are divided into "consistency ranges". A data source's consistency range contains an amount of consistent data. This means that the process data on a data source is consistent if it comes from the same consistency range on the data source.

Data consistency on system-internal data transfer via SafetyNET p

When process data in a consistency range is transmitted system-internally (e. g. PSSu system <-> SafetyNET p <-> PSSu system), it is consistent provided it is transmitted using a single SafetyNET p connection. If the documented SafetyNET p limits are exceeded during system-internal data transfer (see Data transfer limits, page 6-16) , the data from the consistency range is automatically split over several connections. In this case, data consistency is no longer guaranteed.
During the build process, PAS4000 issues a warning if the process data from a consistency range is split over several connections.

Data consistency of a data sink

A data sink's process data (see Validity of process data, page 8-4) is consistent if it comes from the same consistency range on a data source. No statement can be made regarding the relationship between a data sink's process data when it comes from various consistency ranges.

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8.5 Data consistency

8.5.1 Consistency ranges

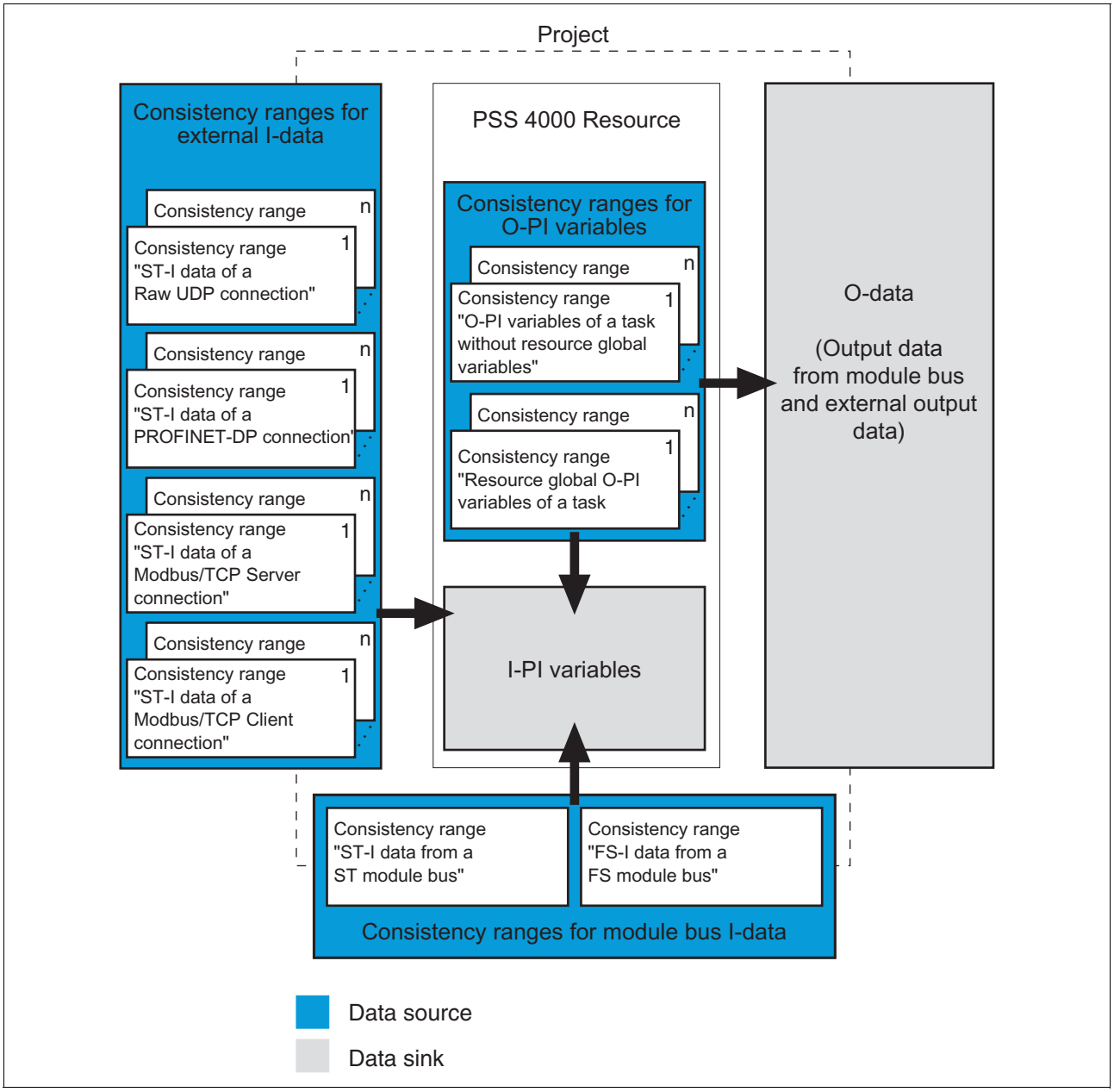

Fig. 8-3: Overview of a project's consistency ranges

8.5 Data consistency

A project may have the following consistency ranges:

- **Module bus I-data**
  - Consistency range "FS-I data from an FS module bus"
  - Consistency range "ST-I data from an ST module bus"
- **External I-data**

  Consistency range "ST-I data of an external communication connection"

  No statement can be made regarding the data consistency of data that is transmitted to a PSS 4000 device with a corresponding system section. It depends on the communication mode (e.g. Modbus/TCP, PROFIBUS-DP, Raw UDP) and the options available with the communication mode.

  As soon as the data is available as external I-data in PSS 4000, it is treated as consistent data.

  There are consistency ranges for the external I-data of any communication mode or connection type. Each consistency range for external I-data behaves identically in terms of the data consistency of its data. In most cases, therefore, only the general consistency range for external I-data is stated (consistency range "ST-I data of an external communication connection"). If necessary, however, the consistency range for each communication mode or each connection type can be stated separately.

  Examples:
  - Consistency range "ST-I data of a Modbus/TCP Client connection"
  - Consistency range "ST-I data of a Modbus/TCP Server connection"
  - Consistency range "ST-I data of a PROFIBUS-DP connection"
  - Consistency range "ST-I data of a Raw UDP connection"
- **O-PI variables**
  - Consistency range "O-PI variables of a task without resource global variables"

    Such a consistency range includes all O-PI variables of blocks that are executed in the same task.

    For this type of consistency range, no statement can be made regarding the relationship to resource global O-PI variables that are also executed in this task.
  - Consistency range "Resource global O-PI variables of a task"

    No statement can be made regarding the relationship of resource global variables to a consistency range "O-PI variables of a task without resource global variables". This is also the case if they are executed in the same task (see "Task 1" in the example below).

    The following applies for data consistency of resource global O-PI variables:
    - Resource global O-PI variables that are accessed exclusively from blocks that are executed in the same task are consistent

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8.5 Data consistency

and form a consistency range (see "Task 1" and consistency ranges [1] and [2] in the example below).

– The intersection of resource global O-PI variables that are accessed from blocks that are executed in different tasks is consistent and forms a consistency range (see "Task 2", "Task 3" and consistency range [3] in the example below).
– No statement can be made regarding the data consistency of variables in a consistency range which are mapped to an I-PI variable as well as a resource global I-PI variable and which are accessed from blocks that are executed in the same task.

8.5 Data consistency

Example:

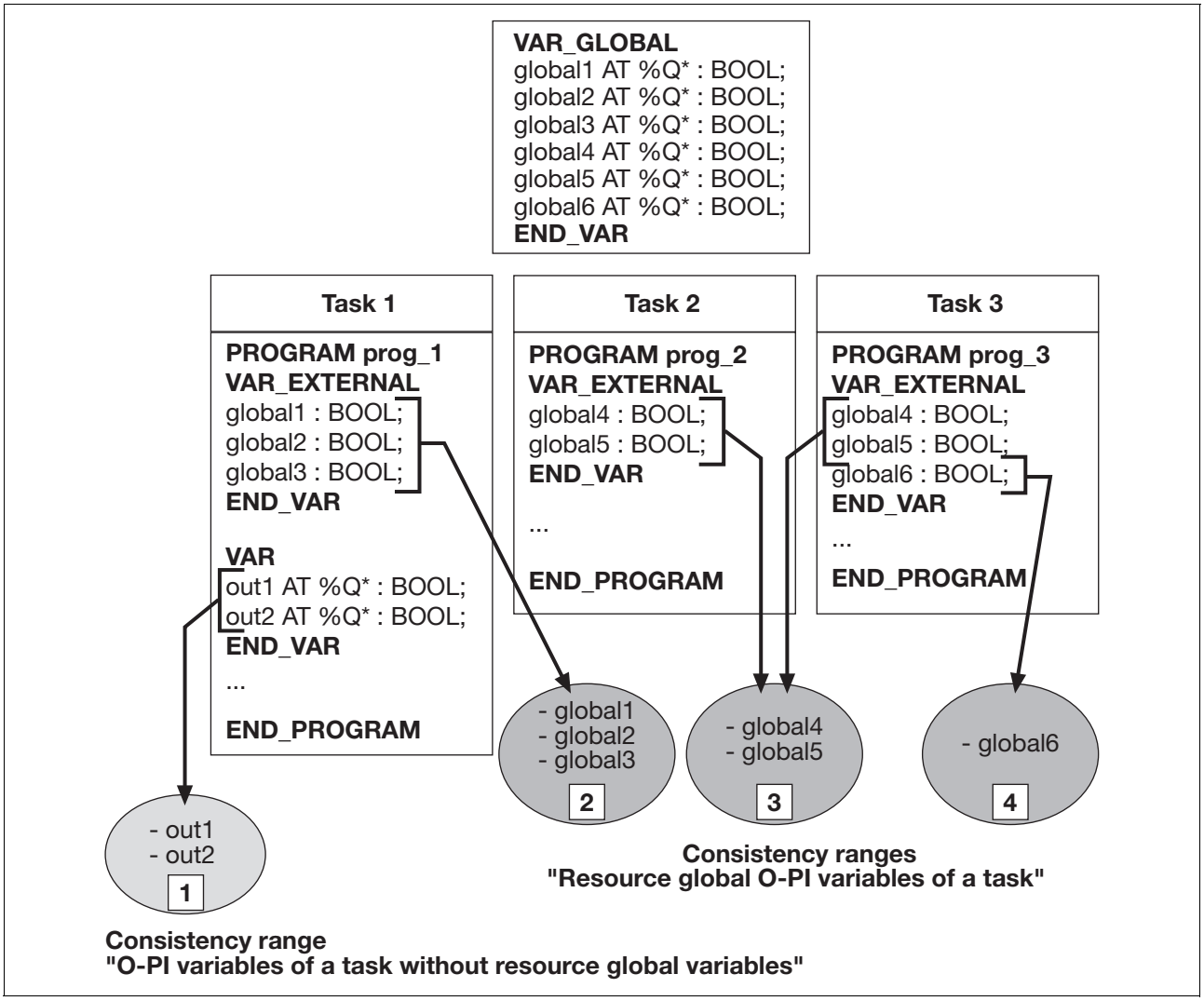

Fig. 8-4: Example for consistency ranges of O-PI variables

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8.5 Data consistency

8.5.2 Influence of scheduling on data consistency

Scheduling regulates the order in which data in a project is processed and also ensures optimum data flow, taking into account the various cycle times, execution times and processing times (see Reaction times, page 9-141) .

In PAS4000, if configurable cycle times (e.g. cycle time with external communication) are calculated automatically by the system, the system will determine the optimum conditions and reaction times for the project. Data consistency in the consistency ranges is guaranteed.

If configurable cycle times are configured by the user, the system will determine the optimum reaction times for the configured conditions. These may deteriorate in comparison with the reaction times that are determined automatically. Data consistency in the consistency ranges is guaranteed.

8.6 Safety status of blocks

In IEC 61131 programming it is possible to program function block-type and function-type POUs, which have a defined safety state. In Multi programming, blocks cannot be programmed with a safety state. However, in Multi programming the POUs programmed in IEC 61131 are used as basic blocks (IEC 61131 basic blocks). These basic blocks have a safety state.

Non-safety-related tasks may be programmed in ST blocks. ST blocks may be executed on either an ST or an FS resource. ST blocks are shown in green in PAS4000.

Safety-related tasks must be programmed in FS blocks. FS blocks may only be executed on an FS resource. FS blocks are shown in yellow in PAS4000.
In IEC 61131 programming, a POU becomes an FS-POU as soon as an FS data type variable is declared or an FS-POU is called/instantiated.

If it is possible to access non-safety-related data (ST data) within an FS block, the block becomes an "FS block with mixed input interface". They are given a special marking in PAS4000:
- Multi programming: half green and half yellow
- IEC 61131 programming: half white and half yellow

This special marking is intended to identify a block as potentially hazardous.

In IEC 61131 programming, an FS-POU will become an FS-POU with mixed input interface in the following circumstances:
- Declaration of an I-PI variable that is **not** an FS data type
- Declaration of a variable of type VAR_INPUT, VAR_IN_OUT or VAR_EXTERNAL, that is **not** an FS data type
- Call/instantiation of a POU in which an I-PI variable or a VAR_EXTERNAL type variable is declared, which is **not** an FS data type

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8.6 Safety status of blocks

When using FS blocks with mixed input interface, please note:

- Data on the ST resource is **not** secure. It may only be an **additional** criterion for a safety-related action (e.g. start/stop) and must **not** prevent safety functions. For example, if for whatever reason a stop signal has not been activated in the ST resource, or a start signal is continuously activated, this must not be able to compromise the safety of the machine or process.
- Appropriate procedures must be put in place to verify safety, e.g. by means of
  - A separate risk analysis and
  - Appropriate commissioning tests, feasibility tests
- We recommend that you test an FS block with mixed interface fully in the first instance, if necessary have it tested and certified by a notified body (e.g. BG, TÜV) and then use PAS4000 to save it as a sealed user block.
- The user is responsible for the correct implementation.

8.7 Device naming via PAS4000

Device naming is performed by the user in PAS4000. The data required to address a device uniquely within the project is defined for each device in the project. This data is called ***naming data***.

To enable the naming data to be transmitted to the devices within the project during device naming, they must be identifiable on the network. This is achieved using fixed data stored in each device as a factory setting. This data is called ***device identification data***.

During device naming, a distinction is made between the following device types:

- PSS 4000-exclusive devices (e.g. PSSu systems)
  These support all device identification data and all naming data.
- PSS 4000-operable devices from Pilz (e.g. operator terminal PMI)
  These support all device identification data and all naming data.
- PSS 4000-operable devices from a third-party manufacturer (e.g. PC)
  These support part of the device identification data and naming data.

INFORMATION
If networks are connected via Routers, device naming can only be performed centrally if the system variable PILZ_SNP_MULTICAST_TTL is configured accordingly (see Network with Routers, page 6-22) .

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8.7 Device naming via PAS4000

8.7.1 Device identification data

PSS 4000-exclusive devices (e.g. PSSu systems)

Device identification data	Meaning	Example
Product type	Kind of device (e.g. head module of a PSSu system)	PSSu H PLC1 FS SN SD
Order number	6-digit number by which the device can be ordered at Pilz (e.g. head module of a PSSu system)	312070
Serial number	6-digit number by which the device can be identified at Pilz (e.g. head module of a PSSu system)	100076

PSS 4000-operable devices from Pilz (e.g. operator terminals PMI)

Device identification data	Meaning	Example
Product type	Kind of device	PMI o438
Order number	6-digit number by which the device can be ordered at Pilz	264260
Serial number	6-digit number by which the device can be identified at Pilz	100057

PSS 4000-operable devices from a third-party manufacturer (e.g. PC)

Device identification data	Meaning
Product type	Kind of device: PSS 4000-PC
Order number	"0" is used as the order number
Serial number	When the PSS 4000 firmware is first started, a random 6-digit number is generated, which is then used internally as a serial number for various identification processes

8.7 Device naming via PAS4000

8.7.2 Naming data

PSS 4000-exclusive devices (e.g. PSSu systems)

Naming data	Default setting	Meaning
Device name	Combination of a prefix (e.g. PSS), 6-digit order number and 6-digit serial number Format: *<Prefix>_<Order number>_<Serial number>* Example: PSS_312070_100076	- Uniquely identifies a device within the project - Used to identify the device on the network when the project is downloaded - Forms part of an address (e.g. I/O mapping)
IP address	IP address in accordance with the Ethernet convention (see Factory default settings for the Ethernet parameters, page 14-1)	Used in conjunction with the serial number to identify the device on the network during device naming
Subnet mask	Settings in accordance with the Ethernet convention (see Factory default settings for the Ethernet parameters, page 14-1)	In accordance with the Ethernet convention
Gateway address	Settings in accordance with the Ethernet convention (see Factory default settings for the Ethernet parameters, page 14-1)	- In accordance with the Ethernet convention - Available as an option
Address of preferred DNS Server		
Address of alternative DNS Server		

PSS 4000-operable devices from Pilz (e.g. operator terminals PMI)

Naming data	Default setting	Meaning
Device name	Combination of a prefix (e.g. PMI) and at least the device generation Examples: PMI4visu, PMI4open	- Uniquely identifies a device within the project - Used to identify the device on the network when the project is downloaded - If the user has assigned a device name at operating system level, this device name will be displayed (e.g. myPMI_1)
IP address	IP address in accordance with the Ethernet convention (see Auto-IP mechanism, page 5-1)	Used in conjunction with the serial number to identify the device on the network during device naming
Subnet mask	Settings in accordance with the Ethernet convention	In accordance with the Ethernet convention
Gateway address	Settings in accordance with the Ethernet convention	- In accordance with the Ethernet convention - Available as an option
Address of preferred DNS Server		
Address of alternative DNS Server		

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8.7 Device naming via PAS4000

PSS 4000-operable devices from a third-party manufacturer (e.g. PC)

Naming data	Meaning, content and default setting
Device name	- Uniquely identifies a device within the project - Used to identify the device on the network when the project is downloaded On a PC, the default device name corresponds to the computer name defined by the user when setting up the Windows operating system.
IP address	When the device is named, used in conjunction with the generated serial number to identify the device on the network IP address in accordance with the Ethernet convention
Subnet mask	Subnet mask in accordance with the Ethernet convention
Gateway address	Available as an option, depending on the device
Address of preferred DNS Server	Available as an option, depending on the device
Address of alternative DNS Server	

8.7 Device naming via PAS4000

8.7.3 Device naming for PSS 4000-exclusive devices: PSSu systems

When device naming for PSS 4000-exclusive devices (e.g. PSSu systems), a distinction can be made between the following cases:

- **PSS 4000-exclusive device in its delivery condition or after an original reset**
  The factory-set defaults are stored on the device that is in its delivery condition or has undergone an original reset (see Naming data, page 8-28) . The Auto-IP mechanism is activated (see Auto-IP mechanism, page 5-1) . No device project is present.
- **Changing the device name**
  The device name of a PSS 4000-exclusive device which has already been through the naming process can be changed retrospectively. In this case, user-specific naming data is already present on the device. A device project may be present. However, it will be deleted during device naming.
  Whether or not the Ethernet parameters are also changed is irrelevant for the device naming procedure.
- **Changing the Ethernet parameters**
  The Ethernet parameters of a PSS 4000-exclusive device which has already been through the naming process can be changed retrospectively. In this case, user-specific naming data is already present on the device. A device project may be present. This will be retained during device naming.
  Whether just one Ethernet parameter is changed or several is irrelevant for the device naming procedure. It is usually only the IP address that is changed. However, if the device name is also changed, the procedure will be as described under "Changing the device name".

INFORMATION

The description below assumes that all preparatory measures have already been carried out. These include:

- A removable data medium is connected to the PSS 4000-exclusive device.
- The relevant naming data has been edited in PAS4000.

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8.7 Device naming via PAS4000

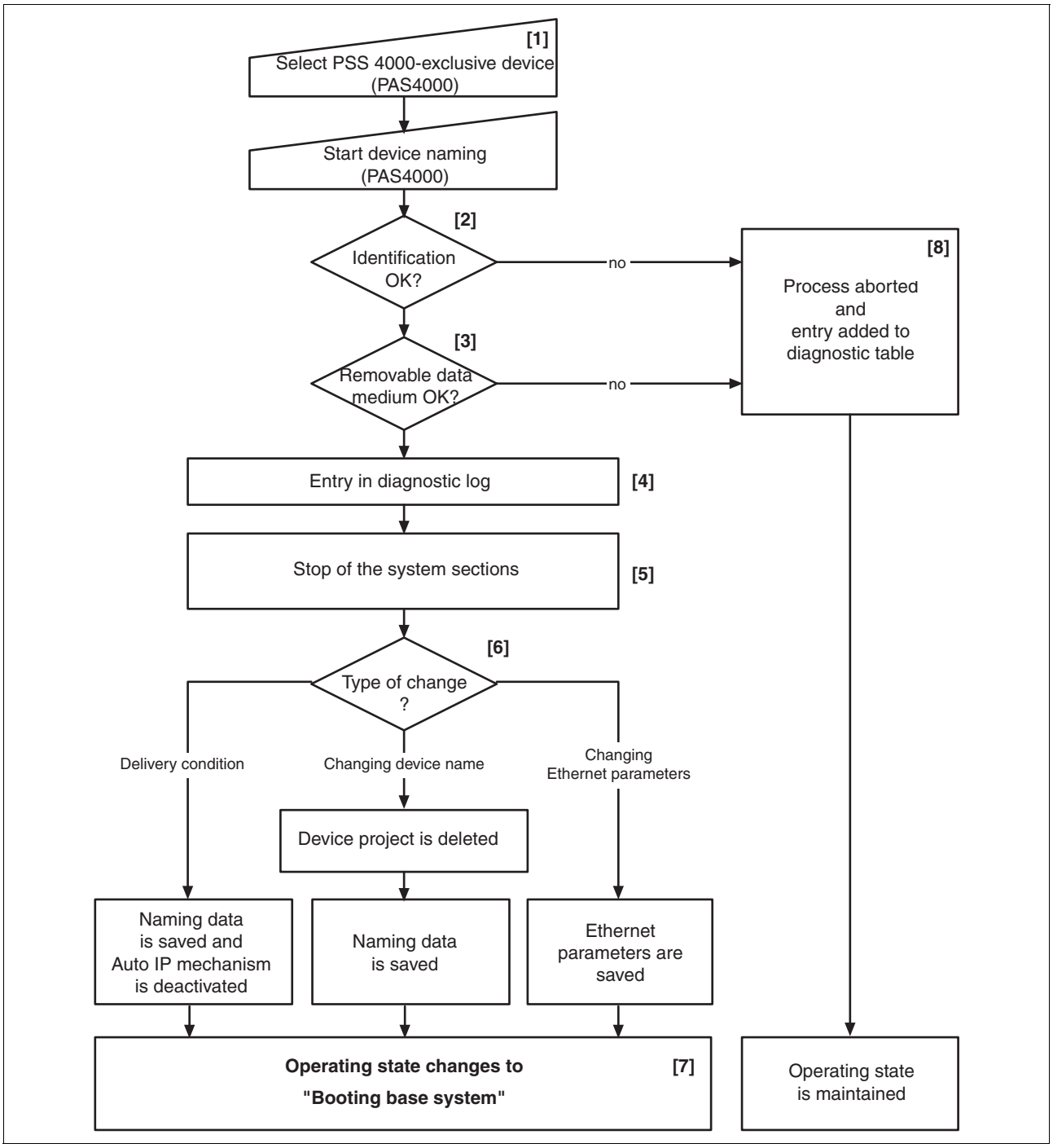

Fig. 8-5: Flowchart for device naming on PSS 4000-exclusive devices

8.7 Device naming via PAS4000

Device naming procedure on a PSS 4000-exclusive device

The following description refers to the flowchart, Fig. "Flowchart for device naming on PSS 4000-exclusive devices".

[1]
In PAS4000, the PSS 4000-exclusive device on which device naming is to be performed is selected. A test can be carried out with PAS4000 to identify the selected device in the field. The test is called "Device Identification". During device identification, the LED on the removable data medium will be activated on the selected device. The status LED (e.g. "SD CARD" LED on a PSSu system) flashes orange.

[2]
Once device naming has started, the device checks that the local serial number and IP address match the serial number and IP address stated as the destination for transferring naming data in PAS4000.

[3]
The device checks whether the removable data medium is accessible, i.e. that the removable data medium is inserted, is not write protected and is not defective.

[4]
An entry in the diagnostic log shows that device naming has been carried out.

[5]
The device's system sections are stopped. On a PSSu system this corresponds to the operating status: "Device in STOP condition without error".

[6]
The rest of the procedure depends on which naming data has been changed:

- **PSS 4000-exclusive devices in their delivery condition or after an original reset**
  The factory-set default naming data in the device memory and on the removable data medium are replaced by the configured naming data. The Auto-IP mechanism is deactivated.
- **Changing the device name**
  The existing naming data is deleted from the device memory and removable data medium. If the removable data medium already contains a device project, the device project will be deleted from the removable data medium. On devices with an FS resource, the check

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8.7 Device naming via PAS4000

sum of the FS device project and the project name will also be deleted from the device memory. The new naming data is then stored on the removable data medium.

- **Changing the Ethernet parameters**
  The existing naming data and any existing device project are retained. The IP address and all other Ethernet parameters are deleted from the device memory and removable data medium. The new IP address and all other Ethernet parameters are then stored on the removable data medium.

[7]
The PSS 4000-exclusive device automatically switches to the operating status "Booting base system" (see Operating states and change in operating status of a PSSu system, page 9-5) . After this boot process, the device switches to the operating status "Booting system sections".
The rest of the procedure depends on which naming data has been changed:

- **PSS 4000-exclusive devices in their delivery condition and Changing the device name**
  During the operating status "Booting system sections", one of the effects is that the new naming data is loaded from the removable data medium to the device memory. The device starts up without a device project. The status LED for the removable data medium (e.g. "SD CARD" LED on a PSSu system) flashes green.
  For the device to obtain a device project, a project will need to be downloaded (see Project download, page 8-46) .
- **Changing the Ethernet parameters**
  During the operating status "Booting system sections", one of the effects is that the new Ethernet parameters are loaded from the removable data medium to the device memory. As soon as a device project is available, the device is started up with the device project.
  If other devices in the network exchange data with the PSS 4000-exclusive device, a new project will need to be downloaded once the IP address and/or other Ethernet parameters have been changed. If not, the other devices will no longer be able to access the PSS 4000-exclusive device.

[8]
If any of the checks is negative, the process is aborted. An entry will be added to the diagnostic list and the operating status of the PSS 4000-exclusive device remains unchanged.

8.7 Device naming via PAS4000

8.7.3.1 Error behaviour during device naming

If any error should occur during device naming, the following error behaviour applies generally:

- Device naming process is aborted
- All system sections of the PSS 4000-exclusive device switch to a safe condition
- All FS outputs on the PSS 4000-exclusive device switch to a safe condition.
- An entry is added to the diagnostic list.

A cold start/reboot command must be executed for the PSS 4000-exclusive device. In this case, the PSS 4000-exclusive device will start up with the "old" naming data and, if available, the "old" device project.

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8.7 Device naming via PAS4000

8.7.4 Device naming for PSS 4000-operable devices from Pilz

When device naming for PSS 4000-operable devices from Pilz (e.g. operator terminals PMI), a distinction can be made between the following cases:

- **PSS 4000-operable device from Pilz during initial device naming**
  After the PSS 4000 firmware has been installed, the factory set defaults are stored (see Naming data, page 8-28) . No device project is present.
- **Changing the device name**
  The device name of a PSS 4000-operable device from Pilz which has already been through the device naming process can be changed retrospectively. In this case, user-specific naming data is already present on the device. A device project may be present. However, it will be deleted during device naming. Whether or not the Ethernet parameters are also changed is irrelevant for the device naming procedure.
- **Changing the Ethernet parameters**
  The Ethernet parameters of a PSS 4000-operable device from Pilz which has already been through the naming process can be changed retrospectively. In this case, user-specific naming data is already present on the device. A device project may be present. This will be retained during device naming.
  Whether just one Ethernet parameter is changed or several is irrelevant for the device naming procedure. It is usually only the IP address that is changed. However, if the device name is also changed, the procedure will be as described under "Changing the device name".

8.7 Device naming via PAS4000

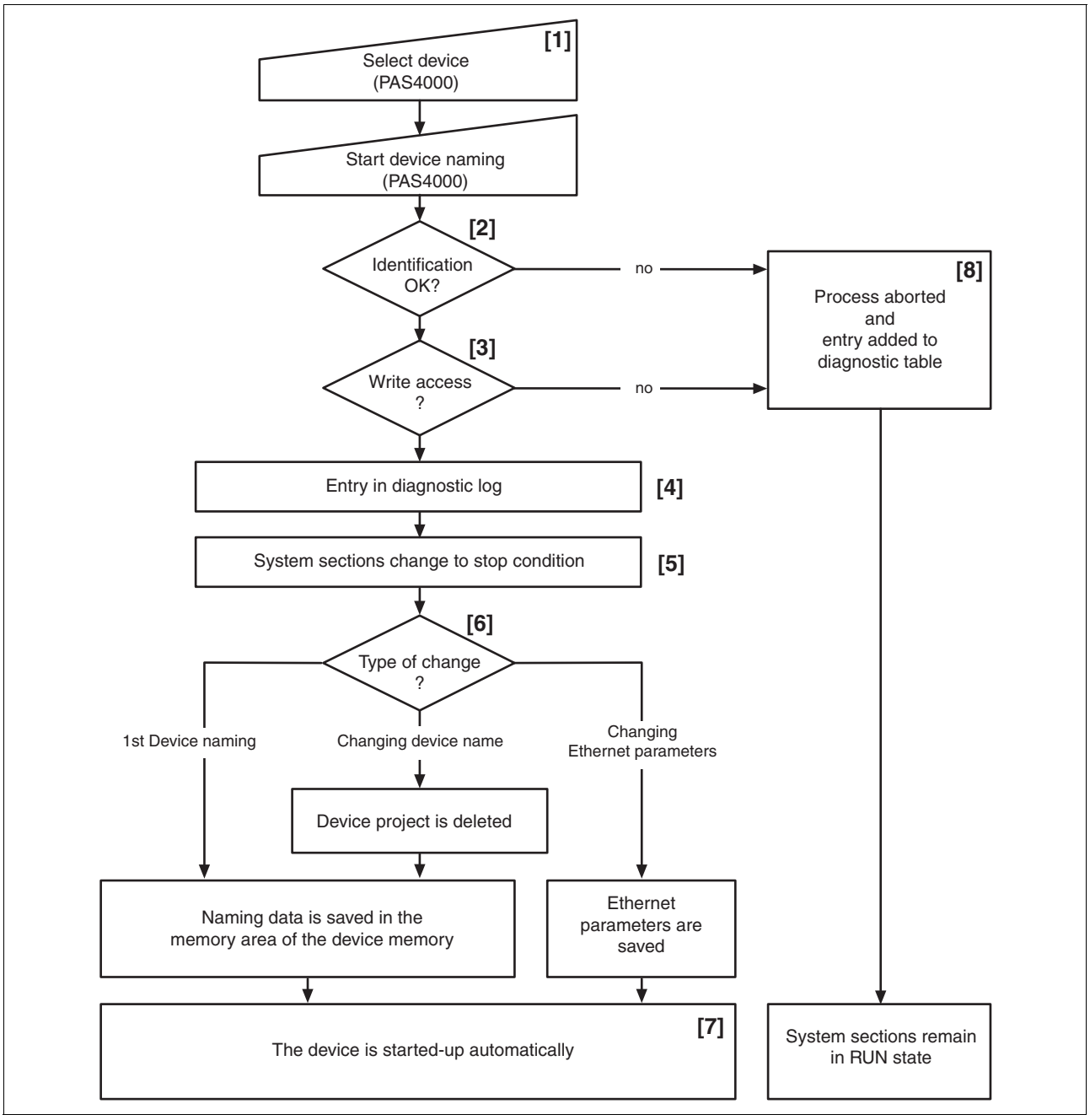

Fig. 8-6: Flowchart for device naming on PSS 4000-operable devices from Pilz

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8.7 Device naming via PAS4000

Device naming procedure on PSS 4000-operable devices from Pilz

The following description refers to the flowchart, Fig. "Flowchart for device naming on PSS 4000-operable devices from Pilz".

[1]
In PAS4000, the PSS 4000-operable device from Pilz on which device naming is to be performed is selected. A test can be carried out with PAS4000 to identify the selected device. The test is called "Device Identification". During device identification, a pop-up window with the following content is opened on the selected device:
PSS 4000 Device name: *<Device name>*.
The pop up window does not disappear until device identification is explicitly ended.

[2]
Once device naming has started, the device checks that the local serial number and IP address match the serial number and IP address stated as the destination for transferring naming data in PAS4000.

[3]
A test is carried out to check whether "write" permission is available for the relevant memory area in the device's security settings.

[4]
An entry in the diagnostic log shows that device naming has been carried out.

[5]
The device stops the system sections of the PSS 4000 firmware (e.g. OPC Server, Diagnostic Server).

[6]
The rest of the procedure depends on which naming data has been changed:

- **PSS 4000-operable device from Pilz during initial device naming**
  The factory-set naming data is deleted from the relevant memory area of the device. The new naming data is then stored in the memory area. A project must then be downloaded, so that the device obtains a device project.
- **Changing the device name**
  The existing naming data and any existing device project are deleted from the relevant memory area of the device. The new naming data is then stored in the memory area. A project must then be downloaded, so that the device obtains a device project.

8.7 Device naming via PAS4000

- **Changing the Ethernet parameters**
  The existing naming data and any existing device project are retained. The IP address and all other Ethernet parameters are deleted from the relevant memory area of the device. The new IP address and all other Ethernet parameters are then stored in the memory area.

[7]
The device is automatically restarted so that the naming data can be adopted.

[8]
If any of the checks is negative, the process is aborted. An entry will be added to the diagnostic list and the system sections of PSS 4000 (e.g. OPC Server, Diagnostic Server) remain in RUN condition.

NOTICE
If the IP address of a PSS 4000-operable device is changed, other devices that do not belong to the PSS 4000 project will no longer be able to access the PSS 4000-operable device via any existing Ethernet communication relationships. The IP address for these Ethernet communication relationships must be adapted in the relevant devices.

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8.7 Device naming via PAS4000

8.7.5 Device naming for PSS 4000-operable devices from a third-party manufacturer

When device naming for PSS 4000-operable devices from a third-party manufacturer, please note the following:

- Device name
  A device name edited during device naming in PAS4000 will appear only in PAS4000, in the diagnostic list and in the diagnostic log. A device name assigned at operating system level (computer name), will not be overwritten during device naming.
- IP address
  The IP address at the device's operating system level cannot be changed during device naming. This must be done at operating system level, for PCs with Microsoft Windows operating system for example.

When device naming for PSS 4000-operable devices from a third-party manufacturer, a distinction can be made between the following cases:

- **PSS 4000-operable device from a third-party manufacturer during initial device naming**
  After the PSS 4000 firmware has been installed, the factory set naming data is stored (see Naming data, page 8-28) . No device project is present.
- **Changing the device name**
  When the device name is changed retrospectively, user-specific naming data will already be present on the PSS 4000-operable device. A device project may be present. However, it will be deleted during device naming.

8.7 Device naming via PAS4000

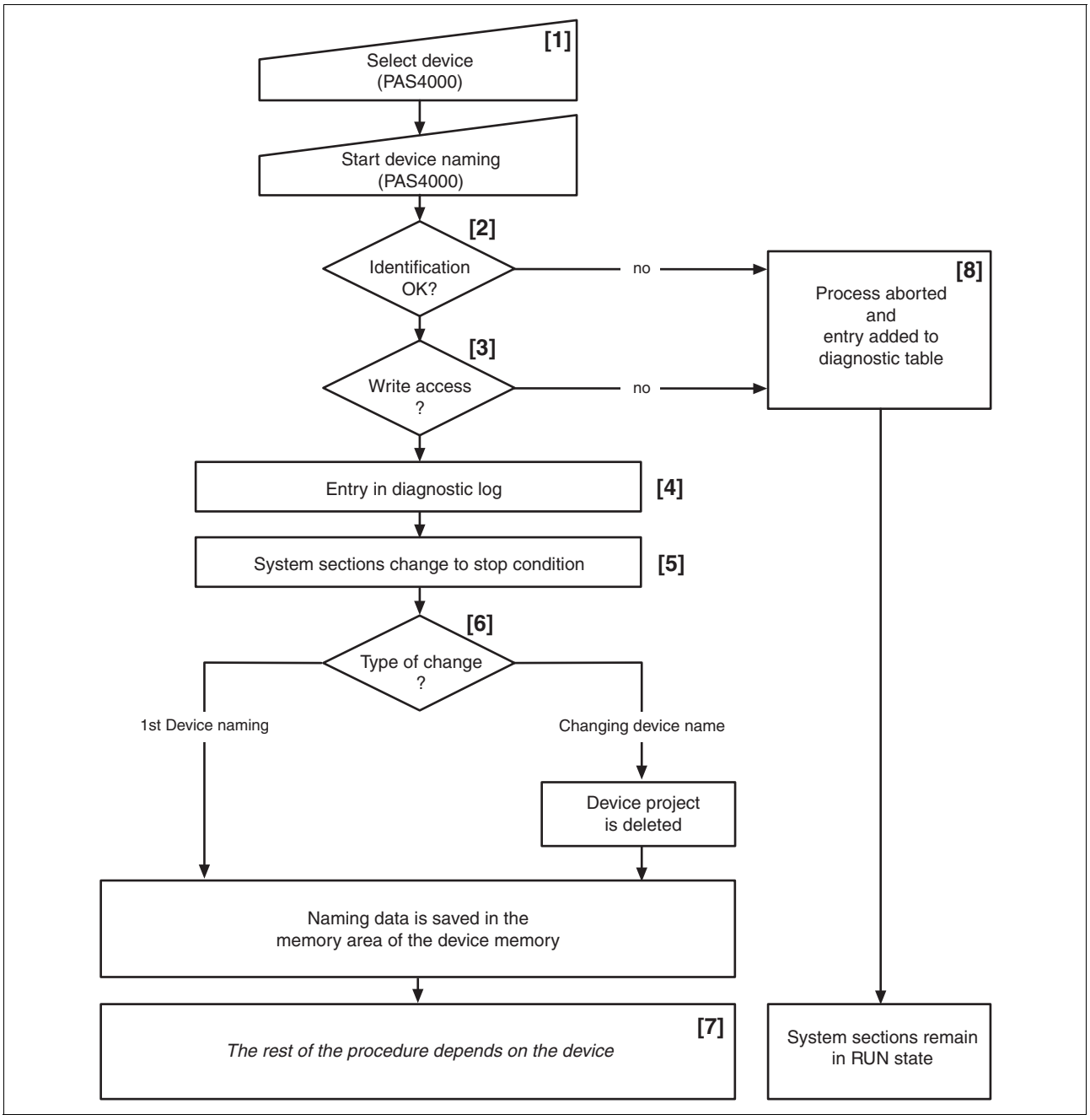

Fig. 8-7: Flowchart for device naming on PSS 4000-operable devices from a third-party manufacturer

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8.7 Device naming via PAS4000

Device naming procedure on PSS 4000-operable devices from a third-party manufacturer

The following description refers to the flowchart, Fig. "Flowchart for device naming on PSS 4000-operable devices from a third-party manufacturer".

[1]
In PAS4000, the PSS 4000-operable device from a third-party manufacturer on which device naming is to be performed is selected. A test can be carried out with PAS4000 to identify the selected device. The test is called "Device Identification". During device identification, a pop-up window with the following content is opened on the selected device: PSS 4000 Device name: *<Device name>*.
The pop up window does not disappear until device identification is explicitly ended.

[2]
Once device naming has started, the device checks that the local serial number and IP address match the serial number and IP address stated as the destination for transferring naming data in PAS4000.

[3]
A test is carried out to check whether "write" permission is available for the relevant memory area in the device's security settings.

[4]
An entry in the diagnostic log shows that device naming has been carried out.

[5]
The device stops the system sections of the PSS 4000 firmware (e.g. OPC Server, Diagnostic Server).

[6]
The rest of the procedure depends on which naming data has been changed:

- **PSS 4000-operable device from a third-party manufacturer during initial device naming**
  The factory-set naming data is deleted from the relevant memory area of the device. The new naming data is then stored in the memory area. A project must then be downloaded, so that the device obtains a device project.

8.7 Device naming via PAS4000

- **Changing the device name**
  The existing naming data and any existing device project are deleted from the relevant memory area of the device. The new naming data is then stored in the memory area. A project must then be downloaded, so that the device obtains a device project.

[7]
The rest of the procedure depends on the device. If the device is a PC, the PSS 4000 firmware on the PC must be manually restarted after device naming so that the naming data can be adopted.

[8]
If any of the checks is negative, the process is aborted. An entry will be added to the diagnostic list and the system sections of PSS 4000 firmware (e.g. OPC Server, Diagnostic Server) remain in RUN condition.

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8.7 Device naming via PAS4000

NOTICE

Please note the following special features for the IP address of PSS 4000-operable devices from a third-party manufacturer:

- The IP address must be configured during the hardware configuration in PAS4000, to enable the other devices in the PSS 4000 project to communicate with this device.
- The IP addresses in the hardware configuration, device naming and at operating system level must match. During device naming with PSS 4000-operable devices from a third-party manufacturer, the IP address at operating system level is **not** automatically adapted to the setting for device naming.
- The IP address at operating system level must be adapted using the setting options provided by the operating system (e.g. Microsoft Windows XP: Start -> Control Panel -> Network Connections).
- If the IP address of a PSS 4000-operable device is changed, other devices that do not belong to the PSS 4000 project will no longer be able to access the PSS 4000-operable device via any existing Ethernet communication relationships. The IP address for these Ethernet communication relationships must be adapted in the relevant devices.

8.8 Device naming when exchanging devices of PSSu systems

When a PSSu system is exchanged it is not strictly necessary to undergo a new device naming procedure via PAS4000. The device naming data and device project on the existing PSSu system can be transferred to the exchange device by re-using the existing removable data medium containing the naming data and device project for that device.

INFORMATION
If the PSSu system is used for safety-related applications, when exchanging devices it is absolutely essential that you comply with the information regarding changes as stated in the "PSS 4000 Safety Manual".

Prerequisites
The exchange PSSu system must still be in its delivery condition or the PSSu system must undergo an original reset prior to the exchange.

Procedure

1. Switch the existing PSSu system to a STOP condition and remove the supply voltage connectors.
2. Uninstall the existing PSSu system.
3. Remove the data medium from the head module of the existing PSSu system and plug it into the exchange device.
4. Install the exchange device.
5. Plug the supply voltage connectors into the exchange unit.
6. Follow the procedure below to transfer the device naming data and device project:
   - Press the reset button on the exchange device's head module and keep it held down for longer than 5 s
   - Perform the deliberate operator action for device naming:
     Release the reset button - press the reset button - release the reset button
     The deliberate operator action must be performed within 10 s, otherwise the transfer is aborted.

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8.8 Device naming when exchanging devices of PSSu systems

Once the naming data and device project have been transferred, the exchange PSSu system is restarted; the behaviour is the same as for a cold start/reboot command.

8.9 Project download

During the project download the project is divided into device projects and downloaded to the PSS 4000-exclusive devices (e.g. PSSu systems) and, where available, to the project's PSS 4000-operable devices.

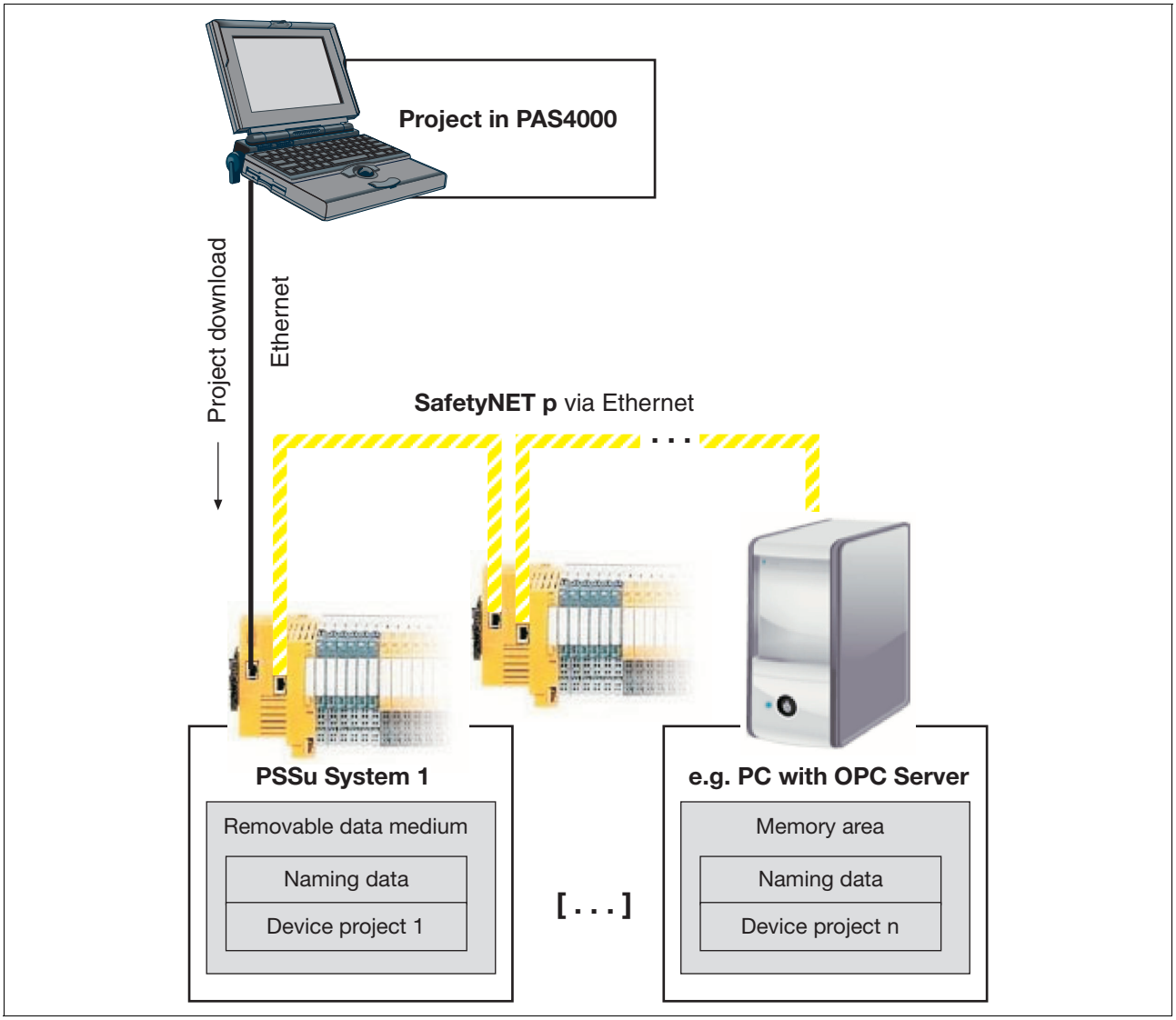

Fig. 8-8: Principle of project download (example)

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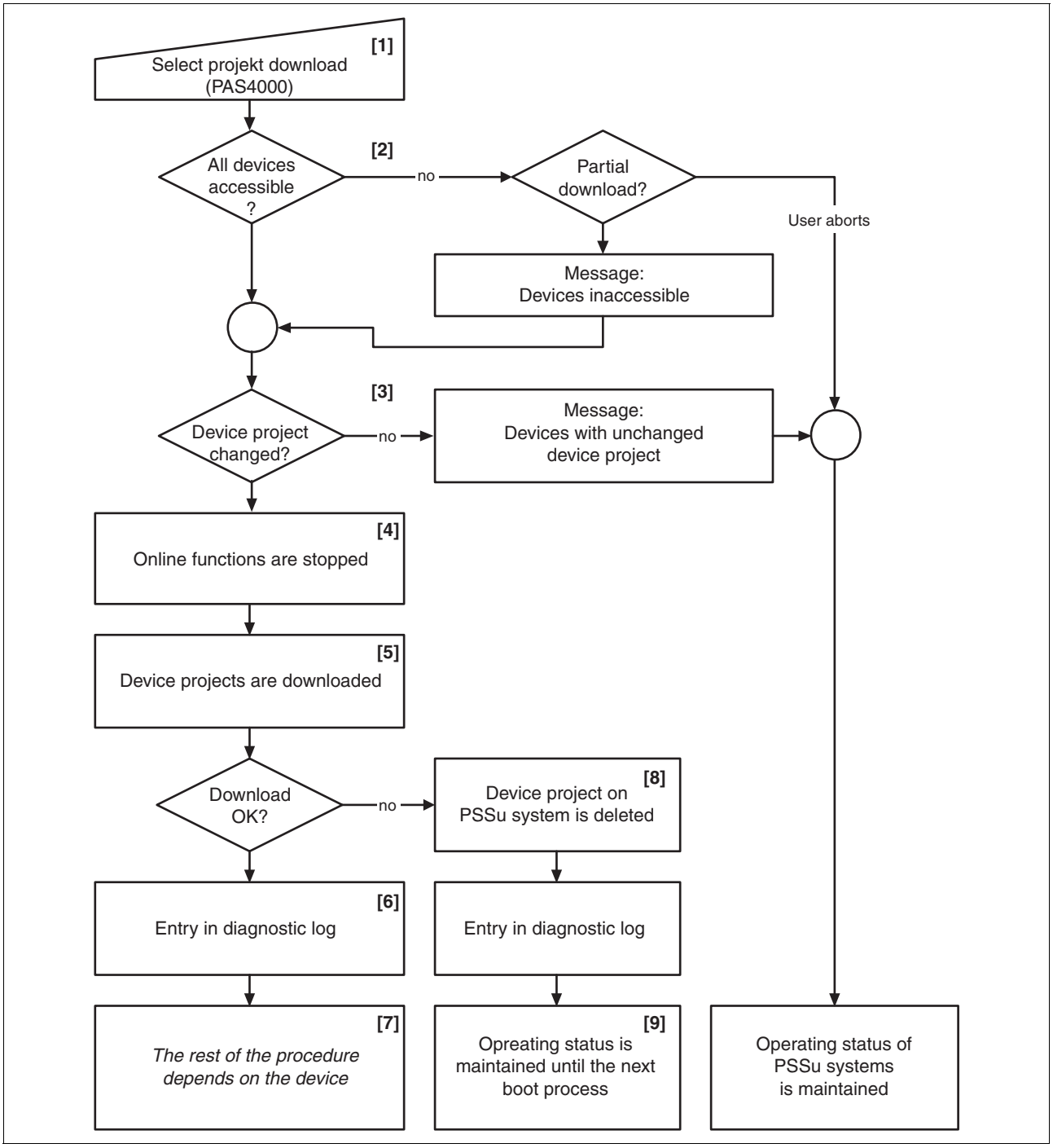
8.9 Project download

Prerequisites

- There must be a physical connection (Ethernet cable) between the PAS4000-PC and the network containing the project's PSS 4000 devices.
- The project must be active in PAS4000.
- Device naming must have been performed.
- The project must have been built.
- On the project's PSS 4000 devices with a removable data medium, the removable data medium must be inserted.
- There must be write access to the relevant memory areas.
  For example:
  – Write protection on the removable data media must have been removed
  – "Write" permission must be set in the security settings for the relevant memory area of a PC.

8.9 Project download

Procedure for project download



[1]
"Project download" is selected in PAS4000.

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8.9 Project download

[2]
PAS4000 checks that all the project's devices are accessible (e.g. devices are switched on, network connection cables to the devices are plugged in). If some of the project's devices are inaccessible, the following options are available:

- User can abort the project download
  The current operating status of all devices is maintained.
- Project download is continued
  All accessible devices are selected for the project download. The devices excluded from the download will be displayed in PAS4000.

[3]
PAS4000 checks each device to see if there is any difference between the existing device project and the new device project.
If the device project is unchanged, the device will be excluded from the project download. Devices on which the device project is unchanged are displayed in PAS4000. The current operating status of these devices is maintained.

[4]
The online functions (e.g. force variables, watch variables) are stopped. The device remains in its current operating status.

[5]
The device projects are downloaded for the relevant devices.

- PSS 4000-exclusive devices (e.g. PSSu systems)
  If the removable data medium on a PSS 4000-exclusive device already contains a device project, the device project will be deleted from the removable data medium and the check sum of the FS device project and project name will be deleted from the device memory. The new device project will then be stored on the removable data medium.
- PSS 4000-operable devices (e.g. operator terminal PMI, PC)
  If available, on a PSS 4000-operable device the device project is deleted from the relevant memory area first and then the new device project is stored in the memory area.

[6]
Once a project has been downloaded successfully, an entry is made in the diagnostic log.

8.9 Project download

[7]
Once a device project has been successfully downloaded, the rest of the procedure depends on the device:

- PSS 4000-exclusive devices (e.g. PSSu systems)
  The device is restarted automatically.
  Impact of start-up:
  – The impact of start-up is that of a warm reset.
  – PSS 4000-exclusive devices that have been stopped manually prior to the project download via one of the stop commands will not be started automatically. These devices will need to be restarted manually.
  – If the user program from the old device project contained non-volatile variables, the device will start up with the following non-volatile variable values:

	Variables with the attribute RETAIN PERSISTENT
The unchanged variable is available in the user program	Saved values
Variable in the user program is new	Set to initial values
Variable is no longer available in the user program	Delete from the variable memory

Note:
When the project is downloaded to the devices, the content of a variable with the attribute RETAIN PERSISTENT is retained if the instance path of the variable and the data type are unchanged, compared with the previous download. It's important to note that the instance path is not only changed by a different call structure in the user program, but also when a program is assigned to another resource.

- PSS 4000-operable devices from Pilz (e.g. operator terminals PMI)
  The device is restarted automatically.
- PSS 4000-operable devices from a third-party manufacturer (e.g. PC)
  The PSS 4000 firmware on the device is restarted automatically.

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8.9 Project download

[8]
Various errors may arise as the device project is downloaded to a PSS 4000 device.
Examples:
- User aborts
- Timeout
- Error occurs while saving the device project

Impact
On PSS 4000-exclusive devices, the device project on the PSS 4000 device is deleted from the removable data medium and the project name and check sum of the FS device project are deleted from the device memory. On PSS 4000-operable devices, the device project is deleted from the relevant memory area. An entry is added to the diagnostic log.

Remedy
Download project again

[9]
The device's operating status is maintained until the next boot process. The next time the system is booted (e.g. after a cold start/reboot command), the device will start up without a device project.

8.10 Mechanisms for protecting access to blocks

PAS4000 contains various mechanisms for protecting access to blocks. A block with access protection is identified by an icon in the project tree. The following access protection mechanisms are available:

- Write protection for blocks
  The block may be read, but not modified. A check sum is created for the block. In the project tree, the block is assigned the icon for write-protected blocks.
- Read/write protection for blocks
  The block can be neither read nor modified. A check sum is created for the block. In the project tree, the block is assigned the icon for read/write-protected blocks.

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8.11 Sealed blocks

Sealed blocks are a programming aid. Sealed blocks process tasks that are required frequently (e.g. E-STOP) and can be created by the user or purchased from Pilz.

- Sealed user blocks

  A block that a user has created and write-protected may be sealed. This process may be run on blocks that have been tested and certified by a notified body such as BG or TÜV for example. Sealing the block makes the block read/write protected; a check sum is created and it is assigned the icon for sealed user blocks. Sealed user blocks are processed by the FS resource. The following details may be stored for sealed user blocks, for example:
  - Name of the person who tested the sealed block
  - Company name
  - Name of the notified body
  - Certification number
- Sealed Pilz blocks

  Pilz provides various blocks which have been tested and certified by a notified body (e.g. BG, TÜV). These blocks have a check sum and are assigned the icon for sealed Pilz blocks. The blocks cannot be modified and are safe from manipulation. The user program they contain will not require testing, even when used on machinery that is subject to mandatory inspection.

It is preferable to use blocks that have been certified by a notified body. You should check that the assumed operating conditions for these blocks match the conditions required by the user program.

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9.1 Communication between PAS4000 and PSS 4000 devices

In order to perform online actions, the computer on which PAS4000 is installed (PAS4000-PC) must be connected to the network containing the project's PSS 4000 devices (PSS 4000-exclusive devices such as PSSu systems and/or PSS 4000-operable devices).

Further information is available in PAS4000's online help.

9.1 Communication between PAS4000 and PSS 4000 devices

9.1.1 Establish a point-to-point connection

With a point-to-point connection, PAS4000 can access an individual PSS 4000-exclusive/operable device as well as all PSS 4000-exclusive/operable devices on the network.

Principle

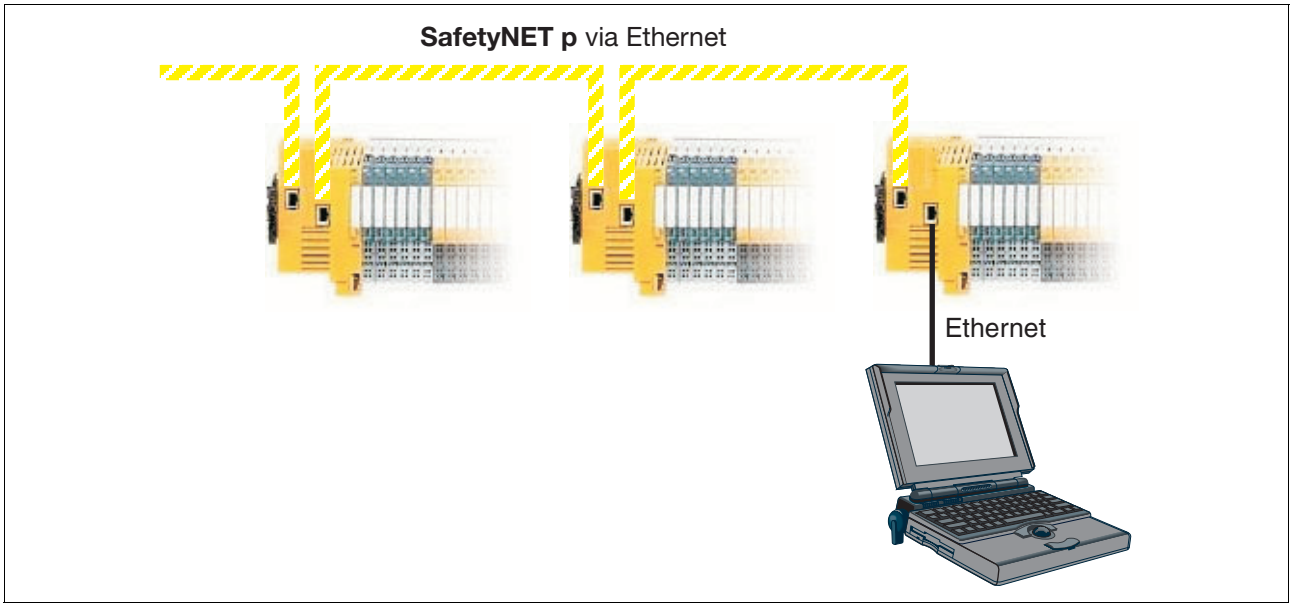

Fig. 9-1: Principle of a point-to-point connection with PAS4000

Please refer to the information on networks without Routers (see Network without Routers, page 6-20)

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9.1 Communication between PAS4000 and PSS 4000 devices

9.1.2 Establish a remote connection

With a remote connection, PAS4000 can access an individual PSS 4000-exclusive/operable device as well as all PSS 4000-exclusive/operable devices on the network.

NOTICE
Data security risk
Please note the special features regarding data security when communicating via remote connections (e.g. for diagnostics) (see "PSS 4000 Safety Manual").

Principle

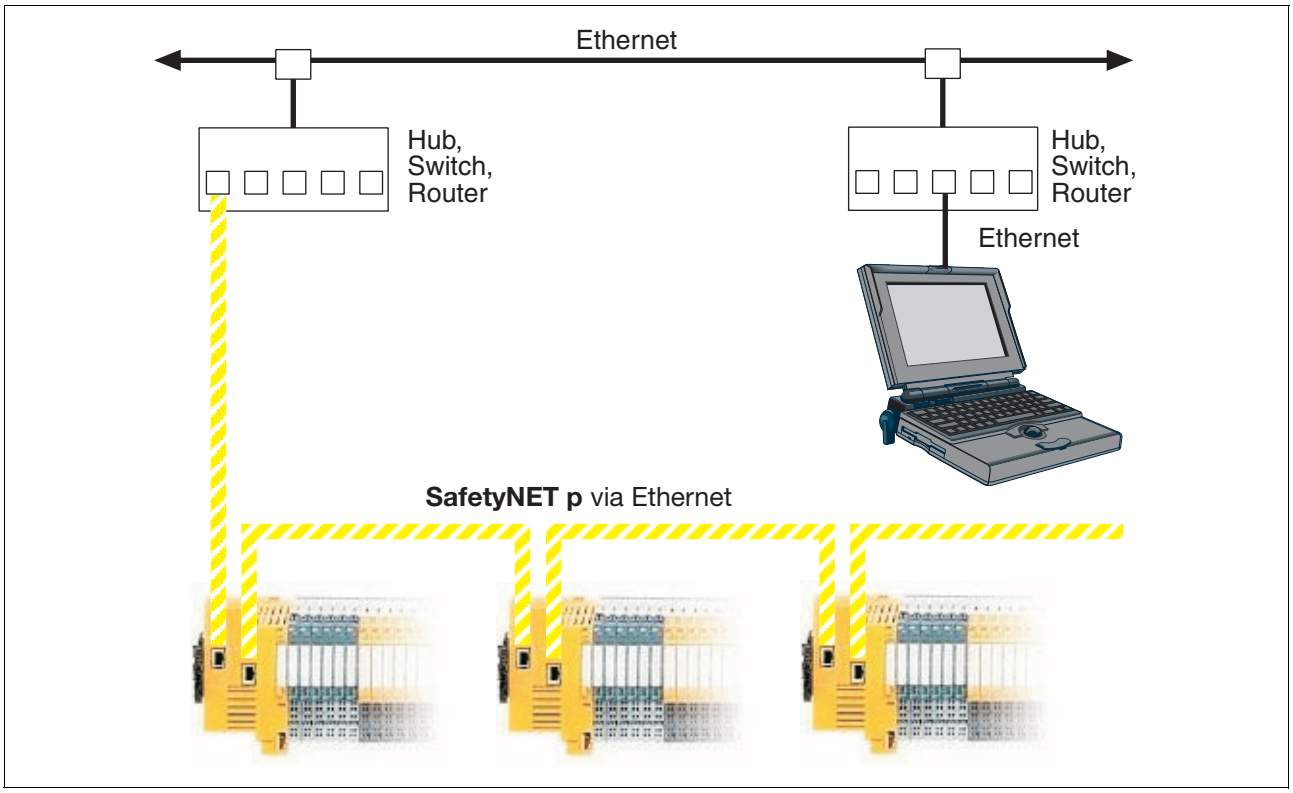

Fig. 9-2: Principle of a remote connection with PAS4000

Please note the restrictions when using Routers (see Network with Routers, page 6-22) .

9.2 Operating states and change in operating status of a PSSu system

There are some operating states and changes in operating status that affect all system sections on a PSSu system and others whose impact is restricted to one plant section. A PSSu system may contain all or just a subset of the following system sections:

- Resources
  - FS resource system section
  - ST resource system section
- Module bus
  - FS module bus system section
  - ST module bus system section
- SafetyNET p RTFN
  - FS SafetyNET p RTFN system section
  - ST SafetyNET p RTFN system section
- External communication
  - IP connections system section (Modbus/TCP, Raw UDP)
  - PROFIBUS-DP Slave system section

The description below deals exclusively with the operating states that affect all of the system sections on a PSSu system.

The diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) provides an overview of the operating states (grey):

- The figures in square parentheses indicate the various changes in operating status.
- The sections with Roman numerals I and II are connection points, which are referenced from other diagrams.
- The sections with Roman numerals III, IV, V a/b, VI a/b and VII refer to diagrams showing operating states and changes in the operating status of system sections.

The following description assumes that the PSSu system contains a valid device project.

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9.2 Operating states and change in operating status of a PSSu system

9.2.1 Flow chart

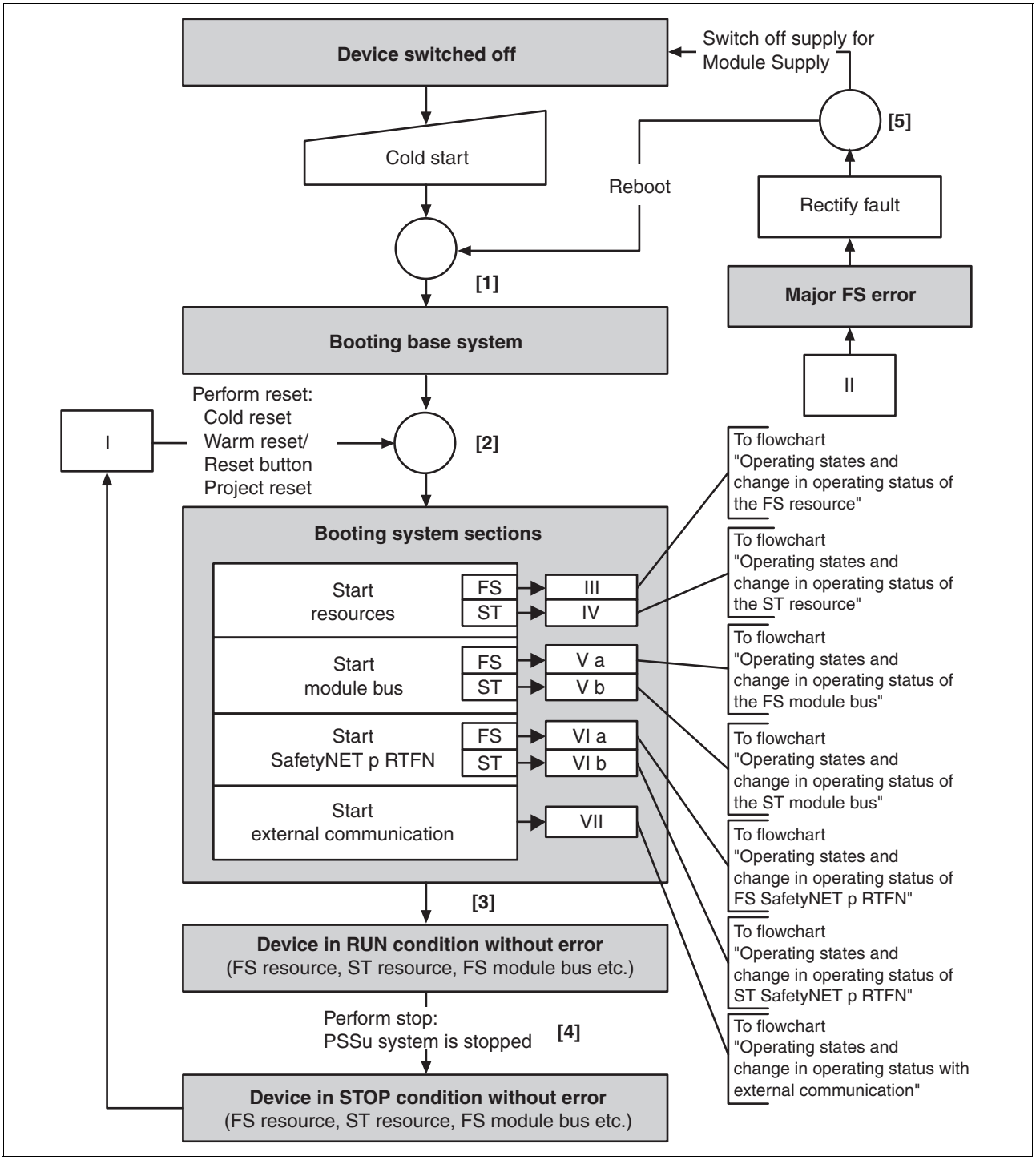

Fig. 9-3: Operating states and change in operating status of a PSSu system

9.2 Operating states and change in operating status of a PSSu system

9.2.2 Operating states on the PSSu system

A PSSu system may assume the following operating states (see Flow-chart, page 9-5) :

- Operating status "Device switched off"
- Operating status "Booting base system"
- Operating status "Booting system sections"
- Operating status: "Device in RUN condition without error"
- Operating status: "Device in STOP condition without error"
- Operating status "Major FS error"

INFORMATION

The description of each operating status includes a list of the options for triggering a change in operating state. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

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9.2 Operating states and change in operating status of a PSSu system

9.2.2.1 Device switched off

"Device switched off" is the PSSu system in a power-free state. Switching on the supply voltage for the module supply (cold start) switches the PSSu system to the operating status "Booting base system".

9.2 Operating states and change in operating status of a PSSu system

9.2.2.2 Operating status "Booting base system"

Various start-up tests are performed (e.g. memory test). If there are any faults during the boot process, the PSSu system will not start. The "DIAG" LED on the PSSu system's head module flashes red.

Remedy

- Check the technical details (e.g. supply voltage for module supply, ambient temperature)
- It may be necessary to swap the device

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9.2 Operating states and change in operating status of a PSSu system

9.2.2.3 Operating status "Booting system sections"

"Booting system sections" is either the phase

- After the base system is booted, until all system sections of a PSSu system are in a RUN condition or
- After a reset command is triggered (cold reset, reset button/warm reset), until all system sections of the PSSu system are restored to a RUN condition or
- After the base system is booted or a reset command is triggered, until a system section is in an error condition
  These error conditions are described in the respective system section.

Effects

Before the system sections are booted, various self tests and initialisations are performed. This may take some time. One of the self tests deals is concerned with checking the removable data medium and its data.

9.2 Operating states and change in operating status of a PSSu system

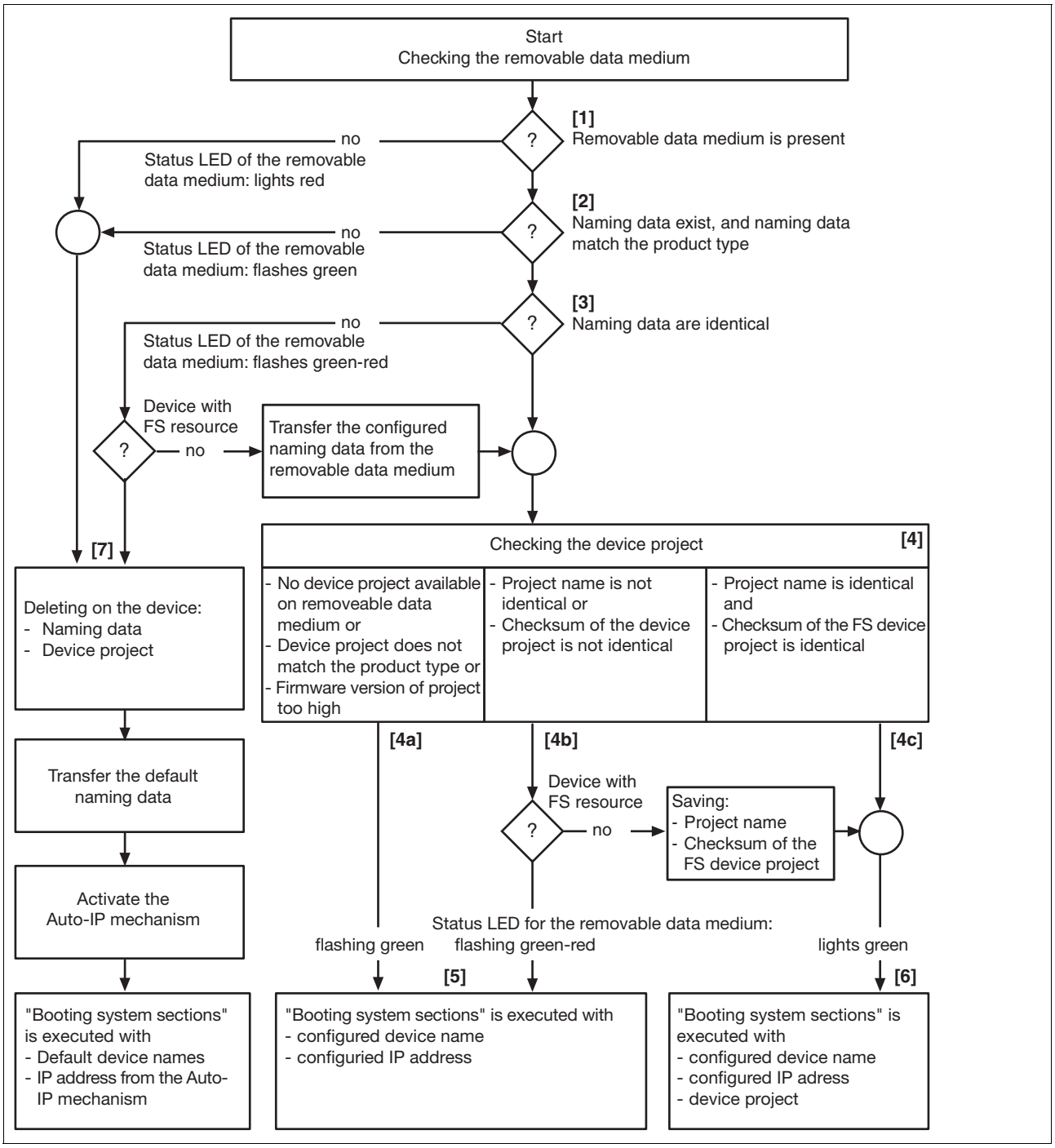

Fig. 9-4: Flowchart for checking the removable data medium

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9.2 Operating states and change in operating status of a PSSu system

[1]
The first test checks whether the device's removable data medium is accessible, i.e. it checks whether the removable data medium is

- plugged in
- intact
- not empty

If the removable data medium is not accessible, the device will start without a device project and with the factory-set default naming data (see [7]).

[2]
A test determines whether the removable data medium contains naming data (see Naming data, page 8-28) and whether the naming data on the removable data medium matches the device's product type.
If the removable data medium contains no naming data or the naming data does not match the device's product type, the device will start without a device project and with the factory-set default naming data (see [7]).

[3]
A test determines whether the naming data on the device matches that of the removable data medium.

- Identical naming data:
  The device project is tested as the next step (see [4]).
- Non-identical naming data on a device **without** FS resource (e.g. device belonging to the "decentralised system PSSu I/O"):
  The naming data on the device is deleted and the device adopts the naming data on the removable data medium. The device project is tested as the next step (see [4]).
- Non-identical naming data on a device **with** FS resource (e.g. control system PSSu PLC, control system PSSu multi):
  The device will start without a device project and with the factory-set default naming data (see [7]).

[4]
Various tests are carried out for the device project. The rest of the procedure depends on the result of the test:

- Procedure follows [4a] if at least one of the following conditions is met:
  - There is no device project on the removable data medium;
    This may occur during device naming for example.
  - The device project on the removable data medium does not match the device's product type;

9.2 Operating states and change in operating status of a PSSu system

This may occur if the removable data medium has been exchanged, for example.

– The device requires a higher firmware version for the device project on the removable data medium

In all these cases, the device will start with the naming data configured by the user (device name, IP address), but without a device project (see [5]). For the device to obtain a device project, a project will either need to be downloaded (see Project download, page 8-46) or the "Deliberate operator action" will need to performed (see Deliberate operator action to transfer the naming data and/or device project, page 9-128) .

- Procedure follows [4b] if at least one of the following conditions is met:
  – The project name on the device is not identical to the project name on the removable data medium;
  This may occur if the removable data medium has been exchanged, for example.
  – On a device with FS resource, the check sum of the FS device project on the device is not identical to the check sum of the FS device project on the removable data medium;
  This may occur if the removable data medium has been exchanged, for example.

  A device **with** FS resource will start with the naming data configured by the user (device name, IP address), but without a device project (see [5]). For the device to obtain a device project, a project will either need to be downloaded (see Project download, page 8-46) or the "Deliberate operator action" will need to performed (see Deliberate operator action to transfer the naming data and/or device project, page 9-128) .

  A device **without** FS resource will delete the project name and the check sum of the FS device project from its device memory and adopt the project name and check sum of the FS device project on the removable data medium. The device will start with the naming data configured by the user (device name, IP address) and with the device project from the removable data medium (see [6]).
- Procedure follows [4c] if one of the following conditions is met:
  The project name and check sum of the FS device project are identical on the removable data medium and device.
  This procedure corresponds to the device in a "sound condition", i.e. the device meets all the requirements necessary for the operation to run smoothly. For example, these requirements include:
  – Removable data medium is accessible
  – Device naming and project download have been carried out successfully
  – Removable data medium has not been exchanged improperly

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9.2 Operating states and change in operating status of a PSSu system

The device will start with the naming data configured by the user (device name, IP address) and with the device project from the removable data medium (see [6]).

[7]

The procedure follows [7] in the following cases:

- A removable data medium is not plugged into the device or it is empty or defective.
- The removable data medium contains no naming data or the naming data on the removable data medium does not match the device's product type. This may occur, for example, if the removable data medium that is used is unsuitable or is from a device with a different product type.
- On a device with FS resource, the naming data on the removable data medium is not identical to that of the device. This may occur, for example, if the naming data has been changed during a new device naming process.

The following is performed when the procedure follows [7]:

- The naming data on the device is deleted.
- The project name and check sum of the FS device project on the device are deleted.
- The device activates the factory-set default naming data.
- The device activates its Auto-IP mechanism.
- The operating status "Booting system sections" is performed. The device uses
  - the factory-set default device name
  - the IP address that was assigned via the Auto-IP mechanism

9.2 Operating states and change in operating status of a PSSu system

Behaviour during "Booting system sections":

- If no faults are detected during the boot process, all system sections will be started. The starts are executed in parallel (see Sections III … VI in the flowchart, page 9-5) .
- If a fault is detected during the boot process, the affected system section will switch to one of the error conditions. All unaffected system sections continue with the boot process and switch to a RUN condition (see Sections III … VII in the flowchart, page 9-5) .
- The boot process has been completed when
  - All system sections have successfully loaded their configuration ("DIAG" LED switches from "Flashing green" to "Lights green")
  - A system section registers a fault ("DIAG" LED switches from "Flashing green" to "Lights orange", "Lights red" or "Flashes red"), then switches to an error condition.
    In these cases, unaffected system sections have still loaded their configuration successfully.
- Status LEDs
  The status LEDs on the head module provide information on the status of the system sections.

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9.2 Operating states and change in operating status of a PSSu system

9.2.2.4 Operating status "Device in RUN condition without error"

This operating status is characterised by the fact that all system sections are in a RUN condition and are operating error-free (see Sections III … VII in the flow chart, page 9-5) .

- Status LEDs

  The status LEDs on the head module provide information on the status of the system sections.

9.2 Operating states and change in operating status of a PSSu system

9.2.2.5 Operating status "Device in STOP condition without error"

This operating status is achieved by triggering an explicit stop via PAS4000 (PSSu system is stopped).

Effects

- The system sections finish what they are currently processing. Any further processing is stopped. All system sections are in a STOP condition. The behaviour during the stop state is described separately (see Stop commands – Behaviour during the STOP condition, page 9-119) .
- Status LEDs
  The status LEDs on the head module provide information on the status of the system sections.

Remedy

The following commands are available for starting the PSSu system:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Start project (PAS4000)

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9.2 Operating states and change in operating status of a PSSu system

9.2.2.6 Operating status "Major FS error"

If a fault results in the operating status: "Major FS error", the affected sections of the PSSu systems are ended as defined. A defined status is achieved.

Possible causes

- Feasibility error
  e.g. irregularities between the microprocessors (different calculation results)
- Memory error

Effects

- In the event of a major error in a safety-related system section, all other safety-related system sections are stopped and/or switched to a safe condition:
  – The FS resource is in a STOP condition and the FS resource tasks are no longer executed.
  – All hardware FS outputs are switched to a safe condition.
  – FS process data communication via SafetyNET p is stopped.
- For process data whose values are determined via the FS resource and which is accessed via other resources, the substitute values are used with Valid Bits = FALSE.
- Please refer to PAS4000's online help for details of how to handle variables (volatile variables, non-volatile variables) whose values are determined via the FS resource
- Hardware ST outputs are unaffected
- Status LEDs on the head module
  The "FS RUN" LED is off, the "FS SNp" LED lights up red and the "MBUS" LED flashes red.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the project diagnostic list and/or the diagnostic log
2. Rectify errors
3. Execute a cold start/reboot command

9.2 Operating states and change in operating status of a PSSu system

9.2.3 Changes in the operating status of a PSSu system

This description of the change in operating status refers to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5)

[1] Change in operating status after a cold start/reboot command
When a PSSu system's module supply is switched on (cold start) or following a reboot command (PAS4000), the PSSu system initially switches to the status "Booting base system", performs various start-up tests and then switches to the status "Booting system sections".

Fundamentally, a change in operating status after "booting the base system" can be enforced via a cold start/reboot command when the PSSu system is in any status (see Section II in the flowchart, page 9-5) . For reasons of availability, we recommend that you only enforce a change in operating status when it is really necessary. For example, after rectifying a fault that has led to a major error.

[2] Change in operating status after a reset
Fundamentally, a reset (cold reset, reset button/warm reset or project reset) can be triggered when the PSSu system is in any status (see Section I in the flowchart, page 9-5) . The effect (e.g. how variables are handled) depends on which reset is used. After a reset, the PSSu system switches to the status "Booting system sections".

For reasons of availability, we recommend that you only trigger a reset when it is really necessary.

The effects of the reset are described separately (see Reset commands, page 9-111) .

[3] Switching from "Booting system sections" to "Device in RUN condition without error"
This change of operating status takes place as soon as all the system sections on the PSSu system are in a RUN condition and are operating faultlessly.

Effects

- The millisecond timer is started.
- The content of non-volatile and volatile variables is documented in the section entitled "Reset, restart, start and stop options (see Effects on local and resource-global variables, page 9-106) .

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9.2 Operating states and change in operating status of a PSSu system

- All values in the PII/PIO are set to ZERO.
  It's possible that the module bus may have already been started by the FS resource and/or ST resource. In this case, the PII may contain current input values.
- An entry is added to the diagnostic list.

[4] Switching from "Device in RUN condition without error" to "Device in STOP condition without error"
This change of operating status must be triggered explicitly via PAS4000 (e.g. stopping the PSSu system).

The effects of a stop are described separately (see Stop commands, page 9-119) .

[5] Switching from "Major FS error" to "Booting system sections"
Once the fault has been rectified, the PSSu system can only be started via a cold start/reboot command. As a result of the cold start/reboot command the PSSu system switches to "Booting base system", performs the start-up tests and then runs through the complete boot process for the status "Booting system sections".

9.3 Operating states and change in operating status of the FS resource

The description below deals exclusively with the operating states of the FS resource, referring to the operating states of the PSSu system where necessary.

The diagram "Operating states and change in operating status of an FS resource" (see Flowchart, page 9-21) provides an overview of the operating states (grey):

- The figures in square parentheses indicate the various changes in operating status.
- The sections marked with the Roman numerals I and II refer to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-21) , as the effects impact the whole PSSu system and not just the FS resource.
- The section marked with the Roman numeral III refers to the diagram "Operating states and change in operating status of a PSSu system", (see Flowchart, page 9-5) as the FS resource is started when booting the system sections of a PSSu system.

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9.3 Operating states and change in operating status of the FS resource

9.3.1 Flow chart

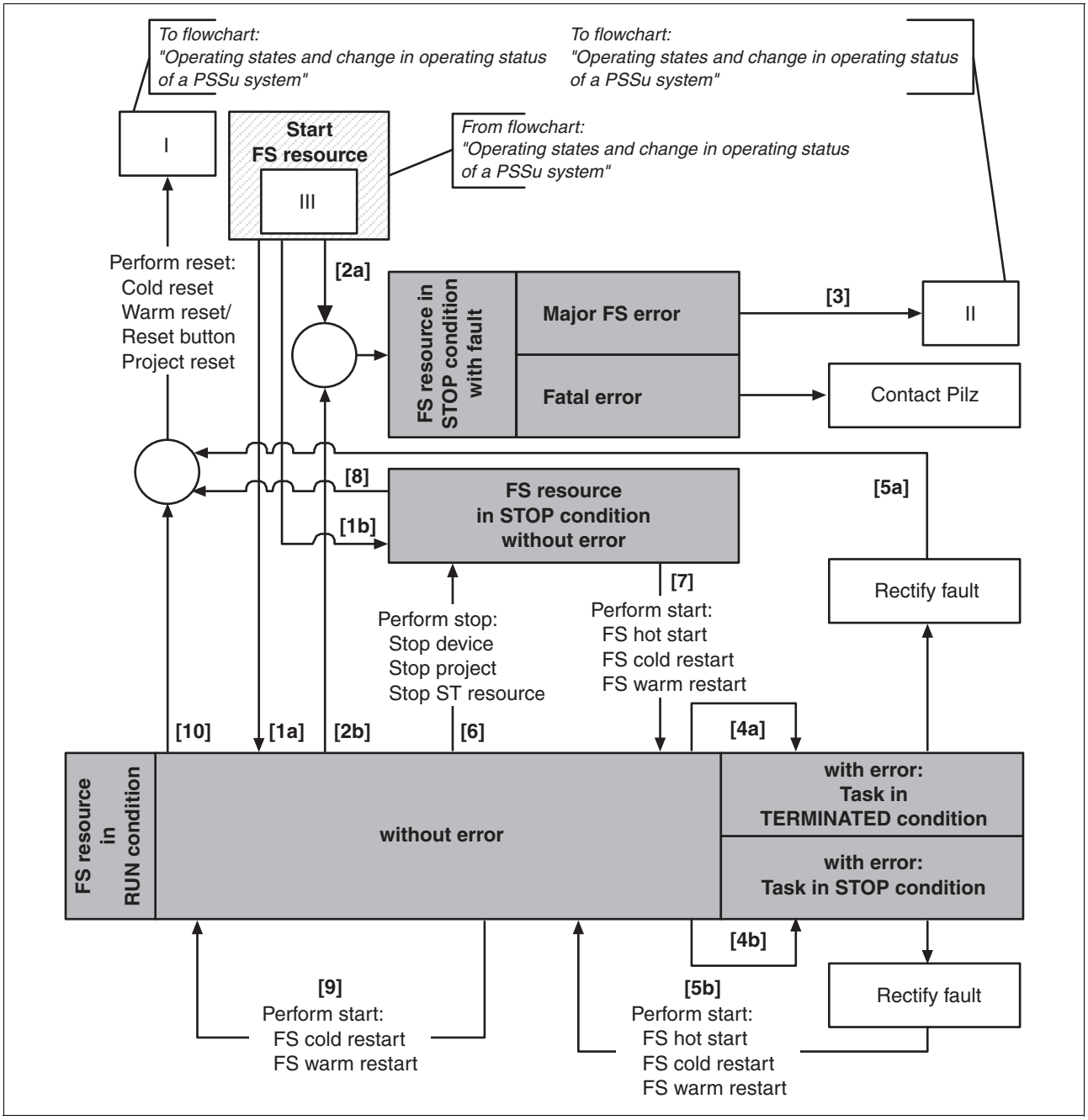

Fig. 9-5: Operating states and change in operating status of the FS resource

9.3 Operating states and change in operating status of the FS resource

9.3.2 Operating states of the FS resource

The description of the various operating states assumes that the PSSu system contains a valid device project.

The FS resource may assume the following operating states (see Flow chart, page 9-21) :

- Operating status conditions "FS resource in RUN condition":
  - FS resource in RUN condition without error
  - FS resource in RUN condition with error: Task in TERMINATED condition
  - FS resource in RUN condition with error: Task in STOP condition
- Operating status "FS resource in STOP condition without error"
- Operating status conditions "FS resource in STOP condition with error"
  - Fatal error
  - Major FS error

INFORMATION
The descriptions of various operating states include a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

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9.3 Operating states and change in operating status of the FS resource

9.3.2.1 FS resource in RUN condition without error

This operating status is achieved through one of the following options:

- After a successful boot process, which was triggered by
  - Cold starting the PSSu system or a reboot command for the PSSu system via PAS4000
  - Pressing the reset button on the PSSu system
  - Triggering a reset via PAS4000
    (cold reset, warm reset, project reset)
- After a start or restart via PAS4000
  (FS cold restart, FS warm restart, FS hot start)

Effects

- In the operating status "FS resource in RUN condition without error", the FS resource tasks are run faultlessly.
- Status LEDs on the head module
  The "FS RUN" LED lights up green.

9.3 Operating states and change in operating status of the FS resource

9.3.2.2 FS resource in STOP condition without error

This operating status is achieved by triggering a stop via PAS4000 (PSSu system is stopped, FS resource is stopped, project is stopped).

Effects

- The behaviour of the hardware inputs, hardware outputs, process data and system sections while a resource is in a STOP condition is described separately (see Stop commands – Behaviour during the STOP condition, page 9-119) .
- The effects on local and resource-global variables are described separetely (see Effects on local and resopurce-global variables, page 9-106) .
- Status LEDs on the head module
  The FS-RUN LED will be off.

Remedy

- FS resource is (re-)started:
  - FS hot start (PAS4000)
  - FS cold restart (PAS4000)
  - FS warm restart (PAS4000)
- PSSu system is reset:
  - Warm reset (PAS4000) or reset button (PSSu system)
  - Cold reset (PAS4000)
- Project is reset
  - Warm reset of project (PAS4000)
  - Cold reset of project (PAS4000)

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9.3 Operating states and change in operating status of the FS resource

9.3.2.3 FS resource in RUN condition with error: Task in TERMINATED condition

If a fault results in this operating status, the affected task is ended as defined. A defined state is achieved.

Possible causes

(see also IEC 61131-3, Table E1)

- Execution time error
  For example, timeout error because the execution time has been exceeded

Effects

- The affected FS resource task is no longer executed, all other FS resource tasks continue to be executed.
- The FS resource continues to be in a RUN condition
- The following applies for all O-PI variables that are declared as local variables or are referenced as VAR_EXTERNAL in the POUs of the task that has been stopped:
  Substitute values are used in the I/O-mapped data sinks (e.g. I-PI variables, hardware outputs) and Valid Bits = FALSE.
- The following applies for all O-PI variables that are created in Multi blocks as O-PI points or are referenced as VAR_EXTERNAL:
  Substitute values are used in the I/O-mapped data sinks (e.g. I-PI variables, hardware outputs) and Valid Bits = FALSE.
- The following applies for resource global variables (not O-PI variables) that are referenced via "VAR_EXTERNAL" in the blocks of the task that has been ended:
  They retain the last valid, stored values and are not set to their initial values.
- If resource global variables are referenced via "VAR_EXTERNAL" in the blocks of a task that has not been ended, the value there can be overwritten. As a result of this overwrite, resource global O-PI variables will again be marked as valid.
- Please refer to PAS4000's online help for details of how to handle variables (volatile variables, non-volatile variables)
- Status LEDs on the head module
  The "FS RUN" LED flashes green

9.3 Operating states and change in operating status of the FS resource

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Perform reset:
   Use a warm reset or cold reset

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9.3 Operating states and change in operating status of the FS resource

9.3.2.4 FS resource in RUN condition with error: Task in STOP condition

If a fault results in this operating status, the affected task is ended as defined. A defined state is achieved.

Possible causes

(see also IEC 61131-3, Table E1)

- Runtime error
  For example, a variable value exceeds the defined range, the numeric result of a function exceeds the value range for a data type, division by 0

Effects

- The affected FS resource task is no longer executed, all other FS resource tasks continue to be executed.
- The FS resource continues to be in a RUN condition
- The following applies for all O-PI variables that are declared as local variables or are referenced as VAR_EXTERNAL in the POUs of the task that has been stopped:
  Substitute values are used in the I/O-mapped data sinks (e.g. I-PI variables, hardware outputs) and Valid Bits = FALSE.
- The following applies for all O-PI variables that are created in Multi blocks as O-PI points or are referenced as VAR_EXTERNAL:
  Substitute values are used in the I/O-mapped data sinks (e.g. I-PI variables, hardware outputs) and Valid Bits = FALSE.
- The following applies for resource global variables (not O-PI variables) that are referenced via "VAR_EXTERNAL" in the blocks of the task that has been stopped:
  They retain the last valid, stored values and are not set to their initial values.
- If resource global variables are referenced via "VAR_EXTERNAL" in the blocks of a task that has not been stopped, the value there can be overwritten. As a result of this overwrite, resource global O-PI variables will again be marked as valid.
- Please refer to PAS4000's online help for details of how to handle variables (volatile variables, non-volatile variables)
- Status LEDs on the head module
  The "FS RUN" LED flashes green

9.3 Operating states and change in operating status of the FS resource

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Perform a (re)start:
   Use an FS hot start, FS warm restart or FS cold restart
   One of the reset commands can also be used. A reset command impacts the whole PSSu system and not just the FS resource.

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9.3 Operating states and change in operating status of the FS resource

9.3.2.5 Major FS error

If a fault results in this operating status, the affected sections of the FS resource are ended as defined. A defined state is achieved.

The effects of a major FS error impact all safety-related sections of a PSSu system (see Operating state "Major FS error of a PSSu system, page 9-17) .

9.3 Operating states and change in operating status of the FS resource

9.3.2.6 Fatal error

If a fault results in the operating status "Fatal error", as far as possible an attempt will be made to exit all the processes running on the PSSu system in an orderly manner. Safety-related system sections are stopped and/or switched to a safe condition.

Possible causes

- Initialisation error
- Internal firmware error
  (e.g. memory error which, although it was detected, has led to a major error in the PSSu system's firmware, as a result of which the firmware can no longer be executed correctly.)
- Hardware defect

Effects

- FS hardware outputs are switched to a safe condition.
- The content of variables and the status of ST hardware inputs/ST hardware outputs is random.
- Status LEDs on the head module
  The status of the LEDs "FS RUN", "ST RUN", "FS SNp", "ST SNp" and "DIAG" is random.

Remedy

It is not possible for the user to rectify the error. If the PSSu system is in this operating state, follow the instructions below:

1. Note the conditions under which the error occurred.
2. Execute a cold start/reboot command in order to read/print the diagnostic list and/or diagnostic log using PAS4000.
   However, this will only be possible if the fatal error was not caused by a fault in the communication area.
3. Contact Pilz

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9.3 Operating states and change in operating status of the FS resource

9.3.3 Change in operating status of the FS resource

This description of the change in operating status assumes that the PSSu system contains a valid device project. The figures refer to the change in operating status in the diagram "Operating states and change in operating status of the FS resource" (see Flowchart, page 9-21) .

INFORMATION
The description of each change of operating status includes a list of the options for triggering the change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

[1a] Switching from "Booting system sections" to "FS resource in RUN condition without error"
"Booting system sections" is one of the PSSu system's operating states (see Flowchart, page 9-5) . If no fault is detected in a safety-related system section as the system sections are booted, the FS resource is started, switching to the status "FS resource in RUN condition without error".

[1b] Switching from "Booting system sections" to "FS resource in STOP condition without error"
"Booting system sections" is one of the PSSu system's operating states (see Flowchart, page 9-5) . Under various circumstances the FS resource may not achieve the operating status "FS resource in RUN condition without error", it changes instead to "FS resource in STOP condition without error":

- A manually executed STOP command (see [6]) causes the FS resource to be in the operating condition "FS resource in STOP condition without error". Instead of one of the start commands (see [7]) one of the reset commands is executed (see [8]). However, in this case, the FS resource cannot achieve a RUN condition via any of the reset commands; instead it switches back to "FS resource in STOP condition without error".
- The FS resource is in the operating status "FS resource in RUN condition with error": Task in a STOP condition" After the fault has been rectified, one of the reset commands is executed instead of one of the start commands (see [5b]). However, in this case, the FS resource cannot achieve a RUN condition via any of the reset commands; instead it switches to "FS resource in STOP condition without error".

9.3 Operating states and change in operating status of the FS resource

[2a] Switching from "Booting system sections" to an error condition
If a fault is detected in a safety-related system section as the system sections are booted (see Flowchart, page 9-5) , the FS resource switches to either of the operating states "Major FS error" or "Fatal error", depending on the fault.

[2b] Switching from "FS resource in RUN condition without error" to an error condition
If a fault is detected in a safety-related system section while the FS resource is in a RUN condition, the FS resource switches to either of the operating states "Major FS error" or "Fatal error", depending on the fault.

[3] Switching from "Major FS error" to "Booting system sections"
Once the error has been rectified, the FS resource can only be started via a cold start/reboot command. As a result of the cold start/reboot command the PSSu system switches to "Booting base system", performs the start-up tests and then runs through the complete boot process for the status "Booting system sections" (see Flowchart, page 9-5) .

[4a] Switching from "FS resource in RUN condition without error" to "FS resource in RUN condition with error: Task in TERMINATED condition"
If an error is detected in an FS resource task, e.g. an execution time error is found, the task is aborted and is no longer executed. All other FS resource tasks continue running.

[4b] Switching from "FS resource in RUN condition without error" to "FS resource in RUN condition with error: Task in STOP condition"
If an error is detected in an FS resource task, e.g. a runtime error is found, the task is stopped and is no longer executed. All other FS resource tasks continue running.

[5a] Switching from "FS resource in RUN condition with error: Task in TERMINATED condition" after "FS resource in RUN condition without error"
Once the fault has been rectified, the FS resource can be restarted via one of the reset commands:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

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9.3 Operating states and change in operating status of the FS resource

[5b] Switching from "FS resource in RUN condition with error: Task in STOP condition" after "FS resource in RUN condition without error"

Once the fault has been rectified, the affected task can be restarted via one of the (re)start commands:

- FS hot start
- FS warm restart
- FS warm start
- One of the reset commands can also be used. A reset command impacts the whole PSSu system and not just the FS resource.

[6] Switching from "FS resource in RUN condition without error" to "FS resource in STOP condition with error"

If the FS resource is in a RUN condition without error, the user can explicitly cause the FS resource to switch to a STOP condition. The STOP condition will be maintained until the user explicitly restarts the FS resource.

It may be useful to trigger this change in operating status when commissioning plant sections, for example, or when making adjustments.

The STOP status of the FS resource can be triggered by one of the following options:

- Stopping the project (PAS4000)
- Stopping the PSSu system (PAS4000)
- Stopping the FS resource (PAS4000)

[7] Switching from "FS resource in STOP condition without error" to "FS resource in RUN condition with error"

This change in operating status can be brought about using one of the following commands:

- FS hot start (PAS4000)
- FS cold restart (PAS4000)
- FS warm restart (PAS4000)

[8] Reset in status "FS resource in STOP condition without error"

If one of the reset commands is executed in this operating status (see [8]), as the system sections are booted the FS resource will switch back to "FS resource in STOP condition without error" (see [1b]). A change in operating status to "FS resource in RUN condition without error" cannot be achieved using any of the reset commands.

9.3 Operating states and change in operating status of the FS resource

[9] Restart in status "FS resource in RUN condition without error"
If it is necessary to set variables to defined values, during commissioning for example, one of the restart commands can be used (see Impact on local variables and resource global variables, page 9-106) .

This change in operating status can be triggered using one of the following commands:
- FS warm restart (PAS4000)
- FS cold restart (PAS4000)

[10] Switching from "FS resource in RUN condition without error" to "Booting system sections"
This change in operating status affects all the system sections of the PSSu system (see Flowchart, page 9-5) .

This change in operating status can be triggered using one of the following commands:
- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

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9.4 Operating states and change in operating status of the ST resource

The description below deals exclusively with the operating states of the ST resource, referring to the operating states of the PSSu system where necessary.

The diagram "Operating states and change in operating status of an ST resource" (see Flowchart, page 9-36) provides an overview of the operating states (grey):

- The figures in square parentheses indicate the various changes in operating status.
- The section marked with the Roman numeral I refers to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the effects impact the whole PSSu system and not just the ST resource.
- The section marked with the Roman numeral IV refers to the diagram "Operating states and change in operating status of a PSSu system", (see Flowchart, page 9-5) as the ST resource is started when booting the system sections of a PSSu system.

9.4 Operating states and change in operating status of the ST resource

9.4.1 Flow chart

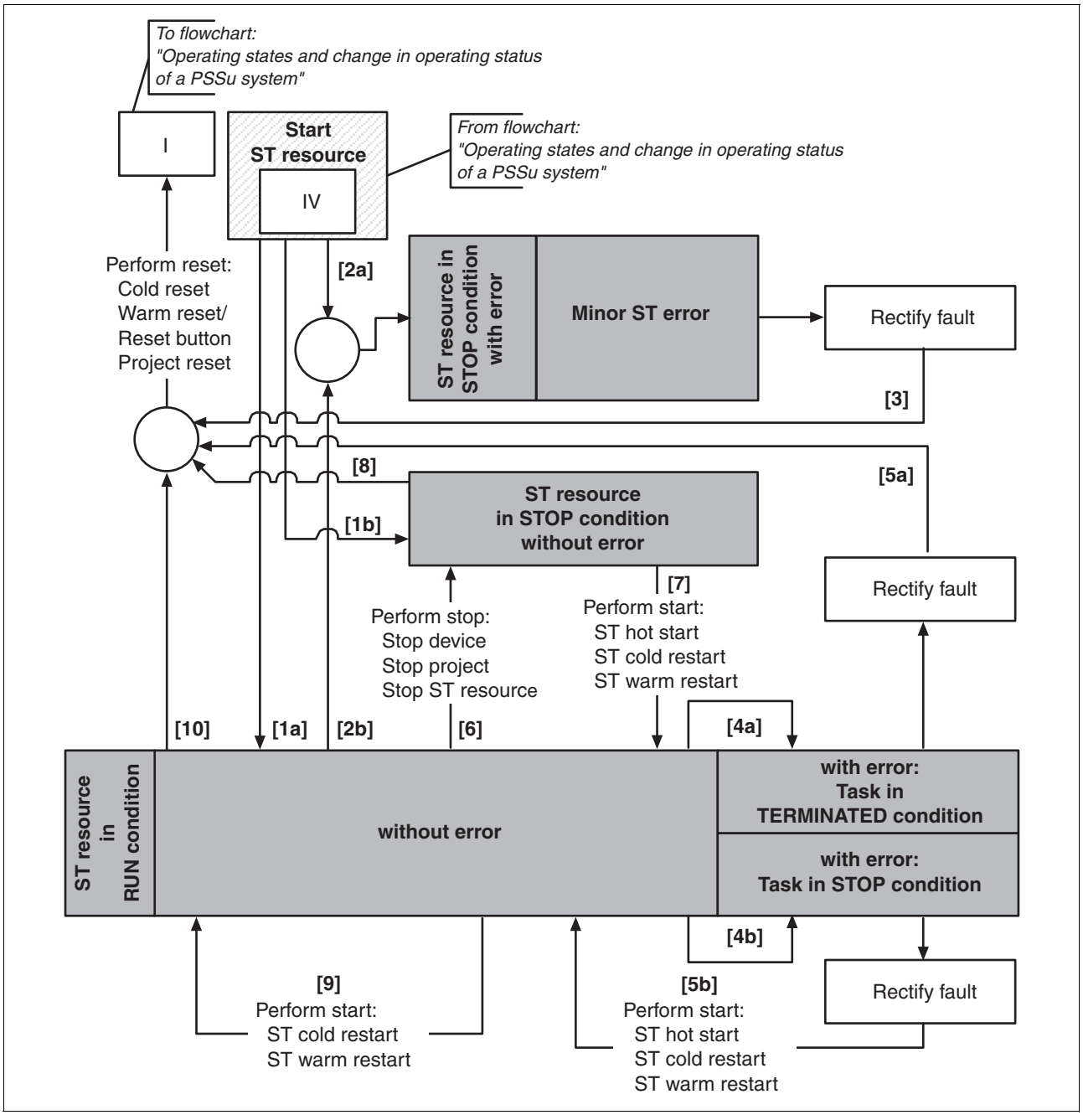

Fig. 9-6: Operating states and change in operating status of the ST resource

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9.4 Operating states and change in operating status of the ST resource

9.4.2 Operating states of the ST resource

The description of the various operating states assumes that the PSSu system contains a valid device project.

The ST resource may assume the following operating states (see Flow chart, page 9-36) :

- Operating statuses "ST resource in RUN condition":
  - ST resource in RUN condition without error
  - ST resource in RUN condition with error: Task in TERMINATED condition
  - ST resource in RUN condition with error: Task in STOP condition
- Operating status: "ST resource in STOP condition without error"
- Operating status: "ST resource in STOP condition with error":
  - Minor ST error

INFORMATION
The description of each operating status includes a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

9.4 Operating states and change in operating status of the ST resource

9.4.2.1 ST resource in RUN condition without error

This operating status is achieved through one of the following options:

- After a successful boot process, which was triggered by
  - Cold starting the PSSu system or a reboot command for the PSSu system via PAS4000
  - Pressing the reset button on the PSSu system
  - Triggering a reset via PAS4000
    (cold reset, warm reset, project reset)
- After a start or restart via PAS4000
  (ST cold restart, ST warm restart, ST hot start)

Effects

- In the operating status "ST resource in RUN condition without error", the ST resource tasks are run faultlessly.
- Status LEDs on the head module
  The "ST RUN" LED lights up green.

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9.4 Operating states and change in operating status of the ST resource

9.4.2.2 ST resource in STOP condition without error

This operating status is achieved by triggering a stop via PAS4000 (PSSu system is stopped, ST resource is stopped, project is stopped).

Effects

- The behaviour of the hardware inputs, hardware outputs, process data and system sections while a resource is in a STOP condition is described separately (see Stop commands – Behaviour during the STOP condition, page 9-119) .
- The effects on local and resource-global variables are described separetely (see Effects on local and resopurce-global variables, page 9-106) .
- Status LEDs on the head module
  The ST-RUN LED will be off.

Remedy

- ST resource is (re-)started:
  - ST hot start (PAS4000)
  - ST cold restart (PAS4000)
  - ST warm restart (PAS4000)
- PSSu system is reset:
  - Warm reset (PAS4000) or reset button (PSSu system)
  - Cold reset (PAS4000)
- Project is reset
  - Warm reset of project (PAS4000)
  - Cold reset of project (PAS4000)

9.4 Operating states and change in operating status of the ST resource

9.4.2.3 ST resource in RUN condition with error: Task in TERMINATED condition

If a fault results in this operating status, the affected task is ended as defined. A defined state is achieved.

Possible causes

(see also IEC 61131-3, Table E1)

- Execution time error
  Task was not completed within the task cycle time

Effects

- The affected ST resource task is no longer executed, all other ST resource tasks continue to be executed.
- The ST resource continues to be in a RUN condition.
- The following applies for all O-PI variables that are declared as local variables or are referenced as VAR_EXTERNAL in the POUs of the task that has been stopped:
  Substitute values are used in the I/O-mapped data sinks (e.g. I-PI variables, hardware outputs) and Valid Bits = FALSE.
- The following applies for all O-PI variables that are created in Multi blocks as O-PI points or are referenced as VAR_EXTERNAL:
  Substitute values are used in the I/O-mapped data sinks (e.g. I-PI variables, hardware outputs) and Valid Bits = FALSE.
- The following applies for resource global variables (not O-PI variables) that are referenced via VAR_EXTERNAL in the blocks of the task that has been stopped:
  They retain the last valid, stored values and are not set to their initial values.
- If resource global variables are referenced via VAR_EXTERNAL in the POUs of a task that has not been stopped, the value there can be overwritten. As a result of this overwrite, resource global O-PI variables will again be marked as valid.
- Please refer to PAS4000's online help for details of how to handle variables (volatile variables, non-volatile variables)
- Status LEDs on the head module
  The "ST RUN" LED flashes green

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9.4 Operating states and change in operating status of the ST resource

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Perform reset:
   Use a warm reset or cold reset

9.4 Operating states and change in operating status of the ST resource

9.4.2.4 ST resource in RUN condition with error: Task in STOP condition

If a fault results in this operating status, the affected task is ended as defined. A defined state is achieved.

Possible causes

(see also IEC 61131-3, Table E1)

- Runtime error
  For example, a variable value exceeds the defined range, the numeric result of a function exceeds the value range for a data type, division by 0

Effects

- The affected ST resource task is no longer executed, all other ST resource tasks continue to be executed.
- The ST resource continues to be in a RUN condition.
- The following applies for all O-PI variables that are declared as local variables or are referenced as VAR_EXTERNAL in the POUs of the task that has been stopped:
  Substitute values are used in the I/O-mapped data sinks (e.g. I-PI variables, hardware outputs) and Valid Bits = FALSE.
- The following applies for all O-PI variables that are created in Multi blocks as O-PI points or are referenced as VAR_EXTERNAL:
  Substitute values are used in the I/O-mapped data sinks (e.g. I-PI variables, hardware outputs) and Valid Bits = FALSE.
- The following applies for resource global variables (not O-PI variables) that are referenced via VAR_EXTERNAL in the blocks of the task that has been stopped:
  They retain the last valid, stored values and are not set to their initial values.
- If resource global variables are referenced via VAR_EXTERNAL in the POUs of a task that has not been stopped, the value there can be overwritten. As a result of this overwrite, resource global O-PI variables will again be marked as valid.
- Please refer to PAS4000's online help for details of how to handle variables (volatile variables, non-volatile variables)
- Status LEDs on the head module
  The "ST RUN" LED flashes green

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9.4 Operating states and change in operating status of the ST resource

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Perform a reset or (re)start
   Use an ST hot start, ST warm restart or ST cold restart
   One of the reset commands can also be used. A reset command impacts the whole PSSu system and not just the ST resource.

9.4 Operating states and change in operating status of the ST resource

9.4.2.5 Minor ST error

If a fault results in this operating status, the affected sections of the ST resource are ended as defined. A defined state is achieved.

Possible causes

- Error in the memory of the non-volatile variables

Effects

- The affected ST resource task is no longer executed, all other ST resource tasks are stopped.
- The ST resource is in a STOP condition.
- For process data whose values are determined via this task, the substitute values are used and with PI variables also the corresponding Valid Bit = FALSE.
- Please refer to PAS4000's online help for details of how to handle variables (volatile variables, non-volatile variables)
- Status LEDs on the head module
  The "ST RUN" LED will be off.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Perform reset

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9.4 Operating states and change in operating status of the ST resource

9.4.3 Change in operating status of the ST resource

This description of the change in operating status assumes that the PSSu system contains a valid device project. The figures refer to the change in operating status in the diagram "Operating states and change in operating status of the ST resource" (see Flowchart, page 9-36) .

INFORMATION
The description of each change of operating status includes a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

[1a] Switching from "Booting system sections" to "ST resource in RUN condition without error"
Booting system sections is one of the PSSu system's operating states (see Flowchart, page 9-5) . If no fault is detected in a safety-related system section as the system sections are booted, the ST resource is started, switching to the status "ST resource in RUN condition without error".

[1b] Switching from "Booting system sections" to "ST resource in STOP condition without error"
Booting system sections is one of the PSSu system's operating states (see Flowchart, page 9-5) . Under various circumstances, as the system sections are booted the ST resource may not achieve the operating status "ST resource in RUN condition without error", but switches instead to "ST resource in STOP condition without error":

- A manually executed STOP command (see [6]) causes the ST resource to be in the operating status "ST resource in STOP condition without error". Instead of one of the start commands (see [7]), one of the reset commands is executed (see [8]). However, in this case, the ST resource cannot achieve a RUN condition via any of the reset commands; instead it switches back to "ST resource in STOP condition without error".
- The ST resource is in the operating status "ST resource in RUN condition with error": Task in a STOP condition" After the fault has been rectified, one of the reset commands is executed instead of one of the start commands (see [5b]). However, in this case, the ST resource cannot achieve a RUN condition via any of the reset commands; instead it switches to "ST resource in STOP condition without error".

9.4 Operating states and change in operating status of the ST resource

[2a] Switching from "Booting system sections" to error condition "Minor ST error"
If a fault is detected as the system sections are booted (see Flowchart, page 9-5) , the ST resource switches to the operating status "Minor ST error".

[2b] Switching from "ST resource in RUN condition without error" to error condition "Minor ST error"
If a fault is detected while the ST resource is in a RUN condition, the ST resource switches to the operating status "Minor ST error".

[3] Switching from "Minor ST error" to "Booting system sections"
Once the fault has been rectified, the ST resource can be restarted via one of the reset commands, provided an FS error is not present at the same time:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

[4a] Switching from "ST resource in RUN condition without error" to "ST resource in RUN condition with error": Task im TERMINATED-Zustand"
Wird in einem Task der ST-Ressource z. B. ein Ausführungszeitfehler festgestellt, wird der Task beendet und nicht mehr ausgeführt. Alle anderen Tasks der ST-Ressource werden weiter ausgeführt.

[4b] Switching from "ST resource in RUN condition without error" to "ST resource in RUN condition with error": Task im STOP-Zustand"
Wird in einem Task der ST-Ressource z. B. ein Laufzeitfehler festgestellt, wird der Task gestoppt und nicht mehr ausgeführt. Alle anderen Tasks der ST-Ressource werden weiter ausgeführt.

[5a] Switching from "ST resource in RUN condition with error: Task in TERMINATED condition" after "ST resource in RUN condition without error"
Once the fault has been rectified, the ST resource can be restarted via one of the reset commands:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

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9.4 Operating states and change in operating status of the ST resource

[5b] Switching from "ST resource in RUN condition with error: Task in STOP condition" to "ST resource in RUN condition without error"
Once the fault has been rectified, the affected task can be restarted via one of the (re)start commands:

- ST hot start
- ST warm restart
- ST warm start

One of the reset commands can also be used. A reset command impacts the whole PSSu system and not just the ST resource.

[6] Switching from "ST resource in RUN condition without error" to "ST resource in STOP condition without error"
If the ST resource is in a RUN condition without error, the user can explicitly cause the ST resource to switch to a STOP condition. The STOP condition will be maintained until the user explicitly restarts the ST resource.

It may be useful to trigger this change in operating status when commissioning plant sections, for example, or when making adjustments.

The STOP status of the ST resource can be triggered by one of the following commands:

- Stopping the project (PAS4000)
- Stopping the PSSu system (PAS4000)
- Stopping the ST resource (PAS4000)

[7] Switching from "ST resource in STOP condition without error" to "ST resource in RUN condition without error"
This change in operating status can be brought about using one of the following commands:

- ST hot start (PAS4000)
- ST cold restart (PAS4000)
- ST warm restart (PAS4000)

[8] Reset in status "ST resource in STOP condition without error"
If one of the reset commands is executed in this operating status (see [8]), as the system sections are booted the ST resource will switch back to "ST resource in STOP condition without error" (see [1b]). A change in operating status to "ST resource in RUN condition without error" cannot be achieved using any of the reset commands.

9.4 Operating states and change in operating status of the ST resource

[9] Restart in status "ST resource in RUN condition without error"
If it is necessary to set variables to defined values, during commissioning for example, one of the restart commands can be used (see Impact on local variables and resource global variables, page 9-106) .

This change in operating status can be triggered using one of the following commands:
- ST warm restart (PAS4000)
- ST cold restart (PAS4000)

[10] Switching from "ST resource in RUN condition without error" to "Booting system sections"
This change in operating status affects all the system sections of the PSSu system (see Flowchart, page 9-5) .

This change in operating status can be triggered using one of the following commands:
- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

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9.5 Operating states and change in operating status of the FS module bus

The description below deals exclusively with the operating states of the FS module bus, referring to the operating states of the PSSu system where necessary.

The diagram "Operating states and change in operating status of an FS module bus" (see Flowchart, page 9-50) provides an overview of the operating states (grey):

- The figures in square parentheses indicate the various changes in operating status.
- The sections marked with the Roman numerals I and II refer to the diagram"Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the effects impact the whole PSSu system and not just the FS module bus.
- The section marked with the Roman numeral Va refers to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the FS module bus is started when booting the system sections of a PSSu system.

9.5 Operating states and change in operating status of the FS module bus

9.5.1 Flow chart

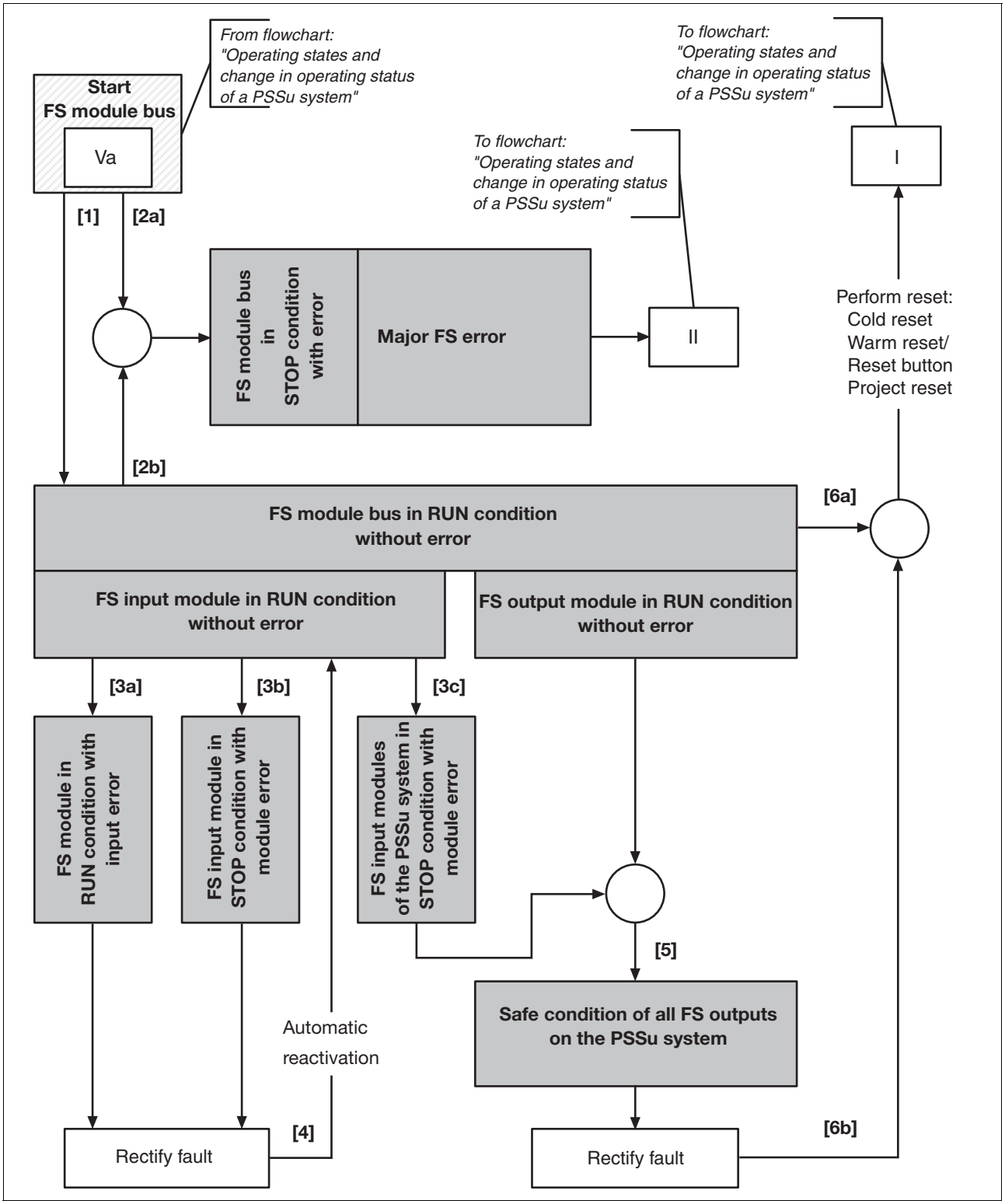

Fig. 9-7: Operating states and change in operating status of the FS module bus

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9.5 Operating states and change in operating status of the FS module bus

9.5.2 Operating states of the FS module bus

The description of the various operating states assumes that the PSSu system contains a valid device project.

The FS module bus may assume the following operating states (see Flow chart, page 9-50) :

- Operating states "FS module bus in RUN condition without error" with
  - "FS input module in RUN condition without error"
  - "FS input module in RUN condition with input error"
  - "FS input module in STOP condition with module error"
  - "FS input module of the PSSu system in STOP condition with module error"
  - "FS output module in RUN condition without error"
  - "Safe condition of all FS outputs on the PSSu system"
- Operating status "FS module bus in a STOP condition with error":
  - "Major FS error"

INFORMATION

The descriptions of various operating states include a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

9.5 Operating states and change in operating status of the FS module bus

9.5.2.1 FS module bus in RUN condition without error

This operating status is achieved through one of the following options:

- After a successful boot process, which was triggered by
  - Cold starting the PSSu system or a reboot command for the PSSu system via PAS4000
  - Pressing the reset button on the PSSu system
  - Triggering a reset via PAS4000
    (cold reset, warm reset, project reset)

Effects

- The FS module bus is in RUN condition without error.
- The FS modules are operating faultlessly, i.e.
  - the input signals/input values present at the inputs are recorded correctly and transmitted faultlessly via the FS module bus
  - the outputs are activated correctly.
- Status LEDs on the head module
  The "MBUS" LED lights up green, provided the ST module bus is also operating faultlessly.

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9.5 Operating states and change in operating status of the FS module bus

9.5.2.2 FS input module in RUN condition without error

The operating status is achieved as soon as the module is ready for operation, irrespective of the module bus status. The FS module bus is where the FS input module provides the input data for data transport to the head module.

9.5 Operating states and change in operating status of the FS module bus

9.5.2.3 FS module in RUN condition with input error

An FS input error only influences the affected FS hardware input. The FS module bus remains in the operating state "FS module bus in RUN condition without error".

Possible causes

- Test pulse error
- Input error

Effects

- The substitute value is used for the input signal/input value, with Valid Bit = FALSE.
- The FS input module remains in RUN condition and the unaffected FS hardware inputs continue to be processed.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Once the error has been rectified, the FS hardware input is reactivated automatically.

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9.5 Operating states and change in operating status of the FS module bus

9.5.2.4 FS input module in STOP condition with module error

A module fault only impacts the affected FS input module. The FS module bus remains in the operating state "FS module bus in RUN condition without error".

Possible causes

- Temperature error
- Voltage error (module supply)
- A module was disconnected during operation
- A defective module was detected during operation

Effects

- The substitute values are used for all the module's input signals/input values, with Valid Bits = FALSE.
- The unaffected FS input modules on the PSSu system continue to be processed.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Once the error has been rectified, the FS input module is reactivated automatically.

9.5 Operating states and change in operating status of the FS module bus

9.5.2.5 FS input modules of the PSSu system in STOP condition with module error

The FS input error affects all FS input modules and FS outputs of the PSSu system. The FS module bus remains in the operating state "FS module bus in RUN condition without error".

Possible causes

- The PSSu system detects an FS input error where the error location cannot be uniquely identified (e. g. PSSu E F AI U).

Effects

- The substitute values are used for all the PSSu system's input signals/ input values, with Valid Bits = FALSE.
- All FS hardware outputs on the PSSu system switch to a safe condition.
- The substitute values are used for the module's FS outputs, with Valid Bits = FALSE.
- Status LEDs on the head module
  – The "MBUS" LED lights up red.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Perform reset
   (warm reset/reset button, cold reset, project reset)

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9.5 Operating states and change in operating status of the FS module bus

9.5.2.6 FS output module in RUN condition without error

The operating status is achieved as soon as the module is ready for operation, irrespective of the module bus status. The FS output module processes the output data provided by the FS module bus.

9.5 Operating states and change in operating status of the FS module bus

9.5.2.7 Safe condition of all FS outputs on the PSSu system

If an error results in this operating state, the effects of the error will be limited to the FS hardware outputs of the PSSu system on which it was detected. The FS module bus remains in the operating state "FS module bus in RUN condition without error".

Possible causes

- Output error
  e.g. shorts across contacts, short circuit, error in the output test
- Temperature error
- Voltage error (module supply)
- A module was disconnected during operation
- A defective module was detected during operation
- Operating state "FS input module in STOP condition with module error"

Effects

- All FS hardware outputs on the PSSu system switch to a safe condition.
- The substitute values are used for the FS outputs of the modules.
- Status LEDs on the head module
  The "MBUS" LED lights up red.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Perform reset
   (warm reset/reset button, cold reset, project reset)

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9.5 Operating states and change in operating status of the FS module bus

9.5.2.8 Major FS error

If a faults results in this operating status, the affected sections of the FS module bus are ended as defined. A defined state is achieved.

The effects of a major FS error impact all safety-related sections of a PSSu system (see Operating state "Major FS error of a PSSu system, page 9-17) .

9.5 Operating states and change in operating status of the FS module bus

9.5.3 Change in operating status of the FS module bus

This description of the change in operating status assumes that the PSSu system contains a valid device project. The figures refer to the change in operating status in the diagram "Operating states and change in operating status of the FS module bus" (see Flowchart, page 9-50) .

INFORMATION
The description of each change of operating status includes a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

[1] Switching from "Booting system sections" to "FS module bus in RUN condition without error"
"Booting system sections" is one of the PSSu system's operating states (see Flowchart, page 9-5) . If no fault is detected in a safety-related system section as the system sections are booted, the FS module bus is started, switching to the status "FS module bus in RUN condition without error".

[2] Switching from "Booting system sections" to "Major FS error"
If a fault is detected in a safety-related system section as the system sections are booted, the FS module bus switches to the operating status "Major FS error".

The status "Booting system sections" and the status "Major FS error" (see Flowchart, page 9-5) are both operating states that impact the PSSu system.

[2b] Switching from "FS module bus in RUN condition without error" to "Major FS error"
If a fault is detected in a safety-related system section while the FS module bus is in a RUN condition, the FS module bus switches to the operating status "Major FS error".

The operating status "Major FS error" (see Flowchart, page 9-5) is an operating status that impacts the PSSu system.

[3a] Switching from "FS input module in RUN condition without error" to "FS module in RUN condition with input error"
If an input error is detected on an FS hardware input, the FS input module switches to the operating status "FS module in RUN condition with input error".

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9.5 Operating states and change in operating status of the FS module bus

[3b] Switching from "FS input module in RUN condition without error" to "FS input module in STOP condition with module error"
If a fault is detected on an FS input module, the relevant FS input module on the PSSu system switches to the operating status "FS input module in STOP condition with module error".

[3c] Switching from "FS input module in RUN condition without error" to "FS input modules on the PSSu system in STOP condition with module error"
If an FS input error is detected and the PSSu system cannot assign it uniquely to one of its FS hardware inputs, all the FS input modules on the PSSu system switch to the operating status "FS input module in STOP condition with module error" and all the FS outputs on the PSSu system switch to the operating status "Safe condition of all FS outputs on the PSSu system" (see [5]).

[4] Switching from one of the operating states "FS input module in RUN condition with input error" or "FS input module in STOP condition with module error" to "FS input module in RUN condition without error"
If the relevant fault (input error, module error) is rectified, the affected section on the FS input module is reactivated automatically and the module switches to the operating status "FS input module in RUN condition without error".

[5] Switching from "FS output module in RUN condition" to "Safe condition of all FS outputs on the PSSu system"
If a fault is detected on an FS output module or FS output, or if the FS input modules on the PSSu system switch to the operating status "FS input modules on the PSSu system in STOP condition with module error", all FS outputs on the PSSu system will switch to a safe condition.

[6a] Switching from "FS module bus in RUN condition without error" to "Booting system sections"
This change in operating status affects all the system sections of the PSSu system (see Flowchart, page 9-5) .

This change in operating status can be triggered using one of the following commands:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

9.5 Operating states and change in operating status of the FS module bus

[6b] Switching from "Safe condition of all FS outputs on the PSSu system" to "Booting system sections"
This change in operating status affects all the system sections of the PSSu system (see Flowchart, page 9-5) .

Once the fault has been rectified, the change in operating status can be triggered using one of the following commands:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

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9.6 Operating states and change in operating status of the ST module bus

The description below deals exclusively with the operating states of the ST module bus, referring to the operating states of the PSSu system where necessary.

The diagram "Operating states and change in operating status of an ST module bus" (see Flowchart, page 9-64) provides an overview of the operating states (grey):

- The figures in square parentheses indicate the various changes in operating status.
- The sections marked with the Roman numerals I and II refer to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the effects impact the whole PSSu system and not just the ST module bus.
- The section marked with the Roman numeral Vb refers to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the ST module bus is started when booting the system sections of a PSSu system.

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9.6 Operating states and change in operating status of the ST module bus

9.6.1 Flow chart

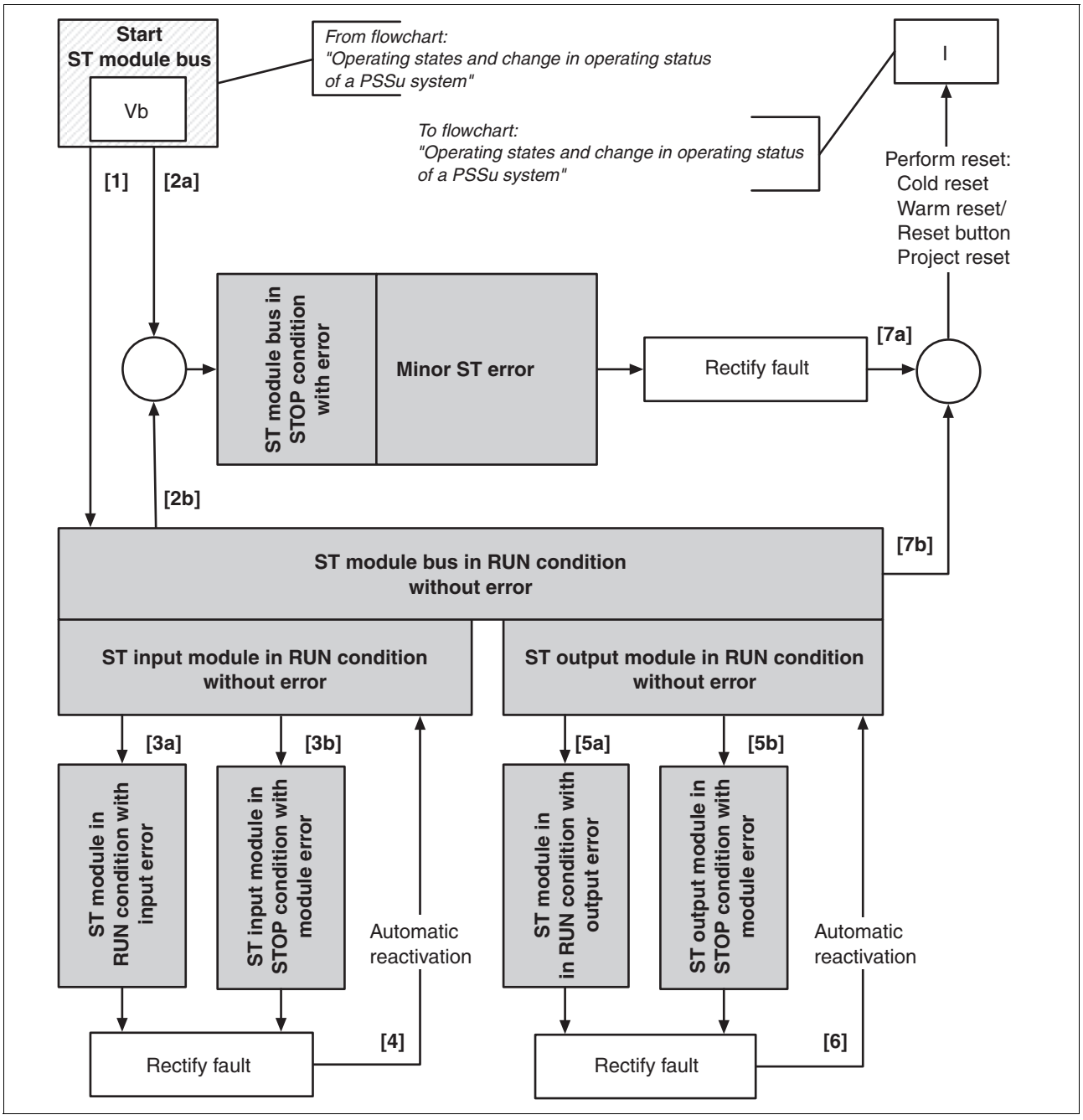

Fig. 9-8: Operating states and change in operating status of the ST module bus

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9.6 Operating states and change in operating status of the ST module bus

9.6.2 Operating states of the ST module bus

The description of the various operating states assumes that the PSSu system contains a valid device project.

The ST module bus may assume the following operating states (see Flow chart, page 9-64) :

- Operating states "ST module bus in RUN condition without error" with
  - "ST input module in RUN condition without error"
  - "ST module in RUN condition with input error"
  - "ST input module in STOP condition with module error"
  - "ST output module in RUN condition without error"
  - "ST module in RUN condition with output error"
  - "ST output module in STOP condition with module error"
- Operating status "ST module bus in STOP condition with error":
  - "Minor ST error"

INFORMATION
The descriptions of various operating states include a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

9.6 Operating states and change in operating status of the ST module bus

9.6.2.1 ST module bus in RUN condition without error

This operating status is achieved through one of the following options:

- After a successful boot process, which was triggered by
  - Cold starting the PSSu system or a reboot command for the PSSu system via PAS4000
  - Pressing the reset button on the PSSu system
  - Triggering a reset via PAS4000
    (cold reset, warm reset, project reset)

Effects

- The ST module bus is in RUN condition without error.
- The ST modules are operating faultlessly, i.e.
  - the input signals/input values present at the inputs are recorded correctly and transmitted faultlessly via the ST module bus
  - the outputs are activated correctly.
- Status LEDs on the head module
  The "MBUS" LED lights up green, provided the FS module bus is also operating faultlessly.

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9.6 Operating states and change in operating status of the ST module bus

9.6.2.2 ST input module in RUN condition without error

The operating status is achieved as soon as the module is ready for operation, irrespective of the module bus status. The ST module bus is where the ST input module provides the input data for data transport to the head module.

9.6 Operating states and change in operating status of the ST module bus

9.6.2.3 ST module in RUN condition with input error

An input error only influences the affected ST hardware input. The ST module bus remains in the operating status "ST module bus in RUN condition without error".

Possible causes

- Input error

Effects

- The substitute value is used for the input signal/input value, with Valid Bit = FALSE.
- The ST input module remains in RUN condition and the unaffected ST hardware inputs continue to be processed.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Once the fault has been rectified, the ST hardware input is reactivated automatically.

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9.6 Operating states and change in operating status of the ST module bus

9.6.2.4 ST input module in STOP condition with module error

A module fault only impacts the affected ST input module. The ST module bus remains in the operating status "ST module bus in RUN condition without error".

Possible causes

- Temperature error
- Voltage error (module supply)
- A module was disconnected during operation
- A defective module was detected during operation

Effects

- The substitute values are used for all the module's input signals/input values, with Valid Bits = FALSE.
- The unaffected ST input modules on the PSSu system continue to be processed.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Once the error has been rectified, the ST input module is reactivated automatically.

9.6 Operating states and change in operating status of the ST module bus

9.6.2.5 ST output module in RUN condition without error

This operating status is achieved as soon as the module is ready for operation, irrespective of the module bus status. The ST output module processes the output data provided by the ST module bus.

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9.6 Operating states and change in operating status of the ST module bus

9.6.2.6 ST module in RUN condition with output error

An ST output error only influences the affected ST hardware output. The ST module bus remains in the operating status "ST module bus in RUN condition without error".

Possible causes

- Output error
  (e.g. overload, short circuit)

Effects

- The substitute value is used for the output signal/output value, with Valid Bit = FALSE.
- The ST output module remains in RUN condition and the unaffected ST hardware outputs continue to be processed.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Once the fault has been rectified, the ST hardware output is reactivated automatically.

9.6 Operating states and change in operating status of the ST module bus

9.6.2.7 ST output module in STOP condition with module error

A module fault in an ST output module only impacts the affected ST output module. The ST module bus remains in the operating status "ST module bus in RUN condition without error".

Possible causes

- Temperature error
- Voltage error (module supply)
- A module was disconnected during operation
- A defective module was detected during operation

Effects

- The substitute values are used for all the module's output signals/output values, with Valid Bits = FALSE.
- The unaffected ST output modules on the PSSu system continue to be processed.
- Status LEDs on the head module
  The "MBUS" LED lights up red.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Once the error has been rectified, the ST output module is reactivated automatically.

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9.6 Operating states and change in operating status of the ST module bus

9.6.2.8 Minor ST error

If a fault results in this operating status, the affected sections of the ST module bus are ended as defined. A defined state is achieved.

Possible causes

- Configuration error
  (e.g. differences between the set/actual hardware registry)
- Defective ST module detected when starting the module bus

Effects

- If the fault is detected when starting the ST module bus, the ST outputs are not activated and the ST inputs are not read.
- If other PSSu systems access the ST I/O data on this PSSu system, the substitute values are used for all signals/values, with Valid Bits = FALSE.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Once the fault has been rectified, the PSSu system must be restarted via one of the reset commands.

9.6 Operating states and change in operating status of the ST module bus

9.6.3 Change in operating status of the ST module bus

This description of the change in operating status assumes that the PSSu system contains a valid device project. The figures refer to the change in operating status in the diagram "Operating states and change in operating status of the ST module bus" (see Diagram, page 9-64) .

INFORMATION
The description of each change of operating status includes a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

[1] Switching from "Booting system sections" to "ST module bus in RUN condition without error"
"Booting system sections" is one of the PSSu system's operating states (see Diagram, page 9-5) . If no fault is detected as the system sections are booted, the ST module bus is started, switching to the status "ST module bus in RUN condition without error".

[2a] Switching from "Booting system sections" to "Minor ST error"
If a fault is detected as the system sections are booted, the ST module bus switches to the operating status "Minor ST error".

The operating status "Minor ST error" is an operating status that only impacts the ST module bus of a PSSu system.

[2b] Switching from "ST module bus in RUN condition without error" to "Minor ST error"
If a fault is detected while the ST module bus is in a RUN condition, the ST module bus switches to the operating status "Minor ST error".

The operating status "Minor ST error" is an operating status that only impacts the ST module bus of a PSSu system.

[3a] Switching from "ST input module in RUN condition without error" to "ST input module in RUN condition with input error"
If an input error is detected on an ST hardware input, the ST input module switches to the operating status "ST module in RUN condition with input error".

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9.6 Operating states and change in operating status of the ST module bus

[3b] Switching from "ST input module in RUN condition without error" to "ST input module in STOP condition with module error"
If a module error is detected on an ST input module, the ST input module switches to the operating status "ST input module in STOP condition with module error".

[4] Switching from one of the operating states "ST input module in RUN condition with input error" or "ST input module in STOP condition with module error" to "ST input module in RUN condition without error"
If the relevant fault (input error, module error) is rectified, the affected section on the ST input module is reactivated automatically and the module switches to the operating status "ST input module in RUN condition without error".

[5a] Switching from "ST output module in RUN condition without error" to "ST output module in RUN condition with output error"
If an output error is detected on an ST hardware output, the ST output module switches to the operating status "ST module in RUN condition with output error".

[5b] Switching from "ST output module in RUN condition without error" to "ST output module in STOP condition with module error"
If a module error is detected on an ST output module, the ST output module switches to the operating status "ST output module in STOP condition with module error".

[6] Switching from one of the operating states "ST output module in RUN condition with output error" or "ST output module in STOP condition with module error" to "ST output module in RUN condition without error"
If the relevant fault (output error, module error) is rectified, the affected section on the ST output module is reactivated automatically and the module switches to the operating status "ST output module in RUN condition without error".

9.6 Operating states and change in operating status of the ST module bus

[7a] Switching from "Minor ST error" to "Booting system sections"
This change in operating status affects all the system sections of the PSSu system (see Fig. 8-3 in the section entitled "Operating states and change in operating status of a PSSu system"). Once the fault has been rectified, the ST module bus can be restarted via one of the reset commands:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

[7b] Switching from "ST module bus in RUN condition without error" to "Booting system sections"
This change in operating status affects all the system sections of the PSSu system (see Diagram, page 9-5) .

This change in operating status can be triggered using one of the following commands:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

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9.7 Operating states and change in operating status of the FS SafetyNET p RTFN

The description below deals exclusively with the operating states of the system section FS SafetyNET p RTFN, referring to the operating states of the PSSu system where necessary.

The diagram "Operating states and change in operating status of FS SafetyNET p RTFN" (see Flowchart, page 9-78) provides an overview of the operating states (grey):

- The figures in square parentheses indicate the various changes in operating status.
- The sections marked with the Roman numerals I and II refer to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the effects impact the whole PSSu system and not just the system section FS SafetyNET p RTFN.
- The section marked with the Roman numeral VIa refers to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the system section FS SafetyNET p RTFN is started when booting the system sections of a PSSu system.

9.7 Operating states and change in operating status of the FS SafetyNET p RTFN

9.7.1 Flow chart

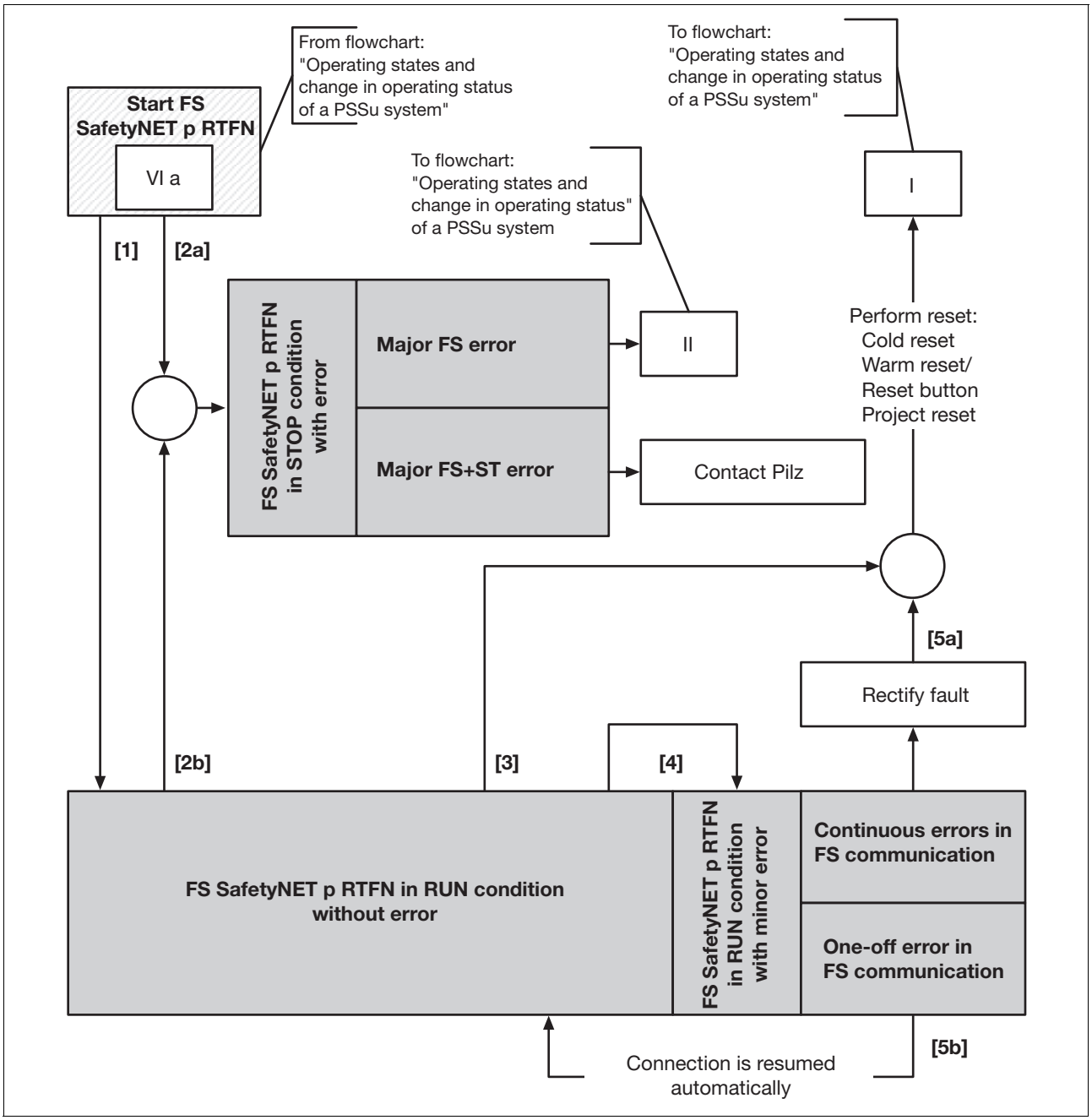

Fig. 9-9: Operating states and change in operating status of the FS SafetyNET p RTFN

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9.7 Operating states and change in operating status of the FS SafetyNET p RTFN

9.7.2 Operating states of FS SafetyNET p RTFN

The description of the various operating states assumes that the PSSu system contains a valid device project.

The system section FS SafetyNET p RTFN may assume the following operating states (see Flowchart, page 9-78) :

- Operating status "FS SafetyNET p RTFN in RUN condition without error"
- Operating status "FS SafetyNET p RTFN in STOP condition with error":
  - "Major FS error"
  - "Major FS+ST error"
- Operating status "FS SafetyNET p RTFN in RUN condition with minor error"
  - "Continuous errors in FS communication"
  - "One-off error in FS communication"

INFORMATION
The description of each operating status includes a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

9.7 Operating states and change in operating status of the FS SafetyNET p RTFN

9.7.2.1 FS SafetyNET p RTFN in RUN condition without error

This operating status is achieved through one of the following options:

- After a successful boot process, which was triggered by
  - Cold starting the PSSu system or a reboot command for the PSSu system via PAS4000
  - Pressing the reset button on the PSSu system
  - Triggering a reset via PAS4000
    (cold reset, warm reset, project reset)

Effects

- In the operating status "FS SafetyNET p RTFN in RUN condition without error", pending FS process data can be transmitted faultlessly via SafetyNET p.
- Status LEDs on the head module
  The "FS SNp" LED lights up green.

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9.7 Operating states and change in operating status of the FS SafetyNET p RTFN

9.7.2.2 Major FS error

In the event of a fault that leads to this operating status, the affected parts of the system section FS SafetyNET p RTFN are ended as defined. A defined status is achieved. The effects of a major FS fault impact all safety-related sections of a PSSu system. (see Operating state "Major FS error of a PSSu system, page 9-17) .

9.7 Operating states and change in operating status of the FS SafetyNET p RTFN

9.7.2.3 Major FS+ST error

In the event of a fault that leads to the operating status "Major FS+ST error", the affected sections of FS SafetyNET p RTFN are ended as defined. A defined status is achieved.

Possible causes

- Internal fault

Effects

- The system section FS SafetyNET p RTFN and the system section ST SafetyNET p RTFN both switch to a STOP condition. It will no longer be possible to exchange process data with the PSSu system
- The substitute values are used for the affected process data, with Valid Bits = FALSE.
- Status LEDs on the head module
  The "FS SNp" and "ST SNp" LEDs flash red.

Remedy

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9.7 Operating states and change in operating status of the FS SafetyNET p RTFN

9.7.2.4 FS SafetyNET p RTFN in RUN condition with minor error

If a fault results in a minor error in FS communication, the affected section is stopped or ended as defined. A defined status is achieved.

Possible causes

- Continuous errors in FS communication
  e.g. a PSSu system cannot be reached temporarily because it has been removed from SafetyNET p; the bus connector on a PSSu system has been unplugged
- One-off error in FS communication
  e.g. transient, one-off error on the bus cable

Effects

- FS process data is no longer exchanged with the affected PSSu system; FS process data continues to be exchanged with all other PSSu systems.
- The system section FS SafetyNET p RTFN continues to be in a RUN condition
- The substitute values are used for the affected process data, with Valid Bits = FALSE.
- Status LEDs on the head module
  "FS SNp" LED flashes green.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Reset or resume the connection automatically
   – Continuous errors in FS communication:
     Perform reset (warm reset/reset button, cold reset, project reset)
   – One-off error in FS communication:
     The connection is resumed automatically. Once the connection is restored, the process values are output at the outputs.

9.7 Operating states and change in operating status of the FS SafetyNET p RTFN

9.7.3 Change in operating status of FS SafetyNET p RTFN

This description of the change in operating status assumes that the PSSu system contains a valid device project. The figures refer to the change in operating status in the diagram "Operating states and change in operating status of FS SafetyNET p RTFN" (see Flowchart, page 9-78) .

INFORMATION
The description of each change of operating status includes a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

[1] Switching from "Booting system sections" to "FS SafetyNET p RTFN in RUN condition without error"
"Booting system sections" is one of the PSSu system's operating states (see Flowchart, page 9-5) . If no fault is detected in a safety-related system section as the system sections are booted, the system section FS SafetyNET p RTFN is started, switching to the status "FS SafetyNET p RTFN in RUN condition without error".

[2a] Switching from "Booting system sections" to an error condition
If a fault is detected in a safety-related system section as the system sections are booted (see Flowchart, page 9-5) , FS SafetyNET p RTFN switches to a STOP condition, achieving the operating status "Major FS error" or "Major FS+ST error", depending on the fault.

[2b] Switching from "FS SafetyNET p RTFN in RUN condition without error" to an error condition
If a fault is detected in a safety-related system section while FS SafetyNET p RTFN is in a RUN condition, FS SafetyNET p RTFN switches to a STOP condition, achieving the operating status "Major FS error" or "Major FS+ST error", depending on the fault.

[3] Switching from "FS SafetyNET p RTFN in RUN condition without error" to "Booting system sections"
This change in operating status affects all the system sections of the PSSu system (see Flowchart, page 9-5) .

This change in operating status can be triggered using one of the following commands:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)

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9.7 Operating states and change in operating status of the FS SafetyNET p RTFN

- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

[4] Switching from "FS SafetyNET p RTFN in RUN condition without error" to "FS SafetyNET p RTFN in RUN condition with minor error"
The change in operating status has resulted due to an FS communication error. Faults that result in this error are classified as follows:

- Continuous error in FS communication
- One-off error in FS communication.

[5a] Switching from "FS SafetyNET p RTFN in RUN condition with error" to "FS SafetyNET p RTFN in RUN condition without error"
The operating status "FS SafetyNET p RTFN in RUN condition with error" has resulted due to a continuous error in FS communication. Once the fault has been rectified, the system section can be restarted via one of the reset commands:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

[5b] Switching from "FS SafetyNET p RTFN in RUN condition with error" to "FS SafetyNET p RTFN in RUN condition without error"
The operating status "FS SafetyNET p RTFN in RUN condition with error" has resulted due to a transient, one-off error in FS communication. The connection will be resumed automatically.

9.8 Operating states and change in operating status of the ST SafetyNET p RTFN

The description below deals exclusively with the operating states of the system section ST SafetyNET p RTFN, referring to the operating states of the PSSu system where necessary.

The diagram "Operating states and change in operating status of ST SafetyNET p RTFN" (see Flowchart, page 9-87) provides an overview of the operating states (grey):

- The figures in square parentheses indicate the various changes in operating status.
- The sections marked with the Roman numerals I and II refer to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the effects impact the whole PSSu system and not just the system section ST SafetyNET p RTFN.
- The section marked with the Roman numeral VIb refers to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the system section ST SafetyNET p RTFN is started when booting the system sections of a PSSu system.

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9.8 Operating states and change in operating status of the ST SafetyNET p RTFN

9.8.1 Flow chart

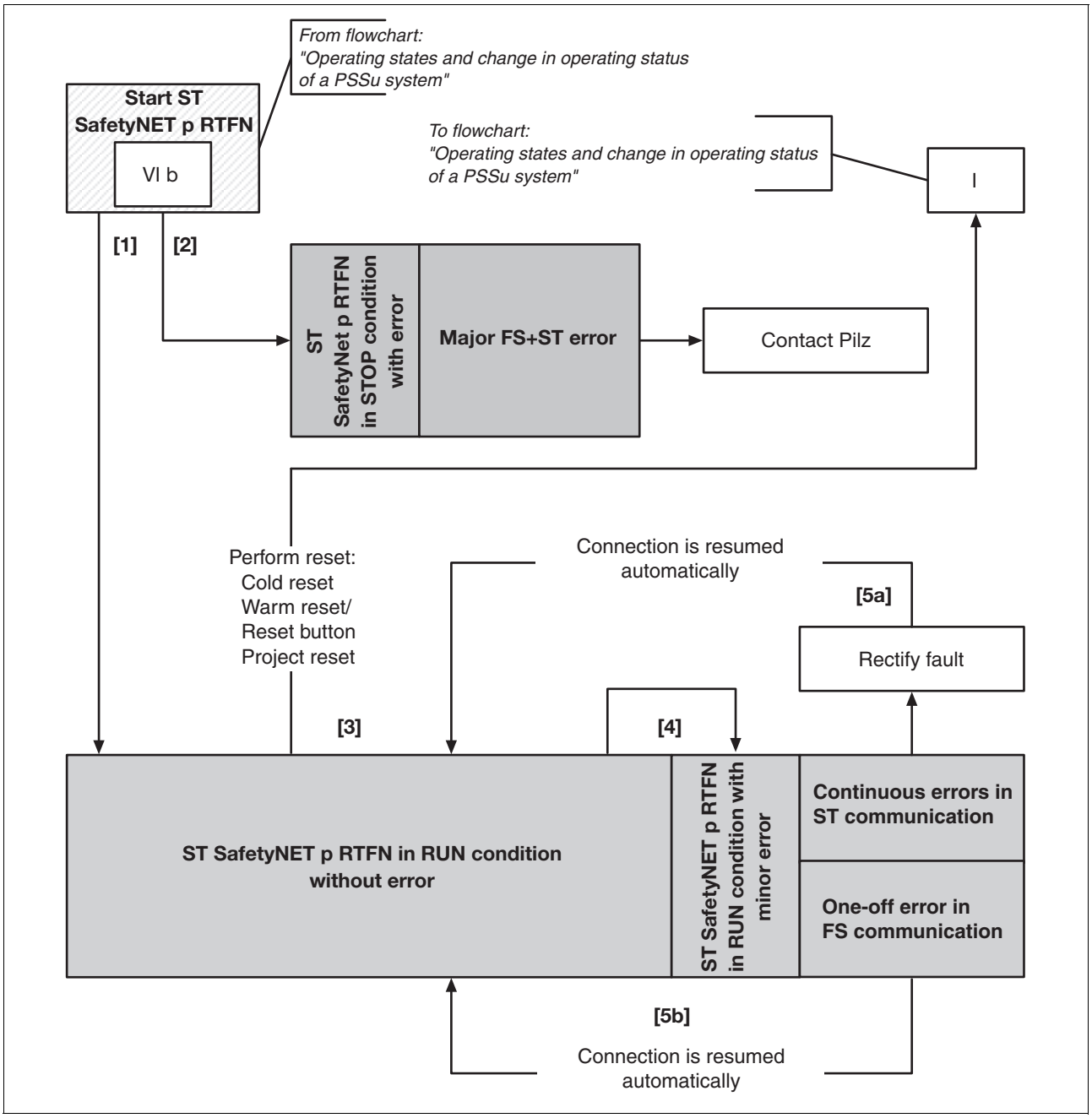

Fig. 9-10: Operating states and change in operating status of the ST SafetyNET p RTFN

9.8 Operating states and change in operating status of the ST SafetyNET p RTFN

9.8.2 Operating states of ST SafetyNET p RTFN

The description of the various operating states assumes that the PSSu system contains a valid device project.

The system section ST SafetyNET p RTFN may assume the following operating states
(see Flowchart, page 9-87) :

- Operating status "ST SafetyNET p RTFN in RUN condition without error"
- Operating status "ST SafetyNET p RTFN in STOP condition with error":
  - "Major FS+ST error"
- Operating status "ST SafetyNET p RTFN in RUN condition with minor error":
  - "Continuous errors in ST communication"
  - "One-off error in ST communication"

INFORMATION
The description of each operating status includes a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

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9.8 Operating states and change in operating status of the ST SafetyNET p RTFN

9.8.2.1 ST SafetyNET p RTFN in RUN condition without error

This operating status is achieved through one of the following options:

- After a successful boot process, which was triggered by
  - Cold starting the PSSu system or a reboot command for the PSSu system via PAS4000
  - Pressing the reset button on the PSSu system
  - Triggering a reset via PAS4000
    (cold reset, warm reset, project reset)

Effects

- In the operating status "ST SafetyNET p RTFN in RUN condition without error", pending ST process data can be transmitted faultlessly via SafetyNET p.
- Status LEDs on the head module
  The "ST SNp" LED lights up green.

9.8 Operating states and change in operating status of the ST SafetyNET p RTFN

9.8.2.2 Major FS+ST error

In the event of a fault that leads to the operating status "Major FS+ST error", the affected sections of FS SafetyNET p RTFN are ended as defined. A defined status is achieved.

Possible causes

- Internal fault

Effects

- The system section FS SafetyNET p RTFN and the system section ST SafetyNET p RTFN both switch to a STOP condition. It will no longer be possible to exchange process data with the PSSu system
- The substitute values are used for the affected process data, with Valid Bits = FALSE.
- Status LEDs on the head module
  The "FS SNp" and "ST SNp" LEDs flash red.

Remedy

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9.8 Operating states and change in operating status of the ST SafetyNET p RTFN

9.8.2.3 ST SafetyNET p RTFN in RUN condition with minor error

In the event of a fault that leads to a minor error in ST communication, the affected section is stopped or ended as defined. A defined status is achieved.

Possible causes

- Continuous errors in ST communication
  e.g. a PSSu system cannot be reached temporarily because it has been removed from SafetyNET p; the bus connector on a PSSu system has been unplugged
- One-off error in ST communication
  e.g. transient, one-off error on the bus cable

Effects

- ST process data is no longer exchanged with the affected PSSu system; ST process data continues to be exchanged with all other PSSu systems.
- The system section ST SafetyNET p RTFN continues to be in a RUN condition
- The substitute values are used for the affected process data, with Valid Bits = FALSE.
- Status LEDs on the head module
  The "FS SNp" LED flashes green.

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify fault
3. Resume the connection
   – Continuous errors in ST communication:
     The connection is resumed automatically.
   – One-off error in ST communication:
     The connection is resumed automatically.

9.8 Operating states and change in operating status of the ST SafetyNET p RTFN

9.8.3 Change in operating status of ST SafetyNET p RTFN

This description of the change in operating status assumes that the PSSu system contains a valid device project. The figures refer to the change in operating status in the diagram "Operating states and change in operating status of ST SafetyNET p RTFN" (see Flowchart, page 9-87) .

INFORMATION
The description of each change of operating status includes a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

[1] Switching from "Booting system sections" to "ST SafetyNET p RTFN in RUN condition without error"
"Booting system sections" is one of the PSSu system's operating states (see Flowchart, page 9-5) . If no fault is detected as the system sections are booted, the system section ST SafetyNET p RTFN is started, switching to the status "ST SafetyNET p RTFN in RUN condition without error".

[2] Switching from "Booting system sections" to "Major FS+ST error"
If a fault is detected as the system sections are booted (see Flowchart, page 9-5) , the system section ST SafetyNET p RTFN switches to a STOP condition, achieving the operating status "Major FS+ST error".

[3] Switching from "ST SafetyNET p RTFN in RUN condition without error" to "Booting system sections"
This change in operating status affects all the system sections of the PSSu system (see Flowchart, page 9-5) .

This change in operating status can be triggered using one of the following commands:
- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

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9.8 Operating states and change in operating status of the ST SafetyNET p RTFN

[4] Switching from "ST SafetyNET p RTFN in RUN condition without error" to "ST SafetyNET p RTFN in RUN condition with minor error"
The change in operating status has resulted due to an ST communication error. Faults that result in this error are classified as follows:

- Continuous error in ST communication
- One-off error in ST communication.

[5a] Switching from "ST SafetyNET p RTFN in RUN condition with error" to "ST SafetyNET p RTFN in RUN condition without error"
The operating status "ST SafetyNET p RTFN in RUN condition with error" has resulted due to a continuous error in ST communication. Once the fault has been rectified, the connection is resumed automatically.

[5b] Switching from "ST SafetyNET p RTFN in RUN condition with error" to "ST SafetyNET p RTFN in RUN condition without error"
The operating status "ST SafetyNET p RTFN in RUN condition with error" has resulted due to a transient one-off error in ST communication. The connection will be resumed automatically.

9.9 Operating states and change in operating status with external communication

The description below deals exclusively with the operating states with external communication (see Communication modes for external communication, page 7-1) . The operating states are identical for the respective system section (e.g. system section "IP connections", system section "PROFIBUS-DP Slave"). Where necessary, reference is made to the operating states of the PSSu system.

The diagram "Operating states and change in operating status with external communication" (see Flowchart, page 9-95) provides an overview of the operating states (grey):

- The figures in square parentheses indicate the various changes in operating status.
- The section marked with the Roman numeral I refers to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the effects impact the whole PSSu system and not just the system section for the respective external communication.
- The section marked with the Roman numeral VII refers to the diagram "Operating states and change in operating status of a PSSu system" (see Flowchart, page 9-5) , as the system section for the respective external communication is started when booting the system sections of a PSSu system.

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9.9 Operating states and change in operating status with external communication

9.9.1 Flow chart

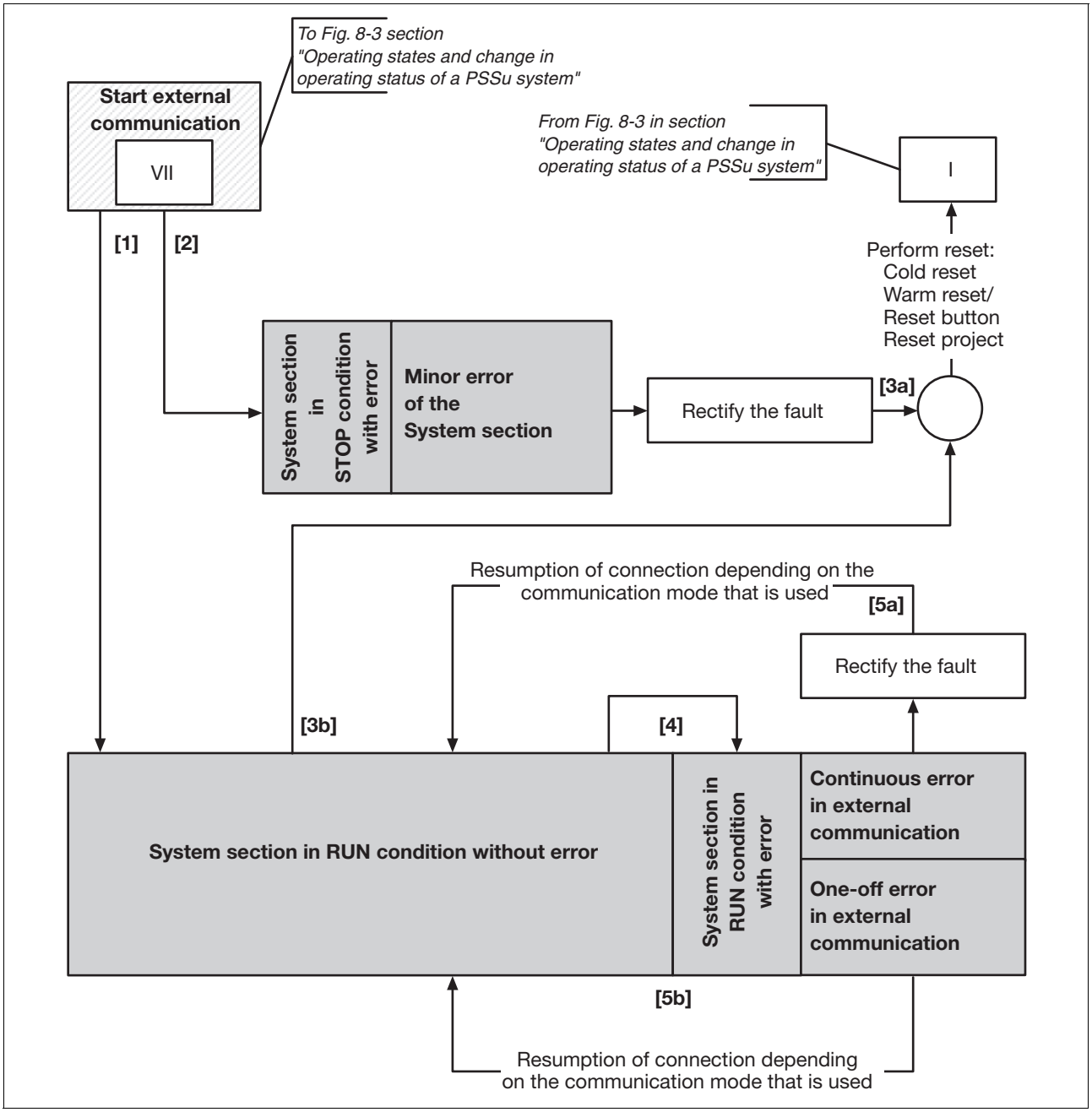

Fig. 9-11: Operating states and change in operating status with external communication

9.9 Operating states and change in operating status with external communication

9.9.2 Operating states with external communication

The description of the various operating states assumes that the PSSu system contains a valid device project.

The system section for the respective external communication (e.g. Modbus/TCP, Raw UDP, PROFIBUS-DP Slave) may assume the following operating states (see Flowchart, page 9-95) :

- Operating status "System section in RUN condition without error"
- Operating status "System section in STOP condition with error"
  - "Minor error on the system section for external communication"
- Operating status "System section in RUN condition with error"
  - "Continuous errors in external communication"
  - "One-off error in external communication"

INFORMATION

- The descriptions of various operating states include a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .
- In some communication modes various operating states can be displayed via status LEDs of the head module. The presence of status LEDs and their meaning depends on the communication mode used.
  Examples:
  Modbus/TCP and Raw UDP are protocols that are based on Industrial Ethernet. The have no status LEDs to display operating states.
  On PROFIBUS-DP Slave the two status LEDs "SF" and "BF" display various states.

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9.9 Operating states and change in operating status with external communication

9.9.2.1 System section in RUN condition without error

This operating status is achieved through one of the following options:

- After a successful boot process, which was triggered by
  - Cold starting the PSSu system or a reboot command for the PSSu system in PAS4000
  - Pressing the reset button on the PSSu system
  - Triggering a reset via PAS4000
    (cold reset, warm reset, project reset)

Effects

- When the operating status of the respective external communication (e.g. Modbus/TCP, Raw UDP, PROFIBUS-DP Slave) is "System section in RUN condition without error", pending ST process data is transmitted faultlessly using the respective communication mode.
- Status LEDs on the head module
  Depends on the communication mode that is used

9.9 Operating states and change in operating status with external communication

9.9.2.2 Minor error on the system section for external communication

In the event of a fault that leads to this operating status, the affected parts of the system section are ended as defined. A defined status is achieved.

Possible causes

- Configuration error

Effects

- System section for the respective external communication switches to a STOP condition. With the PSSu system It is not possible to exchange process data via the corresponding communication mode.
- The substitute values are used for the affected process data, with Valid Bits = FALSE.
- Status LEDs on the head module
  Depends on the communication mode that is used

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify the fault
   e. g. synchronize the configuration of the communication partners
3. Perform reset

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9.9 Operating states and change in operating status with external communication

9.9.2.3 System section in RUN condition with error

If a fault results in an error in external communication, the affected section is stopped or ended. A defined state is achieved.

Possible causes

- Continuous errors in external communication
  e. g. the communication partner cannot be reached because it has been removed; the bus connector on a PSSu system has been unplugged
- One-off error in ST communication
  e.g. transient, one-off error on the bus cable, loss of telegram

Effects

- There is not longer process data exchange with the communication partner.
- The interface continues to be in a RUN condition.
- The substitute values are used for the affected process data, with Valid Bits = FALSE.
- Status LEDs on the head module
  depends on the communication mode that is used

Remedy

1. Diagnostics
   e.g. use PAS4000 to read the diagnostic list and/or the diagnostic log
2. Rectify errors
3. Resume the connection
   The options for resuming the connection depend on the communication mode that is used and in various cases also on the configuration options of the communication partners.
   If this is supported by the communication mode, the interface of the PSSu system automatically resumes the connection. Otherwise, the interface must be restarted via one of the reset commands.
   – Warm reset (PAS4000) or reset button (PSSu system)
   – Cold reset (PAS4000)
   – Warm reset of project (PAS4000)
   – Cold reset of project (PAS4000).

9.9 Operating states and change in operating status with external communication

INFORMATION

Please note:

- Under some circumstances it is necessary to restart the communication partner
- The fault may have been caused by the communication partner. In this case the fault with the communication partner must be rectified first, before the interface of the PSSu system can restore the connection.

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9.9 Operating states and change in operating status with external communication

9.9.3 Operating status change with external communication

This description of the change in operating status assumes that the PSSu system contains a valid device project. The figures refer to the change in operating status in the diagram "Operating states and change in operating status with external communication" (see Flowchart, page 9-95) .

INFORMATION
The description of each change of operating status includes a list of the options for triggering a change in operating status. These options are described separately (see Reset, restart, start and stop options, page 9-104) .

[1] Switching from "Booting system sections" to "System section in RUN condition without error"
"Booting system sections" is one of the PSSu system's operating states (see Flowchart, page 9-5) . If no fault is detected as the system sections are booted, the system section for the respective external communication is started, switching to the status "System section in RUN condition without error".

[2] Switching from "Booting system sections" to "Minor error on the system section for external communication"
If a fault is detected as the system sections are booted (see Flowchart, page 9-5) , the system section switches to a STOP condition, achieving the operating status "Minor error on the system section for external communication".

[3a] Switching from "Minor error on the system section for external communication" to "Booting system sections"
Once the fault has been rectified, the system section for the external communication can be restarted via one of the reset commands. This change in operating status affects all the system sections of the PSSu system (see Flowchart, page 9-5) .

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

9.9 Operating states and change in operating status with external communication

[3b] Switching from "System section in RUN condition without error" to "Booting system sections"
This change in operating status affects all the system sections of the PSSu system (see Flowchart, page 9-5) .

This change in operating status can be triggered using one of the following commands:
- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

[4] Switching from "System section in RUN condition without error" to "System section in RUN condition with error"
The change in operating status has resulted due to a communication error. Faults that result in this error are classified as follows:
- Continuous error in external communication
- One-off error in external communication.

[5a] Switching from "System section in RUN condition with error" to "System section in RUN condition without error"
The operating status "System section in RUN condition with error" has resulted due to a continuous error in external communication. Once the fault has been rectified, the options for resuming the connection depend on the communication mode that is used and in various cases also on the configuration options of the communication partners.

If the actual cause of the error does not lie with the communication partner, the system section for external communication can be restarted with one of the following commands:
- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

[5b] Switching from "System section in RUN condition with error" to "System section in RUN condition without error"
The operating status "System section in RUN condition with error" has resulted due to a transient one-off error in external communication. The options for resuming the connection depend on the communication mode that is used and in various cases also on the configuration options of the communication partners.

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9.9 Operating states and change in operating status with external communication

If the actual cause of the error does not lie with the communication partner, the system section for external communication can be restarted with one of the following commands:

- Warm reset (PAS4000) or reset button (PSSu system)
- Cold reset (PAS4000)
- Warm reset of project (PAS4000)
- Cold reset of project (PAS4000)

9.10 Reset, restart, start and stop

PSS 4000 operates in accordance with the principle of "de-escalation". The aim of the principle of de-escalation is to limit the effects of intervening in the control process (e.g. when a fault occurs) to the affected areas if possible. All unaffected areas should continue operating without disruption if possible, and without repercussions on the safety function.

Various options are available to stop and start specific plant/machine sections, during commissioning for example. The implications of intervening in the control process depend on the specific command that is used.

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9.10 Reset, restart, start and stop

9.10.1 Overview

9.10.1.1 Reset, restart, start and stop options

The following table provides an overview of the reset, restart, start and stop options and the corresponding commands in PAS4000:

Options	PAS4000
Cold start a PSSu system (affects all system sections on a PSSu system)	- - -
Reboot a project (affects all system sections on all the project's PSSu systems)	Reboot
Reboot a PSSu system (affects all system sections on a PSSu system)	Reboot
Reset a project (affects all system sections on all the project's PSSu systems)	Cold reset
	Warm reset
Reset a PSSu system (affects all system sections on a PSSu system)	Cold reset
	Warm reset
Reset via the reset button of a PSSu system	- - -
Restart a project (affects all resources on all PSSu systems)	Cold restart
	Warm restart
Restart a resource (affects a resource on a PSSu system)	FS cold restart
	ST cold restart
	FS warm restart
	ST warm restart
Start tasks on a resource (affects one or more tasks on a resource)	FS hot start
	ST hot start
Stop a project (affects all resources on all the project's PSSu systems)	Stop
Stop a PSSu system (affects all resources on a PSSu system)	Stop
Stop a resource (affects a resource on a PSSu system)	FS stop
	ST stop

9.10 Reset, restart, start and stop

9.10.1.2 Impact on local and resource global variables

The following table provides an overview of the impact of a reset, restart, start or stop on local variables and resource global variables (not O-PI variables).

After one of the stated commands, the affected sections (e.g. tasks on a resource, system sections) are started up with the following variable values:

Action	Variable with attribute RETAIN PERSISTENT	Volatile variable
Cold start **Reboot**	Saved value	Variable is set to initial value
Warm restart **Warm reset**		
Cold restart **Cold reset**	Variable is set to initial value	
Hot start	Saved value	
Stop	Saved value is retained	

Notes:

- The content of the variable with the attribute RETAIN PERSISTENT is saved after a task is executed and is retained even in the event of a power failure or restart/reboot.
- The saved content of the variable with the attribute RETAIN PERSISTENT may come from the penultimate task execution before the power failure.
  If several variables are saved, some may come from the penultimate task execution and others from the last execution.

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9.10 Reset, restart, start and stop

9.10.1.3 Impact on active "variable forcing"

The following table provides an overview of the impact of a reset, restart, start or stop on active "variable forcing":

Action	Impact on "variable forcing"
Cold start Reboot	"Variable forcing" is stopped, "variable forcing" will then need to be started manually
Warm restart Warm reset	
Cold restart Cold reset	
Hot start	"Variable forcing" is stopped, "variable forcing" will then be started automatically through the system
Stop	"Variable forcing" is stopped, the way in which "variable forcing" is restarted depends on the subsequent (re-) start action/reset action: - Warm restart/warm reset - Cold restart/cold reset - Hot start

9.10 Reset, restart, start and stop

9.10.1.4 Impact on "variable controlling"

"Variable controlling" is executed once only. A reset, restart, start or stop command only has an impact if "variable controlling" has not yet been run.

The following table provides an overview of the impact of a reset, restart, start or stop on "variable controlling":

Action	Impact on "variable controlling"
Cold start Reboot	"Variable controlling" actions that have not yet been run are deleted
Warm restart Warm reset	
Cold restart Cold reset	
Hot start	"Variable controlling" actions that have not yet been run are run after a hot start
Stop	"Variable controlling" is not run, whether the "variable controlling" action is run depends on the subsequent (re-) start action/reset action: - Warm restart/warm reset - Cold restart/cold reset - Hot start

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9.10 Reset, restart, start and stop

9.10.2 Cold start and Reboot command

The effect of a cold start (supply voltage for the module supply is switched off and on) and a reboot command is device-based, i.e. it affects all the system sections on a PSSu system (FS resource, ST resource etc.).

Procedure

Performing a cold start/reboot command initiates the following procedure:

1. Processing is aborted
2. PSSu system switches to "Booting base system" operating status.
3. "Booting system sections" operating status is achieved and all system sections are started
4. Operational entry in the diagnostic log
5. Impact after the cold start/reboot command
   The impact on local variables and resource global variables is described separately (see Impact on local and resource global variables, page 9-106) . Impact on "variable forcing" is also described separately (see Impact on active "variable forcing", page 9-107) .

9.10 Reset, restart, start and stop

Behaviour during a cold start/reboot command

The table below describes the behaviour of the process data and system sections:

Process data, system sections		Behaviour	
Process data	I-data of the module bus with I/O mapping [1]	Bit modules	Inputs = current physical input signals
		Byte modules	Inputs = current physical input values
	O-data of module bus	Bit modules	Outputs = ZERO
		Byte modules	Outputs = switch-on values (see module's operating manual)
	O-PI variables with I/O mapping [1]	O-PI variables are marked as invalid	
System sections	FS resource	See "Procedure"	
	ST resource		
	FS module bus		
	ST module bus		
	FS SafetyNET p RTFN		
	ST SafetyNET p RTFN		
	External communication e.g. "IP connections" system section, "PROFIBUS-DP Slave" system section		

[1]
Process data that is accessed by other PSSu systems is set to substitute values in the other PSSu systems; Valid Bits = FALSE (see Validity of process data, page 8-4) .

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9.10 Reset, restart, start and stop

9.10.3 Reset commands

The effect of a reset (cold reset, warm reset) is device-based, i.e. it affects all system sections of a PSSu system (FS resource, ST resource etc.). The main difference between a cold reset and a warm reset is the way in which the non-volatile variables are handled.

A cold reset can be used when a defined output status is to be brought about on a PSSu system in respect of the variables.

A warm reset can be used when the desired behaviour on a PSSu system is the same as that for a cold start/reboot command in respect of the non-volatile variables.

The following resets are available:

- Cold resets
  - Cold reset of all a project's PSSu systems
  - Cold reset of one PSSu system
- Warm resets:
  - Warm reset of all a project's PSSu systems
  - Warm reset of one PSSu system (PAS4000 or reset button)

9.10 Reset, restart, start and stop

Procedure

Performing a reset initiates the following procedure:

1. All system sections are stopped
   - Resetting a project:
     The tasks on all resources and all other system sections on all the project's PSSu systems are run through to the end; any further execution is then stopped.
   - Resetting a PSSu system:
     The tasks on all resources and all other system sections of the PSSu system are run through to the end; any further execution is then stopped.
2. Booting system sections
   - Resetting a project:
     All the project's PSSu systems switch to "Booting system sections" operating status, including starting all system sections and all tasks on all resources that were in a RUN condition or had a task error prior to the reset.
   - Resetting a PSSu system:
     Selected PSSu system switches to "Booting system sections" operating status, including starting all system sections and all tasks on all resources that were in a RUN condition or had a task error prior to the reset.
3. Diagnostic log
   - Resetting a project:
     Operational entry is made in the diagnostic log for each of the project's PSSu systems
   - Resetting a PSSu system:
     Operational entry is made in the diagnostic log for the selected PSSu system
4. Diagnostic list
   - Resetting a project:
     Diagnostic list is deleted
   - Resetting a PSSu system:
     Messages about the selected PSSu system are deleted from the diagnostic list
5. Impact after a reset
   The impact on local variables and resource global variables is described separately (see Impact on local and resource global variables, page 9-106) . Impact on "variable forcing" is also described separately (see Impact on active "variable forcing", page 9-107) .

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9.10 Reset, restart, start and stop

Behaviour during a reset

The table below describes the behaviour of the process data and system sections during a reset:

Process data, system sections		Behaviour	
Process data	I-data of the module bus with I/O mapping [1]	Bit modules	Inputs = current physical input signals
		Byte modules	Inputs = current physical input values
	O-data of module bus	Bit modules	Outputs = ZERO
		Byte modules	Outputs = switch-on values (see module's operating manual)
	O-PI variables with I/O mapping [1]	O-PI variables are marked as invalid	
System sections	FS resource	See section entitled "Procedure"	
	ST resource		
	FS module bus		
	ST module bus		
	FS SafetyNET p RTFN		
	ST SafetyNET p RTFN		
	External communication e.g. "IP connections" system section, "PROFIBUS-DP Slave" system section		

[1]
Process data that is accessed by other PSSu systems is set to substitute values in the other PSSu systems; Valid Bits = FALSE (see Validity of process data, page 8-4) .

9.10 Reset, restart, start and stop

9.10.4 Hot start commands

A hot start (FS hot start, ST hot start) impacts on the following system sections of a PSSu system:

- FS hot start: affected tasks belonging to the FS resource
- ST hot start: affected tasks belonging to the ST resource

With a hot start, the process is continued exactly at the point at which it was previously stopped (runtime error or stop command). A hot start has no effect on the diagnostic list, i.e. the entries are retained.

A hot start is suitable for commissioning, for example. One of the stop commands (see Stop commands, page 9-119) can be used to halt a targeted subprocess (e.g. for adjustment, step-by-step commissioning), which is then continued with a hot start.

Hot start in operating status "Resource in RUN condition with task error":

Procedure for an FS/ST hot start while the FS/ST resource is in a RUN condition with a task error: Task in a STOP condition"

Prerequisite: The error has been rectified

1. Operational entry is made in the diagnostic log
2. Affected tasks on the FS/ST resource are started
   Only those resource tasks that were no longer run due to a fault are started. A hot start does not affect any tasks on the FS/ST resource that have run faultlessly.
3. Impact after a hot start
   The impact on local variables and resource global variables is described separately (see Impact on local and resource global variables, page 9-106) . Impact on "variable forcing" is also described separately (see Impact on active "variable forcing", page 9-107) .

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9.10 Reset, restart, start and stop

Hot start after a stop command

Procedure for an FS/ST hot start after a stop command:

Prerequisite: No task errors are present.

1. Operational entry is made in the diagnostic log
2. Affected tasks on the FS/ST resource are started
   All tasks on the selected resource are started. The user program is continued at the point at which it was previously stopped via the stop command.
3. Impact after a hot start
   The impact on local variables and resource global variables is described separately (see Impact on local and resource global variables, page 9-106) . Impact on "variable forcing" is also described separately (see Impact on active "variable forcing", page 9-107) .

9.10 Reset, restart, start and stop

9.10.5 Restart commands

The effect of a restart (cold restart, warm restart) is resource-based, i.e. it affects the selected resource on a PSSu system (ST/FS resource). The main difference between a cold restart and a warm restart is the way in which it handles the non-volatile variables used to start a resource after a restart.

A cold restart can be used when a defined output status is to be brought about for a resource (FS resource/ST resource) in respect of the variables.

A warm restart can be used when the desired behaviour for a resource (FS resource/ST resource) is the same as that for a cold start/reboot command in respect of the non-volatile variables.

The following restarts are available:
- Cold restart for a project
- Warm restart for a project
- FS cold restart for the FS resource on a PSSu system
- ST cold restart for the ST resource on a PSSu system
- FS warm restart for the FS resource on a PSSu system
- ST warm restart for the ST resource on a PSSu system

As a restart is always preceded by an automatic stop (fault on the ST/FS resource) or a manually executed stop (stop command), the impact on the affected process data and system sections is determined by the resource's STOP condition. While a resource is in a STOP condition, the process data and system sections always behave in the same way, so it does not matter how the STOP condition was triggered (see Stop commands – Behaviour during the STOP condition, page 9-119) .

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9.10 Reset, restart, start and stop

Restart in the operating status "Resource in RUN condition without error"

Procedure for a restart while the selected resource is in a RUN condition without error:

1. Resources are stopped
   - Restarting the resources on a project's PSSu systems:
     On all the project's PSSu systems, the resources (FS and ST resources) are run through to the end; any further execution is then stopped.
   - Restarting the resource on a PSSu system:
     The selected resource (FS/ST resource) on the PSSu system is run through to the end; any further execution is then stopped.
2. Diagnostic log
   - Restarting a project:
     Operational entry is made in the diagnostic log for each of the project's resources
   - Restarting a resource on a PSSu system:
     Operational entry is made in the diagnostic log for the selected resource
3. Diagnostic list
   - Restarting a project:
     Messages for all the resources are deleted from the diagnostic list.
   - Restarting a resource on a PSSu system:
     Messages for the selected resource are deleted from the diagnostic list
4. Resources are started
   - Cold/warm restart for a project:
     The resources (FS and ST resources) are started on all the project's PSSu systems.
   - Cold/warm restart for a resource on a PSSu system:
     The selected resource (FS/ST resource) on the PSSu system is started.
5. Impact after a cold/warm restart
   The impact on local variables and resource global variables is described separately (see Impact on local and resource global variables, page 9-106) . Impact on "variable forcing" is also described separately (see Impact on active "variable forcing", page 9-107) .

9.10 Reset, restart, start and stop

Restart after a stop command/error

Procedure for restarting after a stop command/error:

Prerequisite in the event of an error: The fault has been rectified

1. Diagnostic log
   - Restarting a project:
     Operational entry is made in the diagnostic log for each of the project's resources
   - Restarting a resource on a PSSu system:
     Operational entry is made in the diagnostic log for the selected resource
2. Diagnostic list
   - Restarting a project:
     Messages for all the resources are deleted from the diagnostic list
   - Restarting a resource on a PSSu system:
     Messages for the selected resource are deleted from the diagnostic list
3. Resources are started
   - Restarting a project:
     The resources (FS and ST resources) are started on all the project's PSSu systems.
   - Cold/warm restart of a PSSu system:
     The selected resource (FS/ST resource) is started.
4. Impact after a restart
   The impact on local variables and resource global variables is described separately (see Impact on local and resource global variables, page 9-106) . Impact on "variable forcing" is also described separately (see Impact on active "variable forcing", page 9-107) .

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9.10 Reset, restart, start and stop

9.10.6 Stop commands

The following stop commands are available:

- Stopping a resource
  The command is resource-based, i.e. it affects the selected resource on a PSSu system:
  – Stop FS resource: Stops the FS resource on a PSSu system
  – Stop ST resource: Stops the ST resource on a PSSu system
- Stopping a PSSu system
  The command is device-based, i.e. it affects all resources (FS resource, ST resource) on the selected PSSu system.
- Stopping a project
  The command is device-based, i.e. it affects all resources (FS resource, ST resource) on all a project's PSSu systems.

Procedure for stopping a resource

Stopping the selected resource (FS resource/ST resource) on a PSSu system initiates the following procedure:

1. All tasks on the selected resource are stopped
   The impact on local and resource global variables processed via the selected resource is described separately (see Impact on local and resource global variables, page 9-106) . Impact on "variable forcing" is also described separately (see Impact on active "variable forcing", page 9-107) .
2. Operational entry is made in the diagnostic log for the selected resource
3. Message is entered in the diagnostic list

9.10 Reset, restart, start and stop

Procedure for stopping a PSSu system

Stopping a PSSu system initiates the following procedure:

1. All resources on the selected PSSu system are stopped
   The impact on local and resource global variables processed via the selected resources is described separately (see Impact on local and resource global variables, page 9-106) . Impact on "variable forcing" is also described separately (see Impact on active "variable forcing", page 9-107) .
2. Operational entries are made in the diagnostic log for the resources on the PSSu system
3. Messages are entered in the diagnostic list

Procedure for stopping a project

Stopping a project initiates the following procedure:

1. All resources on all the project's PSSu systems are stopped
   The impact on local and resource global variables processed via the selected resources is described separately (see Impact on local and resource global variables, page 9-106) . Impact on "variable forcing" is also described separately (see Impact on active "variable forcing", page 9-107) .
2. Operational entries are made in the diagnostic log for all of the project's resources
3. Messages are entered in the diagnostic list

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9.10 Reset, restart, start and stop

Behaviour during the STOP condition

The behaviour of the process data and system sections while a resource is in a STOP condition is always the same, whether the STOP condition was triggered by a fault or a manual stop command. The table below describes the behaviour of the process data and system sections while a resource is in a STOP condition:

Process data, system sections		Behaviour	
Process data	I-data of the module bus with I/O mapping (for "Stopping a PSSu system" see [1])	Bit modules	Inputs = current physical input signals
		Byte modules	Inputs = current physical input values
	O-data of the module bus with I/O mapping (for "Stopping a resource" see [2])	Bit modules	Outputs = ZERO
		Byte modules	Outputs = switch-on values see module's operating manual)
	O-PI variables of the stopped resource or resources	O-PI variables are marked as invalid (see [1] and [2])	
System sections	FS resource	See sections - Procedure for stopping a resource - Procedure for stopping a PSSu system - Procedure for stopping a project	
	ST resource		
	FS module bus	No impact	
	ST module bus		
	FS SafetyNET p RTFN		
	ST SafetyNET p RTFN		
	External communication e.g. "IP connections" system section, "PROFIBUS-DP Slave" system section		

[1]
Process data that is accessed by other PSSu systems is set to substitute values in the other PSSu systems; Valid Bits = FALSE (see Validity of process data, page 8-4) .

[2]
Only the hardware outputs that are assigned to the O-PI variables on the stopped resource behave as described in the above table. Hardware outputs that are assigned to the O-PI variables on other (running) resources continue to be written by these variables.

9.11 Functions of the reset button

The availability of a reset button depends on the device. Details can be found in the operating manual of the relevant device. On modular PSSu systems, the reset button is on the head module, for example,

The reset button has various functions:

- Perform a warm reset for a PSSu system
- Deliberate operator action
  - To perform an original reset for the PSSu system
  - To transfer the naming data and/or device project from the removable data medium

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9.11 Functions of the reset button

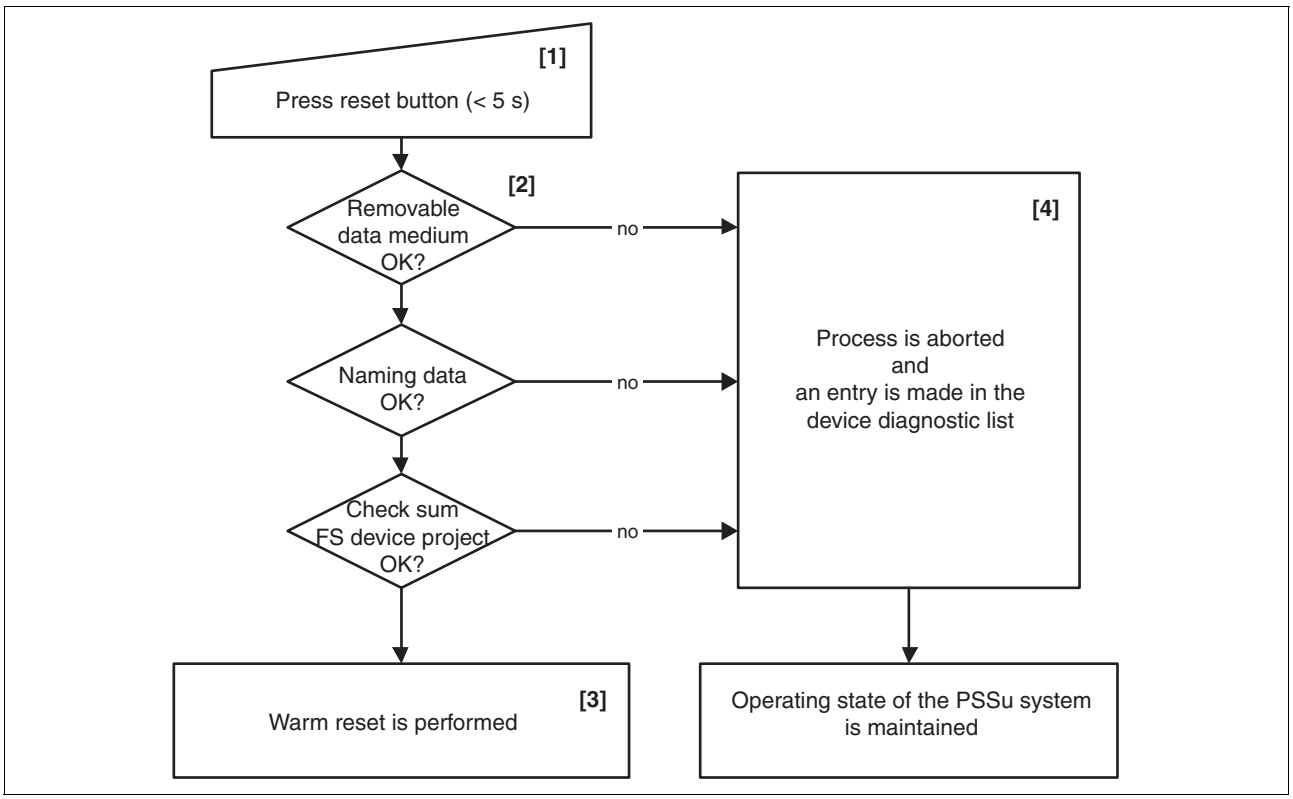
9.11.1 Perform a warm reset for a PSSu system

On a PSSu system, a warm reset triggers a switch to the operating status "Booting system sections".

The general effects of a warm reset are described separately (see Reset commands, page 9-111) .

This section describes how to perform a warm reset via the reset button on the head module of a PSSu system. The tool's online help describes how to perform a warm reset in PAS4000.

Procedure for a warm reset via the reset button



[1]
A reset via the reset button is a warm reset. For a warm reset, the reset button on the head module of the PSSu system must be pressed for max. 5 s.

9.11 Functions of the reset button

[2]
Various checks are made before performing the warm reset. While these checks are carried out, the PSSu system remains unchanged in its current operating status. The following checks are performed:

- Is the removable data medium accessible, i.e.
  - The removable data medium is present
  - The removable data medium is intact
- Does the naming data on the removable data medium match that of the PSSu system
- Is the check sum of the FS device project on the removable data medium identical to that of the PSSu system.
  Further information on check sums is available in PAS4000's online help under "Security mechanisms".

[3]
If all the checks are positive, the warm reset is performed.

[4]
If any of the checks is negative, the process is aborted. The PSSu system remains unchanged in its current operating status.

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9.11 Functions of the reset button

9.11.2 Deliberate operator action for an original reset of the PSSu system

An original reset can be performed using the reset button on the head module of a PSSu system.

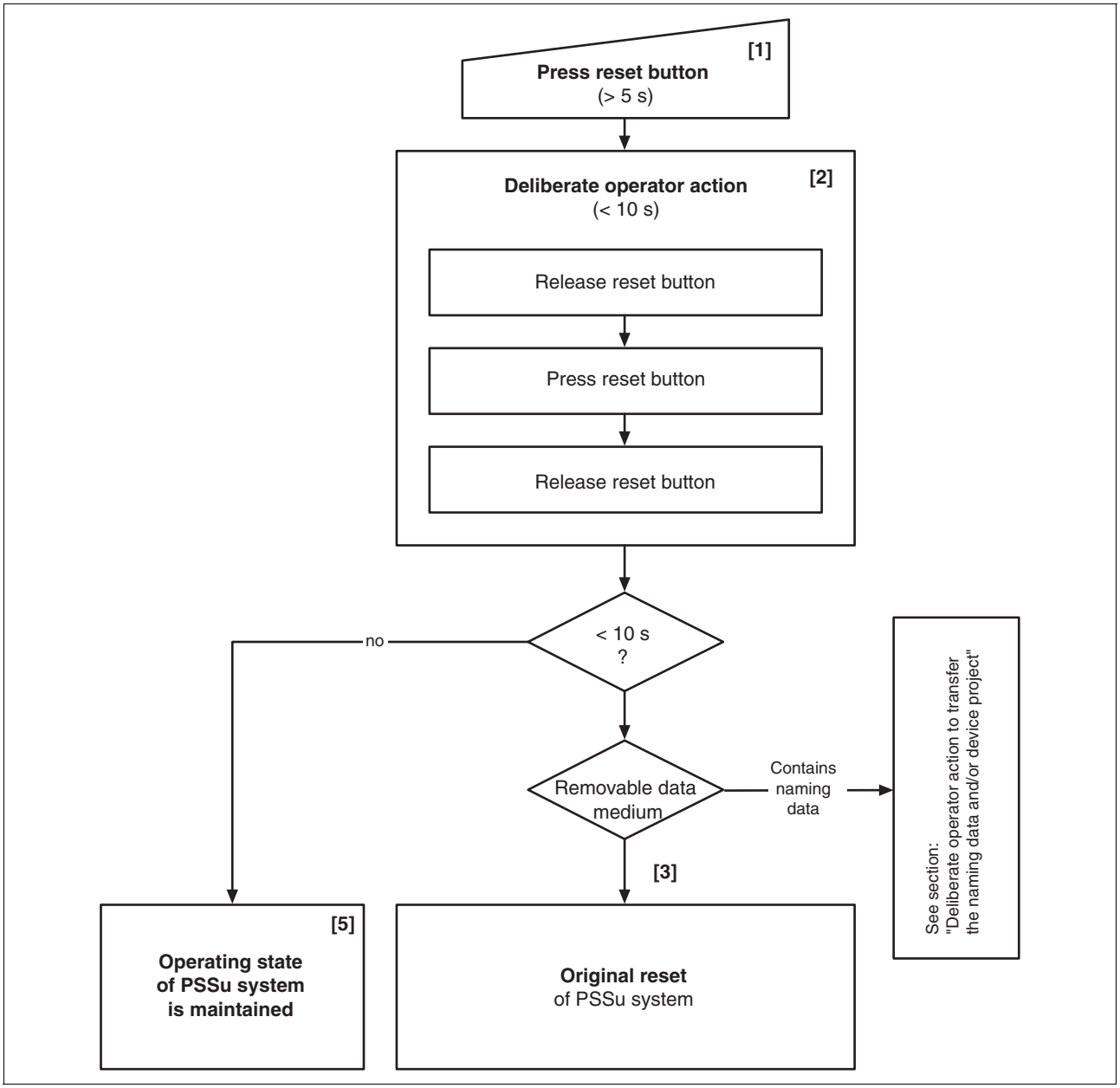
Prerequisites

The removable data medium on the head module of the PSSu system must be either disconnected or empty.

INFORMATION
Please note that a defective removable data medium will also trigger an original reset.

9.11 Functions of the reset button

Procedure for an original reset



[1]
The reset button on the head module of the PSSu system is pressed for longer than 5 s. The PSSu system remains unchanged in its current operating status.

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9.11 Functions of the reset button

[2]
Deliberate operator action within 10 s:
Release reset button – Press reset button – Release reset button
The start of deliberate operator action is displayed through the DIAG LED (flashing red-green).

[3]
The removable data medium is checked. If an empty removable data medium is connected, or no data medium is connected, the original reset is performed (see Original reset, page 9-134) .

Please note:
If the removable data medium contains naming data, an original reset will not be performed (see “Deliberate operator action to transfer the naming data and/or device project”, page 9-128) .

[4]
If deliberate operator action is not performed within 10 s, the PSSu system will remain unchanged in its current operating status.

9.11 Functions of the reset button

9.11.3 Deliberate operator action to transfer the naming data and/or device project

The naming data and/or device project can be transferred from the removable data medium to the PSSu system using the reset button. In many cases, a warm reset will be sufficient to enable data to be transferred using the reset button (see Perform a warm reset for a PSSu system, page 9-123) . In the following cases, deliberate operator action is absolutely essential for transferring data:

- The device has an FS resource.
- The device is **not** a new device and **not** a device for which an original reset has been performed.

Prerequisites

- A removable data medium must be connected on the PSSu system.
- The removable data medium must be neither empty nor defective.
- The device project on the removable data medium must match the product type.

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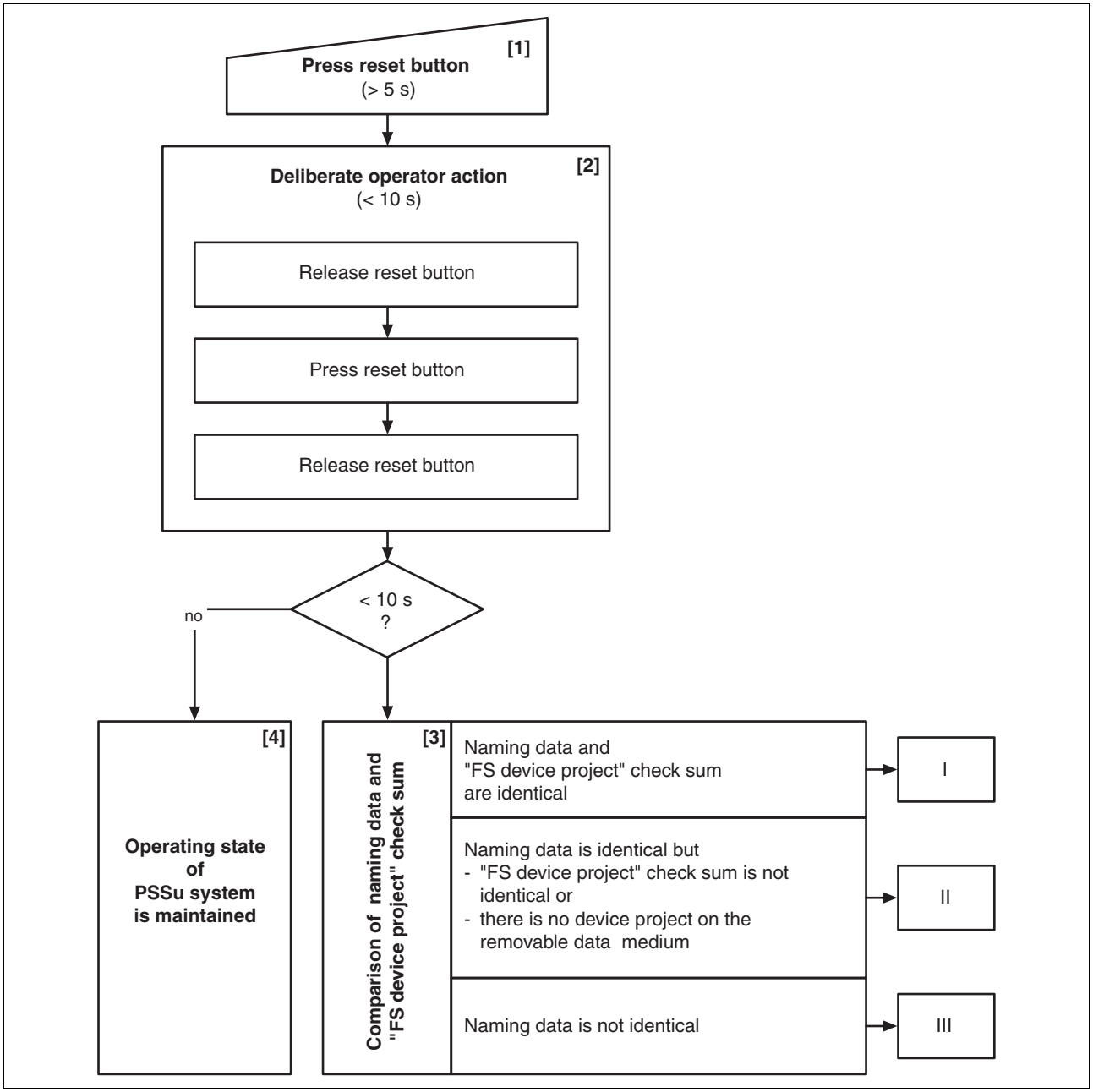
9.11 Functions of the reset button

Procedure for transferring the naming data and/or the FS device project



[1]
The reset button on the head module of the PSSu system is pressed for longer than 5 s. The PSSu system remains unchanged in its current operating status.

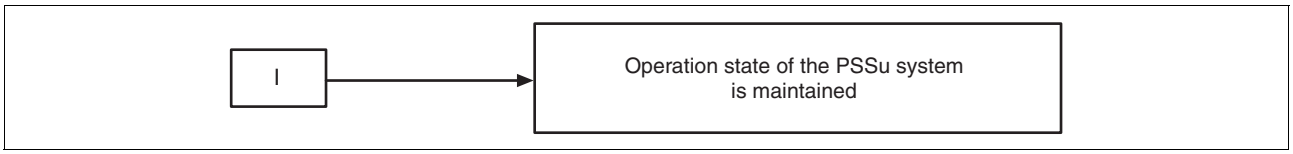
9.11 Functions of the reset button

[2]
Perform deliberate operation action within 10 s:
Release reset button – Press reset button – Release reset button
The start of deliberate operator action is displayed through the DIAG LED (flashing red-green).

[3]
When the naming data and the check sum of the FS device project on the removable data medium are compared with the corresponding data on the PSSu system, a distinction is made between various cases. The sections marked with the Roman numerals I, II and III refer to the corresponding diagrams and description.

[4]
If deliberate operator action is not performed within 10 s, the PSSu system will remain unchanged in its current operating status.

Procedures after the comparison



The naming data and check sum of the FS device project are identical.
The PSSu system remains unchanged in its current operating status.

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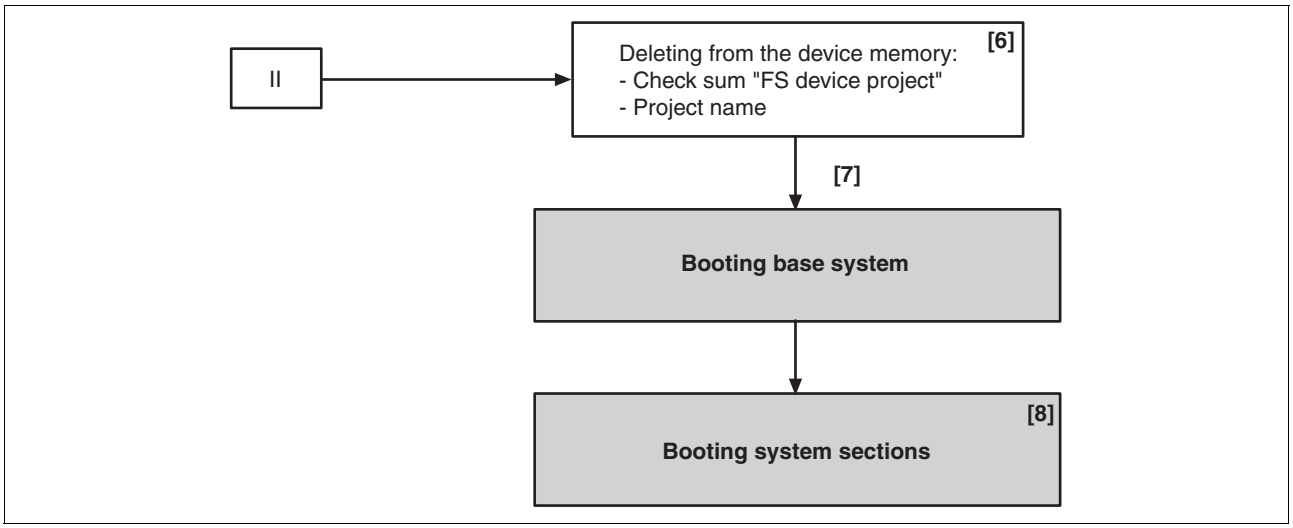
9.11 Functions of the reset button



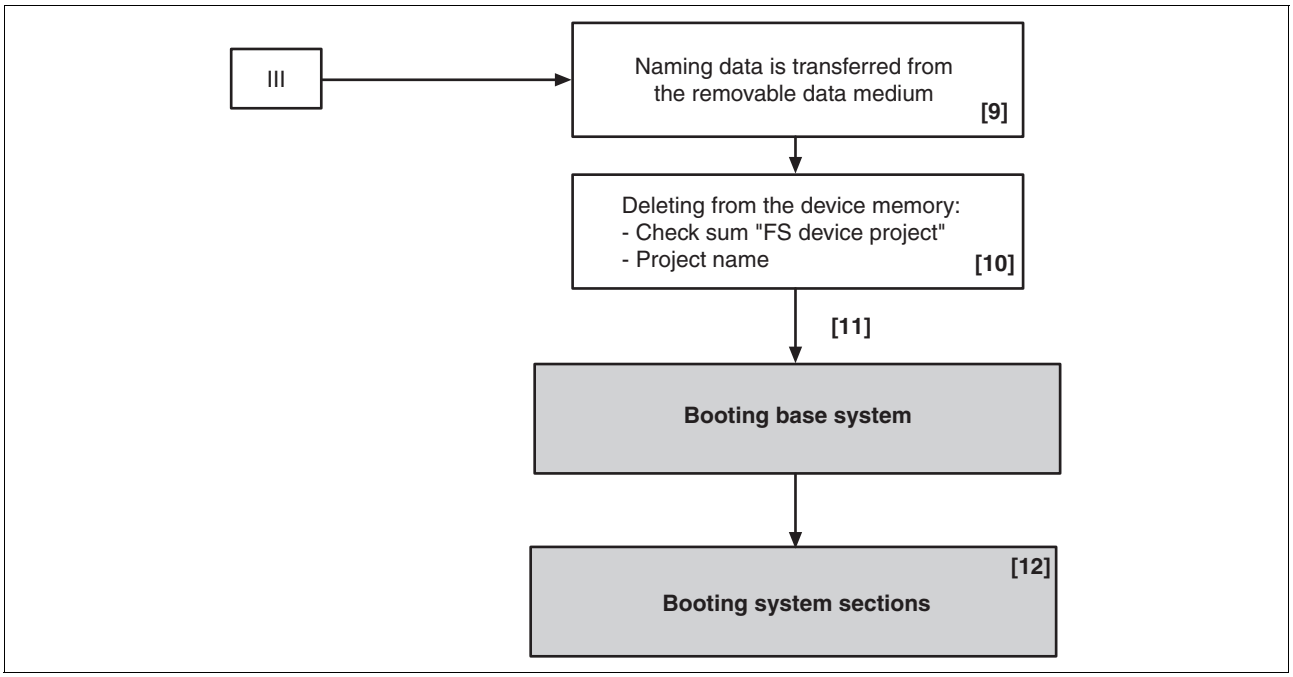
[6]
If the naming data is identical, but the check sum of the FS device project is not identical, or there is no device project on the removable data medium, the check sum of the FS device project and the project name will be deleted from the device memory of the PSSu system.

[7]
The PSSu system is restarted; the behaviour is the same as for a cold start/reboot command (see Operating states and change in operating status of a PSSu system, page 9-5) .

[8]
If the removable data medium contains a device project that matches the product type, the device project will be transferred from the removable data medium in the operating status "Booting system sections".

If the removable data medium does not contain a device project, or contains a device project which does not match the product type, the PSSu system will start without a device project. In this case, for the PSSu system to obtain a device project, a project will either need to be downloaded or deliberate operator action will need to be carried out again, this time with a removable data medium containing a device project that matches the product type.

9.11 Functions of the reset button



[9]
If the naming data is not identical, the naming data from the removable data medium will be transferred to the PSSu system.
This procedure also applies if the PSSu system is in its delivery condition or if an original reset has been performed (see Device naming when exchanging devices, page 8-44)

[10]
The check sum of the FS device project and the project name are deleted from the device memory of the PSSu system.

[11]
The PSSu system is restarted; the behaviour is the same as for a cold start/reboot command (see Operating states and change in operating status of a PSSu system, page 9-5) .

[12]
If the removable data medium contains a device project that matches the product type, the device project will be transferred from the removable data medium in the operating status "Booting system sections". If the user program from the old device project contained non-volatile var-

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9.11 Functions of the reset button

iables, the PSSu system will start up with the following non-volatile variable values:

	Variables with the attribute RETAIN PERSISTENT
The unchanged variable is available in the user program	Saved values
Variable in the user program is new	Set to initial values
Variable is no longer available in the user program	Delete from the variable memory

If the removable data medium does not contain a device project, or contains a device project which does not match the product type, the PSSu system will start its system sections without a device project. For the PSSu system to obtain a device project, a project will either need to be downloaded or deliberate operator action will need to be carried out again, this time with a removable data medium containing a corresponding device project.

9.12 Original reset

An original reset is always sensible or indeed necessary when a PSS 4000-exclusive device or PSS 4000-operable device is removed from an existing plant/machine, possibly to re-use it in another application.

If a PSS 4000-exclusive device/operable device is re-used in a project belonging to the automation system PSS 4000 following an original reset, a new device naming procedure will need to be carried out.

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9.12 Original reset

9.12.1 Effects of an original reset

An original reset has the following general effects on a PSS 4000-exclusive device or a PSS 4000-operable device:

- All the project-related data and working directories stored on the device will be deleted. These include:
  - The project name
  - With a device for safety-related applications: The check sum of the FS device project
  - With a device with non-volatile memory: Non-volatile variables
- The device name is reset to the default device name (see Naming data, page 8-28) .
- In devices with removable data medium, all the project-related data and working directories stored on the removable data medium are deleted. These include:
  - The device project (includes the configuration of all related system sections)
  - With a device for safety-related applications: The check sum of the FS device project
- The messages on the device diagnostic list changes to "inactive" state. The status change is not logged in the device diagnostic log.
- The device diagnostic log is retained.
- The current version of the PSS 4000 firmware remains on the device.
- After an original reset the PSS 4000 firmware restarts on the device. The effect is as in a reboot command.

In addition to these general effects there also device-specific effects for

- PSS 4000-exclusive devices
- PSS 4000-operable devices from Pilz
- PSS 4000-operable devices from a third-party manufacturer:

9.12 Original reset

9.12.1.1 Effects on a PSS 4000-exclusive device

An original reset has the following device-specific effects on a PSS 4000-exclusive device:

- All outputs on the PSSu system are set to ZERO.
- Process data that is accessed by other devices is set to its substitute values in the other devices; Valid Bits = FALSE (see Validity of process data, page 8-4) .
- The device resets the IP address to the default setting and activates its Auto-IP mechanism(see Auto-IP mechanism, page 5-1) .
- Device with the system section PROFIBUS-DP Slave:
  If the DIP switch on the device is set to 126_D, the device's station address is reset to 126_D.

9.12.1.2 Effects on a PSS 4000-operable device from Pilz

The original reset has the following device-specific effects on a PSS 4000-operable device from Pilz:

- The network settings (IP address etc.) of the device remains unchanged, i.e. the original reset is without influence on the network settings of the device (see Naming data, page 8-28) .

9.12.1.3 Effects on a PSS 4000-operable device from a third-party manufacturer

The original reset has the following device-specific effects on a PSS 4000-operable device from a third-party manufacturer:

- An original reset only has an effect on the PSS 4000 firmware of a device.
- The network settings (IP address etc.) of the device remains unchanged, i.e. the original reset is without influence on the network settings of the device (see Naming data, page 8-28) .

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9.12 Original reset

9.12.2 Perform original reset

Depending on the device, the original reset can be performed as follows:

- PSS 4000-exclusive devices
  An original reset is performed either in PAS4000 or by using the reset button on the PSS 4000-exclusive device (see Deliberate operator action for an original reset of the PSSu system, page 9-125) .
- PSS 4000-operable devices from Pilz
  An original reset is performed in PAS4000.
- PSS 4000-operable devices from a third-party manufacturer
  An original reset is performed in PAS4000.

9.13 Enable principle

With the enable principle, an ST data source can control an FS hardware output, provided there is an enable from an FS data source. In the event of an error, the FS data source must ensure that the FS hardware output controlled by the ST data source can no longer be set.

- Valid ST data sources are:
  - ST-O-PI variables
  - ST-I data from external communication (e.g. Modbus/TCP, field-buses)
- Valid FS data sources are:
  - FS-O-PI variables
  - FS-I data from external communication (e.g. FS bus system of another manufacturer)

Principle

In I/O mapping in PAS4000, the user maps an ST data source and an FS data source to the same FS data sink (e.g. FS hardware output). PSS 4000 performs the evaluation internally, based on this I/O mapping. This means that the evaluation is not performed in a PSSu system's resource, so no programming is required in the user program. The ST data source, the valid bit from the ST data source, the FS data source and the valid bit from the FS data source are logically linked and evaluated during the internal evaluation. The result of the logic operation controls the FS hardware output.

The following rules apply:

- Provided the FS data source and the valid bit from the FS data source are "TRUE", the FS hardware output can be switched on and off with the ST data source. The enable LED on the FS hardware output will light.
- As soon as the FS data source and/or the valid bit from the FS data source is "FALSE", the substitute value is used for the FS hardware output. With a digital FS hardware output this means that it is shut down safely. The enable LED on the FS hardware output will not be lit. Control via the ST data source is ignored.
- As soon as the valid bit from the ST data source is "FALSE", the substitute value is used for the FS hardware output. With a digital FS hardware output this means that it is shut down safely. The enable LED on the FS hardware output will light.

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9.13 Enable principle

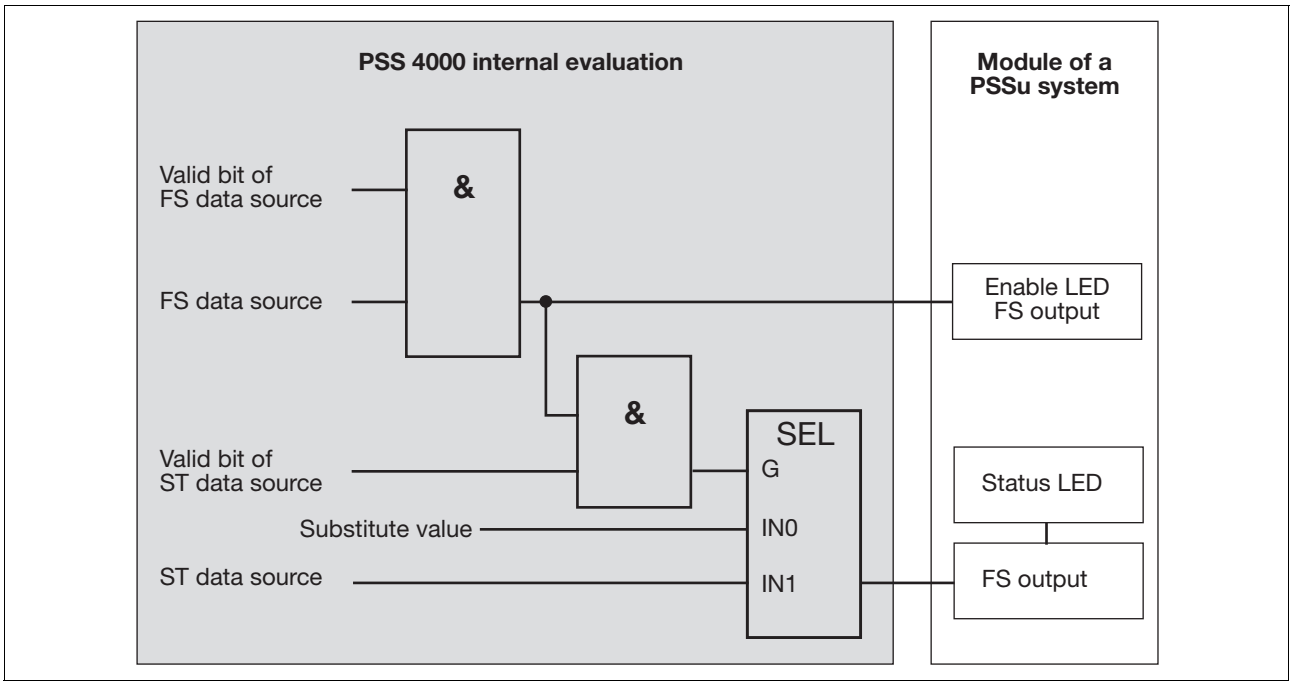

Fig. 9-12: Evaluation (principle)

Please note:
ST data that is processed on the ST resource is **not** safe. It may only be an **additional** criterion for a safety-related action (e.g. start/stop) and must **not** prevent safety functions. For example, if for whatever reason a stop signal has not been activated in the ST resource, or a start signal is continuously activated, this must not be able to compromise the safety of the machine or process.

9.14 Reaction times

The following description of the reaction times refers exclusively to the inputs and outputs on PSSu systems. If the inputs and outputs are distributed over various PSSu systems, the processing time of the SafetyNET p interfaces and the SafetyNET p transmission time must also be taken into account.

If necessary, the relevant external communication relationships (e.g. communication via Modbus/TCP, UDP, PROFIBUS-DP), third party periphery devices, sensors/actuators and third party control systems must also be taken into account when determining the overall reaction times. These influences are not described here.

INFORMATION
The following description of reaction times is valid for PAS4000 from version 1.2.0

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9.14 Reaction times

9.14.1 Times that influence reaction times

The reaction times are determined by the following times:

- **Cycle time of a periodic task (t_{Task})**

  The task cycle time t_{Task} is defined by the user during the task configuration in PAS4000. It defines the time within which a task must be executed (see Task basics, page 8-9) .

  Value range:
  ST tasks: 2 ms ... 2 000 000 ms
  FS tasks: 6 ms ... 10 000 ms

- **Task execution time ($t_{ProcTask}$)**

  The execution time $t_{ProcTask}$ is the length of time from the start of the task cycle to the end of the task execution, i.e. the point at which the process image of outputs and the resource global variables are available (see Formation of data paths – Data paths with tasks, page 9-145) .

- **Module bus cycle time (t_{MBUS})**

  The FS module bus and ST module bus of a PSSu system each have a cycle time, which is calculated by PAS4000 and displayed. The cycle time t_{MBUS} is the time needed to transport data between the head module and module.

  Value range:
  ST module bus: 2 ms ... 45 ms
  FS module bus: 6 ms ... 30 ms

  Please note:

  – The cycle time of the respective module bus always corresponds to that of the task with the shortest cycle time, provided the task cycle time is less than/equal to the maximum possible cycle time for the corresponding module bus:
  $t_{MBUS} = t_{Task\ min}$

  – If only one task is executed on a PSSu system, the module bus cycle time will correspond to the task's cycle time, provided the task cycle time is less than/equal to the maximum possible cycle time of the corresponding module bus:
  $t_{MBUS} = t_{Task}$.

- **Processing time for a module's input data (t_{ProcIM})**

  Processing time t_{ProcIM}: see module's technical datails

  The processing time t_{ProcIM} is the time a module requires internally to process the I-data. The processing time takes into account the input filter time and various influences such as internal run times, temperature drifts, spread of components, etc. It varies depending on the module.

9.14 Reaction times

- **Processing time for a module's output data (t_{ProcOM})**
  Processing time t_{ProcOM}: see module's technical datails
  The processing time t_{ProcOM} is the time a module requires internally to process the O-data The processing time takes into account various influences such as internal run times, temperature drifts, spread of components, etc. It varies depending on the module.
- **Basic cycle time of SafetyNET p RTFN ($t_{BasicSNp\ RTFN}$)**
  The basic cycle time $t_{BasicSNp\ RTFN}$ describes the time it takes to run tests within a project as part of each cycle, to check whether data is available to send via SafetyNET p RTFN.
  The basic cycle time is calculated by PAS4000 and displayed.
- **Cycle time of SafetyNET p RTFN ($t_{SNp\ RTFN}$)**
  The cycle time refers to a transmit connection (Tx connection) on a PSSu system. In other words, each TX connection on a PSSu system has its own cycle time $t_{SNp\ RTFN}$. The cycle time $t_{SNp\ RTFN}$ describes the time it takes to start a Tx connection as part of each cycle, in order to send data. The cycle times of the Tx connections are calculated by PAS4000 and displayed.
- **Transmission delay time of SafetyNET p RTFN ($t_{DelaySNp\ RTFN}$)**
  The transmission delay time $t_{DelaySNp\ RTFN}$ describes the time that may elapse within a project between the start of data transmission via a transmit connection (Tx connection) on a PSSu system A and the data becoming available for further processing in a PSSu system B. The maximum time for the transmission delay time is $t_{DelaySNp\ RTFN} = 2 \times t_{BasicSNp\ RTFN}$.
- **Cycle time with external communication (t_{ExtCo})**
  External communication refers to data exchange in which O-data leaves the automation system PSS 4000 and I-data enters the system (e.g. via Modbus/TCP, UDP, fieldbuses). External O-data is sent from the O-data area of a PSSu system, depending on the communication mode that is used. Depending on the communication mode that is used, external I-data can be found in the I-data area of a PSSu system and is read from there.
  In this description, the cycle times for send and receive are designated with t_{ExtCo}. Their meaning depends on the communication mode that is used:
  - **Modbus/TCP Client connection:**
    The cycle time t_{ExtCo} describes the time the connection Client takes to start data transfer as part of each cycle.
    The cycle time can be set separately in PAS4000 for each connection Client on a PSSu system; in other words, each connection Client on a PSSu system has its own cycle time t_{ExtCo}. It can either be calculated automatically it can be configured by the user (con-

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9.14 Reaction times

figuration in PAS4000).

– **Modbus/TCP Server connection:**
  The cycle time t_{ExtCo} describes the time it takes to read data from a Server allocation table of a PSSu system and for the data requested from a Server allocation table to be transferred to the connection Client, as part of each cycle.
  The cycle time can be set separately in PAS4000 for each Server allocation table on a PSSu system; in other words, each Server allocation table on a PSSu system has its own cycle time t_{ExtCo}. It can either be calculated automatically it can be configured by the user (configuration in PAS4000).
– **Raw UDP communication "Receive data" and "Send data":**
  The cycle time t_{ExtCo} describes the time it takes to read in external I-data from a UDP connection and start transmitting data (external O-data) via a UDP connection as part of each cycle.
  The cycle time can be set separately in PAS4000 for each UDP connection on a PSSu system; in other words, each UDP connection has its own cycle time t_{ExtCo}. It can either be calculated automatically it can be configured by the user (configuration in PAS4000).
– **PROFIBUS-DP Slave "Receive data" and "Send data":**
  The cycle time t_{ExtCo} describes the time it takes to read in external I-data from the PROFIBUS-DP Master and start transmitting the requested data (external O-data) as part of each cycle.
  The cycle time can be defined in PAS4000 for each PSSu system, i.e. each PSSu system has its own cycle time t_{ExtCo} for data transfer with PROFIBUS-DP. It can either be calculated automatically it can be configured by the user (configuration in PAS4000).

9.14 Reaction times

9.14.2 Processing rules during data processing

The following applies for data processing on a PSSu system:

- **Processing times of modules**
  The processing times of modules (t_{ProcOM} and t_{ProcIM}) are constant. They are not influenced by the current task cycle.
- **Module bus cycle times**
  The ST module bus and the FS module bus each have their individual cycle times. The module bus cycle time t_{MBUS}always corresponds to that of the task with the shortest cycle time, provided that the task cycle time is less than/equal the maximum possible cycle time of the corresponding module bus:
  $t_{MBUS} = t_{Task\ min}$
- **Cycle times of tasks**
  The cycle times of tasks (t_{Task}) are constant. They are not influenced by the current task cycle.

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9.14 Reaction times

9.14.3 Formation of data paths

Data subpaths are available to enable you to track a single I/O datum over a complete data path. A data path, therefore, is made up of the relevant data subpaths.
The reaction time of a data path is calculated by adding the reaction times of the relevant data subpaths. A data path always starts with the I-datum in a data source and ends with the O-datum in a data sink. A data source/data sink is always located in a system section (see System sections, page 2-6) .

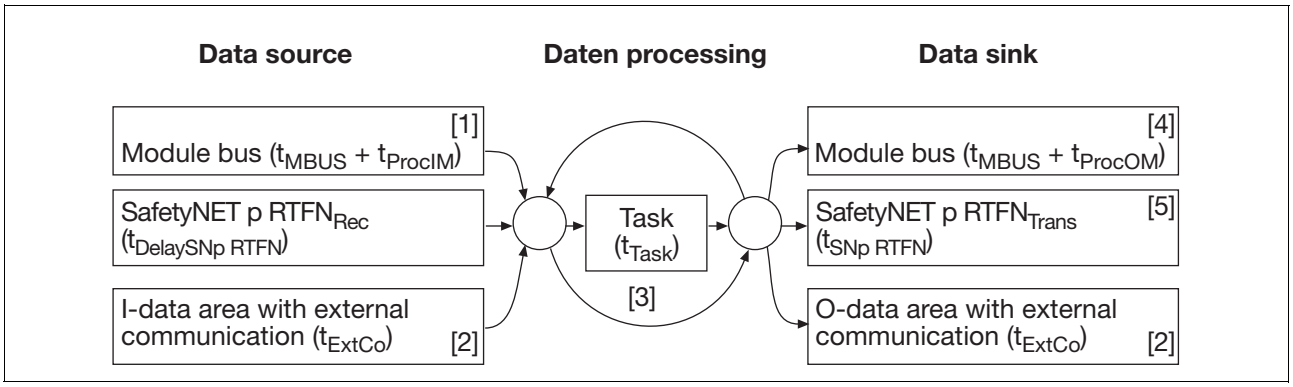

Fig. 9-13: Data paths on a PSSu system

[1]
If the data source is an I-datum from a PSSu module, the processing time for the I-datum on the module bus (t_{ProcIM}) needs to be considered in addition to the module bus cycle time (t_{MBUS}).

[2]
With external communication, the I-data from the I-data area is also referred to as "external I-data" and the O-data from the O-data area as "external O-data".

[3]
The following data paths are impossible:
- Data source: Module bus (I-datum) -> Data sink: Module bus (O-datum)
- Data source: SafetyNET p RTFN$_{Rec}$ ->
  Data sink: SafetyNET p RTFN$_{Trans}$

9.14 Reaction times

[4]
If the data sink is an O-datum on a PSSu module, the processing time for the O-datum on the module (t_{ProcOM}) needs to be considered in addition to the module bus cycle time (t_{MBUS}).

[5]
If there are several SNp connections between two devices, the data that is transmitted is the data in the connection or in one of the connections that has the same cycle time as the data source of the data on this device.

Data paths with tasks

For data paths with tasks, please note:

- **Task as data source**
  The reaction time for a datum starts at the beginning of the task cycle and ends after the execution time $t_{ProcTask}$ with the process image of outputs and the resource global variables available in the data sink for further processing.
  When the processing time $t_{ProcTask}$ almost corresponds to the task cycle time t_{Task}, that is the maximum reaction time.

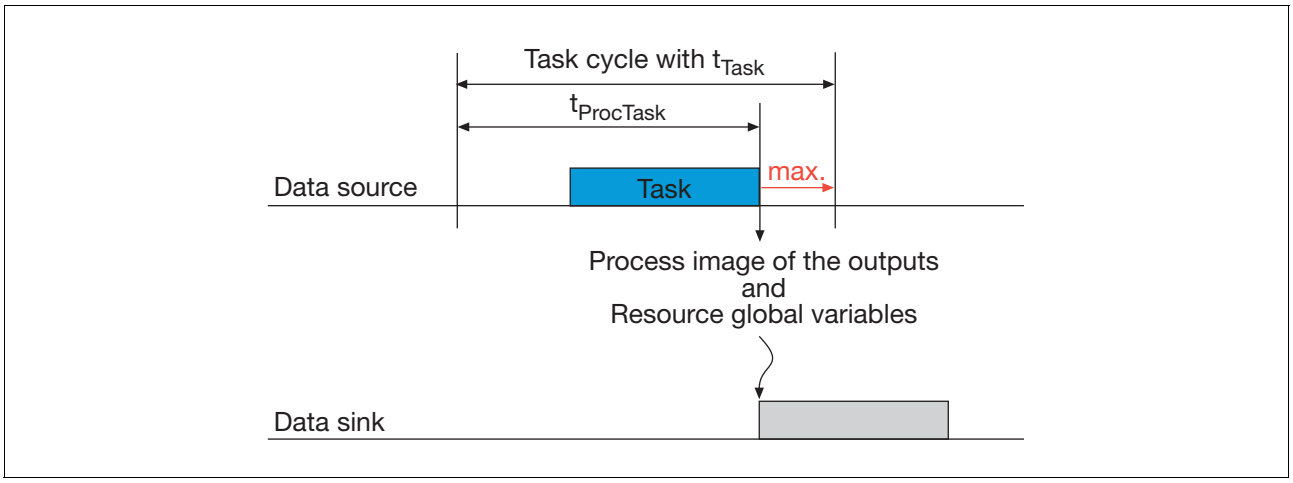

Fig. 9-14: Reaction time with a task's POUs as data source

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- **Task as data sink**

  The reaction time for a datum starts at the beginning of the task cycle and ends after the execution time $t_{ProcTask}$ with the process image of outputs and the resource global variables available for further processing.

  When the processing time $t_{ProcTask}$ almost corresponds to the task cycle time t_{Task}, that is the maximum reaction time.

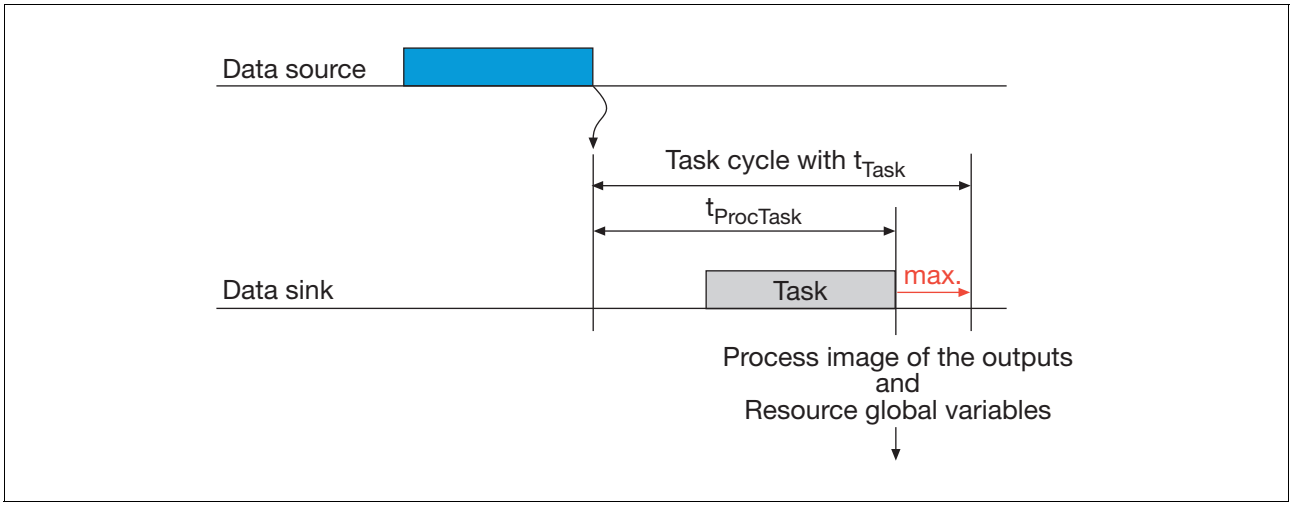

Fig. 9-15: Reaction time with a task as data sink

9.14 Reaction times

9.14.4 Maximum reaction times for data subpaths

The following description contains the formulas for calculating the maximum reaction time for all permitted data subpaths.

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9.14 Reaction times

9.14.4.1 Maximum reaction time for data subpaths with module bus as data source

- **Module bus -> Task**

PSS 4000-Firmware from version 1.2.0 to 1.3.x:

$$t_{MBUS_Task_max} = t_{ProcIM} + 2t_{Task} + t_{MBUS}$$

PSS 4000 firmware from version 1.4.0:

$$t_{MBUS_Task_max} = t_{ProcIM} + 2t_{Task}$$

$t_{MBUS_Task_max}$:	Max. reaction time for this data subpath
t_{ProcIM}:	Processing time for a module's I-data
t_{MBUS}:	PSSu system's module bus cycle time
t_{Task}:	Task cycle time of the task on the PSSu system

- **Module bus -> SafetyNET p $RTFN_{Trans}$**

$$t_{MBUS_SNp_max} = t_{ProcIM} + 2t_{SNp\ RTFN}$$

$t_{MBUS_SNp_max}$:	Max. reaction time for this data subpath
t_{ProcIM}:	Processing time for a module's I-data
t_{MBUS}:	PSSu system's module bus cycle time
$t_{SNp\ RTFN}$:	Cycle time for the cyclical start of the SNp Tx connection (send data)

9.14 Reaction times

Module bus -> O-data area with external communication

$$t_{MBUS_ExtCo_max} = t_{ProcIM} + 2t_{ExtCo}$$

$t_{MBUS_ExtCo_max}$:	Max. reaction time for this data subpath
t_{ProcIM}:	Processing time for a module's I-data
t_{MBUS}:	PSSu system's module bus cycle time
t_{ExtCo} :	Cycle time for the cyclical start of data transfer from the O-data area with external communication

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9.14 Reaction times

9.14.4.2 Data subpaths with SafetyNET p RTFN as data source

▸ **SafetyNET p RTFN$_{Rec}$ -> Task**

$$t_{SNp_Task_max} = t_{DelaySNp\ RTFN} + 2t_{Task}$$

$t_{SNp_Task_max}$:	Max. reaction time for this data subpath
$t_{DelaySNp\ RTFN}$:	Transmission delay time of SafetyNET p RTFN in a project
t_{Task}:	Task cycle time of the task on the PSSu system

▸ **SafetyNET p RTFN$_{Rec}$ -> Module bus**

PSS 4000-Firmware from version 1.2.0 to 1.3.x:

$$t_{SNp_MBUS_max} = t_{DelaySNp\ RTFN} + 3t_{MBUS} + t_{ProcOM}$$

PSS 4000 firmware from version 1.4.0:

$$t_{SNp_MBUS_max} = t_{DelaySNp\ RTFN} + 2t_{MBUS} + t_{ProcOM}$$

$t_{SNp_MBUS_max}$:	Max. reaction time for this data subpath
$t_{DelaySNp\ RTFN}$:	Transmission delay time of SafetyNET p RTFN in a project
t_{MBUS}:	PSSu system's module bus cycle time
t_{ProcOM}:	Processing time for O-data on a module with outputs

9.14 Reaction times

- **SafetyNET p RTFN$_{Rec}$ -> O-data area with external communication**

$$t_{SNp_ExtCo_max} = t_{Delay\ RTFN} + 2t_{ExtCo}$$

$t_{SNp_ExtCo_max}$:	Max. reaction time for this data subpath
$t_{DelaySNp\ RTFN}$:	Transmission delay time of SafetyNET p RTFN in a project
t_{ExtCo} :	Cycle time for the cyclical start of data transfer from the O-data area with external communication

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9.14 Reaction times

9.14.4.3 Data subpaths with external I-data as data source

- **I-data area with external communication -> Module bus**

$$t_{ExtCo_MBUS_max} = t_{ExtCo} + \min(t_{ExtCo}, t_{MBUS}) + t_{MBUS} + t_{ProcOM}$$

$t_{ExtCo_MBUS_max}$:	Max. reaction time for this data subpath
t_{ExtCo} :	Cycle time for cyclical reading of the external I-data from the I-data area with external communication
t_{MBUS}:	PSSu system's module bus cycle time
t_{ProcOM}:	Processing time for O-data on a module

- **I-data area with external communication -> Task**

$$t_{ExtCo_Task_max} = 2t_{ExtCo} + 2t_{Task}$$

$t_{ExtCo_Task_max}$:	Max. reaction time for this data subpath
t_{ExtCo} :	Cycle time for cyclical reading of the external I-data from the I-data area
t_{Task}:	Task cycle time of the task on the PSSu system

- **I-data area with external communication -> SafetyNET p RTFN$_{Trans}$**

$$t_{ExtCo_SNp_max} = 2t_{ExtCo} + 2t_{SNp\ RTFN}$$

$t_{ExtCo_SNp_max}$:	Max. reaction time for this data subpath
t_{ExtCo} :	Cycle time for cyclical reading of the external I-data from the I-data area with external communication
$t_{SNp\ RTFN}$:	Cycle time for the cyclical start of the SNp Tx connection (send data)

9.14 Reaction times

- **I-data area with external communication -> O-data area with external communication**

$$t_{ExtCo1_ExtCo2_max} = 2t_{ExtCo1} + 2t_{ExtCo2}$$

$t_{ExtCo1_ExtCo2_max}$:	Max. reaction time for this data subpath
t_{ExtCo1} :	Cycle time for cyclical reading of the external I-data from the I-data area (external communication with communication mode 1)
t_{ExtCo2} :	Cycle time for the cyclical start of data transfer from the O-data area (external communication with communication mode 2)

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9.14 Reaction times

9.14.4.4 Data subpaths with a task as data source

▸ **Task -> Module bus**

PSS 4000-Firmware from version 1.2.0 to 1.3.x:

$$t_{Task_MBUS_max} = 2t_{MBUS} + t_{ProcOM}$$

PSS 4000 firmware from version 1.4.0:

$$t_{Task_MBUS_max} = t_{MBUS} + t_{ProcOM}$$

$t_{Task_MBUS_max}$:	Max. reaction time for this data subpath
t_{MBUS}:	PSSu system's module bus cycle time
t_{ProcOM}:	Processing time for O-data on a module

▸ **Task -> SafetyNET p RTFN$_{Trans}$**

$$t_{Task_SNp_max} = 2t_{SNp}$$

$t_{Task_SNp_max}$:	Max. reaction time for this data subpath
$t_{SNp\ RTFN}$:	Cycle time for the cyclical start of the SNp Tx connection (send data)

▸ **Task1 -> Task2**

$$t_{Task1_Task2_max} = 2t_{Task2}$$

$t_{Task1_Task\ 2_max}$:	Max. reaction time for this data subpath
t_{Task2} :	Task cycle time of task2

9.14 Reaction times

Task -> O-data area with external communication

$$t_{Task_ExtCo_max} = 2t_{ExtCo}$$

$t_{Task_ExtCo_max}$:	Max. reaction time for this data subpath
t_{ExtCo} :	Cycle time for the cyclical start of data transfer from the O-data area with external communication

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9.14 Reaction times

9.14.4.5 Example for calculating a data path on one PSSu system

The example was created for a device that has a PSS 4000 firmware from version 1.4.0.
For the data path in this example, the following applies:

- I-datum (e.g. HW input of a module) and O-datum (e.g. HW output of a module) are on the same PSSu system.
- The data path is composed as follows:
  Module bus (I-datum) -> Task -> Module bus (O-datum)
- To calculate the maximum reaction time, the data path is divided into the following data subpaths:

  – **Data subpath 1: Module bus (I-datum) -> Task**
  Applicable for the maximum reaction time of data subpath 1:
  $t_{MBUS_Task_max} = t_{ProcIM} + 2t_{Task}$

  – **Data subpath 2: Task -> Module bus (O-datum)**
  Applicable for the maximum reaction time of data subpath 2:
  $t_{Task_MBUS_max} = t_{MBUS} + t_{ProcOM}$

Applicable for the data path's maximum reaction time:

$$\mathbf{t_{React_max} = t_{ProcIM} + 2t_{Task} + t_{MBUS} + t_{ProcOM}}$$

9.14 Reaction times

9.14.4.6 Example for calculating a data path via three PSSu systems

The example was created for devices with a PSS 4000 firmware from Version 1.4.0.

For the data path in this example, the following applies:

- The I-datum (e.g. HW input) is on PSSu system A. The datum is transferred to PSSu system B via SafetyNET p RTFN.
- On PSSu system B, the datum is processed in a task and is then transferred to PSSu system C via SafetyNET p RTFN.
- On PSSu system C, the datum is transferred to a module with outputs.
- The data path is composed as follows:
  Module bus (I-datum) to PSSu system A -> SafetyNET p RTFN -> Task on PSSu system B -> SafetyNET p RTFN -> Module bus (O-datum) on PSSu system C
- To calculate the maximum reaction time, the data path is divided into the following data subpaths:

  – **Data subpath 1: Module bus$_{(A)}$ (I-datum) -> SafetyNET p RTFN$_{Trans(A)}$**
  The following applies for the maximum reaction time of data subpath 1:
  $t_{MBUS_SNp_max(A)} = t_{ProcIM} + 2t_{SNp\ RTFN(A)}$

  – **Data subpath 2: SafetyNET p RTFN$_{Rec(B)}$ -> Task$_{(B)}$**
  The following applies for the maximum reaction time of data subpath 2:
  $t_{SNp_Task_max(B)} = t_{DelaySNp\ RTFN} + 2t_{Task(B)}$

  – **Data subpath 3: Task$_{(B)}$ -> SafetyNET p RTFN$_{Trans(B)}$**
  The following applies for the maximum reaction time of data subpath 3:
  $t_{Task_SNp_max(B)} = 2t_{SNp\ RTFN(B)}$

  – **Data subpath 4: SafetyNET p RTFN$_{Rec(C)}$ -> Module bus$_{(C)}$ (O-datum)**
  The following applies for the maximum reaction time of data subpath 4:
  $t_{SNp_MBUS_max(C)} = t_{DelaySNp\ RTFN} + 2t_{MBUS(C)} + t_{ProcOM}$

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9.14 Reaction times

The following applies for the data path's maximum reaction time:

t_{React_max}	$= t_{ProcIM} + 2t_{SNp\ RTFN(A)} + t_{DelaySNp\ RTFN} + 2t_{Task(B)} + 2t_{SNp\ RTFN(B)} + t_{DelaySNp\ RTFN} + 2t_{MBUS(C)} + t_{ProcOM}$

9.15 System time synchronisation

As devices in industrial automation systems are often involved in complex networks, each device is required to have the same system time. This is all the more important when precise data evaluation and processing of time-critical data (e.g. process data, reaction times for safety-related tasks, time stamp for logs) must not be delayed by the network load, the size of the data packets or mechanisms within the communication protocol.

In Ethernet-based industrial automation systems this requirement can be met using a system clock that provides the date and time. At least one real-time clock is used, depending on the applied technology, and this provides the reference time within the automation system (Server). All other network subscribers (Clients) synchronise their device time based on this reference time. In this way, each network subscriber has a standardised system time which is subject only to very minor deviations.

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9.15 System time synchronisation

9.15.1 System time synchronisation with SNTP

The Simple Network Time Protocol (SNTP) is a synchronisation protocol used to communicate and synchronise time in Ethernet-based networks. SNTP operates in accordance with the Client-Server principle. It uses UDP as the communication protocol. The (time) Server uses the port with port number 123 for this service by default. On PSS 4000-exclusive devices the port is permanently set and cannot be modified by the user. The (time) Server is called an SNTP Server in PAS4000.

In the automation system PSS 4000, a project can be operated with or without an SNTP Server.

If an SNTP Server is configured for a project in PAS4000, the Simple Network Time Protocol (SNTP) is used to ensure the same time base for diagnostic messages and log entries for all devices within a project. This guarantees the correct chronological sequence of diagnostic messages coming from a variety of devices with their own real-time clock. STNP is also used to synchronise the time automatically after exchanging devices. PAS4000 only needs to be used to set the time on the new device if the exchanged unit is to be used as an SNTP Server.
The automation system PSS 4000 supports SNTP Unicast as a communication mechanism. This means that there can only be one SNTP Server in a project. All other network subscribers automatically become SNTP Clients.
With the Unicast communication mechanism, an SNTP Client sends a time synchronisation request to the SNTP Server and receives time information from the SNTP Server.
On PSS 4000, time synchronisation between an SNTP Client and the configured SNTP occurs with a cycle time of </= 60 s. The user cannot configure the cycle time.
Any device within the project that has a real-time clock can be configured as an SNTP Server for the project. However, PAS4000 also supports the use of external devices. These may be special switches designed for this purpose, for example.

If **no** SNTP Server is configured for a project in PAS4000, then each device with a real-time clock operates with its own time base. As a result, there is no standard time base for diagnostic messages and log entries within the project. The correct chronological sequence of diagnostic messages cannot be guaranteed.

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10.1 General requirements

Secure the site in accordance with the regulations (barrier, warning signs etc.). The system may only be commissioned/recommissioned by a competent person.

- Please refer to the information and specifications stated in the relevant documentation
  (e.g. PSS 4000 Safety Manual, PSSuniversal Installation Manual, operating manuals for the modules you are using).
- During commissioning/recommissioning, make sure that no personal injury and/or material damage can occur, even if the plant/machine moves unintentionally.
  (e.g. physical barrier for the danger zone or for the whole plant/machine if necessary).

10.2 Initial commissioning

The following description assumes that

- The following documentation has been considered when deciding on the installation site, mechanical structure and electrical connection
  - PSSuniversal Installation Manual
  - "SafetyNET p" chapter in this System Manual (if necessary)
  - Operating manuals for the modules you are using
  - Installation guidelines for the standard fieldbus you are using (if necessary)
  - Relevant documents from the risk analysis (e.g. assembly instructions, wiring diagram)
- All the required PSSu systems are fully assembled, wired and connected
- A removable data medium is plugged into all PSSu systems
- The project in PAS4000 is complete
  (see PAS4000's online help)
- The project has been downloaded
  (see PAS4000's online help)
- Any advice provided during the project download has been heeded and any errors rectified
  (e.g. all the project's PSSu systems are accessible with PAS4000, set hardware registry matches the actual hardware registry)
- Description is available of all the activities required for commissioning (e.g. check lists and test specifications from the risk analysis)
- Supply voltages to the plant/machinery are **not** switched on at this point

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10.2 Initial commissioning

Procedure

1. Check installation and wiring

Check the assembly and wiring based on the specific assembly instructions and wiring diagram for the plant/machinery.
Please refer to the relevant documents from the risk analysis (see PSS 4000 Safety Manual).

2. Switch on supply voltages

Switch on all the PSSu systems' supply voltages together.
It may take a little time (max. 10 s for a PSSu system) for all the PSSu systems to be ready for operation. The LEDs on the head module will show you when a PSSu system is ready for operation.

3. Use commissioning aids

PAS4000 provides some important aids to help with any problems during commissioning:

- Watch variables
  Watches the current state of variables dynamically
- Control variables
  The value of variables is set once to a specified value. This can be changed afterwards by the user program.
  Make sure you heed the information and requirements stipulated in the PSS 4000 Safety Manual, even when controlling non-safety-related variables!
- Force variables
  The value of variables is fixed and cannot be changed by the user program. If "Force variables" is stopped, the variable will retain its force value until it is overwritten with a new value.
  Make sure you heed the information and requirements stipulated in the PSS 4000 Safety Manual, even when forcing non-safety-related variables!
- Diagnostic log
  Log that shows when diagnostic messages arrived, when they were cleared and when they were acknowledged;
  It also contains entries regarding operation and debugging.
- Diagnostic list
  List of current diagnostic messages (project diagnostic list, device diagnostic list)
- Project comparison
  Option in PAS4000 to find out whether the original project in PAS4000 is identical to the project on the machine
  The online projekt is compared with the offline project. Differences in the check sum are displayed.

10.2 Initial commissioning

4. **Test safety functions and fault detection facilities**
   If the project contains safety functions and fault detection facilities, use the test specification to test all the plant-specific safety functions and fault detection facilities.
   It is **essential** that all the specified safety functions and fault detection facilities are fully tested.
   It is **essential** that you heed the information and requirements stipulated in the PSS 4000 Safety Manual.
5. **Test FS blocks with mixed input interface**
   If FS blocks with mixed input interface have been used, test these using the defined test procedures (e.g. feasibility tests).
   It is **essential** that you heed the information and requirements stipulated in the PSS 4000 Safety Manual.
6. **Optimise task cycle time**
   During commissioning you can optimise the task cycle time.
7. **Create backup copy**
   Create a backup copy of the project, declare the project as the original project and save it in accordance with the project backup plan.
8. **Documentation**
   – Document and log all actions taken during commissioning.
     For all safety-related actions it is **essential** that you heed the information and requirements stipulated in the PSS 4000 Safety Manual.
   – Document the check sum of the original project
9. **Normal operation**
   The project is running normally once all PSSu systems are switched on and there are no errors present.

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10.3 Recommissioning

Recommissioning is always necessary when a change is made to the plant/machine or process. In all cases, the following changes must result in recommissioning:

- A change to a safety requirement
- A change due to the occurrence of a systematic error
- A change due to new operation or production requirements
- A change to the plant/machine by:
  - Adding or removing components (e.g. PSSu system, a PSSu system module)
  - Exchanging components (e.g. PSSu system, a PSSu system module, a PSSu system removable data medium)
- A change to the process cycle

The following description assumes that

- A risk analysis has been performed prior to any change
- The following documentation has been considered when adding, removing or exchanging components
  - PSSuniversal Installation Manual
  - "SafetyNET p" chapter in this System Manual (if necessary)
  - Operating manuals for the modules you are using
  - Installation guidelines for the standard fieldbus you are using (if necessary)
  - Relevant documents from the risk analysis for the changes
- All modified components are fully assembled/plugged in and wired
- A removable data medium is plugged into all PSSu systems
- The changes to the project in PAS4000 are complete
  (see PAS4000's online help)
- The project has been downloaded
  (see PAS4000's online help)
- Any advice provided during the project download has been heeded and any errors rectified
  (e.g. all the project's PSSu systems are accessible with PAS4000, set hardware registry matches the actual hardware registry)
- Description is available of all the activities required for recommissioning (e.g. check lists and test specifications from the risk analysis)
- Supply voltages to the plant/machinery are **not** switched on at this point

10.3 Recommissioning

Procedure

1. Check installation and wiring

Check the assembly and wiring of the modified components based on the specific assembly instructions and wiring diagram for the plant/machinery.

Please refer to the relevant documents from the risk analysis for the changes (see PSS 4000 Safety Manual).

2. Switch on supply voltages

Switch on all the PSSu systems' supply voltages together.

It may take a little time (max. 10 s for a PSSu system) for all the PSSu systems to be ready for operation. The LEDs on the head module will show you when a PSSu system is ready for operation.

3. Use commissioning aids

PAS4000 provides some important aids to help with any problems during recommissioning:

- Watch variables
  Watches the current state of variables dynamically
- Control variables
  The value of variables is set once to a specified value. This can be changed afterwards by the user program.
  Make sure you heed the information and requirements stipulated in the PSS 4000 Safety Manual, even when controlling non-safety-related variables!
- Force variables
  The value of variables is fixed and cannot be changed by the user program. If "Force variables" is stopped, the variable will retain its force value until it is overwritten with a new value.
  Make sure you heed the information and requirements stipulated in the PSS 4000 Safety Manual, even when forcing non-safety-related variables!
- Diagnostic log
  Log that shows when diagnostic messages arrived, when they were cleared and when they were acknowledged;
  It also contains entries regarding operation and debugging.
- Diagnostic list
  List of current diagnostic messages (project diagnostic list, device diagnostic list)
- Project comparison
  The FS project contains a check sum, on which the user can base the comparison
- Comparison of POUs
  Each POU contains a check sum on which the user can base the comparison

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10.3 Recommissioning

4. Test safety functions and fault detection facilities

Following a change, if the safety analysis has shown that safety functions need to be validated and tested, the change itself must be tested, as must the course of the entire process.

Please note:
Based on the check sum for the FS project, a project comparison can be used to determine whether the FS project has changed and therefore whether safety functions need to be validated and tested. However, the project comparison may only be used as an additional aid. Under no circumstances can it replace a prior safety analysis for the changes.

It must be ensured that only the desired changes are made to the project. It is **essential** that you heed the information and requirements stipulated in the PSS 4000 Safety Manual.

5. Test FS blocks with mixed input interface

If FS blocks with mixed input interface are affected by the changes, test these using the defined test procedures (e.g. feasibility tests).
It is **essential** that you heed the information and requirements stipulated in the PSS 4000 Safety Manual.

6. Optimise task cycle time

During recommissioning you can optimise the task cycle time.

7. Create backup copy

Create a backup copy of the amended project, declare the amended project as the new original project and save it in accordance with the project backup plan.

8. Documentation

- Document all changes
- Document and log all actions taken during recommissioning.
  For all safety-related actions it is **essential** that you heed the information and requirements stipulated in the PSS 4000 Safety Manual.
- Document the check sum of the new original project

9. Normal operation

The project is running normally once all PSSu systems are switched on and there are no errors present.

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11.1 Maintenance and repair

Before starting maintenance or repair work, please note the following:

- Maintenance and repair work may only be carried out by competent persons.
- Make sure that power to the plant or machine is removed in accordance with the regulations.
- The plant or machine should be safeguarded against inadvertent reconnection.
- If you exchange components (PSSu system, a PSSu system module, a PSSu system removable data medium):
  - Heed the information and requirements stipulated in the PSS 4000 Safety Manual
  - Switch the PSSu system to a STOP condition before exchanging components
  - Note that if other PSSu systems access the process data on the PSSu system, substitute values will be used in the other PSSu systems!
  - When exchanging the removable data medium on a PSSu system, be aware that a new device naming procedure may need to be carried out (see Device naming when exchanging devices, page 8-44)
  - Heed the information on recommissioning(see Recommissioning, page 10-5)

Maintenance and repair of PSSu systems

No maintenance work is necessary on a PSSu system. Please send any faulty PSSu systems and/or modules back to Pilz.

INFORMATION
When exchanging modules and PSSu systems, please comply with the information regarding assembly/removal as stipulated in the PSSuniversal Installation Manual.

11.2 Decommissioning

Please comply with the mission time t_M in the safety-related characteristic data of FS modules.

Please comply with the information regarding assembly/removal as stipulated in the PSSuniversal Installation Manual and in the operating manuals for the relevant modules.

When decommissioning, please comply with local regulations regarding the disposal of electronic devices (e.g. Electrical and Electronic Equipment Act).

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12.1 Overview

OPC (Openness, Productivity and Collaboration) is a standardised software interface, through which PC-based software from a range of manufacturers can exchange data. The OPC Foundation is responsible for maintaining and propagating the standard. Around one hundred companies are currently members, including Pilz.

The current OPC standard is specified as platform-dependent for the Windows operating systems (e.g. Windows 2000, Windows XP, Windows Vista). It is based on Windows technologies such as OLE (Object Linking and Embedding), COM (Component Object Model) and DCOM (Distributed COM).

On networked plants, an OPC Server will typically collect diagnostic data, process data etc. and display it in the defined namespace. An OPC Client is typically used for process visualisation and/or to record operating data. It accesses and then processes the data provided by the OPC Server. In order to process the data the OPC Client must contain the relevant OPC-enabled software (e.g. visualisation software with ActiveX Control, process visualisation system PMI-PRO from Pilz).

In the PSS 4000 automation system a PC or a PMI operator terminal obtains the OPC Server system section as part of the installation of PSS 4000 firmware. By installing the PSS 4000 Firmware a PC becomes a "PSS 4000-operable device from a third-party manufacturer" and a PMI operator terminal PMI becomes a "PSS 4000-operable device from Pilz" (see System Overview, page 2-3) .

The following boundary conditions apply to the OPC Server:

- The OPC Server supports various OPC properties for the access of OPC Clients (see OPC properties, page 12-4) .
- The OPC Server can be installed on a PC or Pilz PMI operator terminal (see System requirements, page 12-5) .
- An OPC Server can collect the data of exactly one project that has been created with PAS4000 and provide it for the OPC Clients.
- Each project created with PAS4000 may contain precisely one OPC Server.
- It is possible to access the OPC Server with more than one Client.
- All project-based settings for the OPC Server are made in PAS4000 and are transferred to the OPC Server as an OPC device project when the project is downloaded.

12.1 Overview

12.1.1 Design options

In a minimum configuration, the OPC Server will be on the same PC as the OPC Client with the graphics software.

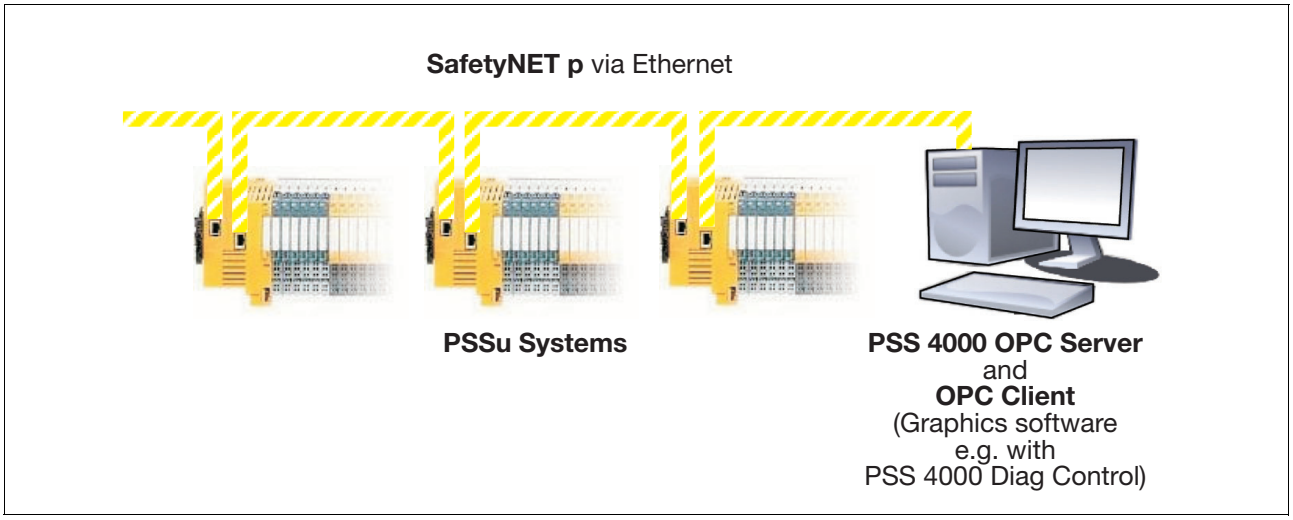

Fig. 12-1: Process visualisation with a minimum OPC configuration (principle)

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12.1 Overview

Other types of combinations are also conceivable, such as:

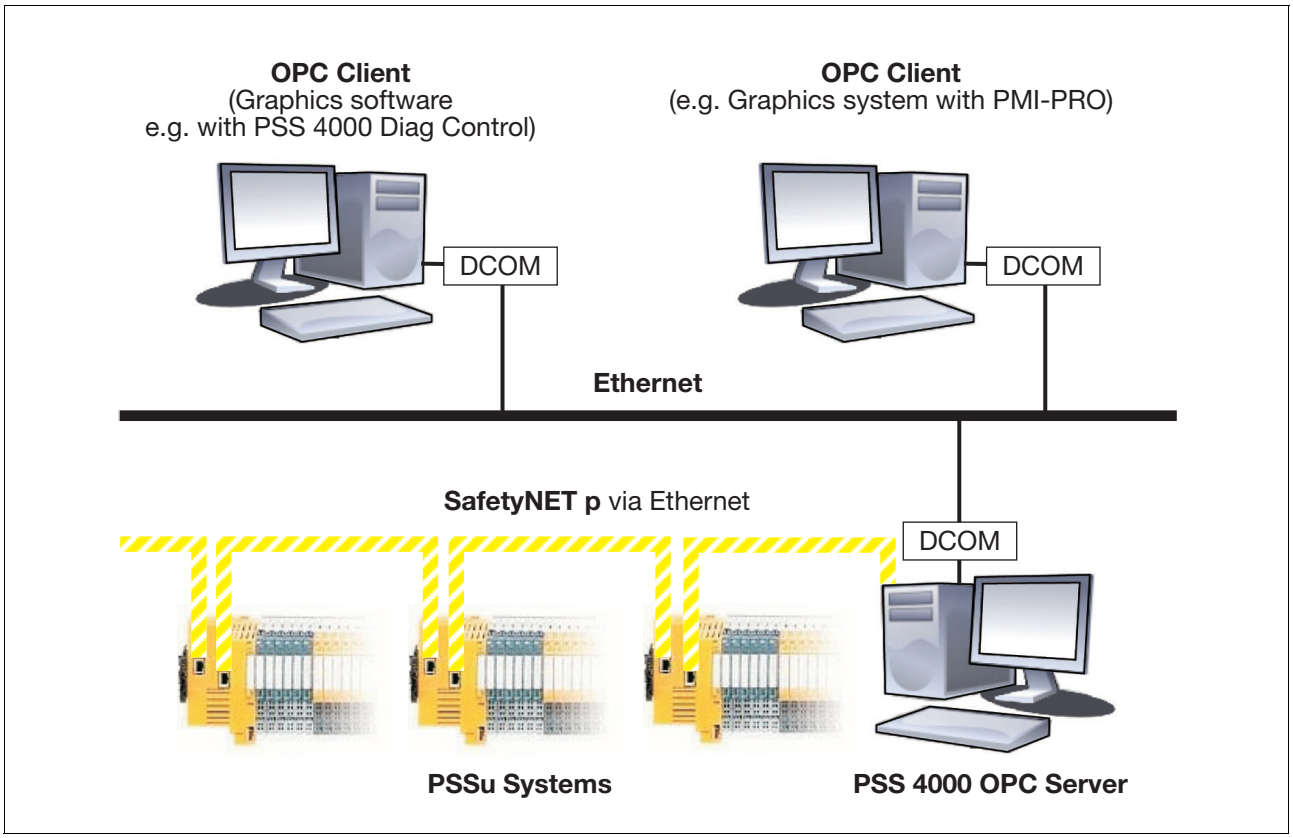

Fig. 12-2: Networking OPC Server and OPC Clients via Ethernet (principle)

12.1 Overview

12.1.2 OPC properties

The PSS 4000 OPC Server supports the following OPC properties for access from OPC Clients:

- OPC specification with
  - Data Access 1.0.a
  - Data Access 2.05
  - Data Access 3.0
- OPC interfaces with
  - All "Mandatory Interfaces" in accordance with the data access specification
  - Symbolic access to process data in the namespace
- OPC data types
  - VT_I1, VT_I2, VT_I4, VT_I8
  - VT_UI1, VT_UI2, VT_UI4, VT_UI8
  - VT_R4, VT_R8
  - VT_BOOL
  - VT_BSTR
  - VT_DATE

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12.2 System requirements

Various system requirements must be met so that the PSS 4000 firmware can be installed on a device.

12.2.1 PC with Microsoft Windows operating system

The PSS 4000 firmware can be installed on a PC with one of the following operating systems:

- Microsoft Windows XP with ".NET Framework" from version 2.0
- Microsoft Windows 7 with ".NET Framework" from version 2.0 in one of the versions
  - Home
  - Premium
  - Professional
  - Ultimate
  - Enterprise

12.2 System requirements

12.2.2 Device with Microsoft Windows Embedded Standard 7

The PSS 4000 firmware can be installed on a system (e. g. PC) with the operating system **Microsoft Windows Embedded Standard 7** .
".NET Framework Version 2.0" is required for installation. The following Windows Embedded Standard 7 OS components must be available on the system:

Application and Services Development	
.Net Framework	NET Framework 2.0 Client Profile
Application Support	COM OLE Application Support
	COM+ Application Support
	Win32 Application Runtimes and Libraries

Internet Services	
Browser	Internet Explorer 8.0
	Internet Explorer 8 Browser
	Internet Explorer 8 Engine and Display
	Internet Explorer 8 Foundation

Core OS	
Devices and Printers	Device Framework
	Driver Frameworks
System Services	Core File System
	Remote Client
	Simplified Message Block (SMB)
	Remote Procedure Call
	Windows Installer

File Systems and Data Store	
Data Access and Storage	Windows Data Access Components

Diagnostics	
Diagnostics	Common Diagnostic Tools

Fonts	
Fonts	TrueType Fonts
	Western Fonts

Graphics and Multimedia Technologies	
Graphics and Multimedia	Graphics Platform

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12.2 System requirements

Device Management	
Management	Microsoft Management Console (MMC)
	System Management Administrative Tools
	System Management Utilities
	Windows Management Instrumentation (WMI)

Communication Services and Networking	
Networking	Extensible Authentication Protocol (EAP)
	Internet Authentication Service
	Networking Base
	Networking Foundation
	IRDA and UNIMODEM
	Domain Services
	Network and Sharing Center
	Peer Networking
	Remote Access Service (RAS)
	Telephony API Client
	Windows Firewall

Security	
Security	Windows Security Center
	Security Base

Shell and User Interface	
User Interface	Embedded Core Help Content
	Help and Support Engine
	Application User Experience
	Shell Controls and UI Support Functions
	Shell Foundation
	Windows Explorer Shell
	System Control Panel
	Search Indexing

12.2 System requirements

12.2.3 Operator terminals PMI 4 from Pilz

The PSS 4000 firmware can be installed on a PMI operator terminal that meets the following system requirements:

- Kernel from Kernel version 1.7
- min. 30 MB free Flash memory.
- Products:
  - PMIvisu with "4" as the first digit in the device name (e. g. PMI v**4**16)
  - PMIopen with "4" as the first digit in the device name (e. g. PMI o**4**38)

PMIvisu already contains the graphics software PMI-PRO, so no other visualisation software is required.

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12.2 System requirements

12.2.4 Operator terminals PMI 5 from Pilz

The PSS 4000 firmware can be installed on a PMI operator terminal that meets the following system requirements:

- min. 30 MB free Flash memory.
- Products:
  PMIvisu with "5" or higher as the first digit in the device name (e. g. PMI **5**26)

12.3 Licensing

Licensing of the OPC Server takes place when a project is licensed in PAS4000. Further information on licensing is available in PAS4000's online help.

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12.4 Installation

The current installation files are available in the download area of the Pilz homepage (www.pilz.de -> Downloads). "Software" can be entered as the search term, for example.
The software download is only available for registered users. Unregistered users can register free of charge. A valid E-mail address is required for registration.

Several installation kits are available for the PSS 4000 firmware, depending on the application area:

- The PSS 4000 firmware is installed on a **PC**:
  Required installation kit:
  PSS_4000_PC_Installer_<*version number*>.zip
  (e. g. PSS_4000_PC_Installer_1.1.0.zip)
- The PSS 4000 firmware is installed on an operator terminal **PMI 4**:
  Required installation kit:
  PSS_4000_PMI_Installer_<*version number*>.zip
  (e. g. PSS_4000_PMI_Installer_1.1.0.zip)
  The installation files are in the subdirectory "PMI_4" after unzipping.
- The PSS 4000 firmware is installed on an operator terminal **PMI 5**:
  Required installation kit:
  PSS_4000_PMI_Installer_<*version number*>.zip
  (e. g. PSS_4000_PMI_Installer_1.1.0.zip)
  The installation files are in the subdirectory "PMI_5" after unzipping.

12.4 Installation

12.4.1 Install PSS 4000 firmware on a PC

The PSS 4000 firmware is installed on the PC that serves as the diagnostic unit. The diagnostic unit may also be used simultaneously as a display unit. When the PSS 4000 firmware is installed, the OPC Core Components are also installed automatically. The OPC Core Components consist of various auxiliary programs and software components for OPC Servers. The PSS 4000 Firmware Controller is also installed.

INFORMATION

- If the OPC Server is installed on the same PC as PAS4000, the PAS4000 firmware version must be identical to the version of the PSS 4000 firmware.
- If the OPC Server is installed on the same PC as PAS4000, we recommend that you install PAS4000 first, followed by the PSS 4000 firmware.
- If the OPC Server is installed on the same PC as PAS4000, the PSS 4000 firmware sets the system variable PILZ_SNP_MULTICAST_TTL to 64 during installation.
- Before an OPC Client can access the OPC Server, the Server must first be started. There are various procedures for doing this:
  - Automatic start via the Autostart menu
    When installing the PSS 4000 firmware, the default setting in the installation window is retained. This means that the PSS 4000 Firmware Controller is entered in the Autostart menu of the Windows operating system. Each time the PC is booted, the OPC Server is started automatically.
  - Manual start
    During installation, the option responsible for the entry in the Autostart menu is deselected in the installation window. This means that, after installation and each time the PC is booted, the OPC Server must be started manually via the PSS 4000 Firmware Controller.

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12.4 Installation

12.4.1.1 First-time installation of the PSS 4000 firmware

With a first-time installation, proceed as follows:

1. Start the PC on which the PSS 4000 firmware is to be installed.
2. If you haven't already done so:
   Create a directory on the PC, copy the installation kit (ZIP file) into the directory and unzip it. The following file will be available:
   – PSS_4000_PC_Installer_*<version number>*.exe
     (e. g. PSS_4000_PC_Installer_1.1.0.exe)
3. Double-click the EXE file.
   Follow the on-screen instructions to complete the installation.
   The following tasks are executed on the PC:
   – OPC Server Software, PSS 4000 Firmware Controller and OPC Core Components are installed
   – Software is registered in the registry
   – Icon is added to the task bar that displays the state for the PSS 4000 Firmware Controller;
     (a change in state (start/stop) can be selected by right-clicking on the icon.)

This completes the installation.

INFORMATION
When registering (registry of the PC) the installation program configures, among others, the DCOM setting for the OPC server. When the installation is a first-time installation of the OPC server on the PC, the DCOM settings for the "anonymous remote access" is only effective after the PC is restarted.

12.4 Installation

12.4.2 Install PSS 4000 firmware on a PMI operator terminal

The PSS 4000 firmware is installed on an operator terminal PMI. In this case the PMI is used as a diagnostic and display device.

Installation on a PMI 4 operator terminal

The installation of the PSS 4000 firmware will cause:

- Installation of the OPC Server in the directory *\NAND\PSS4000*
- Installation of the visualisation software PSS 4000 Diag Control in the directory *\NAND\PSS4000_Diag_Control*
- Installation of core components in the directory *\NAND\OPCCore*
- Configuration of the DCOM settings to enable OPC Clients to access the OPC Server
- Adaptation of the batch file *PMIStart.cmd*
  Existing entries in any existing batch file are maintained. The entries made during the installation of the batch file will allow the following software to be started during the start of a PMI:
  - **PMIopen:**
    - PSS 4000 Firmware Controller
    - OPCEnum
    - PSS 4000 Diag Control
    - PSS4000_Diag.html
  - **PMIvisu**:
    - PSS 4000 Firmware Controller
    - OPCEnum
- Deactivation of the PMI internal SNTP server
- Generation of the log file *PSS4000_Installer.log*
  The file includes information on the installation status (e. g. message on successful installation, error messages).
- Impact after a first-time installation:
  If the first-time installation of the PSS 4000 firmware has been successful, the point for "FirmwareUpdate" is set to the default value "2009-01-01-00:00:00.000" (see namespace: pss4000.net.*<device name>*.Device.Product.FirmwareUpdate").
- Impact after a firmware update:
  - If a device naming procedure has been performed before the firmware update, the naming data from this device naming procedure are retained on the removable data medium.
  - If a project download has been performed before the firmware update, the device project is retained on the removable data medium.
- After installation the PMI 4 operator terminal will be restarted.

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12.4 Installation

Installation on a PMI 5 operator terminal

The installation of the PSS 4000 firmware will cause:

- Installation of the PSS 4000 OPC Server in the directory *\FLASH\PSS4000*
- Installation of the visualisation software PSS 4000 Diag Control in the directory *\FLASH\PSS4000_Diag_Control*
- Configuration of the DCOM settings to enable OPC Clients to access the PSS 4000 OPC Server
- Adaptation of the batch file *PMIStart.cmd*
  Existing entries in any existing batch file are maintained. The entries made during the installation of the batch file will allow the following software to be started during the start of a PMI:
  – OPCEnum
  – PSS 4000 Firmware
  – PSS 4000 Diag Control
- Deactivation of the PMI internal SNTP server
- Generation of the log file *PSS4000_Installer.log* in the directory *\FLASH*
  The file includes information on the installation status (e. g. message on successful installation, error messages).
- Impact after a first-time installation:
  If the first-time installation of the PSS 4000 firmware has been successful, the point for "FirmwareUpdate" is set to the default value "2009-01-01-00:00:00.000" (see namespace: pss4000.net.*<device name>*.Device.Product.FirmwareUpdate").
- Impact after a firmware update:
  – If a device naming procedure has been performed before the firmware update, the naming data from this device naming procedure are retained on the removable data medium.
  – If a project download has been performed before the firmware update, the device project is retained on the removable data medium.
- After installation the PMI 5 operator terminal will be restarted.

12.4 Installation

12.4.2.1 First-time installation of the PSS 4000 firmware

With a first-time installation, proceed as follows:

1. Start the PMI on which the PSS 4000 firmware is to be installed.
   We recommend to operate the PMI via keyboard during the installation.
   Exit all programs with a PMI that has already been started.
2. If you haven't already done so:
   Copy the installation set (ZIP file) into a directory on a PC and unpack it.
   In the "PMI_4" subdirectory you receive the following installation files for operator terminals PMI 4:
   – PSS_4000_PMI_4_Installer_<*version number*>.exe
   – PSS_4000_PMI_4_Data_<*version number*>.cab
   In the "PMI_5" subdirectory you receive the following installation files for operator terminals PMI 5:
   – PSS_4000_PMI_5_Installer_<*version number*>.exe
   – PSS_4000_PMI_5_Data_<*version number*>.cab
3. Transfer installation files to the PMI
   We recommend that you copy the installation files from PC to an USB stick and then to connect the USB stick to the PMI.
4. Start the Explorer on the PMI (*Hard Disk*) and switch to the USB stick.
5. Start installation
   Please note: Start the installation by double-clicking the EXE file!
6. Run installation
   Follow the on-screen instructions to complete the installation. You cannot change the installation directory *\NAND\PSS4000*.
7. If the installation has been successful, the PMI starts again.
   If errors occur during installation, please note the information in the log file *\NAND\PS4000\PSS4000_Installer.log*.

This completes the installation.

INFORMATION
When installing, the installation program configures the DCOM setting for the OPC Server in the registry file. This configuration downgrades the safety settings.

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12.5 Communication and security settings for PCs

The settings described below are only required if:

- The OPC Server is being operated on a PC and
- OPC Clients that are being operated on PCs access the OPC Server via Ethernet.

Example

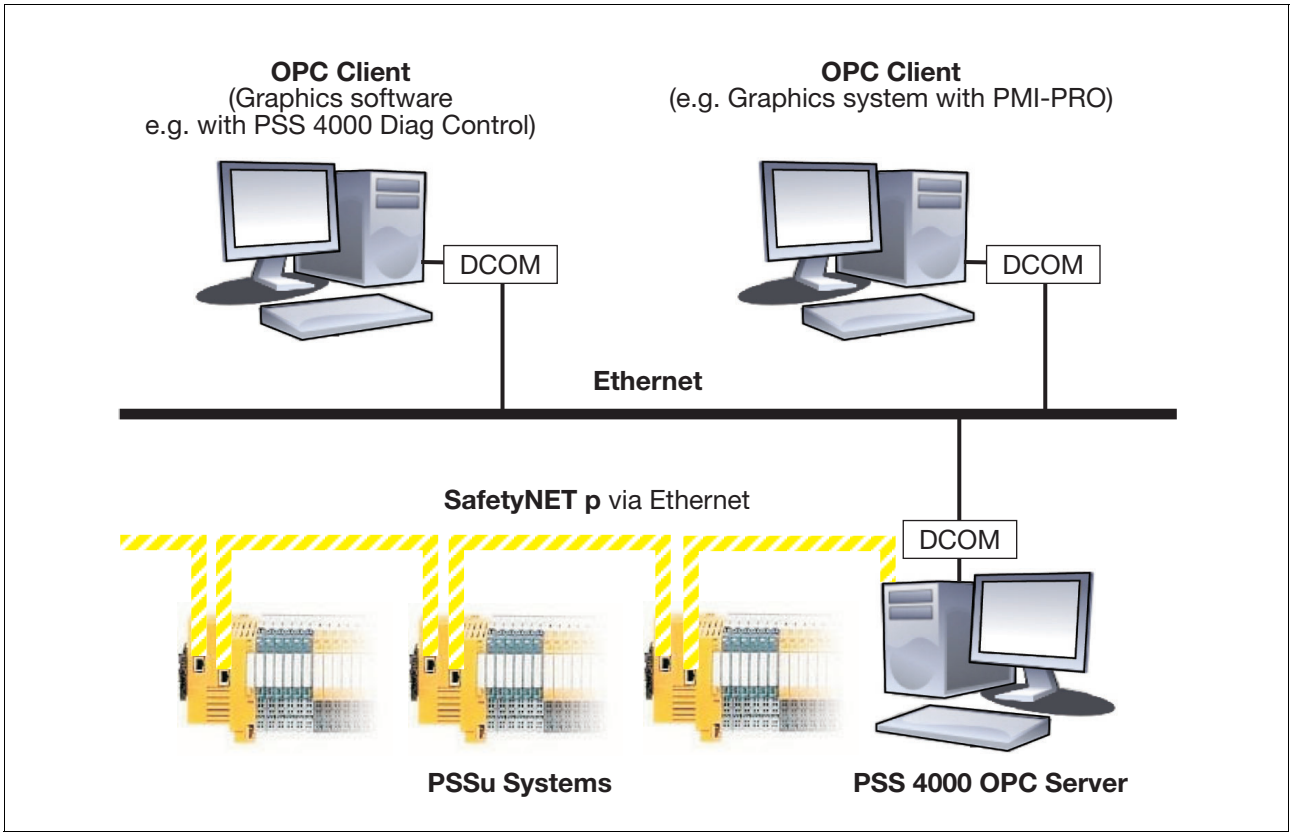

Fig. 12-3: OPC Clients accessing the PSS 4000 OPC Server via Ethernet

To enable OPC Clients to access the OPC Server via Ethernet, various settings must be made in the DCOM configuration for all PCs involved in data exchange. These settings are documented below.

DCOM only permits authenticated access between PCs, so we recommend that the PCs (OPC Server, OPC Clients) are registered in the same domain.

The settings in the DCOM configuration grant access rights to the OPC Server for other network users. An incorrect configuration can compro-

12.5 Communication and security settings for PCs

mise the safety and stability of the operating system. A network administrator can optimise these configurations to protect the OPC Server from unauthorised access.

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12.5 Communication and security settings for PCs

12.5.1 DCOM configuration

The description below applies to the following operating systems

- Microsoft Windows XP with at least SP2
- Microsoft Windows Embedded Standard 7
- Microsoft Windows 7

The required settings and configurations are described predominantly as part of the dialogue boxes of Microsoft Windows XP SP2. The dialogue boxes shown may vary depending on the Windows version and service pack. Further guidelines are available under Windows Help.

12.5 Communication and security settings for PCs

12.5.1.1 Start DCOM configuration

Start DCOM configuration under Microsoft Windows XP

- Select ***Run...*** in the Windows Start menu
  The ***Run*** window opens.

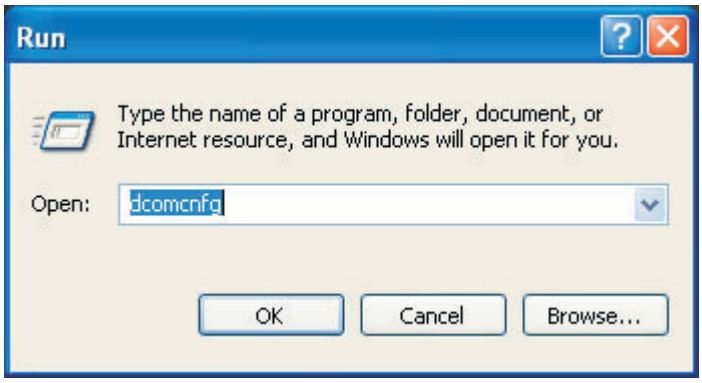
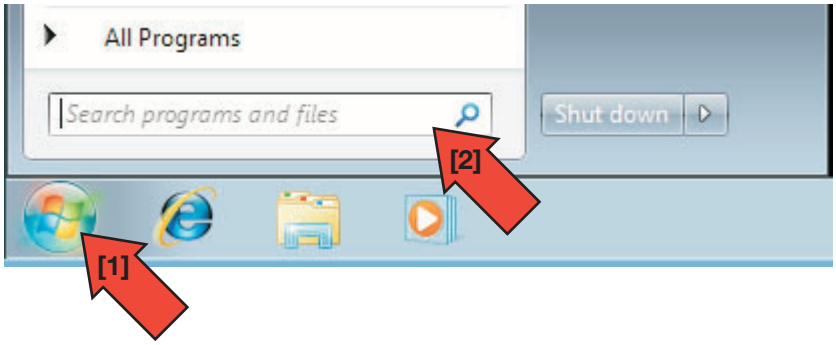


Fig. 12-4: "Run" window

- Enter "dcomcnfg" and click ***OK***.
  The ***Component Services*** window opens.

Start DCOM configuration under Microsoft Windows 7

- Click the Windows Start symbol [1] and enter "dcomcnfg.exe" as a search criterion [2].
  A window is opened, in which the program "dcomcnfg" is displayed as a search result.



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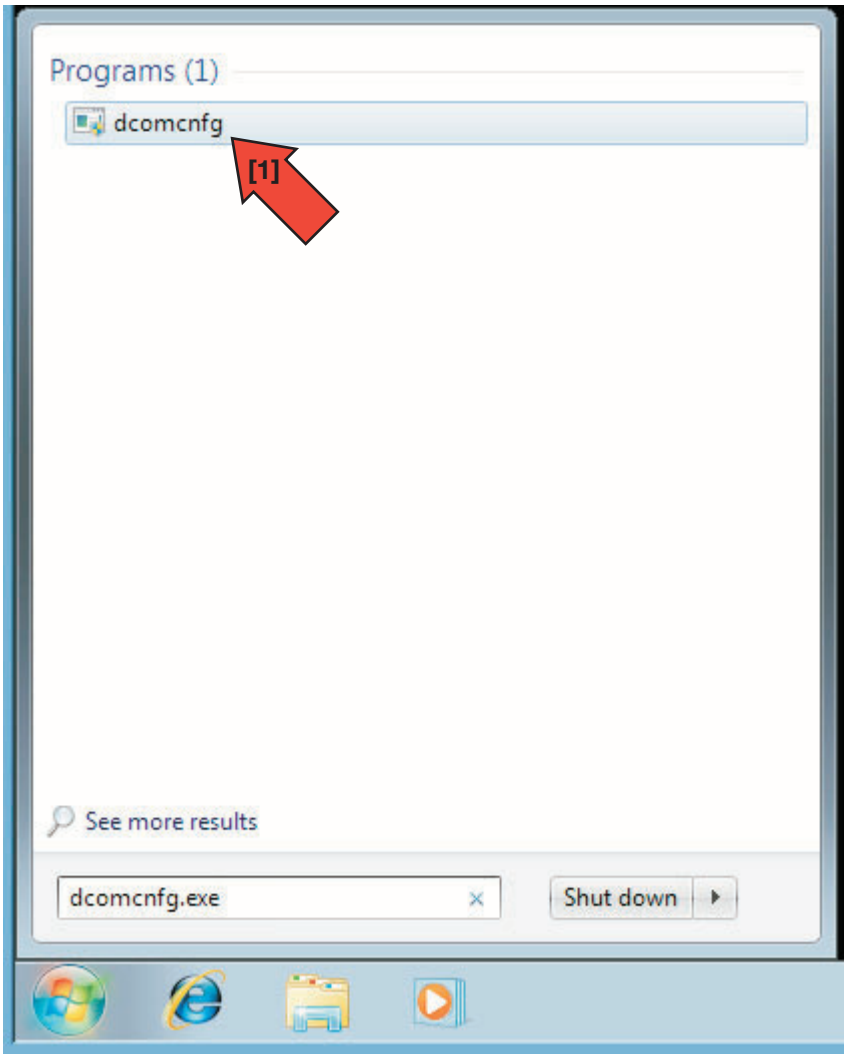
12.5 Communication and security settings for PCs

- Select the program "dcomcnfg" [1] and confirm your selection.
  The ***Component Services*** window opens.



12.5 Communication and security settings for PCs

Component services

- Open the directory in the ***Component Services*** window (window's left-hand column)
  Console Root / Component Services / Computers / My Computer.

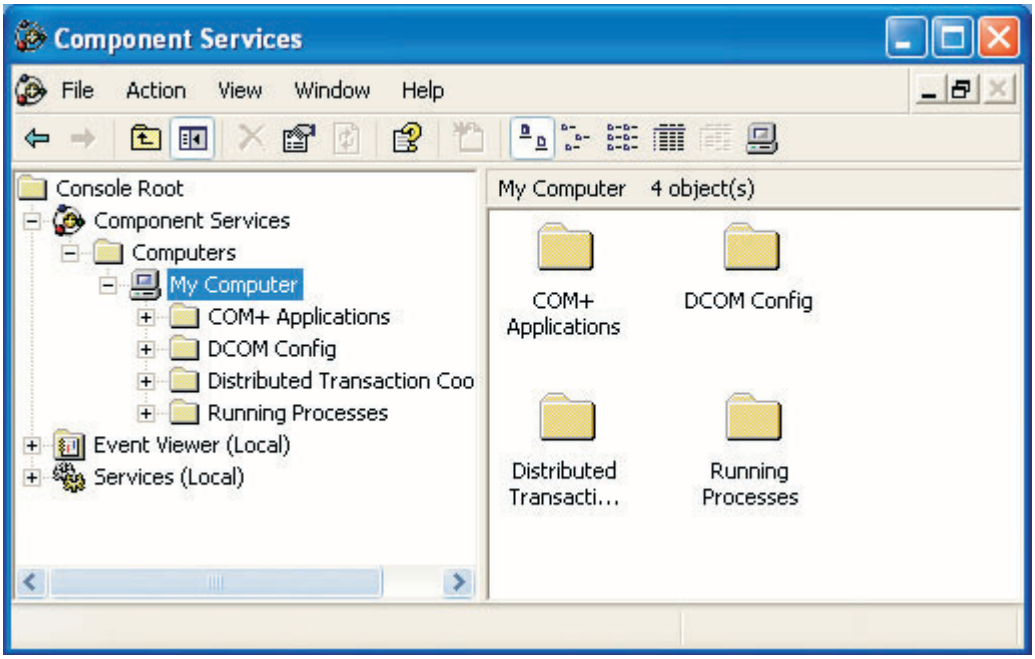


Fig. 12-5: "Component Services" window

- For further details of the configuration, please refer to the sections:
  - DCOM configuration for the OPC Server and OPC Clients
  - DCOM configuration for the OPC Server
  - OPCEnum configuration for the OPC Server

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12.5 Communication and security settings for PCs

12.5.1.2 DCOM configuration for the OPC Server and OPC Clients

The following communication and security settings must be made on all PCs (OPC Server, OPC Clients) involved in data exchange. These settings are called the "general DCOM configuration" and specify the access that other PCs may have to a PC.

- Open the ***Component Services*** window.
  A description can be found under "Start DCOM configuration".
- Right-click on ***My Computer*** and select ***Properties***.
  The ***My Computer Properties*** window opens.
- Select the ***Default Properties*** tab.
  - Select ***Enable Distributed COM on this Computer***.
  - Select ***None*** under ***Default Authentication Level***.
  - Select ***Accept Identity*** or ***Identify*** under ***Default Impersonation Level***.

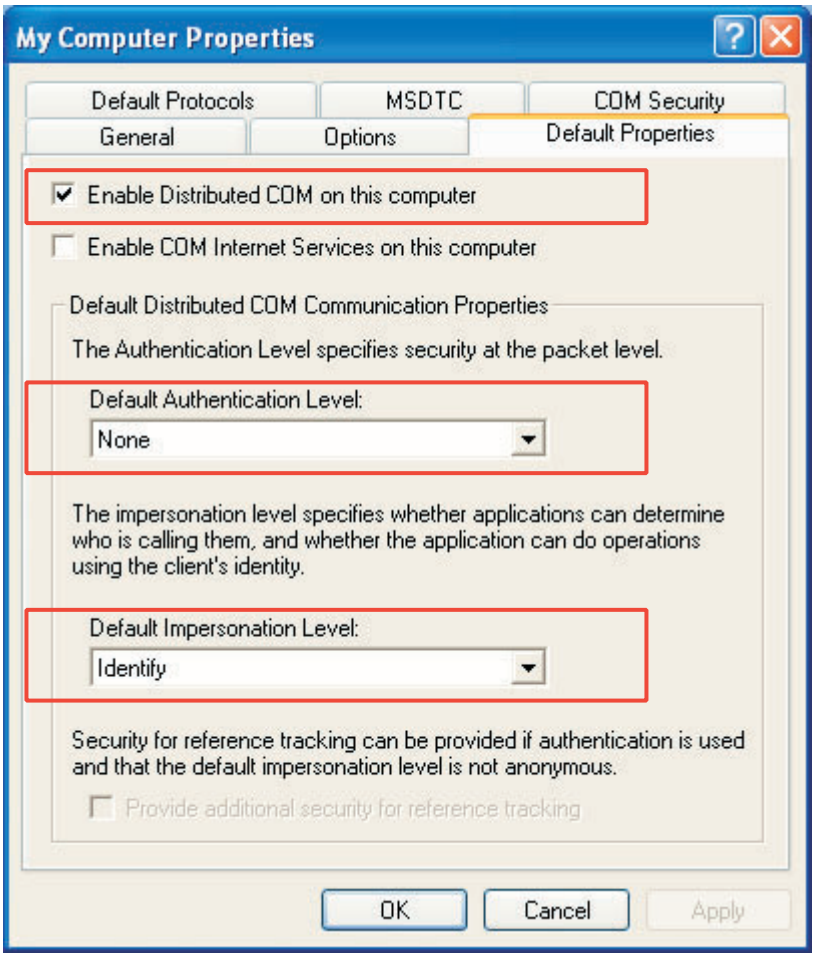

Fig. 12-6: "Default Properties" tab

12.5 Communication and security settings for PCs

- Select the ***Default Protocols*** tab.
  If the connection protocol ***Connection-oriented TCP/IP*** does not appear in the list, you can add it as follows:
  – Click the ***Add*** button.
  The ***Select DCOM protocol*** dialogue box opens.
  – Under ***Protocol Sequence***, select the ***Connection-oriented TCP/IP*** protocol and click ***OK***.
  The ***Default Protocols*** tab is reactivated.

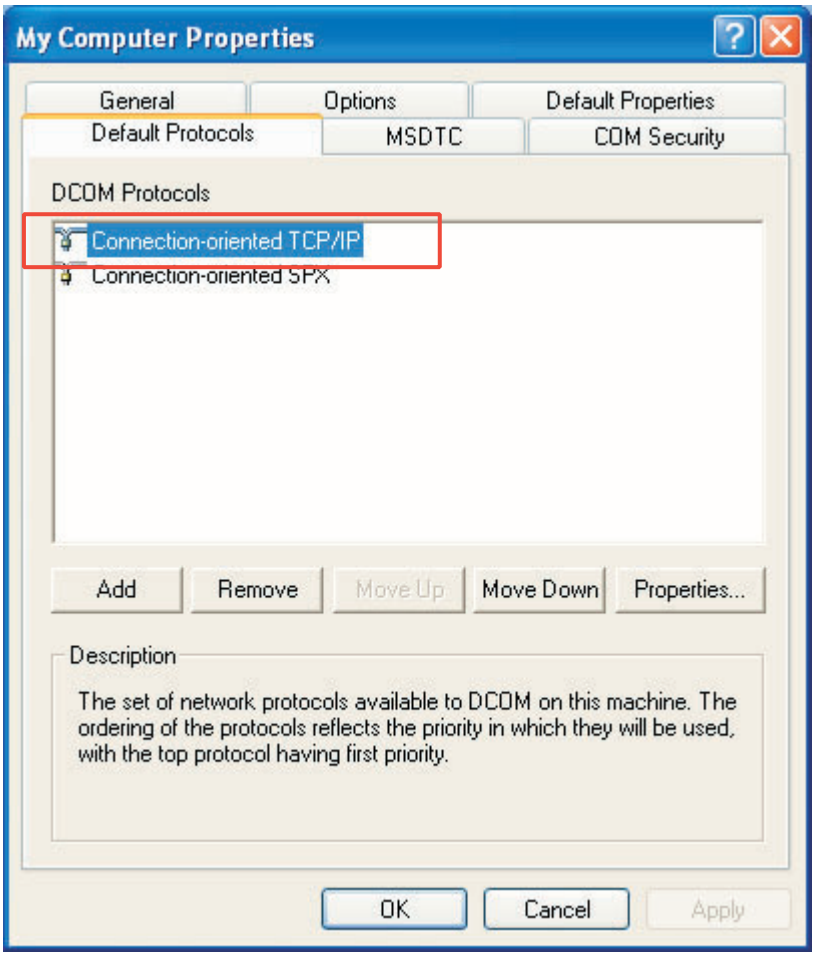

Fig. 12-7: "Default Protocols" tab

- Highlight the ***Connection-oriented TCP/IP*** protocol and move it to the top of the list.
  This will speed up the connection setup.
- Remove any unneeded protocol entries, as these will cause delays when establishing the connection.

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12.5 Communication and security settings for PCs

▸ Select the ***COM Security*** tab.

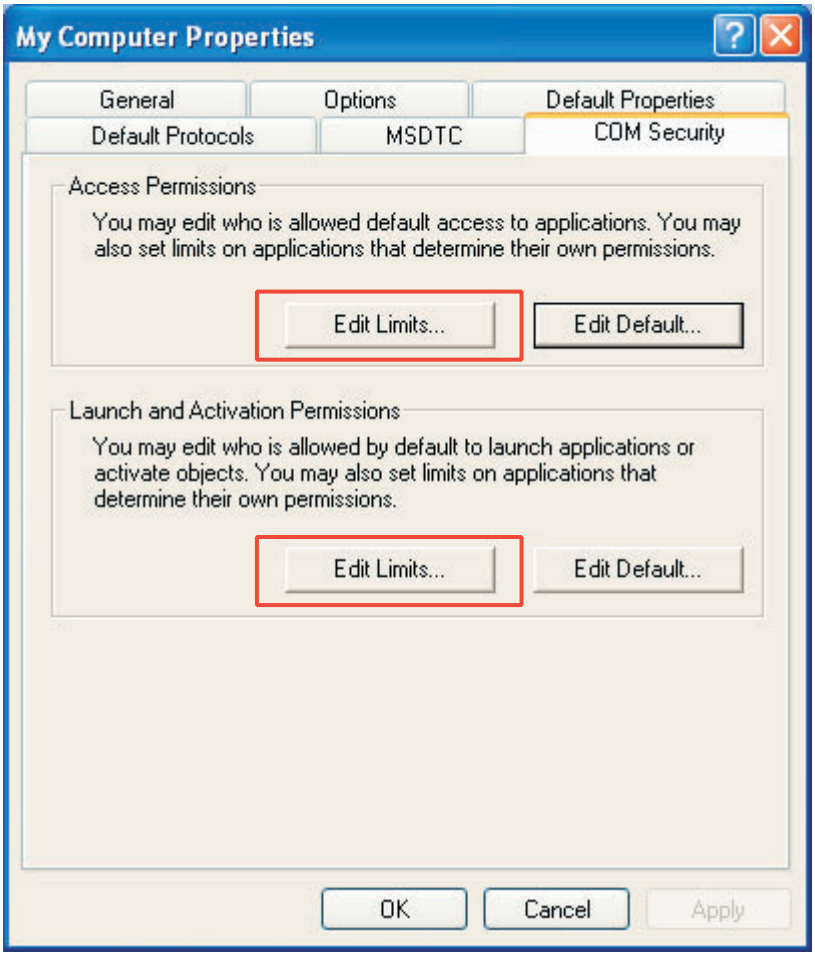

Fig. 12-8: "COM Security" tab

▸ Under ***Access Permissions***, click on ***Edit Limits***
The ***Access Permission*** window opens.

12.5 Communication and security settings for PCs

- Check whether all the following group or user names are available:
  - ANONYMOUS LOGON
  - INTERACTIVE
  - Everyone
  - NETWORK
  - SYSTEM

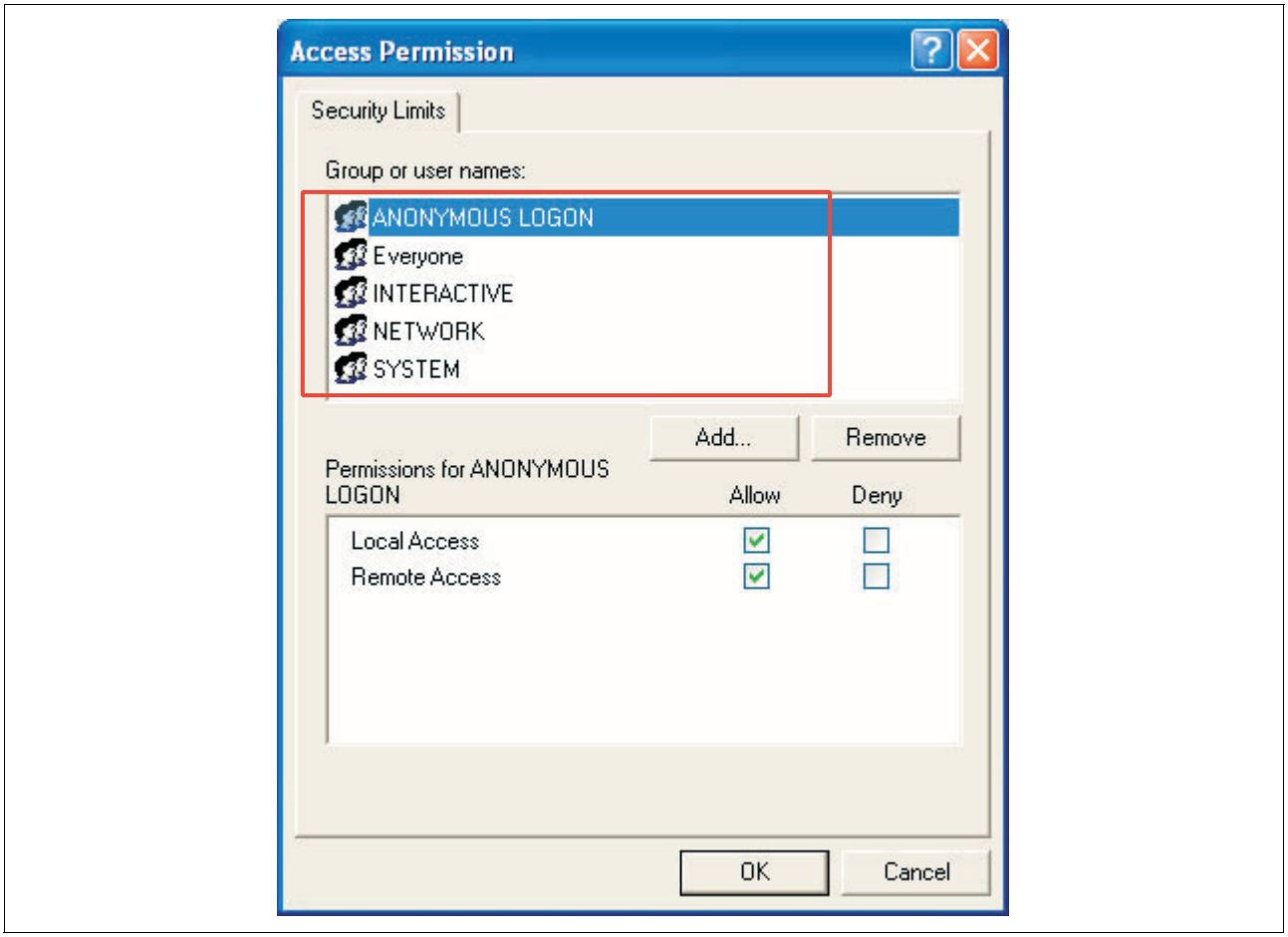

Fig. 12-9: "Access Permission" window: Group or user names (COM Security)

- If one of the group or user names is not available, add it (***Add...*** - ***Advanced*** – ***Search Now***).
  Please note the additional information for the user NETWORK (see Special feature of the user "NETWORK", page 12-51) .
  Then confirm with ***OK***.
  The ***Access Permission*** window is reactivated.

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12.5 Communication and security settings for PCs

- Select each user individually and activate the option ***Allow*** for the permissions.
  - Local Access
  - Remote Access

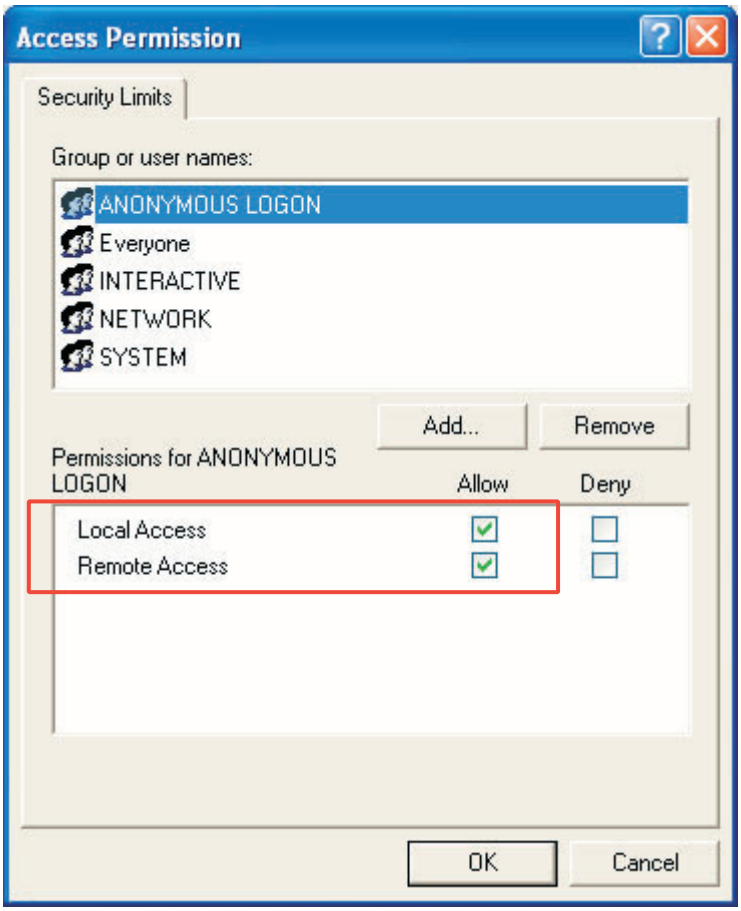

Fig. 12-10: "Access Permission" window: Permissions (COM Security)

- Click ***OK***.
  The ***COM Security*** tab is reactivated.
- Under ***Launch and Activation Permissions***, click on ***Edit Limits***.
  The ***Launch Permission*** window opens.

12.5 Communication and security settings for PCs

- Check whether all the following group or user names are available:
  - Administrators (…)
  - ANONYMOUS LOGON
  - INTERACTIVE
  - Everyone
  - NETWORK
  - SYSTEM

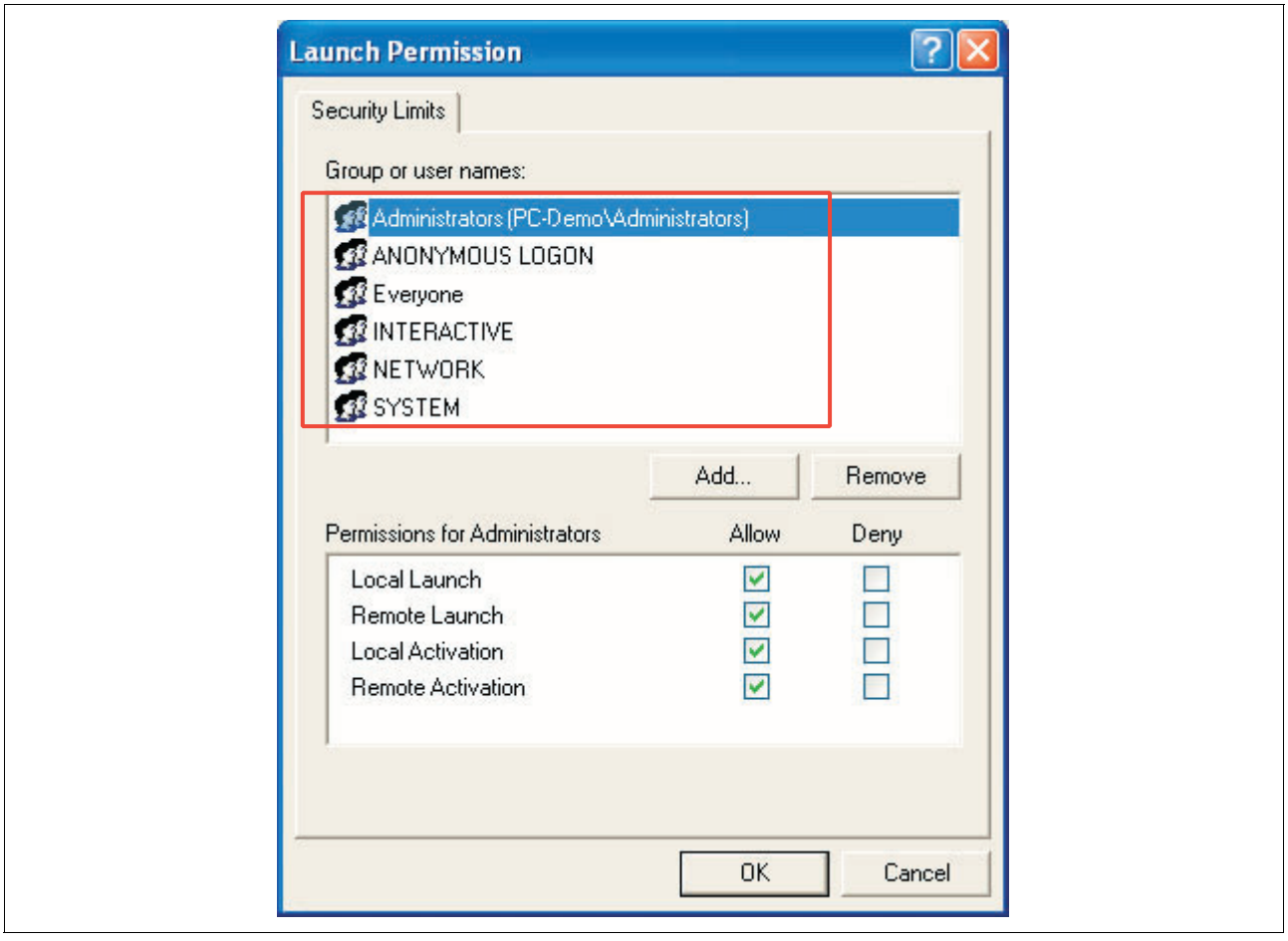

Fig. 12-11: "Launch Permission" window: Group or user names (COM Security)

- If the "Administrators" user is not available, add it. To be able to add the "Administrators" user, the search path has to be adapted (see Special feature of the user "Administrators", page 12-50) .
- If one of the group or user names is not available, add it also (***Add...*** - ***Advanced*** – ***Search Now***).
  Please note the additional information for the user NETWORK (see Special feature of the user "NETWORK", page 12-51) .
  Then confirm with ***OK***.
  The ***Launch Permission*** window is reactivated.

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12.5 Communication and security settings for PCs

- Select each user individually and activate the option ***Allow*** for the permissions.
  - Local Launch
  - Remote Launch
  - Local Activation
  - Remote Activation

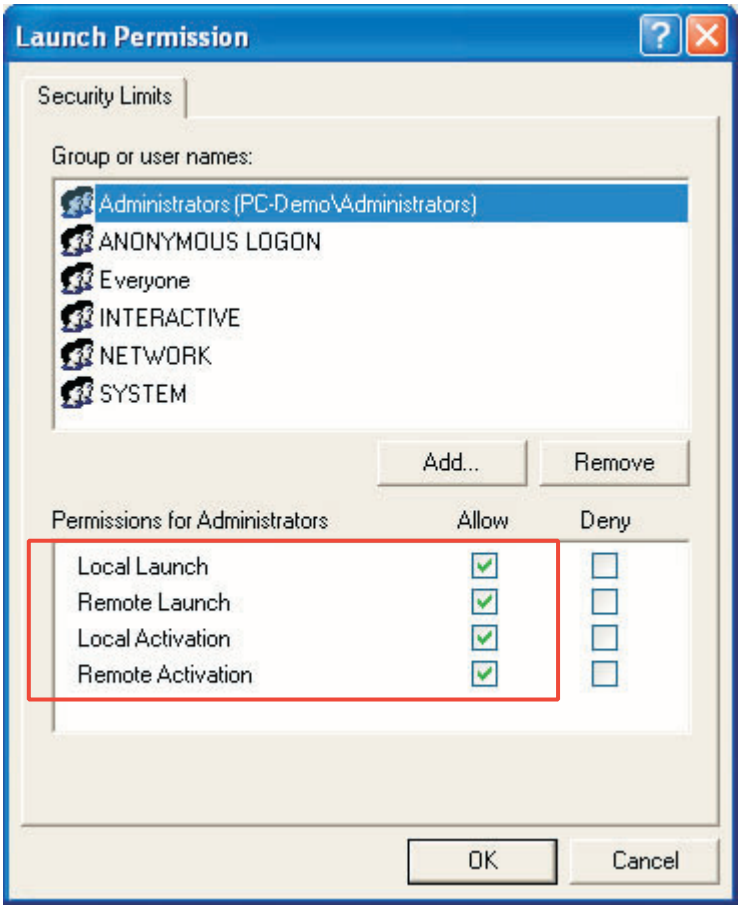

Fig. 12-12: "Launch Permission" window: Permissions (COM Security)

- Click ***OK.***
  The ***COM Security*** tab is reactivated.
- Click ***OK*** to save all the settings and close the ***My Computer Properties*** window.
  This completes the general DCOM configuration for this workstation.
- Close the ***Component Services*** window.
  The settings will take effect the next time the PC is restarted.

12.5 Communication and security settings for PCs

12.5.1.3 DCOM configuration for the OPC Server

The following settings are made automatically when the PSS 4000 OPC Server is installed. Check these settings in the event of an error and modify the stated settings if necessary. These settings are only relevant for the PC containing the OPC Server.

- Open the ***Component Services*** window.
  A description can be found under "Start DCOM configuration".
- Open the ***DCOM Configuration*** directory in the ***Component Services*** window.

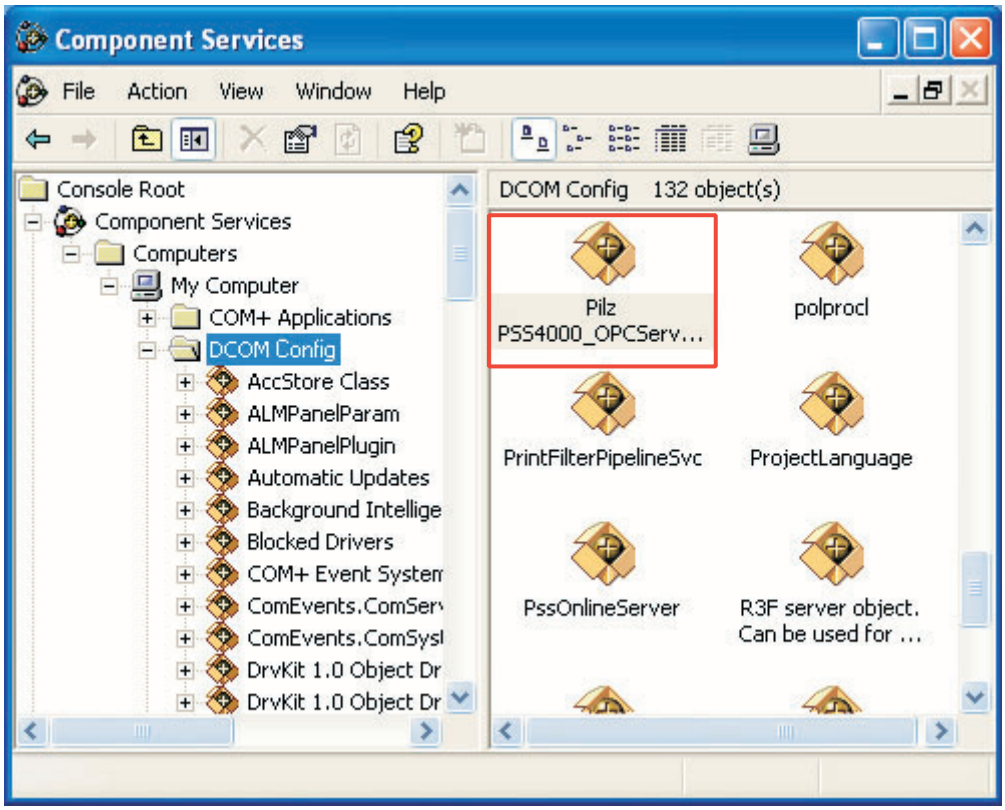

Fig. 12-13: "Component Services" window (DCOM configuration on the OPC Server)

- Right-click on the application ***Pilz PSS4000_OPCServerDA.DA*** and select ***Properties***.
  The ***Pilz PSS4000_OPCServerDA.DA Properties*** window opens.

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12.5 Communication and security settings for PCs

- Select the ***General*** tab.
  Select ***None*** under ***Authentication Level***.

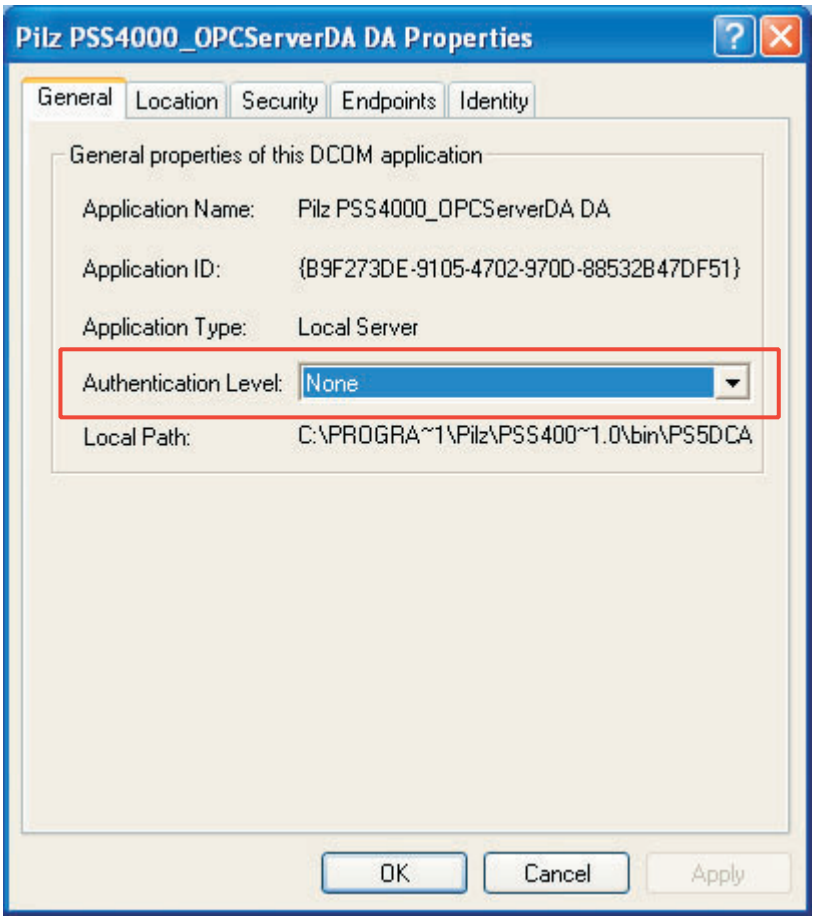

Fig. 12-14: "General" tab (DCOM configuration on the OPC Server)

12.5 Communication and security settings for PCs

- Select the ***Location*** tab
  Enable the option ***Run application on this Computer***.

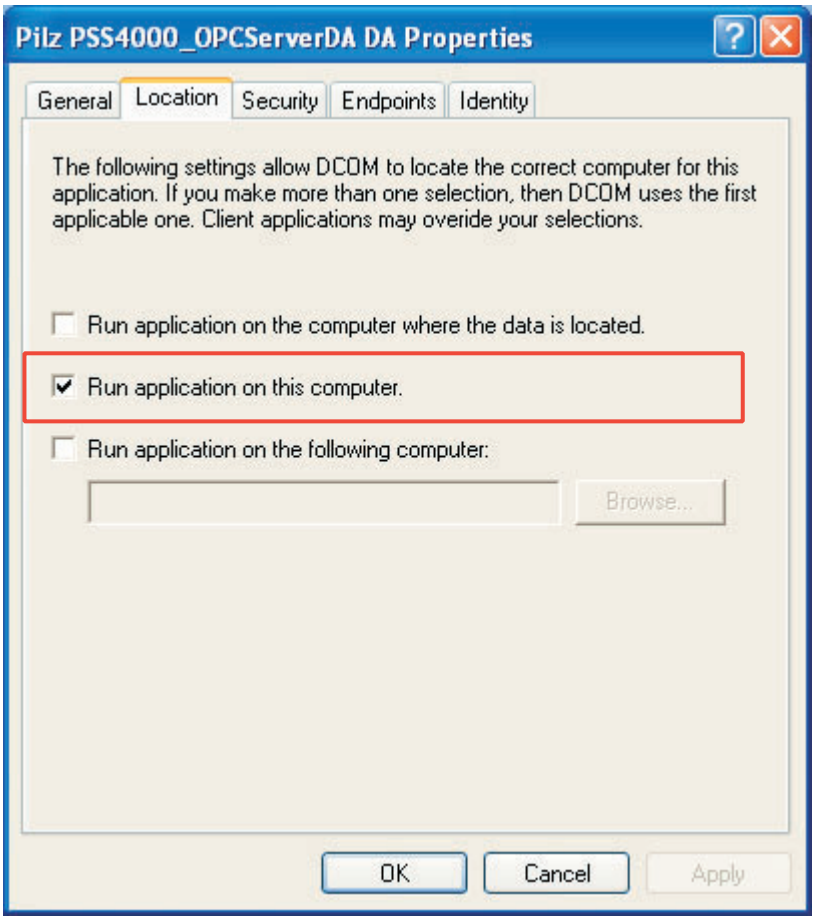

Fig. 12-15: "Location" tab (DCOM configuration on the OPC Server)

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12.5 Communication and security settings for PCs

- Select the ***Security*** tab.
  Select ***Customize*** for ***Launch and Activation Permissions*** and ***Access Permissions*** and then click ***Apply***.

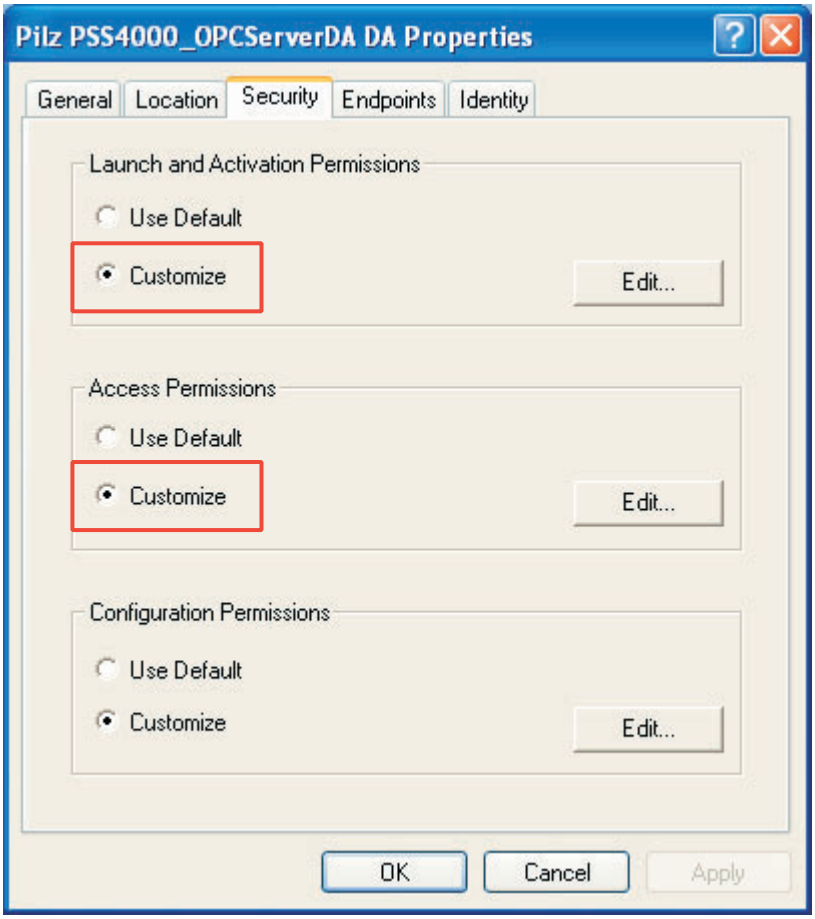

Fig. 12-16: "Safety" tab (DCOM configuration on the OPC Server)

- Click on ***Edit*** in the ***Launch and Activation Permissions*** field.
  The ***Launch Permission*** window is opened.

12.5 Communication and security settings for PCs

- Check whether all the following group or user names are available:
  - Administrators (…)
  - ANONYMOUS LOGON
  - INTERACTIVE
  - Everyone
  - NETWORK
  - SYSTEM

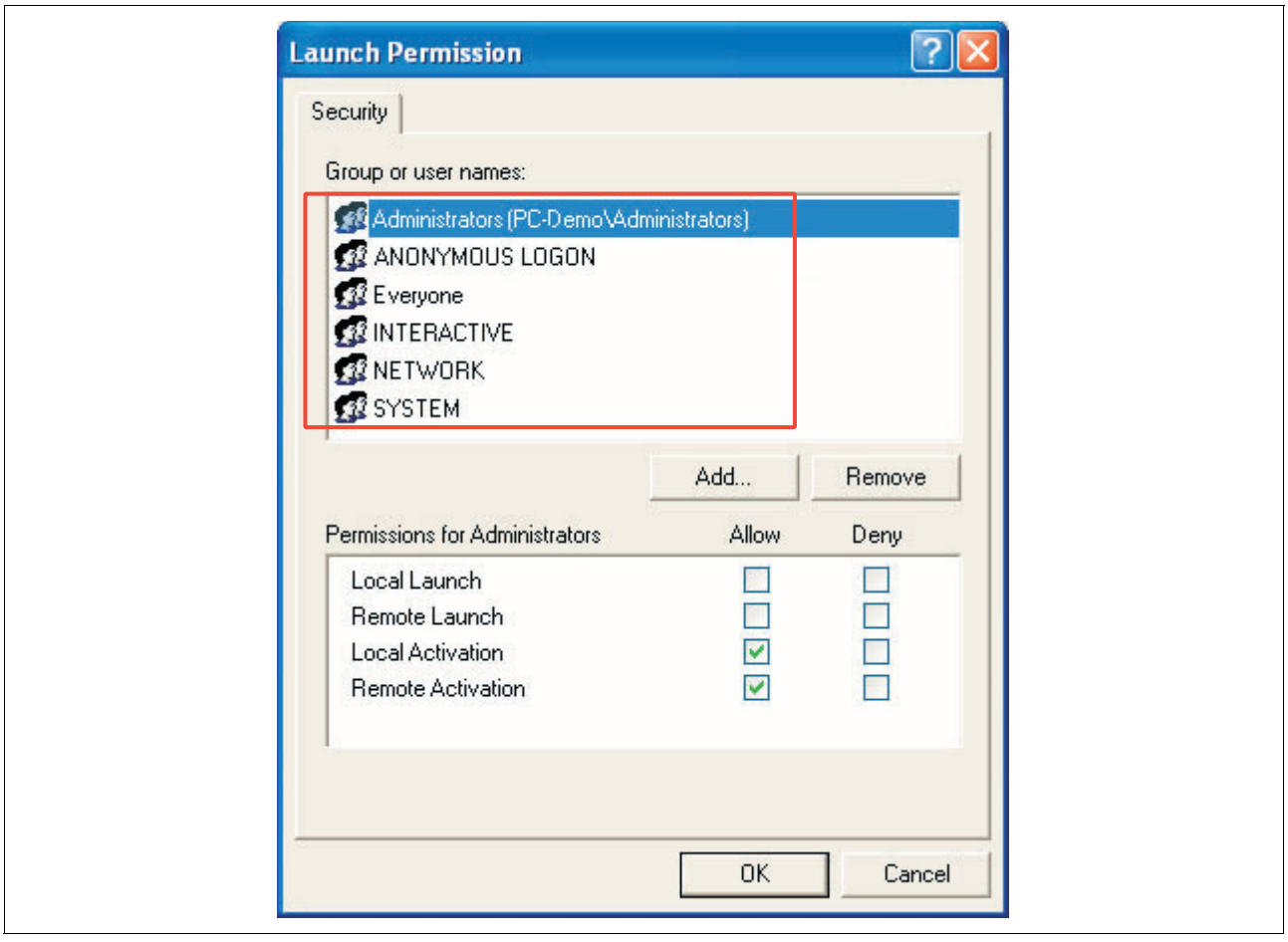

Fig. 12-17: "Launch Permission" window: Group or user names (COM Security on the OPC Server)

- If the "Administrators" user is not available, add it. To be able to add the "Administrators" user, the search path has to be adapted (see Special feature of the user "Administrators", page 12-50) .
- If one of the other group or user names is not available, add it also (***Add... - Advanced – Search Now***).
  Please note the additional information for the user NETWORK (see Special feature of the user "NETWORK", page 12-51) .

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12.5 Communication and security settings for PCs

Then confirm with ***OK***.

The ***Launch Permission*** window is reactivated.

- Select each user individually and tick ***Allow*** for the permissions.
  - Local Activation
  - Remote Activation

  Please note that the PSS 4000 OPC server must **not** be started by clients! This is why the launch permission must not be allowed for ***Local Launch*** and ***Remote Launch***.

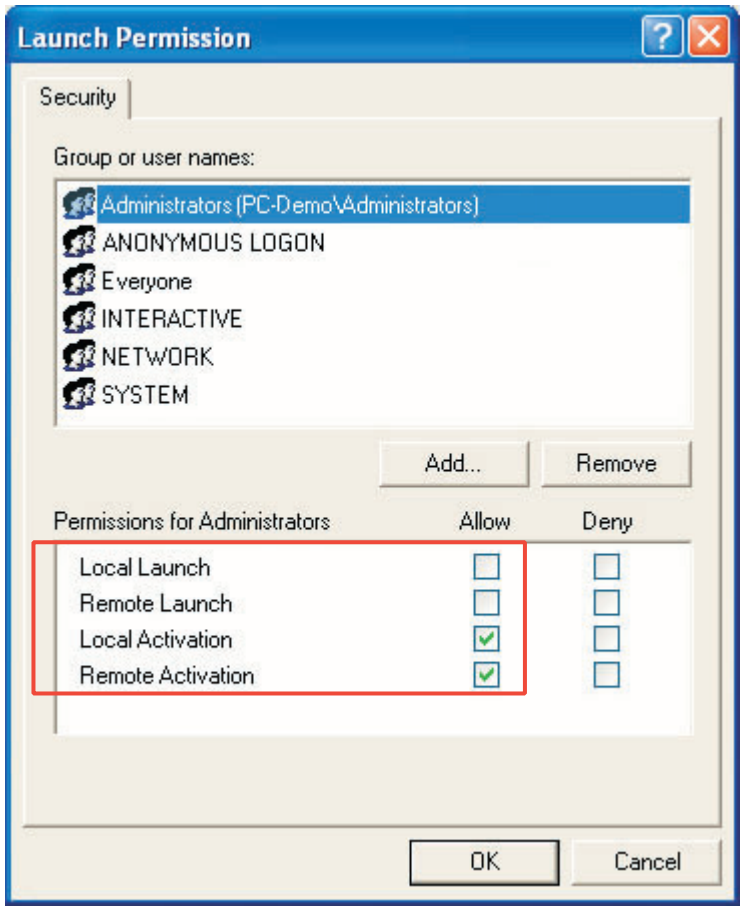

Fig. 12-18: "Launch Permission" window: Permissions (COM Security on the OPC Server)

- Click ***OK***.

  The ***Security*** tab is reactivated.

12.5 Communication and security settings for PCs

- Click on ***Edit*** in the ***Access Permissions*** field.
- Check whether all the following group or user names are available:
  - ANONYMOUS LOGON
  - INTERACTIVE
  - Everyone
  - NETWORK
  - SYSTEM

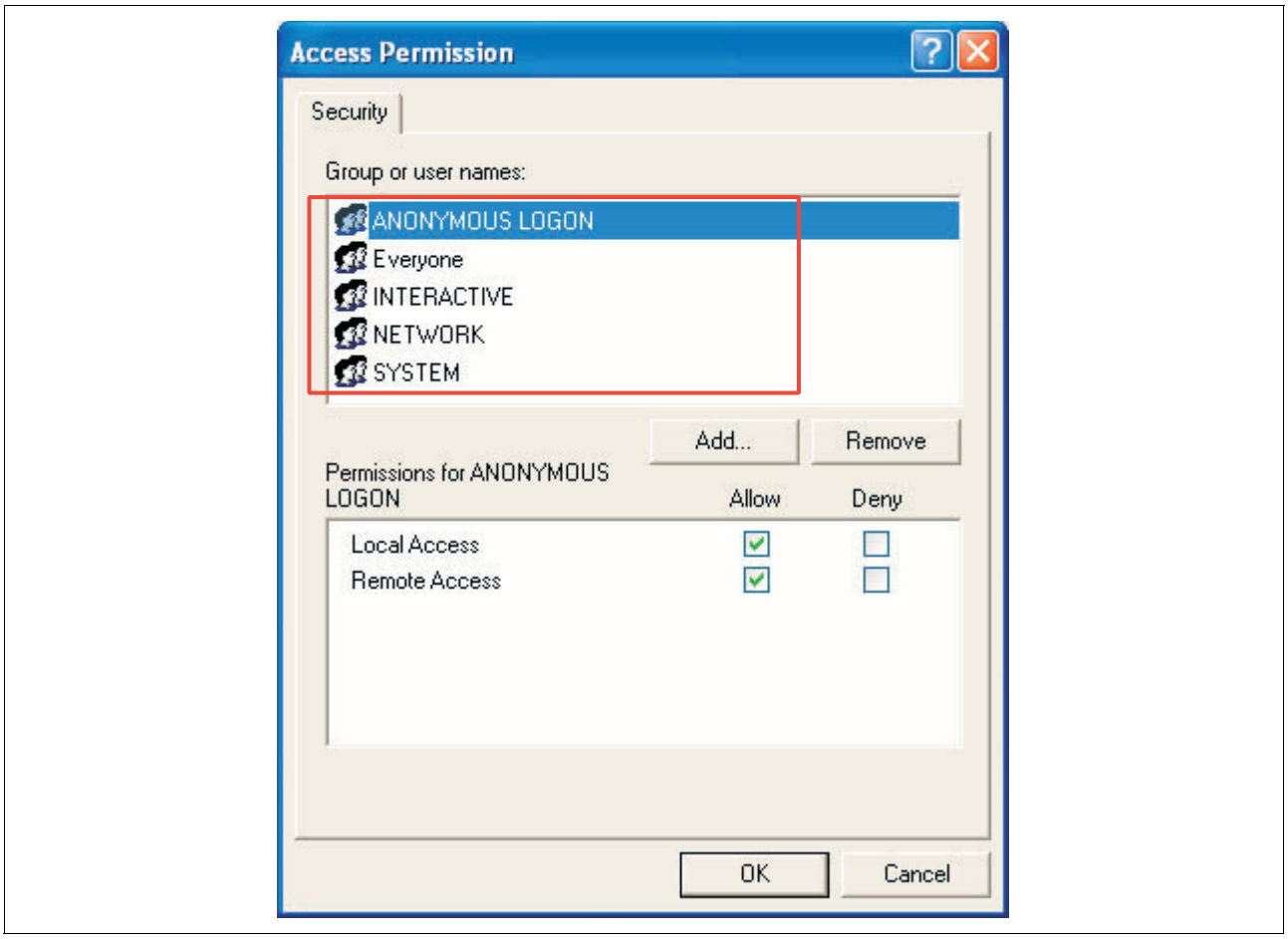

Fig. 12-19: "Access Permission" window: Group or user names (COM Security on the OPC Server)

- If one of the group or user names is not available, add it (***Add... - Advanced – Search Now***).
  Please note the additional information for the user NETWORK (see Special feature of the user "NETWORK", page 12-51) .
  Then confirm with ***OK***.
  The ***Access Permission*** window is reactivated.

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12.5 Communication and security settings for PCs

- Select each user individually and activate the option ***Allow*** for the permissions.
  - Local access
  - Remote Access

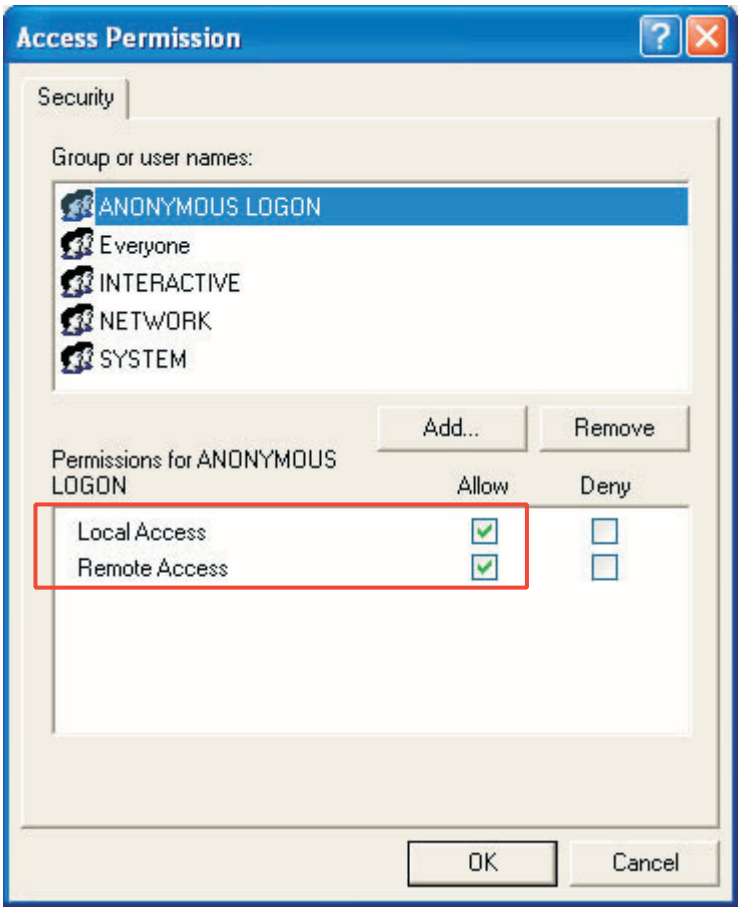

Fig. 12-20: "Access Permission" window: Permissions (COM Security on the OPC Server)

- Click ***OK***.
  The ***Security*** tab is reactivated.

12.5 Communication and security settings for PCs

- Select the ***Identity*** tab.
  Select the option ***Interactive User***.

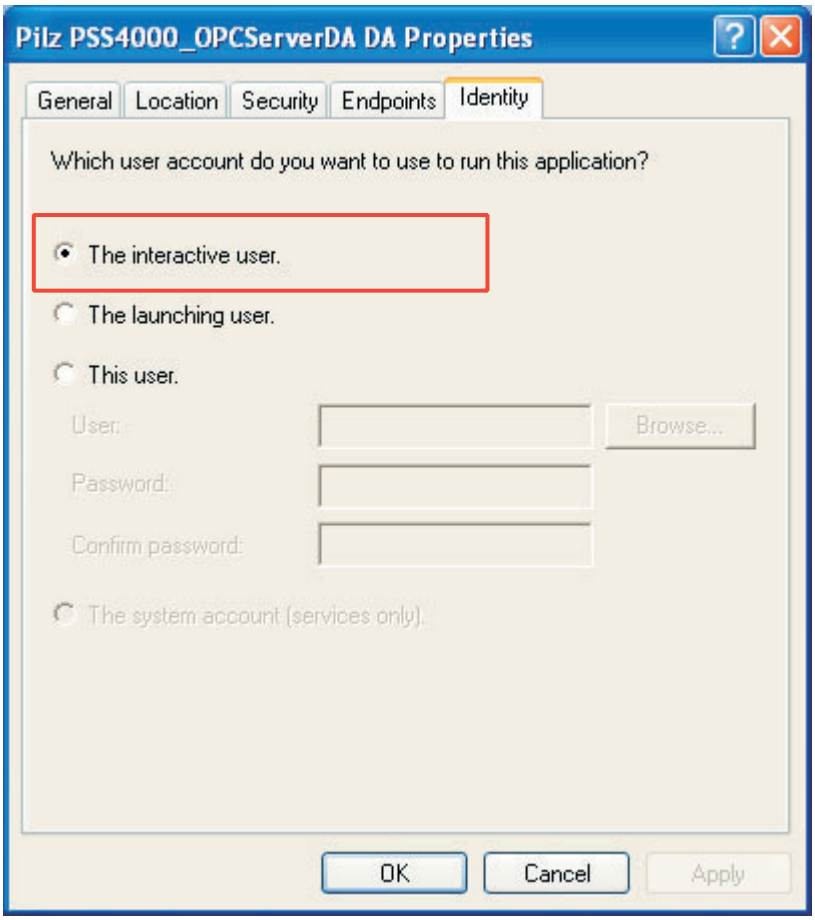

Fig. 12-21: "Identity" tab (COM Security on the OPC Server)

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12.5 Communication and security settings for PCs

- Select the ***Endpoints*** tab.
  If ***Default system protocols*** is not available in the list, add the connection protocol as follows:
  – Click on ***Add*** and select the ***Connection-oriented TCP/IP*** protocol under ***Protocol Sequence***.
  – Click ***OK***.
  The ***Endpoints*** tab is reactivated.

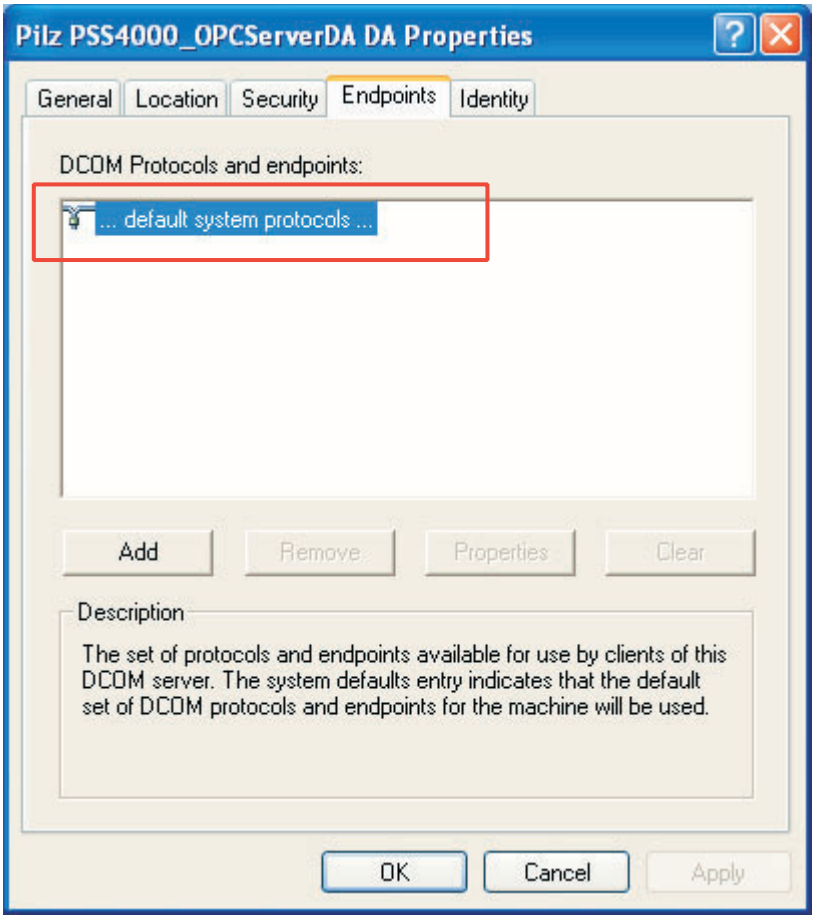

Fig. 12-22: "Endpoints" tab (connection protocol on the OPC Server)

- Click ***OK*** to save all the settings and close the ***Pilz PSS4000_OPCServerDA.DA Properties*** window.
  This completes the DCOM configuration for the OPC Server.

12.5 Communication and security settings for PCs

12.5.1.4 OPCEnum configuration for the OPC Server

The following settings are only relevant for the PC containing the OPC Server.

- Open the ***Component Services*** window.
  A description can be found under "Start DCOM configuration".
- Open the ***DCOM Configuration*** directory in the ***Component Services*** window.
  You may receive several DCOM configuration warnings, but you can ignore all of them for this configuration. Each time click ***No***.

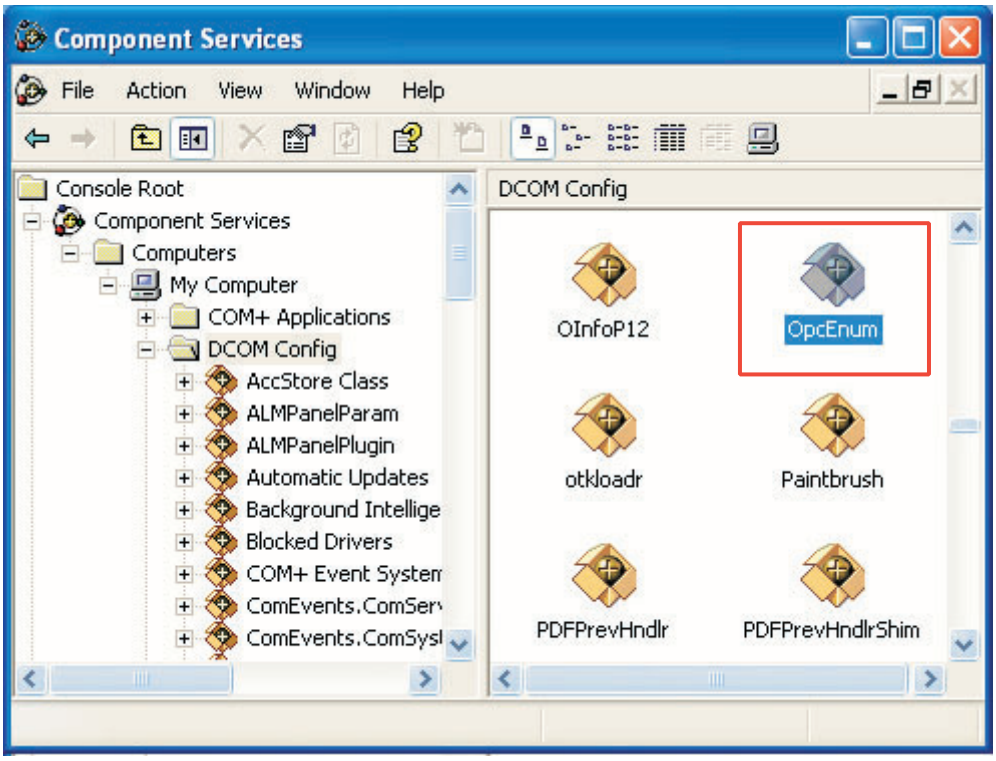

Fig. 12-23: "Component Services" window (DCOM configuration for OPCEnum on the OPC Server)

- Right-click on the ***OpcEnum*** application and select ***Properties***.
  The ***OpcEnum Properties*** window opens.

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12.5 Communication and security settings for PCs

- Select the ***General*** tab.
  Select ***None*** under ***Authentication Level***.

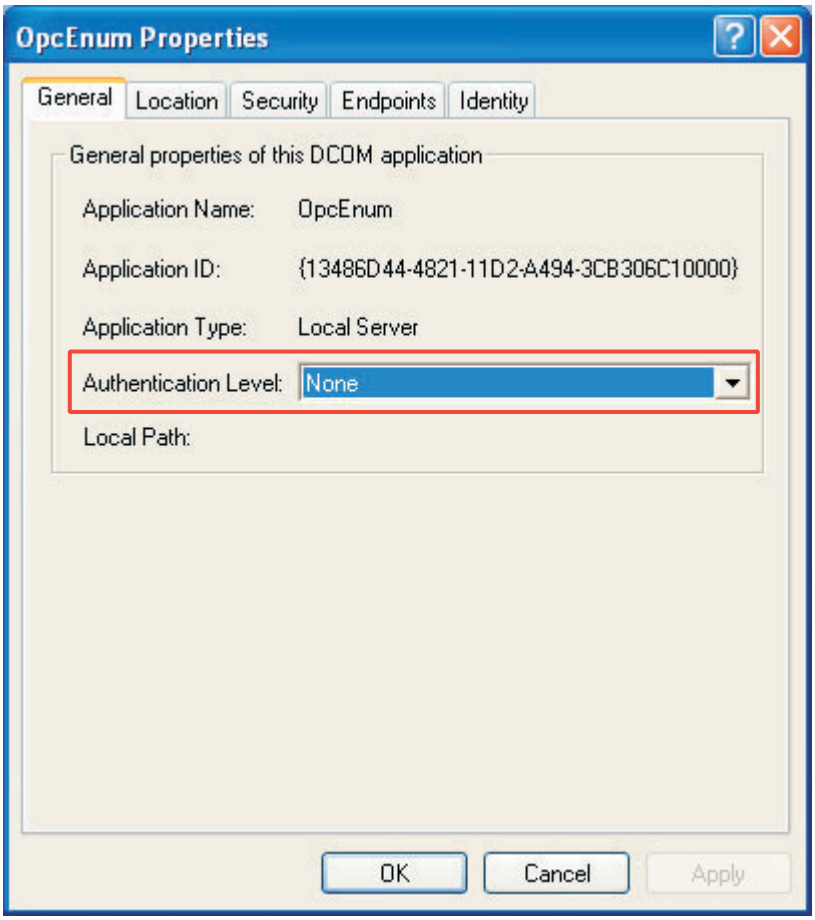

Fig. 12-24: "General" tab (DCOM configuration for OPCEnum on the OPC Server)

12.5 Communication and security settings for PCs

- Select the ***Location*** tab
  Enable the option ***Run application on this Computer***.

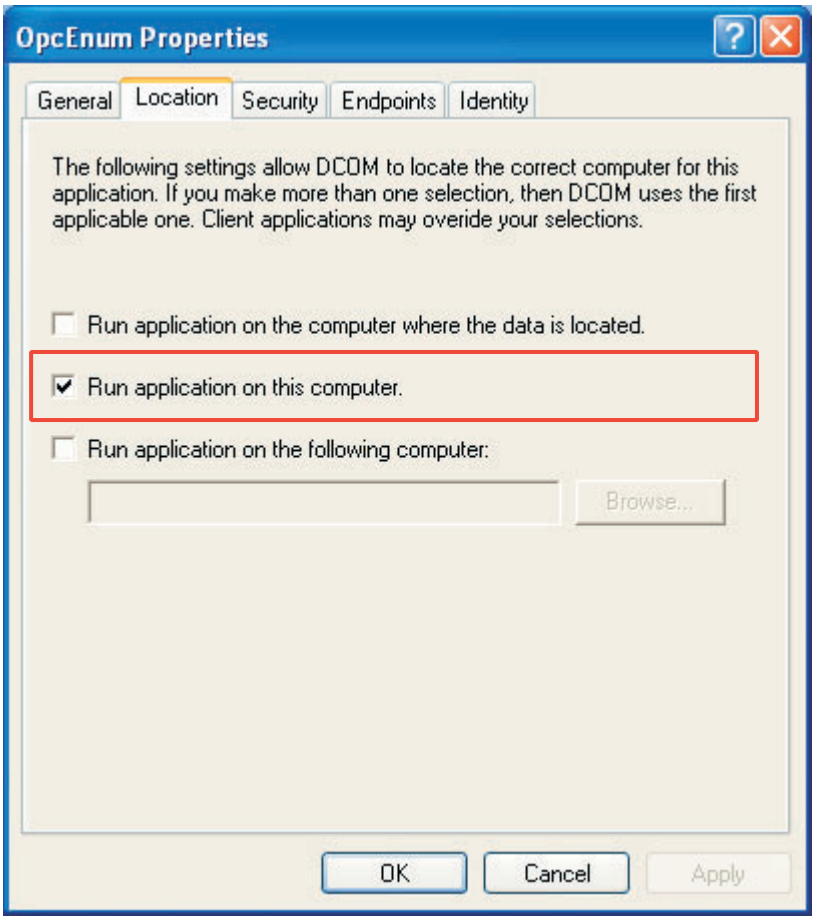

Fig. 12-25: "Location" tab (DCOM configuration for OPCEnum on the OPC Server)

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12.5 Communication and security settings for PCs

- Select the ***Security*** tab.
  Select ***Customize*** for ***Launch and Activation Permissions*** and ***Access Permissions*** and then click ***Apply***.

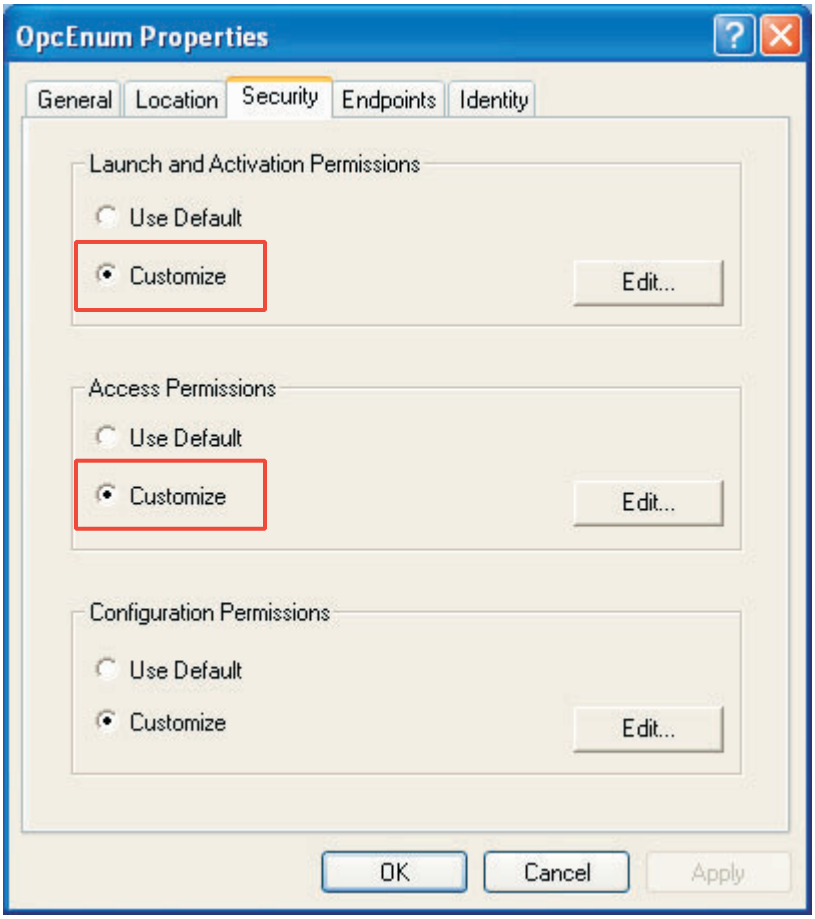

Fig. 12-26: "Security" tab (DCOM configuration for OPCEnum on the OPC Server)

- Click on ***Edit*** in the ***Launch and Activation Permissions*** field.
  The ***Launch Permission*** window is opened.

12.5 Communication and security settings for PCs

- Check whether all the following group or user names are available:
  - Administrators (…)
  - ANONYMOUS LOGON
  - INTERACTIVE
  - Everyone
  - NETWORK
  - SYSTEM

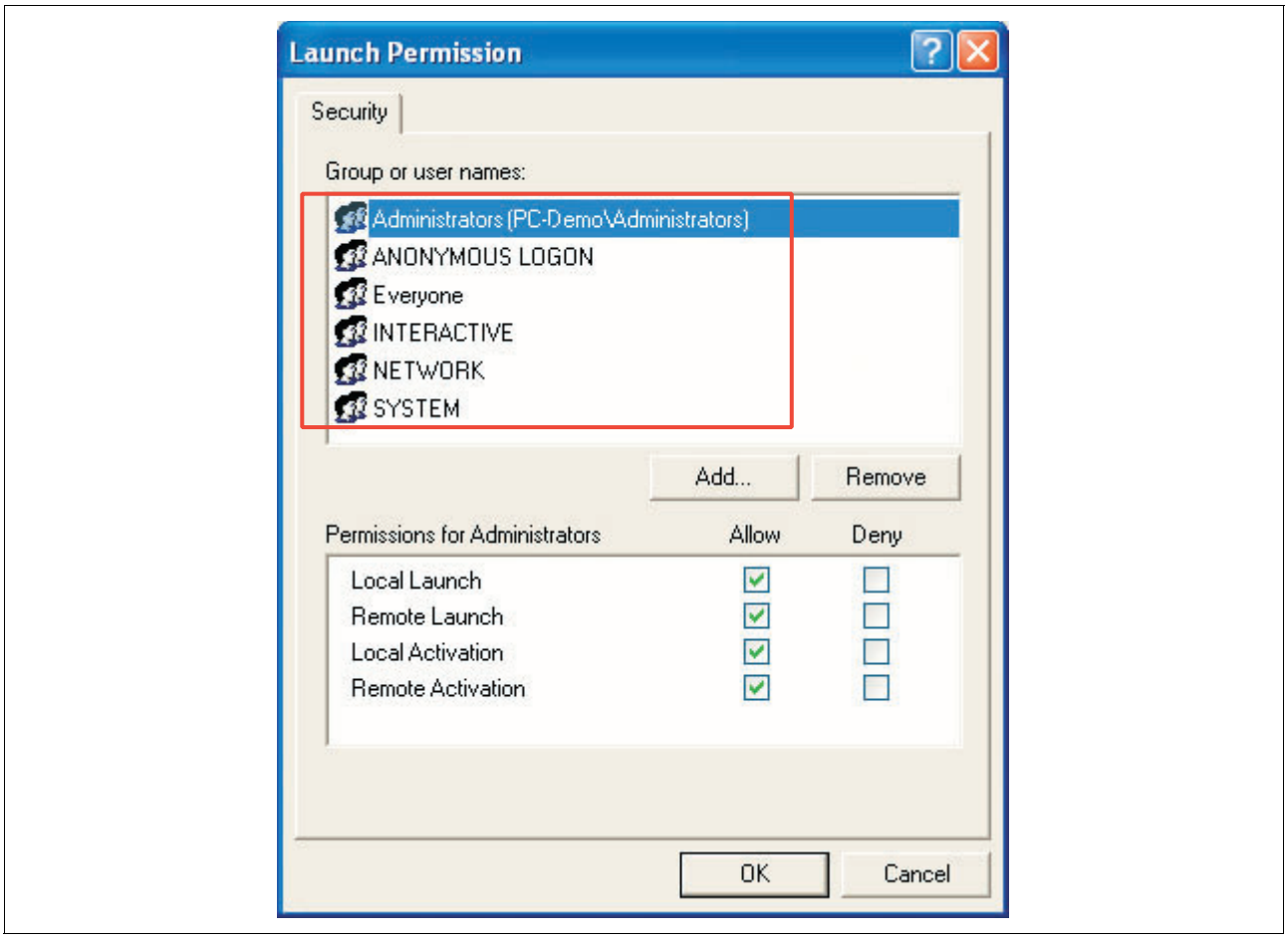

Fig. 12-27: "Launch Permission" window: Group or user names (COM Security on the OPCEnum)

- If the "Administrators" user is not available, add it. To be able to add the "Administrators" user, the search path has to be adapted (see Special feature of the user "Administrators", page 12-50) .
- If one of the other group or user names is not available, add it also (***Add...*** - ***Advanced*** – ***Search Now***).
  Please note the additional information for the user NETWORK (see Special feature of the user "NETWORK", page 12-51) .
  Then confirm with ***OK***.
  The ***Launch Permission*** window is reactivated.

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12.5 Communication and security settings for PCs

- Select each user individually and activate the option ***Allow*** for the permissions.
  - Local Launch
  - Remote Launch
  - Local Activation
  - Remote Activation

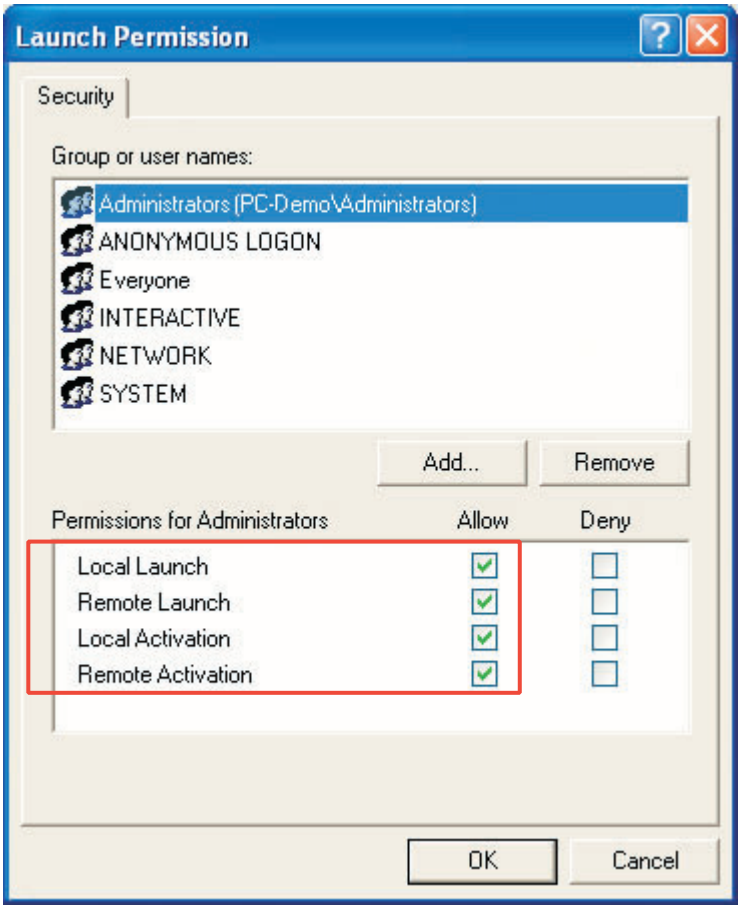

Fig. 12-28: "Launch Permission" window: Permissions (COM Security for OPCEnum)

- Click ***OK***.
  The ***Security*** tab is reactivated.
- Click on ***Edit*** in the ***Access Permissions*** field.

12.5 Communication and security settings for PCs

- Check whether all the following group or user names are available:
  - INTERACTIVE
  - Everyone
  - NETWORK
  - SYSTEM

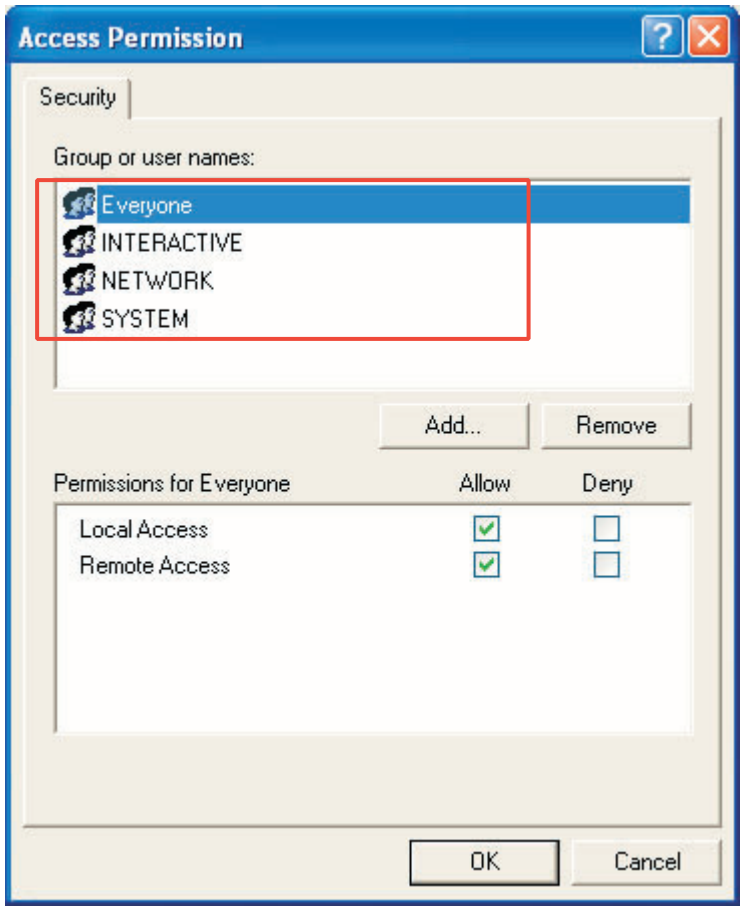

Fig. 12-29: "Access Permission" window: Group or user names (COM Security on the OPCEnum)

- If one of the group or user names is not available, add it (***Add... - Advanced – Search Now***).
  Please note the additional information for the user NETWORK (see Special feature of the user "NETWORK", page 12-51) .
  Then confirm with ***OK***.
  The ***Access Permission*** window is reactivated.

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12.5 Communication and security settings for PCs

- Select each user individually and activate the option ***Allow*** for the permissions.
  - Local Access
  - Remote Access

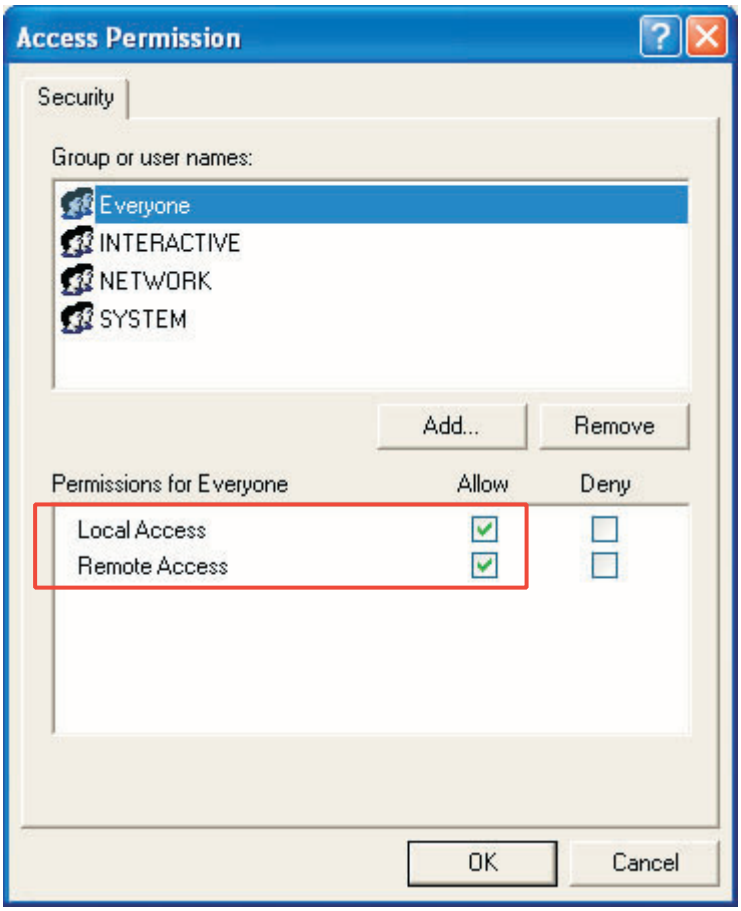

Fig. 12-30: "Access Permission" window: Permissions (COM Security for OPCEnum)

- Click ***OK***.
  The ***Security*** tab is reactivated.

12.5 Communication and security settings for PCs

- Select the ***Identity*** tab.
  Select the option ***Interactive User***.

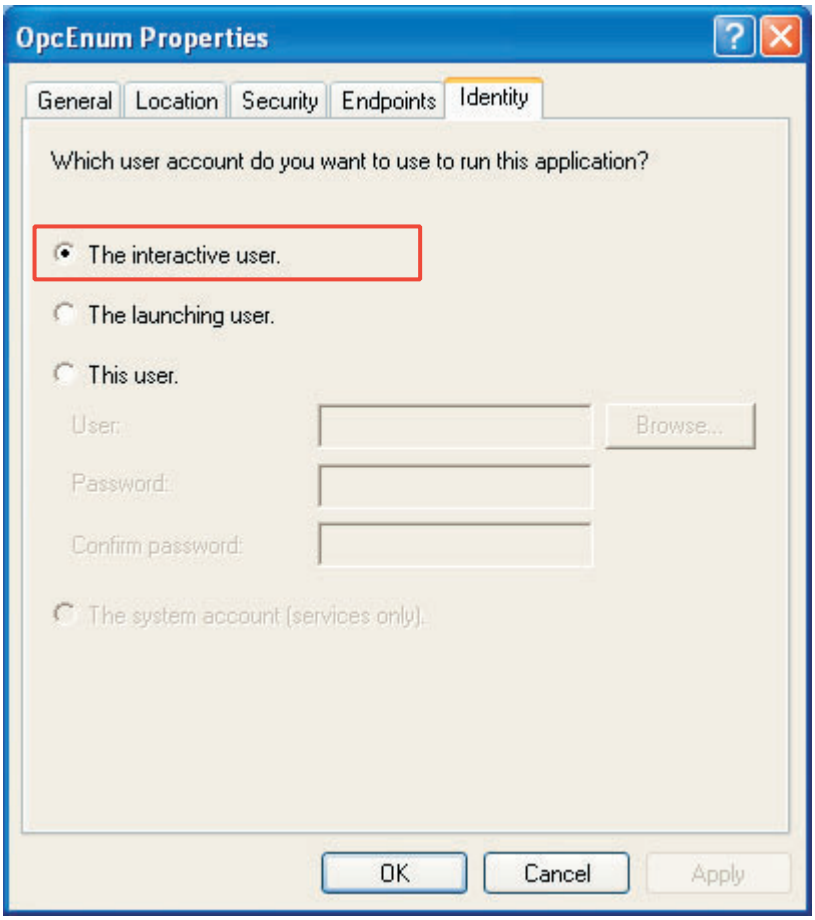

Fig. 12-31: "Identity" tab (COM Security for OPCEnum)

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12.5 Communication and security settings for PCs

- Select the ***Endpoints*** tab.
  If ***Default system protocols*** is not available in the list, add the connection protocol as follows:
  – Click on ***Add*** and select the ***Connection-oriented TCP/IP*** protocol under ***Protocol Sequence***.
  – Click ***OK***.
  The ***Endpoints*** tab is reactivated.

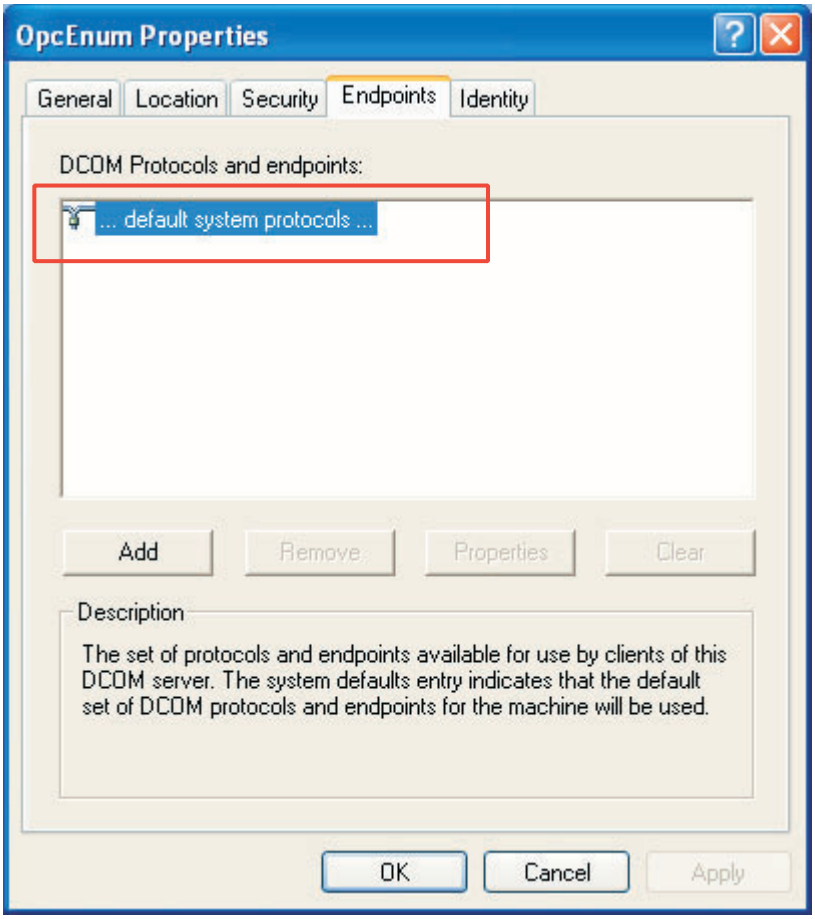

Fig. 12-32: "Endpoints" tab (connection protocols for OPCEnum)

- Click ***OK*** to save all the settings and close the ***OpcEnum Properties*** window.
  This completes the OPCEnum configuration for the OPC Server.
- Close the ***Component Services*** window.
  The settings will take effect the next time the PC is restarted.

12.5 Communication and security settings for PCs

12.5.1.5 Special feature of the user "Administrators"

To be able to add the "Administrators" user to the group or user names of a permission, the search path must first be adapted:

- In the relevant launch permission window click ***Add...*** and then ***Paths...***
- Select the PC where you perform the DCOM configuration (in the example this is "PC-Demo") as a (search) path and confirm with ***OK***.
- Enter "Administrators" as an object name and click ***OK***.

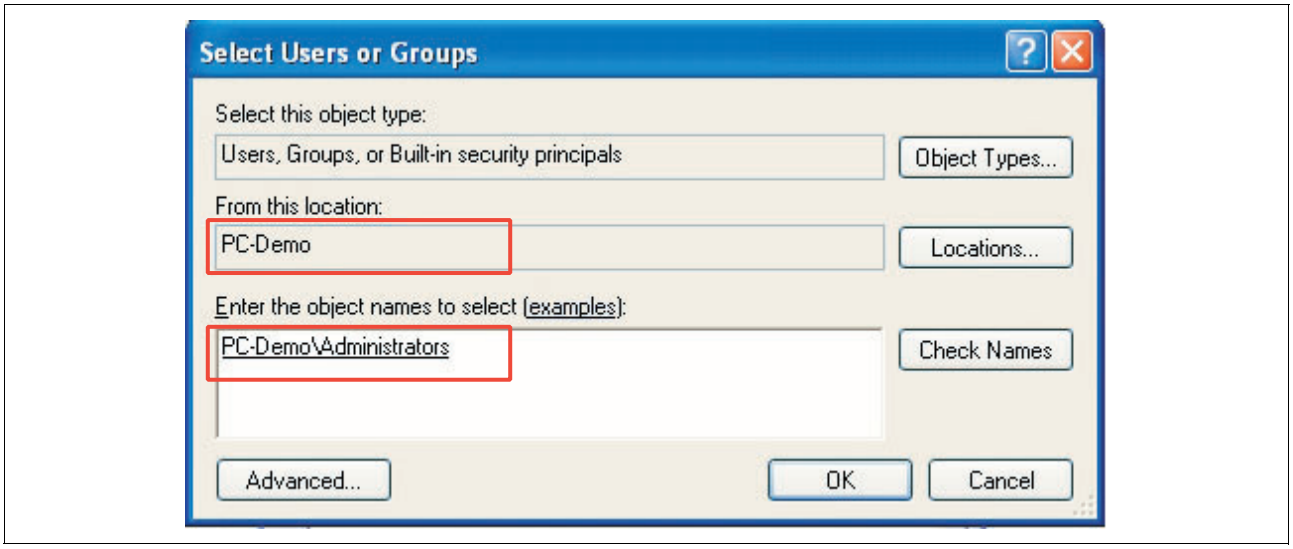

Fig. 12-33: "Select Users or Groups" window

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12.5 Communication and security settings for PCs

12.5.1.6 Special feature of the user "NETWORK"

If you want to add the NETWORK user in one of the permission windows (e. g. Launch Permission window, Access Permission window), you may receive several users for selection when entering the user name "Network". In this case, select the "Network" user.

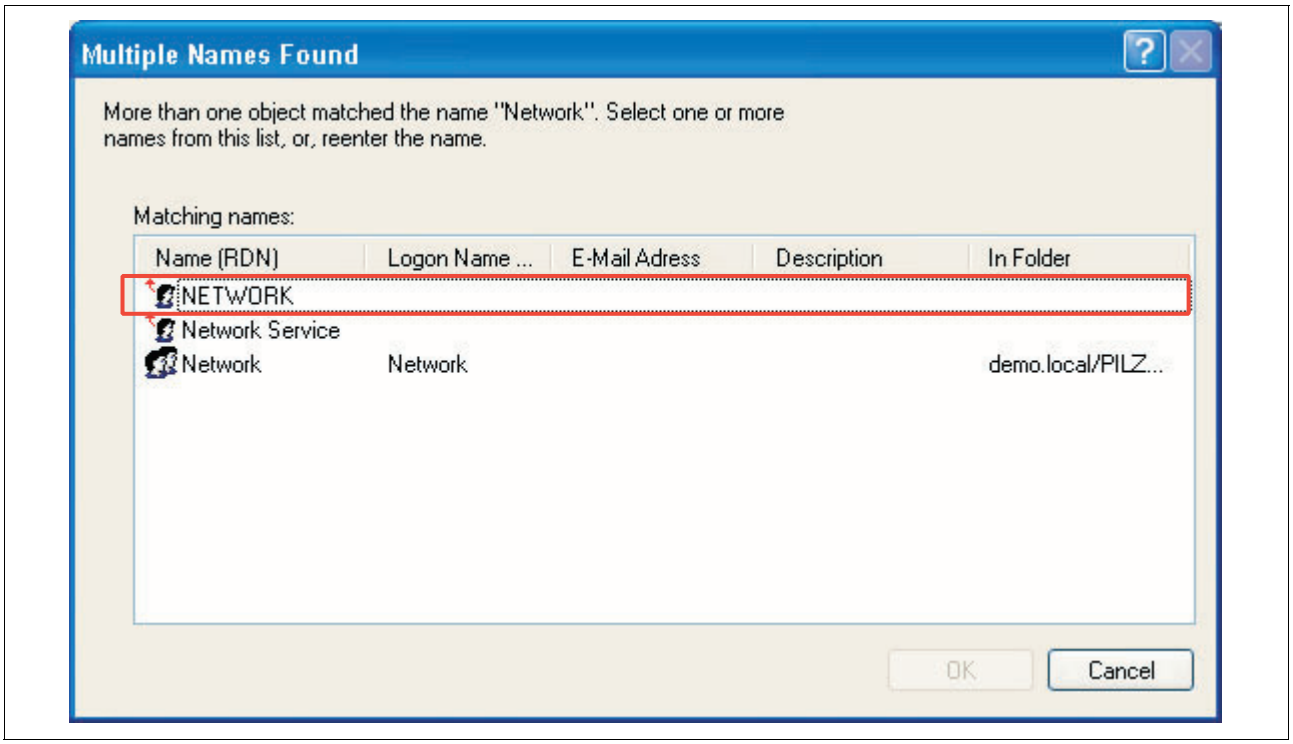

Fig. 12-34: Select NETWORK user

12.5 Communication and security settings for PCs

12.5.2 Firewall configuration

A firewall or any other security mechanisms on the PC and network may prevent the OPC Server from communicating correctly with the connected devices. If this is the case it will be necessary to adjust the security settings and firewall settings. Current documentation on the required security settings is available on the website for the OPC Foundation, under "Downloads" and "White Papers": www.opcfoundation.org

Firewalls allow access to explicitly registered programs. The following programs must have access:

- All OPC Clients
- Microsoft Management Console
- PSS4000_OPCServerDA.exe
- OPCenum.exe

A port must also be enabled for data exchange:

- Name: DCOM
- Port number 135
- Log: TCP

These enables grant access rights to the PC for other users on the network or from the Internet. A network administrator can optimise these Firewall settings to protect the server from unauthorised access.

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12.6 Commissioning of the OPC Server

To commission the OPC Server, proceed as follows:

1. Configure the OPC Server in PAS4000 (see Online help of PAS4000).
2. Perform the project download in PAS4000.
   As the project is downloaded, the device project for the OPC Server is created and is stored on the OPC Server. The device project for the OPC Server contains the OPC configuration, which consists of the configuration data and the complete namespace for all the devices configured on the project.

Once the project has been downloaded, the OPC Server makes the complete namespace for all devices configured on the project available to the OPC Clients.

12.7 Data type assignment

Various data types are assigned through the OPC standard. The table below contains the data types supported via the OPC Server and their assignment to the data types available in the user program on the PSS 4000:

OPC	User program (PSS 4000)
VT_I1	SINT
VT_I2	INT
VT_I4	DINT
VT_I8	LINT
VT_UI1	USINT
	BYTE
VT_UI2	UINT
	WORD
VT_UI4	UDINT
	DWORD
VT_UI8	ULINT
	LWORD
VT_R4	REAL
VT_R8	LREAL
VT_BOOL	BOOL
VT_BSTR	STRING
VT_DATE	TIME
	DATE
	TIME_OF_DAY
	DATE_AND_TIME

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12.8 Namespace

The namespace is a memory area in which the PSS 4000 OPC Server stores all the general and device-based project data from a PAS4000 project. For the most part the namespace can be viewed using the browser on an OPC Client.

The OPC Server always contains the namespace that was transferred with the device project the last time a project was downloaded.

In the namespace, an OPC Client has the following access permissions with regard to variables in the user program, irrespective of whether these were created within blocks or in the resource global variables:

- Project's ST resources
  - Read access to the PI variables and local variables
  - Read/write access to local variables
- Project's FS resources
  - Read access to the PI variables and local variables

In the following section the namespace is represented in a tree structure. The tree branches into various levels, with corresponding sublevels. The branch points are called nodes and are labelled. The nodes are used for data structuring. Data is found exclusively on the lowest level. The display format may vary, depending on the browser on the OPC Client. However, the structure remains the same.

Due to the complexity, the section below can only describe the individual areas consecutively. To ensure that you still retain an overview, the complete path through which the area's node is accessed is stated at the start of each area. As when stating the path, a point is used as the separator between the nodes (e.g. pss4000.net.myDevice1.Device.State).

Definition of symbols

The following symbols are used in the diagrams and tables:

- Names in angle brackets are markers and are replaced by the respective name. <device> becomes myDevice1, for example.

12.8 Namespace

Namespace structuring (main area)

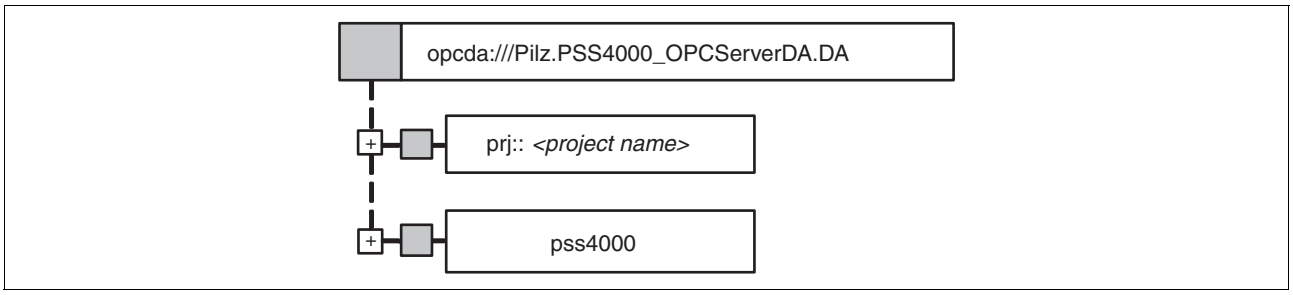

Fig. 12-35: Node names in the main area

Node name	Meaning
prj::<project name>	Area for the general project data containing the project name that was configured in PAS4000. e.g.: "myProject"
pss4000	Area for the device-based project data

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12.8 Namespace

12.8.1 General project data

Area structuring

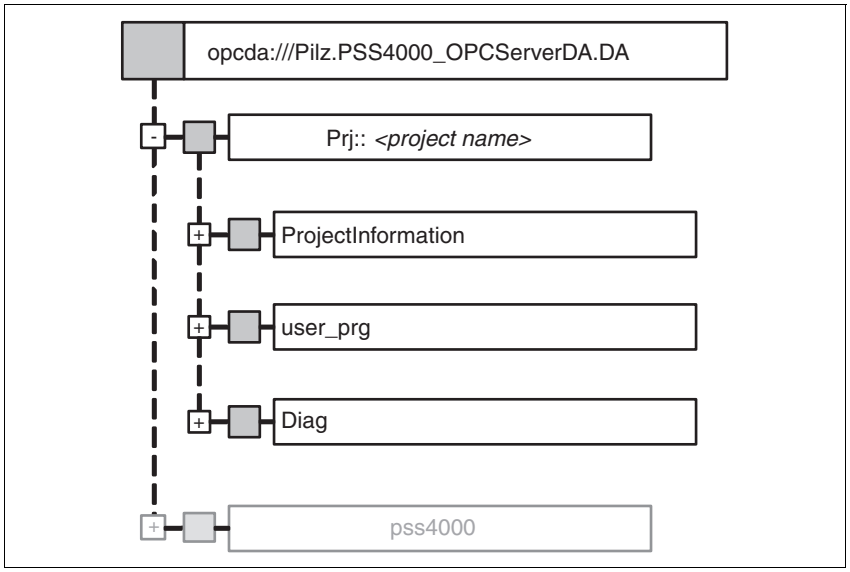

Fig. 12-36: Structuring of "General project data"

Node name (path statement)		Meaning
prj::<project name>	**ProjectInformation**	Area containing project-based information
	(prj::*<project name>*.ProjectInformation.)	
	user_prg	Area containing information about the program (e.g. variables of POUs, variables of component blocks, resource global variables)
	(prj::*<project name>*.user_prg.)	
	Diag	Area containing diagnostic list messages and diagnostic log entries
	(prj::*<project name>*.Diag.)	

12.8 Namespace

12.8.1.1 Projectinformation

Path statement: prj::*<project name>*.ProjectInformation.

Node number	Node name	Meaning
1	ChecksumFSProject	Check sum "FS-Project" Data type: VT_UI4
	(prj::*<project name>*.ProjectInformation.ChecksumFSProject)	

INFORMATION
The check sum "FS-Project" is displayed as a hexadecimal value in PAS4000 and the PSS 4000 Diag Control. To ensure that the check sum can be displayed correctly on a 3rd party visualisation system without using PSS 4000 Diag Control, please select: "Hexadecimal display" for the VT_UI4 value.

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12.8 Namespace

12.8.1.2 user_prg

Path statement: prj::<*project name*>.user_prg.

Node number	Node name (path statement)	Meaning	
1	**var_global**	Area for the resource global variables of the project The area includes all resource global variables created by the user.	
		Access rights to resource global variables in the OPC server:	
		FS-PI variables	Read
		FS variables of type VAR	
		ST-PI variables	
		ST variables of type VAR	Read/write
	(prj::<*project name*>.user_prog.var_global.)		
1.1	***<var global name>***	Name of a resource global variable	
	prj::<*project name*>.user_prog.var_global.<*var global name*>		
2	**app**	Instance path of the variables of the project (see online help of PAS4000) The area includes the instance path of the project with the PI variables and variables of type VAR created by the user. Please note: The variables of type VAR_IN_OUT, VAR_EXTERNAL and VAR_TEMP are not displayed in the OPC server.	
		Access rights to the variables in the OPC server:	
		FS-PI variables	Read
		FS variables of type VAR	
		ST-PI variables	
		ST variables of type VAR	Read/write
	Individual element variable: prj::<*project name*>.user_prog.app.<*Instance path of variable*> .<*Name of variable*> Multi element variable: prj::<*project name*>.user_prog.app.<*Instance path of variable*>.<*Name of variable*>.<*Index of the array element/name of the structure element*>		

12.8 Namespace

12.8.1.3 Diag

Path statement: prj::*<project name>*.Diag.

Diagnostic list:

Node number	Node name (path statement)	Meaning
1	**List**	Area containing diagnostic list messages
	prj::*<project name>*.Diag.List.)	
1.1	**Number**	Number of messages for a severity level
	(prj::*<project name>*.Diag.List.Number.)	
1.1.1	Error	Number of messages of "Error" severity Data type: VT_UI4
1.1.2	Warning	Number of messages of "Warning" severity Data type: VT_UI4
1.1.3	Information	Number of messages of "Status information" severity Data type: VT_UI4
1.2	**Line**	Lines in the diagnostic list
	(prj::*<project name>*.Diag.List.Line.)	
1.2.1	***<LineNumber>***	Information on line number Value range: 1 … 100
	(prj::*<project name>*.Diag.List.Line.*<line number>*.)	
1.2.1.1	PriorityNo	Number of priority Data type: VT_UI1
1.2.1.2	Priority	Name of priority Data type: VT_BSTR
1.2.1.3	Description	Message text Data type: VT_BSTR
1.2.1.4	ScopeNo	Number of scope Data type: VT_UI1
1.2.1.5	Scope	Name of scope Data type: VT_BSTR
1.2.1.6	Timestamp	Time stamp Data type: VT_DATE
1.2.1.7	Did	Diagnostic identifier Data type: VT_BSTR

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12.8 Namespace

Node number	Node name (path statement)	Meaning
1.2.1.8	StateNo	State of diagnostic message **Status number** / **Meaning** 1 / Message is active, unacknowledged Data type: VT_UI1
1.2.1.9	 State	State of diagnostic message: Data type: VT_BSTR
1.2.1.10	ParameterList	Parameter list Data type: VT_BSTR
1.2.1.11	**Location**	Location Information
	(prj::*<project name>*.Diag.List.Line.*<line number>*.Location.)	
1.2.1.11.1	Address	Address Data type: VT_BSTR
1.2.1.11.2	EquipmentId	Equip-ID Data type: VT_BSTR
1.2.1.11.3	Device	Device Data type: VT_BSTR
1.2.1.11.4	Description	Location description Data type: VT_BSTR
1.2.1.12	**Action**	Remedial actions
	(prj::*<project name>*.Diag.List.Line.*<line number>*.Action.)	
1.2.1.12.1	***<action number>***	Number of remedy Value range: 1 … 8
	(prj::*<project name>*.Diag.List.Line.*<line number>*.Action.*<action number>*.)	
1.2.1.12.1.1	Description	Action text Data type: VT_BSTR
1.2.1.12.1.2	ScopeNo	Number of scope Data type: VT_UI1
1.2.1.12.1.3	Scope	Name of scope Data type: VT_BSTR
1.2.1.12.1.4	ResponsibilityNo	Number of responsibility Data type: VT_UI1
1.2.1.12.1.5	Responsibility	Name of responsibility Data type: VT_BSTR
1.2.1.12.1.6	**Location**	Location Information
	(prj::*<project name>*.Diag.List.Line.*<line number>*.Action.*<action number>*.Location.)	
1.2.1.12.1.6.1	Address	Address Data type: VT_BSTR

12.8 Namespace

Node number	Node name (path statement)	Meaning
1.2.1.12.1.6.2	EquipmentId	Equip-ID Data type: VT_BSTR
1.2.1.12.1.6.3	Device	Device Data type: VT_BSTR
1.2.1.12.1.6.4	Description	Location description Data type: VT_BSTR

Diagnostic log:

Node number	Node name (path statement)	Meaning
2	**Log**	Area containing diagnostic log entries
	(prj::*<project name>*.Diag.Log.)	
2.1	Number	Number of log entries Data type: VT_UI4
2.2	**Line**	Lines in the diagnostic log
	(prj::*<project name>*.Diag.Log.Line.)	
2.2.1	***<line number>***	Information on line number Value range 1 … "Number" (see 2.1; max. 4096)
	(prj::*<project name>*.Diag.Log.Line.*<line number>*.)	
2.2.1.1	PriorityNo	Number of priority Data type: VT_UI1
2.2.1.2	Priority	Name of priority Data type: VT_BSTR
2.2.1.3	Description	Message text Data type: VT_BSTR
2.2.1.4	ScopeNo	Number of scope Data type: VT_UI1
2.2.1.5	Scope	Name of scope Data type: VT_BSTR
2.2.1.6	Timestamp	Time stamp Data type: VT_DATE
2.2.1.7	Did	Diagnostic identifier Data type: VT_BSTR

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12.8 Namespace

<table>
<tr><th>Node number</th><th>Node name
(path statement)</th><th colspan="2">Meaning</th></tr>
<tr><td rowspan="6">2.2.1.8</td><td rowspan="6">StateChangeNo</td><td colspan="2">Status number for the status change</td></tr>
<tr><td>Status number</td><td>Meaning</td></tr>
<tr><td>0</td><td>Message cleared</td></tr>
<tr><td>1</td><td>Message arrived</td></tr>
<tr><td>101</td><td>Log entry implemented
(for operational entries, self test entries and debugging entries)</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
<tr><td rowspan="6">2.2.1.9</td><td rowspan="6">StateChange</td><td colspan="2">Status change</td></tr>
<tr><td>Display</td><td>Meaning</td></tr>
<tr><td>cleared</td><td>Message cleared</td></tr>
<tr><td>arrived</td><td>Message arrived</td></tr>
<tr><td>logged</td><td>Log entry implemented
(for operational entries, self test entries and debugging entries)</td></tr>
<tr><td colspan="2">Data type: VT_BSTR</td></tr>
<tr><td>2.2.1.10</td><td>ParameterList</td><td colspan="2">Parameter list
Data type: VT_BSTR</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="2">2.2.1.11</td><td>Location</td><td colspan="2">Location Information</td></tr>
<tr><td colspan="3">(prj::<project name>.Diag.Log.Line.<line number>.Location.)</td></tr>
<tr><td>2.2.1.11.1</td><td>Address</td><td colspan="2">Address
Data type: VT_BSTR</td></tr>
<tr><td>2.2.1.11.2</td><td>EquipmentId</td><td colspan="2">Equip-ID
Data type: VT_BSTR</td></tr>
<tr><td>2.2.1.11.3</td><td>Device</td><td colspan="2">Device
Data type: VT_BSTR</td></tr>
<tr><td>2.2.1.11.4</td><td>Description</td><td colspan="2">Location description
Data type: VT_BSTR</td></tr>
</table>

12.8 Namespace

12.8.2 Device-based project data

Area structuring

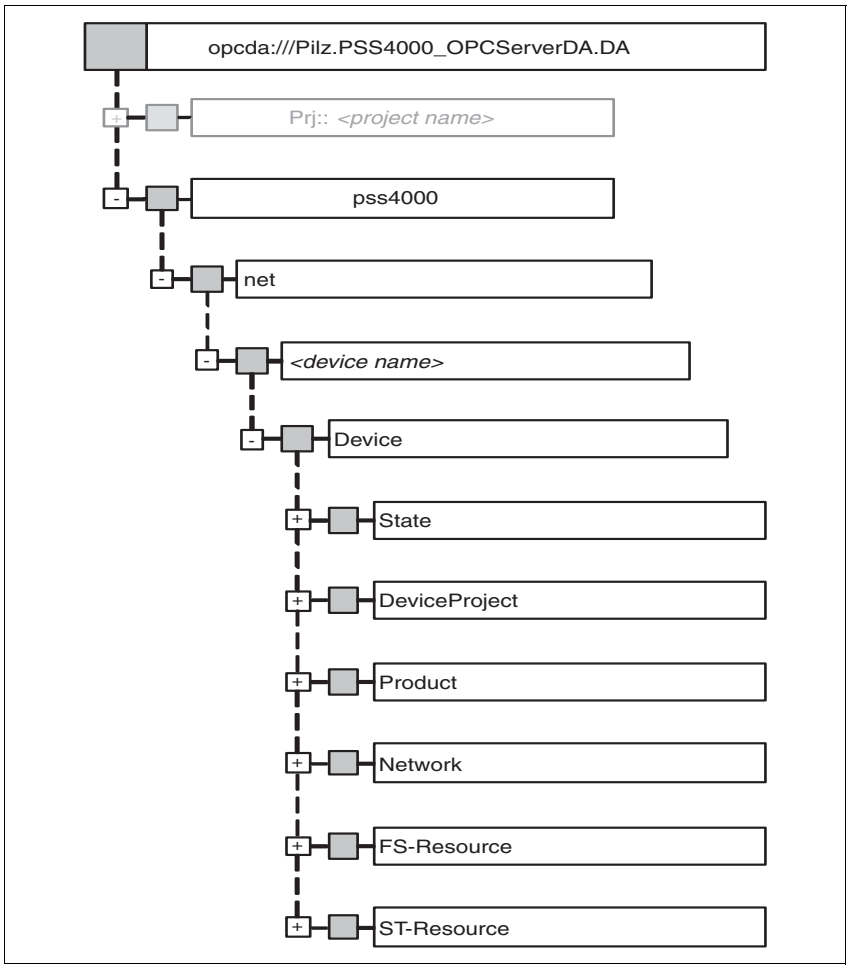

Fig. 12-37: Structuring of "Device-based project data"

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12.8 Namespace

Node name					Meaning
pss4000.	**net.**				Network area
		<device name>.			Area of device containing the device name configured during device naming (PSS 4000-exclusive/operable device)
			Device.		Area containing device-based information
				State	Area containing information about the device's diagnostic state
				(pss4000.net.*<device name>*.Device.State.)	
				DeviceProject	Area containing information about the device project
				(pss4000.net.*<device name>*.Device.DeviceProject.)	
				Product	Area containing product information
				(pss4000.net.*<device name>*.Device.Product.)	
				Network	Area containing the device's network parameters
				(pss4000.net.*<device name>*.Device.Network.)	
				FS resource	Area containing information about tasks of the FS resource
				(pss4000.net.*<device name>*.Device.FS-Resource.)	
				ST resource	Area containing information about tasks of the ST resource
				(pss4000.net.*<device name>*.Device.ST-Resource.)	

12.8 Namespace

12.8.2.1 State

Path statement: pss4000.net.<device name>.Device.State.

<table>
<tr><th>Node number</th><th>Node name</th><th colspan="2">Meaning</th></tr>
<tr><td rowspan="9">1</td><td rowspan="9">Diag</td><td colspan="2">State of the system sections on a PSS 4000 device</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>Booting of the system sections is active</td></tr>
<tr><td>1</td><td>Start of "deliberate operator action"
(function of reset button)</td></tr>
<tr><td>2</td><td>A major FS error is present for at least one FS system section (see diagnostic list).</td></tr>
<tr><td>3</td><td>A message of "Error" severity is present for at least one system section (see diagnostic table).</td></tr>
<tr><td>4</td><td>A message of "Warning" severity is present for the PSSu device (see diagnostic table).</td></tr>
<tr><td>5</td><td>All system sections are in a RUN condition.</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
</table>

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12.8 Namespace

<table>
<tr><th>Node number</th><th>Node name</th><th colspan="2">Meaning</th></tr>
<tr><td rowspan="8">2</td><td rowspan="8">STRun</td><td colspan="2">State of ST resource</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>ST resource has not been started</td></tr>
<tr><td>1</td><td>Operating state "ST resource in RUN condition with error":
- Task in TERMINATED condition or
- Task in STOP condition
At least one ST resource task is not running.
The project is licensed.</td></tr>
<tr><td>2</td><td>Operating state "ST resource in RUN condition without error":
The tasks of the ST resource are running without fault.
The project is licensed.</td></tr>
<tr><td>3</td><td>Operating state "ST resource in RUN condition with error":
- Task in TERMINATED condition or
- Task in STOP condition
At least one ST resource task is not running.
The project is unlicensed.</td></tr>
<tr><td>4</td><td>Operating state "ST resource in RUN condition without error":
The tasks of the ST resource are running without fault.
The project is unlicensed.</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
</table>

12.8 Namespace

<table>
<tr><th>Node number</th><th>Node name</th><th colspan="2">Meaning</th></tr>
<tr><td rowspan="8">3</td><td rowspan="8">FSRun</td><td colspan="2">State of FS resource</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>FS resource has not been started</td></tr>
<tr><td>1</td><td>Operating state "FS resource in RUN condition with error":
- Task in TERMINATED condition or
- Task in STOP condition
At least one FS resource task is not running.
The project is licensed.</td></tr>
<tr><td>2</td><td>Operating state "FS resource in RUN condition without error":
The tasks of the FS resource are running without fault.
The project is licensed.</td></tr>
<tr><td>3</td><td>Operating state "FS resource in RUN condition with error":
- Task in TERMINATED condition or
- Task in STOP condition
At least one FS resource task is not running.
The project is unlicensed.</td></tr>
<tr><td>4</td><td>Operating state "FS resource in RUN condition without error":
The tasks of the FS resource are running without fault.
The project is unlicensed.</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
<tr><td rowspan="4">4</td><td rowspan="4">STForce</td><td colspan="2">State of forcing on the ST resource</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>Forcing on the ST resource is inactive</td></tr>
<tr><td>1</td><td>Forcing on the ST resource is active</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
<tr><td rowspan="4">5</td><td rowspan="4">FSForce</td><td colspan="2">State of forcing on the FS resource</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>Forcing on the FS resource is inactive</td></tr>
<tr><td>1</td><td>Forcing on the FS resource is active</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
</table>

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12.8 Namespace

<table>
<tr><th>Node number</th><th>Node name</th><th colspan="2">Meaning</th></tr>
<tr><td rowspan="8">6</td><td rowspan="8">STSafetyNETp</td><td colspan="2">State of the system section ST SafetyNET p RTFN</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>Operating state "ST SafetyNET p RTFN in STOP condition with error: Major FS+ST error"</td></tr>
<tr><td>1</td><td>ST SafetyNET p RTFN has not been started</td></tr>
<tr><td>2</td><td>Operating state "ST SafetyNET p RTFN in RUN condition with minor error"</td></tr>
<tr><td>3</td><td>Operating state "ST SafetyNET p RTFN in RUN condition without error"</td></tr>
<tr><td>4</td><td>Operating state "ST SafetyNET p RTFN in STOP condition with error: Major FS+ST error"</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
<tr><td rowspan="8">7</td><td rowspan="8">FSSafetyNETp</td><td colspan="2">State of the system section FS-SafetyNET p RTFN</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>Operating state "FS SafetyNET p RTFN in STOP condition with error: Major FS error"</td></tr>
<tr><td>1</td><td>FS SafetyNET p RTFN has not been started</td></tr>
<tr><td>2</td><td>Operating state "FS SafetyNET p RTFN in RUN condition with minor error"</td></tr>
<tr><td>3</td><td>Operating state "FS SafetyNET p RTFN in RUN condition without error"</td></tr>
<tr><td>4</td><td>Operating state "FS SafetyNET p RTFN in STOP condition with error: Major FS+ST error"</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
<tr><td rowspan="8">8</td><td rowspan="8">Module bus</td><td colspan="2">State of the system sections FS and ST module bus</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>Operating state "Safe condition of all FS outputs on the device" or
at least one module cannot be accessed (e.g. a module has been removed during operation, set/actual hardware registry does not match)</td></tr>
<tr><td>1</td><td>No modules present</td></tr>
<tr><td>2</td><td>FS and ST module bus are operating without fault</td></tr>
<tr><td>3</td><td>Operating state "FS module bus in a STOP condition with error" Major FS error"</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
</table>

12.8 Namespace

<table>
<tr><th>Node number</th><th>Node name</th><th colspan="2">Meaning</th></tr>
<tr><td rowspan="8">9</td><td rowspan="8">Media</td><td colspan="2">State of data medium

For PSS 4000 excluding/functional devices whose naming data are saved on an removable data medium:</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>Device identification activated by user</td></tr>
<tr><td>1</td><td>Removable data medium is missing
or
removable data medium not detected
or
removable data medium is defective</td></tr>
<tr><td>2</td><td>Product type on the removable data medium does not match the PSS 4000-excluding/functional device (on PSSu systems: head module's product type)
or
no device project available on the removable data medium</td></tr>
<tr><td>3</td><td>Naming data and device project on the PSS 4000-excluding/functional device and the removable data medium do not match</td></tr>
<tr><td>4</td><td>Naming data and device project on the PSS 4000-excluding/functional device and the removable data medium match</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
<tr><td rowspan="5">10</td><td rowspan="5">SFProfibus</td><td colspan="2">"SF" status LED (PROFIBUS-DP)
The evaluation can only be performed in combination with the LEDs of the "BF" status LED (see operating manual for the device/head module).</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>LED "lights red"</td></tr>
<tr><td>1</td><td>LED "off"</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
</table>

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12.8 Namespace

<table>
<tr><th>Node number</th><th>Node name</th><th colspan="2">Meaning</th></tr>
<tr><td rowspan="7">11</td><td rowspan="7">BFProfibus</td><td colspan="2">"BF" status LED (PROFIBUS-DP)
The evaluation can only be performed in combination with the LEDs of the "SF" status LED (see operating manual for the device/head module).</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>0</td><td>LED "lights red"</td></tr>
<tr><td>1</td><td>LED "flashes red"</td></tr>
<tr><td>2</td><td>LED "lights green"</td></tr>
<tr><td>3</td><td>LED "off"</td></tr>
<tr><td colspan="2">Data type: VT_UI1</td></tr>
</table>

12.8 Namespace

12.8.2.2 DeviceProject

Path statement: pss4000.net.<device name>.Device.DeviceProject

Node number	Node name	Meaning
1	Name	Name of PAS4000 project to which the device *<device name>* belongs Data type: VT_BSTR
2	ChecksumFS	Check sum for the FS device project for the device *<device name>* Data type_:VT_UI4
3	BuildTime	Time at which the PAS4000 project was built Data type: VT_DATE
4	Version	Version of the PAS4000 project to which the device *<device name>* belongs Data type: VT_BSTR
5	LicenceState	Status information on the licensing state of the project

Status	Meaning
0	unlicensed or no project active
1	licensed

Data type: VT_UI1

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12.8 Namespace

12.8.2.3 Product

Path statement: pss4000.net.*<device name>*.Device.Product.

Node number	Node name	Meaning
1	SerialNo	Serial number of the device *<device name>*, PSSu systems: Serial number of the head module Data type: VT_BSTR
2	OrderNo	Order number of the device *<device name>*, PSSu systems: Order number of the head module Data type: VT_BSTR
3	ProductType	Product type of the device *<device name>*, PSSu systems: Name of the head module Data type: VT_BSTR
4	FirmwareVersion	Firmware version of the device *<device name>*, PSSu systems: Firmware version of the head module Data type: VT_BSTR
5	FirmwareRevision	Revision number of the firmware for the device *<device name>*, PSSu systems: Revision number of the firmware for the head module Data type: VT_BSTR
6	FirmwareUpdate	Time at which the firmware for the device *<device name>* was last updated, PSSu systems: Time at which the firmware for the head module was last updated Data type: VT_DATE
7	HardwareVersion	Hardware version of the device *<device name>*, PSSu systems: Hardware version of the head module Data type: VT_BSTR

12.8 Namespace

12.8.2.4 Network

Path statement: pss4000.net.*<device name>*.Device.Network.

Node number	Node name	Meaning	
1	IPAddressV4	IP address of the device *<device name>* Data type: VT_BSTR	
2	SubnetMaskV4	Subnet mask Data type: VT_BSTR	
3	GatewayV4	IP address of the Standard Gateway Data type: VT_BSTR	
4	DHCP	DHCP setting for the device *<device name>*	
		Display	**Meaning**
		FALSE	DHCP not activated
		TRUE	DHCP activated
		Data type: VT_BOOL	
5	DNS1V4	Address of preferred DNS Server Data type: VT_BSTR	
6	DNS2V4	Address of alternative DNS Server Data type: VT_BSTR	
7	MACAddress	MAC address of the device *<device name>* Data type: VT_BSTR	
8	SNTP	SNTP setting for the device *<device name>*	
		Display	**Meaning**
		FALSE	Device is not configured as SNTP server of the project
		TRUE	Device works in the project as SNTP Server
		Data type: VT_BOOL	
9	SNTPV4	IP address of the SNTP Server from which the device obtains its time Data type: VT_BSTR	
10	RealTimeClock	Current time on the device Data type: VT_DATE	

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12.8 Namespace

12.8.2.5 FS resource

Path statement: pss4000.net.*<device name>*.Device.FS-Resource.

<table>
<tr><th>Node number</th><th>Node name
(path statement)</th><th>Meaning</th></tr>
<tr><td rowspan="2">1</td><td><task name></td><td colspan="2">Name of task in the FS resource of the device <device name></td></tr>
<tr><td colspan="3">pss4000.net.<device name>.Device.FS-Resource.<task name>.)</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="5">1.1</td><td rowspan="5">State</td><td colspan="2">Status of task</td></tr>
<tr><td>State</td><td>Meaning</td></tr>
<tr><td>1</td><td>Task in STOP condition</td></tr>
<tr><td>2</td><td>Task in RUN condition</td></tr>
<tr><td>3</td><td>Task in TERMINATED condition</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="2">1.2</td><td>ProcessingTime</td><td colspan="2">Task execution time $t_{ProcTask}$
The execution time is only available for periodic tasks
(see Reaction times, page 9-141)</td></tr>
<tr><td colspan="3">(pss4000.net.<device name>. Device.FS-Resource.<task name>.ProcessingTime.)</td></tr>
<tr><td>1.2.1</td><td>Minimum</td><td colspan="2">Minimum execution time
The displayed time is the shortest execution time that has been detected since the start of the task.

Data type: VT_UI4</td></tr>
<tr><td>1.2.2</td><td>Maximum</td><td colspan="2">Maximum execution time
The displayed time is the longest execution time that has been detected since the start of the task.

Data type: VT_UI4</td></tr>
<tr><td>1.2.3</td><td>Current</td><td colspan="2">Current task execution time
Data type: VT_UI4</td></tr>
</table>

12.8 Namespace

12.8.2.6 ST resource

Path statement: pss4000.net.*<device name>*.Device.ST-Resource.

Node number	Node name (path statement)	Meaning
1	***<task name>***	Name of task in the device's ST resource *<device name>*
	pss4000.net.*<device name>*.Device.ST-Resource.*<task name>*.)	
1.1	State	Status of task **State** / **Meaning** 1 / Task in STOP condition 2 / Task in RUN condition 3 / Task in TERMINATED condition Data type: VT_UI4
1.2	**ProcessingTime**	Task execution time $t_{ProcTask}$ The execution time is only available for periodic tasks (see Reaction times, page 9-141)
	(pss4000.net.*<device name>*. Device.ST-Resource.*<task name>*.ProcessingTime.)	
1.2.1	Minimum	Minimum execution time The displayed time is the shortest execution time that has been detected since the start of the task. Data type: VT_UI4
1.2.2	Maximum	Maximum execution time The displayed time is the longest execution time that has been detected since the start of the task. Data type: VT_UI4
1.2.3	Current	Current task execution time Data type: VT_UI4

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Effective diagnostics are required in order to keep machine downtimes to a minimum. Diagnostics must provide all the information necessary to rectify errors quickly, prevent faults and analyse machine conditions.

The PSS 4000 distinguishes between system diagnostics and process diagnostics.

- System diagnostics
  Diagnostics on hardware and firmware, including errors in the hardware configuration or user program.
  The system diagnostics are provided by Pilz in full. Only a few adjustments can be made by the user, e.g. switch off mandatory reset.
- Process Diagnostics
  Diagnostics on procedures and conditions. The process diagnostics are created by the user within the user program. Pilz blocks are supplied with process diagnostics, which users can adapt to suit their own requirements.

In development
The acknowledgement of diagnostic messages is not yet implemented in the current version of PSS 4000.

During operation, system messages and process messages are entered in a diagnostic list. Each device has its own device diagnostic list. The diagnostic server combines the device diagnostic lists of all the devices in the project to form the project diagnostic list.

The diagnostic list only contains current messages. Once a fault has been rectified, the message is deleted from the diagnostic list, unless it is a message that requires an acknowledgement. Messages that require acknowledgement are not deleted until they have been acknowledged by the user.
The order in which the diagnostic messages appear in the diagnostic list is determined by the priority of the diagnostic message. That makes it easy to see which message is the most important.
In system diagnostics, a distinction is made between the first fault and subsequent faults. Only the first fault is reported. This avoids unnecessary messages in the diagnostic list.

As well as describing the event that has occurred and indicating its location, diagnostic messages also contain suggested remedies. These tell you what to do, which area is affected and who is responsible for rectifying the problem.

The diagnostic log records when a diagnostic message arrived, when it was cleared or when it was acknowledged. The diagnostic log also contains information on any changes in the operating condition, e.g. if a device has been restarted, as well as information for Pilz technical support. Each device has its own device diagnostic log. The diagnostic server combines the device diagnostic logs of all the devices in the project to form the project diagnostic log.

The diagnostic server forwards the project diagnostic list and log to the diagnostic clients (e.g. PSS 4000 OPC Server). The diagnostic clients then provide the information to the displays (e.g. PSS 4000 Diag Control).
The project diagnostic list and project diagnostic log are also displayed in PAS4000. The diagnostic list and diagnostic log in PAS4000 may vary slightly from the diagnostic list and diagnostic log on a display (e.g. PSS 4000 Diag Control), because they also contain messages/entries for online actions, for example.
The device diagnostic lists and logs are not displayed.

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13.1 Diagnostic list

During operation, diagnostic messages are entered in diagnostic lists.

Diagnostic lists only contain current messages, i.e. diagnostic messages with the state "active" and/or "unacknowledged" (see State of diagnostic messages, page 13-6) .

A new diagnostic message is entered in the diagnostic list if the state of the diagnostic message switches to "active". The diagnostic message is deleted once its state switches to "inactive", unless it is a message that requires an acknowledgement. Messages that require acknowledgement are not deleted until they have been acknowledged by the user.

Each device has its own device diagnostic list. The device diagnostic lists from all the devices in a project are combined within a project diagnostic list.

- Device diagnostic list
  - Generated by the device's firmware
  - Contains a device's diagnostic messages (raw data only, no texts)
  - Memory for at least 128 diagnostic messages
  - If the maximum number of diagnostic messages is reached, the diagnostic message with the lowest priority is deleted
  - Deleted in the event of an original reset
  - Cannot be displayed; used as the basis for the project diagnostic list
- Project diagnostic list
  - Generated by the Diagnostic Server
  - Contains plain text diagnostic messages for all the devices in a project
  - Memory for at least 256 diagnostic messages
  - If the maximum number of diagnostic messages is reached, the diagnostic message with the lowest priority is deleted
  - Always up-to-date as it is continuously synchronised with the device diagnostic lists
  - Should the Diagnostic Server lose the connection to a device, all the device's diagnostic messages are deleted from the project diagnostic list and a corresponding diagnostic message is entered in the project diagnostic list
  - The diagnostic list in PAS4000 may vary slightly from the diagnostic list on a display (e.g. PSS 4000 Diag Control), because it also contains messages for online actions, for example.

13.1 Diagnostic list

13.1.1 Diagnostic messages

The following diagnostic messages are available:

- System messages
  Message that is issued when an event occurs in system diagnostics.
- Process messages
  Message that is issued when an event occurs in process diagnostics, i.e. the set condition is met.

During operation, diagnostic messages are entered in a diagnostic list.

A diagnostic message contains a description of the event. Each diagnostic message includes a remedy. The remedy describes how to react to the event. The remedy contains a maximum of 8 steps, the so-called "Actions".

Components of a diagnostic message:

- Time stamp
  Time at which the diagnostic message was activated
- Diagnostic identifier
  In system diagnostics, the diagnostic identifier is used for unique identification of a diagnostic message. In process diagnostics, the diagnostic identifier is used for unique identification of the diagnostic item responsible for the diagnostic message.
  (see Diagnostic identifier, page 13-19)
- Severity and priority
  Importance of the diagnostic message
  (see Severity and priorities, page 13-9)
- Scope
  Approximate description of the kind of event
  (see Scopes, page 13-12)
- Description (message text)
  Description of what has happened.
- Location information
  Information about the location at which the event occurred (see Location information, page 13-13) .
  The diagnostic message's location information contains the following details:
  - Device
  - Equip-ID
  - Address
  - Location description

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13.1 Diagnostic list

- Parameter list
  Contains all the information required by technical support to evaluate a diagnostic message. This is the diagnostic identifier and all parameters.
- State
  Indicates the state of the diagnostic message: "Active, acknowledged", "inactive, unacknowledged" or "active, unacknowledged"
  (see State of diagnostic messages, page 13-6)
- Acknowledgement
  Information on whether the diagnostic message needs to be acknowledged
  (see Acknowledgement of diagnostic messages, page 13-8)

Action components

- Scope
  Approximate description of the kind of action
  (see Scopes, page 13-12)
- Responsibility
  Information about who should undertake the action
  (see Responsibilities, page 13-11)
- Description (action text)
  Description of what has to be done
- Location information
  Information about the location at which the action is to be taken(see Location information, page 13-13) .
  The location information for action components contains the following details:
  – Device
  – Equip-ID
  – Address
  – Location description

13.1 Diagnostic list

13.1.1.1 State of diagnostic messages

The state of a diagnostic message depends on the event that triggered it and on whether the diagnostic message requires an acknowledgement.

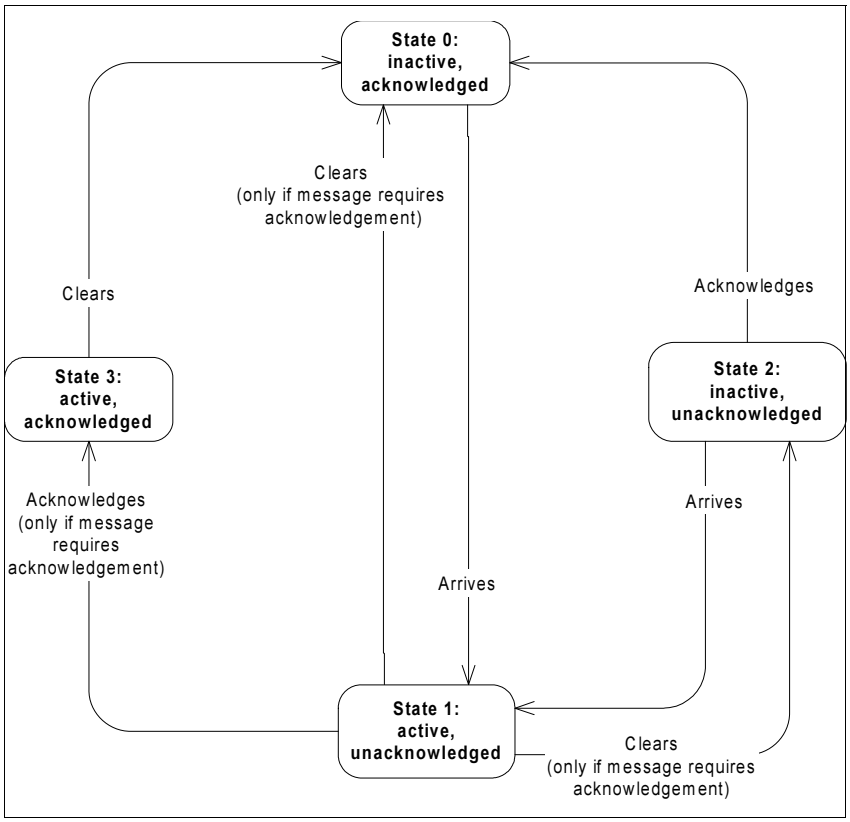

Fig. 13-1: State of diagnostic messages

- System diagnostics
  If an event is present (e.g. short circuit at an input), the diagnostic message becomes "active" (change of state: "arrives"). If the fault has been rectified, the diagnostic message becomes "inactive" (change of state: "clears"). If the diagnostic message needs to be acknowledged, this must be done before or after the fault is rectified (status change: "acknowledges").
- Process Diagnostics
  If the programmed condition is met, the diagnostic message becomes "active" (change of state: "arrives"). If the condition is no longer met, the diagnostic message becomes "inactive" (change of state: "clears"). If the diagnostic message requires acknowledgement, this

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13.1 Diagnostic list

must be done before or after the condition is no longer met (change of state: "acknowledges").

The diagnostic list only contains diagnostic messages with the status 1, 2 or 3.
Each time the state of a diagnostic message changes, a log entry is triggered in the diagnostic log.

Changes in state are symbolised by the following character strings:

- <+> for "arrived"
- <-> for "cleared"
- <o> for "acknowledged"

13.1 Diagnostic list

13.1.1.2 Acknowledgement of diagnostic messages

In progess

The acknowledgement of diagnostic messages is not yet implemented in the current version of PSS 4000.

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13.1 Diagnostic list

13.1.1.3 Severity and priority

Diagnostic messages are differentiated according to their importance. They are divided into three levels of severity:

Error
Diagnostic message to which the user must react immediately. This diagnostic message provides information on system conditions in which one or more functions have failed or are adversely affected.

Warning
Diagnostic message which demands the user's attention. This diagnostic message warns the user about potential or imminent critical system conditions.

Status information
Diagnostic message which describes the current condition of the process and/or system.. This diagnostic message is provided for information; operation is neither impeded nor adversely affected.

Priorities allow a more precise classification. Each level of severity has 5 priorities. Priority 1 is the highest priority and priority 15 the lowest.

Severity	Priority	Name of priority
Error	1	
	2	
	3	Error
	4	
	5	
Warning	6	
	7	
	8	Warning
	9	
	10	

13.1 Diagnostic list

Severity	Priority	Name of priority
Status Information	11	
	12	
	13	Status Information
	14	
	15	

The user can assign names to these priorities. The names for priority 3 "Error", priority 8 "Warning" and priority 13 "Status information" are pre-defined by Pilz because they are used in system diagnostics and in Pilz-generated process diagnostics.

These pre-defined names can be modified by the user but cannot be deleted.

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13.1 Diagnostic list

13.1.1.4 Responsibilities

The responsibility stands for the person or group who is supposed to perform the remedial action.

Some responsibilities are pre-defined by Pilz and a maximum of 15 responsibilities can be defined by the user. The pre-defined responsibilities are used in system diagnostics and in Pilz-generated process diagnostics. The user can change the name of the pre-defined responsibilities, but cannot delete them.

Pre-defined responsibilities:

- Operator
  This action involves the release, actuation or operation of a safety device.
  Responsible person: Plant operator, for example
- Electrical maintenance engineer
  This action refers to the mechanics/electrics/ electronics outside the Pilz devices, e.g. rectify short circuit, check supply voltage, check switch contacts.
  Responsible person: Maintenance engineer, for example
- Device exchange
  The device is defective and must be exchanged.
  Responsible person: Maintenance engineer, for example
- Project engineer
  This action can only be performed with PAS4000 or requires some programming knowledge, e.g. check or adapt hardware configuration, check or adapt programming.
  Responsible person: Maintenance engineer, programmer, project engineer, for example
- Communication
  This action can be performed by users with a technical understanding of SafetyNET p/IP connections/fieldbuses, who can check the bus load or check cable lengths, for example.
  Responsible person: Maintenance engineer, bus specialist, for example
- ---
  No details of responsibility are possible or necessary.

13.1 Diagnostic list

13.1.1.5 Scopes

The scope roughly describes the kind of event/action. The scope is stated for diagnostic messages and remedial actions.

Some scopes are pre-defined by Pilz and a maximum of 15 scopes can be defined by the user. The pre-defined scopes are used in system diagnostics and in Pilz-generated process diagnostics. The user can change the name of the pre-defined scopes, but cannot delete them.

Pre-defined scopes:

- Hardware
  Affects the mechanics, electrics, electronics or operating system.
  Examples: Defective device, periphery error (e.g. wiring, actuator/sensor or supply voltage is faulty), bus error (e.g. error in SafetyNET p or Ethernet)
- Project configuration
  Affects the user program and hardware configuration.
  Examples: Division by zero in the user program
- Operation
  Affects sequence or operation.
  Examples: Sequence error (cylinder fails to reach an end position), safety device was triggered (e.g. E-STOP operated)
- Plant
  Affects the hardware or project configuration.
- ---
  No details of the scope are possible or necessary.

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13.1 Diagnostic list

13.1.1.6 Location information

Location information is available for diagnostic messages and for the individual remedial actions. The diagnostic message contains details of the location in which the event occurred. The information for the action includes details of where the action is to be taken.

The location information contains the following details:

- Device
  Relevant element
- Equip-ID
  The equipment identifier is used to identify a piece of hardware in a project and should be unique.
- Address
  The address is generated automatically.
- Location description
  Additional information about a location, e.g. information about the control cabinet in which a device is located.

The information content depends on the location. The following locations are possible:

- Module/device
- Terminal
- Sensor/actuator
- Block instance
- Position in the user program
- Other locations

The individual locations and location information details are described below.

INFORMATION
If "<???>" is displayed in the diagnostic list or diagnostic log instead of location information, either the current project has not been downloaded to all devices or not all the I/O mappings have been performed (see Diagnostic Server, page 13-25) .

13.1 Diagnostic list

Module/device

Only used in system diagnostic messages and log entries.

- Device
  Text that the user has entered in the Device Editor (e.g. PSSu Module Editor) as "Device" location information for the module/device; the default setting is the product type of the module/device (e.g. "PSSu E F 4DI").
  In rare cases the situation can arise on PSSu systems in which it is impossible to determine which module triggered a diagnostic message. In this case, the text "anonymous module" is displayed as the device.
- Equip-ID
  Equip-ID of the module/device (e.g. "-4A1"), entered by the user in the Device Editor (e.g. PSSu Module Editor)
- Address
  Automatically generated address of the module/device
- Location description
  Additional information on the module/device, entered by the user in the Device Editor (e.g. PSSu Module Editor)

Terminal

In the system diagnostics or process diagnostics, if the underlying PI variable is mapped to an I/O datum from the module bus:

- Device
  "Device" location information for the module/device on which the terminal is located (see "Device" under "Module/device")
- Equip-ID
  Equip-ID of module/device on which the terminal is located, including details of the terminal (e.g. "-4A1:12", whereby "12" refers to the terminal)
- Address
  Automatically generated terminal address
- Location description
  Additional information on the module/device, entered by the user in the Device Editor (e.g. PSSu Module Editor); no location description can be entered for the terminal itself

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13.1 Diagnostic list

In the process diagnostics, if the underlying PI variable is mapped to an external I/O datum:

- Device
  "Device" location information for the module/device containing the external I/O datum (see "Device" under "Module/device")
- Equip-ID
  Equip-ID of the module/device containing the external I/O datum (see "Equip-ID" under "Module/device")
- Address
  Automatically generated address of the external I/O datum
- Location description
  Location description of the module/device containing the external I/O datum (see "Location description" under "Module/device")

In the process diagnostics, if the underlying PI variable is mapped to another PI variable:

- Device
  "Device" location information for the module/device on which the resource of the mapped PI variable is located (see "Device" under "Module/device")
- Equip-ID
  Equip-ID of the module/device on which the resource of the mapped PI variable is located (see "Equip-ID" under "Module/device")
- Address
  Automatically generated address of the mapped PI variable
- Location description
  Location description of the module/device on which the resource of the mapped PI variable is located (see Location description" under "Module/device")

13.1 Diagnostic list

Sensor/actuator

In the system diagnostics or process diagnostics, if the underlying PI variable is mapped to an I/O datum from the module bus:

- Device
  Text that the user has entered in the Device Editor (e.g. PSSu Module Editor) as "Device" location information for the sensor/actuator
- Equip-ID
  Equip-ID of the sensor/actuator, entered by the user in the Device Editor (e.g. PSSu Module Editor)
- Address
  Automatically generated address of the terminal to which the sensor/actuator is connected
- Location description
  Additional information on the sensor/actuator, entered by the user in the Device Editor (e.g. PSSu Module Editor)

In the process diagnostics, if the underlying PI variable is mapped to an external I/O datum:

- Device
  "Device" location information for the module/device containing the external I/O datum (see "Device" under "Module/device")
- Equip-ID
  Equip-ID of the module/device containing the external I/O datum (see "Equip-ID" under "Module/device")
- Address
  Automatically generated address of the external I/O datum
- Location description
  Location description of the module/device containing the external I/O datum (see "Location description" under "Module/device")

In the process diagnostics, if the underlying PI variable is mapped to another PI variable:

- Device
  "Device" location information for the module/device on which the resource of the mapped PI variable is located (see "Device" under "Module/device")
- Equip-ID
  Equip-ID of the module/device on which the resource of the mapped PI variable is located (see "Equip-ID" under "Module/device")

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13.1 Diagnostic list

- Address
  Automatically generated address of the mapped PI variable
- Location description
  Location description of the module/device on which the resource of the mapped PI variable is located (see Location description" under "Module/device")

Block instance

Only used in process diagnostic messages and log entries.

- Device
  Name of the type of Multi block/POU
- Equip-ID
  Not used
- Address
  Instance path of the Multi block/POU
- Location description
  Not used

Position in the user program

Only used in system diagnostic messages and log entries.

- Device
  Name of the type of Multi block/POU
- Equip-ID
  Not used
- Address
  Instance path of the Multi block/POU, with additional positional data
  Positional data on the Multi block: X and Y co-ordinate in the Multi Editor; X is the column number (counting from left to right, from 1 to 30) and Y is the line number (counting from top to bottom, from 1 to 30)
  Positional data with IL-POU and STL-POU: Line number
  If a Multi block/POU is read-protected, the instance path will end with details of the last unprotected Multi block/POU. The position is the point at which the protected Multi block/POU is called.

13.1 Diagnostic list

- Location description
  Not used

Other locations

If the location information listed above isn't suitable, the location information can be freely defined.

- Device
  Process diagnostics: Any; defined in the type or instance of the diagnostic item
  System diagnostics: Names the location (e.g. "Hardware configuration" or "User program")
- Equip-ID
  Process diagnostics: Any; defined in the type or instance of the diagnostic item
  System diagnostics: Not used
- Address
  Not used
- Location description
  Process diagnostics: Any; defined in the type or instance of the diagnostic item
  System diagnostics: Not used

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13.1 Diagnostic list

13.1.1.7 Diagnostic identifier

In system diagnostics, the diagnostic identifier is used for unique identification of a diagnostic message. In process diagnostics, the diagnostic identifier is used for unique identification of the diagnostic item responsible for the diagnostic message. In process diagnostics, the uniqueness is limited to the project.

The diagnostic identifier consists of three parts:

<Kind> - <Class> - <Number>

- Kind
  A letter indicates the kind of diagnostics
  S: System diagnostics
  P: Process diagnostics, generated by Pilz
  C: Process diagnostics, generated by the user
- Class
  A decimal figure of a maximum of 4 digits indicates the class. The meaning of class depends on the kind of diagnostics.
  – System diagnostics
    The class defines the kind of error, e.g. device error, user program
    Classes in system diagnostics:
    100 ... 110 Device error
    120 Error caused by a device project
    121 Error caused by the naming data
    122 Error caused by a boot command
    123 Error caused by firmware update
    200 ... 220 Error in the hardware registry/hardware configuration
    300 Error in the FS or ST resource system section
    303 Licensing is missing
    400 Periphery error
    410 Faulty supply voltage
    600 ... 602 Error in the FS or ST SafetyNET p RTFN system section
    700 ... 710 Error in the FS or ST module bus system section
    801 Internal error in PAS4000
    908 Ethernet error
    910, 911 Error in the IP connections system section
    912, 913 Error in the PROFIBUS-DP Slave system section
    9000 Operational entries in the diagnostic log
    9001 Self test entries in the diagnostic log
    9900 Debugging entries in the diagnostic log

13.1 Diagnostic list

- Process diagnostics, generated by Pilz
  The class indicates the Pilz block to which the diagnostic message belongs. The class refers to the type of block, not to an instance.
- Process diagnostics, generated by the user
  The user can decide what the class means. We recommend that the class is used along similar lines to that of the Pilz process diagnostics.

▸ Number
Unique number of a diagnostic message/diagnostic item within a class. The number is a 4-digit decimal figure.

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13.2 Diagnostic log

The diagnostic log records when a diagnostic message arrived, when it was cleared or when it was acknowledged. The diagnostic log also contains information on any changes in the operating state, e.g. if a device has been restarted, as well as information for Pilz technical support.

Each device has its own device diagnostic log. The log entries for all the devices in a project are combined within the project diagnostic log.

- Device diagnostic log
  - Generated by the device's firmware
  - Contains a device's log entries (raw data only, no texts)
  - Memory for at least 256 log entries;
    one memory area is reserved for system, process and self test entries and the other memory area for operational entries (see Log entries)
  - If the maximum number of log entries has been reached, the oldest log entry is deleted;
    this is the case respectively within the memory area for system, process and self test entries and the memory area for operational entries
  - Cannot be displayed; used as the basis for the project diagnostic log
- Project diagnostic log
  - Generated by the Diagnostic Server
  - Contains plain text log entries for all the devices in a project
  - Memory for at least 4096 log entries;
    one memory area is reserved for system, process and self test entries and the other memory area for operational entries (see Log entries)
  - If the maximum number of log entries has been reached, the oldest log entry is deleted;
    this is the case respectively within the memory area for system, process and self test entries and the memory area for operational entries (This is why a project diagnostic log may contain very old operational entries while at the same time containing new system, process and self test entries or vice versa.)
  - Always up-to-date as it is continuously synchronised with the device diagnostic logs
  - Should the Diagnostic Server lose the connection to a device, all of the device's previous log entries are retained in the project diagnostic log. There will also be a log entry showing the loss of the connection.

13.2 Diagnostic log

– The diagnostic log in PAS4000 may vary slightly from the diagnostic log on a display (e.g. PSS 4000 Diag Control), because it also contains entries for online actions, for example.

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13.2 Diagnostic log

13.2.1 Log entries

The following log entries are available:

- System entries
  Information about system messages changing state, i.e. when a system message arrived, when it was cleared or when it was acknowledged. System entries are part of the system diagnostics.
- Process entries
  Information about process messages changing state, i.e. when a process message arrived, when it was cleared or when it was acknowledged. Process entries are part of the process diagnostics.
- Operational entries
  Information about changes in the operating status (e.g. when a device was restarted) or any other changes relevant to the operation (e.g. executing a project download). Operational entries are part of the system diagnostics.
- Self test entries
  Information about a fault occurring during the self test in the "Booting base system" operating status, which has meant that the device could not be started.
- Debugging entries
  Information for Pilz technical support. Debugging entries are part of the system diagnostics and are only visible when enabled by technical support.

During operation, log entries are entered in the diagnostic log.

With system entries and process entries, the log entry matches the diagnostic message, except that some information is left out, such as the remedy for example. The time stamp means something different and the change in state is displayed rather than the state.

Components of a log entry (operational entries and debugging entries are not included in the list):

- Time stamp
  Time at which the state of the diagnostic message changed (see State of diagnostic messages, page 13-6)
- Change of state
  Symbol for change of state (see State of diagnostic messages, page 13-6)
  <+> for "arrived"
  <-> for "cleared"
  <o> for "acknowledged"
  or
  <#> for operational entries, self test entries and debugging entries

13.2 Diagnostic log

- Diagnostic identifier
  Diagnostic identifier for the diagnostic message (see Diagnostic identifier, page 13-19)
- Severity and priority
  Importance of the diagnostic message(see Severity and priority, page 13-9)
- Scope
  Approximate description of the kind of event(see Scopes, page 13-12)
- Description
  Description of what has happened.
- Location information
  Information about the location at which the event occurred (see Location information, page 13-13) .
  The diagnostic log's location information contains the following details:
  – Device
  – Equipment identifier
  – Address
  – Location description

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13.3 Diagnostic server

A Diagnostic Server is required if you wish to display a project's diagnostic data.
The Diagnostic Server forwards the project diagnostic list and log to the diagnostic clients (e.g. PSS 4000 OPC Server). The diagnostic clients then provide the information to the displays (e.g. PSS 4000 Diag Control).

The Diagnostic Server gathers the raw data in the device diagnostic lists and device diagnostic logs of every device in the project and uses it to generate the project diagnostic list and project diagnostic log in plain text. In other words, the Diagnostic Server takes the references to message texts and location information in the device diagnostic lists and device diagnostic logs and replaces them with legible text.
The Diagnostic Server always needs the current project data: user program, hardware configuration, resource assignment and I/O mapping. If the current project data is unavailable to the Diagnostic Server, references to message texts and location information cannot be replaced correctly. In this case they will be replaced with the wrong message texts/location information or by "<???>" if no text is available. This can also happen if the Diagnostic Server has the current project data, but a device within the project is still operating with an older version of the project.

- Show on display
  If the project diagnostic list and log are to be shown on a display (e.g. PSS 4000 Diag Control), a device within the project must provide the Diagnostic Server system section. If the project contains an OPC Server (PSS 4000 OPC Server), the PSS 4000 device on which the OPC Server is installed will provide the Diagnostic Server. A project may only contain one Diagnostic Server.
  The texts displayed for system diagnostics and process diagnostics are those which were available when the project was built in PAS4000 and which were transferred when the project was downloaded.
- Display in PAS4000
  PAS4000 has its own Diagnostic Server.
  The texts displayed for system diagnostics are the diagnostic texts supplied with PAS4000. The texts displayed for process diagnostics are the diagnostic texts which were available when the project was built.

13.3 Diagnostic server

INFORMATION

The diagnostic list and diagnostic log are displayed correctly if the current project has been downloaded to the Diagnostic Server and to all the devices in the project.

If the computer on the OPC Server is used as the diagnostic server, you will also need to download the current project to the computer on the OPC Server (this will be done automatically if the OPC Server is connected to SafetyNET p during download).

We also recommend that the version of the PSS 4000 firmware on the device containing the Diagnostic Server should be equal to or higher than the version in the project.

If the texts are to be displayed in PAS4000, you will need to activate the current project in PAS4000. Always use the latest version of PAS4000.

After an extended period of operation, log entries which are no longer available on the project devices may still be stored in the project diagnostic log on the Diagnostic Server. These old log entries will be deleted when the device with the Diagnostic Server has a warm reset or when the PAS4000 is cold started.

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14.1 Factory default settings for the Ethernet parameters

The Auto IP mechanism is activated.with PSS 4000-exclusive devices in delivery status or after an original reset. The Ethernet parameters are set as follows:

Parameter	Default setting		Meaning
IP address	In the network the Auto IP mechanism is active for exactly one device.	169.254.1.1	If in the netwok the Auto IP mechanism is active for exactly one device, the Auto IP mechanism assigns the stated IP address for the device if it is still free.
	In the network the Auto IP mechanism is active for several devices.	169.254.1.1 to 169.254.1.254	If in the network the Auto IP mechanism of several devices is active, the Auto IP mechanism assigns a free IP address from the stated address range.
Subnet mask	255.255.0.0		The Auto IP mechanism assigns the stated Subnet mask.
Address of Standard Gateway	deactivated (0.0.0.0)		configurable as an option when SafetyNET p is divided into subnetworks through Gateways and, from the communication partner's perspective, the product is behind a Gateway.
Address of preferred DNS Server	deactivated (0.0.0.0)		configurable as an option when the Domain Name Service is claimed.
Address of alternative DNS Server			

14.2 Factory default settings for port numbers for various services

Port numbers have standard default settings for various services.

Service		Default setting	Meaning
SafetyNET p		40000	SafetyNET p protocol
DNS		53	Domain Name Service Protocol
OPC via DCOM	Connection Setup (Server)	135	Distributed Component Object Model Protocol
	Communication (Server)	Dynamic	
DHCP		67, 68	Dynamic Host Configuration Protocol
Modbus/TCP		502	Modbus over TCP
SNTP		123	Simple Network Time Protocol

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15 List of abbreviations

POU (Program Organisation Unit)	Program organisation unit
FS (Failsafe)	Failsafe, in the sense of "safety-related"
FW	Firmware
HW	Hardware
ST (Standard)	Standard, in the sense of "non-safety-related"
SW	Software

15 List of abbreviations

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Auto IP mechanism	Technology for configuration-free and/or automatic assignment of a free IP address from the address range 169.254.0.0/16 [Ethernet]
Autocrossing	Automatic crossing of the send and receive lines on twisted pair interfaces; devices that support this function can be connected via a 1:1 wired cable (patch cable) instead of a crossed cable (crossover cable). [Ethernet]
Autosensing	Automatic bit rate detection (10 MBit/s or 100 MBit/s) [Ethernet]
Basic diagnostic item	Section of the user program that defines a process state that is to be monitored for diagnostic purposes. Also, the basic diagnostic item contains the information and texts for one or more diagnostic messages and diagnostic log entries.
Bit module	Electronic/compact module whose data requires one bit each in the process image. Example: Digital input/output modules
Block	Generic term for Multi program, component block, basic block and program organisation units of the type program, function block and function
Build	The code for the individual devices (device projects) is built from the project.
Byte module	Electronic/compact module, the data for which requires different data widths in the process image (bit, byte and/or word). Example: Counter modules
Certification	Procedure by which a product's compliance with the applicable regulations and standards is tested by a notified body; proven compliance is confirmed through the issue of a certificate.
Certification body	Notified body in accordance with Article 14 of the Directive 2006/42/EC Otherwise: Accredited institution, often a government body, which examines and confirms a product's compliance with applicable regulations and standards.
Check sum	Sum which is formed via an object, e.g. a project or program organisation unit (POU). This can be used to detect whether the object has been modified.
Competent person	A person who, through training, experience and current professional activity, has acquired the necessary knowledge and authorisation to test, assess and handle devices, systems, plant and machinery in accordance with the general standards and guidelines for safety technology.

Consistency range	Amount of consistent data of a data source (e.g. consistency range "FS-I data from the module bus of a PSSu system")
Control variables	The value of variables is set once to a specified value. This can be changed afterwards by the user program.
Crossover cable	Cross wired cables for wiring Ethernet components and end devices such as PLC or network components (hubs, switches) [Ethernet]
Data consistency	Keeping together data that is recorded at a certain time and is considered current and related during a defined period.
Debugging	Troubleshooting and fault recovery during programming or commissioning.
Device configuration	Settings for a device, e.g. test pulses
Device Editor	Software tool for defining the settings for a device and for calling up information from the device [PAS4000]
Device project	Part of the project that is downloaded to a device. [PSS 4000]
Diagnostic item	Generic term for basic diagnostic item and summary diagnostic item
Diagnostic list	List of the current diagnostic messages
Diagnostic log	Log that shows when diagnostic messages arrived, when they were cleared and when they were acknowledged. It also contains entries regarding operation and debugging.
Download	Download of data from the PC to the device
Enable principle	Configuration that enables the ST section to have write access to the FS section; FS outputs can be switched via the ST section PSS 4000: By using the enable principle, FS data sinks (e.g. FS hardware outputs) can be switched via ST data sources (e.g. ST hardware inputs).
Ethernet infrastructure	All the hardware (e.g. cables, plug-in connections, adapters, switches, routers, hubs) and software (e.g. network services and their configuration) required for data transfer in an Ethernet network
Failsafe	Abbreviation: FS Safety-related, failsafe; a failsafe system switches to a safe condition in the event of an error

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Fast Ethernet	Fast data network which was standardised by IEEE 802.3 in 1995; based on a communication speed of 100 MBit/s with a variable packet length of 64 to 1518 Byte. [Ethernet]
Firmware	Abbreviation: FW Software created by a manufacturer for a device, to perform device-specific functions.
Firmware update	Updating a device's firmware
Force variables	The value of variables is fixed and cannot be changed by the user program.
FS resource	Execution unit for safety-related control code
Function block (FB)	In accordance with IEC 61131-3: Programmable controller programming language element consisting of: 1) the definition of a data structure partitioned into input, output, and internal variables; and 2) a set of operations to be performed upon the elements of the data structure when an instance of the function block type is invoked.
Gigabit Ethernet	Very fast data network which has been standardised by IEEE 802.3 since 1999; based on a communication speed of 1000 MBit/s with a variable packet length of 64 to 1518 Bytes. [Ethernet]
Hardware input	Physical input of a device
Hardware output	Physical output of a device
Hub	Hardware of the Ethernet infrastructure, for star-shape connection of several Ethernet subscribers, data packets received at one Port, will be transmitted to all other Ports. The device operates on Layer 1 of the OSI Reference Model. Synonym: Hub [Ethernet]
I/O mapping	Mapping of a PI variable to an input/output or to another PI variable.
Instruction list (IL)	Text-based, machine-oriented programming language; all operations are shown in text format
Intended use of a machine	Use of a machine in accordance with the information provided in the instructions for use [EN ISO 13849-1] and [EN ISO 14121-1]
I-PI variable	Variable in the process image which can be mapped to a hardware input or O-PI variable.

Location Description	Part of the location information in the diagnostics: Precise description of the location, e.g. information about the control cabinet in which a device is located.
Location information	Generic term for all location information in diagnostic messages, plus the remedy.
O-PI variable	Variable in the process image which can be mapped to a hardware output or I-PI variable.
Patch cable	1:1-wired cable with a max. length of 5 m; it is primarily used to connect Ethernet components within an enclosure (control cabinet etc.). [Ethernet]
PI variable	Variable in the process image which can be mapped to a hardware input/ output or to another PI variable. There are I-PI and O-PI variables.
Process value	Real value of process data; in contrast to substitute value
Program	Logical assembly of all the programming language elements and constructs necessary for the intended signal processing required for the control of a machine or process by a PLC-system. [IEC 61131-1]
Program organisation unit	Abbreviation: POU Function, function block or program [IEC 61131-3]
Project	A project contains all the data needed to control and monitor a system (plant, machine). Project = User program + hardware configuration
Quality of process data	Information on whether process data relates to the "process value" or a "substitute" value.
Real-time system	System in which the validity of a calculated result depends not only on logical accuracy but also on the time at which the result is provided. A response that is too early or too late is an incorrect response.
Resource	Entity to execute code, e.g. FS resource, ST resource, VISU resource, MC resource. Term in the component model: Unit that executes the content of the aspect blocks. Example: a PSSu system contains two resources: one to execute failsafe (FS) IEC 61131 code and one to execute non-failsafe (ST) IEC 61131 code

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Resource assignment
Assignment of program-type program organisation units or basic blocks to resources.
Term in the component model:
Definition of which component blocks/aspect blocks are to be executed by which resources.
Logic blocks may also be assigned by the user; if they are not assigned by the user, they are executed automatically by the most suitable resource.

Router
Hardware of the Ethernet infrastructure, for connecting different networks, based on the Net-ID (= section of the IP address) the router decides which data packets are to be transmitted to a different network. The device operates on Layer 3 of the OSI Reference Model.
[Ethernet]

Safe condition
Condition in which power is removed from the safety circuits.

Scalability of a system
Ability of a system to adapt to changing requirements

- **horizontal scaling**:
Functions are distributed to other or additional devices
- **vertical scaling**:
A device or parts of a device are replaced by a more powerful alternative.

Sealed
Property of project elements (e.g. program organisation units, component blocks); project element can no longer be changed and the content can no longer be displayed.

ST resource
Execution unit for non-safety-related control code

Standard
Abbreviation: ST
Not safety-related, in contrast to failsafe

Standard bus system
Non-safety-related bus system, e.g. DeviceNet or PROFIBUS, in contrast to SafetyBUS p or SafetyNET p from Pilz

Substitute value
If process data cannot be calculated due to an error, it is replaced by substitute values.

Summary diagnostic item
Combination of several basic diagnostic items. A summary diagnostic item contains its own diagnostic messages and diagnostic log entries.

Switch
Hardware of the Ethernet infrastructure, for star-shape connection of several Ethernet subscribers, data packets received at one Port, will be analysed and only transmitted to the Port where the subscriber is registered. Broadcast messages are forwarded. The device operates on Layer 2 of the OSI Reference Model.
[Ethernet]

System section	Defined unit of functionalities, which provides utilities that are visible to the user (e.g. ST/FS resource, ST/FS module bus, ST/FS SafetyNET p RTFN, PROFIBUS-DP Slave, Raw UDP)
Task	Execution control element providing for periodic or triggered execution of a group of associated program organisation units. [IEC 61131] Execution control element providing for periodic or triggered execution of a group of associated IEC 61131 programs and/or basic blocks. [PSS 4000]
Test pulse	Test pulse signal which is wired to an input in order to detect wiring errors in that input. These errors may be: open circuit, short circuit to 24 VDC or 0 V or shorts between between two inputs.
Timeliness	Occurrence of an event within a defined time window; events that occur earlier or later are invalid.
User program	All the program organisation units, Multi blocks and diagnostics within a project
Variable list	List in which variables that are to be controlled, forced or watched are entered.
Variable mapping	Mapping of a PI variable to an input/output or to another PI variable
VISU resource	Execution unit for visualisation

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