Configuration for Communication

applications & TOOLS

SIMATIC Field Automation with PROFIBUS in the Process Industry

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SIMATIC
Field Automation with PROFIBUS in the Process Industry

System Overview

04/2005 Edition

Safety instructions

This manual contains instructions to be observed to ensure your personal safety and to avoid damage of property. The instructions are emphasized with a warning triangle and are represented as follows, according to the degree of danger:

Danger

Failure to observe the appropriate precautions will result in death, serious injury or considerable damage.

Warning

Failure to observe the appropriate precautions can result in death, serious injury or considerable damage.

Caution

Failure to observe the appropriate precautions can result in slight injury or damage.

Note

This is important information relating to the product, handling of the product, or part of the documentation to which particular attention must be paid.

Qualified personnel

Startup and operation of equipment may only be carried out by qualified personnel. In the context of the safety instructions of the manual, qualified personnel are persons authorized to place the equipment, systems and circuits in operation according to the safety standards, to ground them and mark them.

Normal use

Observe the following:

Warning

These products may only be used for the applications intended in the catalog and in the technical description, and only in association with non-Siemens devices and components recommended or approved by Siemens.
Perfect and reliable operation of the product requires proper transportation and storage, setting up and installation as well as careful operation and maintenance.

Trademarks

Foreword

Purpose of this system overview

The first part of this system overview provides you with essential information about the versatile applications of PROFIBUS and SIMATIC in the process industry. It presents SIMATIC PROFIBUS modules and network structures that are suitable for the special communication tasks in the process industry.
The second part presents you with information about the mechanical and electrical structure and about the hardware and software configuration of the PROFIBUS network.
The system overview is intended primarily for those who want to obtain a quick overview of this complex subject or require a prompt answer to a specific question. It should, however, be remembered that the legal and standardization definitions are subject to continuous changes and adaptations to new technologies. The information contained in this brochure therefore corresponds to the state of the art at the time of publication

Required basic knowledge

To understand the manual, you require general knowledge in the field of automation technology. In addition, you should have some knowledge of the STEP 7 and SIMATIC PDM basic software.

Scope

This system overview includes the following systems and modules:

- PROFIBUS PA with the modules DP/PA link and DP/PA coupler.
- PROFIBUS DP RS485-IS with the system ET 200iSP and the RS 485-IS coupler.
- HART Communication with the analog input and output modules of the ET 200 M and ET 200iSP.
- SIMATIC PDM – the configuration and parameterization system for PROFIBUS field devices and field devices with HART communication.

Table of Contents

Part 1 System Overview

Fundamentals 1

This chapter contains:

1.1 PROFIBUS in the SIMATIC Automation System

General

The leading international fieldbus technology PROFIBUS is used in SIMATIC systems as standard communication in order to permit an open and future-oriented solution.
The PCS 7 system is given priority in this overview because the entire performance range of the fieldbus components can be used conveniently in PCS 7. SIMATIC PCS7 is the Siemens distributed control system (DCS) for the process and manufacturing industries.

Components

The SIMATIC family comprises the following main components

- PCS 7 process control system for DCS-based solutions
- SIMATIC S7 automation system for PLC/SCADA-based solutions in connection with SIMATIC HMI
- SIMATIC HMI – the operator control and monitoring systems (such as operator stations and operator terminals based on WinCC)
- SIMATIC NET – the communications basis comprising PROFIBUS and PROFINET
- PROFIBUS DP – the fieldbus system for distributed IO based on ET200M with S7-300 IO and PROFIBUS DP compatible field devices
- PROFIBUS PA – the expansion of the PROFIBUS DP fieldbus system to include the optimized transmission system for the supply of process devices via the bus.
- SIMATIC Industrial Software (e.g. engineering system STEP 7 with SIMATIC Manager for SIMATIC S7 and PCS 7)

Requirements

In order to use the field engineering package, at least the following releases of the selected engineering software must be available:

Device /software package	Software release
SIMATIC STEP7	from V 5.3 SP1
SIMATIC STEP7 and SIMATIC PDM	STEP7 from V 5.3 SP1 PDM from V 5.2 SP1
PCS7 (contains STEP7 + PDM)	from V 6.1
COM PROFIBUS and SIMATIC PDM	COM PROFIBUS from V 5.0 PDM from V 5.2 SP1

Table 1-1: Basic requirements for the field engineering package

Conformity

Activities serving the interaction of components in the overall SIMATIC system are available in various conformity classes. They offer different degrees of convenience and functionality in configuring and operation.
The control system functionality of the PCS 7 system with its special control-related activities and tools for selected components offers a maximum of system performance and convenience for the user.

Positioning in the system

Field automation is positioned at the lowest level of the automation system.

- PROFIBUS PA forms the communications channel between control level, automation system and field device over great distances with minimum overhead.
- HART modules provide the information channel for the HART protocol between control level and field devices with HART protocol.
- SIMATIC PDM is a user-friendly configuring and parameter assignment system for field devices with PROFIBUS PA connection or the HART protocol.

Figures 1-1 and 1-2 show examples of the positioning within an automation system.

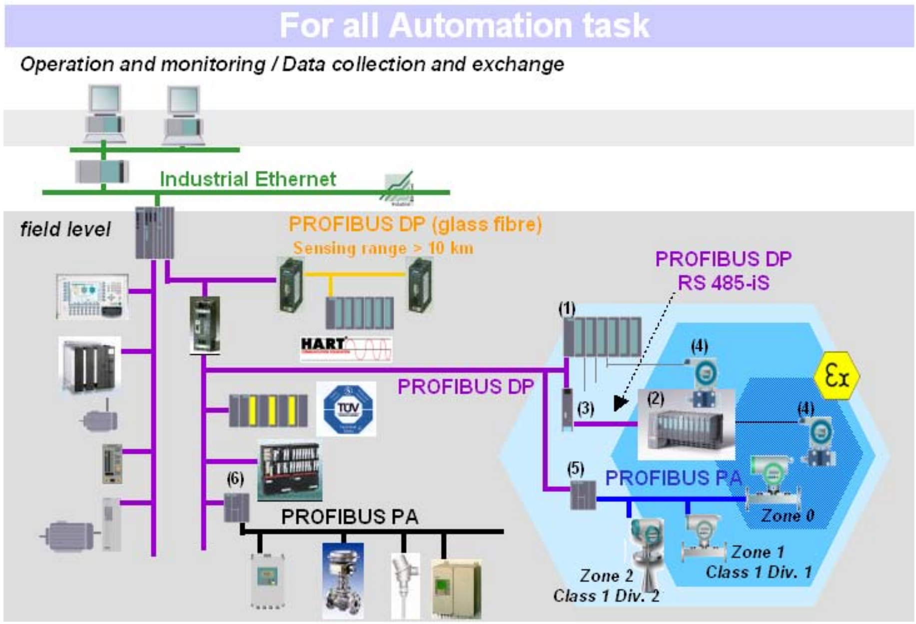


Fig. 1-1 Positioning of the new field device systems in the IOs of the SIMATIC automation system

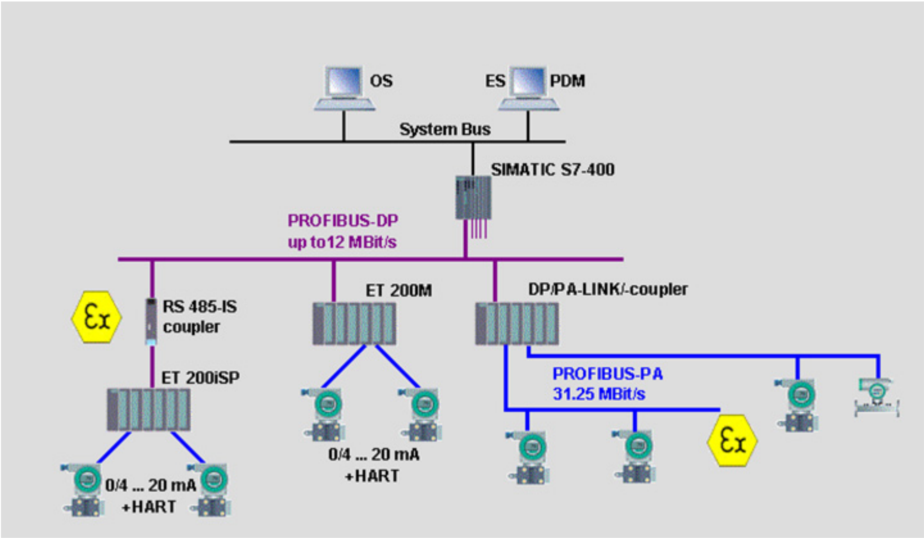


Fig. 1-2 Positioning of the PROFIBUS PA fieldbus system and HART I/O modules in the SIMATIC S7/PCS 7 automation system

PROFIBUS

PROFIBUS is a multi-master bus system. PROFIBUS is the field bus intended for SIMATIC PCS 7 in medium-sized to large installations. Up to 126 bus nodes can be connected to a PROFIBUS. It can operate at transmission rates of 9.6 kbit/s to 12 Mbit/s and, if optical transmission technology is used, it can cover network ranges of up to 15 km at 1.5 Mbit/s.

PROFIBUS DP

The exchange of data between automation system and distributed I/O as well as intelligent field devices is nowadays carried out via fieldbus systems with low installation overhead. The standardized PROFIBUS DP is used for SIMATIC S7 and PCS 7. PROFIBUS DP is a MASTER/SLAVE bus system. The master function is performed by an automation system (master class 1) or by one or more personal computers (master class 2). The automation system (master class 1) has full access to the process signals of all bus nodes assigned to it via cyclic message frames. By means of the personal computer (master class 2), data can be exchanged as required with all connected bus nodes by means of acyclic message frames for the configuration, commissioning, operation monitoring and maintenance. The distributed IO ET 200 and also individual field devices are connected via PROFIBUS DP. Depending on the standard, up to 126 bus nodes can also be connected to a PROFIBUS DP. PROFIBUS can operate at transmission rates of 9.6 kbit/s to 12 Mbit/s and can have a network size of up 15 km.

PROFIBUS DP is based on the international standards IEC 61158 and IEC 61784 and can be executed with the following transmission technologies:

RS485	Simple and cost-effective transmission technology on the basis of a shielded two-core cable.
RS485-IS	Intrinsically safe electrical transmission technology with a shielded two-wire cable and a transmission rate of 1.5 Mbit/s for hazardous areas up to Zone 1 (gas) or Zone 21 (dust).

FOC — Optical transmission technology with glass or plastic fiber-optic cables over distances of up to 15 km.

PROFIBUS PA

PROFIBUS PA is the extension of PROFIBUS DP to include the optimized transmission system for field devices while retaining the communications function of PROFIBUS DP. With the selected transmission system, field devices, even in hazardous areas, can be connected to the automation system over great distances and powered via PROFIBUS PA. With a relatively low transmission rate of 31.25 kbit/s, the typical communication time of a transducer is only about 10 ms. This enables practically all typical applications in the process industry to be implemented with fast cycle times and in widely distributed systems. PROFIBUS PA is the communications-compatible extension of PROFIBUS DP.

PROFIBUS PA

=

PROFIBUS DP communication

+

optimized transmission technology for field devices

HART - communication

HART (highway addressable remote transducer) is a serial transmission method, with which additional data such as measuring range, attenuation, etc., can be transmitted to connected sensors or actuators over a 4 mA to 20 mA current loop. In the course of time, this technology has developed with the support of the HART Communication Foundation (HCF) into a vendor-independent standard. The HART field devices described with the standardized electronic device description (EDD) are integrated into the SIMATIC PDM engineering tool via the HCF catalog.
Utilization of the HART protocol becomes possible with the two HART analog modules offered by SIEMENS. This extends considerably beyond the option of incorporating a handheld terminal in the current loop.

1.2 PROFIBUS as the Universal Fieldbus

General

PROFIBUS (Process Fieldbus) is a bus system standardized according to the international standards IEC 61158 and IEC 61784 and has been used successfully for several years in manufacturing and process automation (chemicals and process engineering).
The possible applications of the fieldbus system are determined essentially by the transmission technologies available. Apart from the general requirements, such as high security of transmission, long range and distance and high transmission speed, the operation in hazardous areas and the transmission of data and energy through a shared cable must also be possible for use in process automation. Several transmission methods are therefore available in the PROFIBUS system:

- RS485 transmission for universal application in discrete industry
- RS485-IS transmission in hazardous areas
- MBP transmission for use in process automation
- Fiber optic cables for greater range and immunity to interference

The following sub-topics describe, in addition to the technical properties of PROFIBUS PA, the integrating function of PROFIBUS PA in the automation of chemical and process engineering processes. PROFIBUS PA is a communications-compatible extension of PROFIBUS DP into the field. Using the selected MBP (Manchester Coded, Bus Powered) transmission technology, transducers and actuators can communicate with the central programmable controller and also be supplied by it, even in hazardous areas and over large distances.
For more detailed information, please see the References in section 5.3.
Fig. 1-3 illustrates the integrated PROFIBUS system with its various transmission technologies.

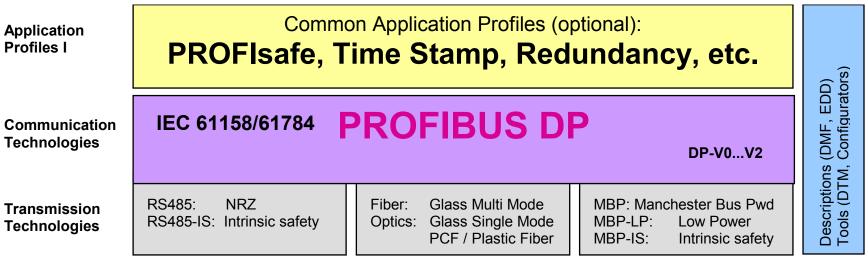


Fig. 1-3 PROFIBUS system structure

1.2.1 PROFIBUS DP

Introduction

PROFIBUS DP is the most widely used fieldbus system in the world.
The technical characteristics of PROFIBUS DP allow operation in almost all areas of industrial automation. Notable features are, in addition to the simple installation (two-wire cable), the extremely high transmission rate (up to 12 Mbit/s), the versatile network configurations (linear, star, ring) and optional

redundancy with a fiber-optic double ring. PROFIBUS DP is a master/slave bus system with which the master function is assumed by a programmable controller (master class 1) or a personal computer (master class 2). Master class 1, in which the automation functions (closed-loop and open-loop control) also take place, has full access to the field devices via cyclic and acyclic message frames. Master class 2 can, if required, exchange data via acyclic frames with master class 1 (upload/download, read master diagnosis) and exchange data with the field devices (read measured value, read slave diagnosis, write parameters).

Technical data:

- Transmission system: RS485, RS485-IS, FOC (multimode or single-mode glass fiber, PCF, plastic fiber)
- Topology: linear, star, ring
- Medium: twisted pair cable, FOC optional
- Number of bus nodes: max. 126 (max. 32 per segment)
- Number of segments: max. 10
- Network size: max. 2000 m at 1.5 Mbit/s with 9 repeaters (optically up to 15 km)
- Transmission rate: max. 12 Mbit/s
- Use in intrinsically safe area by means of RS485-IS transmission technology
- Redundancy: with optical link modules (OLMs) and fiber-optic double ring
- Redundancy with DP slaves, e.g. two redundant Profibus interface modules IM 152-1 in one ET 200iSP
- Operation of redundant DP/PA links on S7-H system
- Use of components of the SCALANCE system for integrating PROFIBUS into end-to-end networks

Modern field devices such as transducers, actuators and drives have, in addition to the measured value or manipulated variable, many parameters which must be changed during startup and, to some extent also during operation in order to utilize the "intelligence" of these field devices such as preventive maintenance or optimization of the interface to the sensor. On account of the different time-related demands for data access of the master, PROFIBUS DP offers cyclic and acyclic services.
All output values (control commands) are written to the field devices and all input values (measured values) are read out of the field devices in one cycle. Subsequently, an acyclic data interchange can take place with a particular field device. Settings of the field devices can be read or parameters can be modified. With the facility for supplementing each transmission cycle with precisely one single acyclic message frame, short, deterministic cycle times are ensured as the basis for software control in the programmable controller/automation system.

1.2.2 PROFIBUS PA

Introduction

PROFIBUS PA is the extension of PROFIBUS DP to include the optimized transmission system for field devices (for example, for powering the field devices via the data cable and utilization in a hazardous environment up to Zone 0) while retaining the communications functions of PROFIBUS DP. This was achieved by adopting the PROFIBUS DP protocol for PROFIBUS PA.
The choice of the internationally standardized transmission system MBP which is defined in IEC 61158-2 alongside other connection technologies ensures the future-oriented field installation with PROFIBUS PA. MBP is a transmission technology with "**M**anchester Coding" and supply over the bus - "**B**us **P**owering".
PROFIBUS PA is more than a two-wire line connecting the field devices (transducers and actuators). The following sub-topics describe, in addition to the technical properties of PROFIBUS PA, the integrating function of PROFIBUS PA in the automation of chemical and industrial processes.

With its physical extension PROFIBUS PA, the PROFIBUS technology facilitates a complete solution for the process industry, i.e.:

- Networking of transducers, valves, actuators via a serial bus system (two-wire line),
- with field device powering via the data cable, as well as
- for applications in hazardous areas ("intrinsically safe" type of protection EEx[i])

Signal conversion

Conversion of the PROFIBUS DP transmission system from RS485 (coding with asynchronous NRZ code) to MBP (bit coding with synchronous Manchester code) for PROFIBUS PA takes place via the "DP/PA coupler" or "DP/PA link" described in Chapter 3 ff.

Application

PROFIBUS PA is designed for use in the intrinscially safe and non-intrinsically safe areas.

1.3 PROFIBUS Components

1.3.1 Transition from PROFIBUS DP to PROFIBUS PA

Two network components, DP/PA coupler and DP/PA link, are available for the transition of the transmission system from PROFIBUS DP (RS485) to PROFIBUS PA (MBP). Their use is governed by the automation requirements.

DP/PA coupler

The DP/PA coupler has the following tasks:

- Conversion of the data format from asynchronous (11 bits/character) to synchronous (8 bits/character) and, associated with this, conversion of the transmission rate from 45.45 kbit/s to 31.25 kbit/s. The DP/PA coupler acts "like a wire"; it is not configured and cannot be detected by the bus nodes.
- Powering of the field devices

- Limiting of the supply current by barriers (for hazardous applications)

Two variants of the DP/PA coupler are available: a non-Ex variant with supply for up to 31 field devices, and a certified Ex variant for operation in Zones 1 and 2 with powering of up to 9 field devices that can be installed in Zone 0.

Note:

The maximum usable number of field devices is governed by the current consumption of the individual field devices (typ. 12 mA) and the maximum currents at the coupler outputs (110 mA for Ex-, 1000 mA for non-Ex variants). The actual current consumption of all field devices on the segment, the voltage drop that this causes in the line, and the minimum supply voltage required at the coupler can result in a further limitation of the number of field devices or the line length.

DP/PA ink

The DP/PA link comprises up to 5 DP/PA couplers (Ex variants/ non-Ex variants) that are connected via a header module to PROFIBUS DP. The header module is a slave on the higher-level PROFIBUS DP (12 Mbit/s max.) and a master for the subordinate PA segments. These PA segments form one logical bus. The maximum number of bus nodes in each PA master system is restricted to 64. The total of all field devices on a DP/PA link is limited to 31. A restriction to 9 field devices on the Ex-coupler is a result of the maximum current carrying capacity. The maximum length of the frames for configuration data, parameterization data, diagnostics data and for I/O data is 244 bytes in each case.
The DP/PA link is employed in the case of high demands on cycle time and large quantity frameworks.

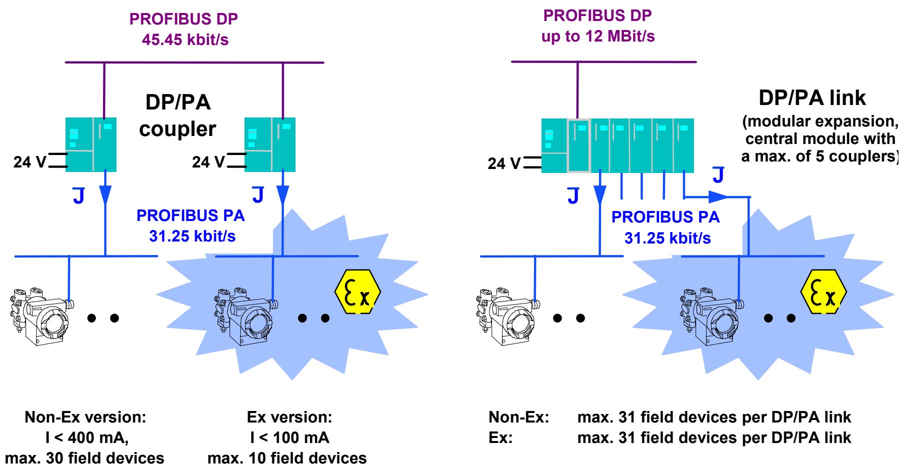


Fig. 1-4 Network components: DP/PA coupler and link module for PROFIBUS DP/PA

Potential savings

The comparison between conventional, that is, parallel cabling of the field devices and the PROFIBUS PA fieldbus system highlights the enormous potential savings in configuring, hardware overhead, installation and plant documentation.

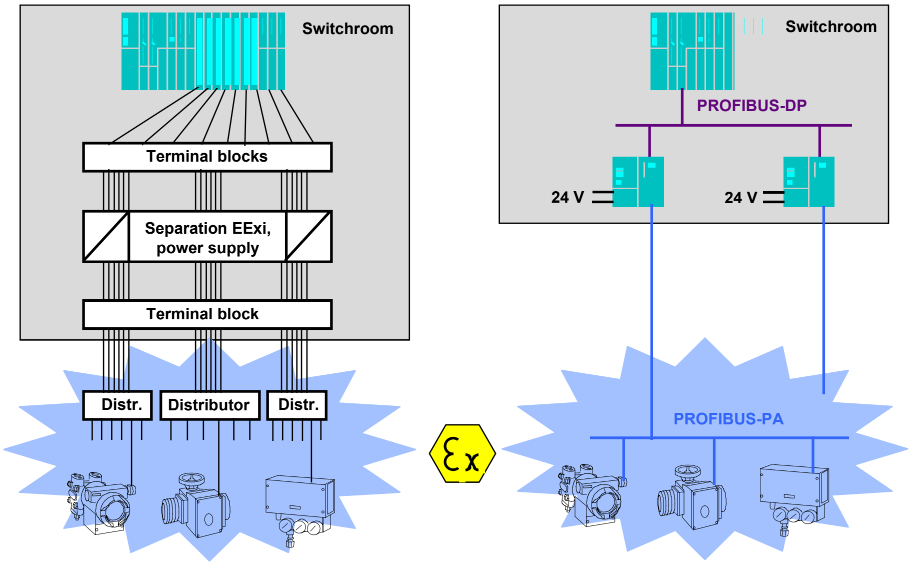


Fig. 1-5 Block diagram: comparison between parallel cabling and serial cabling (fieldbus)

The cost savings when using PROFIBUS PA result primarily from the discarding of terminal blocks, supply isolators and field distributors as well as reduced space requirement in the switch room. Consequently, the costs of documentation and testing of field cabling with PROFIBUS PA are reduced to a minimum ("a few two-wire lines").
Clearly, fieldbus structures with PROFIBUS PA have considerably lower fault potential than conventional cabling. If a fault should occur, it can be very quickly located and corrected on account of the simple structure and detailed diagnostics.

1.3.2 PROFIBUS PA configuration with SIMATIC S7

In conjunction with SIMATIC S7 and the SIMATIC PCS 7 control system, the DP/PA coupler is used for smaller quantity frameworks or low time-related demands, and the DP/PA link for large quantity frameworks and high time-related demands. The DP/PA link permits configuration with up to 5 lower-level PA lines with short cycle times (approximately 100 ms for 10 field devices). This data is transferred to the SIMATIC PCS 7 control system via PROFIBUS DP at up to 12 Mbit/s without significant loss of time (approximately 0.5 ms per link, maximum 123 links).

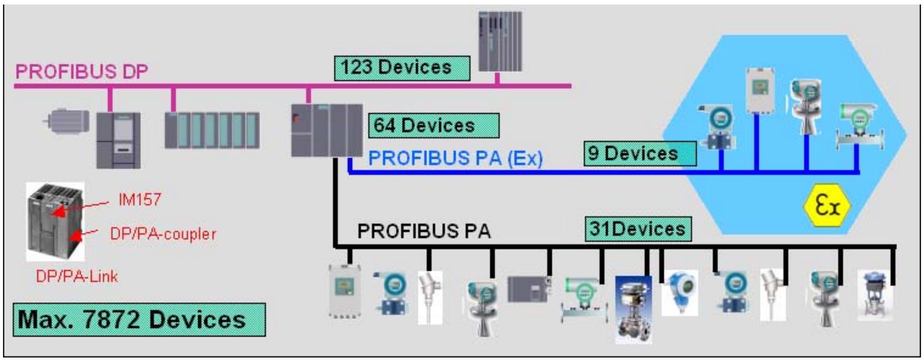


Fig. 1-6 Applications of the DP/PA coupler and link module for PROFIBUS DP/PA

Quantity framework

Theoretically, as many as 7872 PA devices can be connected to one SIMATIC S7:

- Interface module IM157 for implementing the bus transmission rates
  - Slave on the PROFIBUS DP (one address), master on PROFIBUS PA
  - **Up to 64 PA devices**
  - The configuration frame and the useful data frames of the DP/PA link are in each case derived from the frame contents of the lower-level PA field devices. The maximum length of the frames for configuration data, parameterization data, diagnostics data and for I/O data is 244 bytes in each case.
- DP/PA coupler for a PROFIBUS PA segment
  - Integrated power supply - (Ex-option: Class 1, Div. 1, ZONE 0)
  - Integrated terminating resistor
  - Up to 31 (9 Ex) PA devices
- Total number of devices per PROFIBUS master system
  - **Up to 123 DP slaves**
  - DP/PA connection in one DP slave
    -> 123 x 64 = max. **7872 PA devices**

1.3.3 Transition from PROFIBUS DP RS485 to RS485-IS

In order to be able to use distributed IO devices in the Ex-area Zone 1, PROFIBUS DP must be designed to be intrinsically safe. The RS 485-IS coupler converts PROFIBUS DP to PROFIBUS RS485-IS intrinsically safe (type of protection: intrinsic safety Ex i). The RS 485-IS coupler acts like a safety barrier. IS stands for “intrinsic safety”.
The RS 485-IS coupler also enables devices, such as operating panels which can only be operated in Zone 2, to be connected to PROFIBUS RS485-IS.

On the intrinsically safe PROFIBUS, the hot swapping of PROFIBUS connectors is possible under hazardous conditions. Likewise, the hot swapping of modules of the ET 200iSP is possible.

RS 485-IS coupler

Only field devices with certification for PROFIBUS RS485-IS interface or ET 200iS with PROFIBUS DP-Ex i interface can be connected to the RS 485-IS coupler:

- max. 31 bus nodes (RS485-IS field devices)
  with PROFIBUS RS485-IS interface
  or
- max. 16 bus nodes (ET 200iS stations)
  with PROFIBUS DP Ex i interface.

RS 485-IS couplers have a repeater functionality in order to amplify data signals on bus cables and to couple bus segments.
Repeaters are used where:

- the maximum number of nodes permitted in the hazardous area is exceeded,
- the maximum line length in one segment of the hazardous area is exceeded,
- a PROFIBUS RS485-IS segment is coupled with a PROFIBUS DP Ex i segment.

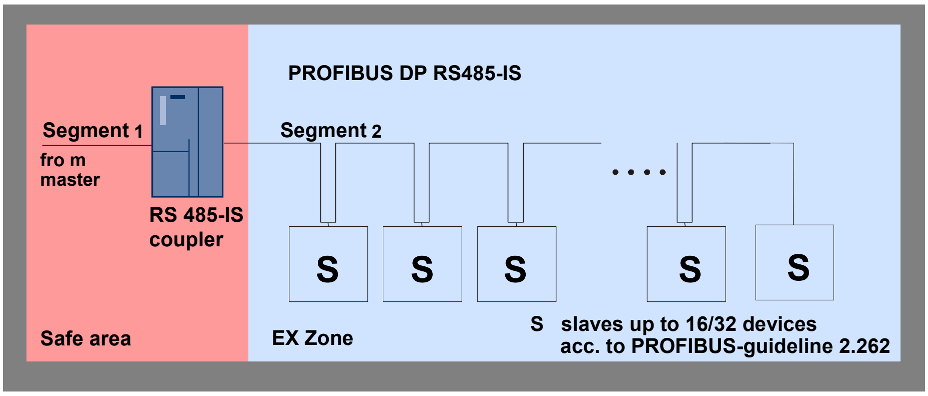


Fig. 1-7 Structure of an RS485-IS segment

All devices connected to the PROFIBUS RS485-IS must comply with the PROFIBUS interface guideline 2.262. This defines maximum safety values, taking into account the PTB Report "Volume 113, Issue 2/2003". If these limit values are observed, no ignitable sparks are created in the bus system.

- Max. input voltage between signal lines: Ui = 4.2 V
- Max. input current on signal lines: Ii = 4.8 A

- The voltage sources have a linear characteristic
- Maximum L/R ratio of the cable: L'/R' = 15 μH/Ω
- For the relevant voltage (< 10 V) the cable capacity does not represent any additional danger. Nevertheless, for functional reasons the cable capacity for the bus cable is restricted to C' < 40 nF/km.
- No concentrated inductances are permissible at the RS485-IS. The capacities at the RS485-IS should be geared toward a standard RS485 installation for PROFIBUS.
- Maximal safety values of the RS485-IS
  - The maximum safety values Uo and Io for each device can be calculated as follows for a maximum number of bus nodes N=32:
  - Max. output voltage between signal lines: Uo = Ui = 4.2 V
  - Max. output current on signal lines: Io = Ii/N = 4.8/32 = 0.15 A
  - Definition: The maximum output voltage of a device for the RS485-IS is defined with Io ≤ 149 mA. The remaining total current of 32 mA is reserved for two external active bus terminations.

1.3.4 Overview of PROFIBUS applications

Various transmission methods are available in the PROFIBUS system: This makes it possible to connect field devices over great distances to the central automation device/system while observing the time constraints:

	Connect. layer	**Application**	**Max. segment length @ baud rate**
PROFIBUS DP	RS485	Distributed IO Intelligent drives Intelligent field devices	1200m @ <93.75 kbit/s 1000m @ 187.5 kbit/s 400m @ 500 kbit/s 200m @ 1.5 kbit/s 100m @ 12 Mbit/s
	RS485-IS	Distributed Ex-IO	1200m @ <93.75 kbit/s 1000m @ 187.5 kbit/s 400m @ 500 kbit/s 200m @ 1.5 Mbit/s
	Glass fiber	Fast transmission Long distances EMC stability	> 10000m @ 12 Mbit/
PROFIBUS PA	MBP (Manchester Coded Bus Powered)	Process devices Power supply via the bus Ex-applications	1900m @ 31.25 kbit/s

Table 1-2: Overview of PROFIBUS applications

1.4 HART Functions

Introduction

HART (highway addressable remote transducer) is a serial transmission method with which additional data can be transferred via a 4 mA to 20 mA current loop. The HART protocol describes the physical form of the transmission, transaction procedures, message structure, data formats and many commands. Furthermore, HART users can define their own commands.

HART signal

The HART signal is a digital communication modulated onto the normal analog signal. Sine waves of 1200 Hz and 2200 Hz represent the HART signal and are modulated onto the analog signal (4 – 20 mA). Since the signal has a mean value of 0, the analog signal is not affected. The HART signal can be easily filtered out with a filter, and the original analog signal is then available again. In addition, the HART signal can be evaluated:

- HART signal with a frequency of 2200 Hz signifies a logical “0”
- HART signal with a frequency of 1200 Hz signifies a logical “1”
- The signal sequences are transferred alternately as the command (C) and response (R).

Application criteria/ characteristics

HART modules are characterized by the following application criteria and characteristics:

- The vendor-independent HART Communication Foundation (HCF) has developed this transmission technology as a standard.
- Several million HART devices are in operation worldwide.
- They are pin-compatible with conventional analog modules.
- Additional communication facilities via the current loop.
- The low power requirement with HART favors its application in hazardous areas.

The utilization of HART in the ET 200 distributed IO system is possible with HART analog modules.

1.5 Configuration of the PROFIBUS Network

Tools

In a SIMATIC project, field devices and distributed IO components are configured for communication with the PROFIBUS master using the STEP 7 HW-Config configuration tool and parameterized with SIMATIC PDM.

Configuration

The hierarchical structure of networks and communication components including the process devices is set out in graphic form. The modules are automatically assigned addresses which can be adapted where required. The devices to be configured are contained in the catalogs of STEP7 HW-Config. Non-Siemens devices can additionally be integrated using the device master file (GSD) or electronic device description (EDD).

Parameterization

Using the SIMATIC PDM process device manager, the device-specific data and functions of the configured devices are set. The SIMATIC PDM process device manager is used as an integrated tool in STEP 7 or as a standalone tool under Windows 2000/XP.
Parameters are set for units of measurement, limit values, default values and value ranges for the cyclic communication and interrupt and diagnostics messages for the acyclic communication. A further parameterization function is the setting of bus parameters of the communication modules.

Field Automation Components 2

This chapter contains:

2.1 Introduction

This chapter provides you with an overview of the field automation components. Detailed descriptions of the individual components can be found in the corresponding manuals which are referred to in the appropriate sections. These descriptions concern the following components:

Hardware:

- PROFIBUS PA
  - PROFIBUS DP/PA coupler
  - PROFIBUS DP/PA link
- HART modules of the ET 200M
  - Analog input module SM331, AI 2 x 0/4...20mA HART Ex(i)
  - Analog output module SM332, AO 2 x 0/4...20 mA HART Ex(i)
- ET 200iSP with the components
  - Interface module IM152-1
  - 4 AI HART, for 2-wire connection
  - 4 AI HART, for 4-wire connection
  - 4 AO HART
- RS 485-IS coupler

Software:

- STEP 7 (HW-Config)
- PCS 7 driver library
- SIMATIC PDM field device parameterization tool
- COM PROFIBUS

2.2 Hardware Components

2.2.1 PROFIBUS PA

Applications

DP/PA bus communication can be used in S7 and PCS 7.
You can connect all field devices certified for PROFIBUS PA. The modules are of modular S7-300 design.

DP/PA coupler

DP/PA coupler is available in the following variants:

- DP/PA coupler EEx [i]: 6ES7 157-0AD82-0XA0
- DP/PA coupler: 6ES7 157-0AC82-0XA0

The DP/PA coupler has the following features:

- Type of protection: [EEx ia] II C (6ES7 157-0AD82-0XA0 only)
- Intrinsic safety (6ES7 157-0AD82-0XA0 only)
- Electrical isolation between PROFIBUS DP and PROFIBUS PA
- Diagnostics via LEDs
- Baud rate on PROFIBUS DP 45.45 kBd
- Baud rate on PROFIBUS PA 31.25 kBd

Detailed information can be found in /502/

DP/PA link

The DP/PA link is available in the following variants:

- DP/PA link interface module IM 157 (6ES7 157-0AA00-0XA0) with:
  - DP/PA coupler EEx [i]: 6ES7 157-0AD82-0XA0
  - DP/PA coupler: 6ES7 157-0AC82-0XA0

The DP/PA link has the following features:

- Type of protection: [EEx ia] II C (6ES7 157-0AD82-0XA0 only)
- Intrinsic safety (6ES7 157-0AD82-0XA0 only)
- Electrical isolation between PROFIBUS DP and PROFIBUS PA
- Baud rate on PROFIBUS DP 12 Mbit/s max.
- Baud rate on PROFIBUS PA 31.25 kBd
- Diagnostics via LEDs
- Max. number of DP/PA couplers per DP/PA link: 5
- Implementation of the IM 157 as DPV1 slave
- Master Class 2 connections to slaves on secondary bus, regardless of transfers

Detailed information can be found in /502/

2.2.2 HART modules of the ET 200M

Application

The HART analog modules are primarily intended for use in SIMATIC S7 and PCS 7. You can connect all field devices certified for digital communications with the HART protocol. However, you can also connect field devices with “conventional” 0/4 – 20 mA systems without the HART protocol. The modules are of modular S7-300 design. With PCS 7, the HART modules operate within the ET 200M distributed IO. Detailed information on the ET 200M distributed I/O device can be found in /140/.

Analog input module

Analog input module SM 331; AI 2 x HART(6ES7 331-7TB00-0AB0) has the following characteristics:

- Inputs in 2 channel groups
- Adjustable measured value resolution per channel (depending on the set integration time)
- Deactivation facility for measurement mode selection of the channels
  - Two-wire connection of transducers
  - Four-wire connection of transducers
  - Channels can be deactivated
- Current signal selectable for each channel
  - 0 ... 20 mA (without HART function)
  - 4 ... 20 mA (with/without HART function)
- Parameterizable diagnostics
- Parameterizable diagnostic alarm
- Two channels with limit monitoring
- Parameterizable limit alarm
- Channels electrically isolated from each other
- Open circuit monitoring
- Channels electrically isolated from CPU and L+ load voltage

Analog output module

Analog output module SM 332; AO 2 x HART(6ES7332-5TB00-0AB0) has the following characteristics:

- Two current outputs in two channel groups
- 12 bit resolution (+sign)
- Output mode selectable for each channel
  - Current with HART
  - Current without use of HART
  - Channel deactivated
- Choice of any output range per channel
  - 0 ... 20 mA (without HART function)

- 4 ... 20 mA

- Diagnosis and diagnostic alarm parameterizable
  - Diagnostic alarm
  - Group diagnostics
  - Channels electrically isolated from each other
  - Channels electrically isolated from CPU and L+ load voltage
  - Read-back capability of analog outputs

Detailed information can be found in /503/

2.2.3 ET 200iSP

Application

The distributed IO device ET 200iSP is a bit-modular DP slave with IP 30 protection. Each ET 200iSP consists of a power supply module, an interface module and a maximum of 32 electronic modules. The ET 200iSP can be used in hazardous areas. Intrinsically safe encoders, actuators and HART field devices can be connected.

Approval	ET 200iSP node*	Inputs and outputs
CENELEC	Zone 1, Zone 21	Zone 0, Zone 20
	Zone 2, Zone 22	Zone 0, Zone 20

* in connection with an appropriate enclosure

Detailed information can be found in /601/

Interface module

The interface module IM152-1 (6ES7 152-1AA00-0AB0) has the following properties:

- Connects the ET 200iSP to the PROFIBUS RS485-IS
- Prepares the data for the equipped electronic modules
- The PROFIBUS address can be set by means of switches
- Switching off the 24 V DC supply voltage at the terminal module TM-PS-A also switches off the interface module IM 152
- The maximum address size is 244 bytes for inputs and 244 bytes for outputs
- Can be operated as DPV0-, S7 DP and DPV1 slave
- Slot for the SIMATIC Micro Memory Card (MMC)
- Firmware is updated via PROFIBUS DP or MMC
- Backup of electronic module parameters:
- The parameters/data are stored in the MMC of the IM 152.

- After switching on the voltage supply of the ET 200iSP, the IM 152 distributes the saved parameters/data to the electronic modules (e.g. replacement values for the output modules).
- The PROFIBUS DP is then released and the automation system is put into operation by the DP master.
- Only when the ET 200iSP is exchanging data with the DP master will the current data of the DP master be replaced during output of the replacement values (of the MMC).
- Redundancy of the IM 152

Analog module 4 AI I 2WIRE HART

The analog input module 4 AI I 2WIRE HART (6ES7 134-7TD00-0AB0) has the following properties:

- 4 inputs for the connection of HART field devices, 2-wire transducers (standard applications)
- Input range parameterizable: HART, 4 to 20 mA
- Resolution 12 bits + sign
- Power supply of the transducers
- Feed current max. 23 mA (per channel)
- Short-circuit-proof
- Electrical isolation
  - between channels and backplane bus
  - not between the channels
  - between channels and power bus
- Limit value interrupt parameterizable
- Diagnostic alarm parameterizable
- Diagnostics functions via LEDs, readable
- Open circuit monitoring

Analog module 4 AI I 4WIRE HART

The analog input module 4 AI I 4WIRE HART (6ES7 134-7TD50-0AB0) has the following properties:

- 4 inputs for the connection of HART field devices, 4-wire transducers (standard applications)
- Input range parameterizable: HART, 0 to 20 mA, 4 to 20 mA
- Resolution 12 bits + sign
- No power supply to the transducers

- Short-circuit proof – yes
- Electrical isolation
  - between channels and backplane bus
  - not between the channels
  - between channels and power bus
- Limit value interrupt parameterizable
- Diagnostic alarm parameterizable
- Diagnostics functions via LEDs, readable
- Open circuit monitoring

Analog module 4 AO I HART

The analog output module 4 AO I HART (6ES7 135-7TD00-0AB0) has the following properties:

- 4 outputs for current output
- Output ranges (parameterizable):
  - HART
  - 4 to 20mA
  - 0 to 20mA
- 14 bit resolution
- Electrical isolation
  - between channels and backplane bus
  - not between the channels
  - between channels and power bus
- Diagnostic alarm parameterizable
- Diagnostics functions via LEDs, readable
- Short-circuit and open-circuit monitoring
- Substitute values can be connected and parameterized

2.2.4 RS 485-IS coupler

Application

For the transition of the transmission technology from PROFIBUS DP (RS485) to the intrinsically safe PROFIBUS DP (RS485-IS), the isolating transformer SIMATIC RS 485-IS coupler is available. This enables the use of intrinsically safe DP devices (e.g. ET 200iSP) as far as Zone 1. It is installed in Zone 2.

Detailed information can be found in /602/

RS 485-IS coupler

The RS 485-IS coupler (6ES7 972-0AC80-0XA0)
has the following properties:

- Intrinsic safety for subordinate PROFIBUS RS485-IS
- Transmission speed of 9.6 kbit/s to 1.5 Mbit/s
- On each RS 485-IS coupler, up to 31/16 DP bus nodes can be operated
- Integrated bus termination for PROFIBUS RS485-IS
- Repeater function in hazardous area possible with two RS 485-IS couplers (same behavior as RS485 repeater)
- Repeater-functionality, max. 5 segments in a row
- Certification according to ATEX 100a
- Diagnostics via LEDs
- Transmission rate on PROFIBUS DP and PROFIBUS RS485-IS
  9.6; 19.2; 45.45; 93.75; 187.5; 500; 1500 Kbaud

2.3 Configuring the Field Systems

Introduction

Extensive and convenient software tools are available for configuring the field automation components. Integration takes place according to standard rules, irrespectively of whether it is a standard I/O module or a module with HART functionality or a DP slave or PA slave. The principle of integration is uniform. The capabilities of the new components are described in more detail in the following sections.

COM PROFIBUS

The COM PROFIBUS program package is a testing, diagnostics and parameterization software package for PROFIBUS DP. You require COM PROFIBUS to configure the bus structure. COM PROFIBUS is also well suited to the linking of field devices to non-Siemens (non-SIMATIC) DP masters. To this end, COM PROFIBUS is used to create a GSD file which is loaded into the non-SIMATIC system. Further information and instructions can be found in /501/.
In the S7/PCS7 system, the configuration of the PROFIBUS is generally performed with STEP7 HW-Config.

Field device blocks

Field device blocks are needed to transfer process data between the I/Os for process data processing. These field device blocks implement the interface to the hardware, including verification functionality.
Detailed information on parameter assignment for blocks can be found in /258/, Chapter 5.
A detailed description of all field device blocks can be found in /260/.

Hardware configuring

Hardware configuring within the STEP 7 program package of the S7/PCS 7 automation system is a convenient configuring tool for creating the hardware structures within your projects. You can use it for configuring and assigning parameters to modules of a centralized configurations as well as of DP/PA devices in a distributed configurations.

"Configuring" means:

- The arrangement of racks, modules, interface modules and devices.

During configuring, the addresses in the I/O area of the S7-400 are automatically assigned to the individual modules.

“Parameterization” means:

- The setting of parameters for parameterizable modules for centralized configurations and for a network.
- The setting of bus parameters, DP master and DP/PA slave parameters for a PROFIBUS DP or DP/PA network.

Detailed information can be found in /231/

SIMATIC PDM

SIMATIC PDM is a software package for configuring, parameterization, commissioning and maintenance of devices (e.g. transducers, field devices for the PROFIBUS PA packages and HART analog modules) and for configuring networks. SIMATIC PDM contains a process monitoring feature for process values, interrupts and status information of the device.

SIMATIC PDM is an open tool for device integration. More than 1000 devices have already been integrated by more than 100 device manufacturers. The basis for the device integration is the EDDL (electronic device description language). The EDD (electronic device description) is created by the device manufacturer or a service provider. It is supplied by the device manufacturer on a data medium together with the device, made available on the Internet or integrated into device catalogs of EDD applications.

The catalog of the HART devices of the HART Communication Foundation (HCF) is integrated in PDM. Fig. 2-1 shows the integration of non-Siemens devices by means of SIMATIC PDM.

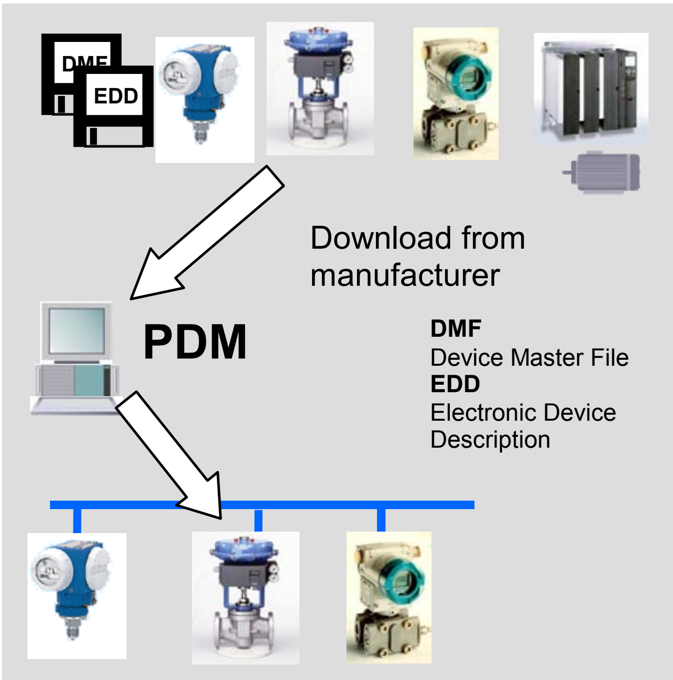


Fig. 2-1 Integration of any field devices in SIMATIC PDM

SIMATIC PDM has also been released for operation under Windows 2000, Windows Me and Windows XP.
With the option “Integration in STEP 7/PCS 7” SIMATIC PDM is based on the software package SIMATIC STEP 7 or SIMATIC PCS 7 and is integrated permanently in the existing installation as an option package. This option additionally allows the configuration of PROFIBUS DP/PA networks and devices with the aid of STEP 7 HW-Config.

The following networks are supported:

- PROFIBUS DP network
- PROFIBUS PA network

- HART modem
- HART interface network
- HART multiplexer network
- SIPART-DR network
- SIREC network
- MODBUS network

Description of the Components 3

This chapter contains:

3.1 Hardware

3.1.1 DP/PA coupler

Variants

Two variants of the DP/PA coupler are available: a non-Ex variant with up to 1000 mA output current for the PA bus, and an Ex variant with up to 110 mA output current. The PA bus cable of the Ex variant can be used in hazardous areas. The DP/PA coupler itself must be installed outside the hazardous area.

Mechanical design

The mechanical design is characterized by the following points:

- Modular S7-300 design on a flat rail with swivel-mounting and screw fixing.
- Arrangement of all indicators and connecting elements on the front side of the module.
- Recessed arrangement of all plug-in connectors, covered by means of the front doors.
- Housing with degree of protection IP 20.
- Cooling by convection.
- Horizontal installation.
- For shielding purposes, the S7 300 rail serves as the functional ground reference point. Each module has an upper and lower shield contact spring at the rear to provide the electrical connection to the mounting rail when the module has been secured. Furthermore, the modules are equipped with additional shielding plates.
- Adequate EMC is ensured through the use of plastic housings and fiber optic elements for the status indications.
- The maximum overall mounting depth is 130 mm, height 125 mm. The width of the DP/PA coupler is 80 mm.
- The mounting rail is supplied in various widths for cabinet installation, and in 2m lengths (standard S7-300 rail).
- Installation clearance of 40 mm above and below the module is necessary for module handling, on account of the swivel-mounting system and securing by means of a screwdriver. Cable ducts must be fitted outside these clearances.

Connection system

The connection system is characterized by the following points:

- The 24 V DC supply voltage is connected with 4-pole screw terminals.
- The PROFIBUS DP interface is connected with a 9-pin sub D connector. Strain relief and shielding are provided by this sub D male connector.
- With the non-intrinsically safe variant, the PROFIBUS PA interface is connected via four screw terminals. The user can terminate the PA cable

or loop it through, as required. The terminating resistor is selectable and integrated in the housing.

- With the intrinsically safe variant, the PROFIBUS PA interface is connected via two screw terminals. The intrinsically safe DP/PA coupler is always situated at the end of the PA cable. The terminating resistor integrated in the housing is always active. With the intrinsically safe variant, this means that the PROFIBUS PA must not be looped through.
- In both versions, the shield contact of the PA cable also serves for strain relief.

A more detailed description of the module can be found in the DP/PA coupler Manual /502/.

3.1.2 DP/PA link

Variants

The DP/PA link is formed from the IM 157 interface module and one or more DP/PA couplers (Ex or non-Ex variants). All components of the DP/PA link are interconnected via S7-300 standard bus connectors.
By combining the IM 157 with Ex or non-Ex variants of the DP/PA coupler, Ex or non-Ex variants of the DP/PA link are also possible. This modular system can be expanded to up to 5 PA lines.

Fig. 3-1 The DP/PA link with IM 157 interface module and a DP/PA coupler

Mechanical design

The mechanical design is characterized by the following points:

- Modular S7-300 design on a shallow rail with swivel-mounting and screw fixing.

- The maximum overall mounting depth is 130 mm, height 125 mm. The width of the IM 157 is 40 mm. The overall width of the DP/PA link depends on the number of DP/PA couplers used.
- The remaining mechanical design data is the same as for the DP/PA coupler.

Connection system

The connection system is characterized by the following points:

- The 24 V DC supply voltage is connected with 4-pole screw terminals.
- The PROFIBUS DP interface is connected only to the IM 157 with a 9-pin sub D connector. The PROFIBUS DP interfaces of the DP/PA couplers used in the DP/PA link have no function. Strain relief and shielding are provided by this sub D male connector.
- With the non-intrinsically safe variant, the PROFIBUS PA interface is connected via four screw terminals. The user can terminate the PA cable or loop it through, as required. The terminating resistor is selectable and integrated in the housing.
- With the intrinsically safe variant, the PROFIBUS PA interface is connected via two screw terminals. The intrinsically safe DP/PA coupler is always situated at the end of the PA cable. The terminating resistor integrated in the housing is always active.
- In both versions, the shield contact of the PA cable also serves for strain relief.

A more detailed description of the module can be found in the DP/PA coupler Manual /502/.

3.1.3 HART modules of the ET 200M

3.1.3.1 Two-channel analog input module

Mechanical design

The mechanical design is characterized by the following points:

- Modular S7-300 design on a shallow rail with swivel-mounting and screw fixing.
- For operation in a distributed configuration in the ET 200M with the IM 153-2 interface module. Detailed information on the ET 200M distributed IO device and interface module can be found in /140/.
- Arrangement of all indicators and connectors at the front of the module.
- Recessed arrangement of all plug-in connectors, covered by means of the front doors.
- Housing with degree of protection IP 20.
- Cooling by convection.
- Horizontal installation.

- For shielding purposes, the S7 300 rail serves as the functional ground reference point. Each module has an upper and lower shield contact spring at the rear to provide the electrical connection to the mounting rail when the module has been secured.. Furthermore, the modules are equipped with additional shielding plates.
- Adequate EMC is ensured through the use of plastic housings and fiber optic elements for the status indications.
- The maximum overall mounting depth is 130 mm, height 125 mm. The width of the module is 40 mm.
- The mounting rail is supplied in various widths for cabinet installation, and in 2m lengths (standard S7-300 rail).
- Installation clearance of 40 mm above and below the module is necessary for module handling, on account of the swivel-mounting system and securing by means of a screwdriver. Cable ducts must be fitted outside these clearances.

Connection system

The connection system is characterized by the following points:

- The 24 V DC supply voltage is connected at the 20-pin front connector by means of screw terminals.
- The 0/4 to 20 mA process signals are connected at the 20-pin front connector by means of screw terminals.
- Strain relief at the front connector.
- Shielding depends on the conductor cross-section, by means of shield contact elements to be ordered separately.
- Hot swapping of the module is possible with an active backplane bus.

A more detailed description of the module can be found in the Manual /503/.

3.1.4 ET 200iSP

Mechanical design

The mechanical design is characterized by the following points:

- The distributed IO device ET 200iSP is a bit-modular and intrinsically safe DP slave with IP 30 protection.
- Rugged construction according to SIMATIC standard thanks to mounting on a 300 rail system.
- In conjunction with an appropriate housing it can be used in hazardous areas with a gaseous or dusty atmosphere.
- The I/O device ET 200iSP principally comprises various passive terminal modules, into which the power supply module, the interface module and a maximum of 32 electronics modules are plugged.
- It can be operated at temperatures between -20°C and +70°C

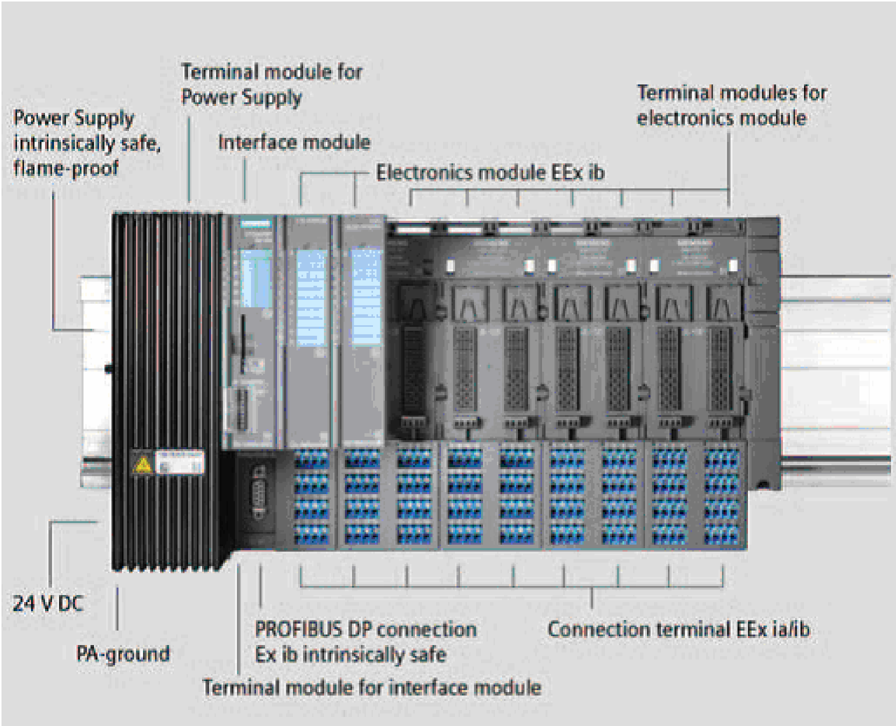


Fig. 3-2 ET 200iSP – mechanical design

Connection system

The connection system is characterized by the following points:

- The ET 200iSP is connected to the PROFIBUS RS485-IS by means of a connector on the terminal module TM-IM/EM
- Screw terminals or spring terminals – use of the most favorable connection technology
- Integral power bus – reduced wiring overhead
- Intrinsically safe inputs and outputs according to EEx ia IIC.
- Intrinsically safe encoders, actuators and HART field devices as far as Zone 0 / 20 can be connected
- “Hot-swapping”, i.e. pulling and inserting modules during live operation and under Ex conditions, is possible
- All digital outputs of a module can be switched off by means of an intrinsically safe switching signal

A more detailed description of the modules can be found in the ET 200iSP distributed IO device manual /601/.

3.1.5 RS 485-IS coupler

Mechanical design

The mechanical design is characterized by the following points:

- The RS 485-IS coupler is an open resource. This means that it may only be set up in housings, cabinets or electrical operating rooms which are only accessible by means of keys or tools. Access to the housings, cabinets or electrical operating rooms should only be granted to persons with the necessary approval or instructions.
- The RS 485-IS can be mounted vertically or horizontally. If mounted vertically, the maximum ambient temperature is +40°C.
- The RS 485-IS coupler is mounted on a DIN rail for the S7 design. To ensure trouble-free installation, the module should be mounted with a clearance of 40 mm above and below.
- The RS 485-IS coupler does not transmit any signals on the S7 backplane bus.
- Further notes on the installation of S7-design modules can be found in the Installation Manual for Automation System S7-300, Setup (6ES7398-8FA10-8AA0) /603/.

Figure 3-3 RS 485-IS coupler

Connection system

The connection system is characterized by the following points:

- The 24 V DC supply voltage is connected with a 4-pole screw terminal, of grounded or non-grounded design.
- PROFIBUS DP and internal logic circuits are non-isolated.
- PROFIBUS DP RS485 and RS485-IS are electrically isolated from the 24 V supply.
- PROFIBUS DP RS485 and RS485-IS are electrically isolated from each other.

A more detailed description of the module can be found in the manual.

3.2 Software / Configuration

3.2.1 Configuration / quantity framework

DP/PA coupler

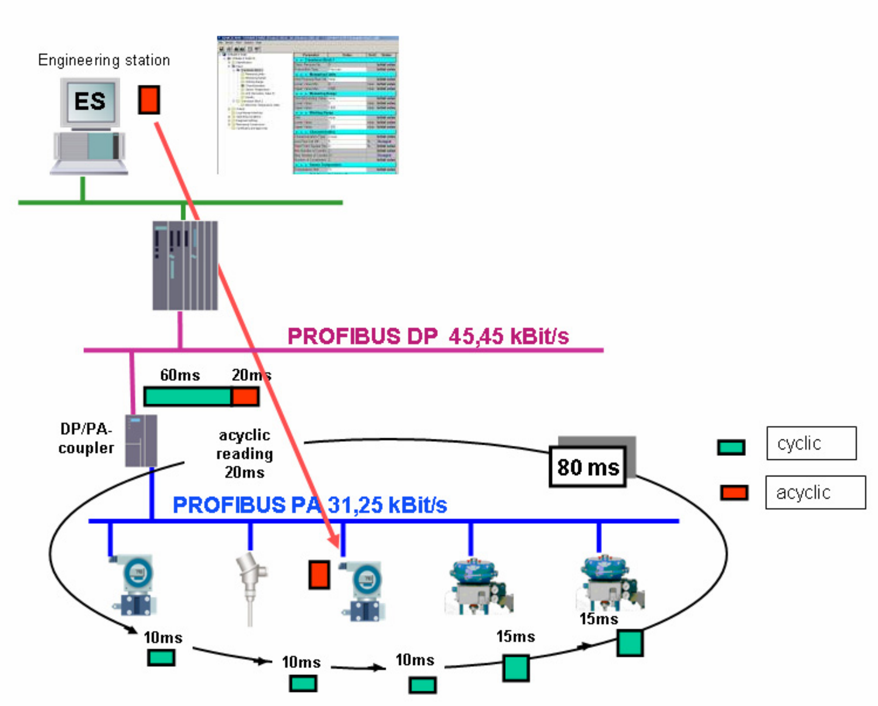


Fig. 3-4 Schematic representation for the determining of cycle times on the PROFIBUS PA using a coupler module

Within the bus cycle time, each field device exchanges the most important input and output data with the master. Additionally, the master accesses a particular field device, for example, to write parameter assignment data or to read diagnostic parameters. The number of field devices on the PROFIBUS PA segment governs the bus cycle time, i.e. the time base in which the process values are exchanged with the field devices. The bus cycle time is obtained by adding the cyclic messages to all field devices, and the acyclic message to a particular field device. In the example:
3 x 10 ms + 2x15 ms + 20 ms = 80 ms.

Note:

The value of 10 ms within the bus cycle time applies to field devices which exchange a measured value or manipulated value with its corresponding status, i.e. 5 bytes of useful data per cycle, with the programmable controller/system. Examples of these field devices are pressure, temperature, level transducers, valves and actuators. Complex field devices, for example those providing several measured variables simultaneously (such as flow transducers), require additional transfer time. With average field instrumentation, the number of these complex field devices is relatively low and their influence on the overall bus cycle time is negligible.

DP/PA link

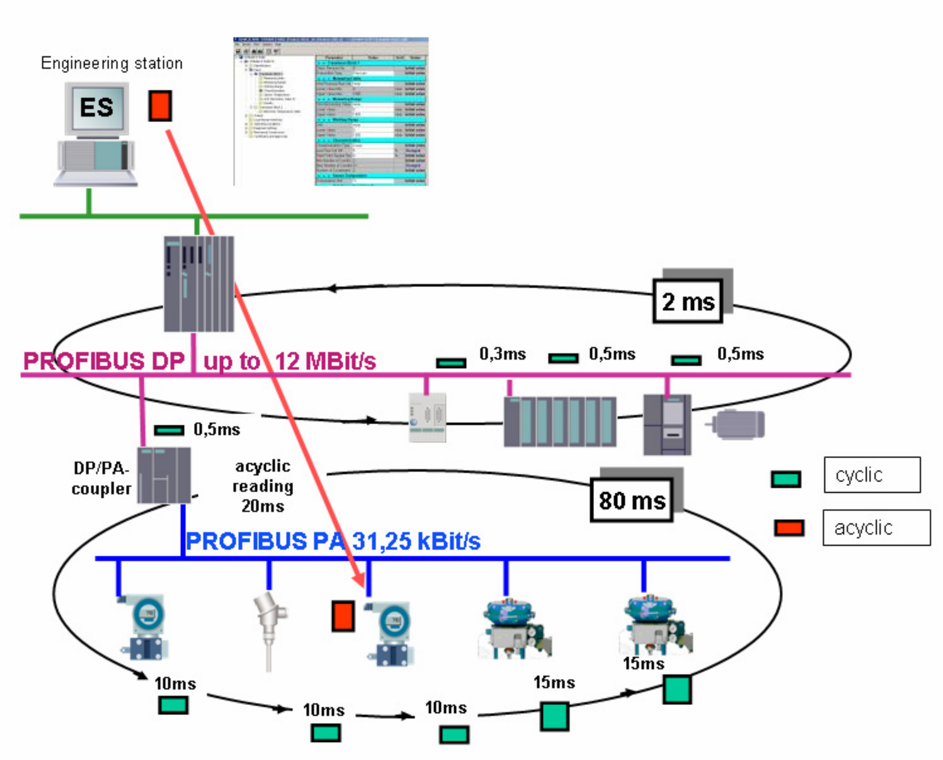


Fig. 3-5 Schematic representation of the determining of cycle times on the PROFIBUS PA using a DP/PA link module

With the DP/PA link in operation, all cyclic frames and one acyclic frames are relayed via PROFIBUS DP to the programmable controller / system within the cycle of the PROFIBUS PA line, in one message frame each. On account of the high data transmission rate of up to 12 Mbit/s, the delay in data transmission is insignificant (only about 1 ms even with 31 field devices per DP/PA link). The DP/PA link (for SIMATIC PCS 7) has the same time response as the DP/PA coupler, up to the maximum number of connectable field devices (31 field devices per DP/PA link. Decisive advantages are obtained with structures in which the field devices are distributed over several DP/PA links. At a transmission rate of 12 Mbit/s on the higher-level PROFIBUS DP, the delays are only in the 1 ms range; the cycle time thus remains almost independent of the number of field devices. With ten non-complex field devices per DP/PA link, the cycle time is approximately 100 ms, and with 30 non-complex field devices per DP/PA link it is approximately 300 ms, if the communication is exclusively cyclic. The cycle times are extended by the duration of all acyclic message frames.

3.2.2 Addressing of PROFIBUS PA field devices

DP/PA coupler

When applying the DP/PA coupler, the field devices are addressed directly from the programmable controller/system; the DP/PA coupler is transparent and does not need to be configured in the HW-Config.

DP/PA coupler (see Fig. 3-6, left half): The DP/PA couplers are not apparent to the programmable controller/system (bus node 1) so that the field devices (nodes 2, 3 and 4) – as seen from addressing – are connected to the same PROFIBUS segment. In this case the field devices are treated as single slaves.

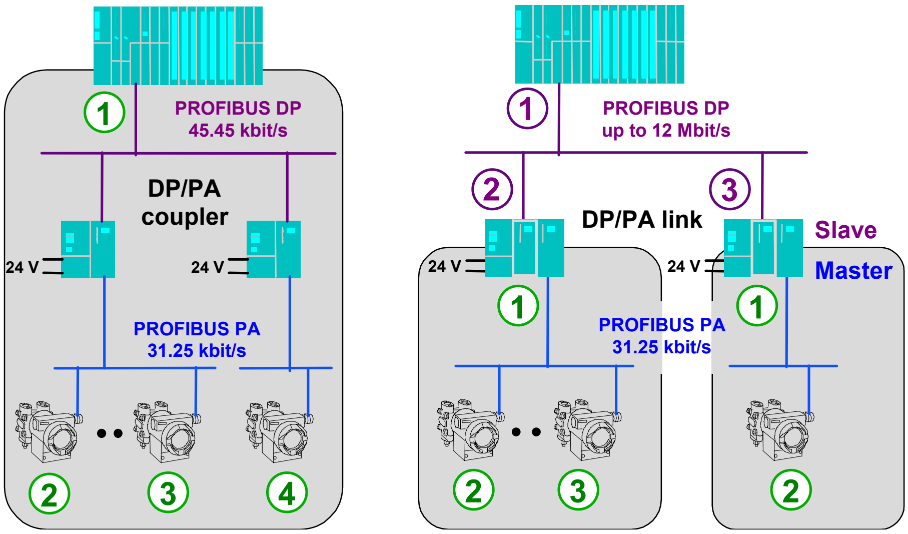


Bild 3-6 Addressing of field devices within an automation system on PROFIBUS PA

DP/PA link

The DP/PA link is a slave on PROFIBUS DP and a master on PROFIBUS PA. The programmable controller/system addresses the field devices via the DP/PA link, that is, indirectly. The DP/PA link must be configured in the HW-Config. The couplers used on the link, however, are not.
DP/PA link (see Fig. 3-6, right half): each DP/PA link (nodes 2 and 3 on PROFIBUS DP) is a node (slave) on the higher-level PROFIBUS DP and therefore appears to the programmable controller/system with only one node address each. In addition, each DP/PA link (node 1 on PROFIBUS PA) is the master for the field devices connected to it (nodes 2 and 3 or 2 on PROFIBUS PA).
Thus the DP/PA link acts as a "decoupler", allowing the SIMATIC PCS 7 control system an extremely large addressing volume (theoretically 64 nodes per PA master system, with 123 slaves on the DP bus, i.e. theoretically 7872 field devices per SIMATIC S7-400). In practice this is limited by the maximum number of measured values to be processed in the user program of the S7-400 CPU.

Summary

In Table 3-1 shows the relationship between project scope and time response - using a DP/PA coupler and link modules with different configurations. It can be seen that where two or more link modules are used with the same number of field devices, the loading on the DP line corresponds approximately to the loading of only one link module.

No. of field devices on PA couplers	Cycle times on shared DP bus [ms]	
	PA coupler without link	PA coupler with link
10	100	100
30	300	300
60	600	300
90	900	300

Table 3-1: Quantity framework and cycle times PROFIBUS PA

Assumptions:
max. 30 devices per coupler, 10 ms/device, no acyclic communication

HART

HART analog modules are used within the ET 200 M distributed I/O system. Support of communication with HART devices via HART analog module, inserted centrally in an S7-300, is not provided. Addressing takes place accordingly. Further information can be found in /140/.

3.2.3 Parameter assignment / device profiles

Introduction

In order to allow uniform device responses, device profile definitions exist (Section 5.3). The basic configuration is explained in more detail below.

PROFIBUS PA

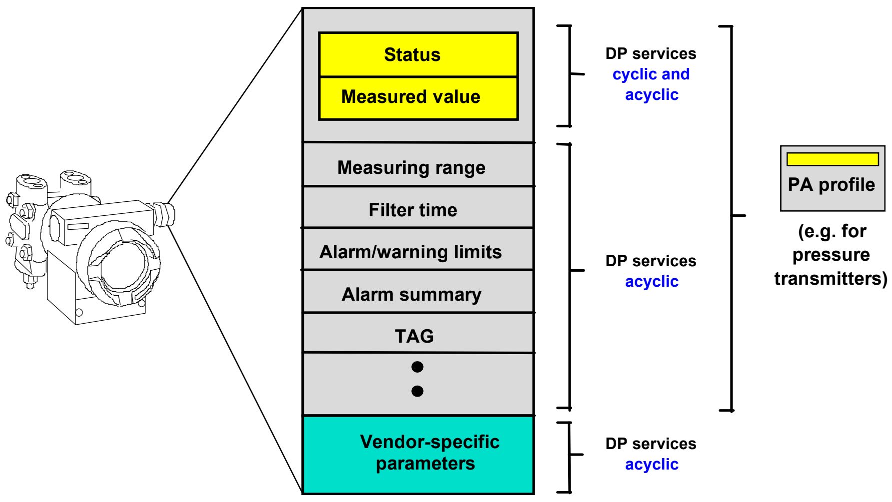


Fig. 3-7 Schematic representation of a device profile for the PA profile on PROFIBUS PA

Parameter groups

The parameters in a field device can be classified in three groups:

1. Process parameters: measured or manipulated value and corresponding status.

2. Operating parameters: measuring range, filter time, interrupt parameters (message, interrupt and warning limits), standard parameters (measuring point identifiers, TAG).

3. Manufacturer-specific parameters, such as special diagnostic information.

1st group

The parameters of the first group are read or written cyclically or acyclically by the programmable controller/system. The measured value and status parameters are present in all measuring field devices, and the manipulated variable and status parameters are in all actuating field devices and are coded uniformly (for example, measured/manipulated value in 4-byte IEEE format).

2nd group

The parameters of the second group can be read and written acyclically by the programmable controller as required. Some of these parameters are exchanged with the field devices via the function blocks in the programmable controller/system, to allow access of the HMI system (for example, visualization of alarm violation).
The parameters, i.e. the associated field device functions of the first and second groups, are defined in the PA profile of the PI guidelines (PROFIBUS International) for PROFIBUS PA. Some of these field device functions are mandatory and some optional. Where optional functions are implemented in the field device, they must comply with the description according to the PA profile.

3rd group

The parameters of the third group are manufacturer-specific. Acyclic access usually takes place with a personal computer for diagnostic and maintenance purposes. In exceptional cases, certain parameters are also read or written from this group by the programmable controller/system.

Interoperability

Programmable controllers/systems and PCs of different manufacturers can read/write the parameters defined in the PA profile from all field devices via PROFIBUS PA, thus affecting the field device functions defined in the PA profile.
The term "interoperability" is understood to mean the interaction between components (control systems and field devices in this case) of different manufacturers on an open bus system, on the basis of a vendor-independent definition of the device and communications functions.

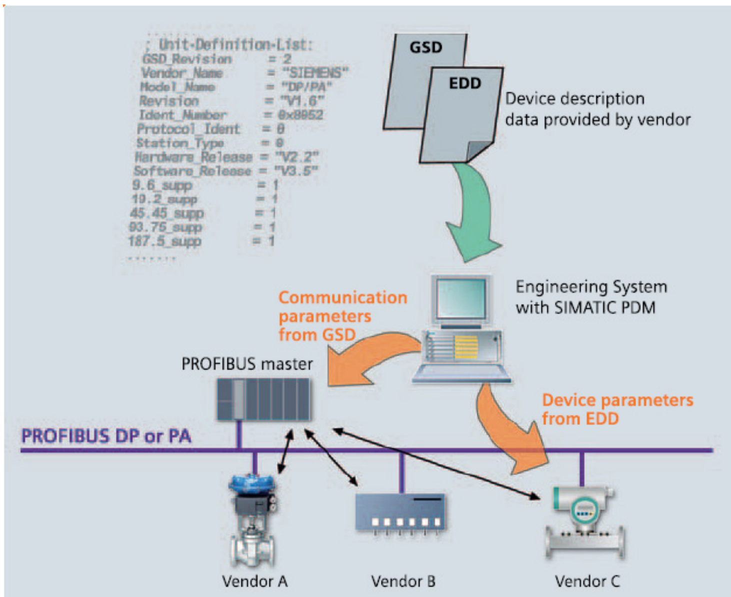


Fig. 3-8 Schematic representation of the interoperability of field devices on the basis of the device profile on PROFIBUS PA

The interoperability of the PROFIBUS allows the user to operate field devices from different manufacturers on one controller. The basis for this are the device descriptions DMF and EDD.
When configuring the bus with the engineering system, the communication parameters for the PROFIBUS master are generated from the DMF. These determine the properties and the scope of functions of the cyclic master-slave communication.
On the basis of the EDD supplied by the device manufacturer, the specific device parameters of the acyclic communication can be defined (e.g. for parameter assignment, diagnostics or measured value monitoring) with the aid of a suitable engineering tool, such as SIMATIC PDM.
Detailed information on the individual special device profile definitions can be found in Section 5.3.

Interoperability

The PROFIBUS master recognizes the manufacturer and PA profile of the devices connected to PROFIBUS from their DMF identification numbers. By means of a vendor-independent “PA profile”, PROFIBUS devices of one profile family can simply be replaced by comparable devices from another manufacturer.

Universal PA profiles such as these are available for

- Devices for counting
- Devices for measuring pressures, flows or levels
- Positioners
- Analyzers
- Digital input/output devices
- Multi-variable devices

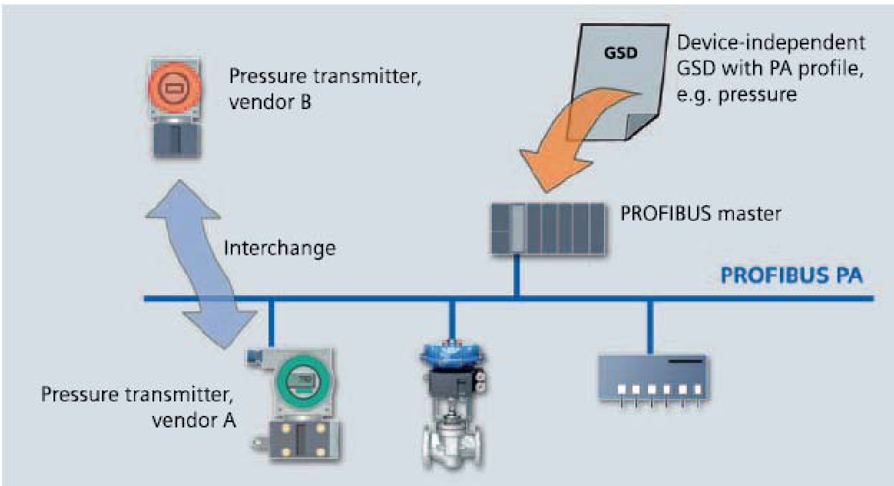


Fig. 3-9 Schematic representation of the exchangeability of field devices on the basis of the device profile on PROFIBUS PA

HART module

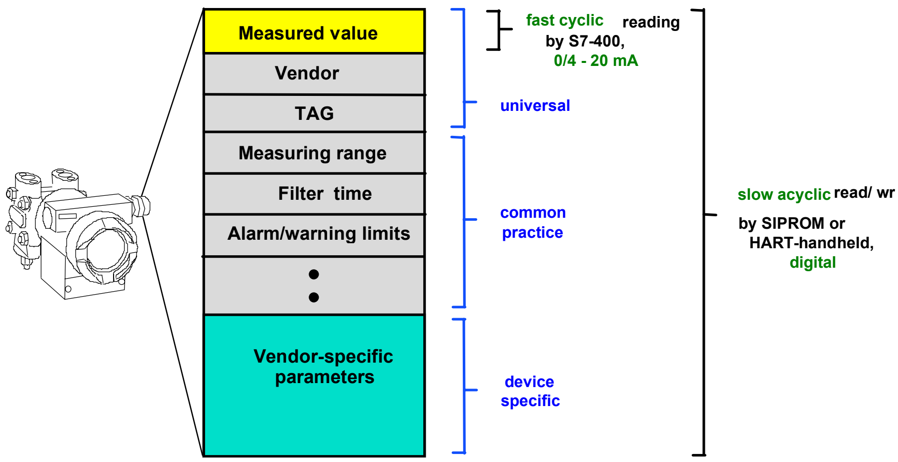


Fig. 3-10 Schematic representation of a device profile for HART communications

Parameter groups

The parameters in a HART field device can be classified in three groups:

1. Universal: measured or manipulated value, manufacturer name and measuring point tag (TAG).
2. Common practice: Measuring range, filter time, interrupt parameters (message, interrupt and warning limits).
3. Device-specific, e.g. special diagnostic information.

All three parameter groups are recorded by means of slow, acyclic reading using SIMATIC PDM or a HART handheld terminal.
The measured value is mapped by a 4...20 mA signal. The A/D or D/A conversion takes place on the HART analog module. This process value is processed by means of fast cyclic reading/writing by the automation terminal. In exceptional cases, certain parameter groups are also written or read acyclically by the programmable controller/system.

3.2.4 DMF and EDD descriptions

What is the DMF?

The DMF stands for device master file
This file contains the device master data, with which a configuration of the PROFIBUS PA field devices is possible in the SIMATIC S7 automation system and in the PCS 7 process control system.
The DMF is an ASCII text file, in which the general and device-specific communication features of a PROFIBUS device are described with the aid of obligatory and optional key words. Manufacturer and profile identification numbers increase configuration security and simplify the interoperability of the devices. The DMF describes all the major parameters for the cyclic communication.
Each manufacturer of PROFIBUS PA field devices supplies a device master file with their devices. These are to be read into the engineering station and updated in the COM PROFIBUS or STEP7 program package in the HW-

Config program section. Further information on this topic can be found in /231/

What is the EDD?

The electronic device description (EDD) is a universal, standardized device and parameter description for PROFIBUS PA and HART-compatible field devices. SIMATIC PDM is supplied with device data from the contents of the device description.
For tasks based on acyclic communication, such as

- Engineering,
- Commissioning,
- Diagnostics,
- Measured value monitoring,
- Asset management or
- Documentation,

the EDD, which is created by the device manufacturer using the powerful electronic device description language EDDL, supplies the necessary device information. The EDD can be used for both simple and complex devices. Together with powerful SIMATIC PDM process device manager it standardizes the user interface and user prompting. It is easy to generate and requires no special knowledge. When generating the EDD, existing EDDs, profile descriptions and text libraries can also be integrated.

3.2.5 Driver function blocks for field automation

Introduction

In order to transfer process data between the I/Os and the user program, field device blocks are needed. These field device blocks provide the interface to the hardware, including verification functionality.
Detailed information on parameter assignment for blocks can be found in /258/, Chapter 5.
Block types are integrated in PCS7 in the form of block libraries. You can also create your own block types as required. The following reference manuals are available:

- Basic Blocks Library /258/
- Technological Blocks Library /259/
- Field Device Blocks Library /260/

The existing set of block types can be extended if necessary. We recommend the use of the basic blocks and reference manual /258/, in which the block concept is described in detail (Chapter 2).

Field device blocks

The scope of blocks used in the SIMATIC PCS 7 automation system is very extensive and varied. We therefore refer you at this point to the document: Library of Field Device Blocks /260/.

Catalog Data

4

This chapter contains

4.1 Ordering Data

Ordering data	Order number
Drivers (Basic Blocks Library)	6ES7 863 - 2DA00 - 0XX0
PA drivers (field device blocks library)	6ES7 863 - 5DA00 - 0XX0
SIMATIC PDM, BASIC V6.0 (4 TAGS)	6ES7 658 - 3AX06 - 0YA5
SIMATIC PDM, INTEGRATION IN STEP 7/PCS 7	6ES7 658 - 3BX06 - 2YB5
SIMATIC PDM, option packages according to engineering and plant structure	6ES7 658 - 3BX06 -
DP/PA coupler, intrinsically safe version	6ES7 157 - 0AD82 - 0XA0
DP/PA coupler, non-intrinsically safe version	6ES7 157 - 0AC82 - 0XA0
DP/PA link (IM 157)	6ES7 157 - 0AA82 - 0XA0
Analog input ET200M SM 331 AI 2 x HART	6ES7 331 - 7TB00 - 0AB0
Analog output ET200M SM 332 AO 2 x HART	6ES7 332 - 5TB00 - 0AB0
RS 485-IS coupler	6ES7 972 - 0AC80 - 0XA0
ET 200iSP interface module IM152-1	6ES7 152 - 1AA00 - 0AB0
Analog input ET200iSP 4 AI I 2WIRE HART	6ES7 134 - 7TD00 - 0AB0
Analog input ET200iSP 4 AI I 4WIRE HART	6ES7 134 - 7TD50 - 0AB0
Analog input ET200iSP 4 AO I HART	6ES7 135 - 7TD00 - 0AB0

4.2 Cross-References to Detailed Catalogs

Catalog	Catalog content	Order No.
ST 50	SIMATIC automation systems SIMATIC S5/505	Available as PDF download: http://www2.automation.siemens.com/simatic/ftp/st50/html_00/st5098_d.pdf
ST 70	SIMATIC S7 Products for Totally Integrated Automation and Micro Automation	E86060-K4670-A111-A9
ST 80	SIMATIC HMI Operator control and monitoring systems	E86060-K4680-A101-B3
IK PI	Industrial Communication for Automation and Drives	E86060-K6710-A101-B4
FI 01	Field devices for process automation	E86060-K6201-A101-A6
FS10	Sensor Technology Factory Automation Sensors	E86060-K8310-A101-A1
	PC-based Automation	E86060-K4670-B111-B2
KT 10.1	SITOP power – power supplies, LOGO!Power	E86060-K2410-A101-A5
KT 10.2	System cabling SIMATIC TOP connect	E86060-K2410-A201-A3
ST PCS 7	SIMATIC Process control system SIMATIC PCS 7	E86060-W4678-A111-A8
ST PCS 7.A	Add-ons for the SIMATIC PCS 7 process control system	E86060-K4678-A121-A4
CA 01	Components for automation	E86060-D4001-A100-C3

The latest catalogs are available on the Internet:
http://www.automation.siemens.com/order_formular/html_00/resoform.asp

4.3 Positioning in the Information Environment

To support your configuration, there is extensive user documentation intended for selective utilization. The following explanations are designed to facilitate utilization of the user documentation.

Title	Table of Contents
Process Control System PCS 7 Configuration Manual	This description provides an overview of components and functionality of the SIMATIC process control system 7, and contains the system topics of interest for operating a control system. A5E00164233-02; A5E00058932-04
Programming with STEP 7 Manual	The STEP 7 Manual explains the basic utilization and functions of the STEP 7 programming software. A5E00261252-01
System software for S7-300/400 System and standard functions Reference Manual	The S7-CPUs contain the system and standard functions integrated in the operating system which you can use in programming. The manual provides an overview of the functions and organization blocks available as a basis with S7, as well as detailed interface descriptions in the form of reference information, for utilization in your user program. A5E00261259-01
CFC for S7 Manual	The manual for the CFC configuring tool (in the PCS 7 engineering package) provides an overview and instructions for the procedure in creating an overall software structure from prepared blocks. When working with the software, you can use the online help which answers your detailed questions on utilizing the CFC editor. A5E00177296-01
SFC for S7 Manual	The manual of the SFC I&C package provides the information needed for configuring sequence controllers. When working with the software, you can use the online help which answers your detailed questions on utilizing SFC. A5E00177374-01
Reference manuals of the block libraries	The "Basic blocks", "Field device blocks" and "Technological blocks" manuals contain detailed information on the blocks of the libraries. Blocks: A5E00180694-02 Driver blocks: A5E00180696-02 Library: A5E00180680-02
WinCC Basic documentation Manual	The manual provides information you require for configuring and working with the HMI system and includes descriptions of the hardware, software and process control. A5E00221788
Bus links DP/PA link and Y-link Device Manual	This manual describes the hardware of the PROFIBUS link DP/PA in detail. It allows you to put bus links into operation. A5E00193840-14
Automation systems S7-300, ET200M Ex IO modules Reference Manual	Chapter 4 of the reference manual describes the HART analog modules. It enables you to put the modules into operation. A5E00172006-07
Distributed IO device ET 200M Manual	This manual describes the design of the distributed IO device ET200M. It contains the description of the module IM 153-2 that is requires for the use of the HART modules. EWA-4NEB780600601-06
Distributed IO device ET 200iSP Manual	This manual contains instructions on configuring, installing, wiring, commissioning, diagnosing and maintaining the ET 200iSP, including the associated HART analog modules. A5E00247482-02
Profibus RS485-IS User and Installation Guideline 2.262 (PI)	These guidelines describe the configuration of RS485-IS networks in hazardous areas. http://www.profibus.com/

SIMATIC PDM Process Device Manager Manual	This manual gives you a complete overview of programming with SIMATIC PDM. It supports you with the installation and commissioning of the software. It explains the procedures for configuring networks, commissioning and runtime functions. The manual is aimed at those who work in field technology for the configuration, commissioning and operation of plants. A5E00210345-01

The latest versions of the manuals are available on the Internet at:
http://www2.automation.siemens.com/simatic/portal/html_00/techdoku.htm

Part 2 Configuring and Startup

Installation Guidelines 5

This chapter contains:

5.1 Introduction

General

The characteristic feature of a bus system is that many stations can communicate with each other with a low cabling overhead. Another important criterion is the possibility of expanding existing plant sections without having to modify available structures. This criterion is met by PROFIBUS PA.
The versatile system configuration of PROFIBUS PA allows optimal adaptation of the field cabling to the local circumstances of the industrial plant.

Fehler!

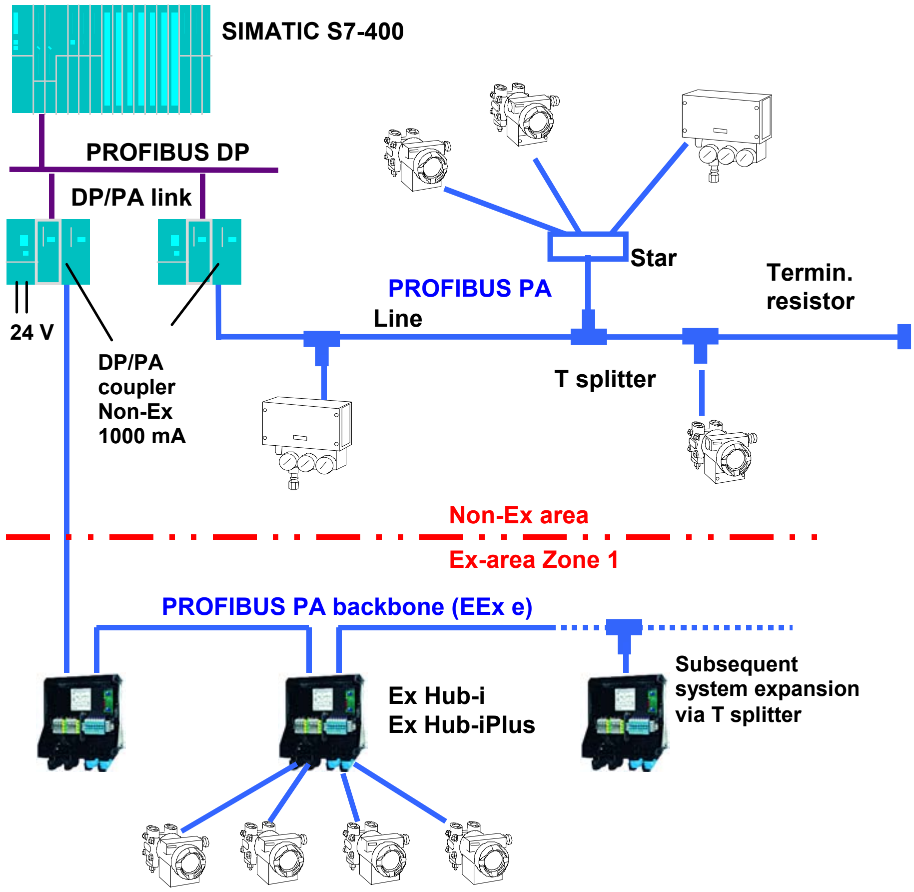


Fig. 5-1 Topology of PROFIBUS PA

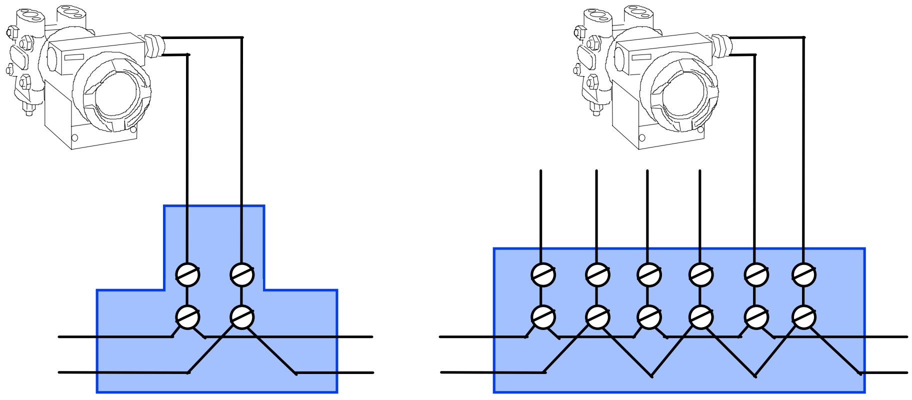
Connection system (connection box).

The field devices are connected to the bus line using T splitters and hubs

In practice, a distinction is made between the following arrangements:

- Bus line from DP/PA coupler or DP/PA Link to the field devices and star-configuration cabling on-site.
- Connection of field devices with T splitters and hubs along the bus line.

- Use of Ex hubs for connecting intrsinsically-safe devices to the non-intrinsically-safe DP/PA coupler in order to increase the number of devices on the PA bus in the Ex area.



T branch

Star / field distributor (e.g. for 3 field devices)

Fig. 5-2 Connection diagram for field devices on PROFIBUS PA

Number of field-devices

By means of the DP/PA coupler or DP/PA link, up to 9 field devices can be powered on a PROFIBUS PA segment (shielded two-wire cable) in the Ex area and up to 31 field devices in the non-Ex area.
By using Ex hubs, the number of field devices in the Ex area can be increased to a maximum of 31 on a non-Ex PA segment.

Cable lengths

The following cable lengths can be achieved regardless of the distribution and number of PROFIBUS PA devices /605/:

- Ex version: 920m
- Non-Ex version: 560m

Depending on the distribution and number of PROFIBUS PA devices and their actual power consumption, the PROFIBUS standard permits the following maximum lengths:

- Non-Ex and Ex[ib] (Ex hubs) version:
  Total length per segment max. 1900 m.

Number of bus nodes	Length of spur line
1 – 12	120 m
13 – 14	90 m
15 – 18	60 m
19 – 24	30 m

- Ex[ia] version: Total length per segment max. 1000 m.

Number of bus nodes	Length of spur line
1 – 24	30 m (FISCO)

Power requirements

Every field device on the PROFIBUS PA draws a static quiescent current of typically 12 mA from the DP/PA coupler or DP/PA link via the data cable. In practice the current consumption is between 10 and 30 mA, depending on the field device. Field devices with lower power consumption such as pressure, temperature or level transducers utilize this quiescent current as their own power supply. The total quiescent currents of all stations is limited to 110 mA in the Ex area and 1000 mA in the non-Ex area.

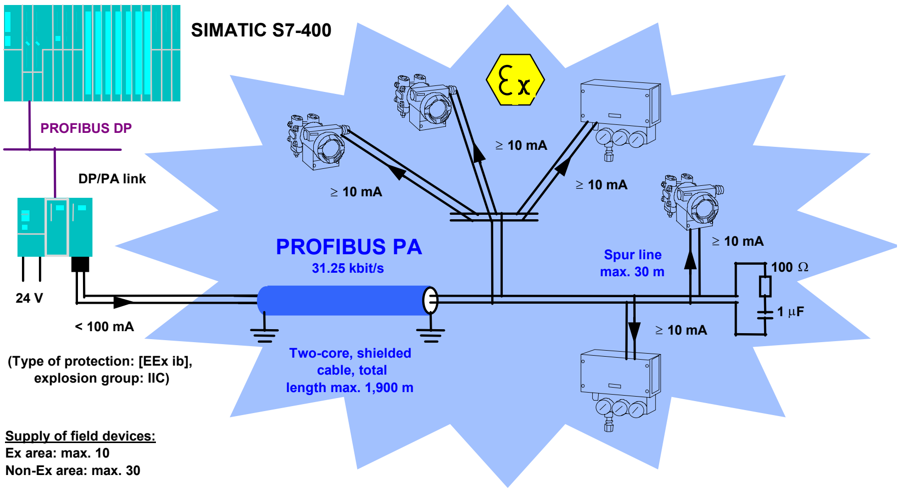


Fig. 5-3 PROFIBUS PA supplying the field devices

Transmission type-

Data is transmitted by modulating the quiescent current with current signals of +/- 9 mA. The design of the Ex version of the DP/PA coupler or DP/PA link in accordance with [EEx ia] IIC allows the use of field devices in Zone 0 (5% of all applications in the Ex area) and Zones 1 and 2 (both accounting for 95% of all applications in the Ex area).

Installation site

The DP/PA coupler and DP/PA link are referred to as "associated apparatus" with an intrinsically-safe circuit (PROFIBUS PA) that is installed outside the Ex area.

Installation

Simple and rugged installation:

- Two-wire line with shield
- Connection by means of terminals, no soldering
- Field devices can be replaced during operation

Hub technology PROFIBUS PA,

Thanks to the electrical isolation of intrinsically-safe and non-intrinsically-safe

the Ex hub makes it possible to also operate non-intrinsically-safe devices via the non-intrinsically-safe DP/PA coupler in the DP/PA Link and thus to work with higher supply voltages and currents (1000 mA). This greatly increases the number of devices that can be connected per bus segment in the Ex area. You can find more information on Ex hub technology in the Catalog ST PCS 7.A Add Ons for the SIMATIC PCS 7 Process Control System.

5.2 Mechanical and Electrical Installation

5.2.1 Installing the cables

Installation

When installing the cables, ensure that they are not twisted, kinked, stretched, or crushed!

Applying the shields

Shielded cables (braided shield) are recommended for the bus cable.
This recommendation also applies to any supply cables from external power supplies to PROFIBUS devices (such as repeaters).
Double-shielded cables are particularly suitable for environments subject to electromagnetic interference. To ensure optimal protection, the outer shield (braided shield) and the inner shield (foil shield) at both cable ends must make large-area contact to ground with a grounding clamp.
Where bus cables are inserted into electronics cabinets, the outer shield is additionally given large-area contact to a shield bus to improve the diverting of radio-frequency interference. The cable insulation should be stripped over the width of the clamp by means of a cable knife without damaging the braided shield. The shield bus must have good electrical connection with the cabinet ground (screw-fitting with a toothed lockwasher).
For industrial areas subject to extreme electromagnetic interference (converters), laying of the cable within a steel pipe or sheet-steel duct is mandatory. The pipe or duct must have multiple grounding at various points. A fiber optic bus can be used as an alternative.

Securing the cables

Bus cables must be mechanically secured at a distance of ≤ 1 meter from the terminal of the connected device (by means of a cable tie or clamp, for example). The device terminals generally serve only to divert the interference currents (shield contact) and cannot counteract vertical or horizontal tensile forces.

Equipotential bonding

Where circulating currents via the shield are expected to be higher than permitted by the cable manufacturer, an additional equipotential bonding conductor (≥ 10 mm^2 copper) should be laid to the bus cable, parallel if possible.

Note:

Particular attention must be paid to VDE 0165 Section 5.3.3. for operation in Ex zones. It specifies that in Ex zones and with more than one ground point, equipotential bonding is mandatory.

5.2.2 Cable routes within buildings and outside buildings

Installing the cables

Shielded bus cables must be laid at a distance of at least 200 mm from supply and high-voltage cables of more than 60 volts. With severe interference sources (welding transformer, switched motors, etc.), the distance must be increased to at least 500 mm.
Installation next to telecommunications cables should be avoided because mutual interference cannot be ruled out. Installation next to signal cables for measurement and control with signal voltages of ≤ 60 volts is possible without problems.

Routing on cable racks and through channels is permissible. Adequate grounding must be ensured. Even short spur cable racks or steel conduits must be grounded.

Protection against damage

Where there is risk of mechanical damage (friction, walkways) special protection must be provided (closed sheet metal duct or conduit).
If no cable racks, channels or ducts are available, the cable must be installed in a conduit. This must be marked accordingly to prevent other cables from being drawn in later. At expansion joints of the building, the conduit may be interrupted for a maximum of 500 mm provided the cables cannot be damaged by falling parts. At specially protected locations (electronics rooms), the cables may be installed without conduit. The subsequent pulling-in of bus cables into an occupied conduit is not permissible on account of the risk of mechanical damage.

Storage and transportation

During storage, transportion and laying, ensure that both ends of the bus cable are sealed with caps or insulating tape. This prevents the ingress of moisture and dirt.

Laying of cables in the ground

In the ground, a cable must be laid in conduits or duct blocks. With direct laying, the cable must be covered with an additional protective layer of sand to protect it against damage. The manufacturer's specifications relating to the suitability of the particular cable for burying in the ground must be observed. Some manufacturers assign a particular color to the cable to facilitate identification (for example, gray cable within buildings and black cable outside buildings and in the ground).
For protection against the effects of lightning strikes, a 70 mm^2 copper cable or 40 x 5 mm steel strip must be laid about 0.5 m above a cable routed underground (covered with sand or in a PVC conduit).

Permissible bending radius

Particularly with fiber-optic cables, the bending radius must not be lower than the minimum value specified by the manufacturer. For example, the bending radius applying to the SIMATIC NET PROFIBUS plastic fiber cable is ≥ 35 mm, and ≥ 150 mm for the corresponding glass fiber cable. The corresponding tensile strengths must also not be exceeded (10 N and 500 N respectively for the cables mentioned above).
The following guide value applies for copper cables with a plastic sheath:
Laying radius = 12 x cable diameter.
Maximum tensile stress (guide value) is 100 N.

5.2.3 Cable specifications and cable recommendation PROFIBUS DP

Cable specification

Cable type	Twisted-pairs 1 * 2 or 2 * 2 or 1 * 4 (star quad), shielded
Impedance	nom. 120 Ω, min. 100 Ω, max. 130 Ω, f > 100 kHz
Cable capacitancet	typ. < 60 pF/m
Core cross-section	min. 0.22 mm^2, corresponds approx. to AWG 24
Signal attenuation	max. 9 dB[1] over entire length of cable section corresponding to 1200 m 100 kbit/s [RS 422A] or approx. 0.75 dB/100m f = 100 kHz
Shielding	Apart from good HF characteristics, ensure that the shield can be correctly connected. Wrapped shield foil is not suitable. If possible, use aluminum foil and copper braid or at least copper braid.

Table 5-1: Cable specification

Cable recommendation The search for suitable cables with the above specifications was unexpectedly difficult. The RS485 signal standard was originally created for transmitting on telephone cables with 120 Ω impedance. These are frequently used without shielding. Where they are shielded, it is usually static which explains the types with aluminum foil and contact wire. However, the advent of ISDN networks resulted in a general need for telephone cables with HF shielding.
Two-wire data transmission right up to the highest frequency ranges has developed greatly in recent years in the form of LANs (local area networks). In newer buildings, LAN-capable universal cables are pre-installed in the infrastructure. Unfortunately, the excellent cables developed for this purpose can hardly be used for PROFIBUS because the impedance of this network cable is a standard 100 Ω. Although this value is precisely at the limit of the PROFIBUS specification, the negative tolerance range of -10 % to -15 % can cause unacceptable reflections with a terminating resistance of 120 Ω. The table below includes only cables with an impedance complying with the specifications.

[1]The PROFIBUS standard specifies 6 dB here, adopted from the quoted standards including CCITT V.11. The max. cable length of 1000 m mentioned therein is assumed to have a max. signal attenuation of 6 dB between transmitter and receiver. The specified test set-up with a twisted telephone cable of 0.51 mm diameter copper and 100 Ω terminating resistance already results in a resistive attenuation of 8.6 dB.

Cable list

The data in this list have been taken from the data sheets.
The list is only intended to provide an overview and therefore does not represent the full range of cables.

Manufacturer/sale	Cable type	Impedance	Cable type (standard designation)	Capacitance in operation 1kHz	Attenuation	Shielding	Remarks
Siemens AG	SIMATIC NET 6XV1 830-0EH10	150Ω ± 15Ω 3 ... 20 MHz	02YSY (ST) CY 1 x 2x 0.64/2.55-150 KF 40 FR VI	approx. 28 nF/km	<4 dB/km bei 38.4 KHz	Al.-clad foil + Cu braid	Bus cable Standard with PVC sheath
Siemens AG	SIMATIC NET 6XV1 830-3FH10	150Ω ± 15Ω 3 ... 20 MHz	02YSY (ST) CY2Y 1 x 2 x 0.64/2.55-150 KF 40 SW	approx. 28 nF/km	<4 dB/km bei 38.4 KHz	Al.-clad foil + Cu braid	Bus cable Buried cable
Siemens AG	SIMATIC NET 6XV1 830-0GH10	150Ω ± 15Ω 3 ... 20 MHz	02YSY (ST) CY 1 × 2 × 0.64/2.55-150 KF 40 FR VI	approx. 28 nF/km	<4 dB/km bei 38.4 KHz	Al.-clad foil + Cu braid	Bus cable with PE sheath (food & beverages)
Siemens AG	SIMATIC NET 6XV1 830-3EH10	150Ω ± 15Ω 3 ... 20 MHz	02YY (ST) C11Y 1 x 2 x 0.64/2.55-150 LI KF 40 FR petrol	approx. 28 nF/km	<4 dB/km bei 38.4 KHz	Al.-clad foil + Cu braid	Bus cable for use as trailing cable
Siemens AG	SIMATIC NET 6XV1 830-3GH10	150Ω ± 15Ω 3 ... 20 MHz	02Y (ST) CY 1 x 2 x 0.65/2.56-150 LI petrol FR	approx. 28 nF/km	<4 dB/km bei 38.4 KHz	Al.-clad foil + Cu braid	Bus cable for festoons

Table 5-2: List of copper cables

Manufacturer/sales	Cable type	Fiber type	Cable type (standard designation)	Material attenuation	Operating temperature	Remarks
Siemens AG	6XV1 873-2A	Multimode graded-index fiber 50/125	AT-W(ZN)YY 2x1G50/125	at 850nm ≤ 2.7dB/km at 1300nm ≤ 0.7dB/km	–25 ºC to +80 ºC	FO standard cable for use indoors and out
Siemens AG	6XV1 820-5AH10	Multimode graded-index fiber 62.5/125	AT-VYY 2G62.5/125 3.1B200 + 0.8F600 F	at 850nm ≤ 3.5dB/km at 1300nm ≤ 0.8dB/km	–20 ºC to +60 ºC	Fiber optic cable for use indoors and out
Siemens AG	6XV1820-6AH10	Multimode graded-index fiber 50/125	AT-W(ZN)Y(ZN)11Y 2G50/125	at 850nm ≤ 2.7dB/km at 1300nm ≤ 0.7dB/km	–25 ºC to +80 ºC	Cables for use in trailing cables for high mechanical stress
Siemens AG	6XV1820-7AH10	Multimode graded-index fiber 62.5/125	T-VHH 2G62.5/125 3.2B200+0.9F600 F TB3 OR FRNC	at 850nm ≤ 3.5dB/km at 1300nm ≤ 1.0dB/km	–20 ºC to +60 ºC	Tread-resistant, halogen-free and non-inflammable cable for use indoors
Siemens AG	6XV1873-3GTأأ	Multimode graded-index fiber 50/125	AT-WQ(ZN)Y(ZN)B2Y 2G50/125	at 850nm ≤ 2.7dB/km at 1300nm ≤ 0.7dB/km	–25 ºC to +70 ºC	Longitudinal and lateral water-tight cable for use outdoors with non-metallic protection against rodents, for direct routing also underground

Table 5-3: Fiber optic cable list

5.2.4 Cable specifications and cable recommendation PROFIBUS PA

Cable specification

According to EN 61158-2, a two-core cable is prescribed for fieldbuses. The electrical data are not specified although they govern the achievable characteristics of the fieldbus (possible distances, number of stations, electromagnetic compatibility). In the standard (Annex C, not for standardization, for information only) a distinction is made between four cable types.
Installations according to the FISCO model are not subject to any safety restrictions if defined limit values are observed. Operation outside these limit values is generally excluded but requires consideration of individual cases.
The cores of all fieldbus cables must be clearly selectable (for example, with color coding or ring marking). Cables with intrinsically safe circuits must be marked according to DIN 57 165/VDE 0165, Section 6.1.3.14 (for example, with a light-blue sheath).
Where multi-pair cables are used in the hazardous area, the special installation conditions of DIN 57 165 / VDE 0165 (Chapter 6) /8/ must be observed.

Cable recommendation

The reference cable (Type A) must be used for conformance tests.
For the new installations of plants, the cables used must meet the minimum requirements of Type A or B. With multi-pair cables (Type B), two or more fieldbuses (31.25 kbit/s) may be operated in one cable. Other circuits on the same cable must be avoided.
Cables of Type C and D must only be used in retrofit applications (use of already installed cables) with a greatly reduced network size. In these cases, allowance should be made for the fact that the interference immunity of transmission often does not meet the requirements described in the standard.

Cable list

The data in this list have been taken from the data sheets.
The list is only intended to provide an overview and therefore does not represent the full range of cables.

Manufacturer/ sale	Cable type	Impedance	Cable type (standard designation)	Capacitance in operation	Attenuation	Shielding	Remarks
Siemens AG	SIMATIC NET 6XV1 830-5EH10	100Ω ± 20Ω	02 Y SY CY 1 x 2 x 1.0/2.55-100 BL OE FR	<28 nF/km	<3 dB/km 38.4 KHz	Cu braid	
Siemens AG	SIMATIC NET 6XV1 830-5FH10	100Ω ± 20Ω	02 Y SY CY 1 x 2 x 1.0/2.55-100 BL OE FR	<28 nF/km	<3 dB/km 38.4 KHz	Cu braid	

Table 5-4: List of copper cables

5.2.5 Shielding concept

To shield or not to shield EN 50170 Vol. 2 allows the user to decide whether to employ shielded cables. Unshielded cables are permissible in an interference-free environment. On the other hand, there is the following argument for always using shielded cables:

- An "interference-free" area exists, if at all, only in the interior of shielding cabinets. However, as soon as relays and switching contactors are installed in them, the protection is lost.

Shielding rules

For optimum electromagnetic compatibility of systems, it is very important that the system components and, in particular, the cables are shielded, and that these shields form a sheath that is as electrically seamless as possible.
To quote the "Grounding, shielding" Section of the DIN standard: "When a shielded bus cable is used, it is recommended that the shield be connected to protective grounds with low inductance at both ends, to achieve the best possible EMC. Separate potentials (e.g. in a refinery) are an exception; as a rule, only single-ended grounding is permitted in these cases.

Note:

In systems without equipotential bonding, circulating currents at line frequency can damage the bus cable in unfavorable cases (by exceeding the permissible shield current). In these systems, therefore, the cable shield should be directly connected to the building ground at one end only.

The connection between the shield and protective ground (unit housing, for example) should preferably be made via the metal housing and the screw-type connection of the sub D connectors. Where this type of shielding is not possible, grounding can be achieved via pin 1 of the connector."
It should be noted, however, that the connection via pin 1 does not meet the "low-inductance" condition. With a view to EMC, it is better to expose the cable shield at a suitable point and ground it to the (metal) structure of the cabinet with the shortest possible cable connection (for example, with a shield clamp in front of the connector).

Shield connection

By far the most important location for connecting the shield ground is at the point where the bus cable enters the control cabinet. Longer external cables are frequently routed via terminals here. For the shield connection to meet the "low-inductance" requirement, the following must be observed:

Note:

The cable shield must make contact over its circumference and have a large-area connection to the grounded structure (for example, ground bus, terminal rail).

Here are the most common mistakes resulting in non low-inductance grounding:

- Connection via a sheath wire or contact wire.
- Connection via a short length of stranded conductor (a few cm), soldered on or crimped on ("pigtail method").

- Opening up or unsplicing the cable shield and clamping it directly in a ground clamp. If the resultant ground wire is not longer than about 2 cm, this method is conditionally permissible.
- Routing of shield grounds via lengths of stranded copper conductor, even with large cross-sections (1.5 mm^2 Cu).

With proper clamping of the cable shield by means of a cable clamp or other clamping device, adequate contact pressure must be ensured. The clamping pressure is often exerted against the cable's insulation which creeps in the course of time. Such arrangements require very great spring travel! The shield connection terminal of Weidmüller's KLBÜ series is a constructive response to this problem.

5.2.6 Grounding and equipotential bonding

Protective grounding

The protection concept of the station supply governs the need for protective grounding of a bus station. Consult the manufacturer's data and local specifications.

Equipotential bonding

The RS485 bus segment with 2 to 32 transceivers (transmitter/receiver modules) is electrically throuogh-connected. Light equipotential bonding is therefore always provided by the bus cable. The question is whether additional, lower-resistance equipotential bonding is necessary, as specified in the RS 485 standard.

2-wire line

With a two-wire line, there is only light equipotential bonding.
Electrical isolation of the transceiver from the station with its other potential connections is unavoidable for fault-free data transmission.

4-wire line

With a four-wire line, equipotential bonding is provided by the DGND conductor. This arrangement does not depend on electrical isolation of the transceiver. If the DGND is grounded with two or more stations, excessive circulating currents can flow on the bus cable. For this case, RS485 specifies a series resistance of about 100 ohms per station. Although this resistance provides protection from excessive circulating currents, it reduces the equipotential effect. Isolation of the transceiver is advantageous, even with equipotential bonding.

Conclusion

Equipotential bonding according to RS 485 is only necessary when there is no isolation of transceivers from other potential connections (such as grounded supply, great capacitive coupling of an ungrounded supply).

Area subject to explosion hazard

This is an area in which the risk of explosion or a hazardous explosive atmosphere can develop as a result of local operational conditions.
According to the classification of this area, there are special requirements for the use of electrical apparatus. Further explanations and instructions can be found in VDE 0165 and /519/.

5.2.7 Lightning protection

Lightning protection is subdivided into external and internal protection. Where bus cables are routed only within a building, only the internal lightning protection need be taken into account.

External lightning protection External lightning protection always refers to the (bus) cables routed to the plant sections located outside the building.
Where cables are laid in PVC or PE tubes, a grounding cable must be laid about 0.5 m above the cables (at least 70 mm^2 copper cable or 40 x 5 mm steel strip). The copper cable or steel strip must be grounded at each entrance to the building.
Bus cables laid above ground must be routed in a closed steel conduit or sheet steel duct. Both the conduit and the duct must be grounded at least at the beginning, at the end and at each entrance to the building.

Internal lightning protection All electrical and metal parts (cables, pipes, etc.) leading into a building must be incorporated into the equipotential bonding for lightning protection This means that all pipes (gas pipes, water pipes, cable conduits, etc) must be directly connected to the equipotential bonding rail at the entrance to the building. The cores of power cables are connected to the equipotential bonding rail via lightning arresters. This relates to EDP and bus cables as well as low-voltaeg cables.

5.2.8 Connectors

PROFIBUS DP 9-pin sub D connectors are used as the connection medium for the bus cable (and for connecting PROFIBUS PA to the DP/PA coupler). The connection between core and socket or pin should be a screw terminal or soldered joint. The cases of the sub D connectors should preferably be metal or metalized to ensure EMC, also at the connector. Connectors should be secured to the interface or station b yan electrically conductive screwed connection.
DIN 41652,Part 1, applies to mechanical and electrical properties of 9-pin sub D connectors.

PROFIBUS PA PA terminals are used as teh connection medium for the bus cable between the individual field devices. The connection between core and socket or pin should be a screw terminal or soldered joint. The cases of the PA terminals should preferably be metal or metalized to ensure EMC, also at the PA terminal.

Note

It is not recommended that PROFIBUS PA be looped-through via the individual field devices. Subsequent replacement of only one field device can result in a breakdown of bus communication.

Sub D connectors with solder terminals Soldering work must be done cleanly and carefully. Additionally, a local 220/230-V outlet is needed for the soldering iron.
Sub D connectors with solder terminals are very common and are available from various manufacturers.

Sub D connectors with crimp terminals The crimping operation is relatively critical and can only be carried out with a special tool. If improperly created, crimp contacts can slip out of their seat and impair the reliability of a connection. However, the work can be carried out by one person. For production in a workshop, an automatic crimping machine can considerably facilitate and accelerate the work (stripping and crimping in one operation).

Sub D connectors with screw terminals

Apart from the screwdriver and stripping tool, no other aids are needed. As with modular terminals, screw connections are less subject to faults and considerably easier to make than a soldered joint. No power is needed for a soldering iron, nor is there any need for assistance by a second person. At present, however, there are few providers of this simple connection system (such as Phoenix Contact, Siemens, etc.).

Connectors for higher degrees of protection (IP65)

9-pin sub D connectors are not suitable for use in a harsh environment and in environments with higher degrees of protection. For these applications, there are circular connectors made of metal which meet the higher requirements.
Another possibility is to provide the plug-in connection in a suitable housing and ensure the degree of protection at the cable bushings by means of suitable heavy-gauge threaded joints. (Interfaces or stations in IP65 housings)

5.2.9 Installation materials and tools

Tools for copper cables

In general, no special tools are required for fitting the copper bus cables.

Tools for Fiber optics

No particular tools are required for fitting the fiber-optic cables. However, the following additional points must be noted:

- The individual companies provide cables, usually prefabricated, for connecting the FO components. These cables require no further treatment.
- Where connectors must be fitted to the glass FO cables on site, there are special splicing methods (mechanical or thermal) with which the connectors can be properly clamped on. Splicing is normally undertaken by trained specialists because maximum accuracy and cleanliness are essential Connectors can be fitted to FO cables or direct connections can be made between FO cables.
- Some companies offer special installation cases containing the necessary tools and materials Sometimes a microscope is needed in addition to the installation case.
- For simple connections, there are so-called finger splices FO cables can be easily interconnected (without special tools) by means of mechanical self-alignment in the splice.
- Plastic FO cables can be preassembled without problems at the plant.

Installation materials

Ground cables are normally connected direct to the supporting metal structure with bolts (M6/M8/M10). To ensure a good contact, toothed lock washers are inserted between the painted metal and the nut or cable lug. Bolts, nuts and lock washers are therefore required as well as cable lugs.
The flexible cores of the signal cables are inserted into the terminals of the PROFIBUS components with ferrules.

The shields are connected to the metal structure by means of large-area cable clamps. Suitable cable clamps are therefore needed for the cables. It should be noted that the shield creeps under the cable clamps. This means that a tightened cable clamp becomes slack after a certain time and may no longer provide large-area contact with the shield. Either the clamps must all be retightened after about six months, or spring-loaded clamps are used to compensate for cable creep.
The sizes of the bolts, nuts, toothed lock washers, cable lugs, ferrules and cable clamps to be procured are determined by the cross-sections of the cables and lines used.

FastConnect®

The system consists of the following coordinated components:

- FastConnect bus cables for quick assembly
- FastConnect stripping tool
- FastConnect bus connector for PROFIBUS

The FastConnect stripping system enables PROFIBUS connectors to be connected quickly and simply to the PROFIBUS bus cables. The special design of the FastConnect cables enables use of the FastConnect stripping tools, with which the outer sheath and shielding braid can be accurately removed in one step. With the help of the FastConnect stripping tool, it is possible to strip the outer sheath and shield of the FastConnect bus cables to the correct lenghts in one step. The cable prepared in this way is connected in the FastConnect bus connectors using the insulation displacement method. The PROFIBUS FastConnect bus cables can also be connected to the conventional bus connectors.

SpliTConnect®

This system is used for setting up PROFIBUS PA fieldbus segments in accordance with IEC 61158-2 with field device connection points. It comprises the connection elements tap, M12 outlet, M12 jack, coupler and terminator for connencting the terminal devices to the FastConnect process cable.

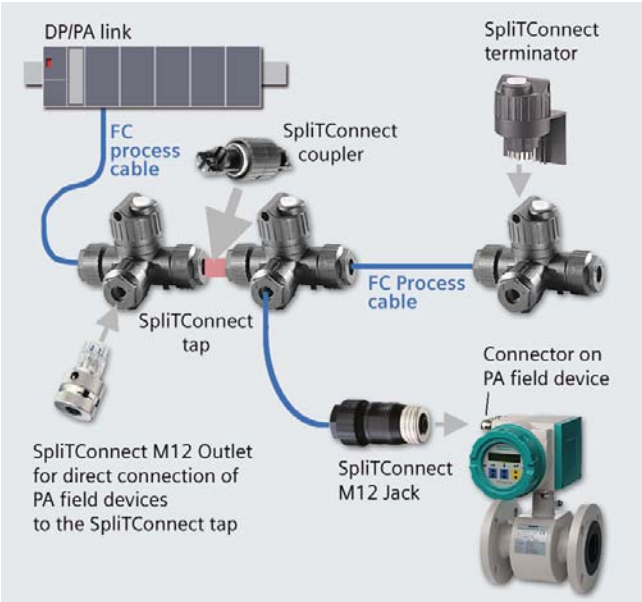


Fig. 5-4 SpliTConnect® connection system

SpliTConnect has the following advantages:

- Simple mounting of the bus cable thanks to the FastConnect system (FastConnect stripping tool, FC process cable in accordance with IEC 61158-2)
- FC process cable: Special bus cable in accordance with IEC 61158-2 for use in areas subject to explosion hazard (Ex)
- Terminal devices can be connected via FC process cables in accordance with IEC 61158-2 or SpliTConnect M12 outlet/M12 jack
- Terminating resistance combination can be integrated (SpliTConnect® terminator)
- Fewer types and parts thanks to standardized connection system for PROFIBUS PA.

Please refer to Catalog IK PI for further information.

5.3 PI (Profibus International) Guidelines and other References

Introduction

PROFIBUS is an open fieldbus system which is suitable for various application areas. The PROFIBUS technology is defined in different standards. The protocol definitions are summarized in IEC 61158. The communication profiles (CPF - communication profile families) are defined in IEC 61784-1. Number 3 (CPF 3) is reserved for PROFIBUS and PROFINET. PROFIBUS International (PI) promotes the continuous further development and global use of PROFIBUS.

References

The table below gives an overview of the most important documentation on the topic of PROFIBUS PA.

Title	Language	Source
PROFIBUS Standard		
IEC 61158 Digital data communication for measurement and control – Fieldbus for use in industrial control systems	English	IEC
IEC 61784-1 Profile sets for continous and discrete manufacturing relative to fieldbus use in industrial control systems	English	IEC
IEC 61784-1 CPF 3/1 PROFIBUS DP communication profile	English	IEC
IEC 61784-1 CPF 3/2 PROFIBUS PA communication profile	English	IEC
Implementation Guide IEC 61158/61784, Type 3 PROFIBUS (PI)	English	PI
PROFIBUS guidelines		
Specification for PROFIBUS Device Description and Device Integration, Volume 1: GSD Specification Order No.: 2.122	English	PI
Specification for PROFIBUS Device Description and Device Integration, Volume 2: EDDL Specification Order No.: 2.152	English	PI
Framework for testing and certification of PROFIBUS products Order No.: TC1-03-0020	English	PI
Test Specifications for PROFIBUS DP-Slaves Order No.: 2.032	English	PI
Test specification for PA-Devices (Profile 3.0) Order No.: 2.062	English	PI
Test specifications for PROFIBUS DP Masters Order No.: 2.072	English	PI
Fiber optical data transfer for PROFIBUS	German	PI
PROFIBUS RS485-IS User and Installation Guideline	English	PI
Installation Guideline for PROFIBUS DP/FMS	Ger./Eng.	PI
PROFIBUS PA User and Installation Guide	English	PI
PROFIBUS profiles		
Profile for communication between controllers	English	PI
Profile for HART	English	PI
Profile for Process Control Devices (PA-Branch profile)	English	PI
Remote I/O for Process Automation	English	PI

Brochures		
PROFIBUS system overview PROFIBUS Technology and Application - System Description Order No.: 4.002	Ger./Eng.	PI
PROFIBUS PA PROFIBUS for Process Automation	German	PI
PROFIBUS – The Multitalent for Communication in the Process Industry	Ger./Eng.	SIE
PROFIBUS Plant-Wide Communication – The Fieldbus Standard for the Process Industry	Ger./Eng.	SIE
Technical literature and training materials		
PROFIBUS documentation on CD-ROM	Ger./Eng..	PI
Book: The New Rapid Way to PROFIBUS DP	Ger./Eng.	PI
Web-Based Training PROFIBUS http://www.profibus.com	Ger./Eng.	PI
Software		
Device master file (DMF) editor	English	PI

Table 5-5: References

This literature can be obtained from:

PI PROFIBUS Nutzerorganisation e.V.
Haid - und - Neu Straße 7, 76131 Karlsruhe, Germany
http://www.profibus.com

SIE Brochures, catalogs:
http://www.automation.siemens.com/order_formular/html_00/resoform.asp
Manuals:
http://www2.automation.siemens.com/simatic/portal/html_00/techdoku.htm

IEC https://domino.iec.ch/webstore/webstore.nsf

Hardware configuring (project example) 6

This chapter contains:

Introduction

- Where field engineering is not directly affected, this chapter does not cover the configuration and installation of AS and OS. Further details are described in the references from /100/.
- A knowledge of the systems and devices used is a basic prerequisite for understanding the following explanations.
- The communications paths within SIMATIC S7/PCS 7 are represented schematically in Fig. 6-1 to facilitate understanding.

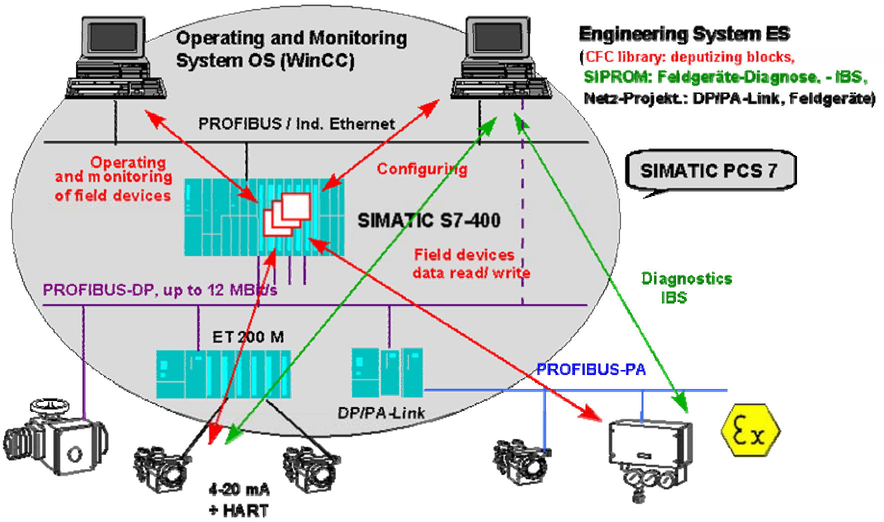


Fig. 6-1 Communications paths for the intelligent field devices within an automation system

The task

The procedure is explained in more detail on the basis of a specific task to show how PROFIBUS PA field devices and HART modules are utilized in a project. The following points are to be implemented in the project:

- Simple level control is to be created.
- The process signal will be acquired by a field device with PROFIBUS PA connection.
- The disturbance variable will be acquired via an analog input module with HART function, incorporated in the ET 200iSP I/O system.
- The actuating signal will be emitted via an analog output module without HART function via the ET 200iSP I/O system.
- Two separate PROFIBUS systems will be used:
  - PROFIBUS PA (DP line 1).
  - ET 200iSP (DP line 2).

The level range is 0 to 20 cm. Setpoint inputs, over the range 0 to 20 cm, are to be made by the plant operator. The controller is only operated in automatic mode. If the level of 17 cm is exceeded, an alarm message is to be sent to the OS.
Based on the task, the information flow is shown in Fig. 6-2. Blocks from the "PCS 7" library are used for process value acquisition, information processing (closed-loop control, operation, signaling) and output.
You can see its structure from the technological block shown in Fig. 6-2. This consists of a group of basic blocks whose interconnection and parameter assignments result in a particular technological function.

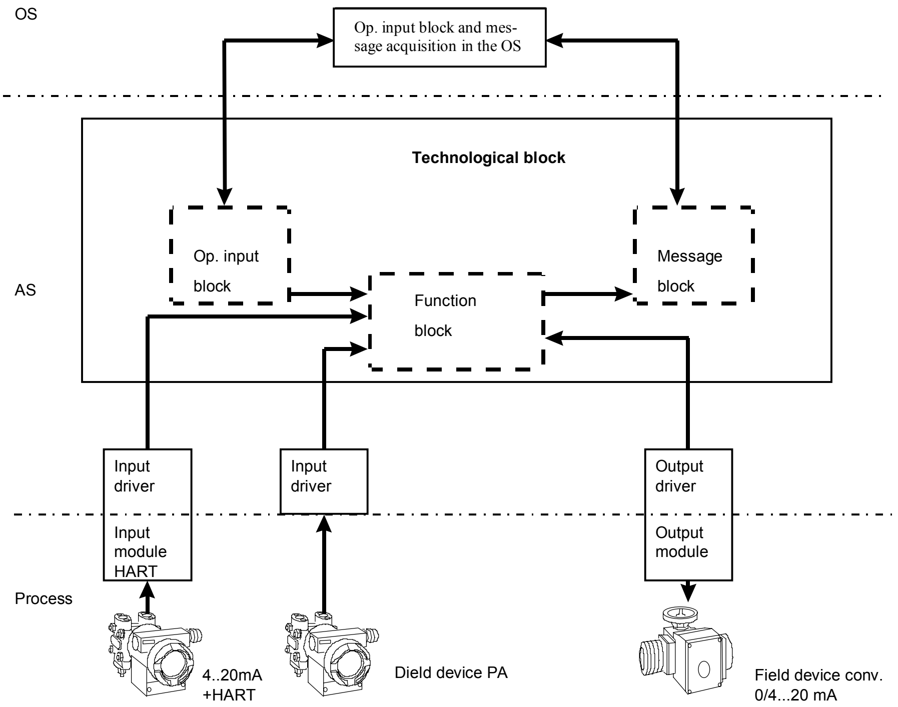


Fig. 6-2 Principle of the solution with blocks, information path

6.1 Configuring a Station

Note

In this description of configuring a station, only those aspects directly relating to the field engineering package are covered. PCS 7 is used as an example. More detailed information can be found in the extensive references in the Appendix.
Fig. 6-3 below is an overview of a possible system configuration in STEP7 HW Config.
Generally, it is possible to configure PA field devices like the SITRANS P via DP/PA coupler (see Fig. 6-3, DP line 1) or via DP/PA link (see Fig. 6-3, DP line 3) on the PLC. For the example project described below, configuring is presented using a DP/PA coupler.

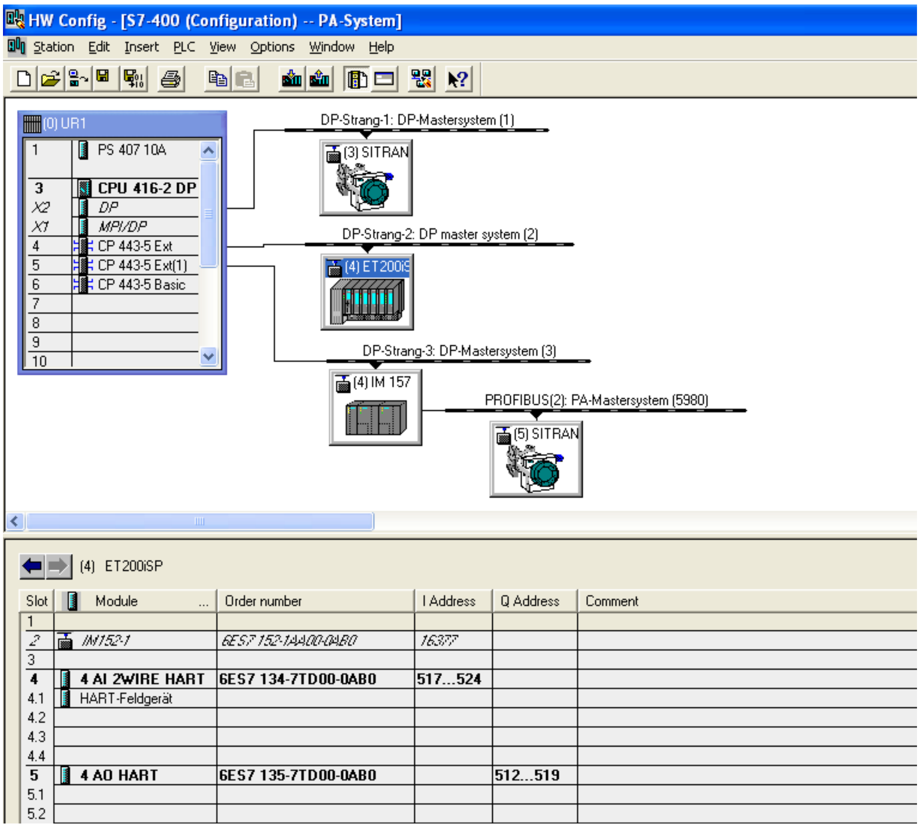


Fig. 6-3 Example of hardware configuration

6.1.1 Creating a station and starting the hardware configuration

To start configuring and parameter assignment, you need to insert a station within your project. The method described below shows this with the help of the "PCS 7" wizard that supports you when creating a project.

Perform the following steps to create a station:

- Open the SIMATIC Manager.
- Start the "PCS 7 wizard" with the menu command File > Wizard 'New Project'.
- The "PCS 7" wizard now leads you through the necessary steps for creating a project with one station. You can select, for example, the project type, project name and an appropriate CPU.
- Follow the instructions of the "PCS 7" wizard.
- After terminating the wizard, open the station by double-clicking on SIMATIC station (right window).
- If you double-click on the "Hardware" icon, a configuration dialog will open.

6.1.2 Configuring the station

Once you have created the station, assemble the hardware components as described in the task description:

- Open catalog "SIMATIC 400" in the hardware catalog

Rack, CPU

Rack, power supply and CPU have already been inserted by the PCS 7 wizard, and must be adapted to the hardware used if required.

DP line 1 (CPU)

The following steps must be taken to parameterize the DP interface integrated in the CPU for DP line 1:

- Enter the address (address 2) with which the integrated DP interface can be addressed on the bus.
- Enter a new subnet for the DP line (NEW button) and change the name to "DP line 1".
- Enter the parameters for "Network settings" according to your system (e.g. for "DP line 1" the highest PROFIBUS number: 126; data transfer rate: 45.45 kbit/s using a DP/PA coupler; profile: DP) and exist the menus for the DP network with "OK". "DP master system (1)" will be displayed.
- If entries are made under menu item "Lines", the bus parameters will be computed automatically.

DP line 2
(CP 443-5 Extented)

You can insert another DP line in the station with the CP 443-5 Extended communications processor.

- Select the next free slot (slot 4) in your rack as the current slot by clicking once (shown in blue).
- Open Catalog "CP-400" in the hardware catalog and insert a CP 443-5 Extended in the rack. You are then automatically in the dialog box for configuring the DP network.
- Enter the address (address 2) with which the integrated CP 443-5 Extended can be addressed on PROFIBUS DP.
- Enter a new subnet for the DP line (NEW button) and change the name to "DP line 2".
- Double click the CP 443-5 Extended and open the "Mode" tab.
- Set the "DP master" and "Delay (ms)" to 0.
- Enter the parameters for "Network settings" according to your system (e.g. for "DP line 2" the highest PROFIBUS number: 31; data transfer rate: 1.5 kbit/s using a PROFIBUS DP/PA (according to network requirements); profile: DP) and complete the dialogs for network configuring with "OK". "DP master system (2)" will be displayed.

System network
(Ethernet)

You need the CP 443-1 communications processor for communication between AS, ES or OS systems via Industrial Ethernet.

- Select the next free slot in your rack (slot 5) as the current slot by clicking once (shown in blue).
- Open "CP-400" in the hardware catalog and insert a CP 443-5 Basic in the rack. You are then automatically in the dialog box for configuring the Ethernet network.
- Enter the IP with which the CP 443-1 can be addressed on the bus (e.g. IP address 192.168.0.1).
- Enter a new subnet for the Ethernet line ("NEW" button), change the name to "Ethernet(1)" and close the dialog box for network configuring with "OK".

6.1.3 Loading the hardware configuration into a CPU

Configuring of the SIMATIC station is complete and you can pass on the information to the CPU with "**Target system** > **Load into module**". To load the module data, the CPU must be in the "STOP" state. A dialog is displayed in which you can select the target module for loading the hardware configuration. In the example, there is a choice of the "CPU 416-2 DP" and "CP 443-1". Leave both modules selected because you must load both modules. The "CP 443-5 Extended" is not offered for loading because this module is loaded as the DP master via the CPU.

Note:

- The first load operation of a CPU can only take place via the MPI of the CPU. The CP 443-5 for PROFIBUS is supplied with the communications parameters. Each subsequent load operation can then take place via PROFIBUS or Ethernet. Ensure that the correct module is assigned in the PG/PC interface.

- You can get more information on hardware configuring in the manual /100/.

6.2 Distributed I/O PROFIBUS DP/PA

Note

Only aspects relating to PROFIBUS DP/PA are dealt with here. When a DP/PA coupler is used in the DP network, the connected PROFIBUS PA field devices act as compact DP slaves. If the DP/PA couplers are grouped in a link module, the link module acts as a modular slave.

The following distinctions are made when configuring the DP slaves:

- Compact DP slaves are directly connected, individual devices (for example, SITRANS P via a DP/PA coupler).
- Modular DP slaves (for example, link modules with up to five PROFIBUS PA lines).
- Intelligent slaves (I slaves) (DR 21 compact controllers).

6.2.1 Inserting a DP slave in a station

6.2.1.1 Device data (Device master file)

Configuring of PROFIBUS PA field devices via the DMF is only necessary with non-Siemens field devices. Siemens field devices can be configured using the hardware catalog in STEP7 HW Config.

Non-Siemens field devices can be inserted into the hardware configuration with the help of the GSD files supplied. They are then available in the hardware catalog.

Note:

You can get more information on hardware configuring in the manual /100/.

6.2.1.2 Using a SITRANS P via a DP/PA coupler

The steps for inserting a slave in a DP/PA line are shown using the example of a SITRANS P. In this case, PROFIBUS PA is linked via a DP/PA coupler to PROFIBUS DP.

Note:
Please ensure that the hardware requirements for the PROFIBUS PA are met and that the data transfer rate is set to 45.45 kbit/s.

- Open the Hardware Catalog and select the "Standard" profile.
- Open the folder "PROFIBUS PA / Sensors / Siemens /" and drag the component "SITRANS P" to the DP line "DP master system (1)" while holding the left mouse key down.
- You will see a menu for making entries for "PROFIBUS Station SITRANS". Enter the slave address and name there. However, changes to the bus characteristics affect all the slaves located on the line and also change the bus characteristics already set for the master.
- Select the object "SITRANS P" and mark the entry for the first slot in the lower list field. Assign a symbolic name with the right mouse key and the command "Edit Symbols...". For the process value (data type "Real"), enter the symbolic name "Print1", for example, and for the relevant quality code (data type "Byte"), enter the name "QC_Print1" and confirm with "OK".
- Save the current configuration.

6.2.1.3 Using an ET 200iSP with a HART module

ET200iSP

The steps for inserting a modular slave into a DP line are shown using the example of an ET 200iSP with a HART module. DP line 2 was configured as described in Section 6.1.2.:

- Open the catalog "PROFIBUS DP" from the hardware catalog.
- Open "ET 200iSP" and drag the "IM153-2" to the DP line "DP master system(2)" while holding the left mouse key down (drag&drop).
- A menu for "PROFIBUS station characteristics" will appear in which you will enter the address of the ET 200iSP. The subnet will be automatically set by allocating the IM 153-2 to a line. Additionally, you can change the characteristics of the DP line (highest number of stations, data transfer rate, profile). However, changes to the bus characteristics affect all the slaves on the line and also change the bus characteristics already set for the master. Exit the menu with "OK" after setting the bus number.
- Select the first slot in the ET 200iSP (slot 4) as the current slot (blue surrounding) and open the hardware catalog of the IM 153-1, which you have dragged to the line.
- Open a module type "AI" (analog inputs) and select module 4AI2WIRE HART by double clicking. This module will automatically be assigned to

the current slot in the ET 200iSP, and the next free slot will become the current slot.

- Open the module type "AO" (analog output modules) and select module 4 AO Hart by double-clicking. This module will automatically be assigned to the current slot in the ET 200iSP, and the next free slot will become the current slot.
- After assigning the modules to the slots, you can double click a module in the ET 200iSP to set the characteristics of the module (current or voltage, live or dead zero, etc.). For assigning parameters to the individual modules, please consult the module descriptions.

Note:

A HART module can be parameterized for use with HART function or without HART function via the module properties.

- Now assign a symbolic name for the relevant process value for the module "4 AI 2WIRE HART" and "4 AO Hart" for each channel used as described in Section 6.2.1.2.

HART module

After inserting the two HART modules, four additional lines per HART module are created in the detailed view of the ET 200iSP. These additional lines can be assigned HART field devices.

- Open the hardware catalog of the IM152-1 that you have dragged to the line.
- Open the module "4 AI 2WIRE HART" and insert the module HART field device into the first slot (channel) of the 4 AI 2WIRE HART by dragging and dropping or by double-clicking.
- Save the current configuration and load it onto your CPU.

SIMATIC PDM

You start the parameterization software tool SIMATIC PDM by double-clicking on the HART field device (channel 1) of the 4 AI 2Wire HART shown. The window "Insert SIMATIC PDM Object", where you can specify a unique device name for the HART field device, will open first. Exit the window with OK.
The device selection window will then open. All the HART-protocol-enabled field devices available in SIMATIC PDM will appear in the device selection window.
The remaining procedure is the same as that described in Section 6.4 as an example for a PROFIBUS PA device.

6.3 Station Diagnostics

You have the facility for reading out the current status of modules for a configured station. A prerequisite is that there is a connection between automation system and PC/PG.

- In the SIMATIC Manager, select the menu command "**View > Online**". You will see an online view of you station.
- Open the AS from which you wish to read the diagnostic data (click on the "+" in front of the AS).
- Open the CPU.
- Select the program in the CPU with a click.
- Execute menu command "**Target system > Module Status**".
- Select the "Diagnostic buffer" tab in the menu shown.

In the "Events" window, you will see messages of events in brief form. If you click on an event in this window, a detailed description of the event will appear in the lower window. By clicking on "Event help" you can obtain further instructions for assessing events or clearing an existing fault.

6.4 SITRANS P Parameter Assignment with SIMATIC PDM

Note

Section 6.1.1.2 describes how you incorporate a field device with PA profile in the hardware configuration. This section shows how you can assign parameters to this field device with the parameter assignment tool SIMATIC PDM. However, only a few aspects are mentioned here. The online help is expressly referred to. The parameter assignment interface represented by SIMATIC PDM largely results from the DD description supplied with the field devices. A description of individual parameters and parameter assignment operations can be found in the device manuals. The online help is available for further support.

Start

You start SIMATIC PDM by double clicking on the field device symbol in the hardware configuration.

Device selection

In the device selection window, you will find all the field devices available in SIMATIC PDM which may pertain to a device database (DMF).

- Double click on the SITRANS P symbol on the DP line to open the "Insert SIMATIC PDM Object" window.
- Exit the window with OK, after making any required changes.
- The "Device Selection" window opens.
- Open catalog "PROFIBUS PA".
- Open the catalogs "Sensors" – "Pressure" – "Siemens" in succession.
- Select the device type (SITRANS P).
- Select the type of measurement (absolute pressure).
- Select the measuring range (250 mbar).

Access authorization

The access authorization (password) for the parameter groups in SIMATIC

PDM is defined in the "user" window. A distinction is made between two access authorizations:

- The specialist has access to all writable parameters.
- The maintenance engineer has only restricted read/write access to the parameters.

Start dialog

The display that now opens consists of three parts:

- Menu bar for data management/data transfer
- Parameter tree for fast access to individual parameter groups.
- Parameter list

The contents of the parameter tree and parameter list are governed by the EDD description (see Fig. 6-4).

Parameter lists

You can change all parameter fields with a white background in parameter lists. Changed parameters and the corresponding parameter tree branch are marked. The marking is only removed:

- when archiving in the database;
- when transferring the parameters to the field device.

Data management

The data record of each field device can be

- edited offline;
- archived in a database;
- read out of the field device;
- transferred to the field device
- or printed.

Online functions

The following online functions can be used with SIMATIC PDM:

- Measured value indication with status
- Alarm status
- Device status
- Address change

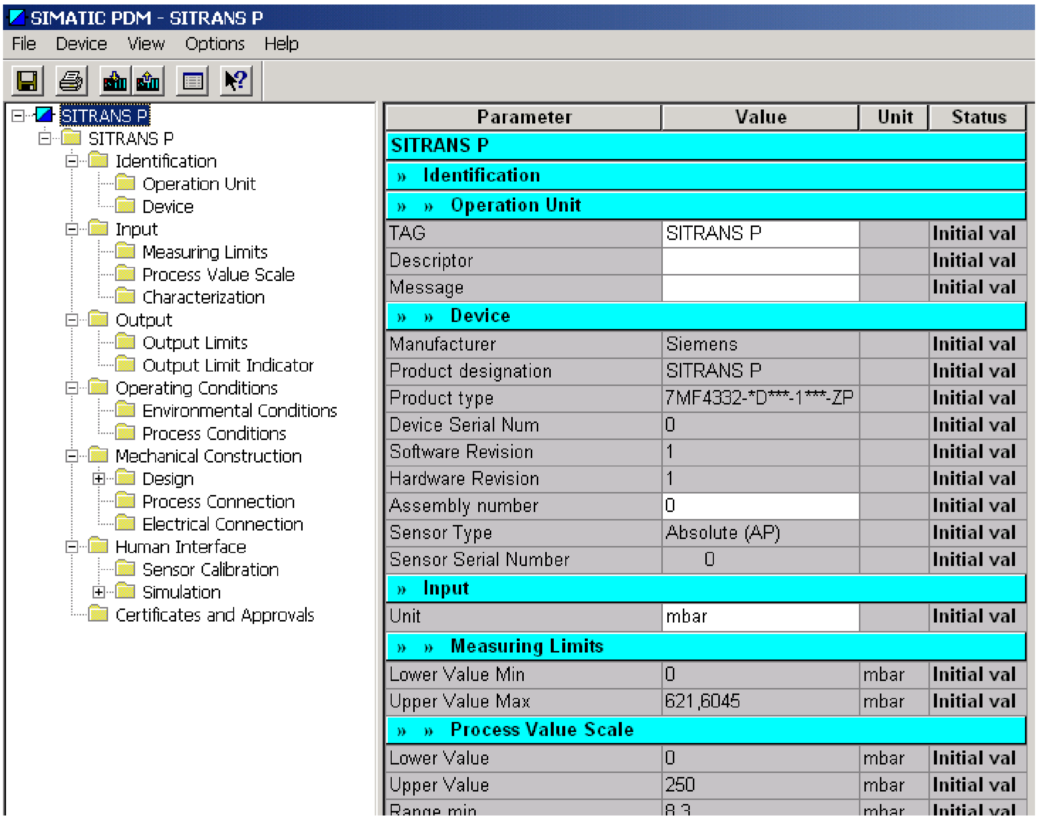


Fig. 6-4 SIMATIC PDM

Software Configuring (Project Example) 7

This chapter contains:

The task

On the basis of the task described in Chapter 6, the first example in this chapter describes the implementation of the control loop as a continuous control loop using the CFC configuring tool. In the second example, the control loop is described as a two-step control loop using the SFC configuring tool.

7.1 Project Example: Control Loop (CFC)

CFC

The continuous function chart (CFC) is a graphics editor. It serves to create an overall software structure for a CPU from prepared blocks (blocks written by the user or adopted from libraries). The blocks are positioned on function charts, assigned parameters, and interconnected. This results in an automation structure that is loaded into the AS after generation of the executable machine code.

Note:

A detailed description of the CFC can be found in the manual /254/.

Basic mode of operation

You work with graphics in the CFC editor: you select prepared blocks from the available set of blocks, position them with drag&drop on the chart, a kind of "drawing sheet" and interconnect them with each other using the mouse. You need not be concerned with such details as algorithms or the allocation of machine resources, but can focus on the technological aspects of configuring.

The run characteristics of the blocks are defaults but can be adapted separately for each block. A considerable aid to working is that you can copy or shift individual blocks or entire groups of blocks from chart to chart. The block interconnections are retained.
When you have created all the functions, you generate the executable machine code by clicking the mouse, load it into the PLC, and test it with the CFC test functions provided for the purpose.

Selecting the blocks

Implementation of the solution principle shown in Fig. 6-2 is executed in steps. The AS hardware was configured with STEP 7 resources in Chapter 6, that is, it is already known which analog input/output modules will be used, in which rack, at which slot they are installed, and to which module channel the relevant level sensor (PROFIBUS PA), flow sensor (HART) or actuator (control valve) is connected. The software can be structured under CFC on this assumption.
By using the blocks from the "PCS 7 Library" library, it is possible to solve the task by simple means. Only the interconnections, parameter assignments and allocation of symbolic names for the configured channels are required.
In this example, we use the extensive block libraries made available to you by PCS 7.

Drivers

- Block IN_A1 (4 AI2xHART analog input module) is selected from the "Driver blocks" section of the "PCS 7" library for reading in the temperature.

- The PA_AI block (SITRANS P pressure transducer) is selected from the "Driver blocks" section of the "PCS7" library for reading in the level.
- The OUT_A1 block (4AO HART analog output module) is selected from the "Driver blocks" section of the "PCS 7" library to output the manipulated variable of the controller.

Function blocks

The tasks of operating, controlling and signaling can be handled with a single block, the CTRL_PID block It has all the necessary characteristics for the task presented:

- PID controller
- Operable with limits
- Signaling capability

This block can be found in the "Control" folder of the "PCS 7" library.

Structuring the blocks

Described in the following is the procedure using the CFC for the task (as the standard tool for configuring process-engineering plants). For details of CFC handling or project management, please consult the CFC manual.

- Create a chart with a designation corresponding to the task (e.g. LICA_123) in the chart container of your project.
- Open the chart.
- Position one instance of each of the previously selected block types (in the example, one each for CH_A1, PA_AI, CH_AO, CTRL_PID) on your chart by transferring it from the block library.
- Name the blocks as required.
- For editing, register all instances in a common time-interrupt OB (e.g. OB32) (CFC keyword "Run characteristics"). In the sequence for block calls from the OB, the general rule "Read in–>Edit–>Output" must be followed. To specify the sequence, you must establish where each block obtains its parameters. As a rule, it must be reported to all other blocks from which it obtains interconnected values. In this example: CH_AI, PA_AI, CTRL_PID, CH_AO.
- Interconnect the outputs of the blocks supplying values to the corresponding inputs of the blocks that process these values.
- With each instance, assign parameters to the inputs with the relevant process values via the symbolic names and their default values.
- Interconnect the outputs with the inputs in accordance with the diagram in Fig. 6-2.
- A dialog is opened using the command "Compile". By selecting the option "Generate Driver Blocks" and confirming with "OK", the CFC chart is compiled and all the necessary driver blocks are generated.
- Now load the program into the CPU.

- Test the structure with the online test resources.
- Configure the OS variable block of the CTRL_PID (see its description in the section entitled "Operator control and process monitoring via OS" /254/).

Reference literature

A

/100/ Manual: S7-400 and M7-400 Programmable Controllers
Installation and Hardware

/101/ Reference Manual: S7-400 and M7-400 Programmable Controllers
Module Specifications

/102/ Instruction list: S7-400 Programmable Controller,
CPU 414/416

/140/ ET 200M Distributed I/O Device
Manual

/141/ ET 200L Distributed I/O Device
Manual

/231/ User Manual: Standard Software for S7 and M7,
STEP 7

/232/ Manual: Statement List (STL) for S7-300/400,
Programming

/233/ Manual: Ladder Logic (LAD) for S7-300/400,
Programming

/234/ Programming Manual: System Software for S7-300/400,
Program Design

/235/ Reference manual: System Software for S7-300/400
System and Standard Functions

/236/ Manual: Function Block Diagram (FBD) for S7-300/400
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/237/ STEP 7 Overall Index

/250/ Manual: Structured Control Language (SCL) for S7-300/400,
Programming

/251/ Manual: GRAPH for S7-300/400,
Sequential Function Charts

/252/ Manual: HiGraph for S7-300/400,
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/253/ Manual: C Programming for S7-300/400,
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Debugging C Programs

/300/ Technical Overview: SIMATIC WinCC,
Windows Control Center

/301/ Manual: SIMATIC WinCC,
Control Center + Global Script + User Administrator

/302/ Manual: SIMATIC WinCC,
Graphics Designer

/303/ Manual: SIMATIC WinCC,
Tag Logging + Alarm Logging + Report Designer

/304/ Manual: SIMATIC WinCC Options,
Basic Process Control + Advanced Process Control + ChipCard + Video

/502/ Manual: SIMATIC,
DP/PA Bus Coupling

/503/ Programmable Controller: SIMATIC S7-300, M7-300, ET200M
Ex I/O Modules, Reference Manual

/504/ Getting Started: SIMATIC Process Control System PCS 7,
Guide

/519/ Programmable Controller: SIMATIC S7-300, M7-300, ET200M
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Manual

/603/ S7-300 Programmable Controller, Installation and Hardware
Manual

/604/ SIMATIC NET PROFIBUS Networks
Manual

/605/ SIMATIC DP/PA Link and Y Link Bus Couplings

Index

B

Glossary C

A

Address
An address is the identification for a particular operand or operand range. Examples: input I 12.1, flag word FW 25, data block DB 3.

Analog module
Analog modules convert analog process values, such as temperature, to digital values which can be further processed by the CPU, or convert digital values to analog manipulated variables.

Arrangement, centralized
There is a centralized arrangement when the process I/Os and CPU are accommodated in the same rack or in expansion units in the same or adjacent cabinet.

Arrangement, distributed
There is a distributed arrangement when the process I/Os are not arranged with the CPU in the same rack or in the same or adjacent cabinet, but are separated and interconnected by a communications bus (e.g. field bus).

Automation system
An automation system is a → programmable controller with control system functionality, comprising at least one → CPU, various input and output modules as well as HMI devices.

B

Backplane bus
The backplane bus is a serial data bus via which the modules communicate with each other and via which they are supplied with the required power. The connection between the modules is provided by bus connectors.

Baud rate
The baud rate is the speed of data transmission; it indicates the number of bits transmitted per second (baud rate → bit rate).
Baud rates of 9.6 kbaud to 12 Mbaud are possible with the ET 200.

Blocks
Blocks are parts of a user program, demarcated by their function, structure or purpose.

Bus segment
→ Segment

C

Central section
The central section of an AS comprises the following components: CPU, rack, power supply, main memory and load memory. The basis is the SIMATIC S7–400 automation system.

CFC
A continuous function chart makes function charts in which blocks can be interconnected and assigned parameters.

Chart
A chart is the highest hierarchical level of a hierarchical block entity system. It has an implicit type but no interface and therefore cannot be connected. Charts cannot contain charts.

Cold restart
During the startup of the AS CPU (e.g. when the mode switch is changed from STOP to RUN or upon POWER ON), either organization block OB 101 (warm restart only with the S7-400) or organization block OB 100 (cold restart) is

first processed before the cyclic program processing (OB 1). With a cold restart, the process image of the inputs is read in and the S7 user program is processed, starting with the first command in OB 1.

Configuration The assignment of modules to racks/slots and addresses. A distinction is made between the actual configuration (modules plugged in) and the specified configuration. You preset the latter with STEP 7, COM PROFIBUS (or COM ET 200 Windows). The operating system can thus detect modules inserted incorrectly during the → start.

CPU Central processing unit of the S7 automation system with its control and arithmetic unit, memory, operating system and interface for programming device.

D

Device description (DD) This is a universal, standardized device and parameter description for PROFIBUS-PA and HART protocol-capable field devices.

Distributed I/O The distributed I/O are devices situated at a distance from the central section and serve for input/output (e.g. field devices or analog and digital modules).

DP address Each station must be given a DP address for unique identification on the PROFIBUS-DP. The PC/PG or ET 200 handheld have the DP address "0". The DP master and DP slaves have a DP address in the range 1 to 125.

DP master A → master which behaves according to standard EN 50170, Volume 2, PROFIBUS, is known as a DP master.

DP slave A → slave which is operated on PROFIBUS with the PROFIBUS-DP protocol and which behaves according to standard EN 50170, Volume 2, PROFIBUS, is known as a DP slave.

DP standard DP standard is the bus protocol according to standard EN 50170, Volume 2, PROFIBUS.

E

Engineering system A PC-based configuring system with which the process control system can be configured or adapted to the required tasks, in a convenient and visual manner.

ES → Engineering system

ET 200 The ET 200 distributed I/O system with the PROFIBUS-DP protocol is a bus for connecting distributed I/Os to a CPU or adequate DP master. ET 200 is characterized by fast reaction times because only a few data (bytes) are transferred. ET 200 is based on standard EN 50170, Volume 2, PROFIBUS. ET 200 operates according to the master-slave principle. DP masters can be, for example, the IM 308-C master interface or the CPU 315-2 DP. DP slaves can be the distributed I/Os ET 200B, ET 200C, ET 200M, ET 200U or DP slaves from SIEMENS or other manufacturers.

F

Field devices
Intelligent field devices can be connected via their field bus interface over PROFIBUS-DP or PROFIBUS-PA, and thus linked to the control system. Substitute blocks are available for the SIEMENS field devices.

FO
The abbreviation for fiber optic (cable) the transmission medium for PROFIBUS.

Function block
According to IEC 1131-3 , a function block (FB) is code block with static data which has a "memory". A function block offers the facility for transferring parameters in the user program. Function blocks are thus suitable for programming frequently recurring complex functions such as closed-loop controls and mode selection.

G

H

I

I/O bus
Part of the S7 300 → backplane bus in the automation system, optimized for the fast exchange of signals between the IM 153 and the signal modules. Useful data (e.g. digital input signals of a signal module) and system data (e.g. _default parameter data records of a signal module) are transferred via the I/O bus.

IP 20
Degree of protection to DIN 40050: Protection against touching with the fingers and against the ingress of solid foreign bodies with a diameter of more than 12 mm.

J

K

L

M

Master
When a master is in possession of the token, it can send data to other stations and request data from other stations: → DP masters are, for example, the CPU 416-2 DP or IM 308-C.

Master-slave procedure
A bus access process with which only one station is the → DP master and all other stations are the → DP slaves.

Message class
The message class governs the nature of the message. With SIMATIC PCS 7 the message classes are alarm, warning, tolerance, AS and OS control system message, process message, operator input request and operator input message.

Message type
There is a further subdivision for each message type (e.g. alarm, warning,

tolerance). Together with the message class, this governs the type of message. Examples of messages types are alarm_high, alarm_low, warning_high, warning_low.

Messages, configuring of The creating of messages with their texts and attributes. Messages are configured from the CFC/SFC.

Module parameters Module parameters are values with which the behavior of the module can be set. A distinction is made between static and dynamic module parameters.

MPI The multipoint interface is the programming device interface of SIMATIC S7. It forms the entry level of a system bus with SIMATIC PCS 7.

N

Network A network comprises one or more linked subnetworks with any number of stations. Two or more networks may exist side by side.

O

ODBC The abbreviation for open database connectivity. This is a Microsoft technology enabling database access.

OLE The abbreviation for object linking and embedding. This is a Microsoft technology enabling the linking of and data interchange between programs.

OLM The abbreviation for optical link module. This is an element for connecting the redundant FO cable of PROFIBUS to the components of PCS 7.

OM The abbreviation for object manager. OMs manage objects persistently stored there. Applications operate with these objects and execute operations on them exclusively by invoking object methods.

Organization block Organization blocks (OB) form the interface between the operating system of the AS CPU and the user program. The sequence for processing the user program is specified in the organization blocks.

OS Operator control and process monitoring system.

P

Parameter A parameter is: 1. a variable of an S7 code block (current parameter, formal parameter); 2. a variable for setting the behavior of a module. Each parameterizable module has, when supplied, a meaningful basic setting which can be changed by STEP 7.

PCS Process control system.

PLC Programmable (logic) controller

PMC Process monitoring and control. Communications mechanisms with SIMATIC S5 and S7.

Process variable The process variable is a resource-neutral (project-global) object. It serves for linking the AS configuring world (STEP 7, CFC...) to the OS configuring world (WinCC). It possesses information about the location at which the process variable exists at runtime (e.g. network address in the AS) and information on specific OS-relevant characteristics.

PROFIBUS PROcess FIeld BUS, the European process and field bus standard defined in the PROFIBUS standard (EN 50170). It specifies the functional, electrical and mechanical characteristics for a bit-serial field bus. PROFIBUS is a bus system for networking PROFIBUS-compatible automation systems and field devices at the cell and field levels. PROFIBUS is available with the protocols DP (→ distributed I/O), FMS (→ fieldbus message specification) or TF (→ technological functions).

PROFIBUS-DP The PROFIBUS bus system with the DP protocol. DP stands for distributed I/O (periphery). The ET 200 distributed I/O system is based on standard EN 50 170, Volume 2, PROFIBUS.

Programmable (logic) A controller whose function is stored in the control unit in the form of a program. Thus the configuration and wiring of the unit do not depend on the function of the controller. The PLC has the structure of a computer; it consists of a CPU with memory, input/output modules and internal bus system. The I/Os and programming language are oriented to the requirements of the control system.

Project A project is a container for all objects of an automation solution, irrespective of the number of stations, modules and their networking.

Q

R

Release All products with an order number have a release; it indicates the version of the product. The release is incremented with upward-compatible function extensions, for production-related modifications (the use of new parts / components) and for error corrections.

S

Segment The bus cable between two terminating resistors forms a segment. A segment contains 0 to 32 → stations. Segments can be linked via RS 485 repeaters.

SFB Standard function block, a preprogrammed function block with a defined application-specific function.

SFC A sequential function chart serves for creating sequence controllers for SIMATIC S7. These can be visualized with the SFC visualization package on the OS.

SIMATIC PCS 7 This is the name of the new control system based on SIMATIC S7.

Slave A slave may only exchange data with the master upon request by the master. Examples of slaves are all DP slaves such as the ET 200B, ET 200C, ET 200M, etc..

SPC/SQC The abbreviation for statistical process control/statistical quality control. Methods for quality control by acquiring and evaluating statistical values.

Standard function blocks These are blocks for the CFC which are provided by the SIMATIC PCS 7 libraries.

Start events Start events are defined events such as faults or alarms and initiate the operating system to start a corresponding organization block.

Startup This is run through during the transition from the STOP state to the RUN operating state. It can be initiated by a POWER ON or by the ES.

Station A unit which can send, receive or amplify data via the bus, e.g. DP master, DP slave, RS 485 repeater, active star coupler.

STEP 7 A programming language for creating user programs for SIMATIC S7 controllers.

Symbol A symbol is a name defined by the user, taking syntax specifications into account. This name can be used for programming and for operator control and process monitoring according to the definition for which it stands (e.g. variable, data type, jump label, block).
Example:
Operand: I 5.0, data type: BOOL, symbol: emergency-off button

Symbol table A table for assigning symbols (→ name) to addresses for global data and blocks. Example: Emergency-off (symbol), I 1.7 (address), controller (symbol), SFB 24 (block).

System bus This is the bus to which all components such as the AS, OS and ES are connected and with which they exchange data with one other.

T

Terminating resistor A terminating resistor is a resistor for matching the line at the bus cable; terminating resistors are required at the cable and segment ends. With ET 200, the terminating resistors are switched on/off in the → bus connector.

Type A type represents a pattern for any number of entities and describes how these entities are structured internally. All entities of a type follow the same basic definition with respect to behavior and information structure (data structure), but contain individual data.

U

User function block A block type created by the user for utilization by the CFC. Block types are created, for example, by SCL → Type.

User program The user program contains the structure for the automation programs, as well as the data for the signal processing with which a plant or process can be controlled.

V

W

X

Y

Z