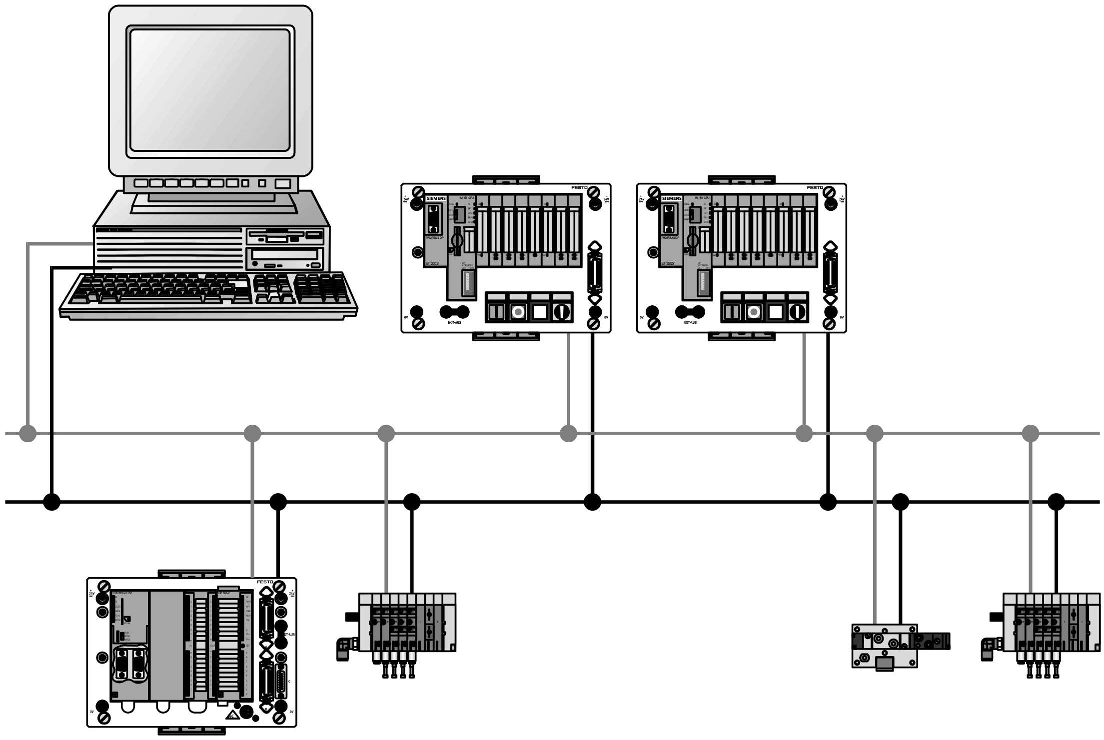
FESTO

Fieldbus technology
Profibus-DP

Workbook
TP 402



534 273 EN

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Introduction

The training package TP 402 Profibus-DP contains equipment and components for automation and industrial communication. The example of a Profibus-DP is used to impart knowledge about fieldbus technology and to acquire the professional skills to deal with such systems.

Training contents

The general training aim to be achieved with this training package is the ability
- to design
- to configure
- and to commission a Profibus-DP system

With this aim in mind, topics are also discussed that are independent of a special bus system:
- Topology of a fieldbus system, master and slave
- Addressing of fieldbus components
- Interfaces and connections
- Data transfer

Significance of these training contents in professional practice

The currently occurring, highly dynamic development of networked automation systems facilitates new types of problem solutions for process technology, telecontrol technology and remote maintenance.

The aim of industrial communication is to solve automation tasks using a single, completely integrated and contiguous communication system that is open to office networks. The benefit of networking is in the cost saving for hardware, assembly and maintenance.

The configuration and commissioning of such networked automation systems has not previously been taught in vocational training or if so only in rudimentary form.

An almost 100 % availability is required from a finished installation. In the event of malfunction, maintenance personnel need to be supported by targeted messages from the system.

Here too, industrial communication is therefore a relevant training subject.

With this technical development, the qualifications of technical staff must be developed in line with further vocational training. This is why the introduction of industrial communication to electrical trades and partly also the engineering trades is of strategic importance. Without insight into the nature of fieldbus communication, it is not possible to gain an understanding of systems using networked components. Employees without fieldbus know-how are not in a position to deal with fieldbus systems, since they cannot adequately react to a system modification or system malfunction.

Benefits for industrial practice

This training package provides the basic knowledge for the sphere of industrial communication, which will be required by future technicians in professional practice for the configuration and commissioning of automated systems networked via Profibus-DP. In this training package, the topic areas of maintenance and fault finding are dealt with in conjunction with the elimination of faults during commissioning.

This basic know-how will enable technicians to increase their knowledge and skills in industrial practice during maintenance and fault finding.

Target group

- Future mechatronics engineers, electrical and electronics engineers:
  For these, professional competence in the field of networking automated processes is absolutely imperative in industrial practice.
- Future industrial mechanical engineers:
  For these, it is becoming ever more important to have a knowledge of simple bus systems on the sensor/actuator level. The training package TP 401 AS-interface is particularly suitable for this target group.
- However, the training package is just as suitable for use in further vocational training

Prerequisites

- Basic technical training
- Basic technical training
- Fundamentals of pneumatics and electropneumatics
- Fundamentals of control technology
- Knowledge about valve terminals
- Programming know-how in Siemens STEP 7
- Interpretation of circuit documentation
- Use of PC and Windows programs

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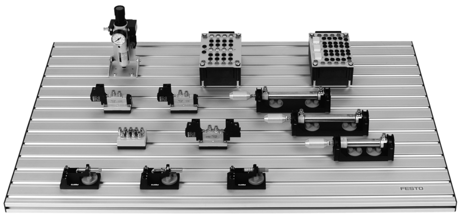
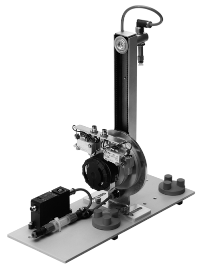
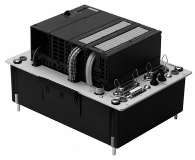
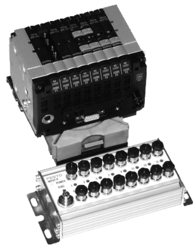
Devices and components

This training package enables you to adapt training packages TP 201/202 and TP 301 to fieldbus technology and to use and network industrial components such as valve terminals and MPS® modules from Festo Didactic into industrial systems.

Bus-independent devices and components	
Programming software Siemens STEP 7, version 5.1 or later	
From the training packages Electropneumatics Basic Level TP 201 or PLC Basic Level TP 301: – 5/2-way double solenoid valve – Double-acting cylinder – Proximity sensor with cylinder mounting – Distributor block – On/off valve with filter regulator	
MPS® modules from the distribution station: Stack magazine module, Order No. 527 434 and Changer module, Order No. 527 435	 
Universal terminal unit with SysLink, Order No. 162 231 I/O data cable, Order No. 034 031	 
Signalling module and distributor, electrical, Order No. 162 244	
Signal input, electrical, Order No. 162 242	
Plastic tubing	
Miscellaneous sets of cables	
Sensor cable – 3-pin, M8 socket/4 mm SIBU, Order No. 184 123 – 3-pin, M8 plug/socket, Order No. 175 488 for cylinder sensors – 4-pin on 3-pin M8 socket/SIBU, Order No. 184 121 for vacuum sensor (changer module) and for sensor (magazine module) – 4-pin on 3-pin M8 plug/socket, Order No. 532 930 – DUO connecting cable, Order No. 018 685	

Profibus-DP	
SIMATIC S7 EduTrainer® Compact : S7 313C-2DP with 16 DI/16 DO; Profibus-DP plus ASi-Master, Order No.527 424 (see illustration) or S7 313C-2DP with 16 DI/16 DO; Profibus-DP plus placeholder module, Order No.533 021 or S7 313C-2DP with 16 DI/16 DO; Profibus-DP plus analogue module 4 AI/2AO, Order No.533 022 or S7 313C-2DP with 16 DI/16 DO; Profibus-DP plus simulator module, Order No. 533 023 In the case of all variants 16 DI/16 DO are wired to 2 SysLink plugs. In the case of Order No. 533 022, the 4 AI/2 AO are wired to 15-pin Submin-D plugs. or S7 EduTrainer® plus as Profibus Master All variants with S7 315-2DP or S7 313C-2DP programming cable with PC adapter, Order No. 184 555	
SIMATIC S7 EduTrainer® ET200S with integrated CPU 12 I/10 O as intelligent slave, Order No. 527 425	
Valve terminal with Profibus-DP interface with 16-off input module, Order No. 527 432	
Profibus-DP cable 50 cm Order No. 533 035 200 cm Order No. 533 036	

An additional slotted assembly board, electrical power supply unit and compressed air supply is required for the assembly of operational fieldbus systems.

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Training aims and contents

Technical competence

Trainees are to be familiar with the fundamentals of fieldbus systems, especially Profibus-DP

To be familiar with ...	
The advantages of bus systems compared to conventional wiring	Part B, Chapter 1
The possibilities and areas of application for fieldbus components	Part B, Chapter 1
The allocation of fieldbus systems in the hierarchical levels of a factory and the requirements for different networks	Part B, Chapter 1
Bus structures (topology, master/slave, master/master) and be able to integrate these into a system	Part B, Chapter 2
The most important basic principles of data transmission within a fieldbus system (addressing, telegram, protocol)	Part B, Chapter 2
The OSI reference model for communication functions	Part B, Chapter 2
Different fieldbus concepts (station-orientated, message-orientated) and the appropriate fieldbus types and to be able to differentiate between the various fieldbus concepts	Part B, Chapter 3
The basic bus systems in industrial use and their specific areas of application	Part B, Chapter 3
The mode of operation of Profibus-DP	Part B, Chapter 4

Professional competence

See exercises and solutions, Part A and C.
Trainees, within certain limits, are able to select, install and operate the process.
They are able to configure and commission a Profibus-DP system.

Trainees are familiar with ...
- the various advantages of bus systems compared to conventional wiring
- the process components of Profibus-DP systems

Trainees are able ...
- to configure a Profibus-DP system and select and handle its components
- to assemble a Profibus-DP system and correctly connect the components
- to configure a Profibus-DP system and its components (address allocation, software and hardware configuration, integration of equipment by other manufacturers)
- to commission a Profibus-DP system
- to program control functions in a Profibus-DP networked system
- to expand and adapt a Profibus-DP system
- to synchronise processes decentralised with PROFIBU-DP, e.g. using intelligent slaves
- to detect and eliminate faults during commissioning

Documenting fieldbus systems

Trainees are able ...
- to represent networks topologically
- to create and document program listings for fieldbus applications
- to adapt and represent circuit diagrams for networked systems
- to create acceptance protocols

Practical notes for training

Room equipment, working material

As part of training, both practical skills in the use of equipment and theoretical contents need to be conveyed. In order to avoid any loss of time as a result of changing rooms, we recommend a laboratory with a plenum area for presentations and discussions.
- The laboratory should be equipped with a sufficient number of laboratory workstations and the corresponding number of PCs as well as automation and fieldbus components.
- A blackboard, beamer and projector should be available in the plenum area

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How to start?

- Provide the trainees with a brief overview of the overall system of industrial communication with the material under Fundamentals, Part B, and a few visual examples from industrial practice.
- Then concentrate on the main points of at least one bus system by involving them in the exercises of this training package.

As an introduction to the topic of „industrial communication“ Festo Didactic offers the multimedia training system „Bus Studio“ as a component part of the workbook. This can be used as a medium for self-tuition by the individual or for training as part of a group or in the form of a presentation.

Also appropriate as a means of introduction is the use of pictures of application examples, graphics (e.g. Part B – Fundamentals) and videos.

Technical terms

- Explain technical terms by means of practical activities, i.e. as these occur when practically implementing the configuration and installation of the bus system!

This method is ideal because, on the one hand, trainees are motivated at that moment by the question arising and on the other hand it counteracts an excess of training with theoretical material.

An explanation of technical terms regarding the subject of industrial communication can be found in the Glossary, Part D.

Fundamentals section and bibliography

The fundamentals section (Part B) is structured in such a way as to enable the use of individual chapters in order to

- introduce a topic
- consolidate and deepen the practical know-how the trainees have acquired whilst working through an exercise.

However, you can also work through the fundamentals section as a whole, like a book.

In the bibliography in Part D, you will find a list of literature for the consolidation of know-how.

The PC as a working device and training aid

The software-guided working method for configuration and diagnosis is fundamental to all fieldbus systems. This therefore calls for knowledge on how to use a PC and Windows software for training purposes. This also requires trainees to be able to deal with initial difficulties when dealing using complex software packages and not to become immediately discouraged by these, but to become used to availing themselves of the on-line help. This represents an important aspect of using one's own initiative.

Of major importance for effective training is whether trainees have a PC at home and, assuming this is the case, whether the configuration and control software can be made available without any licence problems. Experience has shown that more and more trainees have the requisite equipment and that many component manufacturers have started to provide so-called homework software. Therefore, if trainees have the opportunity to practise the use of software in their own time, it is possible to make much more and quicker progress with training during tuition.

PLC programs for Siemens STEP7 on CD-ROM

Complete PLC programs are available on the enclosed CD-ROM “Solutions and STEP7 programs for TP 402” for checking the solutions to the individual project exercises. They can be found in the form of archived STEP7 programs in the subdirectories listed below.

For projects with TP 402, PROFIBUS-DP:
- STEP7-Progr\PROFIBUS-DP\PRO1_PB.ARJ
- STEP7-Progr\PROFIBUS-DP\PRO2_PB.ARJ
- STEP7-Progr\PROFIBUS-DP\PRO3_PB.ARJ
- STEP7-Progr\PROFIBUS-DP\PRO4_PB.ARJ
- STEP7-Progr\PROFIBUS-DP\PRO5_PB.ARJ

The prerequisites for the use of STEP7 programs are:
- PC with Microsoft Windows® 95/98/2000/ME/XP Professional/NT
- 8x CD-ROM drive
- Programming software STEP7 5.1 Servicepack 2 or later
- SIMATIC S7 EduTrainer® with programming cable

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Additional training software Bus Studio WBT on CD-ROM

The web-based, multimedia and interactive training program Bus Studio enclosed with this workbook serves as an additional aid to assist trainees. It is recommended that trainees acquire the basic knowledge on fieldbus technology with this software prior to solving the project exercises, since it provides an optimal overview of this topic, especially for beginners. Various practical examples are visually illustrated by means of animation. All relevant terms on the subject of bus technology can be found in the integrated lexicon.

Depending on the level of knowledge, training time is approximately one hour. The training contents are:
- Mode of operation and advantages of fieldbus systems
- Areas of application for different fieldbus systems
- Open and closed systems
- Technical concepts
- Data transfer standards RS 485 and RS 422
- Topologies of fieldbus systems

The following prerequisites must be met for the use of training software:
- PC with Microsoft Windows® 95/98/2000/ME/XP/NT
- Internet Explorer 5.0 or Netscape 4.7 or later
- Macromedia® Flash Player 5.0 (or later)
- 8x CD-ROM drive

Electronic documentation

The solutions to the exercises in Part C of the workbook are also available in electronic form and can be found on the CD-ROM „Solutions and STEP7 programs for TP 402“, in the subdirectory Documentation. You will need the Acrobat Reader® program from Adobe Systems Incorporated to be able to open the files in PDF format. If this program is not yet installed on your PC, you can install it from the subdirectory Documentation\Acrobat.

Notes regarding the projects

In **Project 1**, the control of automation components is to be realised using conventional wiring.
The purpose of this project and its realisation relates to bus technology insofar as, in subsequent exercises, it will serve to illustrate the advantages of controlling and networking the same system by means of bus technology.
Moreover, the existing knowledge on the subject of “automation with a PLC” is to be extended with the help of this exercise.

Projects 2 and 3 focus mainly on the configuration and commissioning of a bus system.
The configuration and commissioning phase of a bus system makes great demands on trainees in the areas of planning, configuration and programming, primarily because the new know-how and skills will be taught and acquired for these areas.
This is why trainees will require particular guidance and support when working through projects 2 and 3.

In **Project 2**, trainees start with the control and assembly of a mini system consisting of a master and a simple slave (valve/cylinder). In this way, initial experience is concentrated on how a master detects and addresses its slave via an address and how bus addresses are assigned.

In **Project 3**, the mini system is adapted and expanded. Components are adapted and exchanged. The trainees learn which system reaction occurs if a bus station malfunctions or is newly added, thereby facilitating an understanding of the system.

At this point, the advantages of the bus system compared to conventional wiring become particularly apparent. In addition, trainees get to know the specific areas of application of a particular bus system.
Furthermore, a simple error diagnosis is to be carried out.

Projects 4 and 5 are practical exercises dealing with a more extensive problem description. Here, the MPS stack magazine and changer module of the MPS distribution station are to be activated. This establishes the link with an actual process. When working through this project, a knowledge transfer takes place whereby the acquired knowledge is applied to a situation relating to industrial practice, i.e. the separating out of workpieces.

Trainees should work their way through this project mainly on their own initiative, by using and applying previously acquired knowledge.

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Notes on safety and procedure

The following advice should be followed in the interest of your own safety:

- Pressurised air lines that become detached can cause accidents. Switch off supply immediately
- Establish the tubing connections before switching on the compressed air.
- Cylinders may advance as soon as the compressed air is switched on.
- Please observe the following when working through the projects using the MPS® magazine and changer modules:
  – Fill the magazine by means of the drop-tube.
  – Do not reach into these during operation!
  – Stay outside of the range of the changer module during operation!
- Observe the general safety regulations (DIN 58126 und VDE 100).
- Do not operate the electrical limit switch manually during fault finding (use tool).
- Electrical limit switches are to be differentiated into two designs
  – Actuation from the left
  – Actuation from the right
- In the case of high piston speeds, the limit switches should only be approached in the designated direction by the switching cam of the cylinder.
- The limit switches must not be subjected to frontal actuation
- In the pneumatic circuit diagrams of the solutions section, the cylinders are always shown without magnetic cylinder piston, since this is only required if magnetic limit switches are used.
  The Festo Didactic equipment sets only contain cylinders with magnetic piston rod.
- Do not exceed the permissible operating pressure.
- Use only extra-low voltage $\leq$24 V.
- All devices are equipped with 4 mm safety sockets/plugs. Use only cables with safety plugs for the electrical connections.
- Pneumatic circuit design:
  Connect equipment using silver-metallic plastic tubing with an external diameter of 4 mm. To do so, insert the tubing into the QS push-in fitting up to the stop; further securing is not necessary!
- Releasing of the QS push-in fitting:
  The tubing can be released by pressing down the clamping collet (blue ring) (uncoupling under pressure is not possible!)
- Switch off the compressed air and voltage supply prior to dismantling the circuit.

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Contents

Part A – Exercises

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Project 1: Pneumatic door control

Training aims

Trainees are to
- refresh their know-how in dealing with S7/STEP 7.
- have a good command of the commissioning of a simple control device using I/O connection.

Implementation

A simple process is to be directly controlled via the local I/Os of the S7 controller. Since programming is not a training aim in itself, the complete STEP 7 program is provided. Trainees are merely to effect the wiring and commissioning.
The purpose of this exercise is to refresh and consolidate any previous knowledge.

Project task

A CNC machining centre is to be accessed through a pneumatically operated door, which is opened and closed by means of a pneumatic cylinder. An operator is to open the door by pressing a pushbutton once if a workpiece is to be introduced for machining. The operator is to close the door by pressing the pushbutton again.
The control for this pneumatically operated door is to be realised.

Automatic door of the CNC machining centre

Exercise sheet: Design, assembly and commissioning of the door control	
Name:	Date:

Problem description

The piston rod of a cylinder for the actuation of an automatic door is to be actuated by means of a spring returned solenoid valve (coil 1Y1). Two proximity sensors are to signal the positions “advanced” (1B2) and “retracted” (1B1). The cylinder is to be actuated via a pushbutton (S1) in such a way that it extends from the end position in the respective opposite direction. The cylinder is to operate just once each time the pushbutton is pressed. The pushbutton must be released and pressed again in order to trigger a second movement of the cylinder.

Work to be carried out

1. Create the electrical circuit diagram and assemble the circuit.
2. Declare the variables of the PLC program.
3. Load the PLC program to the controller.
4. Commission the system.

Parameters

The equipment set TP 201 is available.

Worksheets

1. Electrical circuit diagram
2.1 – 2.2 Assembly of the circuit
3. Declaration of the variables of the PLC program
4. PLC program

Working aids

- STEP 7 documentation
- Chapter 1: What is a fieldbus system?

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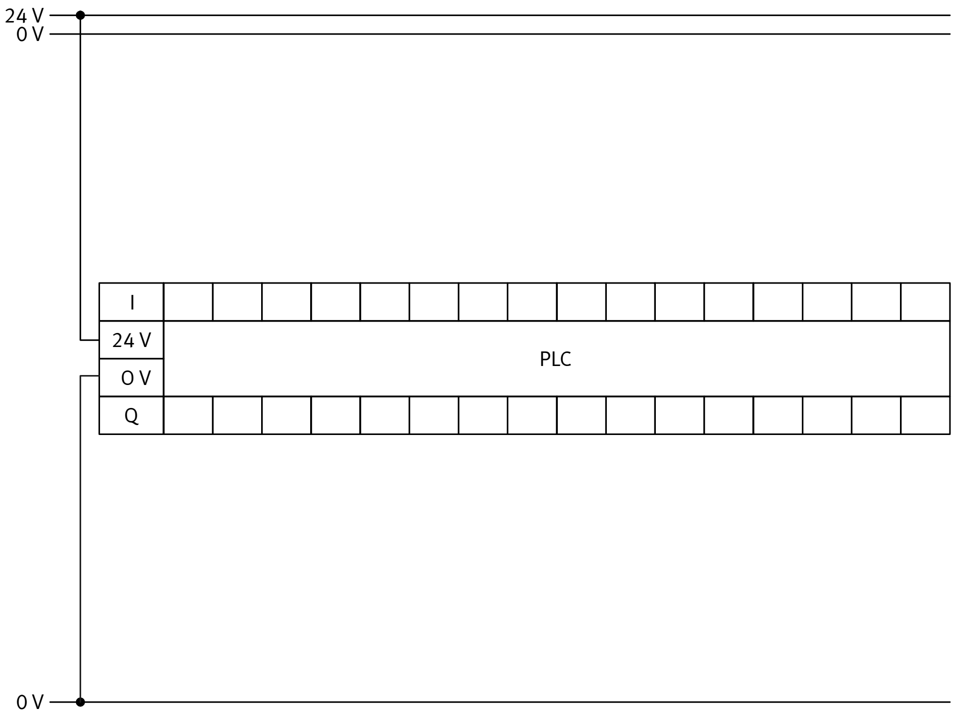
Worksheet 1: Electrical circuit diagram	
Name:	Date:

Complete the electrical circuit diagram.
Identify the individual components.



Worksheet 2.1: Assembly of the circuit	
Name:	Date:

Mount the required components on the slotted assembly board.

Equipment list

Quantity	Description
1	S7 EduTrainer® Compact 313C-2DP
1	Signal input, electrical
1	Double-acting cylinder
1	5/2-way solenoid valve
2	Proximity sensor, inductive-magnetic
1	Universal terminal unit with Syslink cable
2	Sensor cable
1	Set of cables
1	Distributor block
	Plastic tubing

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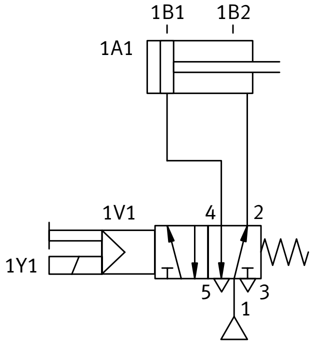
Worksheet 2.2: Assembly of the circuit	
Name:	Date:

Establish the pneumatic connections.

Pneumatic circuit diagram



Worksheet 3: Declaration of variables of the PLC program	
Name:	Date:

Declare the variables required in the PLC program:

Symbol	Address	Data type	Comment

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Worksheet 4: PLC program

Name:	Date:

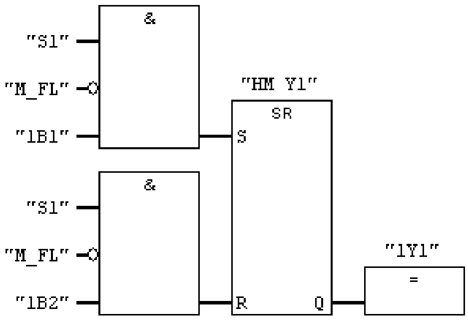
PLC program
Pneumatic door control

OB1 : Hauptprogramm Pneumatische Tür/"Main Program pneumatic door"

Comment:

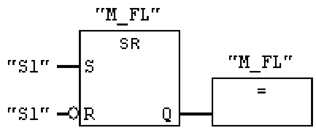
Network 1: Zylinder aus- bzw. einfahren / extend and retract cylinder

Zylinder aus- bzw. einfahren / extend and retract cylinder



Network 2 : Merker M-FL zur Flankenerkennung / flag M-FL for edge detection

Comment:



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Project 2: Pneumatic door control with Profibus valve terminal

Training aims

Trainees are to
- be familiar with the advantages of bus systems compared to conventional wiring
- be familiar with the process components of fieldbus systems
- be familiar with bus structures (topology, master/slave, master/master principle) and to be able to integrate these
- be familiar with the lines and plug and socket connections in Profibus systems
- be familiar with the possible hierarchies and subsystems within fieldbus systems
- be able to configure a Profibus system and to select its components
- be able to assemble a Profibus system

Implementation

The process of a pneumatic door is to be realised with the help of a Profibus-DP connection via a valve terminal.
In this project, trainees are to be guided through the exercise step-by-step. A detailed description is provided as to how
- the physical Profibus connection is configured
- a Profibus project is created and configured in STEP 7,
- the entire project is commissioned.

The project is based on Project 1, pneumatic door control. It is particularly suitable as an initial introduction as to how to handle a Profibus system.

Project task

A CNC machining centre is to be accessed through a pneumatically operated door, which is opened and closed by means of a pneumatic cylinder. An operator is to open the door by pressing a pushbutton once if a workpiece is to be introduced for machining. The operator is to close the door by pressing the pushbutton again.

Since the operator is to monitor several systems, the control for the automatic door and the pushbutton for opening and closing were previously on a central control console and as such at some distance from the CNC machining centre. To reduce the complexity of wiring, the sensors and the cylinder are to be wired to a Profibus-DP slave and connected to the controller.

Automatic door of the CNC machining centre

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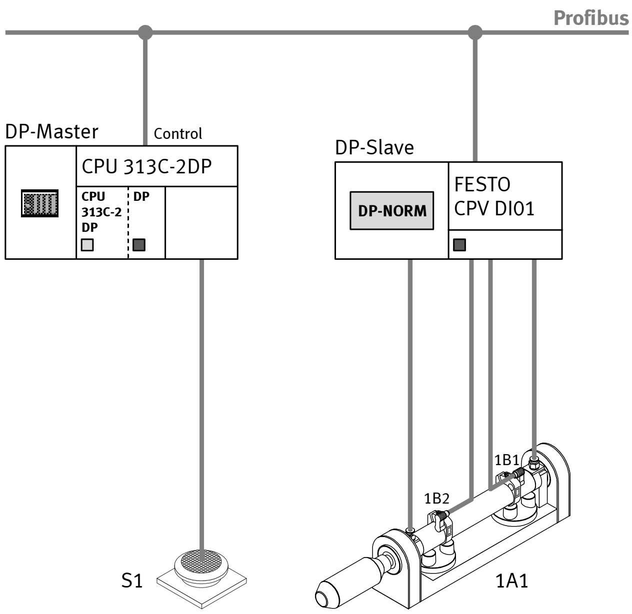
Exercise sheet 1.1: Configuration of the control system using a valve terminal

Name:	Date:

Problem description



An existing pneumatic door control is to be changed so that the sensors and cylinders are connected to a valve terminal equipped with a Profibus-DP interface and connected to the controller via a line. As a result, complex wiring is to be minimised.

Work to be carried out

1. Configure the Profibus-DP system.
2. Create a Profibus-DP project in the control software.
3. Define the hardware configuration for the CPU in the project.
4. Configure the network.
5. Insert the valve terminal into the hardware configuration.
6. Adapt the existing user program and the symbols table.
7. Commission the system.

Exercise sheet 1.2: Configuration of the control system using a valve terminal	
Name:	Date:

Parameters

- The equipment set TP 201 is available
- You can use the existing PLC program of the pneumatic door control.

Worksheets

1. Configuration of the Profibus-DP system
2.1 – 2.2 Assembly of the electrical and pneumatic circuits
3. Establishing the Profibus-DP connection
4.1 – 4.6 CPU 313C-2DP hardware configuration
5.1 – 5.5 Inserting the valve terminal in the hardware configuration
6.1 – 6.4 Adaptation of the symbols table and user program
7. Addresses of the Profibus stations and inputs and outputs
8.1 – 8.3 Commissioning of the pneumatic door control

Working aids

- STEP 7 documentation
- Festo CPV valve terminal documentation
- PLC program for the pneumatic door control with local I/Os
- Chapter 2: Message exchange within a fieldbus system
- Chapter 3: Four different fieldbus concepts and types thereof

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Worksheet 1: Configuration of the Profibus-DP system	
Name:	Date:

Mount the required components on the slotted assembly board:

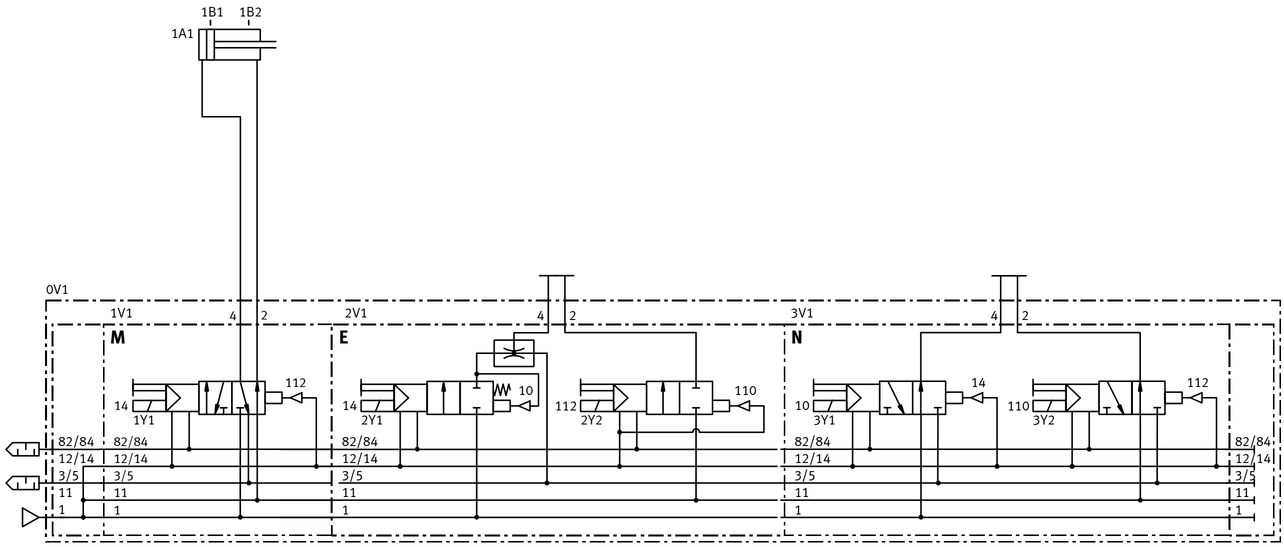
List of equipment

Quantity	Description
1	S7 EduTrainer® Compact 313C-2DP or S7 EduTrainer® plus with 313C-2DP
1	Signal input, electrical
1	Universal terminal unit with Syslink cable
1	Valve terminal with Profibus-DP interface and 16-off input module
1	Power supply cable - valve terminal
1	Double-acting cylinder
2	Proximity sensor, inductive-magnetic
2	Sensor cable
1	Distributor block
1	Profibus cable
1	Programming cable with PC adapter
1	Set of cables
	Plastic tubing

Worksheet 2.1: Assembly of the electrical and pneumatic circuits	
Name:	Date:

Connect the valve terminal to the input module.
Establish the electrical and pneumatic connections for the automatic door.

Pneumatic circuit diagram



Connection diagram See fold-out

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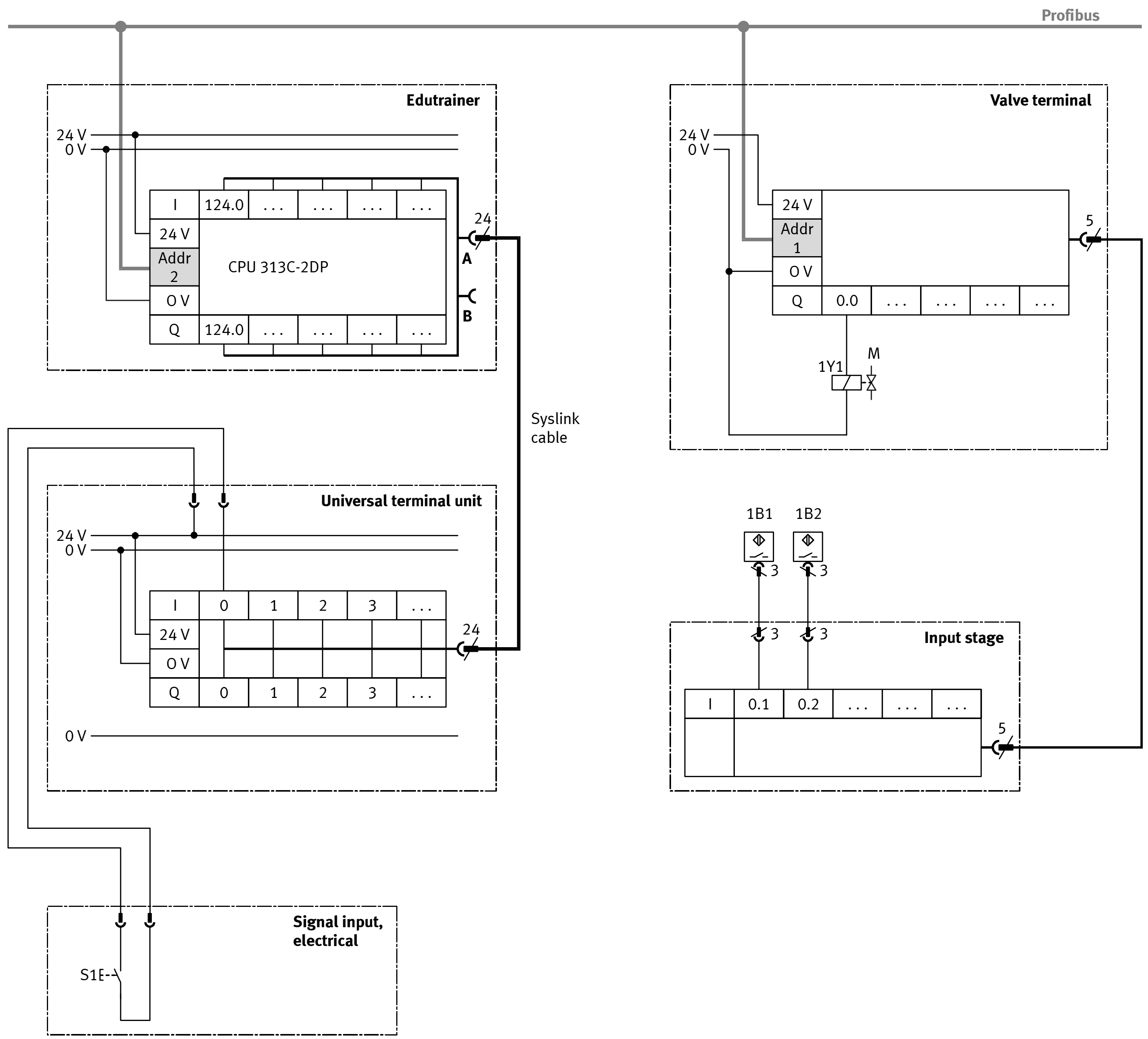

Profibus
Edutrainer
24 V
0 V
I
124.0
24 V
Addr 2
CPU 313C-2DP
0 V
Q
124.0
24
A
B
Syslink cable
Universal terminal unit
24 V
0 V
I 0 1 2 3 ...
24 V
0 V
Q 0 1 2 3 ...
24
0 V
Signal input, electrical
S1
Valve terminal
24 V
0 V
24 V
Addr 1
0 V
Q
0.0
5
1Y1
M
1B1
1B2
3
Input stage
I
0.1
0.2
5

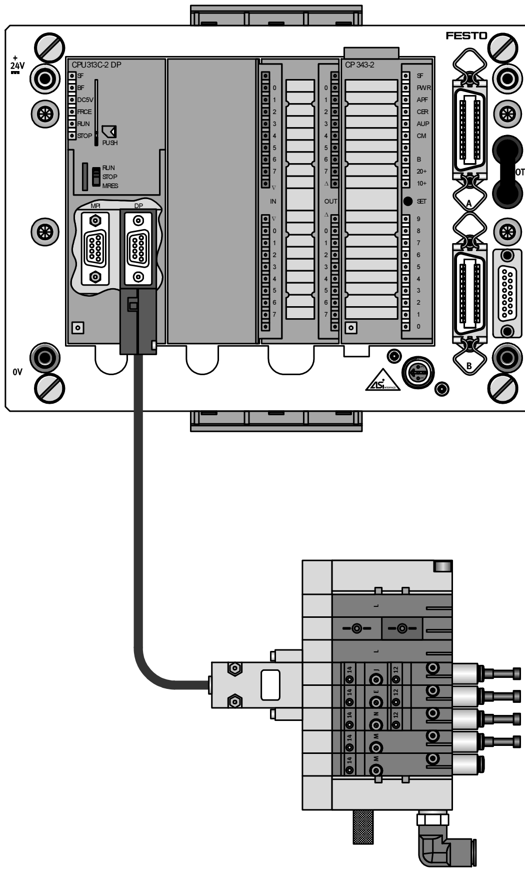
Worksheet 2.2: Assembly of the electrical and pneumatic circuits	
Name:	Date:

Establish the power supply to the valve terminal.
Switch on the DIL switch on the valve terminal (see also valve terminal documentation):

4-fold DIL switch	1	off	Profibus DP protocol
	2	off	
	3	on	Expansion by CP input module
	4	off	No additional output module
8-fold DIL switch	1	on	Profibus address is 1
	2	off	
	3	off	
	4	off	
	5	off	
	6	off	
	7	off	
	8	off	Diagnostic function is switched off

Worksheet 3: Establishing the Profibus-DP connection	
Name:	Date:

Establish the Profibus connection between the controller and the valve terminal.



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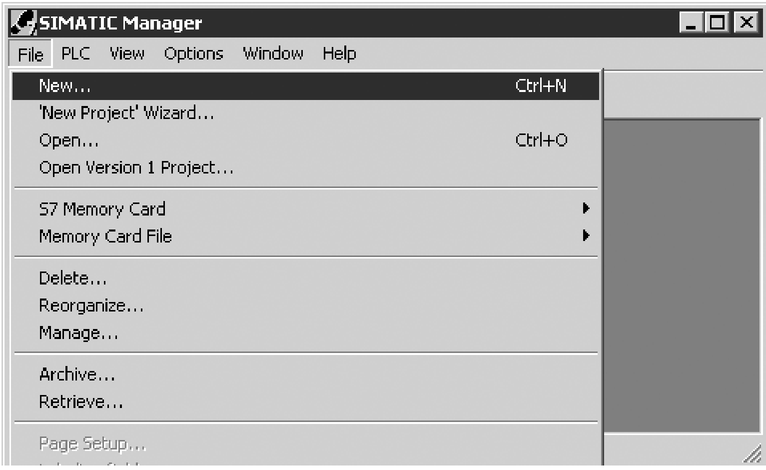
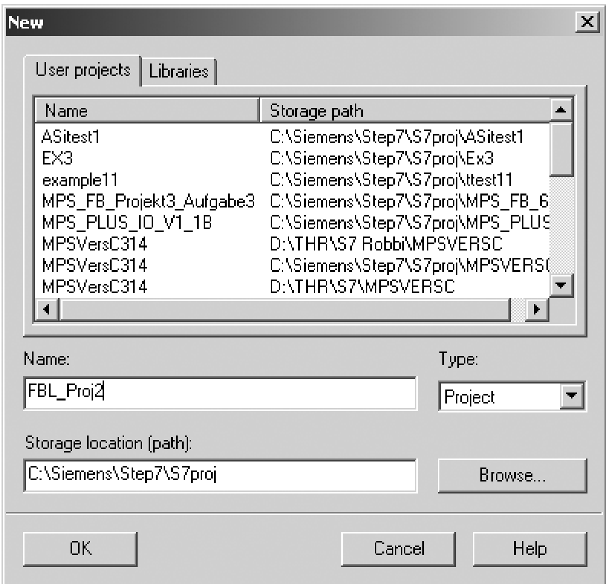
Worksheet 4.1: Hardware configuration CPU 313C-2DP	
Name:	Date:

Create the CPU 312C-2DP hardware configuration in STEP7



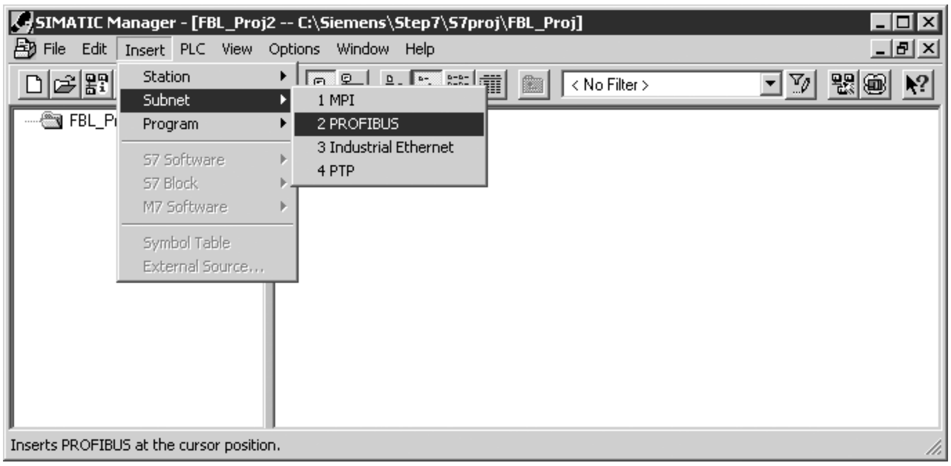
Create a new project (→ File → New).



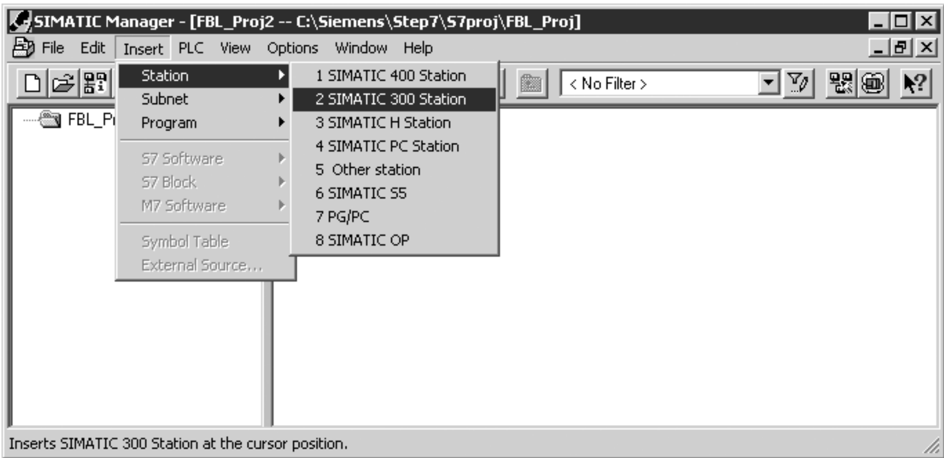
Name the project „Door Control_Proj2"

Worksheet 4.2: CPU 313C-2DP hardware configuration	
Name:	Date:

Highlight your project and insert a Profibus subnetwork (→ Insert → Subnetwork → Profibus).



Now insert a SIMATIC 300 station (→ Insert → Station → SIMATIC 300 station).



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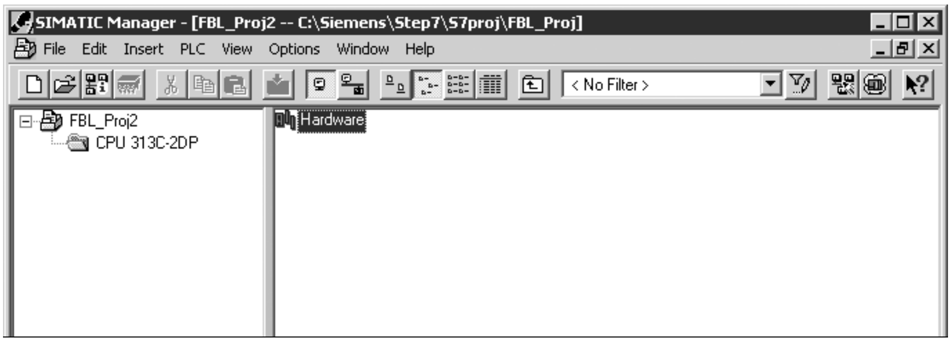
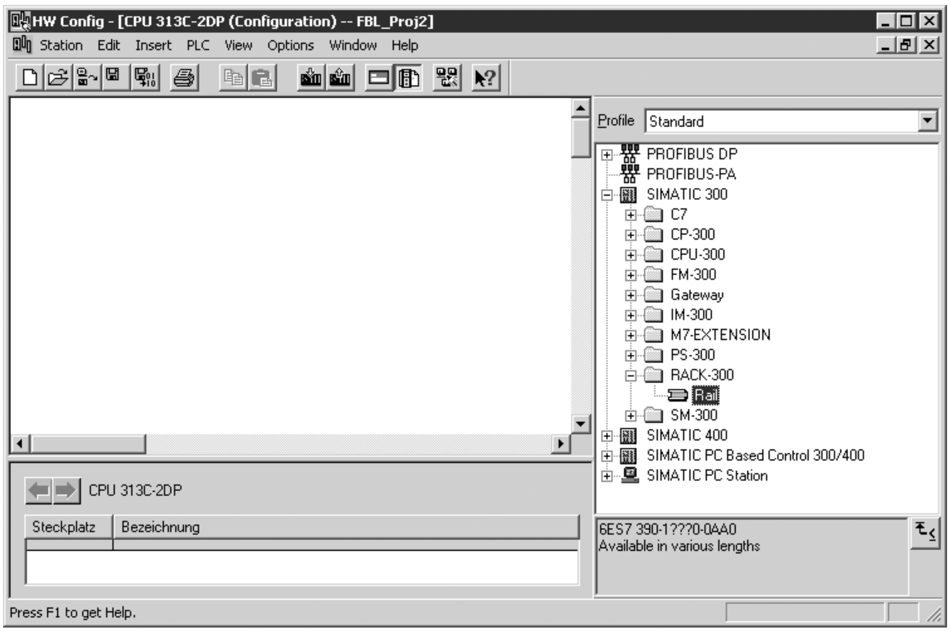
Worksheet 4.3: CPU 313C-2DP hardware configuration	
Name:	Date:

Change the name of the station in „CPU 313C-2DP“.
Open the configuration tool for the hardware with a double click.



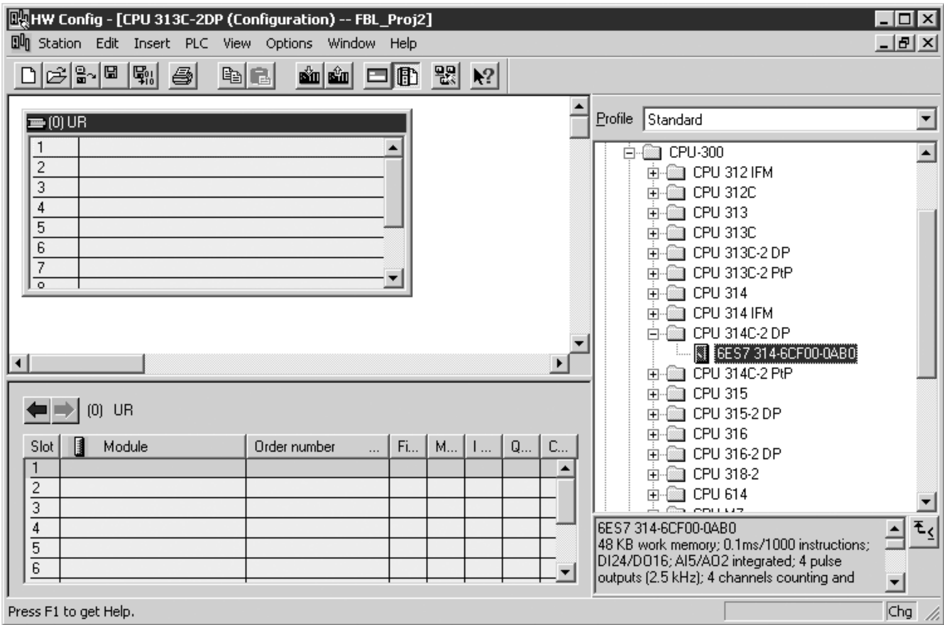
Open the hardware catalogue by clicking onto the symbol (or Insert → hardware components).
This is where all the modules for your project are available in the various directories.

First of all, insert a profile rail (SIMATIC 300 → RACK-300 → Profile rail).



Worksheet 4.4: CPU 313C-2DP hardware configuration	
Name:	Date:

Now insert the CPU 313C-2DP in slot 2 of the profile rail (SIMATIC 300 → CPU 313C-2DP → 6ES7 313-6CE00-0AB0).
Compare the specified order number (6ES7 313-6CE00-0AB0) with the number shown on the device.



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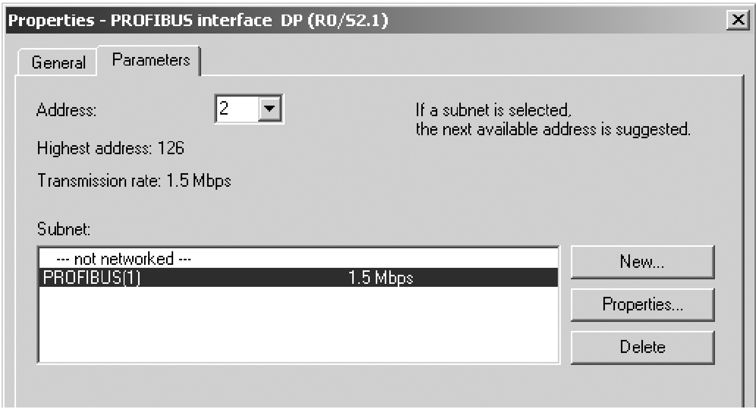
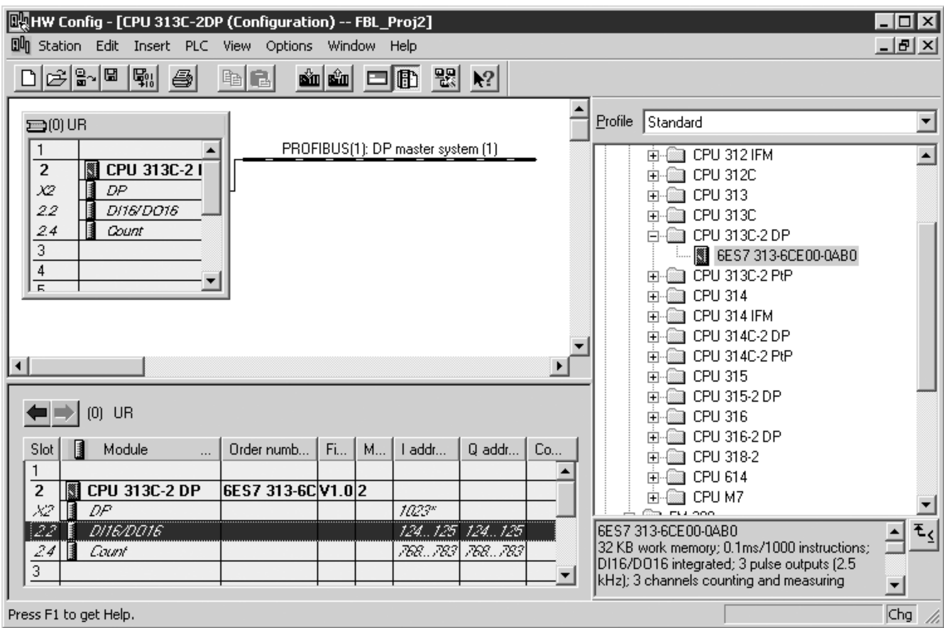
Worksheet 4.5: CPU 313C-2DP hardware configuration	
Name:	Date:

When the CPU is inserted, the following window is displayed, where you can assign a Profibus address to the CPU 313C by selecting (Profibus (1), then address: 2 → OK).

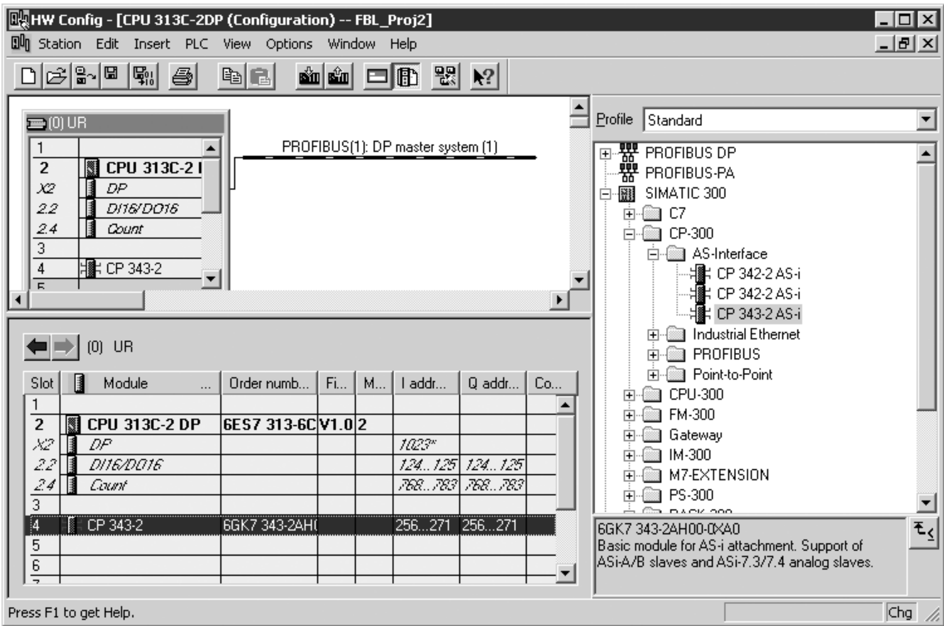


All the modules (Profibus-DP module, I/O module, counter module) pertaining to the CPU 313 are listed in the configuration table. In the line for the I/O module (DI16/DO16), you can already read the defined addresses for the local inputs and outputs: I124 – I125, Q124 – Q125).



Worksheet 4.6: CPU 313C-2DP hardware configuration	
Name:	Date:

Depending on which additional modules your S7 Trainer still contains, you will need to insert the appropriate configuration, even is it is not used in this project. For instance, if the training device still contains an AS-Interface module CP 343-2, you will need to insert this in slot 4 (SIMATIC 300 → CP-300 → AS-Interface → CP 343-2 AS-i). Check the order number shown in the footer; this needs to coincide with the actual module.



The hardware configuration of the CPU is now complete. Save the configuration (Station → Save and compile).
Now close the hardware configuration (Station → Exit).

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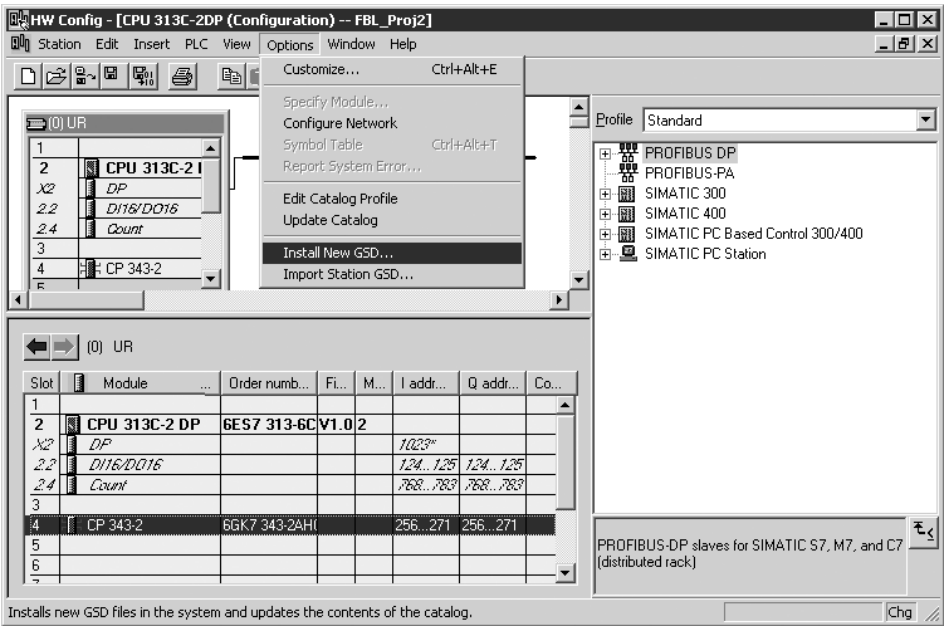
Worksheet 5.1: Insertion of the valve terminal into the hardware configuration	
Name:	Date:

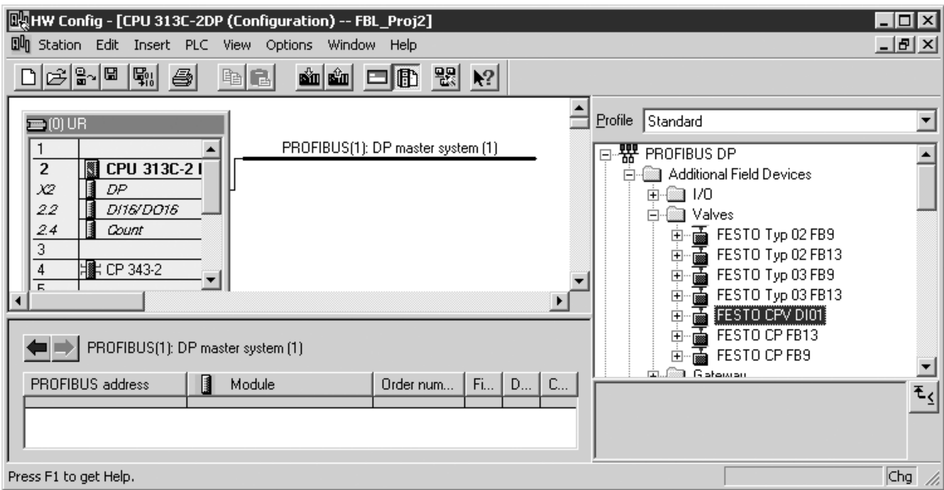
Open the hardware configuration of the CPU 313C-2DP via a double click onto „Hardware“.
Before you can insert the valve terminal into the hardware configuration, you first of all need to import the appropriate device data for the valve terminal into the hardware catalogue. You will find the files on the CD, enclosed with the valve terminal.
Insert the CD-ROM into the CD-drive and start the function „Install New Device Master data“ (Install Extras → New GSD).



Worksheet 5.2: Insertion of the valve terminal into the hardware configuration	
Name:	Date:

In the window„Installing New GSD“, navigate to the appropriate directory (CD Drive → Profibus → GSD → D) and mark all files. Confirm with „Open“.

The device data for the valve terminal is now in the hardware catalogue.
Now highlight the Profibus line in the network configuration (upper window) and insert the valve terminal from the hardware catalogue (Profibus-DP → Additional Field Devices → Valves → Festo CPV DI01).



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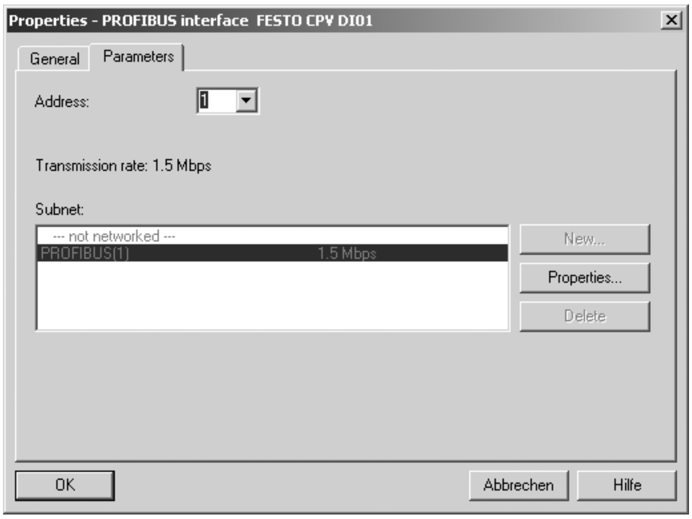
Worksheet 5.3: Insertion of valve terminal into the hardware configuration	
Name:	Date:

In the window „Properties – Profibus interface Festo CPV DI01, the Profibus address 1 and the subnet Profibus (1) are already entered.
Confirm this with OK.
Make a note of the address on your worksheet.

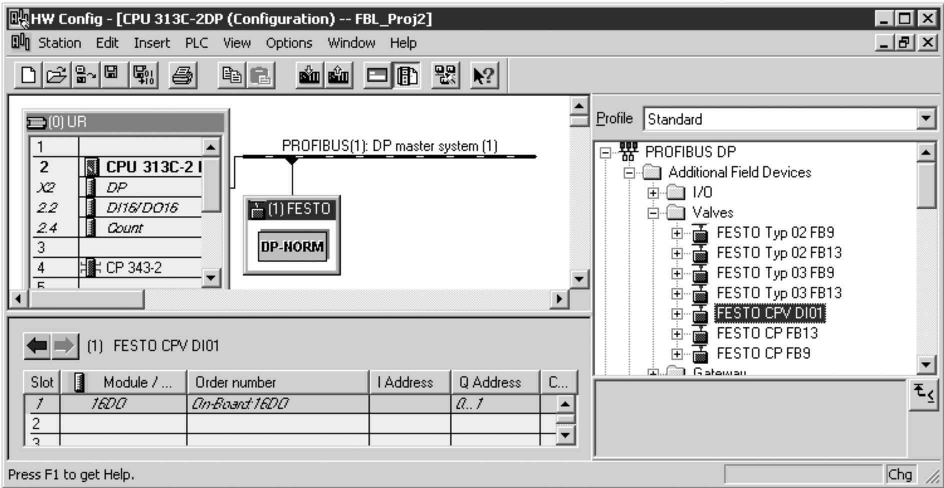
The address entered here must coincide with the address set on the valve terminal via the DIL switches.



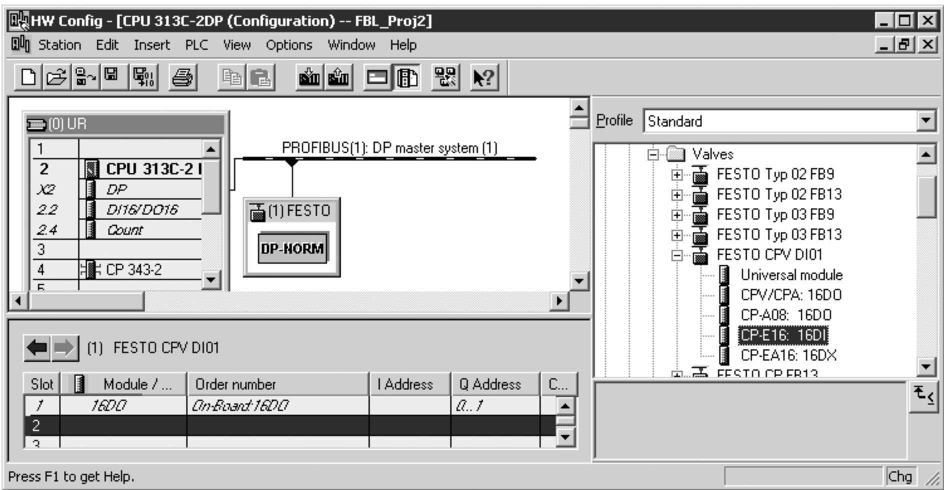
The valve terminal now appears in the network configuration on the Profibus line.

Worksheet 5.4: Insertion of valve terminal into the hardware configuration	
Name:	Date:

The output module 16DO is already entered in the hardware configuration of the valve terminal Festo CPV DI01. Make a note of the output addresses on your worksheet (0 .. 1).



Now insert the input module from the hardware catalogue in slot 2 (Profibus-DP → Additional Field Devices → Valves → Festo CPV DI01 → CP-E16: 16DI).



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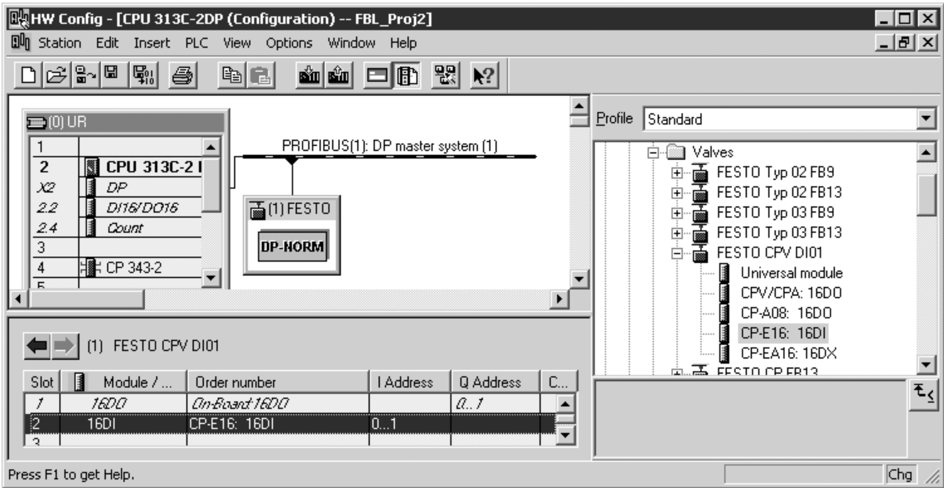
Worksheet 5.5: Insertion of the valve terminal into the hardware configuration	
Name:	Date:

The input module is highlighted in slot 2 of the valve terminal. Make a note of the input addresses (0 .. 1) on your worksheet.



Save the hardware configuration (Station → Save and Compile).

Worksheet 6.1: Adaptation of the symbols table and the user program	
Name:	Date:

You can use the existing user program as well as the symbols table for the control of the pneumatically operated door. However, the inputs and outputs still need to be adapted to the inputs and outputs.

The following steps are necessary to do this:
- Changing the inputs and outputs in the symbols table,
- Changing the inputs and outputs in OB1
- Adding the modules OB82 and OB86 for Profibus communication

The digital inputs and outputs connected to the valve terminal can be addressed by the user program in the CPU 313C-2DP in the same way as the local inputs and outputs. You simply need to observe the special address area.

First of all, copy the existing user program with the symbols table to your project.

Then make a note of all the inputs and outputs to be replaced from the symbols table. The new input and output addresses can also be read from the electrical circuit diagram.

Symbol	Address	New address	Comment

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Worksheet 6.2: Adaptation of the symbols table and the user program	
Name:	Date:

Open the symbols table (CPU 313C-2DP → S7-Program (1) → Symbols) in the SIMATIC Manager.

PRO2_PB\CPU 313C-2DP\CPU 313C-2 DP...\Symbole

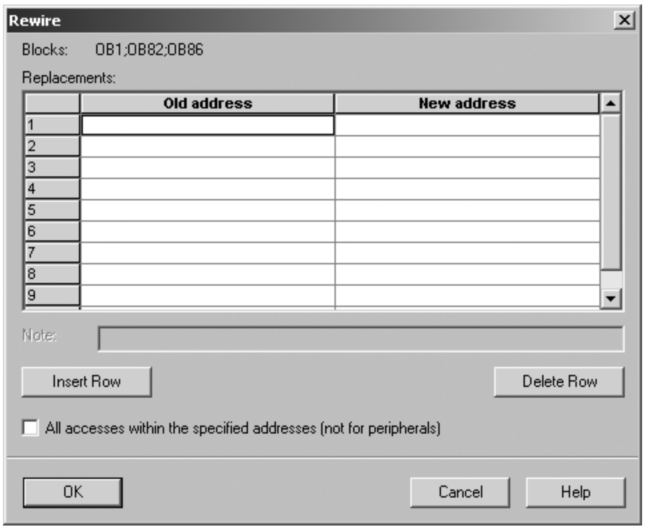
	Symbol	Address	Data type	Comment
1	1B1	I 0.1	BOOL	Zylinder eingefahren / Cylinder retracted
2	1B2	I 0.2	BOOL	Zylinder ausgefahren / Cylinder extended
3	1Y1	Q 0.0	BOOL	Zylinder ausfahren / eject cylinder
4	HM 1Y1	M 64.1	BOOL	Hilfsmerker für Zylinder / Auxiliary flag for cylinder
5	I/O_FLT1	OB 82	OB 82	I/O Point Fault 1
6	M_FL	M 64.0	BOOL	Flankenmerker: alter Zustand / edge flag : old status
7	RACK_FLT	OB 86	OB 86	Loss of Rack Fault
8	S1	I 124.0	BOOL	Starttaster / Start-button
9				

Now change the addresses for the inputs and outputs in the symbols table.

As with the symbols table, you can also change the input and output addresses in the user program OB1, although it is more convenient to do this with the „Rewire“ function.

Worksheet 6.3: Adaptation of the symbols table and the user program	
Name:	Date:

Highlight CPU 313C-2DP → S7-Program (1) → Modules in the SIMATIC Manager. Then call up the “Rewire” function in the menu „Extra“ (Extra → Rewire). In the “Rewire” window you can then enter the old and new operands in a table.



If confirmed with OK, the old operands are automatically replaced by the new ones.

The last step is the addition of two organisational blocks that are required for the Profibus communication, i.e. OB82 and OB86.

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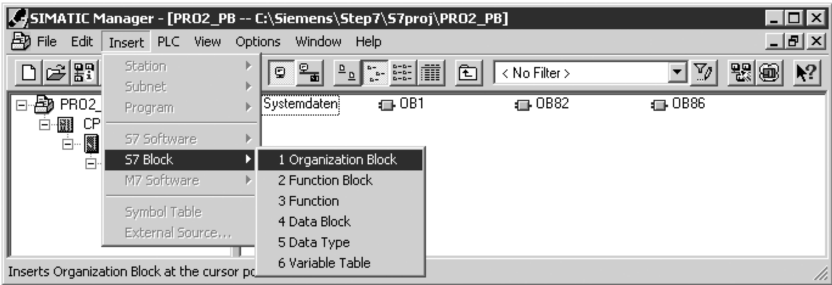
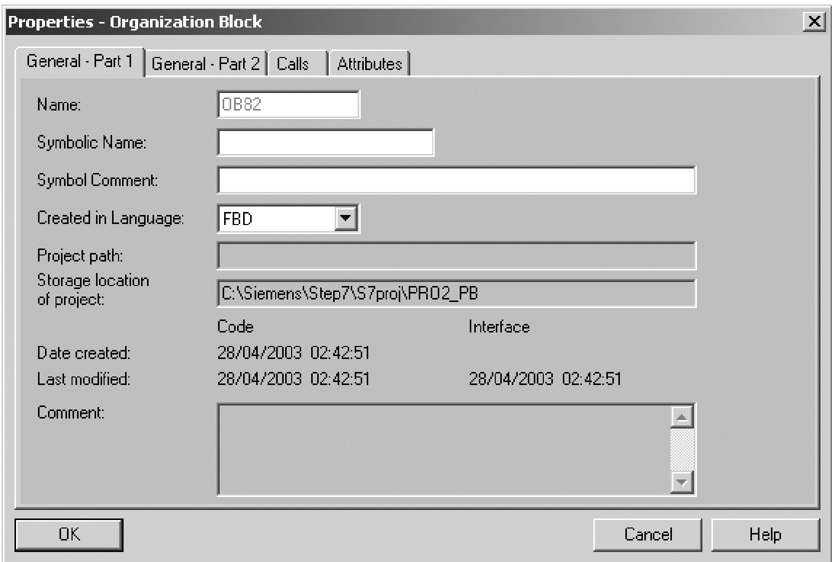
Worksheet 6.4: Adaptation of the symbols table and the user program	
Name:	Date:

Highlight CPU 313C-2DP → S7-Program (1) → Modules in the SIMATIC Manager. Then insert a new organisational block (Insert → S7 Block → Organisational Block).



Enter the name "OB82" in the window „Properties – Organisational Block" and confirm with OK.



Then also insert OB86.

With this, you have adapted the user program to the Profibus project.

Worksheet 7: Addresses of the Profibus stations and inputs and outputs	
Name:	Date:

On this worksheet, you can record the addresses for the Profibus stations and the various address areas for the inputs and outputs to be defined in the course of the hardware configuration. This will provide you with an overview.

Remember that, especially in the case of the Profibus addresses, the addresses assigned in STEP 7 must coincide with the addresses set on the hardware (via the DIL switches).

Device addresses		
CPU 313C-2DP	Profibus address	
	Address area of local inputs	
	Address area of local outputs	
CPV DI01	Profibus address	
	Address range of inputs	
	Address range of outputs	

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Worksheet 8.1: Commissioning of the pneumatic door control	
Name:	Date:

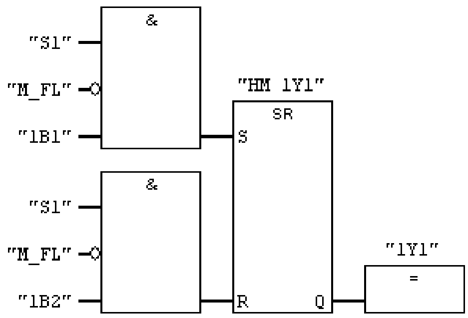
PLC program
Pneumatic door control

OB1 : Hauptprogramm Pneumatische Tür/"Main Program pneumatic door"

Comment:

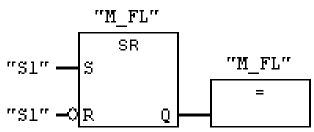
Network 1: Zylinder aus- bzw. einfahren / extend and retract cylinder

Zylinder aus- bzw. einfahren / extend and retract cylinder



Network 2 : Merker M-FL zur Flankenerkennung / flag M-FL for edge detection

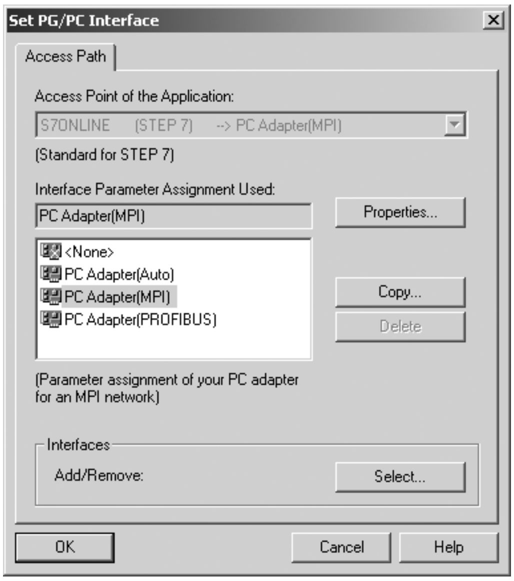
Comment:



Worksheet 8.2: Commissioning of the pneumatic door control	
Name:	Date:

Now commission the pneumatic door control.
To do so, connect your computer and the controller with the programming cable (MPI).

- Make sure that the programming interface is correctly configured (set Extras → PG/PC interfaces).
- Select the interface PC adapter (MPI).



Under „Properties“ of the interface, you can set your COM interface and the transfer rate (19200).

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Worksheet 8.3: Commissioning of the pneumatic door control	
Name:	Date:

Prior to loading the program, you should overall reset the CPU 313C-2DP (Target System → Overall Reset, or directly on the controller).

Load the programs and the configuration to the controller (highlight CPU 313C-2DP → S7-Program (1) → „Modules“, then click the symbol „Load“).

Confirm the overwriting of existing modules and load the system data to the controller; then start the controller.

Now check the correct functioning of the program. The cylinder is to advance if the start button is pressed and retract again if the start button is pressed again.

Switch on the terminating resistor on the Profibus cable plug to ON if the slave is not recognised by the master despite the correct configuration and wiring of the slaves.

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Project 3:
Pneumatic door control with Profibus valve terminal and intelligent slave

Training aim

Trainees are to
- be familiar with the fundamentals of data exchange in a fieldbus system
- be able to commission a Profibus system with a master and an intelligent slave
- be able to identify and eliminate the most frequently occurring faults during commissioning

Implementation

The process of a pneumatic door control is to be controlled with the help of a Profibus-DP connection via a valve terminal and an intelligent slave (ET 200S).

In this project, trainees are to be guided through the exercise step-by-step. The following is described in detail:
- How the Profibus system is to be physically expanded,
- How the hardware in the Profibus project is to be configured,
- How the Profibus-DP connection is to be established and configured,
- How the entire project is to be commissioned.

The project is based on Project 2 Profibus-DP. It is particularly suitable for learning how to use a Profibus system.

Project task

A pneumatically operated door is located at the entrance of a CNC machining centre. The door is to open and close by means of a pneumatic cylinder. Previously, an operator has opened the door by pressing a pushbutton if a workpiece had been delivered for machining. The operator closed the door again by pressing the pushbutton again.

The sensors and the cylinder of the automatic door are connected to a valve terminal and linked to the controller via a Profibus line.

In future, the opening and closing of the pneumatic door is to be assumed by an automatic handling system. From an intelligent Profibus Slave (ET 200S), this sends a signal to open the door to the central controller via the Profibus line.

Prior to this, the signal logic takes place in the Profibus slave. The door is to open and close only if the door release is switched on and the start signal emitted by the handling system.

Automatic door of the machining centre

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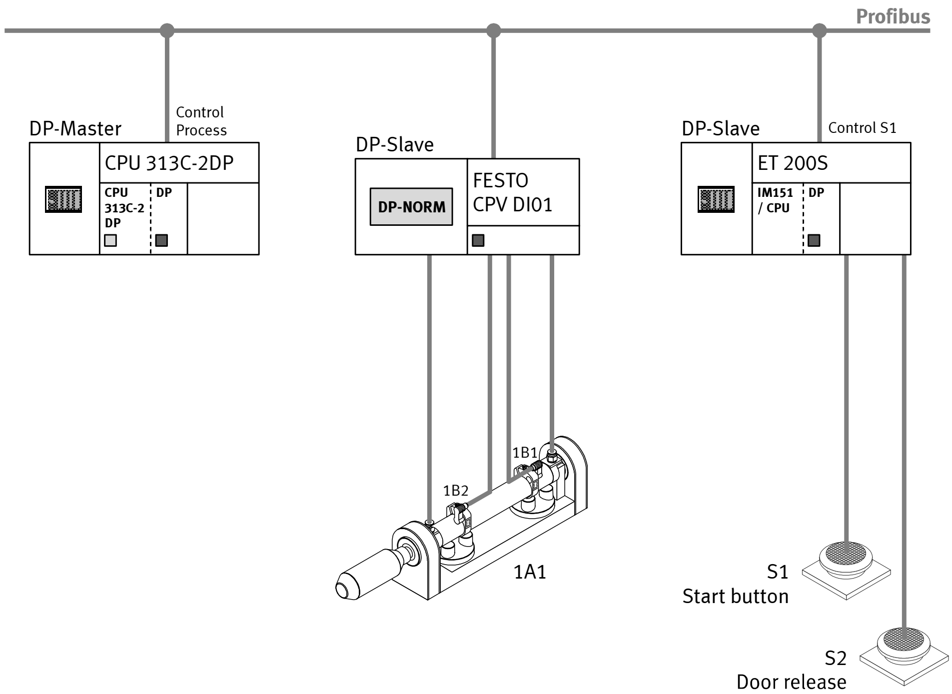
Exercise sheet 1.1: Integration of an intelligent slave	
Name:	Date:

Problem description

An existing Profibus-DP system for a pneumatic door control is to be expanded by adding an intelligent slave (ET 200S), which controls part of the process.



Work to be carried out

1. Configure the Profibus-DP system.
2. Create a Profibus-DP project in the control software.
3. Define the hardware configuration for the CPU 313C-2DP in the project.
4. Insert the valve terminal into the hardware configuration of the CPU 313C-2DP.
5. Define the hardware configuration for the ET 200S in the project.
6. Configure the network.
7. Create the user program and symbols table for the ET 200S.
8. Adapt the existing user program and symbols table for the CPU 313C-2DP.
9. Commission the system.
10. Simulate a fault during commissioning by changing the address on the ET 200S.

Worksheet 1.2: Integration of an intelligent slave	
Name:	Date:

Parameters

- The equipment set TP201 is available as well as all components shown in the list of equipment.
- You can use the existing PLC program of the pneumatic door control.

Worksheets

1. Construction of the pneumatic door control using a Profibus valve terminal
2.1 – 2.2 Designing the electrical and pneumatic circuits
3. Setting up the electrical circuit on the S7 EduTrainer® ET 200S
4. Establishing the Profibus-DP connection
5.1 – 5.7 CPU 313C-2DP hardware configuration
6.1 – 6.5 Inserting the valve terminal in the hardware configuration
7.1 – 7.3 ET 200S hardware configuration
8. Addresses of the Profibus stations and inputs and outputs
9.1 – 9.4 Configuration of the network
10.1 – 10.4 Creating the symbols table and user program in the ET 200S
11.1 – 11.3
Adaptation of the symbols table and user program in the CPU 313C-2DP
12.1 – 12.4 Commissioning of the pneumatic door control
13. Simulating a fault during commissioning

Working aids

- STEP 7 documentation
- Festo CPV valve terminal documentation
- ET 200S documentation
- Chapter 3: Message exchange within a fieldbus system
- Chapter 4: The Profibus-DP

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Worksheet 1: Construction of the pneumatic door control using a Profibus valve terminal	
Name:	Date:

Mount the required components on the slotted assembly board:

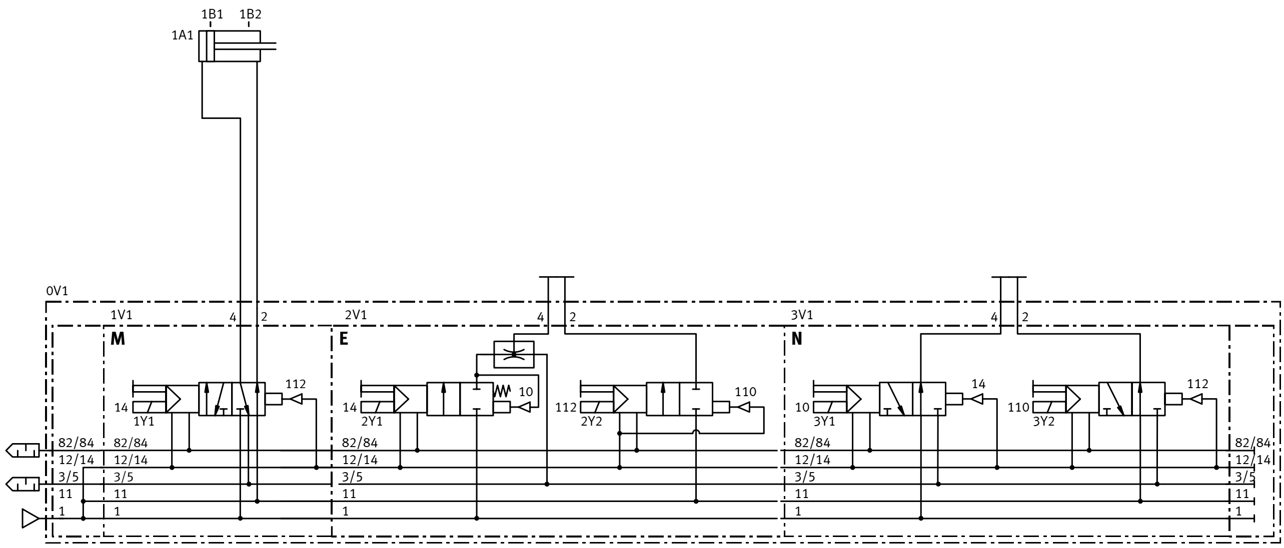
List of equipment

Quantity	Description
1	S7 EduTrainer® Compact 313C-2DP or S7 EduTrainer® plus with 313C-2DP
1	S7 EduTrainer® ET 200S
1	Valve terminal with Profibus-DP interface with 16-off input module
1	Connecting cable with 4 mm safety plug
1	Power supply cable – valve terminal
1	Double-acting cylinder
2	Proximity sensor, inductive-magnetic
2	Sensor cable
2	Profibus cable
1	Programming cable with PC adapter
1	Distributor block
1	Set of cables
	Plastic tubing

Worksheet 2.1: Designing the electrical and pneumatic circuit	
Name:	Date:

Connect the valve terminal to the 16-off input module.
Establish the electrical and pneumatic connections for the automatic door.

Pneumatic circuit diagram



Connection diagram See fold-out

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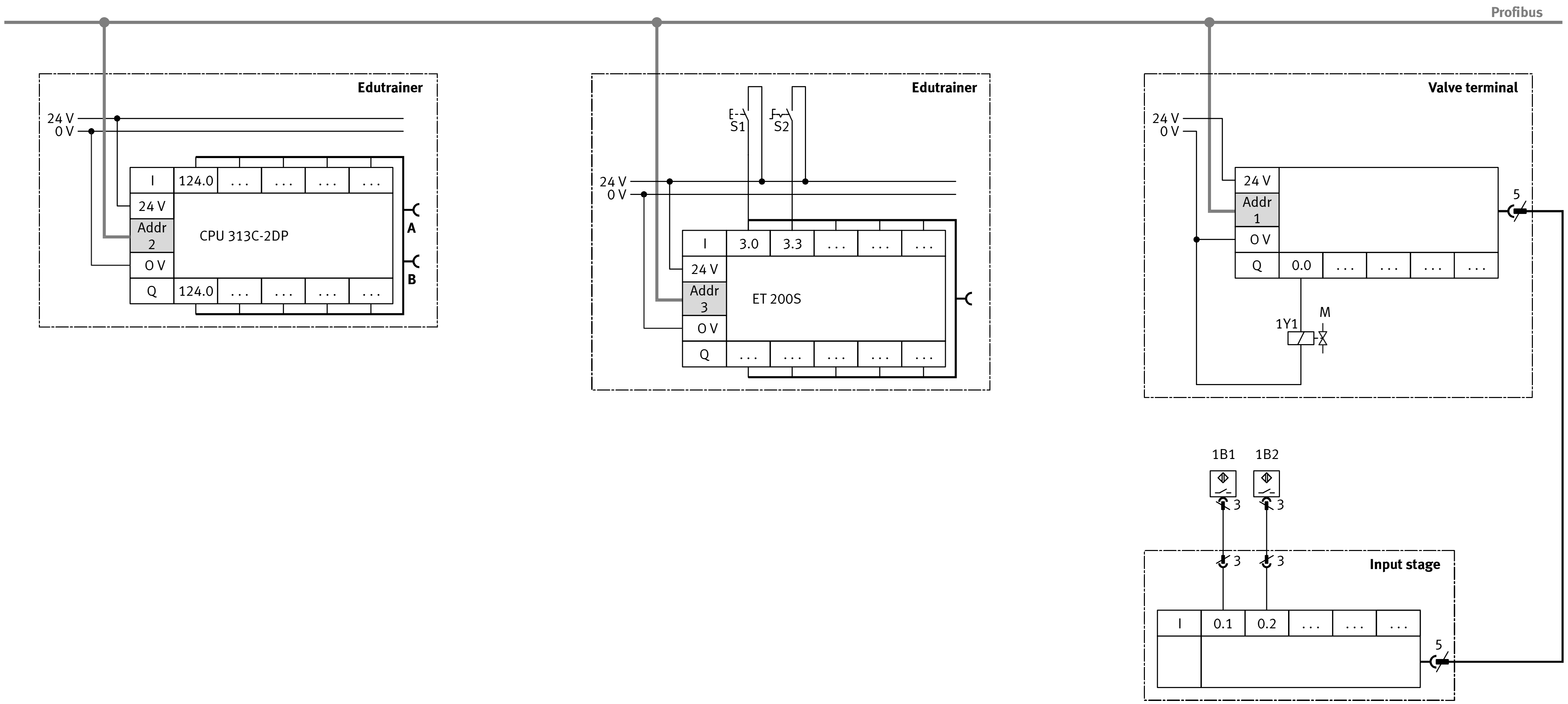

Profibus
Edutrainer
24 V
0 V
I
124.0
24 V
Addr
2
CPU 313C-2DP
0 V
Q
124.0
A
B
Edutrainer
S1
S2
24 V
0 V
I
3.0
3.3
24 V
Addr
3
ET 200S
0 V
Q
Valve terminal
24 V
0 V
24 V
Addr
1
0 V
Q
0.0
5
1Y1
M
1B1
1B2
3
Input stage
I
0.1
0.2
5

Worksheet 2.2: Setting up the electrical and pneumatic circuits	
Name:	Date:

Set the DIL switches on the valve terminal (see also valve terminal documentation):

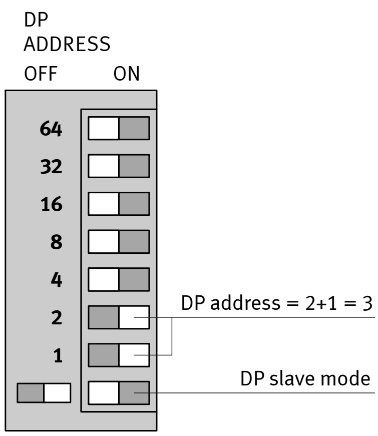
4-off DIL switch	1	off	Profibus-DP protocol
	2	off	
	3	on	Expansion by CP input module
	4	off	No additional output module
8-off DIL switch	1	on	Profibus address is 1
	2	off	
	3	off	
	4	off	
	5	off	
	6	off	
	7	off	
	8	off	Diagnostic function is switched off

Establish the power and compressed air supply of the valve terminal.

Worksheet 3: Setting up the electrical circuit on the S7 EduTrainer® ET 200S	
Name:	Date:

Establish the power supply of the S7 EduTrainer® ET 200S.
The electrical connections between the inputs of the ET 200S and the start pushbutton S1 as well as the selector switch S2 for the door release are already wired up internally in the EduTrainer®.
Set the DIP switches on the ET 200S (see also ET 200S documentation):

- Use switches 1 – 7 to set the Profibus address (here address 3).
- Via switch 8, the ET 200S can be switched between stand-alone mode and DP slave mode (ON: Stand-alone mode, OFF: DP-Slave mode).



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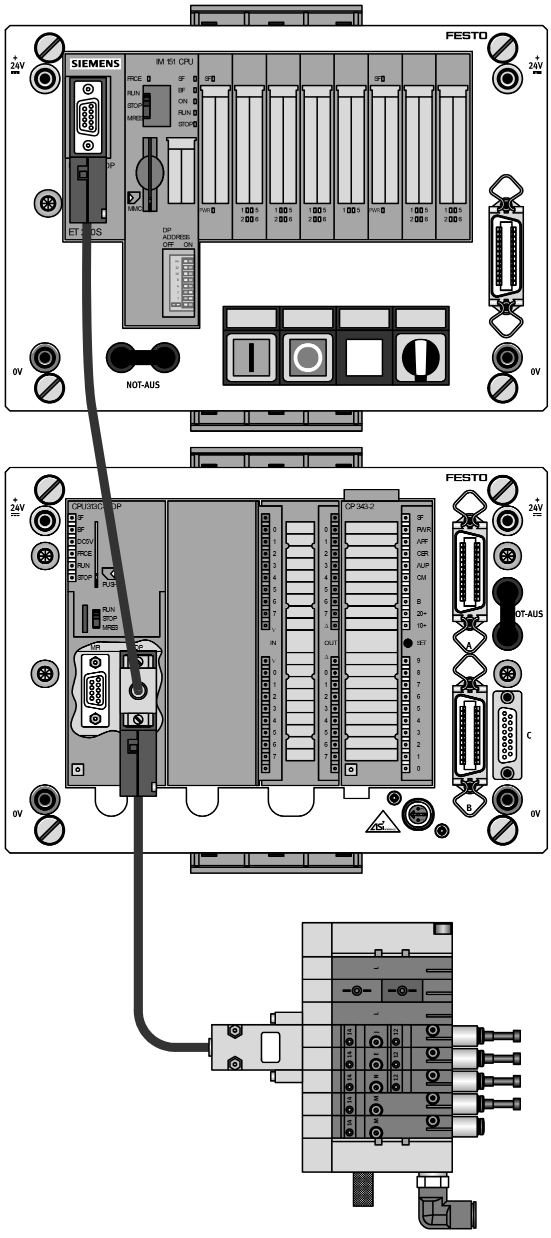
Worksheet 4: Establishing the Profibus-DP connection	
Name:	Date:

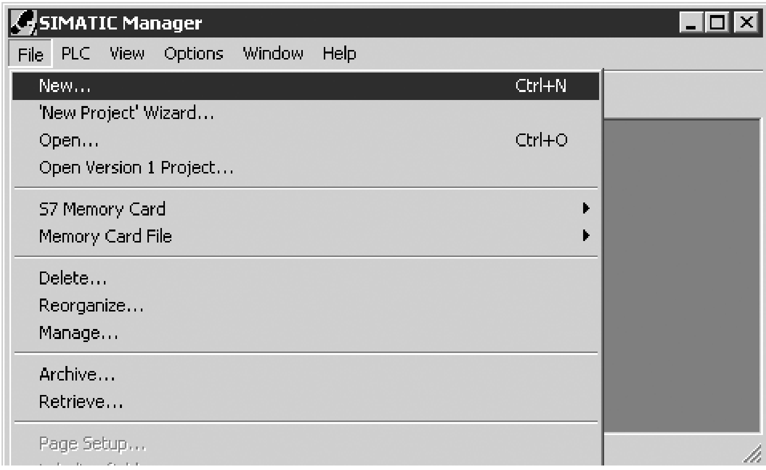
Establish the connection between the CPU 313C-2DP controller, the valve terminal and the ET 200S.

Schematic drawing of the Profibus connection

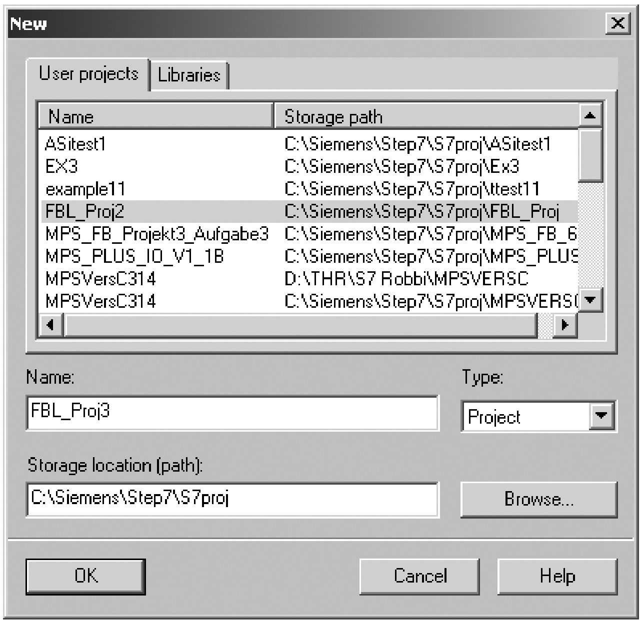


Worksheet 5.1: CPU 313C-2DP hardware configuration	
Name:	Date:

Create the CPU 313C-2DP hardware configuration in STEP7.



Create a new project (→ File → New).



Name the project „FBL_Proj3“.

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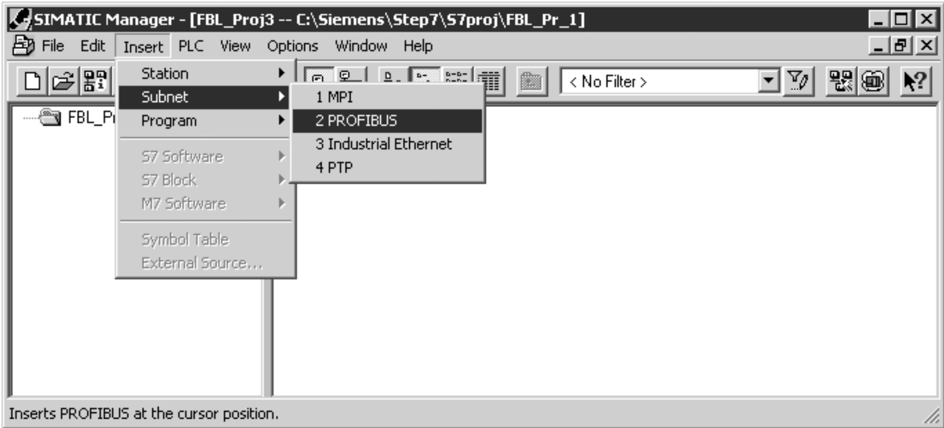
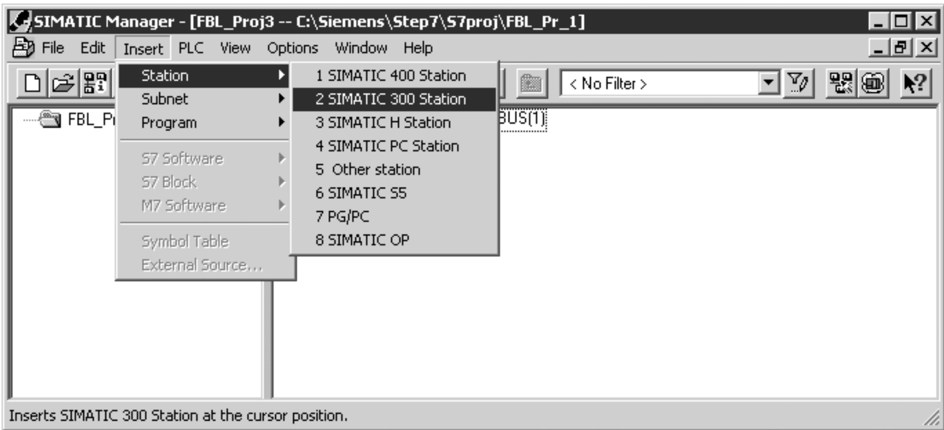
Worksheet 5.2: CPU 313C-2DP hardware configuration	
Name:	Date

Highlight the project and insert a Profibus subnetwork (→ Insert → Subnetwork → Profibus).

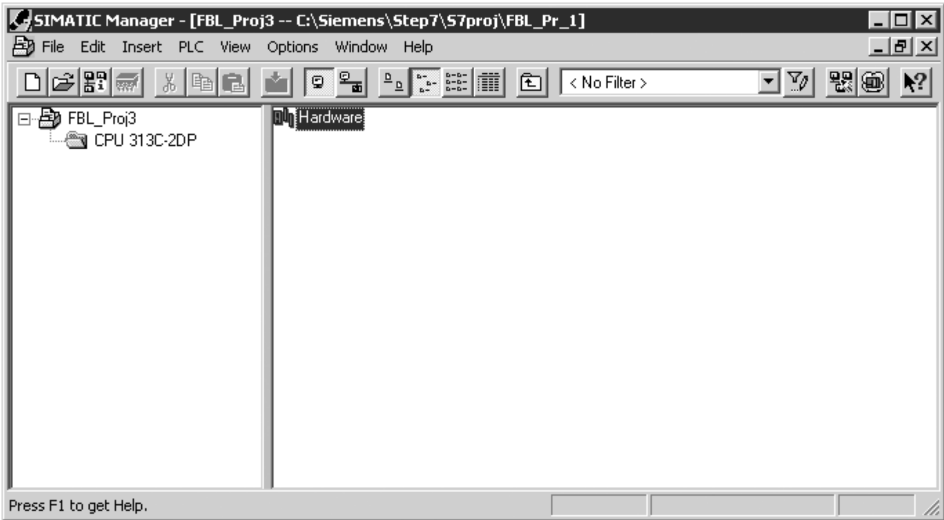


Now insert a SIMATIC 300 station (→ Insert → Station → SIMATIC 300 station).



Worksheet 5.3: CPU 313C-2DP hardware configuration	
Name:	Date:

Change the name of the station in „CPU 313C-2DP".
Open the configuration tool for the hardware via a double click.



Open the hardware catalogue by clicking onto the symbol
Here, all the modules for your project are available in various directories.

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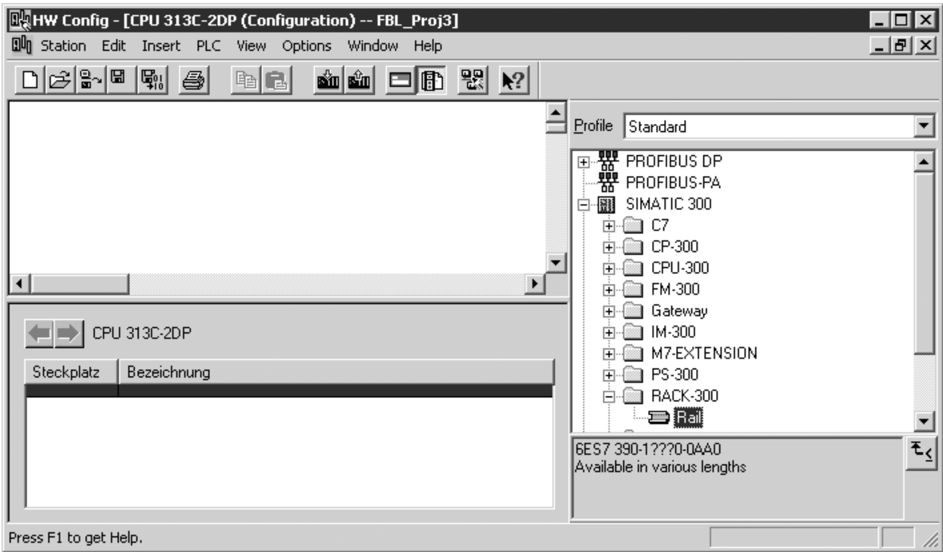
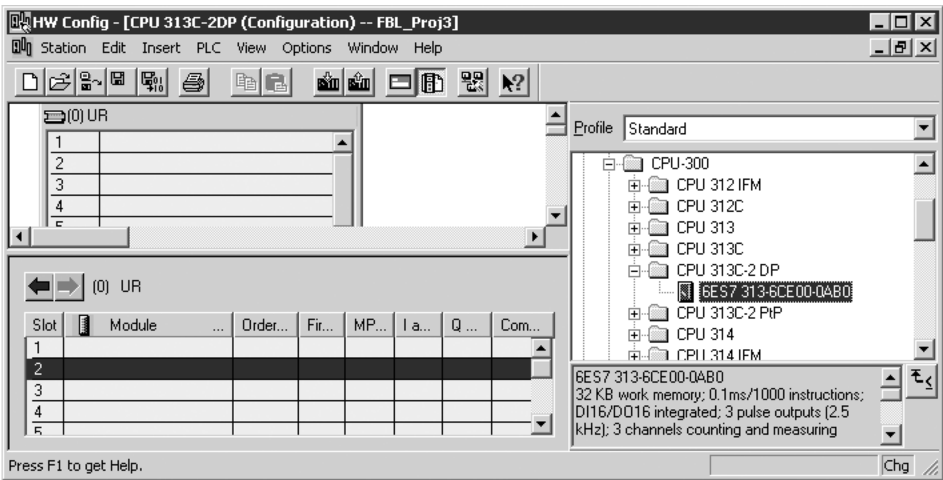
Worksheet 5.4: CPU 313C-2DP hardware configuration	
Name:	Date:

First of all, insert a profile rail (SIMATIC 300 → RACK-300 → Profile rail).

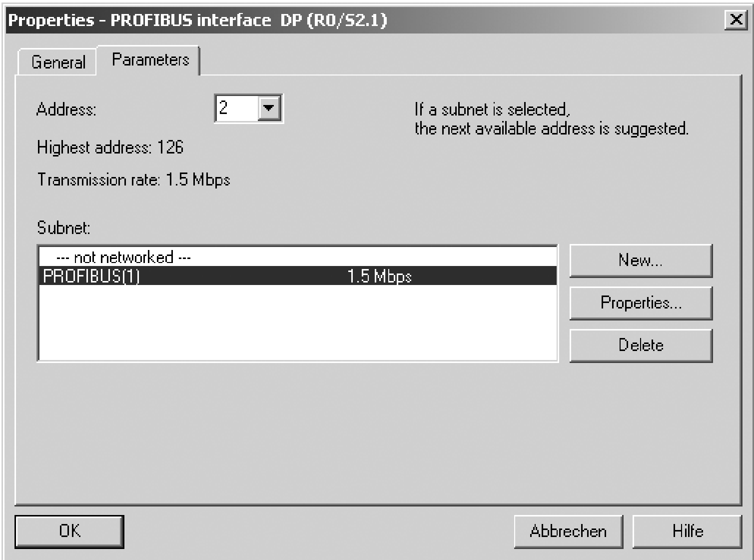


Now insert the CPU 313C-2DP in slot 2 of the profile rail (SIMATIC 300 → CPU 313C-2DP → 6ES7 313-6CE00-0AB0). Compare the order number shown (6ES7 313-6CE00-0AB0) with that shown on the device.



Worksheet 5.5: CPU 313C-2DP hardware configuration	
Name:	Date:

When inserting the CPU, the following window is displayed, where you can assign a Profibus address to the CPU 313C-2DP (→ 2 → OK).



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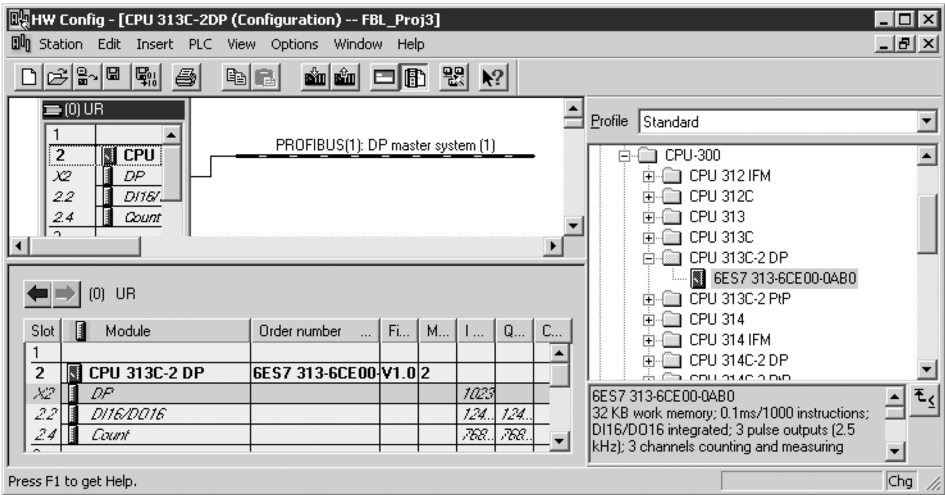
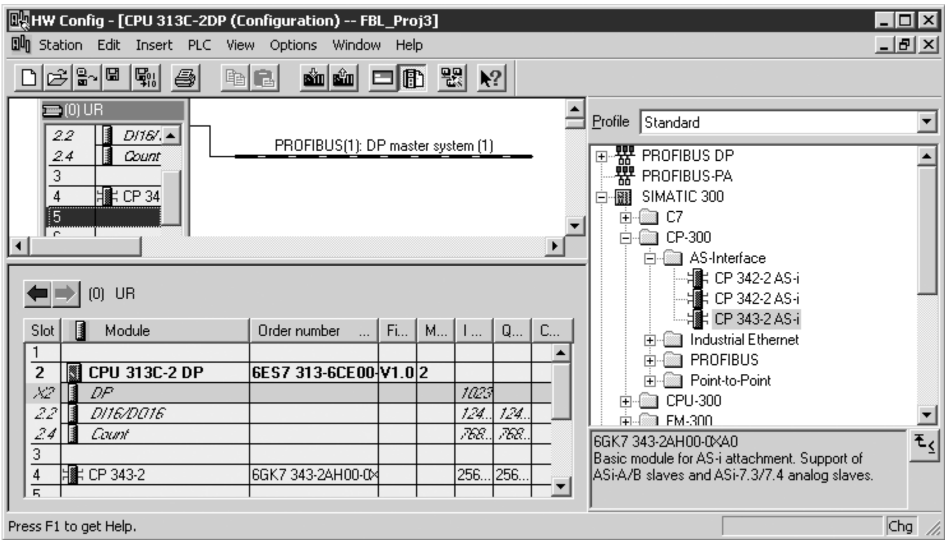
Worksheet 5.6: CPU 313C-2DP hardware configuration	
Name:	Date:

All the modules pertaining to the CPU 313C-2DP are already listed in the configuration table (Profibus-DP module, I/O module, counter module). You can read the already defined addresses for the local inputs and outputs in the line for the I/O module (DI16/DO16): I124 – I125, Q124 – Q125).



Worksheet 5.7: CPU 313C-2DP hardware configuration	
Name:	Date:

Depending on which S7 EduTrainer® variant is used, additional modules need to be inserted into configuration. For instance, if this also comprises the AS-Interface-module
CP 343-2, then this must be inserted into the configuration even if it is not used in the project.
Insert this in slot 4n (SIMATIC 300 → CP-300 → AS-Interface → CP 343-2 AS-i).
Observe the order number shown in the lower window; this must coincide with that of the actual module.



The hardware configuration of the CPU is now complete.
Save the configuration (Station → Save and compile).
Close the hardware configuration (Station → Exit).

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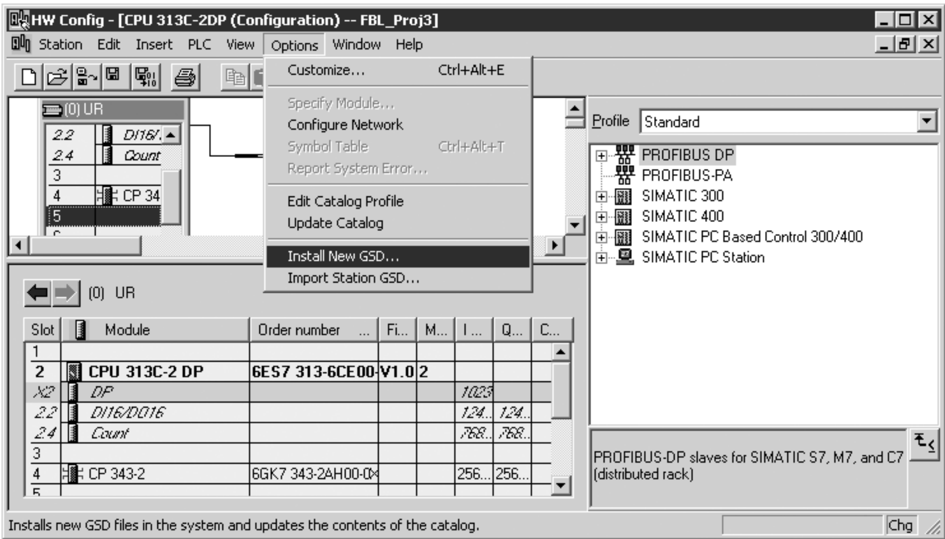
Worksheet 6.1: Inserting the valve terminal in the hardware configuration	
Name:	Date:

Open the hardware configuration of the CPU 313C-2DP by double clicking onto „Hardware".
Before you can insert the valve terminal into the hardware configuration, you will need to import the appropriate device data for the valve terminal into the hardware catalogue. You will find the files on the CD enclosed with the valve terminal.
Insert the CD in the CD-Rom drive and start the function „Install New Device Master Data" (Extras → New GSD).

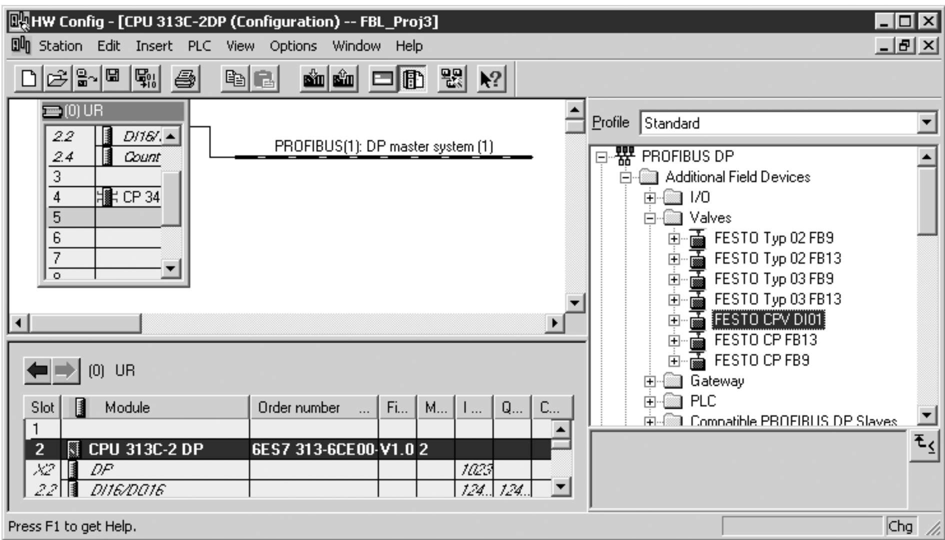


Worksheet 6.2: Inserting the valve terminal in the hardware configuration	
Name:	Date:

Navigate into the appropriate directory (CD-ROM drive → Profibus → GSD → D) in the window „Install New GSD“ and highlight all files.
Confirm with „Open“.

The device data for the valve terminal is now in the hardware catalogue.

Now highlight the Profibus line in the network configuration (upper window) and insert the valve terminal from the hardware catalogue (Profibus-DP → Additional Field Devices → Valves → Festo CPV DI01).



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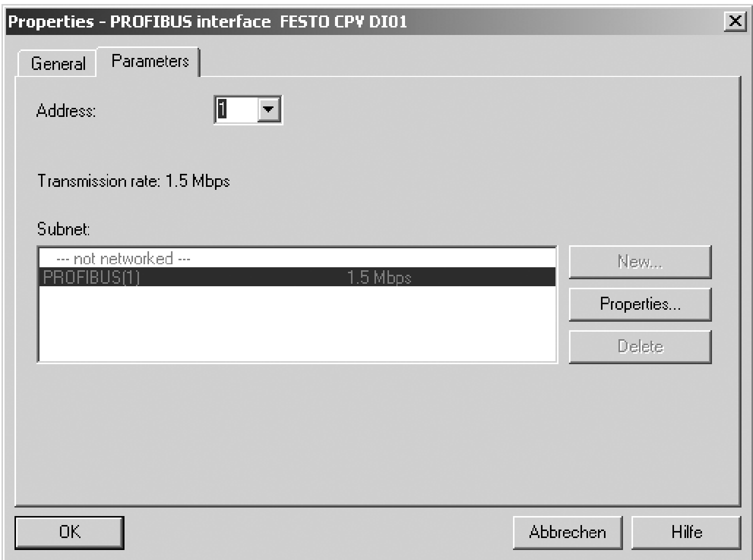
Worksheet 6.3: Inserting the valve terminal in the hardware configuration	
Name:	Date:

The Profibus address 1 and the subnetwork Profibus (1) are already entered in the window „Properties – Profibus Interface Festo CPV DI01.
Confirm this with OK.
Make a note of the address on your worksheet.

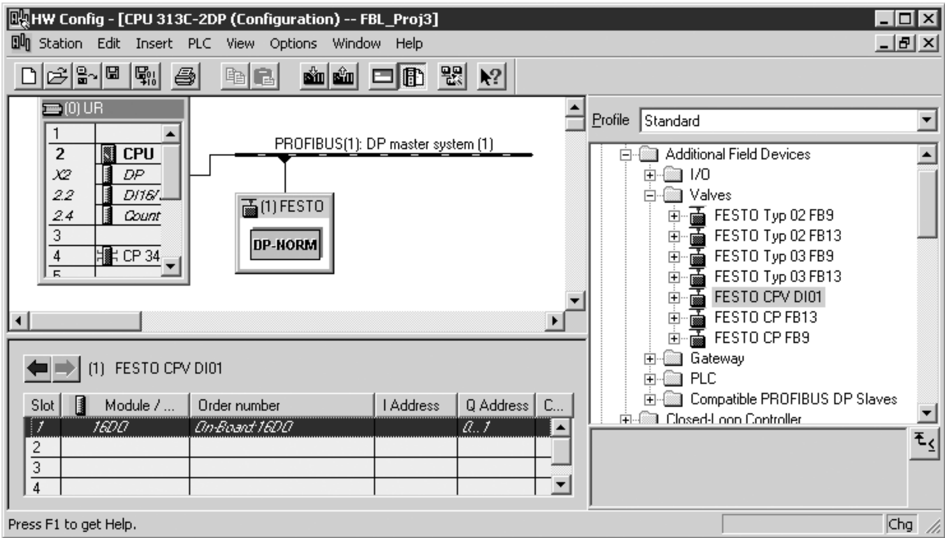
The address entered here must coincide with the address set on the valve terminal via the DIL switches.



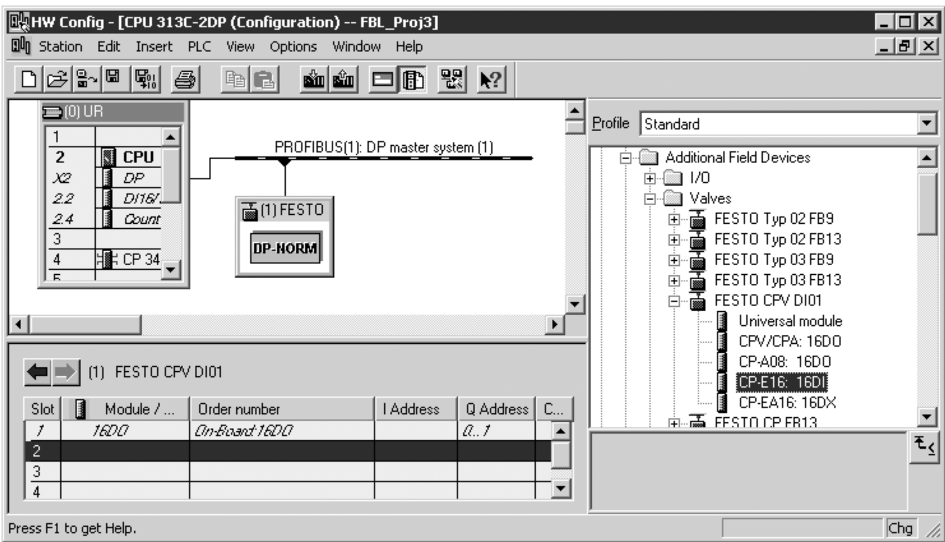
The valve terminal now appears in the network configuration on the Profibus line.

Worksheet 6.4: Inserting the valve terminal in the hardware configuration	
Name:	Date:

The output module 16DO is already entered in the hardware configuration of the Festo CPV DI01 valve terminal. Make a note of the output addresses on your worksheet (0 .. 1).



Now insert the input module from the hardware catalogue in slot 2 (Profibus-DP → Additional Field Devices → Valves → Festo CPV DI01 → CP-E16: 16DI).



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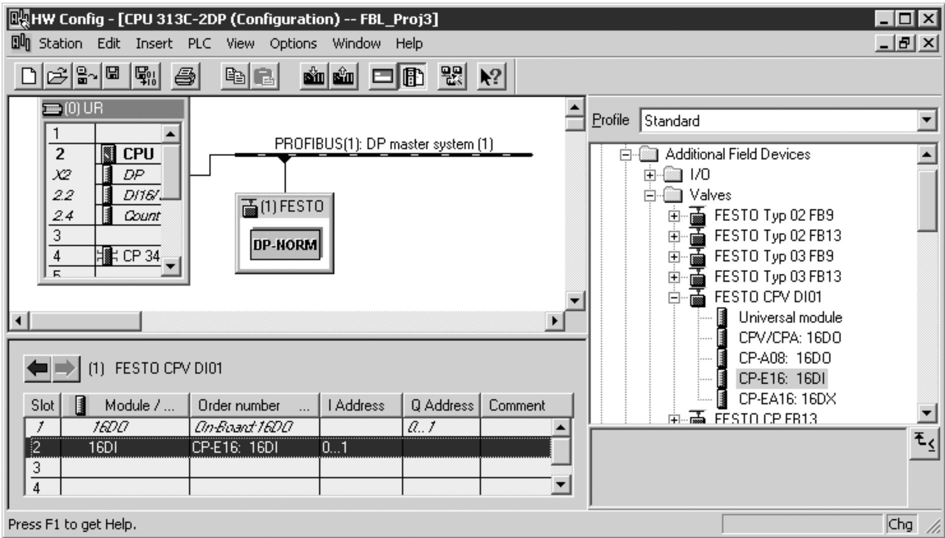
Worksheet 6.5: Inserting the valve terminal in the hardware configuration	
Name:	Date:

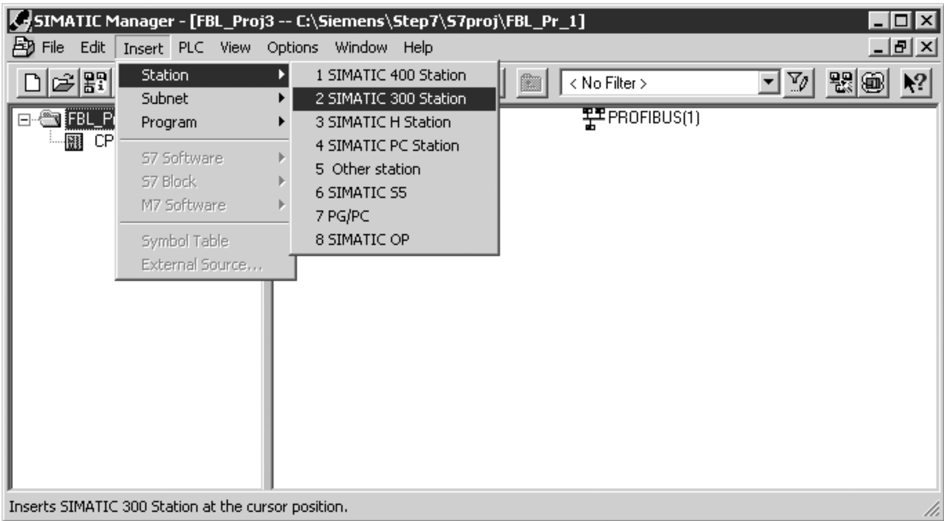
The input module is displayed in slot 2 of the valve terminal. Make a note of the input addresses (0 .. 1) on your worksheet 4.



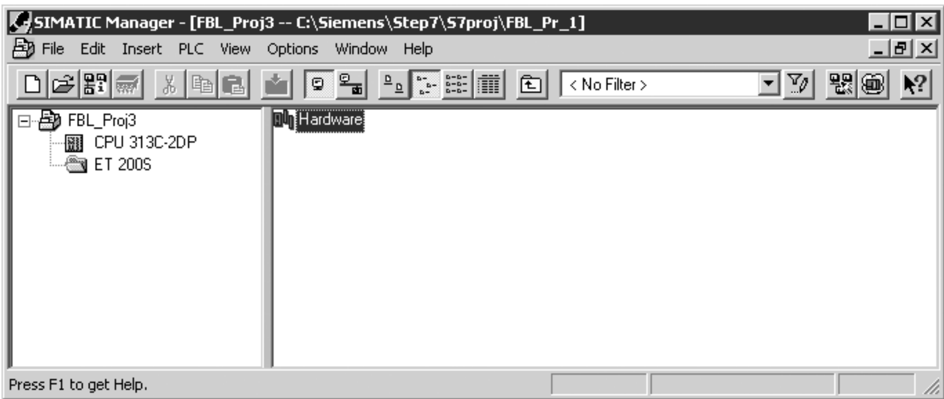
Save the hardware configuration (Station → Save and Compile).

Worksheet 7.1: ET 200S hardware configuration	
Name:	Date:

Insert a new SIMATIC 300 station (→ Insert → Station → SIMATIC 300 station).



Rename the station in „ET 200S".
Open the configuration tool for the hardware via a double click.



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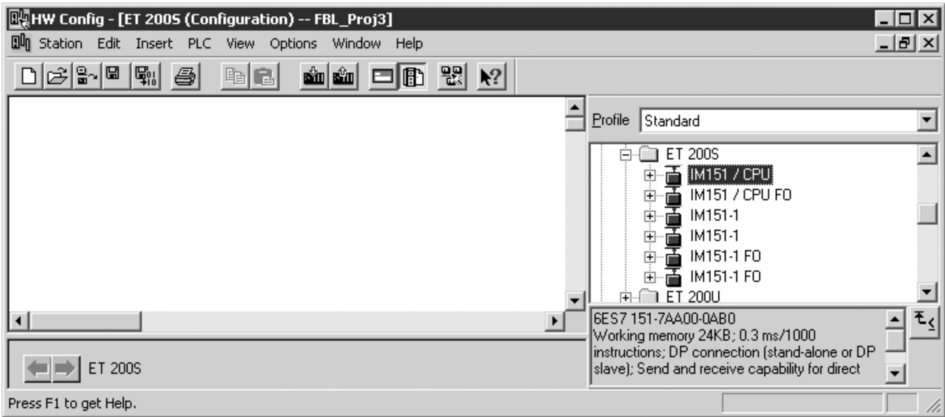
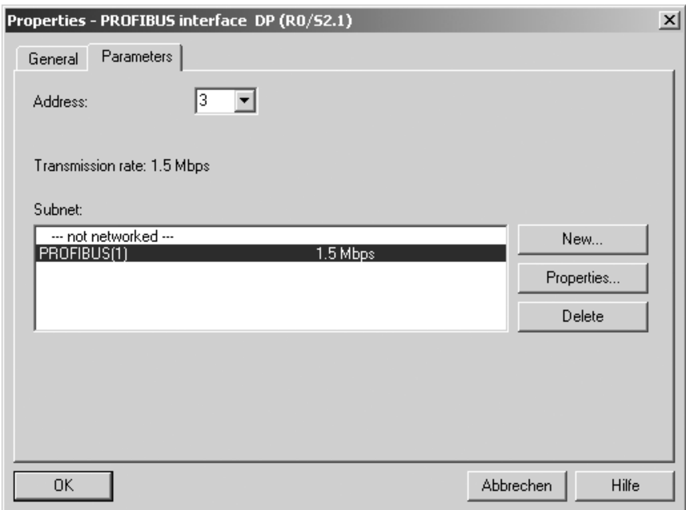
Worksheet 7.2: ET 200S hardware configuration	
Name:	Date:

Insert the ET 200S from the hardware catalogue (Profibus-DP → ET 200S → IM 151/ CPU). Make sure that the order number is correct (6ES7 151 – 7AA00 – 0AB0).



Enter the address 3 in the window „Properties – Profibus Interface DP" and highlight the subnetwork Profibus (1).

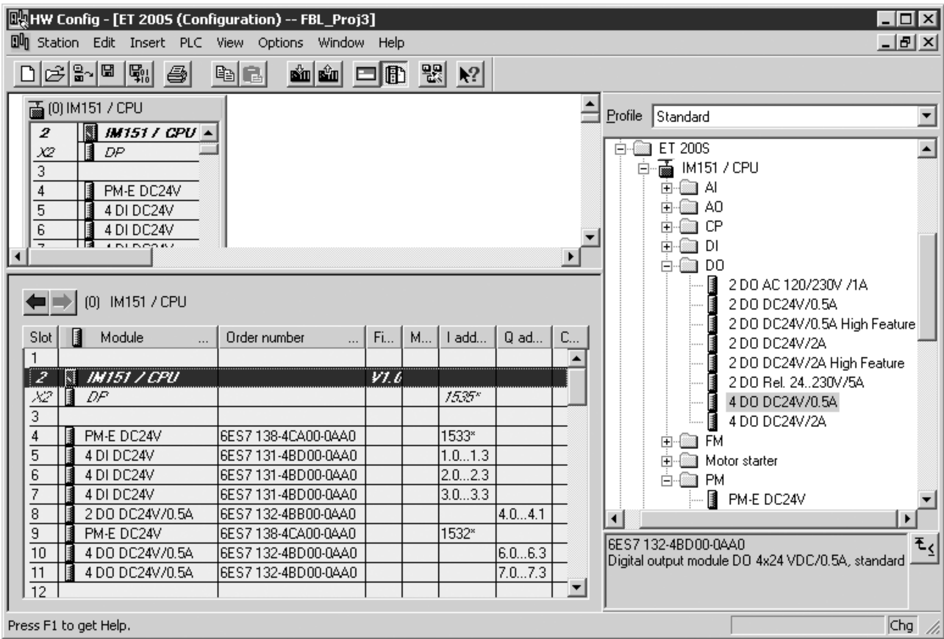


Confirm this via OK. The ET 200S is inserted into the hardware configuration.

Worksheet 7.3: ET 200S hardware configuration	
Name:	Date:

Now sequentially insert all I/O modules according to the available hardware configuration in the following slots starting from slot 4.

You will find the modules listed in the hardware catalogue (Profibus-DP → ET 200S → IM 151). Search for the appropriate module and compare the order number indicated with that printed on the device. The module is inserted in the highlighted slot.



In the hardware configuration you can also read the input and output addressed automatically assigned by STEP7. Make a note of these addresses on your worksheet 4.

Note

In this configuration the address for the start button (green pushbutton) is I 3.0 and the address for the door release (rotary switch) is I 3.3.

Save the ET 200S hardware configuration of the ET 200S (Station → Save and compile).

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Worksheet 8: Addresses of the Profibus stations and inputs and outputs	
Name:	Date:

On this worksheet you can make a note of the addresses for the Profibus stations and the various address areas for the inputs and outputs you are defining in the course of the hardware configuration. His provides you with and overview.

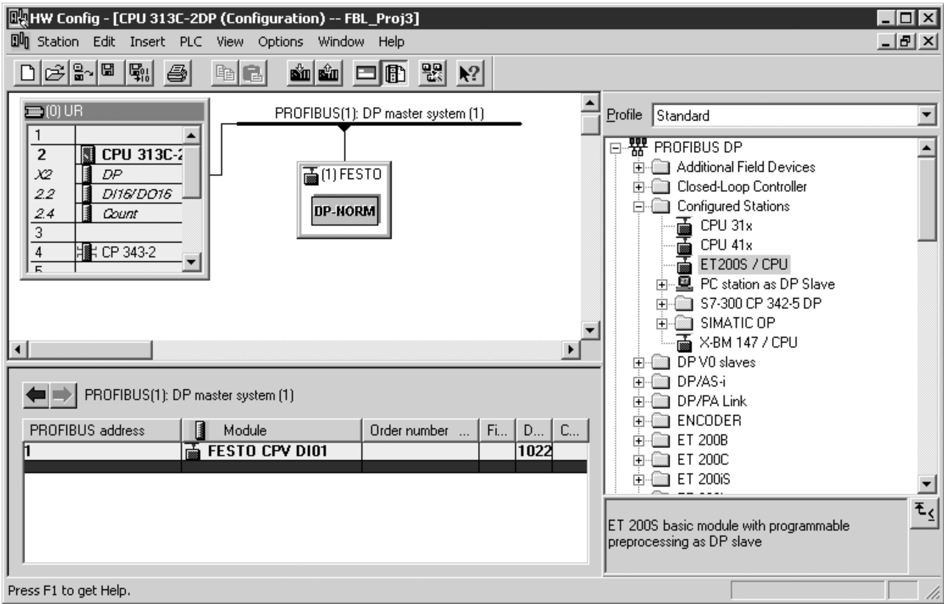
Remember that particularly in the case of the Profibus addresses the address assigned in STEP 7 must coincide with that set on the hardware (via the DIP or DIL switches).

Device addresses		
CPU 313C-2DP	Profibus address	
	Address area – local inputs	
	Address area – local outputs	
CPV DI01	Profibus address	
	Address area – inputs	
	Address area – outputs	
ET 200S	Profibus address	
	Address area - inputs	
	Address area outputs	

Worksheet 9.1: Configuration of the network	
Name:	Date:

Open the CPU 313C-2DP hardware configuration by highlighting the CPU 313C-2DP in the SIMATIC Manager and double clicking onto hardware.

Highlight the Profibus line in the hardware configuration and then insert the ET 200S from the hardware catalogue (Profibus-DP → Configured Stations → ET 200S/CPU).



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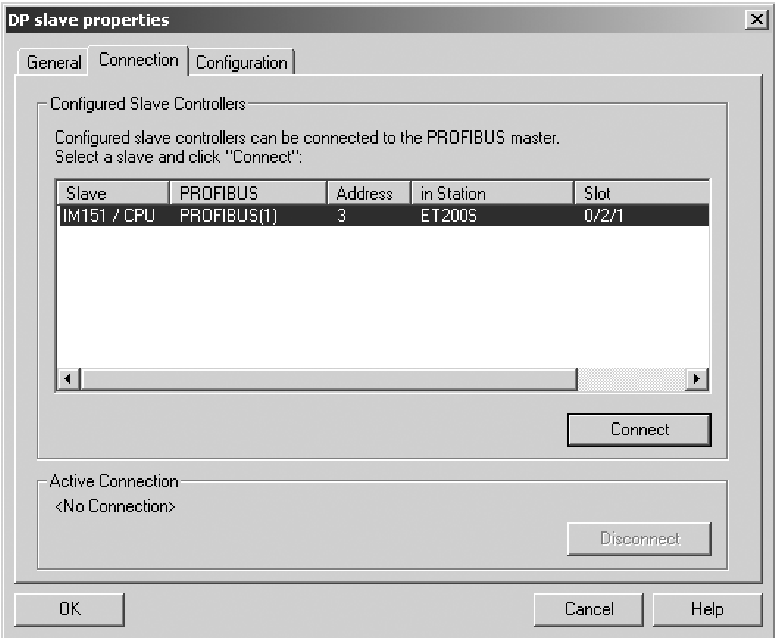
Worksheet 9.2: Configuration of the network	
Name:	Date:

In the window “DP Slave Properties”, click onto the “Connect” button in the index “Connection”. The ET 200S is now integrated into the Profibus network as a DP Slave.



Worksheet 9.3: Configuration of the network	
Name:	Date:

In the index „Configuration“ you now still need to configure the Profibus transmission channels (see manual for ET 200S).
In the Profibus transmission channel, the peripherals input word PIW 128 is to be mapped to the PQW 12 in the CPU 313C-2DP master and vice versa the PQW 128 of the ET 200S to the PIW 12 of the CPU 313C-2DP. To do so, enter the following values in line 1:

Mode		MS	(Master/slave system)
Local: ET 200S	I/O	I	
	Address	128	(Peripherals input word 128 in the ET 200S)
Profibus-DP Partner	Profibus Address	2	(The address of the master is automatically entered)
	I/O	O	
	Address	12	(Peripheral output word 12 in the CPU 313)
	Length	16	
	Unit	Word	
	Consistency	Unit	

Enter the following values in line 2:

Mode		MS	(Master/slave system)
Local: ET 200S	I/O	O	
	Address	128	(Peripherals output word 128 in the ET 200S)
Profibus-DP Partner	Profibus address	2	(The address of the master is automatically entered)
	I/O	I	
	Address	12	(Peripheral output word 12 in the CPU 313)
	Length	16	
	Unit	Word	
	Consistency	Unit	

Confirm the configuration with OK.

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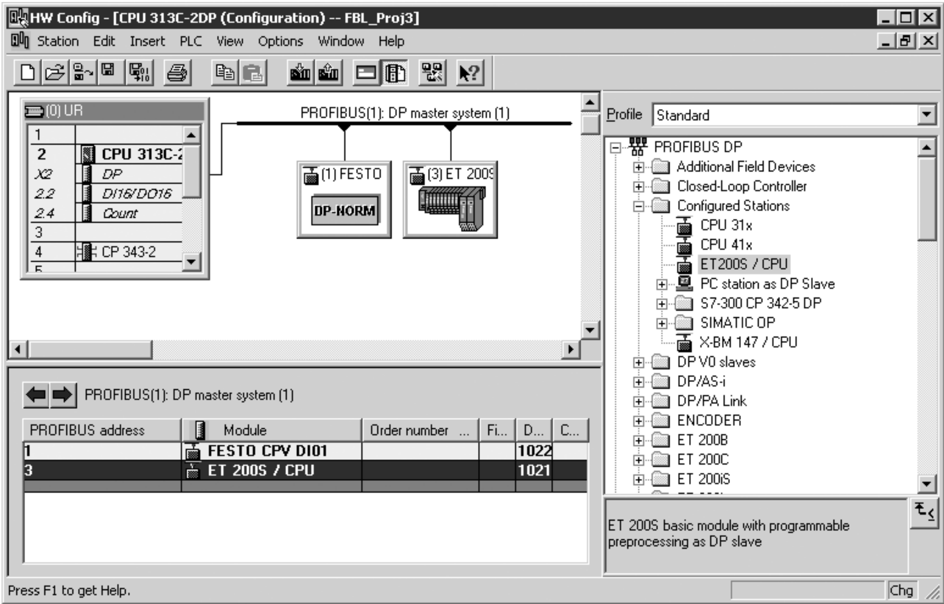
Worksheet 9.4: Configuration of the network	
Name:	Date:

The Profibus Slave ET 200S is now integrated into the Profibus-DP System.



Save the hardware configuration (Station → Save and Compile).

Worksheet 10.1: Creating the symbols table and the user program in the ET 200S	
Name:	Date:

The signal logic of the start signal for the handling system (represented by the start button) and the door release is to be realised in the Profibus slave ET 200S. The resulting logic operation is to be made available to the Profibus master CPU 313.

Now create the symbols table and the PLC program for the ET 200S.

To do so, highlight ET 200S → IM 151/CPU → S7 Program in the SIMATIC Manager and double click „Symbols“.

You will require the following operands for the signal logic:

S1	I 3.0	Start button
S2	I 3.3	Door release
M 13.0	M 13.0	Flag bit for communication via Profibus

The following additional operands are required for Profibus communication:

MB 13	MB 13	Flag byte for communication via Profibus
PSB 128	PQB 128	Start byte of Profibus transmission channel (peripheral output byte 128)

Enter all the operands in the symbols table and save the symbols table.

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Worksheet 10.2: Creating the symbols table and user program in the ET 200S	
Name:	Date:

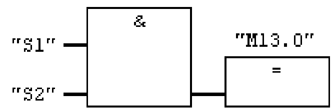
Create the user program for the ET 200S.

The first step is to program the OB1 (ET 200S → IM 151/CPU → S7-Programs → Modules and double click OB1).

Network 1 contains the signal logic of the start button and door release. The result is stored in the flag bit 13.0.

Network 1 : Lokales Programm ET200 / local program ET200

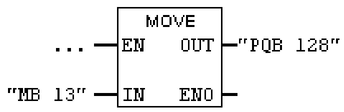
Starttaster und Türfreischaltung / Start-button and door release



In network 2, the logic result is to be copied to the Profibus transmission channel so that the Profibus master can access this. The MOVE module is used for this. The entire flag byte 13 is to be transferred to the Profibus transmission channel.

Network 2 : Kopieren in Profibus-Übertragungskanal / Copy to PROFIBUS-trans.

Das Merkerbyte "MB 13" wird in den PROFIBUS-DP-Übertragungskanal kopiert. / The flag byte "MB 13" is copied to the PROFIBUS-DP-transmission-channel.



Worksheet 10.3: Creating the symbols table and user program in the ET 200S	
Name:	Date:

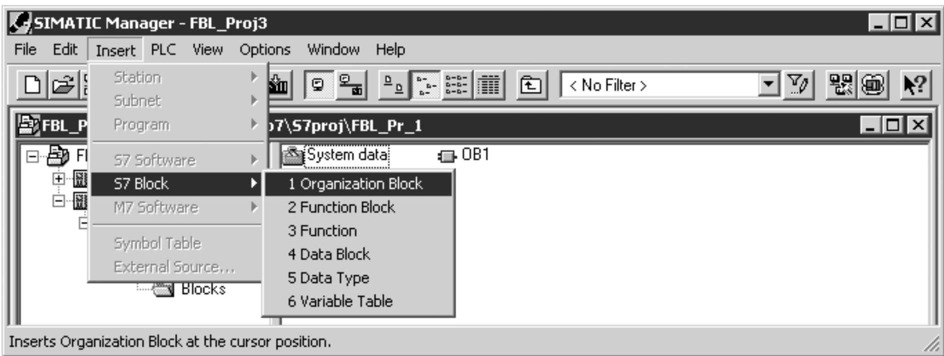
This results in the following communication path for the signal:

ET 200S			CPU 313C-2DP	
S1 & S2 →	M13.0			
	MB 13 →	PQB 128		
		PQW 128 →	PQW 12	
			PIB 12 →	MB 12
				M12.0

The OB1 for the ET 200S is now complete. Save and close the OB1.

In the next step, you will still need to create the modules OB82 and OB86 for the Profibus communication.

To do so, highlight ET 200S → S7-Program → Modules in the SIMATIC Manager. Then insert a new organisational block (Insert → S7-Module → Organisational block).



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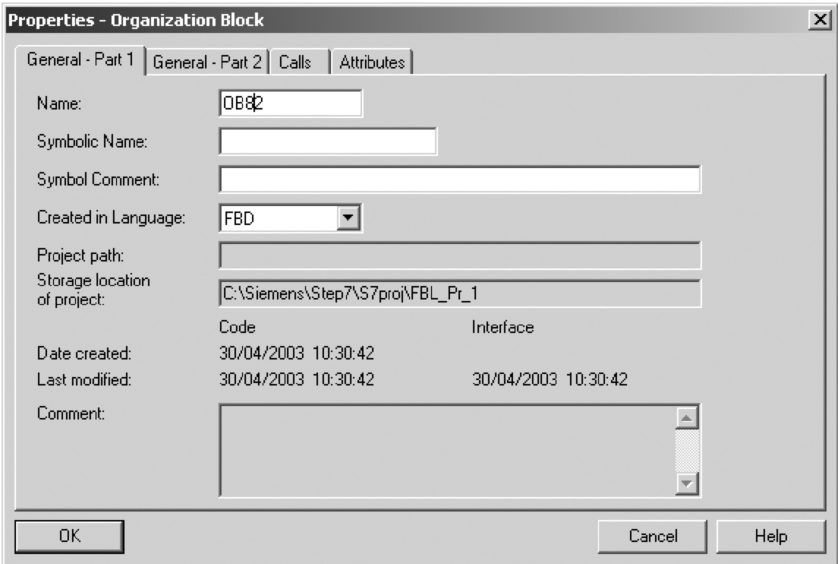
Worksheet 10.4: Creating the symbols table and user program in the ET 200S	
Name:	Date:

Enter the name “OB82” in the window „Properties – Organisational block“ and confirm with OK.



Now also insert the OB86.
With this you have created the entire user program for the ET 200S.

Worksheet 11.1: Adaptation of the symbols table and user program in the CPU 313C-2DP	
Name:	Date:

You can use the existing user program as well as the symbols table from Project 2 for the control of the pneumatically operated door in Profibus master CPU 313. However, a few changes are still required in order to realise the Profibus communication with the ET 200S.

First of all, copy the existing user program (OB1, OB82 and OB86), and the symbols table to your project under CPU 313C-2DP → CPU 313C-2DP → S7-Program.

Now begin with the adaptation of the symbols table (CPU 313C-2DP → CPU 313C-2DP → S7-Program and double click Symbols).

The following operands need to be added:

M 12.0	M 12.0	Logic operation of start button and door release
MB 12	MB 12	Flag byte for communication via Profibus
PIB 12	PIB 12	Start byte of Profibus transmission channel (peripheral input byte 12)

In the next step, you need to adapt the OB1 of the CPU 313 (CPU 313C-2DP → CPU 313C-2DP → S7-Program → Modules and double click OB1).

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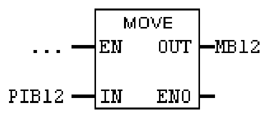
Worksheet 11.2: Adaptation of the symbols table and user program in the CPU 313C-2DP	
Name:	Date:

In network 1 of the OB1 the signals from the Profibus transmission channel need to be evaluated. To do so, insert a new network before the first network of the existing program. Place the cursor on the first line of the program and click onto Insert → Network. A new Network 1 is then displayed before the already existing networks.

The signals from the Profibus transmission channel (peripherals input byte 12) are read in this network and saved in the flag byte MB 12. The MOVE module is used for this.

Network 1 : PROFIBUS-Übertragungskanal / PROFIBUS-DP-transmission-channel

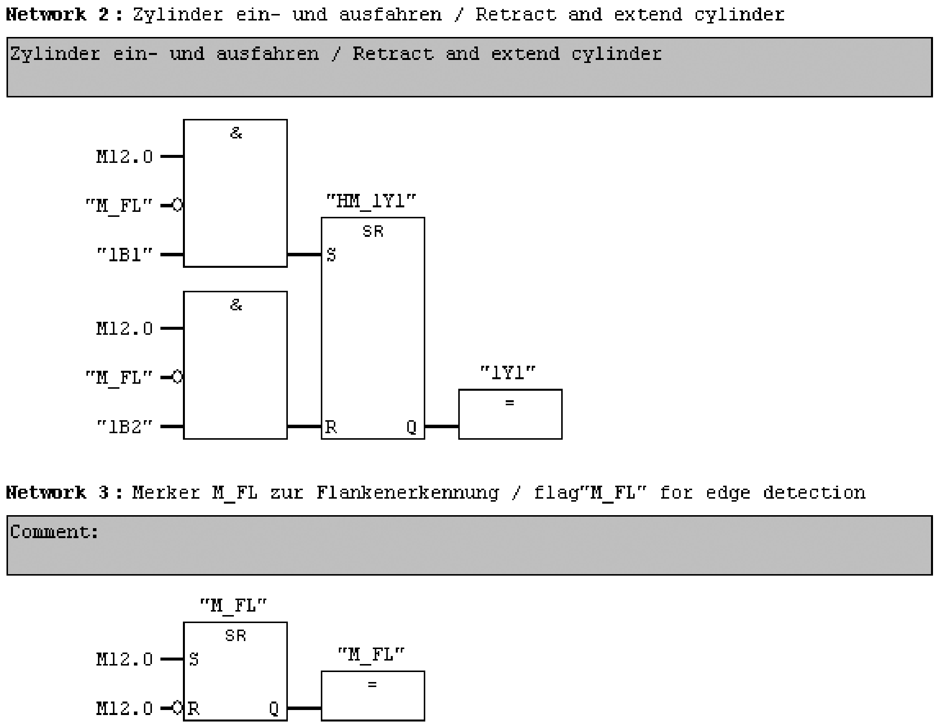
Hier werden die Daten aus dem PROFIBUS-Übertragungskanal ausgelesen und im Merkerbyte 12 abgelegt. / Read-out data from PROFIBUS-DP-transmission-channel and deposit in flag byte "MB 12".



The signal for the logic operation of the start button and door release of the ET 200S is now in the flag bit M 12.0.

Worksheet 11.3: Adaptation of the symbols table and user program in the CPU 313C-2DP	
Name:	Date:

Now the signal S1 from Project 2 still needs to be replaced by the logic signal M 12.0 in the other networks of the program s.



Now save and close the OB1.
You have now completed the adaptation of the symbols table and user program for the CPU 313C-2DP.

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Worksheet 12.1: Commissioning of the pneumatic door control	
Name:	Date:

Now commission the pneumatic door control.

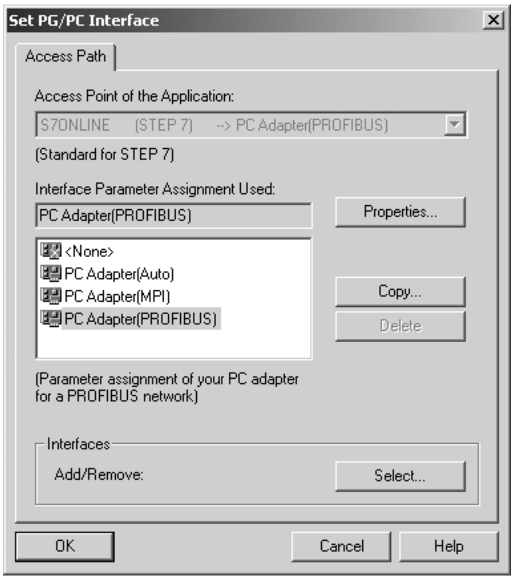
The following steps are required for this:
- Overall reset of ET 200S and CPU 313
- Downloading of programs and configuration in the ET 200S
- Downloading of programs and configuration in the CPU 313
- Starting the ET 200S
- Starting the CPU 313

Begin with the overall reset of the ET 200S.
- Isolate the ET 200S from the power supply. Make sure that the mode selector is set to STOP.
- Switch on the lowest DIP switch (switch for stand-alone mode on the ET 200S).
- Switch on the power supply for the ET 200. All LEDs will briefly light up, the BF and RUN LED are extinguished and the STOP-LED starts to flash slowly. The ET 200S thereby requests an overall reset.
- Now briefly press the mode selector of the ET 200S down to the MRES position. The STOP LED starts to flash quickly and finally goes to steady light. The overall reset is therefore complete. The SF-LED goes out.

Reset the CPU 313 as follows:
- Make sure that the mode selector is set to STOP.
- Switch on the power supply of the CPU 313.
- Turn the mode selector to the MRES position. Keep the mode selector in this position until the STOP LED is illuminated a second time and remains illuminated (corresponds to approx. 3 seconds).
- Within a further 3 seconds you need to turn the mode selector back to the MRES position. The STOP-LED starts to flash quickly and the CPU executes the overall reset. The CPU has completed the overall reset if the STOP LED changes to steady light.

Worksheet 12.2: Commissioning of the pneumatic door control	
Name:	Date:

Check that the Profibus connection between the CPU 313, ET 200S and valve terminal has been correctly installed.
Load the part project for the CPU 313C-2DP, including the system data via the MPI interface of the CPU to the controller.
Now also insert the plug of the programming cable into the bus connection plug of the Profibus cable on the ET 200S and connect the programming cable to the COM interface of your PCs.
Then set the programming interface in the SIMATIC Manager (set Extras → PG/PC interface).
Select the PC-Adapter interface (Profibus).



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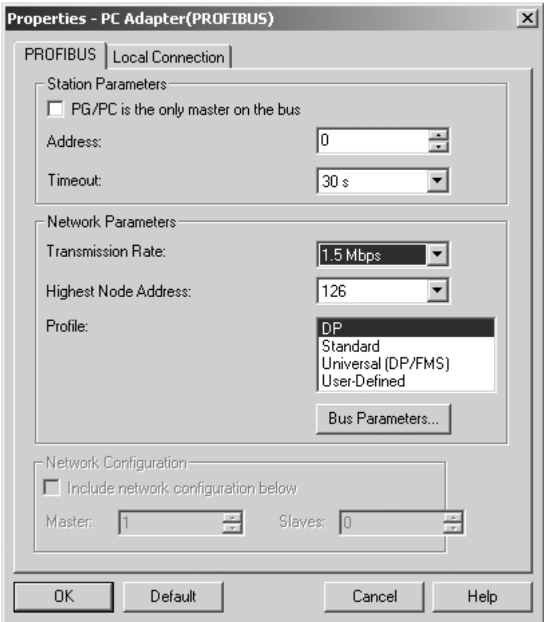
Worksheet 12.3: Commissioning of the pneumatic door control	
Name:	Date:

Now click onto properties and configure the interface in the Profibus index as follows:



Configure the interface as follows in the index Local Connection:

- COM-Port: The interface used by you (e.g. 1 for COM1)
- Transfer rate: 19200

Confirm the setting with OK and close the program Set PG/PC interface. You can now access all Profibus stations with this configuration.

Worksheet 12.4: Commissioning of the pneumatic door control	
Name:	Date:

Now load the programs and the configuration to the ET 200S (highlight ET 200S → IM 151/CPU → S7-Program → Modules in the lefthand window, then load Target System →).
Acknowledge all windows displayed with Yes.

Switch the lower DIP switch of the ET 200S from stand-alone mode to DP slave (to the left).

Please note that when loading the ET 200S, only the RAM memory is loaded with the program and not automatically also the memory on the plugged in micro memory card. The memory contents are therefore lost if the power supply is switched off. To avoid this, you should therefore transfer the RAM contents to the card (copy Target System → RAM to ROM).

Start the ET 200S by switching the mode selector to RUN. This causes the SF-LED (system fault) to be illuminated, since the ET 200S does not yet receive any feedback from the Profibus master.

Now start the CPU 313C-2DP by switching the mode selector to RUN. The SF-LED on the ET 200S goes off.

Check whether the air supply is switched on.
Your pneumatic door control is now commissioned.
Check the functioning of the system.

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Worksheet 13: Simulation of a fault during commissioning	
Name:	Date:

In practice, a frequently occurring fault during the commissioning of a Profibus-DP system is the incorrect addressing of the Profibus stations. Such a fault is to be simulated here.

- Change the station address on the ET 200S: Set the address 6 via the DIP switch.
- Describe what happens when you want to load the STEP 7 program for Project 3.
- In STEP7, activate the functions that indicate the station address on the station and in the configuration
- Eliminate the fault.

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Project 4: Profibus-DP system with stack magazine

Training aim

Trainees are to

- be able to apply the know-how and skills acquired for the configuration and commissioning of a Profibus-DP system to a similar control problem.

Implementation

The MPS® stack magazine module is to be controlled via the ET 200S. In the Profibus-DP system, the function of the CPU 313C-2DP as Profibus master is to poll the respective status of the stack magazine (full/empty) and to illuminate a lamp in the event of the „magazine empty“ signal. Trainees are expected to work relatively independently.

Project task

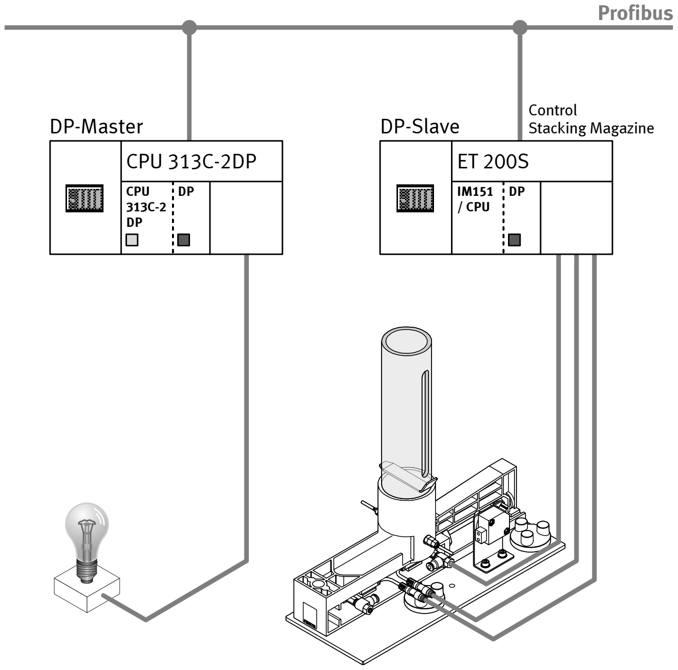
A stack magazine for the separating out of workpieces is to be automatically controlled by a controller (ET 200S). This is to output a signal to a remote control console via a Profibus line if the magazine is empty. The controller (CPU 313C-2DP) in the control console is to operate as the Profibus master. By illuminating a signal lamp, this indicates to the operator if the magazine is empty and needs to be refilled.

The process described is to be realised.

Stack magazine

Exercise sheet 1.1: Controlling a stack magazine	
Name:	Date:

Problem description



A stack magazine is to be automatically controlled via a controller (ET 200S). If the magazine is empty, a signal is to be transmitted to the Profibus master (CPU 313C-2DP) via the Profibus line. A signal lamp is to be illuminated on the Profibus Master if the signal “magazine empty” is received .

Work to be carried out

1. Configure the Profibus-DP system.
2. Create a Profibus-DP project in the control software.
3. Define the hardware configuration for the CPU 313C-2DP in the project.
4. Define the hardware configuration for the ET 200S in the project.
5. Configure the network.
6. Complete the control program and the symbols table for the ET 200S.
7. Create the control program and the symbols table for the CPU 313C-2DP.
8. Commission the system.

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Worksheet 1.2: Controlling a stack magazine	
Name:	Date:

Parameters

- The equipment set TP 201 is available.
- The control program for the ET 200S is available. All you need to do is to add the Profibus network.

Worksheets

1. Assembly of the components and stack magazine
2. Assembly of the electrical and pneumatic circuits
3. Setting the slave ET 200S
4. Establishing the Profibus-DP connection
5. CPU 313C-2DP hardware configuration
6. ET 200S hardware configuration
7. Configuration of the network
8. Addressing of the Profibus stations and inputs and outputs
9. Creating the symbols table and control program for the ET 200S
10. Creating the symbols table and control program for the CPU 313C-2DP
11. Commissioning of the stack magazine project

Working aids

- STEP 7 documentation
- ET 200S documentation
- Chapter 1: What is a fieldbus system?
- Chapter 4: The Profibus-DP

Worksheet 1: Assembly of the components and stack magazine	
Name:	Date:

Assemble the required components on the profile plate:

List of equipment

Quantity	Description
1	S7 EduTrainer® Compact 313C-2DP or S7 EduTrainer® plus with 313C-2DP
1	S7 EduTrainer® ET 200S
1	Profibus cable
1	MPS® stack magazine module
1	5/2-way solenoid valve
2	Universal terminal unit with Syslink cable
1	Signaling device and distributor, electrical
1	Distributor block
1	Sensor cable, 4-pin on 3-pin M8 plug/socket for sensor (stack magazine module)
1	Programming cable with PC adapter
1	Set of cables
2	Sensor cable for limit switch
	Plastic tubing

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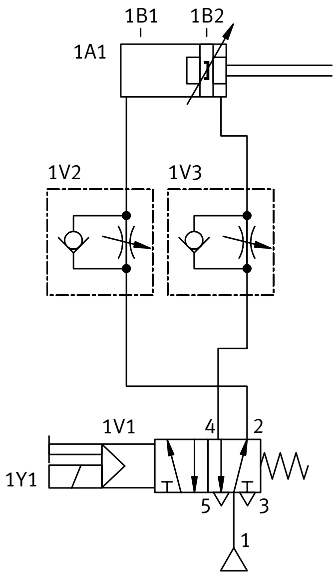
Worksheet 2: Assembly of the electrical and pneumatic circuits	
Name:	Date:

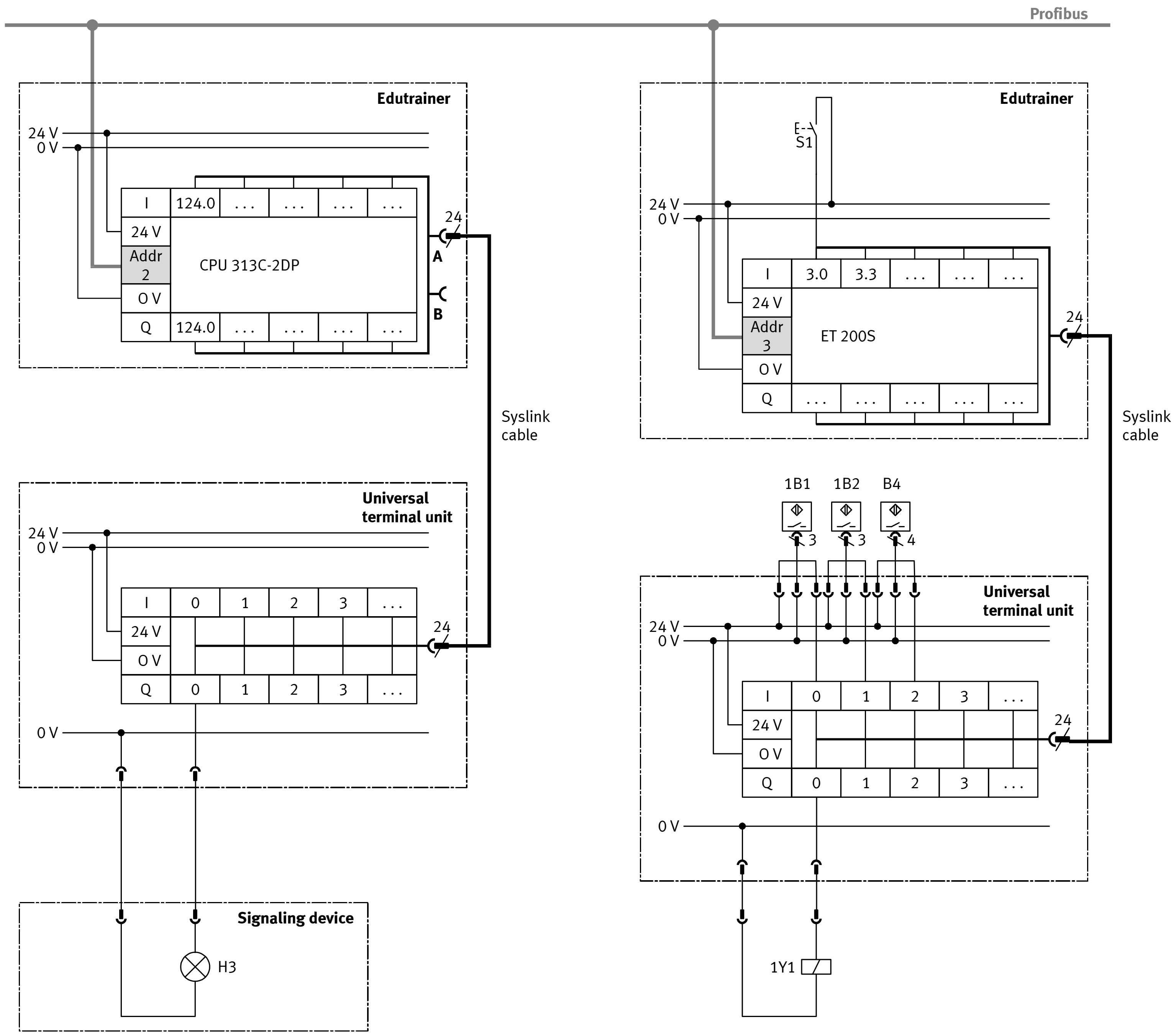
Establish the electrical and pneumatic connections for the stack magazine.
Establish the power supply to the ET 200S.

Pneumatic circuit diagram



Connection diagram

See fold-out

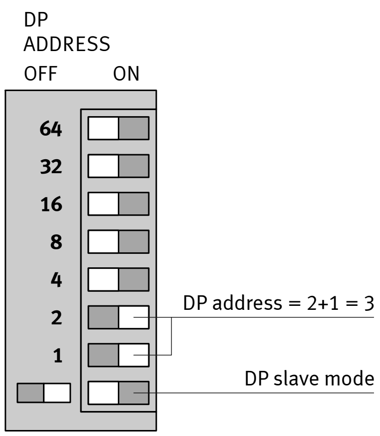


Profibus
Edutrainer
24 V
0 V
I
124.0
...
24 V
Addr 2
CPU 313C-2DP
0 V
Q
124.0
24
A
B
Syslink cable
Universal terminal unit
24 V
0 V
I
0
1
2
3
...
24 V
0 V
Q
0
1
2
3
...
24
0 V
Signaling device
H3
Edutrainer
S1
24 V
0 V
I
3.0
3.3
...
24 V
Addr 3
ET 200S
0 V
Q
...
24
Syslink cable
1B1
1B2
B4
3
3
4
Universal terminal unit
24 V
0 V
I
0
1
2
3
...
24 V
0 V
Q
0
1
2
3
...
24
0 V
1Y1

Worksheet 3: Setting the slave ET 200S	
Name:	Date:

Set the DIP switch on the ET 200S (see also documentation of the ET 200S):

- Set the Profibus address (in this case address 3), using switches 1 – 7.
- Via switch 8, the ET 200S can be switched between stand-alone and DP slave mode (ON: Stand-alone mode, OFF: DP slave mode).



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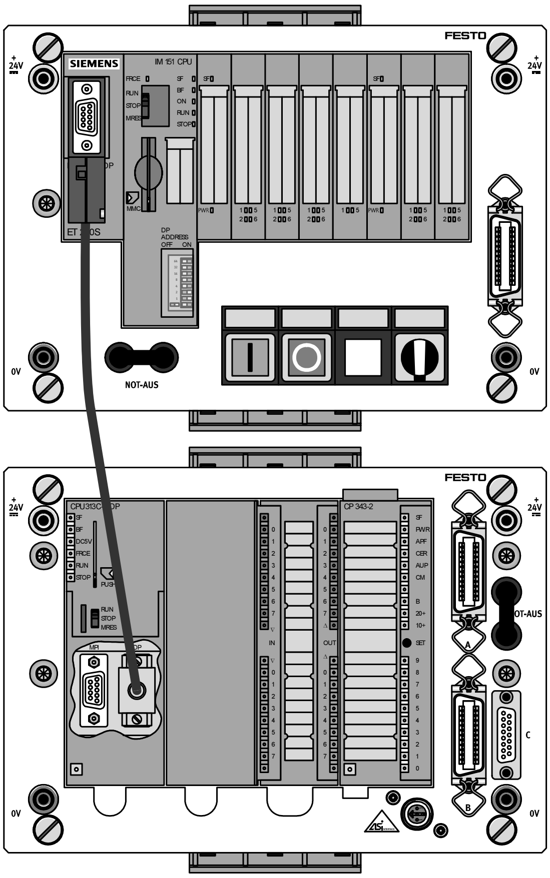
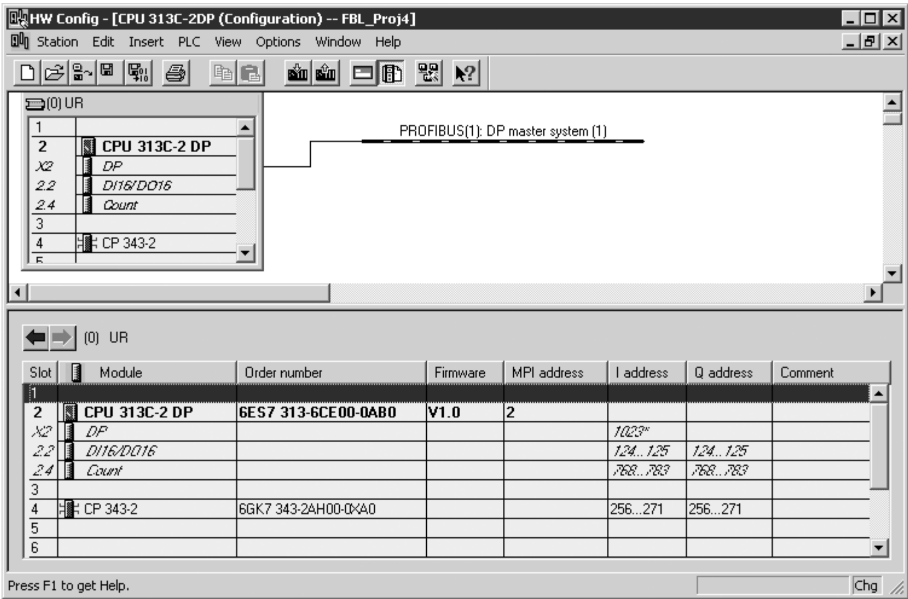
Worksheet 4: Establishing the Profibus-DP connection	
Name:	Date:

Establish the Profibus connection between the CPU 313C-2DP and the ET 200S.



Worksheet 5: CPU 313C-2DP hardware configuration	
Name:	Date:

Create a new Profibus project.
Insert a Profibus subnetwork.
Insert a SIMATIC 300 station and name this „CPU 313C-2DP".
Create the CPU 313C-2DP hardware configuration.



Make a note of the input and output addresses on your worksheet 4.

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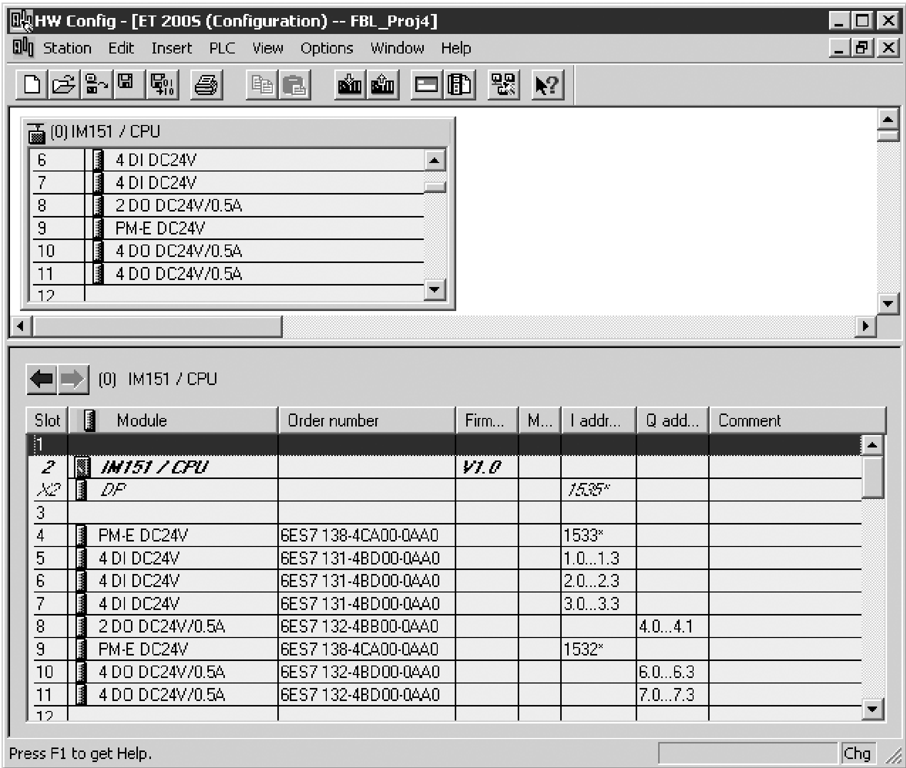
Worksheet 6: ET 200S hardware configuration	
Name:	Date:

Insert a new SIMATIC 300 station in the SIMATIC manager and name this „ET 200S“. Create the ET 200S hardware configuration.



Make a note of the input and output addresses on your worksheet 4.

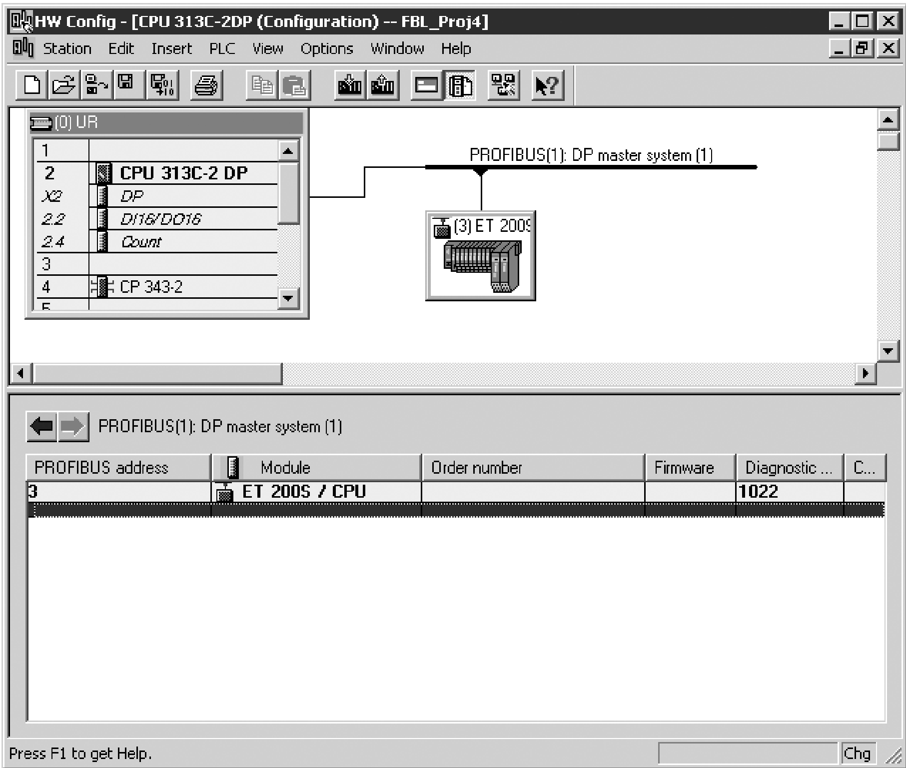
Note

The address for the start button (green pushbutton) is I 3.0 in this configuration.

Save the ET 200S hardware configuration (Station → Save and Compile).

Worksheet 7: Configuration of the network	
Name:	Date:

Open the hardware configuration of the CPU 313C-2DP.
Highlight the Profibus line and insert the ET 200S from the hardware catalogue.
Connect the ET 200S to the Profibus network.
Now configure the Profibus transmission channels.



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Worksheet 8: Addressing of the PROFIBU S stations and inputs and outputs	
Name:	Date:

On this worksheet, you can record the addresses for the Profibus stations and the various address areas for the inputs and outputs defined in the course of the hardware configuration. This provides you with an overview.

Make sure that, particularly in the case of the Profibus addresses, the address allocated in STEP 7 coincides with that set on the hardware (via the DIP switches).

Device addresses		
CPU 313C-2DP	Profibus address	
	Address area – local inputs	
	Address area – local outputs	
ET 200S	Profibus address	
	Address area – inputs	
	Address area - outputs	

Worksheet 9: Creating the symbols table and control program for the ET 200S	
Name:	Date:

The entire stack magazine control is to be executed in the Profibus slave ET 200S. Complete the symbols table for the control program.

Symbol	Address	Data type	Comment
1B1			Ejecting cylinder retracted
1B2			Ejecting cylinder advanced
1Y1			Ejecting cylinder of workpiece to advance
1B4			Sensor – workpiece in magazine
S1			Start pushbutton
P_Auto	FC10	FC10	Sequential program module
P_Komm	FC20	FC20	Communication module
Sstep 01	M 10.0	BOOL	Step 1 Slave
Sstep 02	M 10.1	BOOL	Step 2 Slave

The control program ET 200S consists of the following modules:

- **OB1 Organisational program**
  The communication module P_Komm (FC20) is to be called in OB1. Also, the sequential program P_Auto (FC10) is to be called.
- **OB100 Start-up module**
  The start-up module is to be executed once if the voltage supply to the PLC is switched on. All flags are to be reset (the value 1 is written to the flag byte MB 10).
- **FC10 Sequential program – magazine control**
  Network 1: The process is to start if step Sstep 01 is active, the magazine is full, the magazine ejector is retracted and the start button is pressed. The program is to switch to Sstep 02.
  Network 2: The program is to switch back to Sstep 01 if the magazine ejector is advanced.
  Networks 3 and 4: The ejecting cyliner is to advanced with Sstep 02 and retracted with Sstep 01.
- **FC20 Communication module**
  Transmits the sensor signal to the Profibus transmission channel.

In the next step, create the control program for the ET 200S.

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Worksheet 10: Creating the symbols table and control program for the CPU 313C-2DP	
Name:	Date:

In the CPU 313C-2DP, the signal „magazine empty“ provided by the ET 200S via Profibus is to be evaluated. A signal lamp is to be illuminated when the signal „magazine empty“ is received.
Complete the symbols table for the control program.

Symbol	Addess	Data type	Comment
B4			Sensor – workpiece in magazine
H3			Signal lamp – magazine empty
P_Komm	FC20	FC20	Communication module

The CPU 313C-2DP control program consists of the following modules:

- **OB1 Organisational block**
  The communication module P_Komm (FC20) is to be called up in the OB1. The output for the signal lamp (H3) is to be switched with the signal Magazine Empty.
- **OB100 Start-up module**
  The start-up module is to be executed once if the voltage supply to the PLC is switched on. All flags are to be reset (the value 1 is to be written to the flag byte MB 10).
- **FC20 Communication module**
  This reads the sensor signal from the Profibus transmission channel and stores it in the FB 100.

Now create the control program for the CPU 313C-2DP.

Worksheet 11: Commissioning of the stack magazine project	
Name:	Date:

Now commission the Profibus project Stack Magazine.

This requires the following steps:
- Overall reset the CPU 313C-2DP and ET 200S
- Connecting the programming cable to the MPI interface of the CPU 313C-2DP
- Setting the programming interface in STEP 7 to PC adapter (MPI)
- Downloading of programs and configurations in the CPU 313C-2DP
- Connecting the programming cable to the Profibus interface of the ET 200S
- Setting the programming interface in STEP 7 to PC adapter (Profibus)
- Downloading of programs and configuration in the ET 200S
- Starting the ET 200S
- Starting the CPU 313C-2DP
- Testing the functioning of the program

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Project 5: Profibus-DP system with stack magazine and changer module

Training aim

Trainees are to
- be able to network and commission a more complex control program with decentralised processes via Profibus-DP
- have command of the configuration of Profibus-DP projects in STEP7.

Implementation

In a Profibus-DP system, two processes (stack magazine module and changer module) are to be controlled independently of one another and communicate with one another via Profibus for synchronisation. The stack magazine is to be controlled by the Profibus slave ET 200S. This process corresponds to that in Project 4. The changer module is to be connected to the Profibus system via a valve terminal. The Profibus master CPU 313C-2DP assumes the control of the changer module and the display of the signal„Magazine Empty".

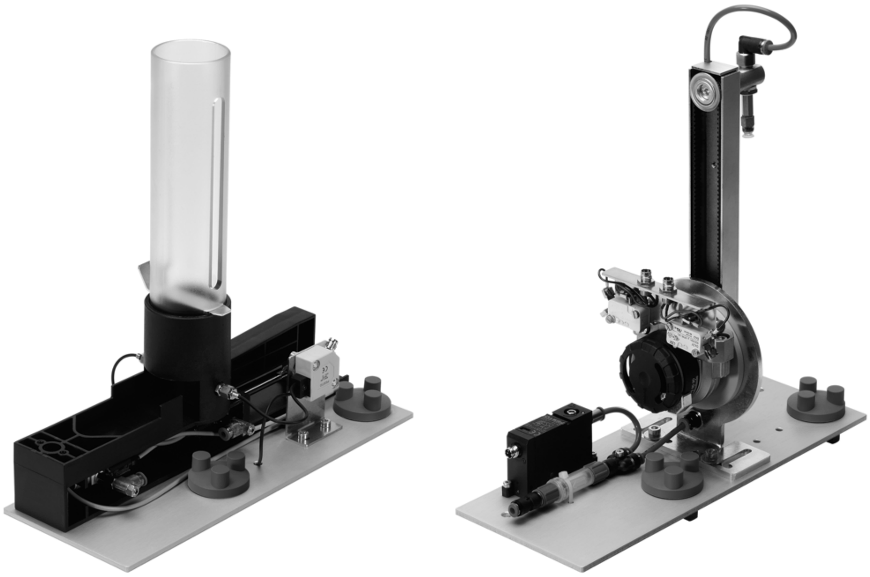
This project lends itself to utilising and consolidating the acquired knowledge and skills in assembling a Profibus system. Moreover, the various possibilities of a Profibus network for decentralised processes can be explained. Trainees are expected to work relatively independently and to have command of the assembly and programming of Profibus systems. The instructor is to provide a greater or lesser degree of help, depending on the level of know-how of the trainees.

Project task

A stack magazine for separating out workpieces is to be automatically controlled by a controller (ET 200S). A Profibus line is to supply a signal to a remote control console if the magazine is empty. The controller (CPU 313C-2DP) on the control console operates as a Profibus master. It is to signal to the operator via a flashing signal lamp if the magazine is empty and needs to be refilled.

A changer module for the transport of the ejected workpieces from the stack magazine is to be integrated into the Profibus-DP system via a valve terminal. The Profibus master CPU 313C-2DP is to control the changer module. The two modules, i.e. the stack magazine and changer module, need to communicate with one another (handshake) for the purpose of synchronisation.

The process described is to be realised.



Stack magazine and changer module

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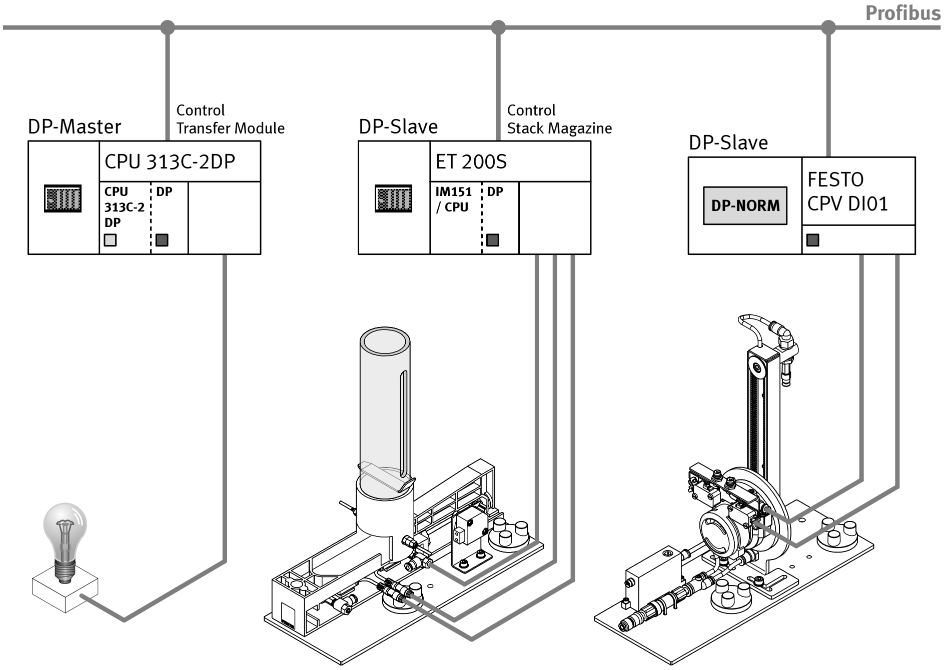
Exercise sheet 1.1: Profibus-DP project with stack magazine and changer module	
Name:	Date:

Problem description



A stack magazine is to be controlled automatically by a controller (ET 200S). If the magazine is empty, a signal is to be sent to the Profibus master (CPU 313) via the Profibus-DP line. A signal lamp is to light up on the Profibus master when the signal „Magazine Empty“ is received.

A changer module for the transporting away of the ejected workpieces is to be integrated into the Profibus-DP system via a valve terminal in the form of a Profibus slave. The Profibus master CPU 313C-2DP is to control the changer module.

Communication is to take place via Profibus for the synchronisation of the two modules.

Exercise sheet 1.2: Profibus-DP project with stack magazine and changer module	
Name:	Date:

Work to be carried out

1. Configure the Profibus-DP system.
2. Create a Profibus-DP project in the control software.
3. Define the hardware configuration for the CPU 313C-2DP in the project.
4. Define the hardware configuration for the ET 200S in the project.
5. Configure the network.
6. Create the control program and the symbols table for the ET 200S.
7. Create the control program and the symbols table for the CPU 313C-2DP.
8. Commission the system.

Parameters

The equipment set TP201 and the MPS® stack magazine and changer modules are available.

Worksheets

1. Assembly of the components, stack magazine and changer module
2. Assembly of the electrical and pneumatic circuits
3. Setting of the slave ET 200S
4. Setting of the valve terminal
5. Establishing the Profibus-DP connection
6. CPU 313C-2DP hardware configuration
7. ET 200S hardware configuration
8. Configuration of the network
9. Addressing of the Profibus stations and inputs and outputs

10.1 – 10.2 Creating the symbols table and control program for the ET 200S

11.1 – 11.2 Creating the symbols table and control program for the CPU 313C-2DP

12. Commissioning of the stack magazine and changer modules

Working aids

- STEP 7 documentation
- ET 200S documentation
- Chapter 2: Message exchange within a fieldbus system
- Chapter 4: The Profibus-DP

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Worksheet 1: Assembly of the components, stack magazine and changer module	
Name:	Date:

Assemble the required components on the slotted assembly board.

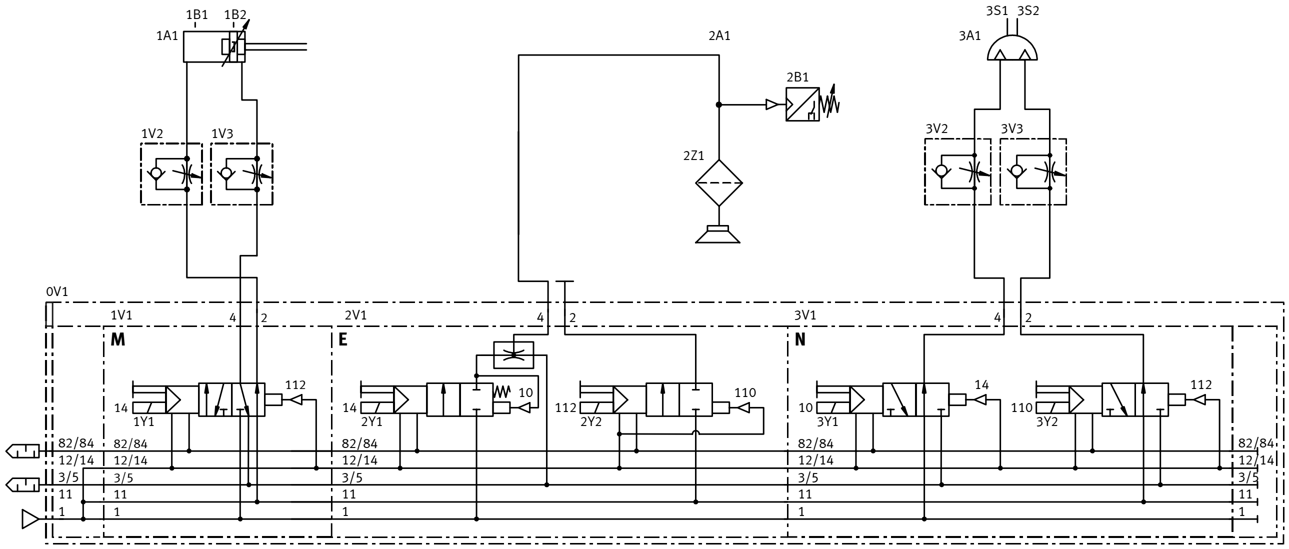
List of equipment

Quantity	Description
1	S7 EduTrainer® Compact 313C-2DP or S7 EduTrainer® plus with 313C-2DP
1	S7 EduTrainer® ET 200S
2	Profibus cable
1	MPS® stack magazine module
1	MPS® changer module
1	5/2-way double solenoid valve
1	Valve terminal with Profibus-DP interface with 16-off input module
1	Connecting cable with 4 mm safety plug
1	Power supply cable – valve terminal
1	Universal terminal unit with Syslink cable
1	Signalling unit and distributor, electrical
1	Distributor block
1	Sensor cable, 4-pin on 3-pin M8 socket/SIBU for sensor/stack magazine module
1	Sensor cable, 4-pin on 3-pin M8 plug/socket for vacuum sensor in the changer module
2	Sensor cable - 3-pin M8 plug/socket
2	Sensor cable 3-pin M8 plug/SIBU
1	Programming cable with PC adapter
1	Set of cables
1	T-piece QST-6 or tubing adapter QS-6-4 for tubing up of valve terminal
	Plastic tubing

Worksheet 2: Assembly of the electrical and pneumatic circuits	
Name:	Date:

Establish the electrical and pneumatic connections for the stack magazine.
Establish the power supply of the ET 200S.
Establish the electrical and pneumatic connections for the changer module.
Establish the power supply of the valve terminal.

Pneumatic circuit diagram stack magazine, changer module



Connection diagram See fold-out

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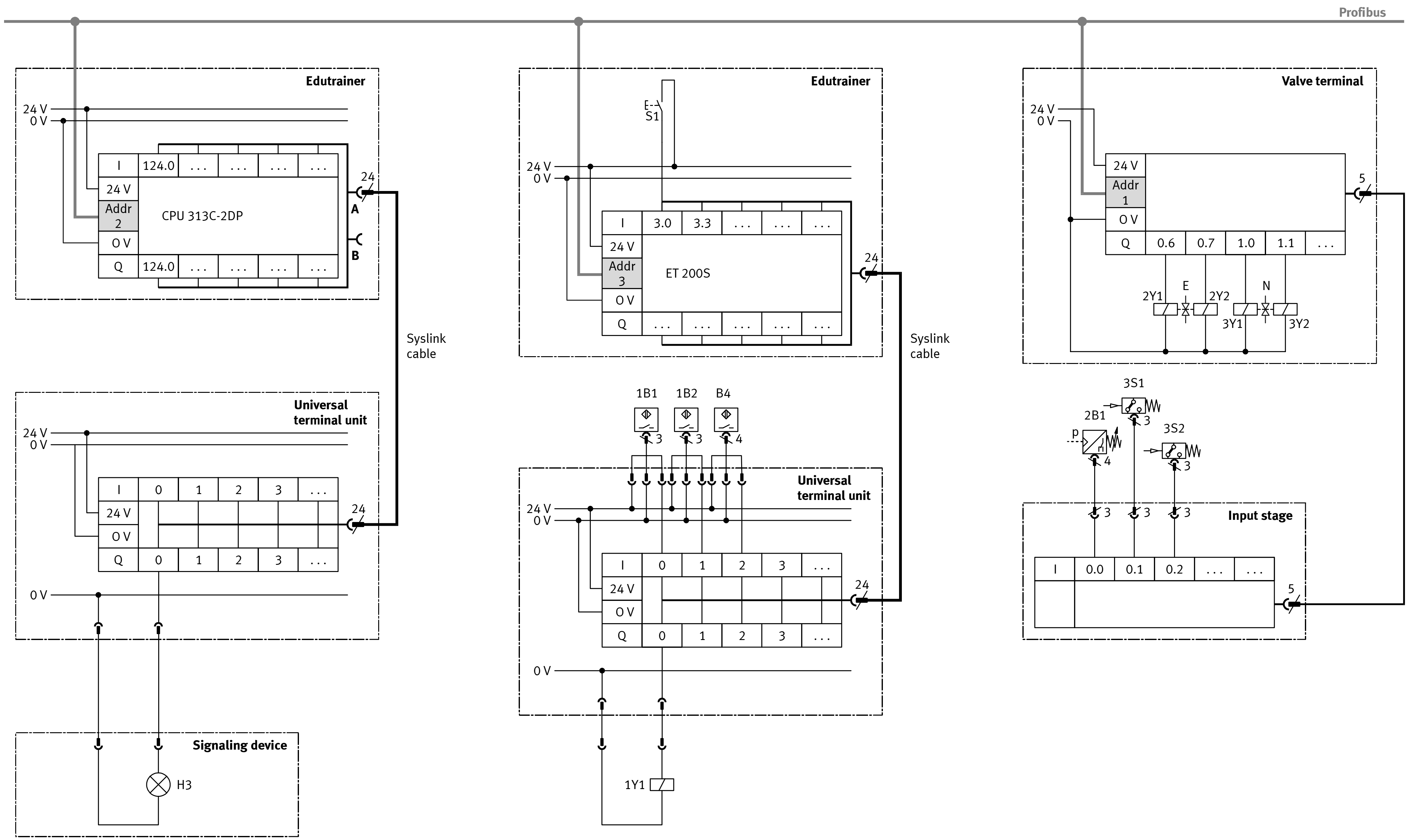

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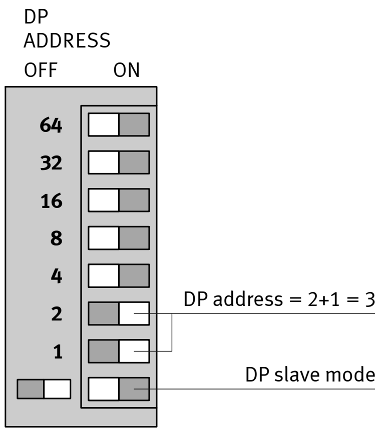
Worksheet 3: Setting of the slave ET 200S	
Name:	Date:

Switch on the DIP switches on the ET 200S (see also ET 200S documentation):

- Set the Profibus address via the switches 1 – 7 stellen (in this case address 3).
- Via switch 8, the ET 200S can be switched between stand-alone mode and DP-slave mode (ON: Stand-alone mode, OFF: DP slave mode).



Worksheet 4: Setting of the valve terminal	
Name:	Date:

Switch on the DIL switches on the valve terminal (see also valve terminal documentation):

4-off DIL switch	1	off	Profibus-DP protocol
	2	off	
	3	on	Expansion by CP input module
	4	off	No additional output module
8-off DIL switch	1	on	Profibus address is 1
	2	off	
	3	off	
	4	off	
	5	off	
	6	off	
	7	off	
	8	off	Diagnostic function is switched off

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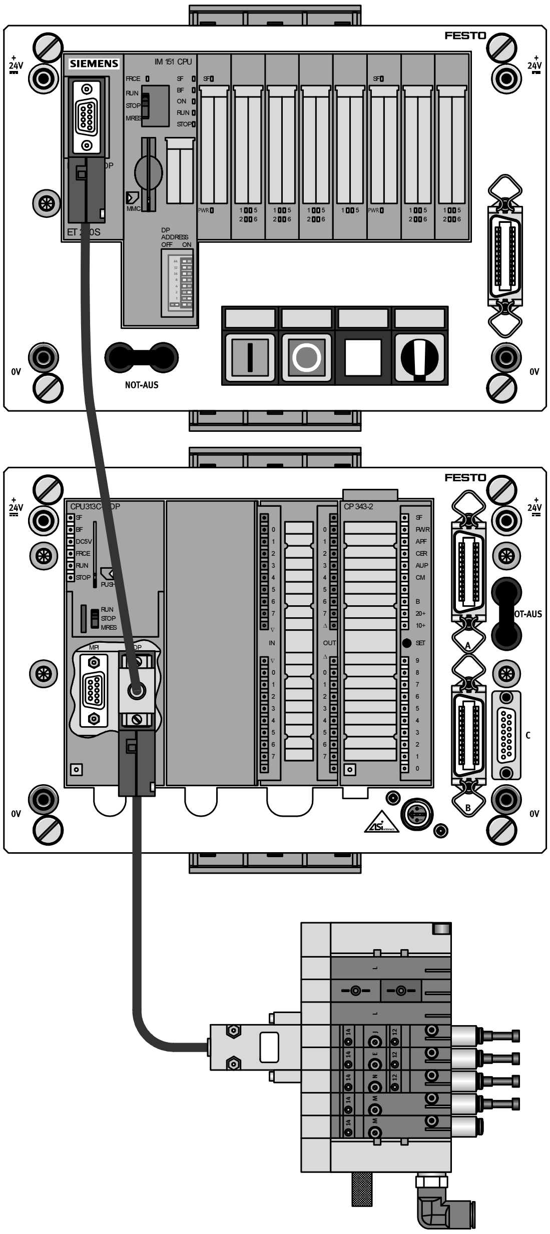
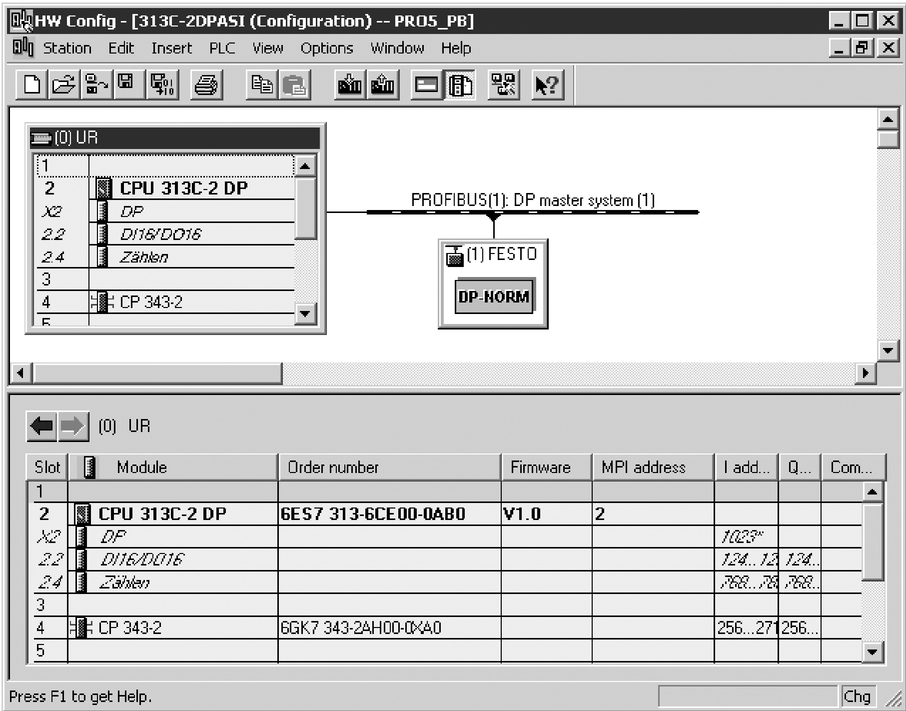
Worksheet 5: Establishing the Profibus-DP connection	
Name:	Date:

Establish the Profibus connection between the CPU 313C-2DP controller and the ET 200S.



Worksheet 6: CPU 313C-2DP hardware configuration	
Name:	Date:

Create a new Profibus project.
Insert a Profibus subnetwork.
Insert a SIMATIC 300 station and name this „CPU 313C-2DP“.
Create the CPU 313C-2DP hardware configuration.
Insert the valve terminal into the hardware configuration.



Make a note of the input and output addresses on your worksheet 4.

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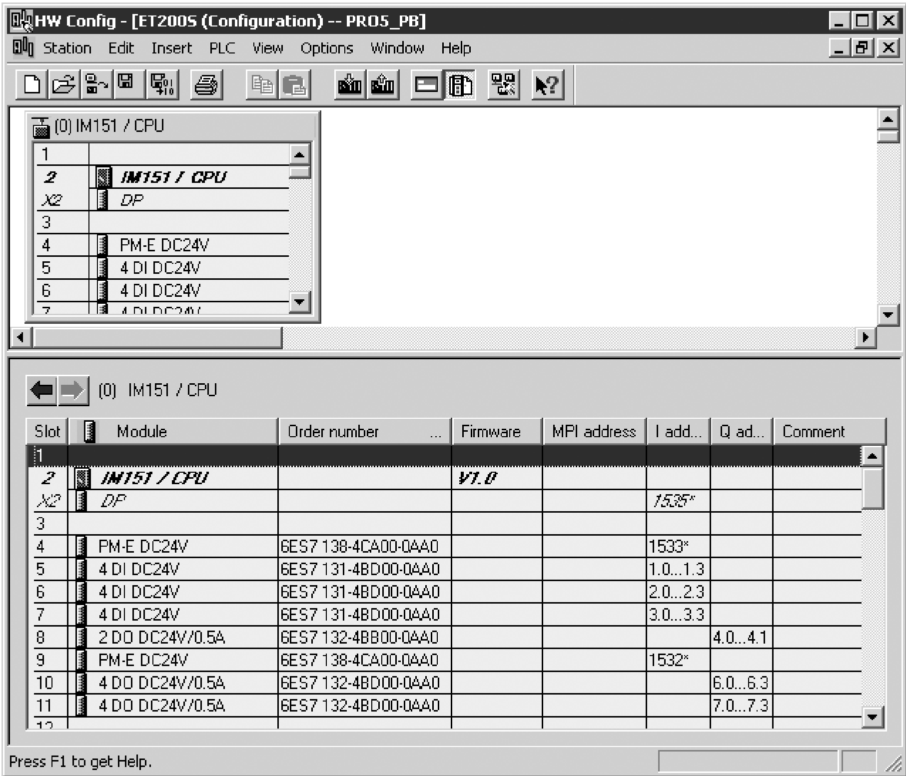
Worksheet 7: ET 200S hardware configuration	
Name:	Date:

Insert a new SIMATIC 300 station in the SIMATIC manager and name this „ET 200S“. Create the ET 200S hardware configuration.



Make a note of the input and output addresses on your worksheet 4.

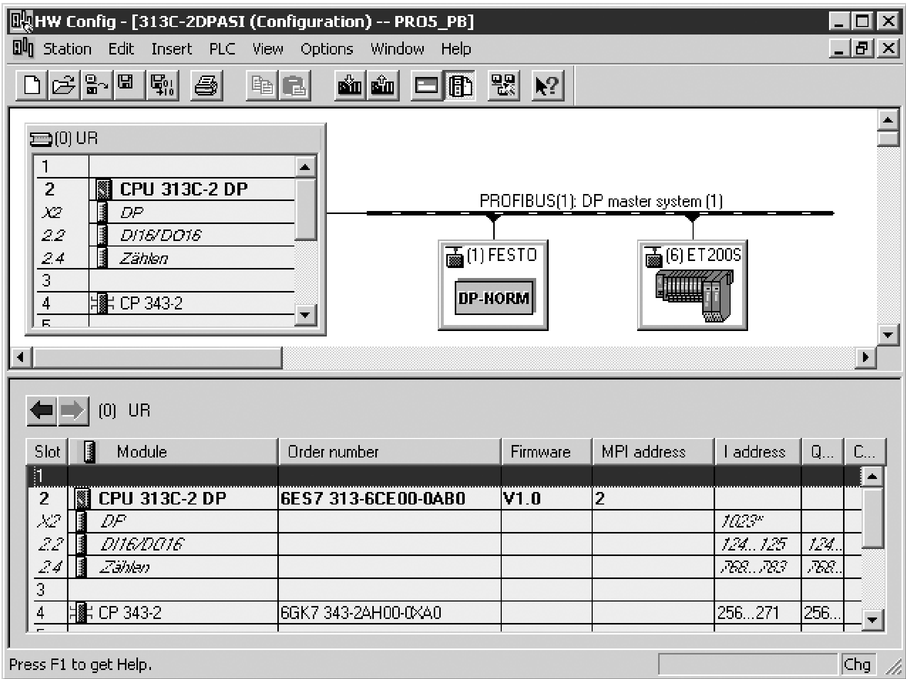
Note

In this configuration, the address for the start button (green pushbutton) is I 3.0.

Save the ET 200S hardware configuration (Station → Save and compile).

Worksheet 8: Configuration of the network	
Name:	Date:

Open the hardware configuration of the CPU 313C-2DP.
Highlight the Profibus line and insert the ET200 S from the hardware catalogue.
Connect the ET 200S to the Profibus network.
Now configure the Profibus transmission channels.



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Worksheet 9: Addressing of the Profibus stations and inputs and outputs	
Name:	Date:

On this worksheet, you can record the addresses for the Profibus stations and the various address areas for the inputs and outputs that you configure in the course of the hardware configuration. This provides you with an overview.

Make sure that, particularly in the case of Profibus addresses, the address allocated in STEP 7 coincides with that set on the hardware (via the DIP or DIL switches).

Device addresses		
CPU 313C-2DP	Profibus address	
	Address area – local inputs	
	Address area – local outputs	
CPV DI01	Profibus address	
	Address area – inputs	
	Address area – outputs	
ET 200S	Profibus address	
	Address area – inputs	
	Address area - outputs	

Worksheet 10.1: Creating the symbols table and control program for the ET 200S	
Name:	Date:

The control of the stack magazine is to be run via the Profibus slave ET 200S. Complete the symbols table for the control program.

Symbol	Address	Data type	Comment
1B1			Ejecting cylinder retracted
1B2			Ejecting cylinder advanced
1Y1			Workpiece ejecting cylinder to advance
B4			Sensor – workpiece in magazine
S1			Pushbutton
P_Auto	FC10	FC10	Sequential program module
P_Komm	FC20	FC20	Communication module
SSchr01	M 10.0	BOOL	Step 1 Slave
SSchr02	M 10.1	BOOL	Step 2 Slave
SSchr03	M 10.2	BOOL	Step 3 Slave
TeilAbg	M 101.0	BOOL	Part picked up
TeilBer	M 100.0	BOOL	Part ready

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Worksheet 10.2: Creating the symbols table and control program for the ET 200S	
Name:	Date:

The control program consists of the following modules:

- **OB1 Organisational program**
  The communication module P_Komm (FC20) is to be called in OB1. Also, the sequential program P_Auto (FC10) is to be called.
- **OB100 Start-up module**
  The start-up module is to be executed once if the voltage supply of the PLC is switch on. All flags are to be reset (the value 1 is to be written to the flag byte MB 10; the value 0 is to be written to the flag bytes MB 100 and MB 101).
- **FC10 Sequential program – magazine control**
  Network 1: The process is to be started if step SSchr01 is active, the magazine is full, the magazine ejector retracted and the start button is pressed. The program is to switch to step SSchr02.
  Network 2: The program is to move to step SSchr03 if the magazine ejector is advanced.
  Network 3: A feedback is to be awaited from the master process (changer module). The process is to re-start with step SSchr01 if the part is picked up.
  Networks 4 and 5: The ejecting cylinder is to advance with step SSchr02 and retract with step SSchr03.
  Network 6: With step SSchr02 a feeback signal is to be sent to the master: Part Ready (PartReady)
- **FC20 Communication module**
  This transmits the signal Part Ready to the Profibus transmission channel and reads the signal Part Picked Up from the Profibus transmission channel.

Create the control program for the ET 200S in the next step.

Worksheet 11.1: Create the symbols table and control program for the CPU 313C-2DP	
Name:	Date:

In the CPU 313C-2DP, the signal „Magazine Empty“ is to be evaluated, which is provided by the ET 200S via Profibus. A signal lamp is to light up when the signal „Magazine Empty“ is received.
Moreover, the CPU 313C-2DP is to control the changer module connected to the valve terminal.
Complete the symbols table for the control program.

Symbol	Address	Data type	Comment
2B1			Workpiece picked up
2Y1			Vacuum On
2Y2			Vacuum Off
3S1			Swivel cylinder in magazine position
3S2			Swivel cylinder in sequential station position
3Y1			Swivel cylinder to magazine
3Y2			Swivel cylinder to sequential station
B4	M 12.2	BOOL	Sensor – workpiece in magazine
H3			Signal lamp – magazine empty
MSchr01	M 10.0	BOOL	Step 1 Master
MSchr02	M 10.1	BOOL	Step 2 Master
MSchr03	M 10.2	BOOL	Step 3 Master
MSchr04	M 10.3	BOOL	Step 4 Master
MSchr05	M 10.4	BOOL	Step 5 Master
P_Auto	FC10	FC10	Sequential program module
P_Komm	FC20	FC20	Communication module
TeilAbg	M 101.0	BOOL	Part picked up
TeilBer	M 100.0	BOOL	Part ready

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Worksheet 11.2: Creating the symbols table and control program for the CPU 313C-2DP	
Name:	Date:

The control program of the CPU 313C-2DP consists of the following modules:

- **OB1 Organisational program**
  The communication module P_Komm (FC20) is to be called in OB1. The output for the signal lamp (H3) is to be switched with the signal Magazine Empty (B4).
- **OB100 Start up module**
  The start up module is to be executed once first when the voltage supply of the PLC is switched on. All flags are to be reset (the value 1 is to be written to the flag byte MB 10).
- **FC10 Sequential program – changer module**
  Network 1: To await Part Ready (slave process)
  Network 2: Swivel arm to magazine
  Network 3: Switch on vacuum
  Network 4: Transport workpiece to sequential station
  Network 5: Switch off vacuum
  Networks 6 and 7: Activation of 2Y1
  Networks 8 and 9: Activation of 2Y2
  Networks 10 and 11: Activation of 3Y1
  Networks 12 and 13: Activation of 3Y2
  Networks 14: Activation of PartPickedUp
- **FC20 Communication module**
  Reads the sensor signal from the Profibus transmission channel and stores this in MB 100.

In the next step, create the control program for the CPU 313C-2DP.

Worksheet 12: Commissioning of the stack magazine and changer module	
Name:	Date:

Now commission the Profibus stack magazine and changer module project.

This requires the following steps:

- Overall resetting of the CPU 313C-2DP and ET 200S
- Connecting the programming cable to the MPI interface of the CPU 313C-2DP
- In STEP 7, setting the programming interface to PC adapter (MPI)
- Downloading of programs and configurations to the CPU 313C-2DP
- Connecting the programming cable to the Profibus interface of the ET 200S
- In STEP7, setting the programming interface to PC Adapter (Profibus)
- Downloading of programs and configuration to the ET 200S
- Starting up the ET 200S
- Starting up the CPU 313C-2DP
- Testing the functioning of the program

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Contents

Part B – Fundamentals

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1. What is a fieldbus system?

Training aims

Trainees are to
- be familiar with the general function and areas of application of a fieldbus system
- be familiar with the advantages of bus systems compared to conventional wiring
- be familiar with the allocation of fieldbus systems in the structural levels of a factory and the different requirements regarding networks

Worldwide, more than 100 different automation vendors offer fieldbus systems.

The above are three fieldbus systems, for which numerous manufacturers and users opt. Standards have now been drawn up for Profibus and AS-Interface and a draft standard exists for Interbus.

Fieldbus systems are used for the automated data transfer at the field level and are a component part of network technology.

The field level covers that part of automation which is directly related to production, i.e. the individual production system, the associated storage area (intermediate store, blanks store, etc.), quality assurance, the acquisition of operational data as well as direct higher-order process control systems.

In the case of data transfer by means of a bus, the data and signal are not sent in parallel form via several lines, but a fixed amount of individual data is bundled together and sent in the form of serial transmission via one line. In lay terms, this can be pictured rather like a bus in a public transport system, whereby each sensor signal and actuator signal are allocated a „fixed seat".

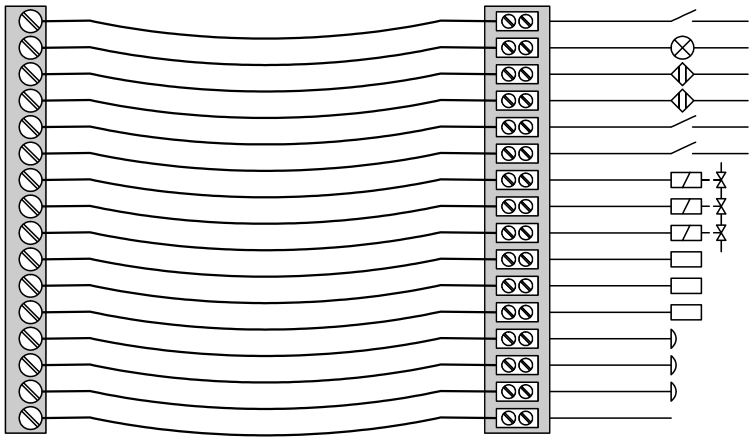
In automation technology, fieldbus systems were orginally developed to reduce costs by minimsing the expenditure on installation.

1.1
Why fieldbus systems at all?

The use of fieldbus systems can on the one hand be geared to existing systems and their possibilities and on the other hand offer new possibilities for automation. In summary, three basic reasons should be listed for the use of fieldbus systems:

Decentralisation of large systems
The increasing complexity of automation technology leads to the ever more complex configuration of installations. Programmable logic controllers with, say 3000 inputs/outputs can no longer be effectively monitored by maintenance staff.

Where data was previously transferred via the individual wiring of components, the bus cable now represents the transmission medium for all connected components.



Conventional wiring

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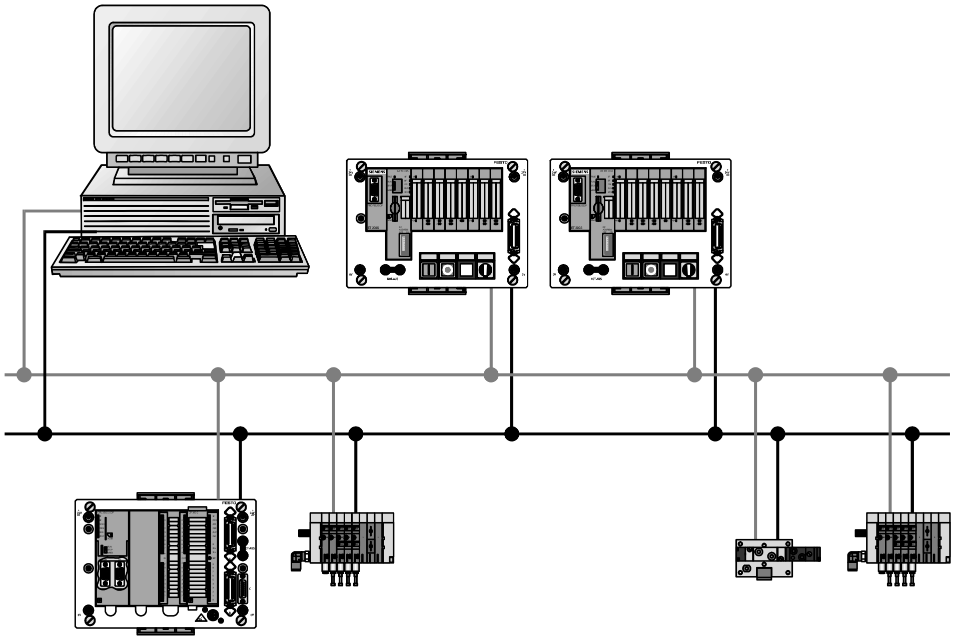

Fieldbus with connected components

Reduction of installation costs for sensors and actuators
However, even decentralisation does not change the fact that the number of sensors and actuators is rapidly increasing. The expenditure for wiring on the actuator/sensor level has therefore correspondingly increased. Material costs for terminals, terminal boxes and cable add to the time for commissioning.

New possibilities thanks to the use of fieldbus systems
With the use of a fieldbus system, it is possible to connect a wide range of different devices to a fieldbus module and configuration is possible without any major hardware changes. This opens up new possibilities for process control and monitoring.

1.2 Where in the factory is the fieldbus allocated?

Fieldbus systems are integrated into the structure of a factory.

To this end, a factory is structured into levels to facilitate the distribution of functions and to be able to clearly configure the equipment used. It is important here to regard such a model as an actual “model” and not as a specified structure. However, in practice a “model” has to become a functioning structure, which will very often differ from the specifications of the model.

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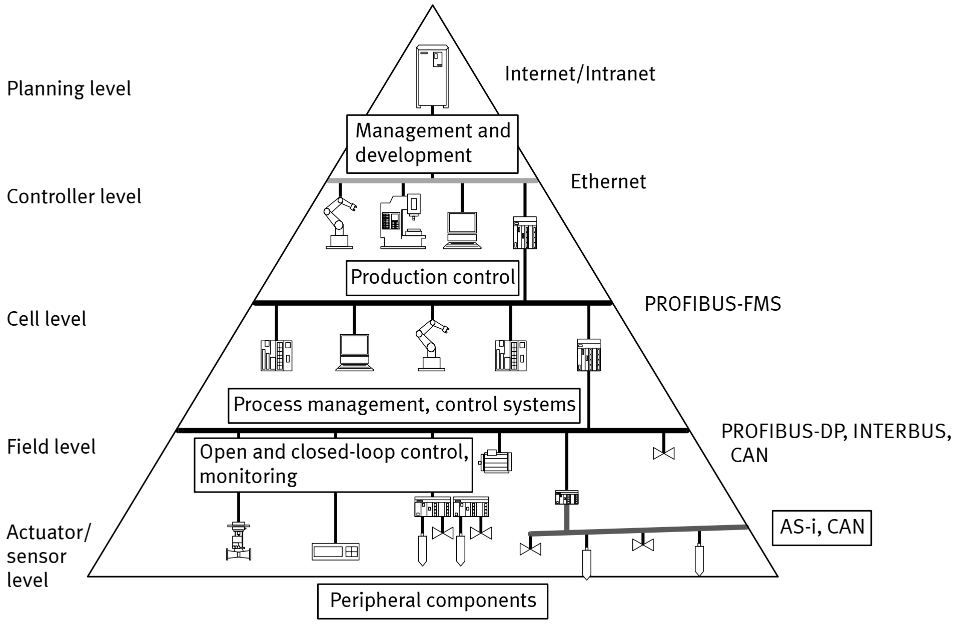
Given these limitations, the model depicting levels of a production system can be differentiated into five levels: The planning level, the master level, the cell level, the controller level and the actuator/sensor level.
In numerous publications, this level structure is shown in the form of a pyramid.



Model of factory control levels

So-called factory bus systems such as Ethernet or token ring are used for the planning and management tasks in a factory.
Fieldbus systems are used in the controller and actuator/sensor area, and in some cases also on the cell level.
The information exchange within and between the individual hierarchy levels is effected vertically and horizontally.

The upper levels are for complex computer systems, dominated by large data sets with uncritical reaction times, large numbers of stations and a extensive network configuration.

Communication on the lower levels is characterised by small data sets and high communication throughput as well as a small number of participants. Here, the focus is on real time requirements. The network configuration therefore tends to be on a small scale.

The planning level

The planning level from this viewpoint of production automation therefore encompasses the entire planning of the factory, including data transfer to sales, design and development, purchasing and long term production planning.

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The planning level therefore assigns to the master level all the requirements for actual product with quantities, type designation, quality requirements and schedules.

In this case, large amounts of data are transferred over an extended period of time and large distances.

The master level

The master level distributes the functions received from the planning level to the various cells that need to interact for a particular product. This includes for example the retrieving of parts from a buffer store, a command to a machine tool cell and possibly also the termination of intermediate steps to higher-order master levels, also the allocation of functions to different cells according to the different methods of production planning systems (PPS), and possibly also the planning measures for preventive maintenance.

The process master computer for configuration, diagnosis, operation and logging are also located on this level.

The cell level

The cell level connects the individual production cells controlled by the cell computer or PLCs. Here, the main focus is on targeted communication between intelligent systems.

The cell level comprises the monitoring of individual production cells. A specific job is assigned to a cell by the master level (e.g. the cutting to size of 250 pipes. Within a cell, the individual work steps required for this are assigned to the various associated controllers, for example the insertion of a pipe by means of an automatic handling device, cutting to length with a saw, de-burring of pipes using a robot, measuring of individual pipes by means of an automatic measuring device. This is followed by the ready message to the master level. Within the cell, requests for maintenance on associated machines are also processed and quality control data is compressed for transfer to the master level for the purpose of statistics.

The field and controller level

The field and controller level comprises programmable devices for open and closed-loop control and monitoring such as PLCs or industrial computers, which evaluate the actuator/sensor level. Larger data quantities with critical reaction times are transmitted for connection to higher-order systems.

The field and controller level comprises the individually associated controllers, i.e. robot controllers, CNC controllers, programmable logic controllers, welding control and positioning control systems..

Ideally, a small buffer is located between the various machines provided with a controller to ensure that any malfunction on the individual controllers will not lead to downtime of the system for a specific time period. An individual machine with associated controller is therefore designed so that it can operate faster by a few percent then required by the overall system. The intermediate buffer upstream of the sequential machine therefore continues to be filled. If the machine fails, the downstream machine can for a few minutes (usually between 10 and 60 minutes) continue to operate from the intermediate buffer.

The actuator/sensor level

The actuator/sensor level forms a component part of the field level and connects the technical process to the controllers. This is effected by means of simple field devices such as sensors and actuators. The main focus here is on the quick, cyclical updating of inputs and outputs, whereby short messages are transmitted. The duration for the updating of input and output data must be slightly shorter than the cycle time of the controller.

The actuator/sensor level is made up of the different sensors and actuators on a machine. This area comprises simple binary sensors such as control elements, simple binary actuators such as a shut-off valve, analogue sensors such as a temperature sensor or revolutions counter, analogue actuators such as a servo valve and finally so-called intelligent sensors or actuators such as a limit value signalling analogue sensor or a complete positioning system, which only requires the parameters of a new position to be transmitted.

The following network structure as shown overleaf is possible:

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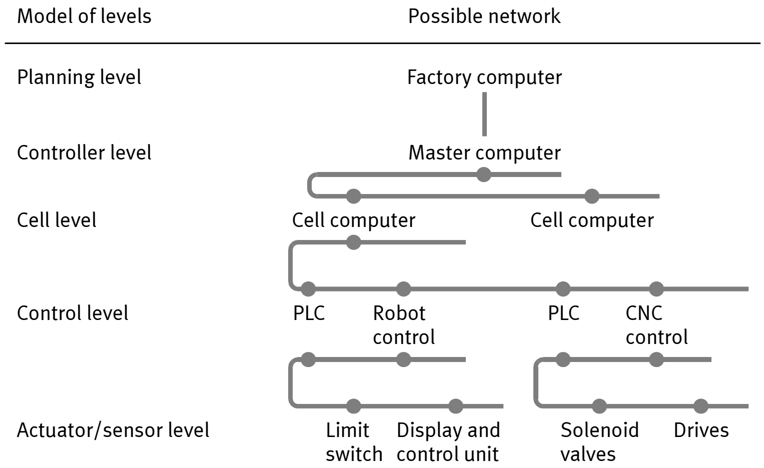
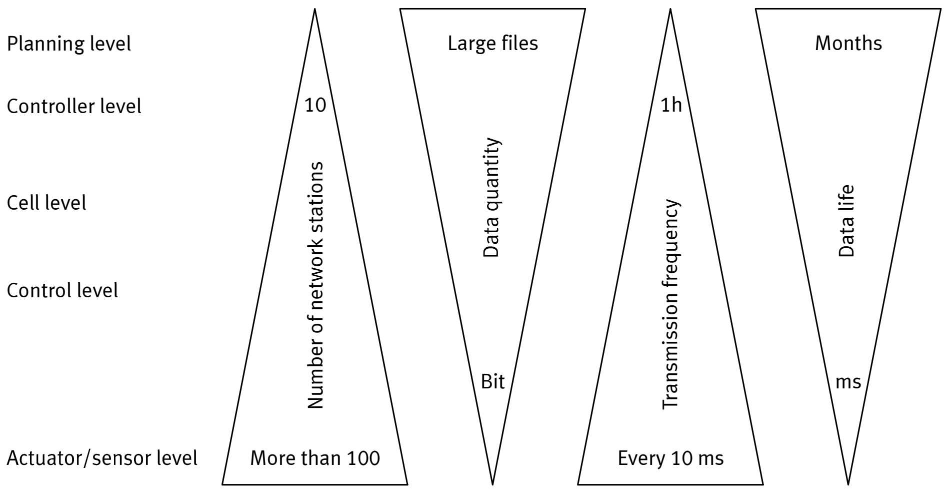


Network on the different levels of a factory

1.3 The allocation of fieldbus systems

Fieldbus systems are used within the operational levels for communication between the actuator/sensor level, the control level and cell level. These are the areas which are immediately related to production.

Requirements on the different networks
The requirements on the different networks vary in many respects.



Different network technology requirements

Number of network stations

The number of network stations in a fieldbus area is considerably greater than that on the higher-order planning and master level.

Data quantity

In contrast to a request by sales concerning the availability of a product, the “data quantity of a proximity sensor consists of a single bit.

Transmission frequency

The interrogating of whether a machine is supplied with sufficient compressed air is realised by means of a pressure controller. The pressure controller signal is possibly interrogated every 100 ms in order to ensure that the system can still reliably move to the initial position if pressure is dropping. In contrast to this, the statistics regarding system utilisation is possibly only updated on an hourly basis; the evaluation of quality assurance data may lead to a newly drawn up diagram on a weekly basis.

Data life

Due to different requirements, the data on the individual levels is required for different time periods and needs to last longer:
On the planning level, global tasks are solved by a small number of decision makers on the basis of a multitude of information. The data of this information and the solutions must be available over an extended period of time, i.e. the life of this data may last for months or years.
In the fieldbus area, small amounts of short data, e.g. input and output values, are processed with great frequency by numerous devices and the data life is therefore very short, lasting from milliseconds to seconds.

1.4 Summary

Fieldbus systems are used for quick and automated data transmission in production and are a component part of network technology.

The use of fieldbus systems has the following advantages:

- Complex process with more than 3000 inputs and outputs are decentralised
- The installation costs for sensors and actuators can be reduced
- And configuration with a wide range of different devices can be realised without any major hardware changes

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1. What is a fieldbus system?

In order to clearly arrange the distribution of functions, equipment used and the network, the factory is structured into the levels that can be graphically illustrated in the form of a pyramid:

- Management and development on the planning level
- Production line with production planning systems on the controller level
- Process management control systems, controlled by cell computers or PLCs on the cell level
- Open and closed-loop control, monitoring with PLCs, robot control systems, CNC and welding control and positioning systems on the field level.
- Peripheral components such as limit switches, valves, drives on he actuator/sensor level. The actuator/sensor level is a component part of the field level and connects the technical process and controllers.

Fieldbus systems are primarily located on the sensor/actuator level, field level and cell level. These are the areas that are directly related to production.

The requirements regarding the different factory networks vary in respect of the number of network stations, data quantity, transmission frequency and data life.

2. Message exchange within a fieldbus system

Training aims

Trainees are to

- be familiar with bus structures (master/slave, master/master, addressing, toplogy and learn how to deal with these
- be familiar with the most important basic principles of data transmission within a fieldbus system (telgram, protocol)
- be familiar with the ISO/OSI reference module for communication functions

Fieldbus systems consist of interlinked stations, whose interrelationship is hierarchicalor or of identical order. The allocation and place value of the stations in the network decide how they may access the bus, e.g. whether, to what extent and when the station may send, read or overwrite data.

2.1
Master/Slave

Fieldbus stations are known are masters or slaves depending on their access right to other station data.

Master

A master is a station, which can transport data of its own accord via a bus. The master is an active station with its own user program, generally a PLC or a PC. The master is exclusively entitled to independent token pasing. In contrast with is the slave which can only send data once the request from the master has been made.

Slave

A slave is a station that is to be regarded solely as a decentralised input/output unit of the master. However, there are also so-called intelligent slaves that can also process programs, but do not have own access rights to a bus. A slave in a fieldbus is a station that can never access a bus of its own accord, i.e. it cannot request data (read or write).

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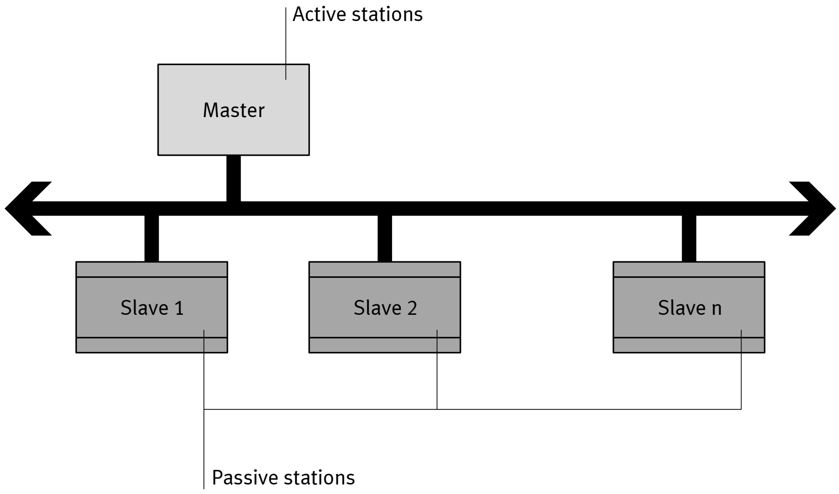
Master/slave system

In the case of a master/slave system, only one bus station, the master, has control over the bus. All the other stations must continually listen on the bus, but are only allowed to send data via the bus once requested by the master.
The master controls the process with its program and continually polls the input and output data of its slaves via the bus, i.e. of the components connected to the bus.



Polling

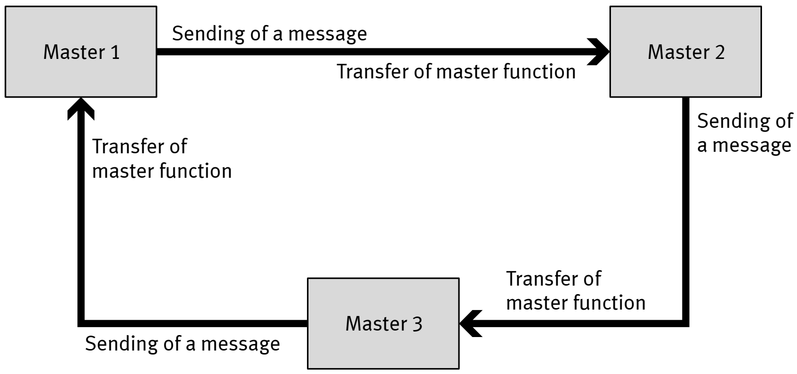
Repeated polling from the first to the last slave is known as the polling cycle. With this polling, the master collects data and/or sends data to slaves. Each data exchange between master and slave requires two defined messages: First from master to slave and then back from slave to master.

Depending on the system, polling can
- be executed automatically via all bus stations
- or include specific set bus stations
- or ask for specific data
- or merely sound out whether any new data is available.

Polling is executed cyclically, not event-driven.

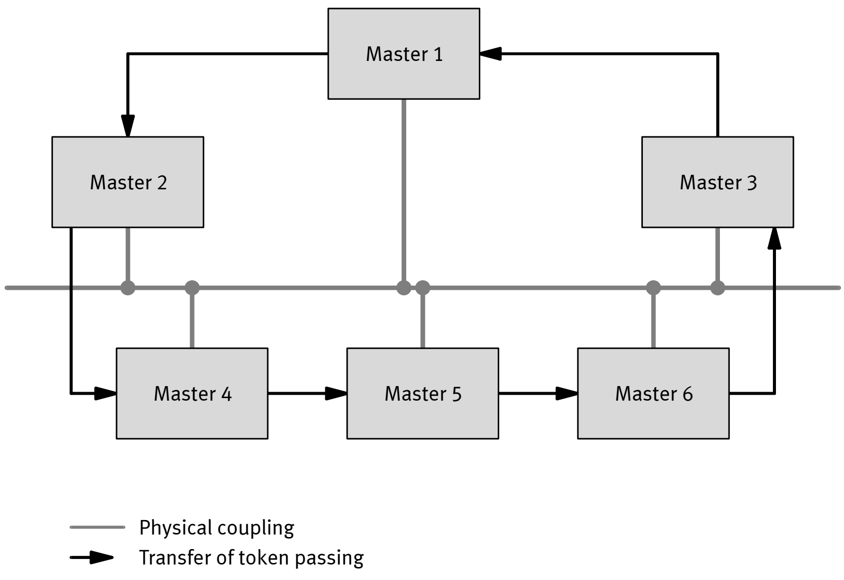
Multimaster system

A multi- master system can consist of several masters, which can all access the bus of their own accord.
It is essential to establish what is to take place in the case of each multimaster if several masters access a bus simulaneously.



Master/master relationship

The definition of access right to a bus is generally independent of a specific bus system. Since only one master is allowed to be active at a specific time in a system, the master function is transferred to another master by means of a communication cycle (token passing) and, if necessary, other data (e.g. for configuration) also transferred.



Token Passing

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2.2
Address of station, bus stations

Each station in the network must be clearly identifiable so that it is clear from whom the data is to be polled and to where the data is to be written.

An example from everyday life clearly illustrates why this is necessary:
If messages are sent in the form of letters or postcards within the “postal network”, a message can only arrive if the address to which it is to be sent is clearly indicated. This is why it is essential for the station, i.e. house, to which the information is to go, to be identified by a house number. Conversely, if a message in the form of a letter is to be sent from the station, house, to the address of another station, then it is necessary to indicate a sender and address so that it can be identified.

The same applies to a bus system:
In order to uniquely identify a bus address, a bus address needs to be assigned to each station in the network. The address is the reference of a station and is generally configured directly on the station by means of a dual-in-line switch (DIL/DIP). The address with which the control program addresses a station must coincide with the address on the station. Addresses must not be double assigned.

2.3
Topology

How the stations of a bus system are wired up, depend on the type of bus (e.g. Profibus or AS-Interface) and its function. The structure of the communication system and where the stations are connected to the system – in principle the type of cable routing – is known as topology.

Current topologies are the line, tree, ring and star structures.

Line

A line consists of a through bus cable, to which the bus stations are connected without cable interruption. A cable for a line must be electrically terminated at the ends, generally by means of bus terminating resistors, possibly by means of special bus stations.

Ring

The ring is a topology, where basically a point-to-point connection is established from station to station. Each station in the ring must therefore pass on unchanged any data not intended for itself. In the field range, fibe optic cables (e.g.Sercos, Beckhoff) are assembled as a ring. Other typical representatives of ring systems are the Interbus or P-Net.

Star

Star topology means that every station is connected to a central station with its own cables.
The advantage of the star is its excellent maintainability. For instance in the case of a cable break, just one connected station fails so that the fault can be easily found.
The disadvantage of the star is that high cabling expenditure is involved.
Star structures are only very rarely used for fieldbus systems.

Tree

A tree topology is a mixture of line and star. A line is connected to a central station; Additional lines branch from the lines connected to this so that, figuratively speaking, a tree like structure can be detected.
The tree topology can be found primarily on sensor/actuator bus systems and reaches right down to the component level. The AS-Interface bus, for example, accepts a tree in order to keep wiring free of restricting regulations as far as this is possible.

2.4 Data transmission

Protocol

The common transmission medium is the bus, with which all stations are connected. In order for two stations to be able to communicate with one another, they need to “speak the same language“. For the exchange of information from different stations different rules and formats apply. The entirety of rules and formats are known as protocol. Identical protocols must be realised within a bus system.
Different bus systems use different protocols. Just as there are different bus systems such as Profibus, Interbus, AS-Interface and CAN, there are also the appropriate protocols that differ from one another.
In order for vendor independent communication to be possible between stations in a common network, protocols have now been standardised, i.e.wie Profibus and AS-Interface.

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Telegram

In the case of data transfer by means of a bus, the data and signals are not sent individually via a line; instead a fixed quantity of individual data is packed into a bundle and transmitted via the line in the form of a unit. This packed quantity of individual data is known as a telegram.
A telegram is a message conveyed via a fieldbus system. As a rule, a telegram consists of an initial character such as address information, length information, the actual useful data, the check data and an end identifier.

2.5 ISO/OSI reference model

For communication of networks, the model developed by ISO (International Standard Organisation) in 1978 is very helpful. The standardisation as a result of this model makes it possible for

- devices by different vendors to communicate with one another.
  This is why the model is called Open System Interconnection, in short OSI.
- the messages to be transmitted are neither corrupted or changed by any other ways or means.

In this model, the communication of computers and other network stations from different vendors is divided in layers. These perceive the different tasks during the processing of data communication and configure these.

<table>
<tr><th colspan="5">Reference model layers</th></tr>
<tr><td>7</td><td>Application</td><td>Application</td><td rowspan="4">Network-independent</td><td rowspan="2">Application dependent</td></tr>
<tr><td>6</td><td>Presentation</td><td>Presentation</td></tr>
<tr><td>5</td><td>Session</td><td>Session</td><td rowspan="2">Application independent</td></tr>
<tr><td>4</td><td>Transport</td><td>Transport</td></tr>
<tr><td>3</td><td>Network</td><td>Network</td><td colspan="2" rowspan="3">Network-dependent</td></tr>
<tr><td>2</td><td>Data back-up</td><td>Link</td></tr>
<tr><td>1</td><td>Transmission</td><td>Physical</td></tr>
</table>

Each individual layer extends globally across the communication system and defines a declared, layer-specific protocol between each of the connected devices. Services are made available at the interface of the next higher layer. Services for instance are defined read and write rights to operands of another station.

Generally, only layers 1,2 and 7 are used for fieldbuses.

Layer 1: Bit transfer layer or physical layer
This is where the electrical and mechanical characteristics of a transmission are defined. For example, the characteristics of the medium (fibre glass or cable), interface, transfer rates (10 Mbit/s or more), coding, level etc. In order for a successful data transfer to be possible with stations from different vendors, the physical properties must coindice or be synchronised.
Layer 1 is very much associated with layer 2, the data link layer.

Layer 2: Data back-up
Here it is ensured that the data transferred actually arrives error-free. In case of doubt, the data is requested anew from the bit transfer layer. All higher layers can therefore assume that the data is error-free. This is ensured by check sums and synchronisation.

Layer 7: Application
Layer 7 provides the direct interface to the user and makes available services that enable the user to create a program largely independent of network hardware and software. Examples are services, for file transfer, variable exchange, event messages and program management.
Another example is the telephone. The operating elements of the telephone represent the application layer, the dial or keypad, a display, preselect button, etc. Different devices offer different user interfaces and functionalities for the user. However, the transmission method (protocol), and the transmission medium (telephone network), is the same for all devices

2.6 Summary

Stations of a fieldbus system are interlinked via networks and are in a coequal or hierarchical relationship. The position within the hierarchy decides which station can access the bus when and how and whether and when the station can send, read or overwrite.

In the case of a master/slave system, only one bus station, i.e. the master – generally a PLC or PC - has control over the bus. All the other stations, the slaves – generally sensors and actuators – are authorised to send data via the bus only if requested by the master. As a rule, the data polled by the master are the statuses of the slave inputs and outputs.

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With a master/slave system, the scanning of data is effected cyclically and always continually from the first to the last slave. This scanning is known as polling.
A multi-master system consists of numerous masters that can all access the bus of their own accord. Token passing is one method by which a large number of masters are controlled.

So that stations in the network can be uniquely identified, an address must be assigned as reference for each station in the network. A station is addressed under that set by the control program.

The method of configuring a network is known as topology which means
- the structure of the communication system
- and the type of cable routing.

Current topologies are the line (Profibus), the ring (Interbus), star or tree (AS-Interface).

For data transfer it is important that stations that wish to send data via the bus speak the same language. This language, the entirety of rules and format are known as protocol. This must be identical within a bus system. The message, into which for instance the slave data is “packed” and which is sent via the bus is referred to as a telegram.

In the ISO/OSI reference model, the communication of network stations from different vendors is divided into layers, which build on one another during the data communication processing and assume different functions. The bit transfer layer (layer 1), the data back-up layer (layer 2) and the application layer (layer 7) are used for fieldbuses.

3. Four different fieldbus concepts and types thereof

Training aims

Trainees are to
- be familiar with different ways of fieldbus concepts and the appropriate fieldbus type and to be able to differentiate between the various fieldbus concepts
- be familiar with the basic bus systems in industrial use and their specific areas of application

Fieldbus system concepts

There are four different basic concepts according to which fieldbus systems are designed.
These are the message-orientated, station-orientated, multimaster and installation concept.

3.1 The message orientated concept

The exchange of information between the individual communication partners corresponds to our familiar notion of „communication“. We are used to telephoning a communication partner. To do so, we dial our counterpart, we may in some cases have to make do with an engaged signal or otherwise announce ourselves with our name and the context of communication. At least theoretically, our counterpart can then decide as to whether or not to enter into communication with us. As long as the telephone connection is established, this connection belongs exclusively to us. Once the desired messages have been exchanged, the connection is terminated again.

In the case of a fieldbus a “connection” is established purely logically, not physically as in a relay switched telephone. The fieldbus uses a common fieldbus cable for data channels, generally a two-wire copper cable or a fibre-optic cable. Whatever the case, the fieldbus cable can only transport just one telegram at any one time.

The physical and logic connection
An message-orientated fieldbus system is usually realised with a “line”, i.e. a continuous fieldbus cable; generally a line with a twisted pair of wires for data transmission. The individual fieldbus stations are connected to the fieldbus line without interrupting the line. This represents the physical connection between all the stations.

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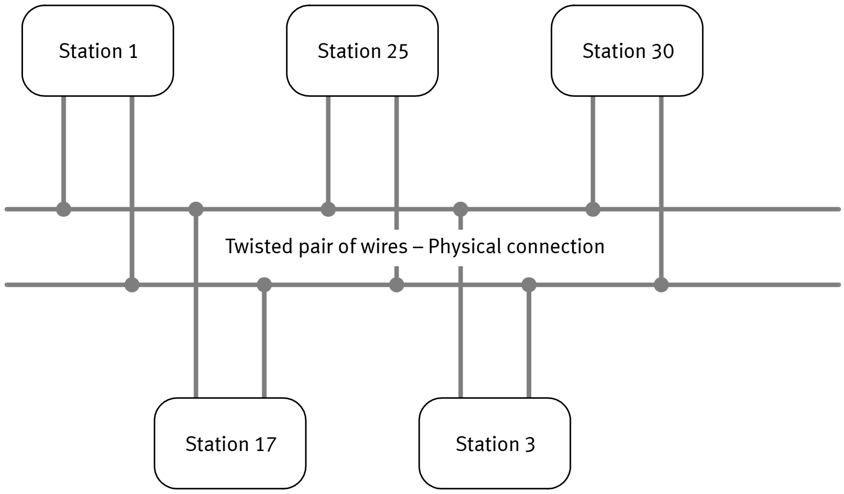


The electrical line forms the physical connection between all bus stations.

A logic connection is established between the stations wishing to exchange data, which is completely independent of the physical sequence of the connected stations.

3.2 The station-orientated concept

Fieldbus systems based on the station-orientated concept are rare. The main representative of this concept is the Interbus developed by Messrs Phoenix-Contact and in the meantime submitted by the Interbus-Club for standardisation (a draft standard is already published).

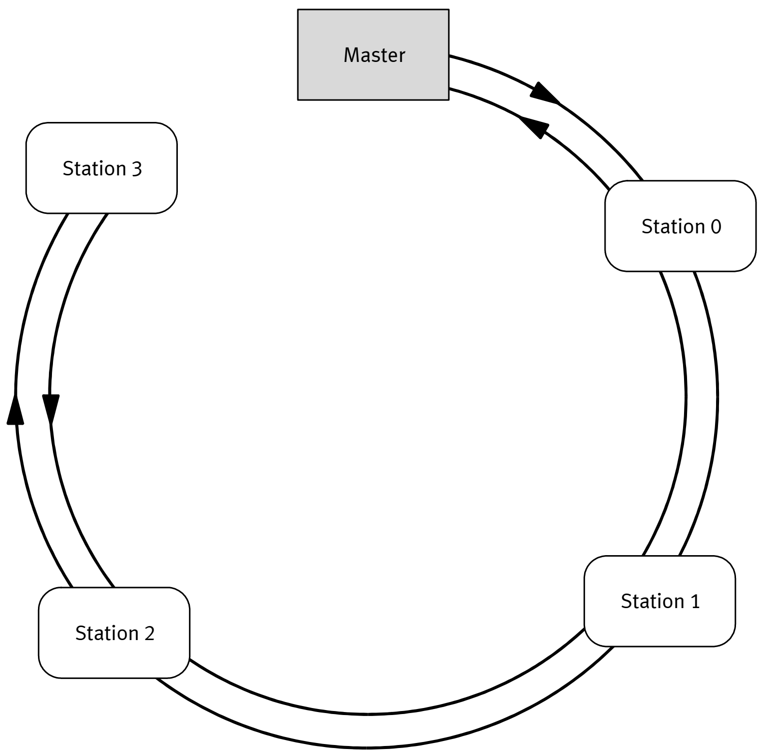
The development of station-orientated bus systems is based on the cabling structure of a machine. An ordinary installation, without the use of a fieldbus, is equipped with a central control cabinet and a large umber of central terminal strips as well as several terminal boxes distributed on the machine.

The cabling of a machine can be considerably simplified if these terminal boxes are replaced by fieldbus stations and a fieldbus master is installed in the central control cabinet.

This example of an ordinary machine installation is also based on the premise that all stations on the machine are cyclically polled by a central PLC, i.e. that all inputs and outputs are polled once with each PLC cycle. In order to ensure that the basic structure of a PLC program is not disturbed, the polling of all stations must be extremely fast and equidistant, i.e. always at identical intervals.

The physical ring

The system developed by Phoenix Contact to meet these requirements is a physical ring. All stations are sequentially connected with a two-wire line, which is interrupted at each station. Since the serious disadvantage of such a configuration means that the entire system is completely blocked even if only one single station malfunctions (the ring is interrupted), the ring structure has been modified so that the ring conductor is routed back through all the stations. In this way, each station closes the ring as soon as it is registered that there is non-sequential station. In contrast with all other topologies this makes it possible to uniquely identify the last station of this “ring”.



The „ring“ is conducted back through all stations with the “last” station automatically closing the ring.

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The shift register

Data within the Interbus ring -Rings is not transmitted via individual polling of the master station; instead the ring is used as a large distributed shift register. Starting from the master station, data is shifted. With this, output data is simultaneously sent from the master to the fieldbus stations and from the fieldbus stations to the masters. With the help of a check word the master station detects whether the ring has been completely executed and how many stations there are in the ring.

In order to read the input data of all connected stations and simultaneously write the output data to all the connected stations, this shift register requires exactly one cycle more than the actual stations comprising the ring. Furthermore, an additional telegram is required to confirm that the data is correct. A very high efficient data transfer is therefore achieved. Added to this, a consistent number of stations only ever require the same number of telegrams in order to perform a complete data exchange.

3.3 The multi-master concept

Doubtless the Profibus can also be used as a multimaster bus, albeit from a different premise.
Systems such as the CAN bus (Controller Area Network) or the EIB (European Installation Bus) “think” about neither of the structures in logic channels, i.e. the communication between two explicitely addresses stations, nor the cyclical polling. With the flawless multimaster concept, each station sends the data that is to be made available to the entire system. Equally, each station uses exactly the data that is of interest for its own purposes.

Example

The temperature contoller
The underlying concept can be most easily explained with the help of an example:
- The oil lubrication of a gear unit is temperature controlled. The temperature controller is equipped with a CAN interface which is programmed as follows. At the correct temperature, a telegram is to be sent cyclically with the current temperature, plus a telegram sent instantaneously if the temperature is not correct.
- The central controller is also equipped with a CAN interface and acquires the messages relayed via the bus. A time module in the central module is programmed in such a way that an error message is generated if a message has not been sent by the temperature controller for more than 6 minutes. The temperature controller is also programmed so that the system is stopped if an incorrect temperature is signalled via the bus.

- A visualisation system with CAN interface is installed in the master console and this is programmed so that an incorrect temperature signalled via the bus is displayed.
- The master computer is also equipped with a CAN interface. This logs each message of an incorrect temperature giving the date, clock time and duration of the anomaly to facilitate contiguous error statistics.

The basic idea of only transmitting telegrams that are necessary (in contrast with cyclical polling of input modules), leads to a drastic reduction in the number of telegrams to be transmitted. The additional idea of each station evaluating each telegram and individually deciding whether this telegram is of any significance also leads to a reduction in the number of telegrams since there is no need for several separate telegrams with identical content to be transmitted via separate logic channels.

Bus access

Such a concept almost automatically leads to the question of what happens if several stations want to simultaneously send a message. As in the case of all bus systems, a message one started is not “interrupted”. However, in the case of for example several hundreds of buses stations it is easily conceivable that two stations will start to transmit a message at exactly the same time. In such a case, each station assigned a priority. The message from the station with the highest priority is evaluated as the most important message by the system and is transmitted, whilst the other messages are interrupted and repeated at a later stage.

3.4
The installation concept

The introduction of fieldbus systems led to new qualification requirements. The careful installation of fieldbus lines, often with bus terminating resistors, the addressing of individual stations via hardware or PC, the strict compliance with a particular topology - all of these are requirements which are in themselves daunting, irrespective of how complex or simple the tasks involved may be.

Added to this is that at the end of all the above described fieldbus concepts (with the exception of CAN), there is a fieldbus station, to which sensors and actuators with plugs or terminal strips need to be connected.

Finally, the hardware of many fieldbus systems is so expensive that it is only worth installing it if a sufficiently high number of actuators/sensors is connected to a bus station.
These findings of these reservations regarding fieldbus systems gave rise to the call for a really simple system. Such a system

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- must be very easy to install, preferably with the need for screwdrivers, and definitely without solering bits,
- must not require bus terminating resistors,
- must not enforce a topology,
- must not require any complex rotary switches or DIL switches in the event of servicing and
- must be sufficiently inexpensive to be routed through to the individual actuator or sensor.

Examples of the response to these calls are the AS-i bus (actuator/sensor/Interface), the Interbus I/O Loop or the Allen-Bradley Device-Net.

3.5 Fieldbus types and their areas of application

Fieldbus type	Area of application	Characteristics
Profibus	Field level and cell networks with few stations	There are three protocol profies for the Profibus, which can be operated jointly on one line (RS 485 or fibe-optic cable
Profibus-FMS (fieldbus message specification)	Data exchange and monitoring – between networked systems and higher-order control systems – between field devices with FMS interface	Typical representative of the multimaster method Topology: Line
Profibus-DP (decentralised peripherals)	Data exchange and monitoring of decentralised processes, e.g. compiling of sensor signals from more than 100 sensors	Very quick reaction times Typical representative of a master/slave system Topology: Line
Profibus PA (process automation)	Expansion of Profibus-DP by a transmission technology which permits use in areas subject to explosion: Transmission of complex measurement data, such as it occurs in large quantities and often with very distant measuring points	
CAN	Interference-free network of intelligent electronics in automobiles	All bus stations are equal, multimaster system with simultaneous access and collision avoidance (CSMA/CA – Carrier-Sense Multiple Access/Collision Avoidance).
Interbus	Such as Profibus-DP in the sensor/actuator area	Very fast reaction times Topology: Ring
Interbus Loop I/O	Network system for binary sensors and actuators on the lowest field level	Topology: Everything is possible
AS-Interface	Network system for binary and analogue sensors and actuators on the lowest field level	Simple installation/network by means of self-healing cable technology Topology: Apart from ring structure, everything is possible

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3.6 Summary

There are four different basic concepts according to which fieldbus systems are designed. These are the message-orientated, station-orientated, multi-master and installation-orientated concept.

The **message-orientated concept** recognises the connection set-up, data exchange and connection termination. The most important representative of this concept is the Profibus. The message-orientated concept is generally connected to a line, usually a line with a twisted pair of cables with a bus blanking plug.

With the **station-orientated concept** the data is passed through all the connected bus stations. The most important representative of this concept is the Interbus. The station-orientated concept is based on the wiring up of machines to a central control cabinet. The machines with their terminal boxes are connected to a central terminal strip within the control cabinet. The fieldbus master assumes the function of the terminal strips. The stations are connected sequentially with a two-wire cable in a physical ring.

The **multimaster concept** is a system in which each station in the fieldbus system is a master, i.e. can access the bus independently. The most important representatives of this concept are the CAN-Bus and the EIB.

In the case of the **installation concept** the emphasis is on the simple installation of the stations to be connected. The most important representatives of this concept are the AS-Interface bus and the Interbus I/O-Loop. A mandatory topology is not specified, i.e.either a line, tree or star structure is possible.

Different preferred areas of application exist in production for the various bus systems. The installation concept for instance is suitable at the sensor/actuator level for the networking of these components. Depending on concept and the requirements in a factory, each bus system has a specific area of application.

4. The Profibus-DP

Training aims

Trainees are to
- be familiar with the differences between the various Profibus types, Profibus FMS, PA and DP
- be familiar with the advantages and characteristics of Profibus-DP
- be familiar with the lines and push-in connections in signal transmission with Profibus-DP
- be familiar with the mode of operation of Profibus-DP: Data exchange, internal and external DP master, connection with active and passive slaves

Profibus actually means PROcess FIeld BUS and has been standardised since 1991 through DIN 19245 and since 1996 through EN 50170. Its area of application is both the actuation of sensors and actuators on the lowest field level and also the networking of automation devices and process controllers on the controller and cell level. The Profibus standard is an open standard and Profibus is therefore vendor independent. Devices from a wide range of different manufacturers with a Profibus interface can therefore be connected without problem and used to solve an automation task. So much for its purpose in theory. However in practice, the rather broad spectrum of application of Profibus requires a degree of specialisation. This is why to date three Profibuses are available:
- Profibus-DP
- Profibus-FMS
- Profibus-PA

Profibus-DP
(Decentralised Peripherals)

Decentralised peripherals means the accommodation of groups of PLC inputs and outputs at decentralised points within the system periphery and their connection to the master via a two-wire line. These days, anyone referring to Profibus generally means Profibus-DP. This is the most widely used of all Profibus systems. Its strength is in its speed of collecting sensor signals from up to 125 bus stations and of distributing actuator signals to as many stations. It is the typical representative of a master/slave system. Because it is so widespread in practice, it is to be explained in detail further on.

Profibus-FMS
(Fieldbus Message
Specification)

The function of the Profibus-FMS is the data exchange between networked systems and with higher-order control systems. It is a representative of the message-orientated multi-master system. In order to maintain systematic communication, a token is passed from one master to the next on completion of its communication. Once all the masters have had a turn, this starts again from the beginning. This structure is known as „logic token ring“ and the method „token passing system“. However, despite this description, the bus stations are by no means connected in ring form. The physical structure (topology) of a Profibus-FMS is the line.

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Profibus-PA
(Process Automation)

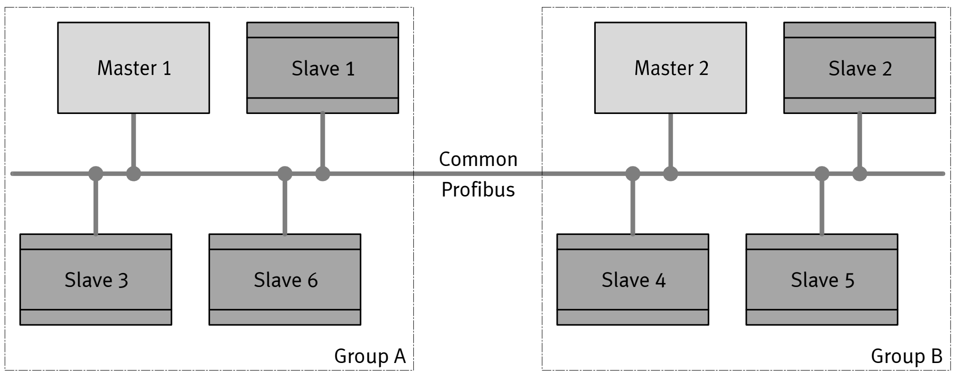
The strengths of the Profibus-PA is the transmission of complex measurement data, such as it frequently occurs with the automation of procedural systems and where the measurement points are often very wide apart. One example of this is an oil refinery. Here, the filling levels of the crude oil store and the fuel distributor are just as important as the temperature and condition of the surplus gas burner. For reasons of safety, these are not arranged directly next to one another, but nevertheless can be connected to the same bus.

4.1 Fundamentals

The Profibus-DP is the most widely used of all Profibus systems. The reasons for this are

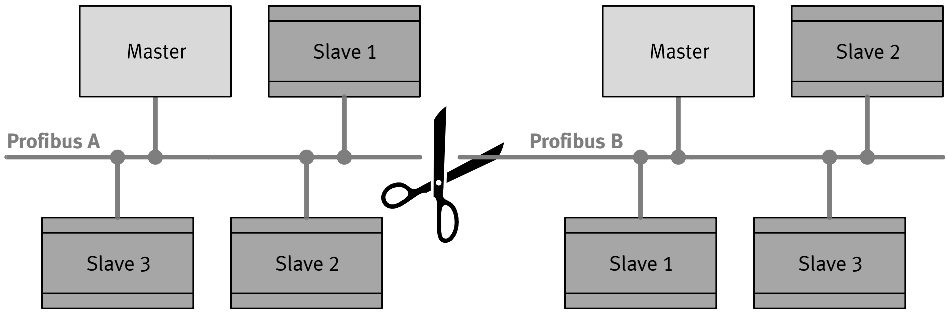
- its speed,
- its very easy to handle system in connection with an S7 controller,
- software tools which enable comprehensive diagnostics.

These facts make it a popular „introductory bus“. In principle, several masters can be connected to a Profibus as in the case of any Profibus. However, for reasons of safety, a slave is only ever assigned to one master. If two masters were to try to write to the outputs of one and the same slave, chaos would reign. In order to create a systematic process of communication, the masters must always pass on a token. Only the master that has the token is allowed to communicate with its slave. All other masters have a mandatory delay. Master/master communication is limited to the passing of the token, whereby a data exchange is not possible.



Profibus as multi-master/slave system

The following picture emerges if you now divide this Profibus into two bus systems that are independent of one another:

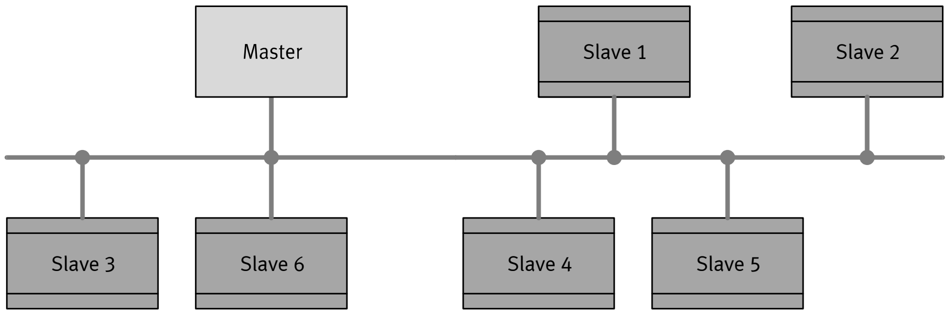


Profibus as master/slave system

The speed with which the addresses of slaves are read and written is more than doubled. On the one hand, there are no mandatory delays during which the other master communicates with its slaves and, on the other hand, no token needs to be passed. As such, it is highly unlikely for anyone to configure a Profibus-DP with several masters. A second master, usually a PC, is only temporarily integrated during test phases for diagnostic purposes.

The Profibus-DP is therefore the typical representative of a (mono or single) master/slave system.

4.2
Topology
of Profibus-DP



Profibus-DP as single master/slave system

As the simple sketch shows, the topology of the Profibus-DP is a line. This means that the bus connection has a beginning and an end. In between the master and all slaves are connected in any order.

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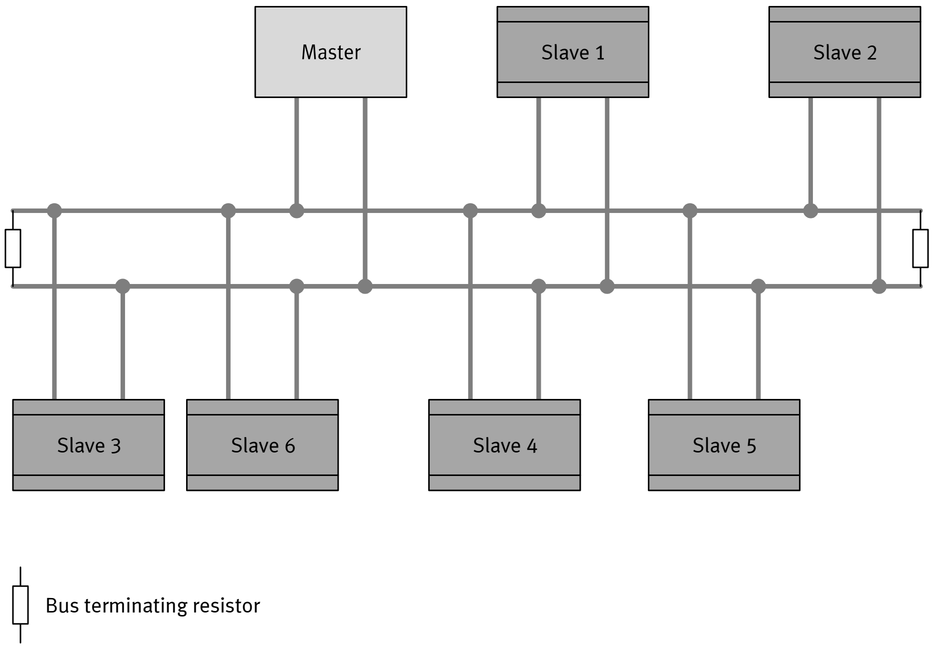
Bus termination

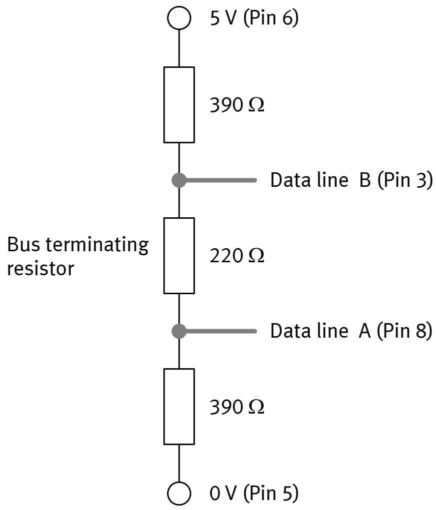
The bus is an electrical twisted, unscreened 2-wire line of up to 200 m in length, terminated at both ends by means of bus terminating resistors. Special plugs are available for connection to the modules, to which two cables (incoming and outgoing) can be connected. Alternatively, so-called „T-connectors“ are available. These are modules with 3 plugs, 1 x incoming, 1 x outgoing and 1 connection for the module. They can also be soldered on to a bus-terminating resistor. The corresponding connecting cable (branch line) must not exceed a maximum length of 30 cm.



Bus termination

A maximum of 31 stations may be connected to a string of this type. This is stipulated by the standardised interface RS 485, which must supply the base load (2x bus terminating resistor) electrically and can supply a maximum of 31 additional interfaces with electrical power. With more interfaces it would be overloaded.

When speaking of a bus terminating resistor, this always refers to a group of three resistors, which are wired according to the following representation:



Bus terminating resistor, wiring

The designation in brackets is the pin allocation in the standardised Profibus - RS 485 plug.

A Profibus-DP master can address and activate up to 127 slaves. The last two addresses (126 and 127) are reserved for commissioning aids. All other addresses are freely selectable and do not need to be contiguous.

With more than 31 slaves or a bus length of more than 200 metres, a so-called repeater needs to be used. In principle, a repeater is no more than an amplifier. It electrically loads the bus on one side like a station, but makes available a completely new line for 31 additional stations on the other side.

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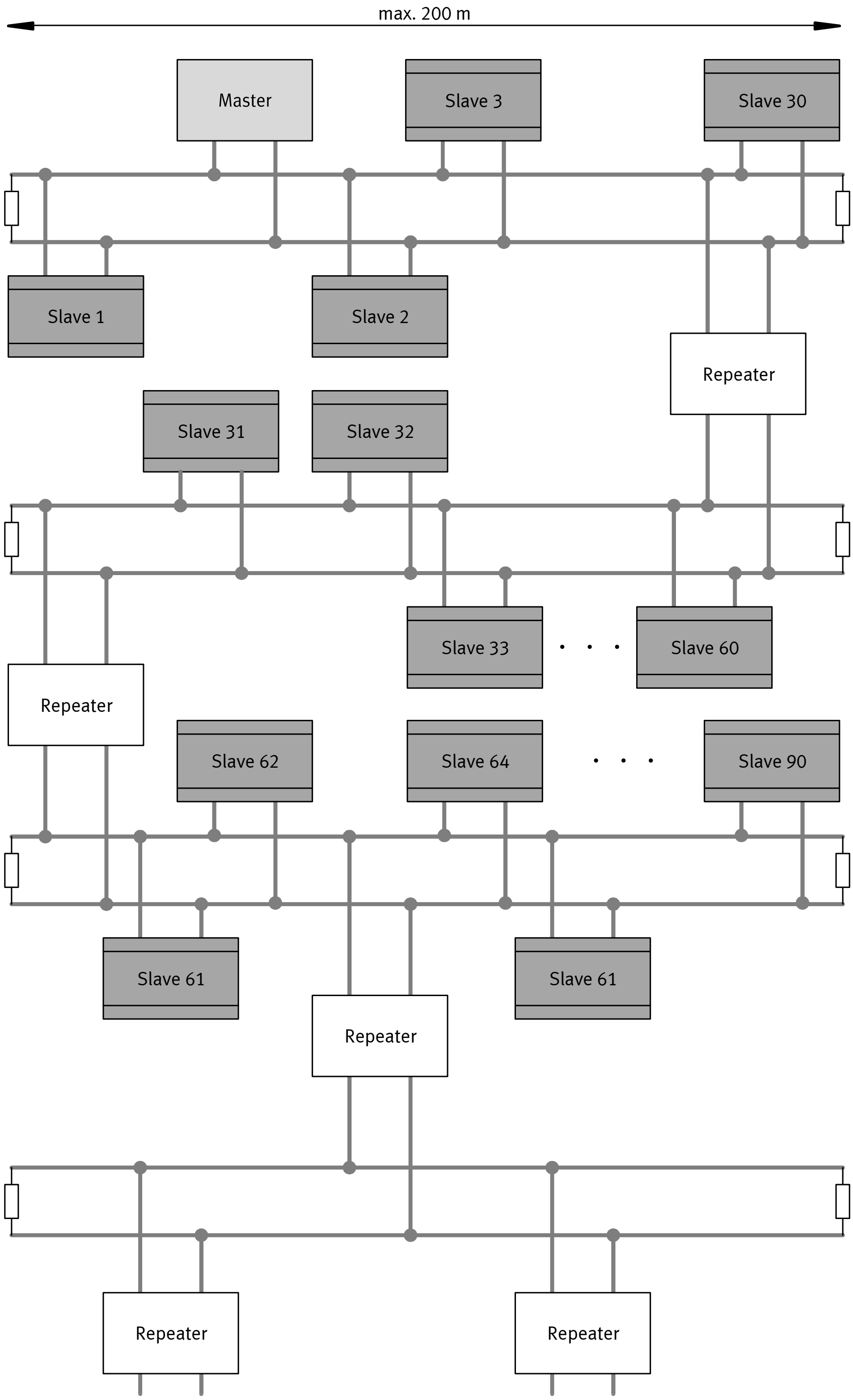
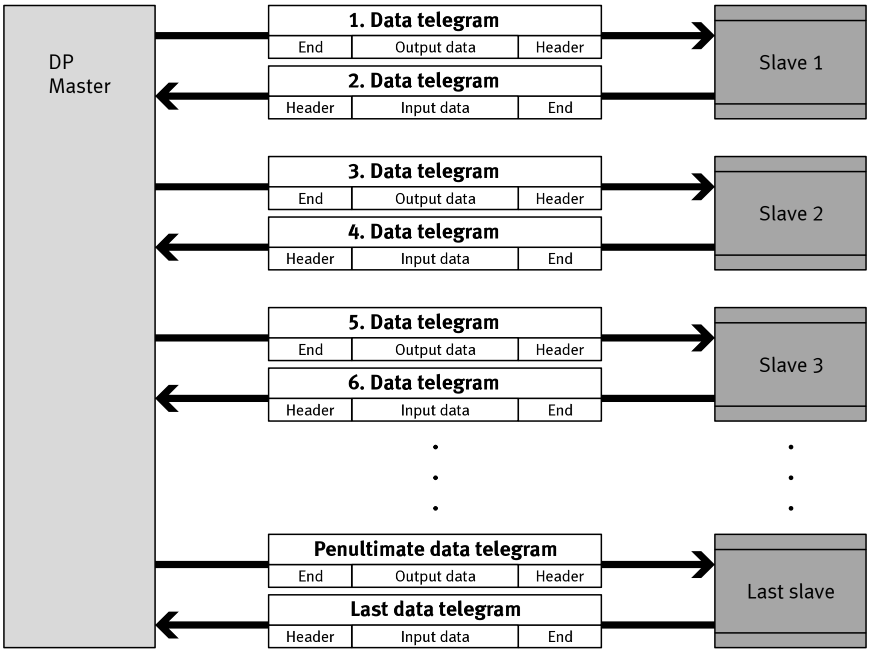


Tree-type bus structures with the help of repeaters

In the upper section of the illustration „tree-type bus structures with the help of repeaters“, you can see repeaters used for the extension of the bus, i.e. for the connection of more than 31 stations. A repeater, like a station, counts as an interface. The lower section of the illustration indicates that, with the use of several repeaters, it is quite possible to realise tree-type structures. However for reasons of clarity, these are not recommended.

4.3 Mode of operation of Profibus-DP

The principle of data exchange is shown in the illustration below:



Data exchange between DP master and slaves

As can be easily seen, each slave requires two data telegrams. Initially, the master sends a telegram to the first slave, which contains the most important information in the header, the address of the slave. This is followed by the current output data for the decentralised outputs. Finally, there are a whole series of check bits and the end bit. The slave with the address specified in the header accepts the data and passes it on to its outputs. It then transmits a response telegram with the current status of its inputs to the DP master. Immediately after this, a watchdog time starts. If no further messages are received from the DP master by the time the watchdog time has expired, it signals a bus malfunction (LED flashing) and moves into a safe status. In most cases this means „switch off all outputs“.

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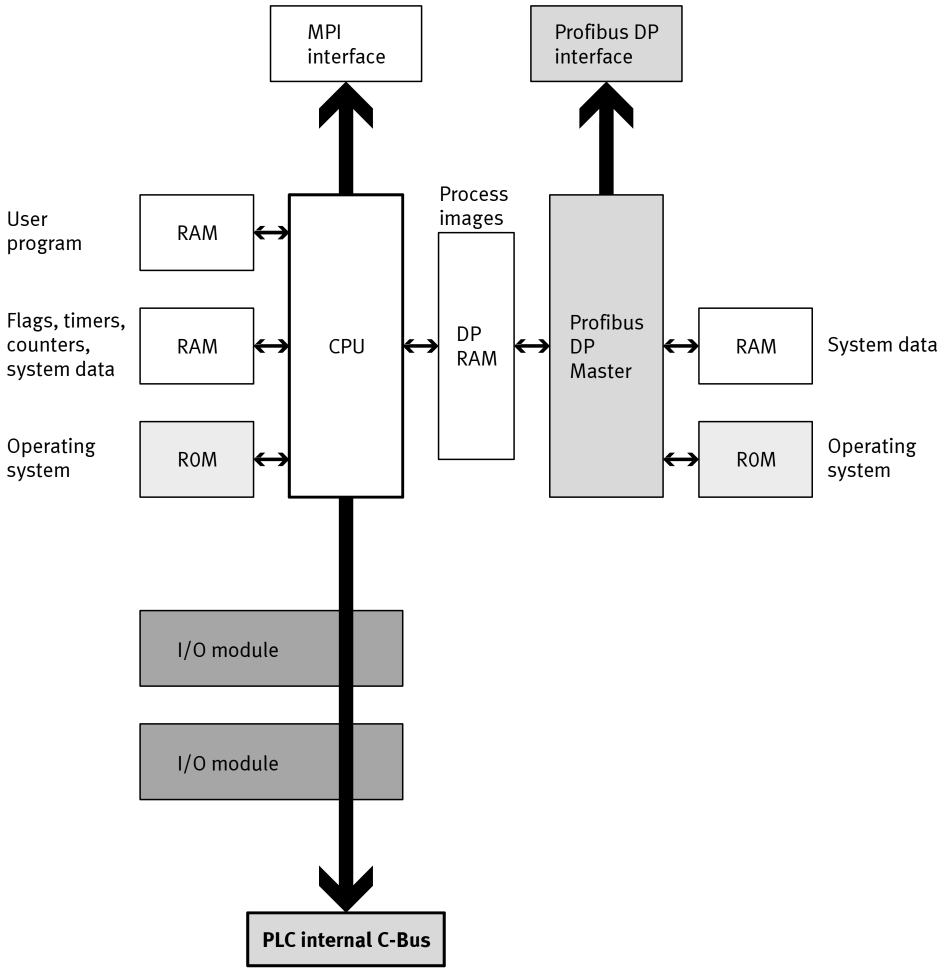
In the interim, the DP master transmits the next telegram to the next slave, which responds again, next slave, and so on. Once the last slave is finished, the master starts again from the beginning.

If a slave does not respond within a specific time, the master repeats its telegram. If a station remains silent after the third call, the DP master signals „station failure“ and moves on to the next slave with its cycle. The watchdog time of a slave is set for at least so long (standard) that, if 124 stations remain silent, the 125th station still does not trigger an alarm.

A small bus with just a few stations is generally executed fairly quickly. The decentralised I/Os are polled in a very short time. If a bus with a large number of stations (e.g. 100 and more) is set at less than 12 Mbit/s and telegrams need to be repeated several times due to major disturbance, several milliseconds may pass until a decentralised input signal of the CPU is available.

4.4 CPU with integrated Profibus-DP master

In the case of conventional use of the Profibus-DP, a PLC controls several slaves. In the most simple of cases, this may be a CPU with integrated Profibus-DP master. In this case, there is a second processor in the same module, the so-called bus processor. This can be established in the second LED line for status messages on the CPU module. The dividing line between CPU and bus processor is the main memory, in which the image table is stored. This is a so-called DP RAM. In this case however, DP does not stand for decentralised peripherals, but DP RAM stands for „Dual Ported – Random Access Memory“.



SIMATIC CPU with integrated DP master

On one side of the DP RAM is the CPU. This reads the input modules via the C-Bus (communication bus) at the start and writes these to the appropriate locations in the DP RAM. After this, the user program is processed using the image table. Finally, the CPU transmits the current output data to the output modules via the C-Bus. Then everything starts again anew. The decentralised I/Os are merely read from the PII (Process Image of Inputs) and written to the PIO (Process Image of Outputs).

On the opposite side of the DP RAM, the Profibus-DP master is continually busy updating the decentralised I/Os. The DP master updates its I/Os, even if the CPU is in the STOP status. This can be established by the fact that a bus malfunction is displayed with BF-LED (BF = Bus Fault), irrespective of the operating status of the CPU. Once the bus fault is eliminated, the BF-LED goes out again, irrespective of the operating status of the CPU.

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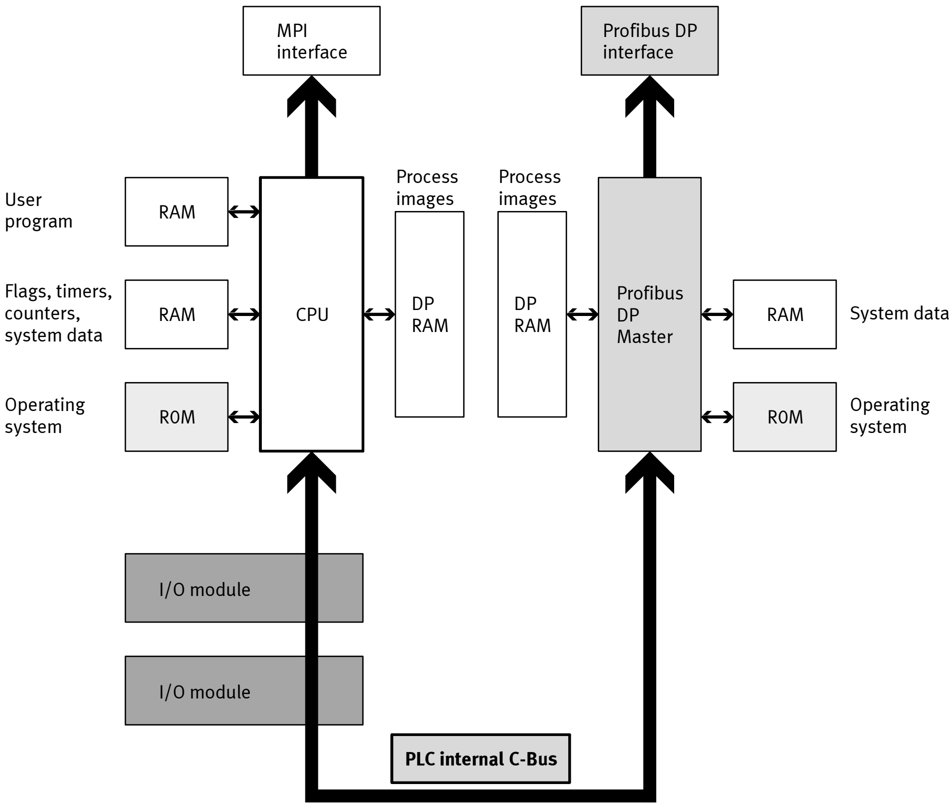
4.5 CPU and external Profibus-DP master

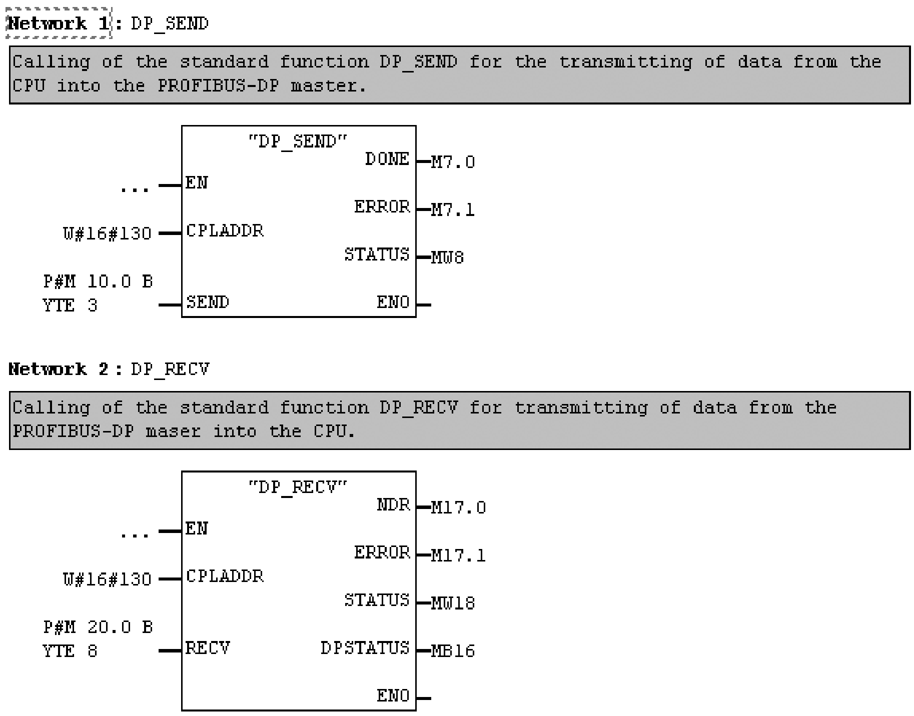
The C-Bus is the sole connection between the modules, if a CPU (e.g.. Siemens CPU 314) is used with an external Profibus-DP master (e.g. Siemens CP 342-5).



SIMATIC CPU and external DP master

With this configuration, the data from the RAM of the CPU needs to be transmitted to the RAM of the DP master and vice versa per program command. The two standard functions „DP_SEND“ and „DP_RECV“ are available for this. These are integrated into the user program in such a way that they are polled in each program cycle.

A program example is illustrated below for the two standard functions „DP_SEND“ and „DP_RECV“ (Siemens STEP 7).



Program example for DP_SEND and DP_RECV

The polling in this example is to be interpreted as follows:

Network 1: DP_SEND

- W#16#130 means the hexadecimal representation of the value „130H“. It is the peripheral address of module No. 7 (130H = 304Dec.). The Profibus-DP master is therefore in slot 7.
- P#M10.0 BYTE 3 means that the peripheral outputs which cannot be directly written by the program, are alternatively in the flag address area as from flag 10.0 and are 3 byte long, i.e. M10.0 – M12.7. The flag area is an arbitrary definition of the programmer. The length is obtained from the number and size of the slaves. 3 byte is unusually little.
- Upon successful execution, a „1“ is written to M7.0.
- A „1“ is written to M7.1, in the event of a fault.
- FW8 records the last occurred fault even after it has been eliminated. The significance of the fault number can be found in the manual of the DP master.

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Network 2: DP_RECV

- W#16#130 means the hexadecimal representation of the value „130H“. It is the peripheral address of module No. 7 (130H = 304Dec.). The Profibus-DP master is therefore in slot 7.
- P#M20.0 BYTE 8 means that the peripheral inputs which cannot be directly read from the program, may alternatively be in the flag address area as from flag 20.0 and 8 byte long, i.e. M20.0 – M27.7. The flag area is an arbitrary definition by the programmer. The length is obtained from the number and size of the slave.
- Upon successful execution, a „1“ is written to M17.0.
- A „1“ is written to M17.1 in the event of a fault.
- MW18 records the number of the last occurred fault, even after it has been eliminated. The significance of the fault number can be found in the manual of the DP master.
- MB16 records the status of the Profibus. The significance of the status number can be found in the manual of the DP master.

For instance, if output 0.0 of a valve terminal is to be set, the flag 10.0 is to be set in the program. The transmission is assumed by the DP_SEND-module.
If input 0.2 of the terminal is to be polled, the flag 20.2 is polled in the program.
All this is dispensed with in the case of a CPU with integrated Profibus-DP master.

OB82 and OB86 in SIMATIC controllers

If a bus fault occurs, e.g. failure of a slave, this is recognised by the integrated DP master and communicated to the CPU. Depending on the fault, this then starts the „rack failure OB“ OB86 or the„diagnostic alarm OB“ OB82. If this call goes undetected, i.e. the polled OB does not exist in the CPU, the CPU inevitably goes to STOP. The operating system would like to write a whole list of diagnostic data regarding type of fault, fault location, date and time, etc. to the local data of the OB so that this can be evaluated by the programmer for each program, but the module has to be available for this. For this reason, you should create both OBs, save them without content and load them to the CPU, even if you are not making any diagnostic evaluation. If a bus station now fails, the CPU will nevertheless continue running.

4.6 Active and passive slaves

Previously, the talk was exclusively of decentralised I/Os, i.e. of slaves without own „intelligence". These slaves are known as „passive slaves". If, during a fault, the master or a major part of the bus fails, then consequently the entire installation stops in the event of a master malfunction, or a major part thereof in the case of a bus fault.

This is why partial tasks are preferably relocated with the corresponding program parts to the slaves. (Dumb) passive slaves therefore become (intelligent) „active slaves".

By intelligent slaves we understand automation devices which execute their own user program. The advantage of such intelligent slaves is in the fact that they facilitate stand-alone subsystems at certain points of a network.

The benefits are:

- A decentralised control of this type to a large extent facilitates maintenance and fault finding. In the event of a fault on the bus or master, the active slave can at least complete the task it has commenced.
- The master is drastically relieved thanks to the relocated program parts. All it needs to do is to effect the higher-order communication between the intelligent slaves.
- Since it is no longer necessary for each input and output status to be communicated to the master, this also drastically relieves the bus. This now merely transmits status messages, enable messages, quantities and workpiece transfer data. This data is much less time critical. Quick reactions to brief sensor signals are directly effected locally.
- The super master with high performance CPU and of virtually unmanageable program complexity can become considerably smaller. Programs become smaller and above all more clearly surveyable.

What is an active, intelligent slave?

Generally an active slave is a CPU with a Profibus-DP master, irrespective of whether it is integrated or in the form of a separate module. The DP master is configured as a "slave" in the configuration and basically is connected to the master like a passive slave. However, the master does not have access to the actual existing I/Os of the active slaves. Additional "virtual" (not actually existing) I/Os are defined in the master configuration. These I/Os only exist in the image table. The connection and data transfer is assumed by the Profibus-DP. The input and output values of the active slave are polled and transmitted by the DP master via flags.

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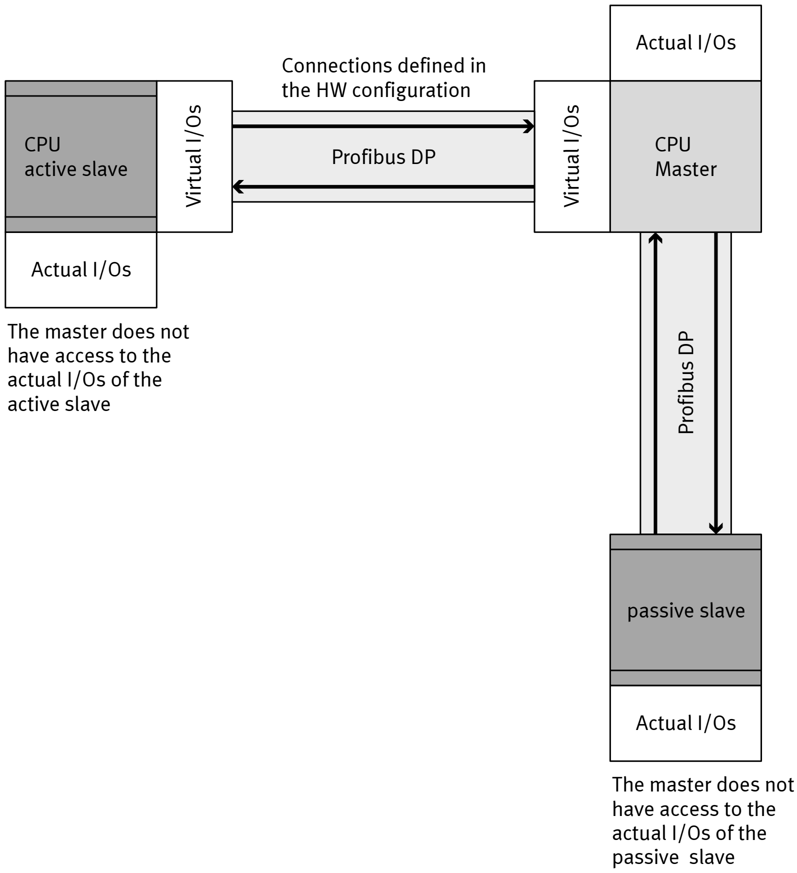

Data exchange between DP master and active, intelligent slave

Whereas the Profibus-DP was previously accommodated on the lowest field level, it can now suddenly be found on the controller level and cell level. This does not make sense and also it is not always possible to make each passive slave into an active slave. A pair of slaves is therefore always combined into an active slave, although this again requires greater cabling complexity. However, the call for a most simple bus system below the Profibus-DP has not gone unheard and sensors and actuators are therefore triggered in the smallest of modules and even individually, for example via AS-Interface.

4.7 Summary

The wide area of application for Profibus necessitated a specialisation into Profibus FMS, DP and PA:
Profibus FMS is particularly suitable for the data exchange and monitoring of networked systems and higher-order control systems. It is a representative of the message-orientated multi-master system.

The Profibus PA deals with the transmission of complex measurement data and is primarily used in process technology.
The Profibus-DP is used in the decentralised periphery for the control of decentralised systems and processes. It is the most widely used of all Profibuses and is the typical representative of a master/slave system in one line. The bus is an electrical twisted, unscreened 2-wire cable of up to 200 metres in length. The line ends with a bus terminator. A maximum of 32 stations can be connected, unless the lines are amplified by means of repeaters.

The data exchange is effected by means of cyclical polling of the slaves. 2 data telegrams are required for each slave, one for the polling of the Profibus-DP master for data and the other for the response of the slave.
In a standard case, a PLC with integrated Profibus master activates several slaves. However, in many cases it is also useful and possible to activate separately with a PLC and an external Profibus-DP master.
With the Siemens S7, bus malfunction is signalled via the organisational blocks OB82 and OB86. In order for faults to be detected and the process if necessary stopped, it is mandatory for these modules to be loaded to the controller.
To avoid bus overload and to facilitate maintenance and fault finding, intelligent, active slaves are used, which execute their own user program and therefore control their own subprocess.

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Contents

Part C – Solutions

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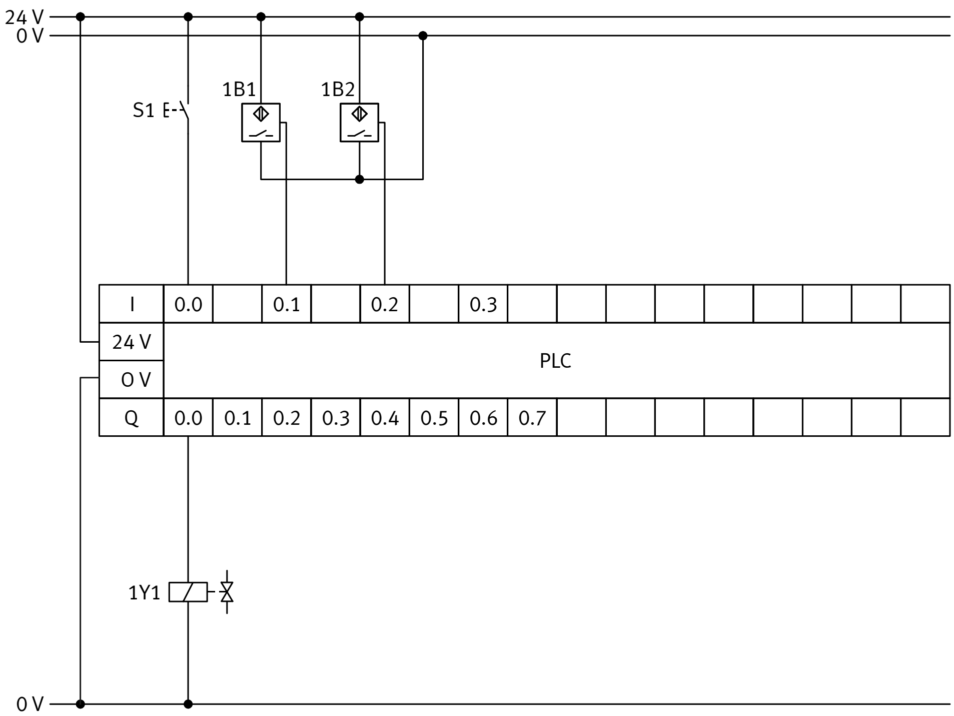
Worksheet 1: Electrical circuit diagram	
Name:	Date:



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Worksheet 3: Declaration of variables of the PLC program	
Name:	Date:

	Symbol	Address	Data type	Comment
1	1B1	I 124.1	BOOL	Zylinder eingefahren / Cylinder retracted
2	1B2	I 124.2	BOOL	Zylinder ausgefahren / Cylinder extended
3	1Y1	Q 124.0	BOOL	Zylinder ausfahren / eject cylinder
4	HM Y1	M 64.1	BOOL	Hilfsmerker für Zylinder / Auxiliary flag for cylinder
5	M_FL	M 64.0	BOOL	Flankenmerker: alter Zustand / Edge flag : old status
6	S1	I 124.0	BOOL	Starttaster / Start-button
7				

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Worksheet 6: Adaptation of the symbols table and the user program	
Name:	Date:

Symbols table of the pneumatic door control

	Symbol	Address	Data type	Comment
1	1B1	I 0.1	BOOL	Zylinder eingefahren / Cylinder retracted
2	1B2	I 0.2	BOOL	Zylinder ausgefahren / Cylinder extended
3	1Y1	Q 0.0	BOOL	Zylinder ausfahren / eject cylinder
4	S1	I 124.0	BOOL	Starttaster / Start-button
5	RACK_FLT	OB 86	OB 86	Loss of Rack Fault
6	I/O_FLT1	OB 82	OB 82	I/O Point Fault 1
7	HM 1Y1	M 64.1	BOOL	Hilfsmerker für Zylinder / Auxiliary flag for cylinder
8	M_FL	M 64.0	BOOL	Flankenmerker: alter Zustand / edge flag : old status
9				

Worksheet 7: Addresses of the Profibus stations and inputs and outputs	
Name:	Date:

Addresses of the Profibus stations and inputs and outputs

Device addresses		
CPU 313C-2DP	Profibus address	2
	Address area – local inputs	I 124.0 – I 125.7
	Address area – local outputs	Q 124.0 – Q 125.7
CPV DI01	Profibus address	1
	Address area - inputs	I 0.0 – I 1.7
	Address area - outputs	Q 0.0 – Q 1.7

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Project 3:
Pneumatic door control with Profibus valve terminal and intelligent slave
Solutions

Worksheet 8: Addresses of the Profibus stations and inputs and outputs	
Name:	Date:

Addresses of the Profibus stations and inputs and outputs

Device addresses		
CPU 313C-2DP	Profibus address	2
	Address area – local inputs	I 124.0 – I 125.7
	Address area – local outputs	Q 124.0 – Q 125.7
CPV DI01	Profibus address	1
	Address area - inputs	I 0.0 – I 1.7
	Address area – outputs	Q 0.0 – Q 1.7
ET 200S	Profibus address	3
	Address area – inputs	I 1.0 – I 1.3
		I 2.0 – I 2.3
		I 3.0 – I 3.3
	Address area - outputs	Q 4.0 – Q 4.3
		Q 6.0 – Q 6.3
		Q 7.0 – Q 7.3

Worksheet 10.1: Addresses of the Profibus stations and input and outputs

Name:	Date:

Symbols table ET 200S

	Symbol	Address	Data type	Comment
1	I/O_FLT1	OB 82	OB 82	I/O Point Fault 1
2	M13.0	M 13.0	BOOL	Intermediate memory bit
3	MB 13	MB 13	BYTE	Intermediate memory byte
4	RACK_FLT	OB 86	OB 86	Loss of Rack Fault
5	S1	I 3.0	BOOL	Start-button
6	S2	I 3.3	BOOL	Door release
7	PSB	PQB 128	BYTE	Initial byte PROFIBUS-transmission
8				

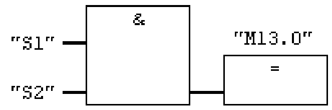
PLC program ET 200S

OB1 : Hauptprogrammzyklus / "Main Program Sweep (Cycle)"

Comment:

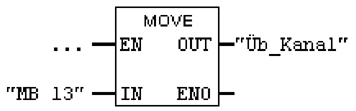
Network 1: Lokales Programm ET200 / local program ET200

Starttaster und Türfreischaltung / Start-button and door release



Network 2 : Kopieren in Profibus-Übertragungskanal / Copy to PROFIBUS-trans.

Das Merkerbyte "MB 13" wird in den PROFIBUS-DP-Übertragungskanal kopiert. / The flag byte "MB 13" is copied to the PROFIBUS-DP-transmission-channel.



Symbols table
CPU 313C-2DP

	Symbol	Address	Data type	Comment
1	1B1	I 0.1	BOOL	Zylinder eingefahren / Cylinder retracted
2	1B2	I 0.2	BOOL	Zylinder ausgefahren / Cylinder extended
3	M12	I 12.0	BOOL	Starttaster und Türfreischaltung / Start-button and door release
4	M_FL	M 64.0	BOOL	Flankenmerker: alter Zustand / Edge flag : old status
5	HM_1Y1	M 64.1	BOOL	Hilfsmerker für Zylinder / Auxiliary flag for cylinder
6	I/O_FLT1	OB 82	OB 82	I/O Point Fault 1
7	RACK_FLT	OB 86	OB 86	Loss of Rack Fault
8	1Y1	Q 0.0	BOOL	Zylinder ausfahren / eject cylinder
9				

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Worksheet 10.2: Addresses of the Profibus stations and inputs and outputs	
Name:	Date:

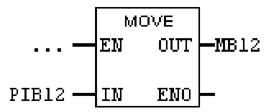
PLC program
CPU 313C-2DP

OB1 : Hauptprogrammzyklus / "Main Program Sweep (Cycle)"

Comment:

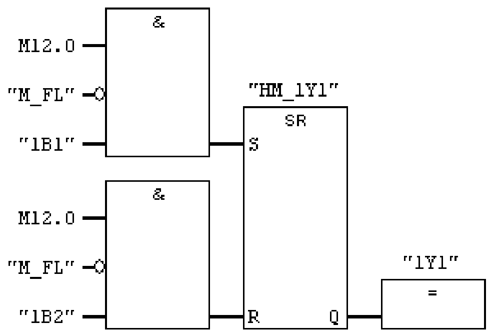
Network 1 : PROFIBUS-Übertragungskanal / PROFIBUS-DP-transmission-channel

Hier werden die Daten aus dem PROFIBUS-Übertragungskanal ausgelesen und im Merkerbyte 12 abgelegt. / Read-out data from PROFIBUS-DP-transmission-channel and deposit in flag byte "MB 12".



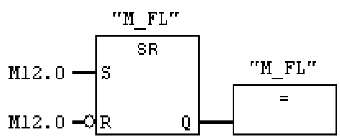
Network 2 : Zylinder ein- und ausfahren / Retract and extend cylinder

Zylinder ein- und ausfahren / Retract and extend cylinder



Network 3 : Merker M_FL zur Flankenerkennung / flag"M_FL" for edge detection

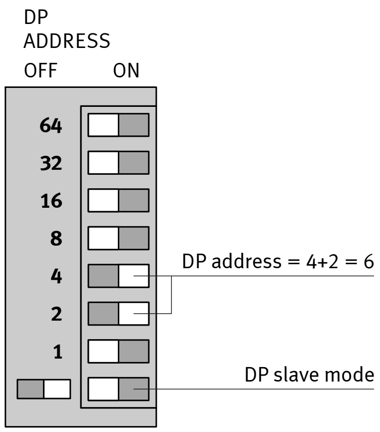
Comment:



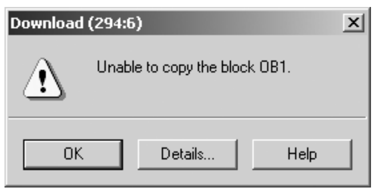
Worksheet 13.1: Simulating a fault during commissioning	
Name:	Date:

Error detection

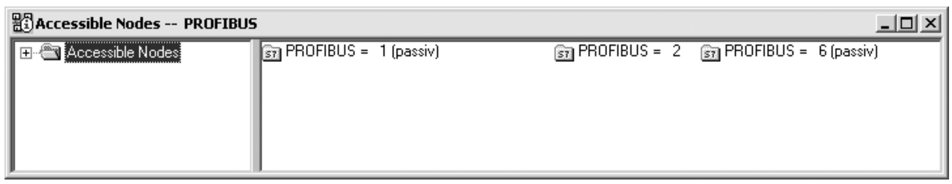
Address 6 on the ET 200S



Error message during program loading



Accessible stations



All stations are networked. Here you can see that station address 6 is set on the ET 200S.

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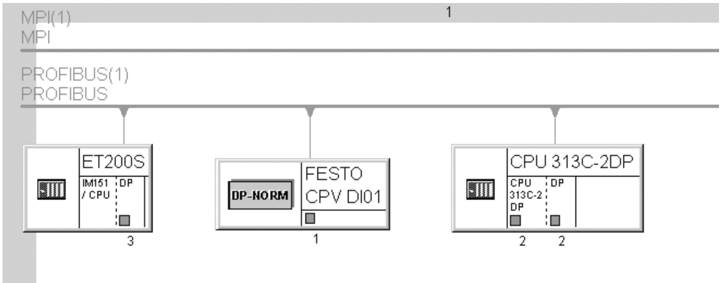
Worksheet 13.2: Simulating a fault during commissioning	
Name:	Date:

Profibus configuration in STEP 7



Address 3 was allocated in STEP 7 for the ET 200S.

The address you have set on the ET 200S therefore does not coincide with the Profibus configuration in STEP 7.

Error elimination

Change

- Either the address on the ET 200S by setting address 3 via the DIP switches-
- or change the address of the ET 200S (address 6) in the Profibus configuration of STEP 7

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Worksheet 8: Addressing of the PROFIBUS stations and inputs and outputs	
Name:	Date:

Device addresses		
CPU 313C-2DP	Profibus address	2
	Address area – local inputs	I 124.0 – I 125.7
	Address area – local outputs	Q 124.0 – Q 125.7
ET 200S	Profibus address	3
	Address area - inputs	I 1.0 – I 1.3
		I 2.0 – I 2.3
		I 3.0 – I 3.3
	Address area - outputs	Q 4.0 – Q 4.3
		Q 6.0 – Q 6.3
		Q 7.0 – Q 7.3

Worksheet 9.1: Creating the symbols table and control program for the ET 200S	
Name:	Date:

Symbols table ET 200S

	Symbol	Address	Data type	Comment
1	1B1	I 1.0	BOOL	Ausschiebzyl. eingefahren / Ejecting cylinder retracted
2	1B2	I 1.1	BOOL	Ausschiebzyl. ausgefahren / Ejecting cylinder extended
3	1Y1	Q 6.0	BOOL	Ausschiebzyl. Werkstück ausschieben/ Ejecting cylinder eject workpiece
4	B4	I 1.2	BOOL	Sensor Werkstück im Magazin / Sensor workpiece in magazine
5	P_Auto	FC 10	FC 10	Ablaufprogramm / Sequence program
6	P_Komm	FC 20	FC 20	Kommunikation / Communication
7	S1	I 3.0	BOOL	Taster Start / Start button
8	SStep01	M 10.0	BOOL	Schritt 1 Slave /Step 2 Slave
9	SStep02	M 10.1	BOOL	Schritt 2 Slave/ Step 2 Slave
10				

PLC program ET 200S
OB1

```
OB1 : Organisationsprogramm / organisation program block

Comment:

Network 1: Kommunikation / Communication

Kommunikation / Communication

        "P_Komm"
... ──EN    ENO──

Network 2 : Ablaufprogram / Program sequence

Ablaufprogramm / Program sequence

        "P_Auto"
... ──EN    ENO──
```

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Worksheet 9.2: Creating the symbols table and control program for the ET 200S	
Name:	Date:

PLC program ET 200S
OB100

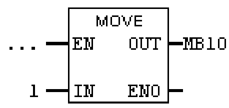
OB100 : Anlaufbaustein / Start-up block

Der Anlaufbaustein wird beim Einschalten der Spannungsversorgung der SPS als erstes einmal durchlaufen. Beim Anlauf setzt der Baustein alle Ausgänge und Merker zurück. Der Initialisierungsmerker wird als einziger Merker gesetzt. Dieser Merker hat für einen Zyklus 1-Signal und wird im OB1 wieder zurückgesetzt.

If the power-supply of the plc is started, first the start-up program block will be activated once. On start-up procedure this program resets all outputs and flags - except the initialisation flag. The initialisation flag "Init_Bit" is set and has 1-signal for one program cycle. The "Init_Bit" is reset after one cycle at the end of the organisation program block OB1.

Network 1: Rücksetzen der Merker / Reset of flags

Alle Merker werden zurückgesetzt (der Wert 1 wird in das Merkerbyte MB10 geschrieben). / Reset of all flags, (the value 1 is written to the flag byte MB10).



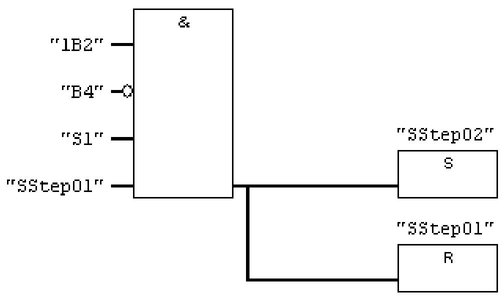
PLC program ET 200S
FC10

FC10 : Magazinsteuerung / Control of magazine

Magazinsteuerung / Control of magazine

Network 1: Prozessanlauf / Starting-up process

Prozess wird gestartet wenn Magazin voll, Magazinschieber eingefahren ist und Starttaster gedrückt wird. / Process is starting if the magazine is filled, the magazine slide is retracted and the start-button was pressed.

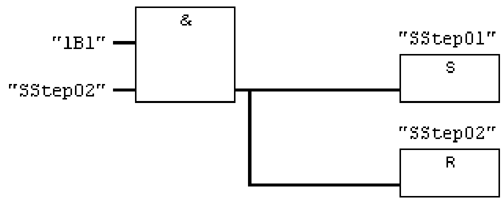


Worksheet 9.3: Creating the symbols table and control program for the ET 200S	
Name:	Date:

PLC program ET 200S
FC10 (continuation)

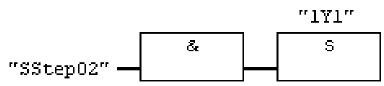
Network 2 : Neustart Prozess / Restart process

Wenn der Magazinschieber ausgefahren ist beginnt der Prozess mit Schritt 1 neu / If the magazine-slide is extended, the process is restarted with Step1.



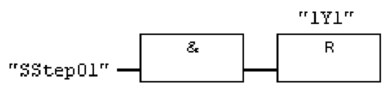
Network 3 : Ansteuerung _1Y1 / Control _1Y1

Ausschiebezyl. Werkstück ausschieben / Ejecting-cylinder eject workpiece



Network 4 : Ansteuerung _1Y1 / Control _1Y1

Ausschiebezyl. zurückfahren / retract ejecting-cylinder



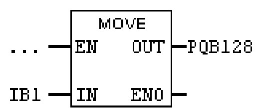
PLC program ET 200S
FC20

FC20 : Title:

Comment:

Network 1: Transmission sensor-signal

Transmission of the sensor-signal in "IB1" to "PQB128".



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Worksheet 10.1: Creating the symbols table and control program for the CPU 313C-2DP

Name:	Date:

Symbols table
CPU 313C-2DP

	Symbol	Address		Data type	Comment
1	1B1	I	0.2	BOOL	Ausschiebzyl. eingefahren / Ejecting cylinder retracted
2	1B2	I	0.1	BOOL	Ausschiebzyl. ausgefahren / Ejecting cylinder extended
3	1Y1	Q	0.0	BOOL	Ausschiebzyl. Werkstück ausschieben/ Ejecting cylinder eject workpiece
4	2B1	I	0.3	BOOL	Werkstück angesaugt / Workpiece gripped
5	2Y1	Q	0.1	BOOL	Vakuum ein / Vacuum on
6	2Y2	Q	0.2	BOOL	Vakuum aus / Vacuum off
7	3S1	I	0.4	BOOL	Schwenkzyl. in Pos. Magazin / Swivel drive in pos. magazine
8	3S2	I	0.5	BOOL	Schwenkzyl. in Pos. Folgestation / Swivel drive in pos. subsequent station
9	3Y1	Q	0.3	BOOL	Schwenkzyl. zu Magazin / Swivel drive to magazine
10	3Y2	Q	0.4	BOOL	Schwenkzyl. zu Folgestation / Swivel drive to subsequent station
11	B4	M	12.2	BOOL	Sensor Werkstück im Magazin / Sensor workpiece in magazine
12	H3	Q	124.0	BOOL	Leuchtmelder Magazin leer / Magazine empty indicator light
13	P_Komm	FC	20	FC 20	Kommunikation / Communication
14	S1	I	1.0	BOOL	Taster Start / Start button
15	S4	I	1.3	BOOL	Taster Richten / Reset button

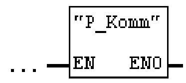
PLC program
CPU 313C-2DP
OB1

OB1 : Organisationsprogramm / Organisation program-block

Comment:

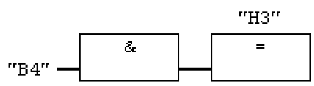
Network 1: Aufruf des Kommunikationsprogramms / Calling communicat.prog.bl.

Aufruf des Kommunikationsprogramms / Calling the communication program block



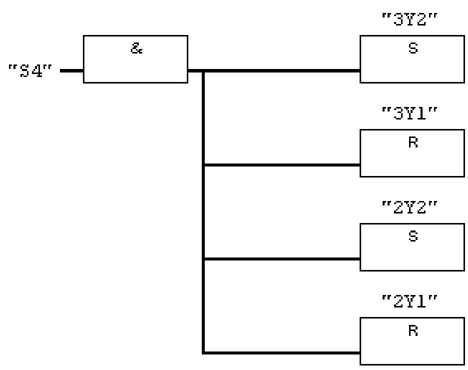
Network 2 : Anzeige Magazin leer / Indication magazine empty

Anzeige Magazin leer / Indication magazine empty



Network 3 : Richten / Reset

Richten / Reset



Worksheet 10.2: Creating the symbols table and control program for the CPU 313C-2DP	
Name:	Date:

PLC program
CPU 313C-2DP
OB100

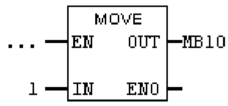
OB100 : Anlaufbaustein / start-up program block

Der Anlaufbaustein wird beim Einschalten der Spannungsversorgung der SPS als erstes einmal durchlaufen. Beim Anlauf setzt der Baustein alle Ausgänge und Merker zurück. Der Initialisierungsmerker wird als einziger Merker gesetzt. Dieser Merker hat für einen Zyklus 1-Signal und wird im OB1 wieder zurückgesetzt.

If the power-supply of the plc is started, first the start-up program block will be activated once. On start-up procedure this program resets all outputs and flags - except the initialisation flag. The initialisation flag "Init_Bit" is set and has 1-signal for one program cycle. The "Init_Bit" is reset after one cycle at the end of the organisation program block OB1.

Network 1: Rücksetzen der Merker / Reset of flags

Alle Merker werden zurückgesetzt (der Wert 1 wird in das Merkerbyte MB10 geschrieben). / Reset of all flags, (the value 1 is written to the flag byte MB10).



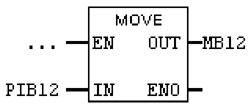
PLC program
CPU 313C-2DP
FC20

FC20 : Title:

Comment:

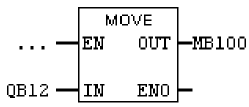
Network 1: Übertragung des Sensorsignals / Transmission of sensor-signal

Übertragung des Sensorsignals / Transmission of sensor-signal



Network 2: Übertragung des Fertigsignals / Transmission signal"ready"

Übertragung des Sensorsignals "Fertig" / Transmission of the sensor-signal "ready".



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Worksheet 9: Addressing the Profibus station and inputs and outputs	
Name:	Date:

Addresses of the Profibus stations and inputs and outputs

Device addresses		
CPU 313C-2DP	Profibus address	2
	Address area – local inputs	I 124.0 – I 125.7
	Address area – local outputs	Q 124.0 – Q 125.7
CPV DI01	Profibus address	1
	Address area – inputs	I 0.0 – I 1.7
	Address area – outputs	Q 0.0 – Q 1.7
ET 200S	Profibus address	3
	Address area – inputs	I 1.0 – I 1.3
		I 2.0 – I 2.3
		I 3.0 – I 3.3
	Address area - outputs	Q 4.0 – Q 4.3
		Q 6.0 – Q 6.3
		Q 7.0 – Q 7.3

Worksheet 10.1: Creating the symbols table and control program for the ET 200S	
Name:	Date:

Symbol table ET 200S

	Symbol	Address	Data type	Comment
1	1B1	I 1.0	BOOL	Ausschiebzyl. eingefahren / Ejecting cylinder
2	1B2	I 1.1	BOOL	Ausschiebzyl. ausgefahren / Ejecting cylinder
3	1Y1	Q 6.0	BOOL	Ausschiebzyl. Werkstück ausschieben/ Eject
4	B4	I 1.2	BOOL	Sensor Werkstück im Magazin / Sensor work
5	P_Auto	FC 10	FC 10	Ablaufprogramm / Program sequence
6	P_Komm	FC 20	FC 20	Kommunikation / Communication
7	S1	I 3.0	BOOL	Taster Start / Start button
8	SStep01	M 10.0	BOOL	Schritt 1 Slave / Step 1 Slave
9	SStep02	M 10.1	BOOL	Schritt 2 Slave / Step 2 Slave
10	SStep03	M 10.2	BOOL	Schritt 3 Slave / Step 3 Slave
11	TeilAbg	M 101.0	BOOL	Teil abgeholt / Workpiece collected
12	TeilBer	M 100.0	BOOL	Teil bereit / Workpiece ready
13				

PLC program ET 200S
OB1

OB1 : Organisationsprogramm / organisation program block

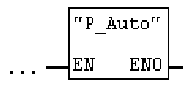
Comment:

Network 1 : Kommunikation / Communication

Kommunikation / Communication

Network 2 : Ablaufprogramm / Program sequence

Ablaufprogramm / Program sequence



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Worksheet 10.2: Creating the symbols table and control program for the ET 200S	
Name:	Date:

PLC program ET 200S OB100

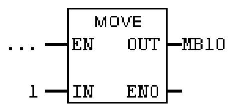
OB100 : Anlaufbaustein / Start-up block

Der Anlaufbaustein wird beim Einschalten der Spannungsversorgung der SPS als erstes einmal durchlaufen. Beim Anlauf setzt der Baustein alle Ausgänge und Merker zurück. Der Initialisierungsmerker wird als einziger Merker gesetzt. Dieser Merker hat für einen Zyklus 1-Signal und wird im OB1 wieder zurückgesetzt.

If the power-supply of the plc is started, first the start-up program block will be activated once. On start-up procedure this program resets all outputs and flags - except the initialisation flag. The initialisation flag "Init_Bit" is set and has 1-signal for one program cycle. The "Init_Bit" is reset after one cycle at the end of the organisation program block OB1.

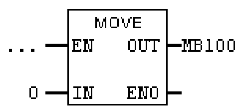
Network 1 : Rücksetzen der Merker / Reset of flags

Alle Merker werden zurückgesetzt (der Wert 1 wird in das Merkerbyte MB10 geschrieben). / Reset of all flags, (the value 1 is written to the flag byte MB10).



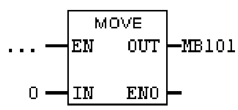
Network 2 : Rücksetzen der Merker / Reset of flags

Alle Merker werden zurückgesetzt (der Wert 0 wird in das Merkerbyte MB100 geschrieben). / Reset of all flags, (the value 0 is written to the flag byte MB100).



Network 3 : Rücksetzen der Merker / Reset of flags

Alle Merker werden zurückgesetzt (der Wert 0 wird in das Merkerbyte MB101 geschrieben). / Reset of all flags, (the value 0 is written to the flag byte MB101).



Worksheet 10.3: Creating the symbols table and control program for the ET 200S

Name:	Date:

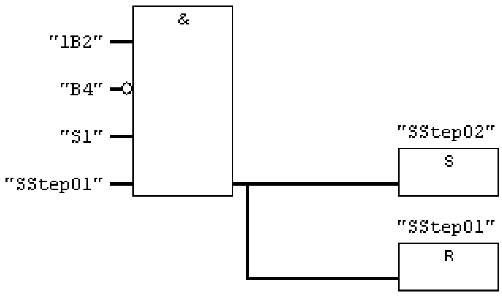
PLC program ET 200S
FC10

FC10 : Magazinsteuerung / Control of magazine

Magazinsteuerung / Control of magazine

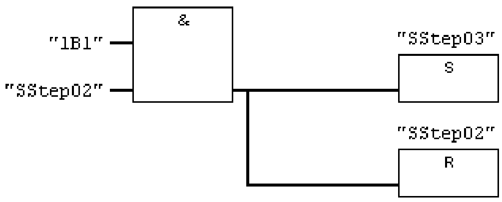
Network 1 : Prozessanlauf / Starting-up process

Prozess wird gestartet wenn Magazin voll, Magazinschieber eingefahren ist und Starttaster gedrückt wird./ Process is starting if the magazine is filled, the magazine slide is retracted and the start-button was pressed.



Network 2 : Neustart Prozess / Restart process

Wenn der Magazinschieber ausgefahren ist beginnt der Prozess mit Schritt 1 neu / If the magazine-slide is extended, the process is restarted with Step 1.



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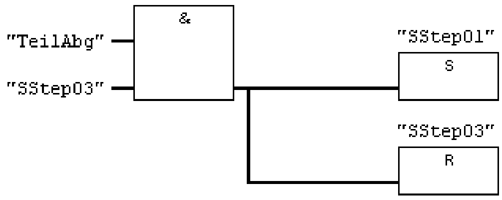
Worksheet 10.4: Creating the symbols table and control program for the ET 200S	
Name:	Date:

PLC program ET 200S
FC10 (continuation)

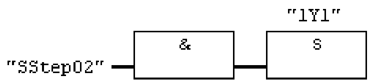
Network 3 : Neustart Prozess / Restart process

Wenn der Magazinschieber ausgefahren ist beginnt der Prozess mit Schritt 1 neu
/ If the magazine-slide is extended, the process is restarted with Step 1.



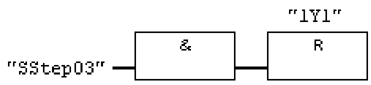
Network 4 : Ansteuerung _1Y1 / Control _1Y1

Ausschiebzyl. Werkstück ausschieben / Ejecting-cylinder eject workpiece



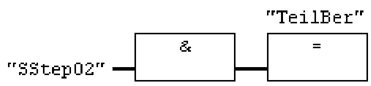
Network 5 : Ansteuerung _1Y1 / Control _1Y1

Ausschiebzyl. Werkstück ausschieben / Ejecting-cylinder eject workpiece



Network 6 : Ansteuerung TeilBer / Control workpiece ready

Ansteuerung TeilBer / Control workpiece ready



Worksheet 10.5: Creating the symbols table and control program for the ET 200S	
Name:	Date:

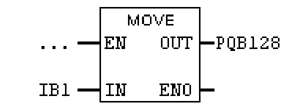
PLC program ET 200S
FC20

FC20 : Title:

Comment:

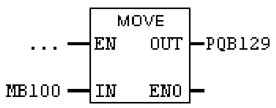
Network 1: Übertragung des Sensorsignals/ Transmission of sensor-signal

Übertragung des Sensorsignals/ Transmission of sensor-signal



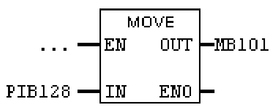
Network 2 : Übertragung des"Teilber"-Signals/ Transmission sig."workp.ready"

Übertragung des Teil bereit Signals / Transmission of the signal "workpiece ready".



Network 3 : Übertragung des"Teilabgh"-Signals/ Transmission sig."workp.col."

Übertragung des Teil abgeholt Signals / Transmission of the signal "workpiece collected".



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Worksheet 11.1: Creating the symbols table and control program for the CPU 313C-2DP	
Name:	Date:

Symbols table
CPU 313C-2DP

	Symbol	Address	Data type	Comment
1	2B1	I 0.0	BOOL	Werkstück angesaugt / Workpiece gripped
2	2Y1	Q 0.6	BOOL	Vakuum ein / Vacuum on
3	2Y2	Q 0.7	BOOL	Vakuum ein / Vacuum on
4	3S1	I 0.1	BOOL	Schwenkzyl. in Pos. Magazin / Swivel drive in pos. magazine
5	3S2	I 0.2	BOOL	Schwenkzyl. in Pos. Folgestation / Swivel drive in pos. subsequent station
6	3Y1	Q 1.0	BOOL	Schwenkzyl. zu Magazin / Swivel drive to magazine
7	3Y2	Q 1.1	BOOL	Schwenkzyl. zu Folgestation / Swivel drive to subsequent station
8	B4	M 12.2	BOOL	Sensor Werkstück im Magazin / Sensor workpiece in magazine
9	H3	Q 124.0	BOOL	Leuchtmelder Magazin leer / Magazine empty indicator light
10	MStep01	M 10.0	BOOL	Schritt 1 Master / Step 1 Master
11	MStep02	M 10.1	BOOL	Schritt 2 Master / Step 2 Master
12	MStep03	M 10.2	BOOL	Schritt 3 Master / Step 3 Master
13	MStep04	M 10.3	BOOL	Schritt 4 Master / Step 4 Master
14	MStep05	M 10.4	BOOL	Schritt 5 Master / Step 5 Master
15	P_Auto	FC 10	FC 10	Ablaufprogramm / Program sequence
16	P_Komm	FC 20	FC 20	Kommunikation / Communication
17	S1	I 1.3	BOOL	Taster Richten / Push-button Reset
18	TeilAbg	M 101.0	BOOL	Teil abgeholt / Workpiece collected
19	TeilBer	M 100.0	BOOL	Teil bereit / Workpiece ready
20				

Worksheet 11.2: Creating the symbols table and control program for the CPU 313C-2DP

Name:	Date:

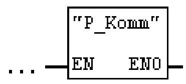
PLC program
CPU 313C-2DP
OB1

OB1 : Organisationsprogramm / organisation program

Comment:

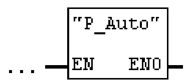
Network 1: Aufruf des Kommunikationsprogrammes / Calling communicat.prog.bl

Aufruf des Kommunikationsprogrammes / Calling communication program block



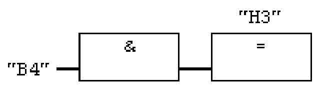
Network 2: Aufruf des Ablaufprogrammes / Calling program sequence

Aufruf des Ablaufprogrammes / Calling program sequence



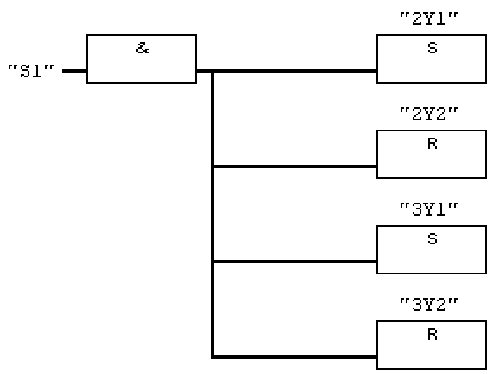
Network 3: Anzeige Magazin leer / Indication magazine empty

Anzeige Magazin leer / Indication magazine empty



Network 4: Richten / Reset

Richten / Reset



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Worksheet 11.3: Creating the symbols table and control program for the CPU 313C-2DP	
Name:	Date:

PLC program
CPU 313C-2DP
OB100

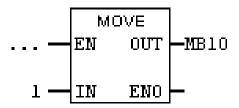
OB100 : Anlaufbaustein / Start-up program block

Der Anlaufbaustein wird beim Einschalten der Spannungsversorgung der SPS als erstes einmal durchlaufen. Beim Anlauf setzt der Baustein alle Ausgänge und Merker zurück.

If the power-supply of the plc is started, first the start-up program block will be activated once. On start-up procedure this program resets all outputs and flags.

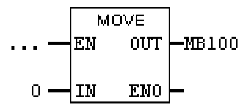
Network 1 : Rücksetzen der Merker / Reset of flags

Alle Merker werden initialisiert (der Wert 1 wird in das Merkerbyte MB10 geschrieben)./ Initialization of all flags, (the value 1 is written to the flag byte MB10).



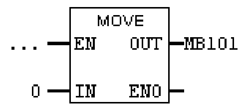
Network 2 : Rücksetzen der Merker / Reset of flags

Alle Merker werden zurückgesetzt (der Wert 0 wird in das Merkerbyte MB100 geschrieben)./ Reset of all flags, (the value 0 is written to the flag byte MB100).



Network 3 : Rücksetzen der Merker / Reset of flags

Alle Merker werden zurückgesetzt (der Wert 0 wird in das Merkerbyte MB101 geschrieben)./ Reset of all flags, (the value 0 is written to the flag byte MB101).



Worksheet 11.4: Creating the symbols table and control program for the CPU 313C-2DP	
Name:	Date:

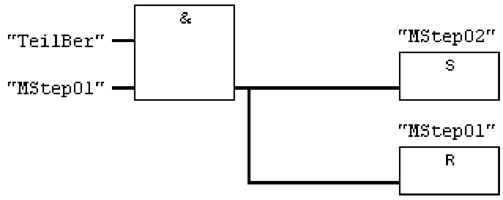
PLC program
CPU 313C-2DP
FC10

FC10 : Schwenkarm (Master) / Swivel drive (Master)

Schwenkarm (Master)/ Swivel drive (Master)

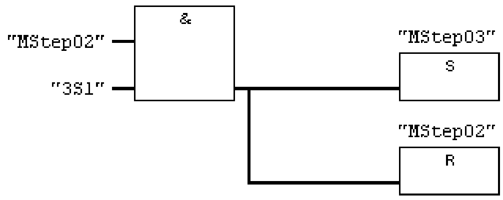
Network 1 : S1

Wenn ein Teil vom Slave produziert wurde kann dieser Prozess gestartet werden./
If the slave produced a workpiece, this process can be initialized.



Network 2 : S2 : Schwenkarm zum Magazin / Swivel drive to magazine

Schwenkzylinder zu Position Magazin schwenken und warten bis Endlage erreicht
und Nachfolgestation frei. / Swivel drive cylinder to position magazine and
wait
until end-position is obtained and the subsequent station is ready.



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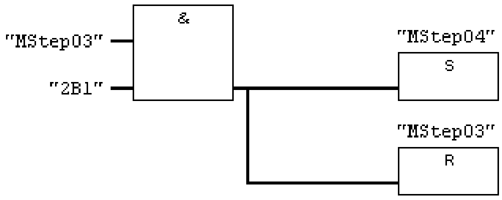
Worksheet 11.5: Creating the symbols table and control program for the CPU 313C-2DP	
Name:	Date:

PLC program
CPU 313C-2DP
FC10 (continuation)

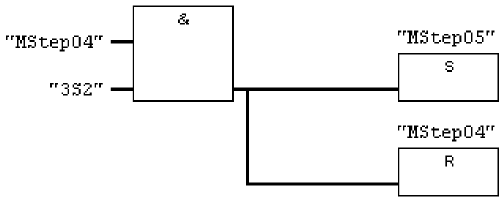
Network 3 : S3 : Vakuum einschalten / Vacuum on

Vakuum einschalten. Warten bis Werkstück angesaugt ist. / Vacuum on. Wait until workpiece is gripped.



Network 4 : S4 : Werkstück zu Folgestation/Workpiece to subsequent station

Werkstück zu Folgestation transportieren (Schwenkzylinder in Position Folgestation schwenken). / Transport workpiece to subsequent station (swivel drive cylinder to position subsequent station).



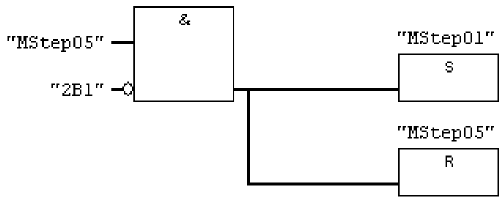
Worksheet 11.6: Creating the symbols table and control program for the CPU 313C-2DP

Name:	Date:

PLC program
CPU 313C-2DP
FC10 (continuation)

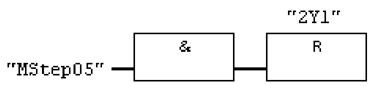
Network 5 : S5 : Vakuum aus / Vacuum off

Vakuum ausschalten. Warten bis Werkstück abgeworfen ist. / Vacuum off. Wait until workpiece is unseated.



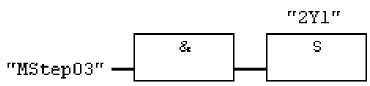
Network 6 : Ansteuerung _2Y1 / Control _2Y1

Vakuum ein / Vacuum on



Network 7 : Ansteuerung _2Y1/ Control _2Y1

Vakuum ein / Vacuum on



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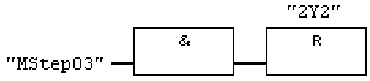
Worksheet 11.7: Creating the symbols table and control program for the CPU 313C-2DP

Name:	Date:

PLC program
CPU 313C-2DP
FC10 (continuation)

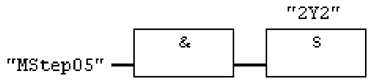
Network 8 : Ansteuerung _2Y2/ Control _2Y2

Vakuum ein / Vacuum on



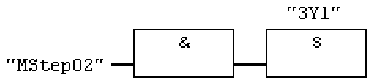
Network 9 : Ansteuerung _2Y2/ Control _2Y2

Vakuum ein / Vacuum on



Network 10 : Ansteuerung _3Y1/ Control _3Y1

Schwenkzyl. zu Magazin / Swivel drive cylinder to position magazine



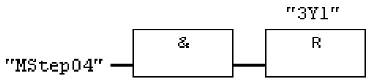
Worksheet 11.8: Creating the symbols table and control program for the CPU 313C-2DP

Name:	Date:

PLC program
CPU 313C-2DP
FC10 (continuation)

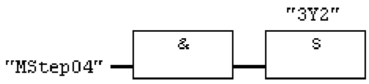
Network 11 : Ansteuerung _3Y1/ Control _3Y1

Schwenkzyl. zu Magazin / Swivel drive cylinder to position magazine



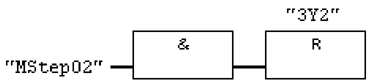
Network 12 : Ansteuerung _3Y2/ Control _3Y2

Schwenkzyl. zu Folgestation / Swivel drive cylinder to position subsequent station



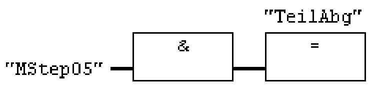
Network 13 : Ansteuerung _3Y2/ Control _3Y2

Schwenkzyl. zu Folgestation / Swivel drive cylinder to position subsequent station



Network 14 : Ansteuerung TeilAbg / Control workpiece collected

Rückmeldung an Slave : Teil abgeholt / acknowledgment to slave : workpiece collected



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Worksheet 11.9: Creating the symbols table and control program for the CPU 313C-2DP	
Name:	Date:

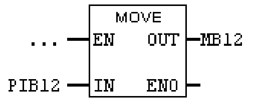
PLC program
CPU 313C-2DP
FC20

FC20 : Title:

Comment:

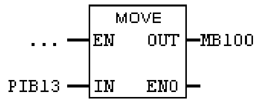
Network 1: Übertragung des Sensorsignals/ Transmission of sensor-signal

Übertragung des Sensorsignals/ Transmission of sensor-signal



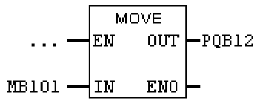
Network 2 : Übertragung des"Teilber"-Signals/ Transmission sig."workp.ready"

Übertragung des Teil bereit Signals / Transmission of the signal "workpiece ready".



Network 3 : Übertragung des"Teilabgh"-Signals/ Transmission sig."workp.col."

Übertragung des Teil abgeholt Signals / Transmission of the signal "workpiece collected".



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Contents

Part D – Appendix

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Glossary

Access	General access to data
Access	General definition of the reading or writing of data.
Actuator/sensor bus	Actuator/sensor bus refers to the area of application of fieldbus systems, in which the sensors and actuators of a machine are connected to a fieldbus. Nowadays this is generally effected by means of modules, to which the individual sensors/actuators are connected either with plugs (via IP65 modules) or to a terminal strip (module level of the actuator/sensor bus). However, bus systems are also available, to which the individual sensors can be directly connected (e.g. AS-interface, Interbus-LOOP etc.).
Address	Unique identification of a station in a fieldbus system. The address is the station reference.
ANSI	American National Standard Institute. Standardisation body for the definition of technical standards in the USA.
Application process	By application we understand the industrial production process controlled by the automation devices.
AS-interface	Actuator/sensor interface, a bus system developed in 1992, in cooperation with 11 companies, including Siemens, to simplify wiring down to an individual sensor or actuator. The AS-interface bus is therefore a sensor/actuator bus which covers the component level. The AS-interface bus operates with power and data transmission via a common 2-wire line. The AS-interface bus is a master/slave system with a maximum of 32 stations of 4 bits each. Wiring is effected via a mechanical, reverse polarity protected ribbon cable, connected by means of self-healing technology without the need for special tools. For maintenance purposes, an individual station can be exchanged without programming tools, since the master automatically assigns the missing station address to the new slave.

Asynchronous connection	Connection without transmission of a data cycle. The start and end of a data word must be marked by a start and stop bit. Sometimes also referred to as asynchronous. The opposite is a synchronous connection. Fieldbus systems use asynchronous connections.
Baud rate	The baud rate indicates the number of statuses of the transmitted signal per second. The baud rate is measured in baud units. The result from the number of bits per status and the baud rate result in the bit rate. Only when the number of statuses is exactly two (i.e. exactly one bit is coded by one status), is the baud rate identical to the bit rate. In the case of fieldbus systems, the baud rate is always set identically to the bit rate.
Boolean	Binary data type. Boolean type data can accept the values TRUE (1) or FALSE (0).
Bus access	The bus access controls the possibility of a station placing a message on the bus. A station that can effect a bus access of its own accord is a master station. If a station can only effect bus access after a request, then it is a slave station.
Bus blanking plug	A bus blanking plug is always necessary for a line. A line is an uninterrupted line closed at both ends by a bus terminating resistor, generally approx. 150 ohm. In many cases (e.g. the Profibus) additional pull-up and pull-down resistors of 300 ohm each are fitted for the connection to +/- 5V. The bus terminating resistors prevent the reflection or echo of the data signal.
CAN	The Controller-Area-Network is bus system jointly developed by Daimler-Benz, Bosch and Intel, which was initially designed to be installed in automobiles but is in the meantime also used in automation technology. CAN is purely a multi-master system with priority controlled bus access. CAN originally only defined as layer 2 in accordance with the OSI reference model. All the remaining layers were defined by the respective applications. This led to a series of non compatible CAN bus systems such as SDS, DeviceNet, SeleCAN, etc. In the meantime, a universal complete specification has been agreed by CAN in Automation.

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Client	Service requesting device of a communication relationship (client - server). It uses the object of another station. With master/slave relations, the master is always the client and the slave always the server since the master uses an object (inputs, outputs, register) of the slave. In the case of master/master relations the roles may change.
Closed fieldbus systems	Closed systems relate to a specific automation system by an individual manufacturer (homogenous system) in contrast with open systems where products from different manufacturers can function together (heterogeneous system).
Coaxial cable	A coaxial cable consists of an individual wire in the centre and screening used as a second wire. The screening and individual wire are very precisely defined in the electrical characteristics. As a result of this high quality, it is possible to obtain much higher data transfer rates, but this cable is more expensive than a standard twisted pair of cables.
Code	A code is an agreed compilation of characters, with which information is represented.
Component level	By components we mean the individual sensors or actuators or small groups of these directly on the machine. Fieldbus systems that extend as far as the components are part of the group of sensor/actuator bus systems. These are specially designed to ensure maximum ease of installation. As-interface, Interbus-Loop, SDS etc. are all fieldbus systems for the direct connection of components.
Configuration	Setting or parameterisation of devices for special application.
Configuration	The selection and assembly of different stations into a operational bus system.
CP terminal	Festo has had an extensive series of fieldbus compatible pneumatic terminals in its product range. Subsequently, this range has been expanded with the addition of Compact Pneumatic terminals. CP terminals are characterised by the use of a completely new design of valves exhibiting significantly higher flow rates within an identical space. Moreover, the CP concept is further modularised so that even small stations with 2 to 4 valves can be economically used.

CRL	Communication Relationship List. This list defines the communication channels between the stations. Data such as the type of communication relationship, type of connection, the context, addressing and the associated virtual field device (VFD) is filed for each communication relationship.
Cyclical data transfer	In contrast with event-driven data transfer, data transmission via cyclical data transfer is time-dependent, irrespective of whether or not new data is created. Cyclical data transfer is used primarily by sensor/actuator stations.
Data transfer rate	The data transfer rate can be specified in bit/s or baud. Bits count the number of the individual bits per time unit. Baud theoretically counts the number of units per second, which can consist of several bits. With fieldbuses in practice baud and bit are used congruently. The exponentiation with kBit/s (or also k/bits or KBit/s) generally refers to the dual system, i.e. kBit/s corresponds to 1024 Bit/s, MBit/s corresponds to 1.048.576 Bit/s. However, this is only of significance for the development of new devices not for applications.
Data type	Binary data that can be processed by electronic units, consisting of a series of valencies 0 and 1. A data type specification provides information as to how these values are to be decoded, e.g. whether they are positive decimal numbers or floating point numbers.
EPROM	Erasable PROM. UV light erasable, non-volatile semiconductor memory.
Ethernet	Ethernet is a specification for a local network (LAN), which was jointly developed in the seventies by Xerox, Intel and DEC. The transmission medium used by Ethernet is a coaxial cable, e.g. a yellow cable. The transfer rate is 10 Mbit/s. The bus is accessed in accordance with the CSMA/CD method. Ethernet was standardised via the IEEE 802.3 in 1983.
Event-driven communication	Event-driven communication means to send a telegram if an event has occurred, e.g. tool breakage. The opposite of event-driven communication is cyclical communication that transmits data, irrespective of whether the data has a new content.

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Explicit objects	Objects defined by the user when the data network is planned, i.e. prior to the actual data transfer.
Factory bus	Factory bus systems are used for data communication on the planning, master and cell level. Typical fieldbuses are MAP, Industrial Ethernet.
Festo Fieldbus node	Festo offers valve and installation terminals that can be equipped with fieldbus nodes for different bus systems. The actual fieldbus node contains the entire electronics in order for a particular fieldbus to be connected to the electronics of a Festo terminal. A fieldbus node can therefore also be described as a gateway between a fieldbus and a Festo terminal.
Fieldbus	A fieldbus is a system for serial data transfer in the field area, i.e. the installation, sensor/actuator and controller level, possibly even up to the cell level.
FIP	Factory Instrumentation Protocol, a fieldbus developed and standardised in France. The FIP operates according to the principle of a spatially distributed data base. The FIP is controlled by a bus arbitrator (master/slave system). It facilitates a contiguous data model throughout all levels of production automation, from the sensor/actuator bus to the factory bus.
Full-duplex	A data transfer is referred to as full-duplex if data can be applied simultaneously in both directions on the bus, i.e. sent and received simultaneously. On the field level this is virtually only possible if two separate wire pairs are used for the outward and return line (e.g. the DIN measuring bus). A system can also be regarded as full-duplex that transmits all data in a ring and in this way simultaneously sends and receives (e.g. Interbus). However, in this case the full-duplex capability purely applies to the actual sensor/actuator data and not for individual messages.
Half-duplex	Half-duplex refers to a type of data transfer which, although data can be exchanged in both directions (send and receive), this is not possible simultaneously but only sequentially. Half-duplex data transfer is used in the case of most fieldbus systems.
IEC	International Electronic Conference; committee which prepared and publishes international standards.

IEEE	Institution of Electrical and Electronic Engineers; association of American electronics engineers.
Initialisation	Start-up phase of a system, whereby software and possibly hardware are put into their operational status.
Initiate	An initiate is a service according to DIN 19245 Profibus. The purpose of Initiate is to configure a logic communication channel.
Installation bus	Installation bus systems are designed especially for the direct connection of binary sensors and in part also actuators and cover the component level of sensor/actuator bus systems. They generally transfer data and energy via a common two-wire line.
Installation terminal	Festo differentiates pneumatic terminals into installation terminals and valve terminals. An installation terminal is equipped with inputs and outputs (valves and/or electrical outputs), valve terminals are equipped with valves exclusively.
Interbus	A fieldbus system for the sensor/actuator level developed by Phoenix Contact in 1985, which has since been standardised (DIN 19 258), and submitted for standardisation (Europe/International). The Interbus operates using a physical ring (hardware) and a total frame telegram (software). Interbus is very fast as a result of the total frame telegram. Interbus has been expanded into the Interbus-Loop for the connection of individual sensors, i.e. for the component level.
Interface	Connection points between two or several stations, via which the transfer of data and control data is effected. An interface comprises all the definitions of the physical characteristics and significance of the signals exchanged on the lines.
ISO	International Organization for Standardization International standardisation committee.
LAN	Local Area Network (local network). A network within a spatially limited area, generally belonging to an individual company/set-up. Fieldbus systems are generally LANs.

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Limits of application for fieldbus systems	In the main, the applicability of fieldbus systems is limited by two factors, i.e. by the prolonged reaction time of an automation system if a fieldbus system is used and insufficiently qualified users.
Line	A line consists of a continuous bus cable, to which the bus stations are connected without interruption of the cable. The termination of a cable must be electrically defined, usually by means of bus terminating resistors or possibly by means of special bus stations.
Logic address	Simplified type of physical addressing, whereby abbreviated notation (indices) is used.
Master	A master is a station that can transfer data via the bus of its own accord. In contrast with this is the slave that can only send data subject to prior request by a master.
Master/slave principle	One of the stations, the master, controls bus access by issuing a time limited send authorisation to the other stations, i.e. the slaves. With a master/slave system, only the bus station, the master, has control over the bus. All the other stations, the slaves, must continually listen to on the bus and can only send data via the bus following a request by the master.
Network	The network topology can establish a connection between two stations along different routes. The best-known network is the telephone network, whereby it is possible to telephone from New York to Moscow via satellite, via Berlin or possibly via Stockholm. The advantage of a network is the high operational reliability. Even if individual transmission links fail, the remaining links can still operate and any connections be established. The disadvantage is the enormous expenditure involved in setting up a network. With fieldbus systems, there are no networks.
Object	A data block for communication is also referred to as an object. An object is of a structured configuration and has attributes such as a data type and access rights. Objects can be data fields (inputs, outputs, flags, message texts, simple variables or also a combination of these data.

Object directory (OD)	An object directory contains a description of the defined objects according to structure, data type, access right and memory address. The object directory is a type of telephone directory of all accessible objects.
Operating system	The system program for the internal control and monitoring in a computer.
OSI reference model	The reference model describes 7 different tasks, all of which may be required for serial data transfer. Generally only layers 7, 2 and 1 are used for fieldbuses. The layers are: 7 Application layer 6 Presentation layer 5 Session layer 4 Transfer layer 3 Network layer 2 Data Link layer 1 Physical layer
Parameter	General description for a changeable variable.
Physical address	The (often hexadecimal) address, with which a module or data cell can be addressed.
Piercing technology	The connection of a bus station to a bus cable via piercing technology (also known as insulation displacement technology) is effected by means of pressing the cable onto a bus terminal (a suitable cable must be used for this), whereby two contact pins contact the copper wires through the insulation. This considerably reduces the expenditure of the electrical insulation, since cutting to length, stripping, placing and press-moulding of cable end sleeves, screw tightening etc. are dispensed with.
Polling	Polling means that a master, for instance for the collection of input data, sequentially requests data from a slave, receives this from the slave, requests data from the next slave, receives this, etc. The same applies for the sending of data. All data exchange between the master and a slave therefore requires two defined messages, first from master to slave, then back from slave to master. Depending on the system, polling can be effected automatically via all bus stations or include specific settable bus stations or request specific data or merely call with the request for new data. Polling is effected cyclically, not event-driven.

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Positive edge	The transition from logic status low (0) to logic status high (1) represents the positive edge.
Process bus	The process range identifies the fieldbus level, on which intelligent systems intercommunicate. These are generally programmable logic controllers, CNC controllers or microprocessor systems of different types. A common factor with all of these systems is that data can be processed independently of the bus. Via the process bus, data is exchanged which is already compressed or pre-processed. As a rule, the requirements regarding the reaction time of a process bus system are considerably less than the reaction time of a sensor/actuator bus system.
Profibus	A fieldbus standard developed in a government assisted joint research project in 1987. In 1991, DIN 19245 was adopted, whereby the Profibus became one of the first standardised fieldbus systems. This is an open fieldbus standard covering a wide area within process and building automation. There are three variants of Profibus: Profibus-FMS (fieldbus message specification) for the controller level, Profibus-DP (decentralised peripherals) for the sensor/actuator level and Profibus-PA (process automation) for intrinsically safe process technology.
Profibus-DP	This Profibus variant is for an optimised transfer rate. It is tailored to the requirements for a quick, efficient data exchange between automation equipment and decentralised devices such as binary or analogue input/output modules and drives for time-critical applications.
Profibus-FMS	This Profibus variant is suitable as a fieldbus for use on the system level with minimal real-time requirements, owing to the extensive telegrams and handling thereof in combination with relatively minimal data rates. This is where automation devices such as PLCs, PCs mainly communicate with one another. In this area of application, extensive functionality is of greater importance than a fast system reaction time.
Protocol	The protocol describes the details regarding information exchange, e.g. the compilation of data into data packets on the different levels of the OSI reference model. In order for two stations to be able to communicate with one another, the same protocols must be realised on all levels of the OSI reference model.

Reaction time/ response time	The reaction time of an automation system is the time that passes between a voltage signal being applied to an input terminal to the generation of a voltage signal on an output terminal. The reaction time consists of: + Input signal delay + Fieldbus transmission time + Fieldbus-CPU organisation + Cycle time of the CPU + CPU-fieldbus organisation + Fieldbus transmission time The output signal delay can be neglected since it is, if anything, very brief compared to the remainder of times.
Read	Read is a service to DIN 19245 Profibus and is used to read an object of another station.
Remote bus	Transmission distance of Interbus with a maximum of 256 stations and a maximum of 400 metres distance each with a permissible overall length of approx. 12 km.
Ring	The ring is a topology, whereby basically a point-to-point connection is established from station to station. Each station in the ring must therefore pass on unchanged the data not intended for itself. On the field level, fibre-optic cable systems (e.g. Sercos, Beckhoff) are configured in the form of a ring. Other typical examples of ring systems are the Interbus or P-Net.
RS 232C	RS 232C is the definition of a serial, bi-directional, asynchronously operating interface. In contrast with the RS 485, the RS 232C operates with a signal level against ground and is therefore relatively interference-prone (distances of up to 30 m).
RS 422	The RS 422 corresponds to the RS 485, with the exception of bus compatibility. This is why the RS 422 is a point-to-point connection.

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RS 485

The RS 485 is the most widely used hardware for fieldbus systems. It defines a line with a maximum of 32 stations, restricted by bus terminating resistors at both ends. Originally it defined a data transfer rate of up to 500 kBit/s. In the meantime, up to 12MBit/s are now realised. Depending on the data transfer rate, distances are between approximately 1200 m and 200 m. The RS 485 operates using twisted and screened data transfer lines.
The RS 485 signal is measured in the form of a differential voltage signal irrespective of ground; a relatively high protection against interference is therefore obtained.

Screened data transfer line

The data transfer line has a metallic screening mesh or foil around the wires (possibly around each pair of wires. The screening must be earthed depending on the bus system, the screening is connected at several points directly to the electrical ground at both ends and/or connected to earth via a bus station.

Screening

The screening of a fieldbus cable is a metallic sheathing that generally covers the twisted wires connected to ground at both ends of fieldbus systems.

Server

A server is a station that ‘works’ for a client, i.e. renders a service. A typical server is an input/output module, which makes available input data for a PLC and receives output data from the client.
In the case of fieldbus system, the server is therefore often the ‘small’ station (input/output data) in contrast with the office world, where the server is the large computer with the enormous hard disc.

Service

A communication service in accordance with DIN 19245. Services are operations on objects, e.g. a measured value is an object, or which read and write services are permissible.

Slave

In contrast with a master, a slave in a fieldbus is a station that is never permitted to access the bus of its own accord.

Standard

Discussions concerning the openness of bus systems invariably refer to the relevant standards. Standardisation differentiates between

- In-house standards that specify the specification with which a supplier is to conform. Depending on the market size of a company issuing a standard, a standard of this type can be of considerable commercial importance.
- National standards (e.g. DIN), to be regarded as state of the art technology within a country.
- European standards (EN ...), of pan-European importance.
- International standards (IEC, ISO), of global importance.

Star

The star topology means that all stations are individually connected to a central station via their own cables.
The advantage of the star is its excellent maintainability. For instance in the case of cable breakage, only one station breaks down so that it is easier to find the fault.
The disadvantage initially is the high cabling expenditure involved. Star structures are only rarely used with fieldbus systems.

Status services

Profibus makes available services, whose task it is to transmit the intrinsic operating status of other stations and vice versa to establish the operating statuses of other stations.

String

A string is identical to a line.

Telegram

A telegram is a message transmitted via a fieldbus system and generally consists of an initial character, possibly length information, the actual useful data, check data and an end identifier.

Topology

By topology we understand the network structure, in principle the type of cable routing and the hierarchy (master/slave) between the stations. Standard topologies are the line, tree and ring structure.

Tree

The tree topology is a mixture of line and star topology. A line is connected to a central station. Further branch lines are connected from this so that – figuratively speaking – a tree-like structure can be detected.
The tree topology can be found primarily on sensor/actuator bus systems that extend down to the component level. The AS-interface bus permits a tree in order to keep the wiring free of restricting regulations as far as this is possible.

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Twisted pair	Data cable with twisted pair of wires, screened paired or jointly.
Twisted data transfer line	The twisted line (also known as 'twisted pair') consists of a pair of wires, which is twisted like a string. The purpose of this is to ensure that electrical interference affects both wires simultaneously. If both wires are floating-ground or of identical potential to ground (differential voltage measurement on the RS 422 and RS 485), then such a system is highly insensitive to interference.
Valve terminal	Festo valve terminals are pneumatic terminals made up solely of valves in contrast with installation terminals, which are equipped with valves and inputs and possibly electrical outputs.
Variable list	A variable list is a stringing together of different data types. A variable list can be changed to the run time.
Virtual Field Device (VFD)	A virtual field device is a model used for the description of data and data structures and the behaviour of an automation system from the viewpoint of the communication partner.
WAN	Wide area network. WAN refers to all networks that encompass countries and continents. A typical WAN is the international telephone network. However there is also a large number of WANs by different owners, both in the form of company-owned WANs for international concerns and also WANs by different telephone companies. The opposite of WAN is LAN (Local Area Network).
Write	Write is a service in accordance with DIN 19245 Profibus and is used to describe an object of another stations.

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