PROFIBUS

The perfect fit for the process industry

Technical Brochure · April 2008
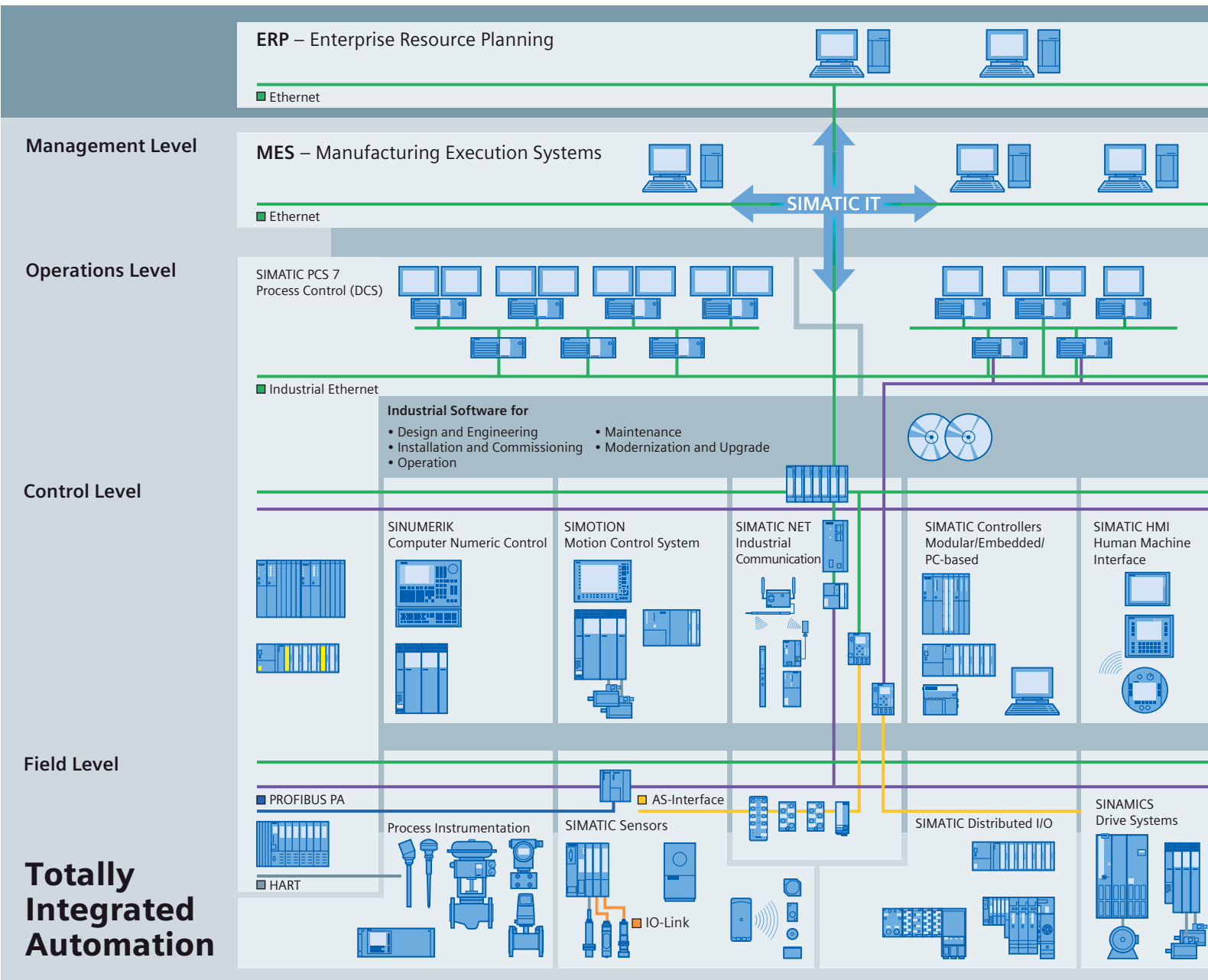
PROFIBUS

www.siemens.com/profibus

SIEMENS

Totally Integrated Automation

ERP – Enterprise Resource Planning

■ Ethernet

Management Level

MES – Manufacturing Execution Systems

SIMATIC IT

■ Ethernet

Operations Level

SIMATIC PCS 7
Process Control (DCS)

■ Industrial Ethernet

Industrial Software for
• Design and Engineering
• Installation and Commissioning
• Operation
• Maintenance
• Modernization and Upgrade

Control Level

SINUMERIK
Computer Numeric Control

SIMOTION
Motion Control System

SIMATIC NET
Industrial
Communication

SIMATIC Controllers
Modular/Embedded/
PC-based

SIMATIC HMI
Human Machine
Interface

Field Level

■ PROFIBUS PA

■ AS-Interface

SINAMICS
Drive Systems

Process Instrumentation

SIMATIC Sensors

SIMATIC Distributed I/O

**Totally
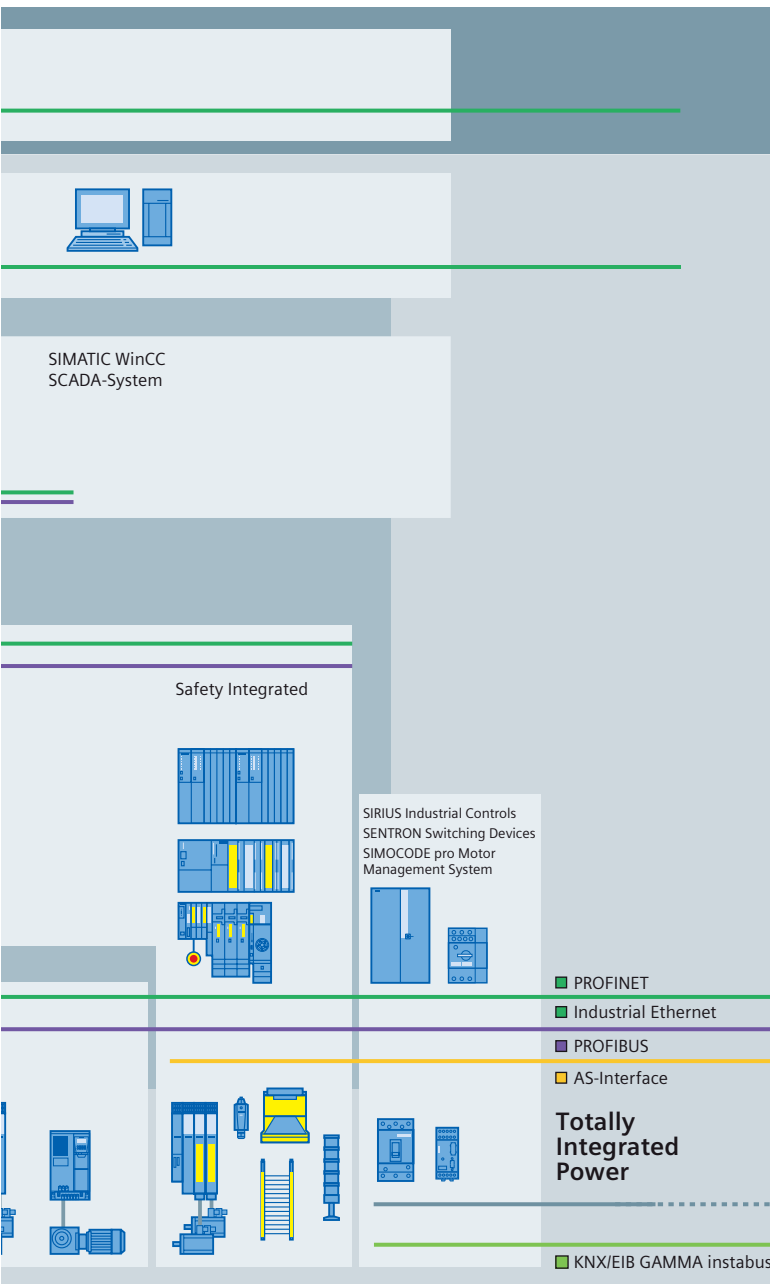Integrated
Automation**

■ HART

■ IO-Link

Thanks to Totally Integrated Automation, Siemens is the only provider of an integrated basis for implementation of customized automation solutions – in all industries from inbound to outbound.

TIA is characterized by its unique continuity.

It provides maximum transparency at all levels with reduced interfacing requirements – covering the field level, production control level, up to the corporate management level. With TIA you also profit throughout the complete life cycle of your plant – starting with the initial planning steps through operation up to modernization, where we offer a high measure of investment security resulting from continuity in the further development of our products and from reducing the number of interfaces to a minimum.

Contents

SIMATIC WinCC
SCADA-System

Safety Integrated

SIRIUS Industrial Controls
SENTRON Switching Devices
SIMOCODE pro Motor
Management System

■ PROFINET

■ Industrial Ethernet

■ PROFIBUS

■ AS-Interface

**Totally
Integrated
Power**

■ KNX/EIB GAMMA instabus

The unique continuity is already a defined characteristic at thedevelopment stage of our products and systems.
The result: maximum interoperability – covering the controller, HMI, drives, up to the process control system. This reduces the complexity of the automation solution in your plant. You will experience this, for example, in the engineering phase of the automation solution in the form of reduced time requirements and cost, or during operation using the continuous Totally Integrated Automation makes a crucial contribution towards optimizing everything that happens in the plant and thus creates the conditions for a significant increase in productivity.

PROFIBUS

An integrated fieldbus for the complete process automation

Control · Distributed control system

Convey

Main PROFIBUS devices:
- Motor starters (SIMOCODE, SIRIUS)
- Drives (SINAMICS)
- Dynamic weighing system/ Belt scale

React

Main PROFIBUS devices:
- Distributed IOs (SIMATIC ET 200)
- Level, pressure, temperature transmitters (SITRANS L, P, T)
- Analysis (ULTRAMAT, LDS6)
- Gas chromatography (Maxum)

Identify

Main PROFIBUS devices:
- Operator panels (SIMATIC HMI)
- Barcode + ID readers (MOBY)
- Distributed IOs (SIMATIC ET 200)

Inspect

Main PROFIBUS devices:
- Machine vision (SIMATIC Machine Vision)
- Distributed IOs (SIMATIC ET 200)
- Valve positioners (SIPART PS)

Mix

Main PROFIBUS devices:
- Flow, level, pressure, temperature transmitters (SITRANS F, L, P, T)
- Weighing system (SIWAREX)
- Motor starters (SIMOCODE, SIRIUS)

Fieldbus requirement: high speed, real-time, deterministic: PROFIBUS DP

INBOUND

Fieldbus requirement: high speed, high data transfer, redundant: PROFIBUS DP and 2-wire devices, operation in hazardous area: PROFIBUS PA

PRIMARY PROCESS

Process Control
• DCS: SIMATIC PCS 7
• PLC: SIMATIC S7-300, S7-400
• Parameterization, Asset Management (SIMATIC PDM)

Physical implementation:

 PROFIBUS DP

 PROFIBUS PA

Separate

Main PROFIBUS devices:
• Flow transmitters (SITRANS F)
• Level transmitters (SITRANS L)
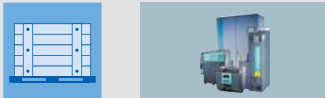• Motor starters (SIMOCODE, SIRIUS)

Store

Main PROFIBUS devices:
• Pressure, temperature transmitters (SITRANS P, T)
• Level (SITRANS L)
• Distributed IOs (SIMATIC ET 200)

Pack/Fill

Main PROFIBUS devices:
• Drives (SINAMICS, SIMATIC Technology, SIMOTION)
• Fail-safe systems (SIMATIC F systems)
• Distributed IOs (SIMATIC ET 200)

Convey

Main PROFIBUS devices:
• Drives (SINAMICS)
• Motor starters (SIMOCODE, SIRIUS)
• Distributed IOs (SIMATIC ET 200)

Identify

Main PROFIBUS devices:
• Barcode + ID readers (MOBY)
• Operator panels (SIMATIC HMI)
• Distributed IOs (SIMATIC ET 200)

Fieldbus requirement:
high speed, real-time,
deterministic: PROFIBUS DP

SECONDARY PROCESS

Fieldbus requirement:
high speed, real-time,
deterministic: PROFIBUS DP

OUTBOUND

Reduce your total cost of ownership –
with the flexible fieldbus for all requirements of the process industry

> "Hybrid industry users in the chemical, pharmaceutical or food & beverage industries can benefit from the unique value proposition of PROFIBUS in its ability to seamlessly integrate process instrumentation, like pressure transmitters and flow meters, with devices for the discrete side of the application, like drives and sensors."
>
> ARC Study
> "The Value Proposition of PROFIBUS in the Hybrid Industries"
> ARC Advisory Group, Dedham/MA, USA

Production processes in the process industry are often "hybrid". Primary processes characterized by activities such as reaction, mixing or separation are combined with discrete applications of the secondary processes, the inbound or outbound logistics. Characteristic of these production applications are activities such as identification, transport, testing, filling, packaging or storing.

The demands placed by these characteristics on the fieldbus are totally different. Direct connection of intrinsically-safe devices and their power supply over the communications medium as well as the high information content of the communication are of great significance to the automation of the process engineering processes which are frequently carried out in environments which are corrosive, dangerous to health or explosive. On the other hand, speed and a strict real-time response are of prime importance for the production applications.

PROFIBUS is the only fieldbus worldwide which can currently cover all these requirements. With transmission technologies which supplement each other, a uniform communications profile, and additive application profiles for typical device functionalities, e. g. PA Devices, PROFIdrive or PROFIsafe, it is able - like no other - to uniformly combine process engineering and production areas together. Further application profiles enable existing installations with 4 to 20 mA technology and HART devices to be seamlessly integrated, thus providing permanent safeguarding of the associated investments.

Such a homogenous fieldbus architecture provides enormous cost advantages. Of prime significance are the reduced costs for design, assembly and wiring, but also for planning, engineering, commissioning and testing as well as documentation and training.

However, even greater significance can be applied to the lasting cost savings which can be achieved through efficient asset management for maintenance and in long-term operation.

PROFIBUS – your advantages

Cost reduction

- Minimization of total cost of ownership through integrated fieldbus communication:
  - For all sectors of the production, process and hybrid industries
  - In all areas of the production process
  - For the complete life cycle of the plant

- Reduced planning and engineering overhead as well as lower commissioning costs compared to conventional signal transmission using parallel point-to-point connections

- Direct linking of process instruments, especially in hazardous areas, saves wiring as well as the hardware systems for jumpering, distribution, power supply and assembly

- Safety Integrated system with safety-oriented PROFIBUS communication as cost-effective alternative to separate safety systems

- Cost-optimized plant configurations for high availability and safety through Flexible Modular Redundancy

- Effective asset management with prediction of remaining service life and planning of preventive maintenance

Increased availability and performance

- Redundancy and comprehensive online diagnostics

- Central parameterization and proactive maintenance with efficient management systems/tools

- No regular calibration of field devices necessary

- Fast and reliable communication, as well as high measuring accuracy

Flexibility and investment safeguarding

- Largest installed basis worldwide with more than 23 million installed PROFIBUS nodes, of which more than 3.3 million in the process industry

- Interoperability and replaceability with a spectrum of more than 2 500 devices and over 1 400 international suppliers

- Coexistence of simple and complex devices through uniform communications protocol and additive application profiles for specific device functions (e. g. PROFIdrive for drives, Ident for barcode readers or PA Devices for process devices)

- Expandability and guaranteed compatibility of further developments

- Seamless integration of conventional 4 ... 20 mA and HART devices which are already installed

- International acceptance through technologies conforming to IEC and ISO

- Global support by PROFIBUS International with
  - 25 regional organizations
  - 36 Competence Centers
  - 10 test laboratories
  - 12 training centers

Protection of man and machine

- Seamless integration of safety communication with PROFIsafe instead of a separate safety bus

- High amount of information and bidirectional communication for enhanced diagnostics functions for faster and more exact fault detection and troubleshooting

Easy installation

- FISCO-certified devices permit Plug&Play in the hazardous area. Complex calculations of intrinsic safety are unnecessary.

PROFIBUS - proven and future-oriented

With its pioneering technology defined in international standards, PROFIBUS has developed into the global leader among the fieldbuses. This technology is characterized by:

- Use of open standards
- Compatibility
- Universal applicability
- Flexible expansion
- High availability

This is proven by the largest installed base worldwide with more than 23 million PROFIBUS nodes, of which more than 3.3 million are in the process industry with a share of approx. 630 000 PROFIBUS PA nodes (values at end of 2007).

PROFIsafe, which permits the transmission of safety-oriented data and control data on one bus cable, has also become established on the market and has gained a leading position in both process and production automation. More than 230 000 PROFIsafe nodes had already been delivered by the end of 2006 since the introduction of PROFIsafe technology in 1999.

All major manufacturers support the PROFIBUS standard with a total of more than 2 500 different products and services.

More than 1 400 vendors and user companies, including the world's leading suppliers of products and systems, have joined together to form PROFIBUS International (PI), the largest international fieldbus user organization. This strong and global organization promotes the expansion and continuous further development of PROFIBUS, and supports its members on all continents by means of a network of:

- 25 regional PROFIBUS organizations in 24 countries
- 36 PROFIBUS Competence Centers in 21 countries
- 10 test laboratories
- 12 training centers in 8 countries

Comprehensive information on PROFIBUS International can be found on the Internet at **www.profibus.com**.

Totally Integrated Automation with PROFIBUS

PROFIBUS, as the communications medium in the field, is an important component of Totally Integrated Automation (TIA), the unique system offered by Siemens for uniform, customized automation of all sectors in the production, process or hybrid industries – starting at inbound logistics up to outbound logistics and for the complete life cycle of a plant.

Within TIA, expandability and safeguarding of investments are ensured through forward and backward compatibility.
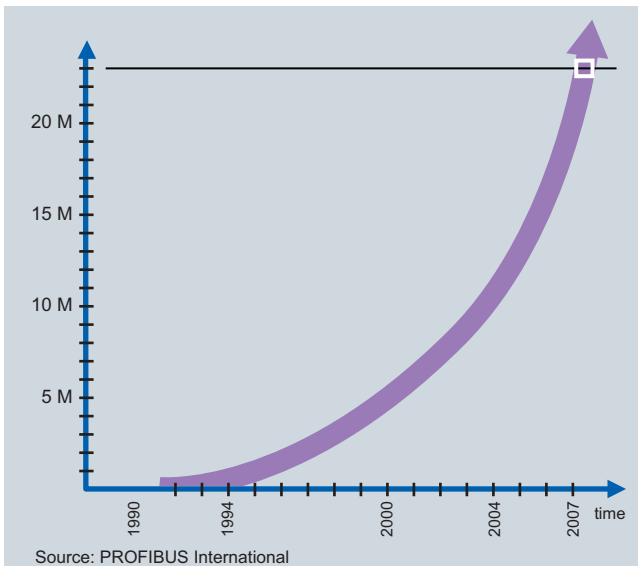
Installed PROFIBUS nodes
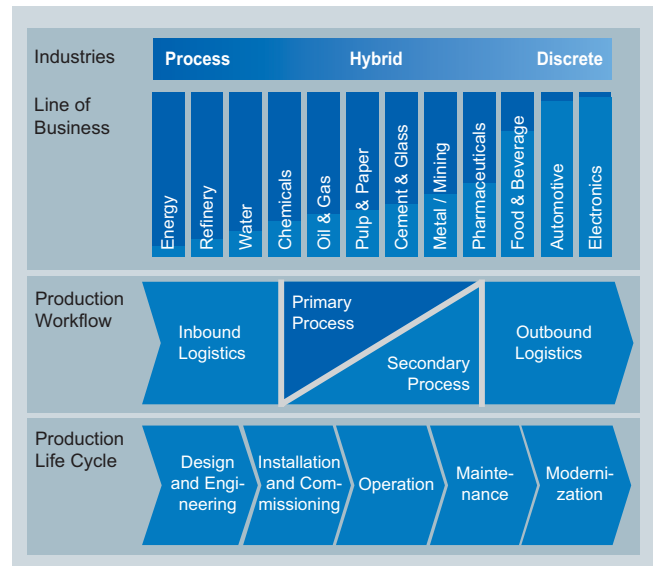
Field communication with PROFIBUS

Technical basis

General features and standards

Classification and features

In the process industry, conventional signal transmission between the sensors/actuators in the field and the input/output modules of the control system is implemented via parallel point-to-point connections with copper cables. Analog signals are usually transmitted with a level of 4 to 20 mA.

In contrast to this, fieldbus systems such as PROFIBUS permit digital communication between the automation system (controller) and the field devices on a single serial bus cable. Such communication is characterized by cyclic transmission of process data and by acyclic transmission of alarms, parameters and diagnostics data.

The associated reduction in cabling overhead and input/output hardware represents enormous potential savings. The significantly greater information content of digital data transmission additionally implies significant cost advantages for plant operation and maintenance through:

• Bidirectional communication (definition of setpoint and reading of actual valve position)
• Comprehensive diagnostics information for asset management
• High accuracy (32-bit resolution)

PROFIBUS is simple, rugged and reliable, can be expanded online, and can be used in both non-critical environments and hazardous areas.

In addition to these properties, the following PROFIBUS functions are particularly relevant to process automation:

• Integration of previously installed HART devices
• Redundancy
• Safety-related communication with PROFIsafe
• Clock synchronization
• Time tagging

As a universal, open fieldbus, PROFIBUS handles:

• Fast communication with intelligent, distributed I/O devices (PROFIBUS with DP system)
• Communication and simultaneous powering for transmitters and actuators (PROFIBUS with PA system)

Thanks to its modular concept with mutually supplementing transmission technologies, a uniform communications protocol and a wide range of associated application profiles (e. g. PA Devices, PROFIsafe, PROFIdrive, Remote-I/O for PA, identification systems or dosing/weighing), PROFIBUS is the only fieldbus which can be used in both the production and process industries.

International standardization

Standardization of the PROFIBUS initially started in 1991 with the German national standard DIN 19245 and in 1996 with the European standard EN 50170. PROFIBUS has been anchored in the international standards IEC 61158 and IEC 61784 since 1999.
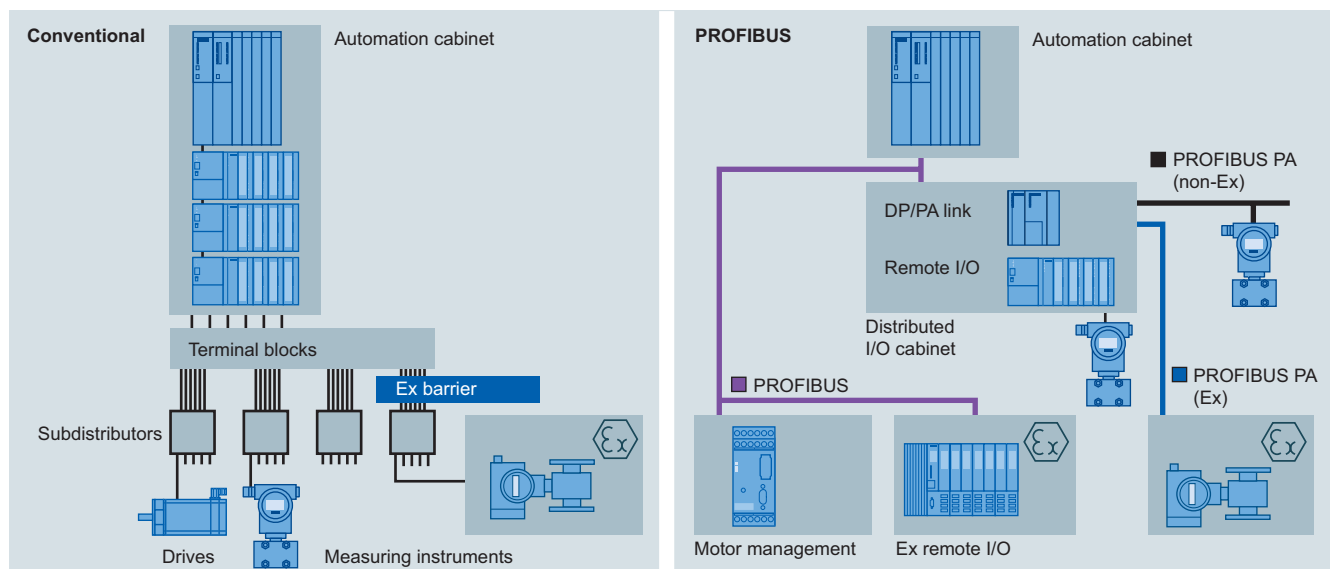
Design of PROFIBUS compared to conventional signal transmission

# PROFIBUS DP and PROFIBUS PA versions

PROFIBUS DP

PROFIBUS DP is designed to provide high data transmission rates (up to 12 Mbit/s) and short response times (up to 1 ms) and is particularly suitable for direct control of:

- Intelligent field devices (e.g. drives, motor starters, analyzers, process controllers or panels)
- Distributed I/O devices: remote I/Os such as ET 200M, ET 200iSP or ET 200S

By combining the standard communications mechanisms of PROFIBUS with a special HART profile for mapping the client/master server model of HART on the PROFIBUS, the large installed base of HART devices in the field can be integrated into existing or new PROFIBUS DP communications networks.
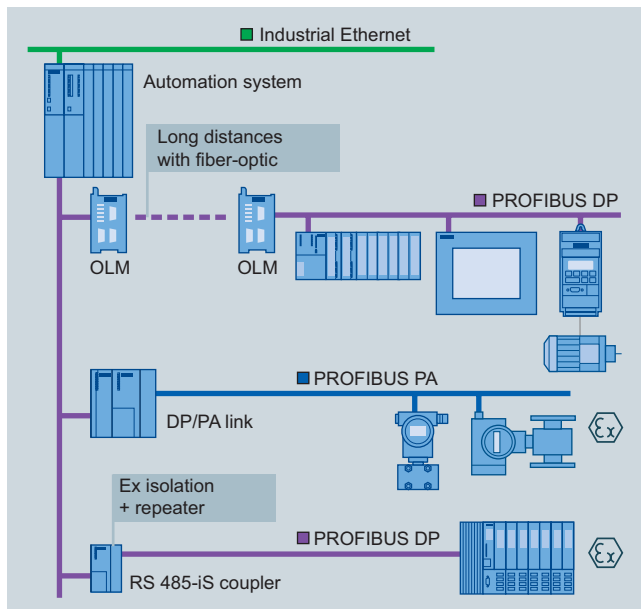
PROFIBUS transmission technologies
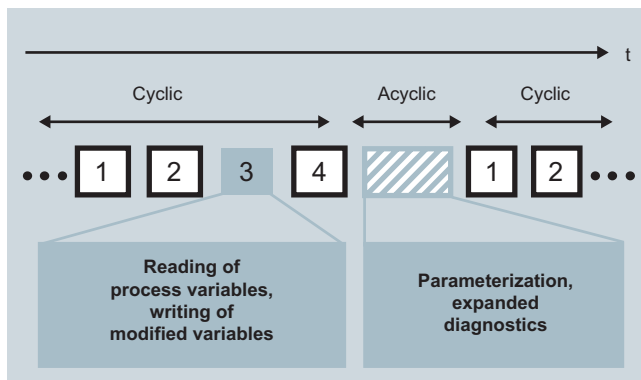
Deterministic bus communication of the PROFIBUS

The advantage is that the same bus cable can be used for the actual PROFIBUS communication and for the HART communication with the distributed I/O stations.

Transmission technologies
PROFIBUS DP networks can be implemented with the following transmission technologies according to IEC 61158 and IEC 61784:

- RS 485
  Simple and cost-effective electrical transmission technology on the basis of a shielded two-wire cable.
  An electrical PROFIBUS network can be configured with a linear or tree structure.
- RS 485-iS
  Intrinsically-safe electrical transmission technology for hazardous areas up to Ex zone 1, implemented using a shielded two-wire cable with a transmission rate of 1.5 Mbit/s.
  Requires decoupling of RS 485 and RS 485-iS by an isolating transformer (RS 485-iS coupler).
- Fiber-optic
  Optical transmission technology using glass or plastic fiber-optic cables, for fast transmission of large data quantities in environments with high interference or for covering large distances.
  The design of an optical network with a linear, ring or star structure is possible with optical link modules (OLM). The ring structure automatically provides fault tolerance in the event of a wire breakage. The maximum distance between two optical link modules can be 15 km. As a result of the almost loss-free optical transmission, the total size of the network is governed primarily by the propagation times.

Deterministic bus communication
A characteristic feature of the PROFIBUS is its deterministic real-time bus communication cycle resulting from the use of a master/slave principle which guarantees the bus cycle time and the defined response times of the participants on the bus. This is characterized by:

- Cyclic transmission of process data
- Acyclic transmission of configuration, alarm and diagnostics data

The time window for acyclic communication is automatically set up during the configuration. If the amount of data is larger than this time window, the acyclic communication is broken up among several cycles.
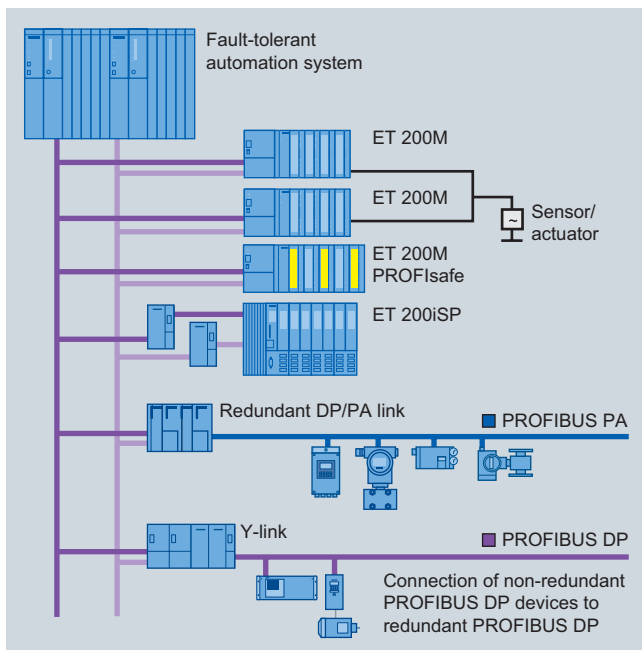
Redundant design of PROFIBUS DP

PROFIBUS PA

PROFIBUS PA, which permits simultaneous transmission of digital data and powering of the bus by means of a two-wire cable and MBP intrinsically-safe transmission technology (Manchester Coded; Bus Powered) in accordance with IEC 61158, can be applied optimally in the process industry for the direct connection to devices such as pneumatic actuators, solenoid valves, sensors and analyzers in environments up to Ex zone 0 or 1.

Despite the seemingly low transmission rate of 31.25 kbit/s, the typical communication time of a transmitter is only approx. 10 ms. This means that practically all typical applications in the process industry can be implemented with minimal constraints on segment device density.

PROFIBUS PA can be designed with a linear or tree structure with long spur lines (up to 120 m) or also with a ring structure. DP/PA couplers or DP/PA links are used for the supply of power and for adaptation of the data transfer rate from PROFIBUS DP to PROFIBUS PA.

Redundancy

PROFIBUS DP can also be used in redundant architectures. Distributed I/Os are connected via two interface modules to two redundant PROFIBUS DP networks within a fault-tolerant automation system, and intelligent field devices on the PROFIBUS PA are connected via a redundant DP/PA link to two interface modules. Non-redundant PROFIBUS DP devices can also be operated in a redundant PROFIBUS DP architecture by using a Y-link.

PROFIBUS DP highlights

- PROFIBUS DP communications protocol

- Designed to provide high data transmission rates (up to 12 Mbit/s) and short response times

- Suitable for direct control of:
  - Intelligent field devices (e.g. drives, motor starters, analyzers, process controllers or panels)
  - remote I/Os such as ET 200M, ET 200iSP, ET 200S

- Redundant operation as option

- Two-wire copper cable for networks up to max. 10 km (RS 485 up to Ex zone 2, RS 485-iS up to Ex zone 1)

- Fiber-optic for interference-free optical networks for large distances (> 15 km), up to Ex zone 1

PROFIBUS PA highlights

- PROFIBUS DP communications protocol

- Permits simultaneous transmission of digital data and powering of the bus by means of a two-wire cable and MBP transmission technology

- Allows direct integration of pneumatic actuators, solenoid valves, and sensors for measuring and analyzing tasks directly in environments up to Ex zone 0 or 1

- Can be designed with a linear, tree or ring structure with segment cable lengths up to 1 900 m

- Ring structures permit modifications during operation as well as automatic isolation of faulty subsegments

- Short device communication cycle times (approx. 10 ms is typical for transmitters)

- By using components certified according to the FISCO model:
  - Enormous simplification of configuring
  - Omission of Ex circuit calculations
  - Maximizes the number of usable devices

- Multi-vendor replaceability of field devices

- Field barriers permit a significant increase in the number of devices which can be connected per bus segment in the Ex area as well as in the cable length

PROFIBUS in hazardous areas
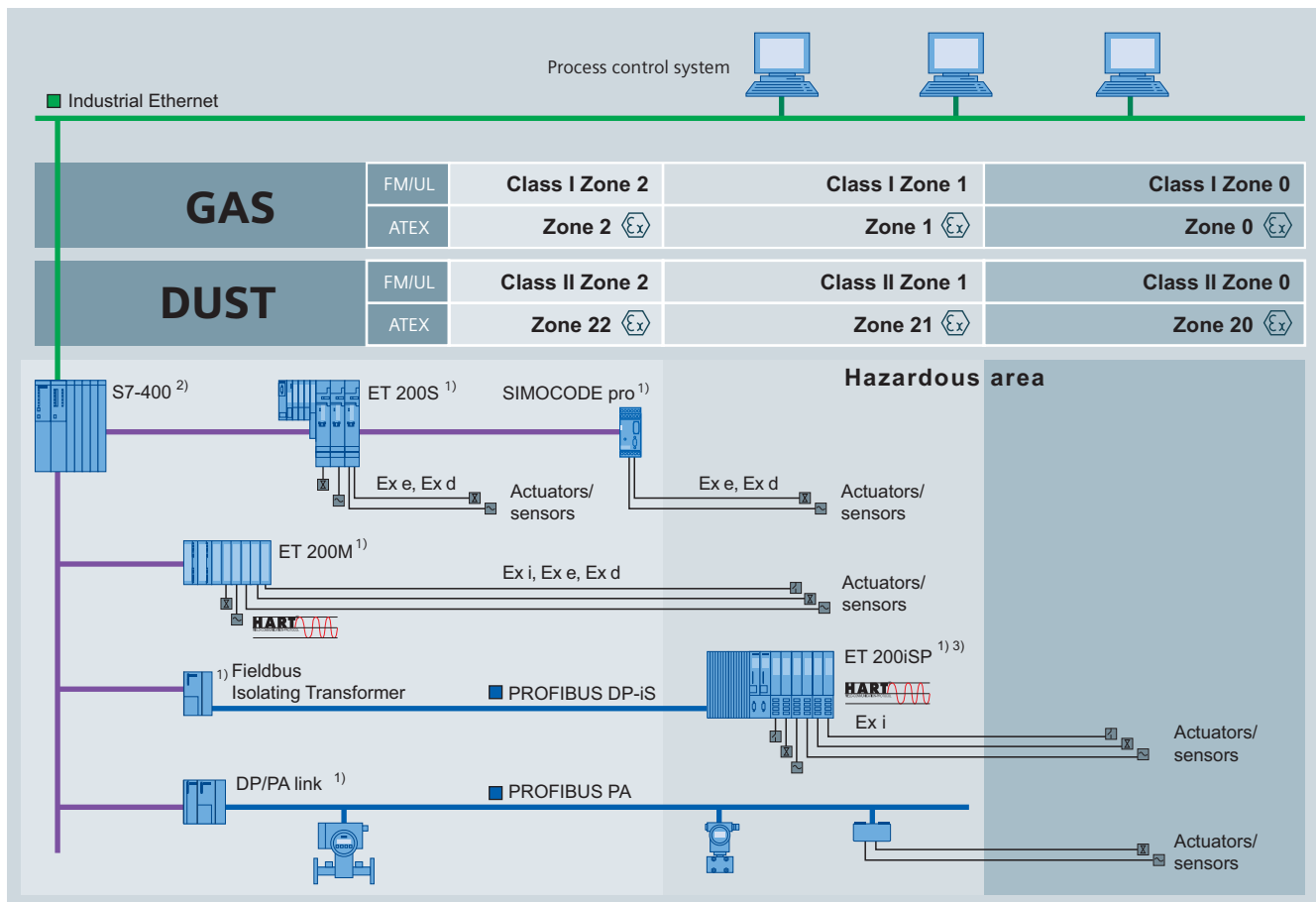
Overview of PROFIBUS application in hazardous gas and dust atmospheres

[1] Dust atmospheres: Installation of components always in an enclosure with IP6x degree of protection

[2] With 10 A DC standard power supply

[3] Also complies with FM/UL according to Class I Division 2

PROFIBUS in hazardous areas

Physical adaptation is necessary in order to use the PROFIBUS in hazardous areas. On the other hand, the PROFIBUS protocol is identical in all operating environments. Using electrical RS 485 or optical transmission systems, the PROFIBUS DP can be routed using standard techniques into Ex zone 2. It is possible to locate the PROFIBUS DP deeper into Ex zone 1 by using an isolating transformer (RS 485-iS coupler) and the RS 485-iS transmission technology. The intrinsically-safe PROFIBUS DP is specified for EEx(ib) type of protection.

With the intrinsically-safe design of the DP/PA link, the PROFIBUS PA segment is decoupled from the PROFIBUS DP segment. The intrinsically-safe PROFIBUS PA segment at the output of the DP/PA coupler can therefore be routed for sensors and actuators directly into hazardous areas of zone 0 or 1. It is compliant with the requirements of the EEx(ia) and EEx(ib) types of protection.

Comparison between Zones and Classes/Divisions		
Standards	**NEC 505**	**NEC 500**
Atmosphere		
Gases, vapors	Zone 0 Zone 1	Class I, Division 1
	Zone 2	Class I, Division 2
Dusts	Zone 20 Zone 21	Class II, Division 1
	Zone 22	Class II, Division 2

Safety-related communication

FISCO model

For the design or extension of a PROFIBUS PA segment in a hazardous area, no complex intrinsically-safe circuit calculations are necessary if the components involved (Ex coupler, cable, field devices, bus terminator) are certified according to the FISCO model (Fieldbus Intrinsically Safe Concept) by an authorized approving authority, e.g. PTB or UL. This results in substantial cost savings in the planning and operating phases. Furthermore, no calculations whatsoever are required any more when adding or removing devices.

According to the FISCO model, a network is intrinsically-safe if the components mentioned observe defined limits for voltage, current, power, inductance and capacitance. When using components approved according to FISCO, e.g. intrinsically-safe DP/PA couplers and PA field devices from Siemens, the number of devices which can be operated on one segment can be maximized, and cross-vendor interchangeability is ensured when replacing an individual device or expanding a plant.

Safety-related communication with PROFIsafe

PROFIsafe is a profile which implements safe PROFIBUS communication between

- safety-related devices located in the field and
- safety-related applications executed in the automation system for maximum requirements up to
  - CAT4 in accordance with EN954
  - AK6 or SIL3 in accordance with IEC 61508.

The PROFIsafe profile is implemented as an additional software layer within the device and automation system, without modifying the standard PROFIBUS communication mechanisms. Thus the standard components (e.g. communications modules, connectors or cables) involved in the communication of the two PROFIsafe participants can be used without modification.
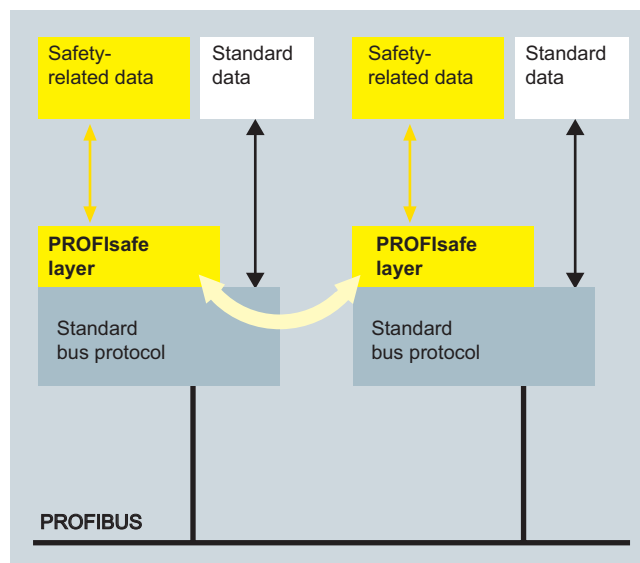
Standard and safety-related data are transmitted with PROFIsafe over the same bus line. Collision-free communication is possible using a bus system with media-independent network components.

Furthermore, PROFIsafe devices can be operated in parallel with standard devices on the PROFIBUS, also in redundant architectures if required. PROFIsafe can also be used within intrinsically-safe applications.

PROFIsafe detects a wide range of possible errors during serial bus communication, e.g.:

- Delay
- Loss
- Data repetition or falsification
- Incorrect sequence
- Faulty addressing

PROFIsafe counteracts these errors through:

- Consecutive numbering of the safety telegrams
- Fixed time frame for incoming telegrams and their acknowledgment
- Identification between transmitter and receiver
- Additional data security (Cyclic Redundancy Check)

The PROFIsafe protocol V2 supports secure communication for the open standard buses – whether the proven PROFIBUS DP or PROFINET IO.

Device management with GSD and EDD

Engineering with GSD and EDD

```
; Unit-Definition-List:
GSD_Revision     = 2
Vendor_Name      = "SIEMENS"
Model_Name       = "DP/PA"
Revision         = "V1.6"
Ident_Number     = 0x8052
Protocol_Ident   = 0
Station_Type     = 0
Hardware_Release = "V2.2"
Software_Release = "V3.5"
9.6_supp         = 1
19.2_supp        = 1
45.45_supp       = 1
93.75_supp       = 1
187.5_supp       = 1
.......
```

Example of device master data file
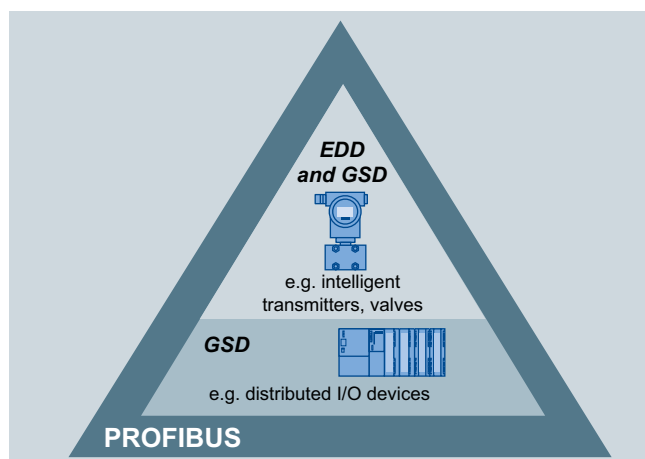
Efficient engineering with GSD and EDD

The intelligence of field devices and distributed I/O compo-
nents has increased enormously in the past few years. These
devices currently offer a scope of functions and information
which was previously only provided by controllers.

The tools used for engineering, parameterization, commis-
sioning, diagnostics, asset management and servicing (e.g.
SIMATIC PDM) and for integration within higher-level control-
lers therefore require an exact and complete description of the
device-specific data and functions, e.g.

- Type of application function
- Configuration parameters
- Dimensional units
- Limits and default values
- Ranges

This description is provided by the vendor in the following
form:

- Device master file (GSD) for the cyclic data exchange be-
  tween the PROFIBUS master and the PROFIBUS slaves
- Electronic Device Description (EDD) which includes both
  standard and vendor-specific properties for acyclic param-
  eterization, diagnostics and monitoring of measured val-
  ues.

Device master file GSD

The GSD is an ASCII text file in which the general and device-
specific communications features of a PROFIBUS device are
described using compulsory and optional keywords or param-
eters. Vendor and profile ID numbers increase the configura-
tion reliability, and facilitate the replacement of devices.

The GSD file describes all parameters important for cyclic com-
munication.

Electronic Device Description EDD

In the case of tasks based on acyclic communication, the EDD,
which is generated by the device vendor using the powerful
EDDL (Electronic Device Description Language), provides the
required device information. The EDD can be used for simple
or complex devices. These tasks include:

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

The EDD standardizes the GUI in conjunction with the power-
ful SIMATIC PDM Process Device Manager. It is extremely con-
venient to generate, and requires no special knowledge. Exist-
ing EDDs, profile descriptions and text libraries can also be in-
corporated.

Interoperability and interchangeability

Interoperability

The interoperability of the PROFIBUS allows users to operate field devices from different vendors together on one controller. This is made possible by the GSD and EDD device descriptions. During configuration of the bus with the engineering system, the GSD file is used to generate the communications parameters for the PROFIBUS master. These define the characteristics and scope of functions for cyclic master/slave communication.

Using the EDD delivered by the device vendor, and together with a suitable engineering tool such as SIMATIC PDM, it is possible to define the specific device parameters for acyclic communication, e.g. for parameterization, diagnostics or monitoring of measured values.
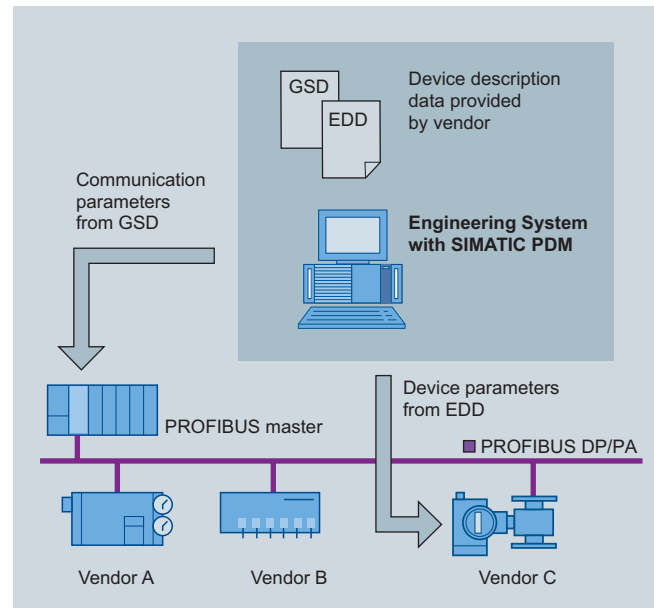
Representation of interoperability of devices from different vendors

Interchangeability

The PROFIBUS master recognizes the vendors and PA profiles of devices connected to the PROFIBUS by means of their GSD identification number. PROFIBUS devices from one profile family can be simply replaced by comparable devices from another vendor as a result of the "PA profile" which is independent of the vendor.

Such universal PA profiles are available e.g. for:

• Devices for counting
• Devices for measurement of pressure, flow or level
• Positioners
• Analyzers
• Digital input/output devices
• Multi-variable devices
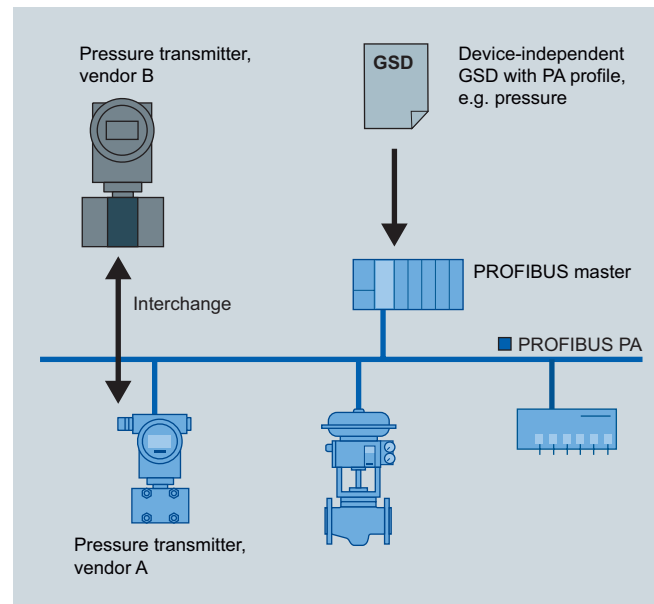
Cross-vendor device replacement

Bus architecture

PROFIBUS DP architecture

Segment length	Number of devices	
1 200 m at max. 93.75 kbit/s	Max. 126 devices	**2**
1 000 m at 187.5 kbit/s	Max. 9 repeaters	Address DP Master
400 m at 500 kbit/s	Max. 32 participants per segment	**3** ... **20**
200 m at 1,5 Mbit/s		Address DP Slaves
100 m at 12 Mbit/s		
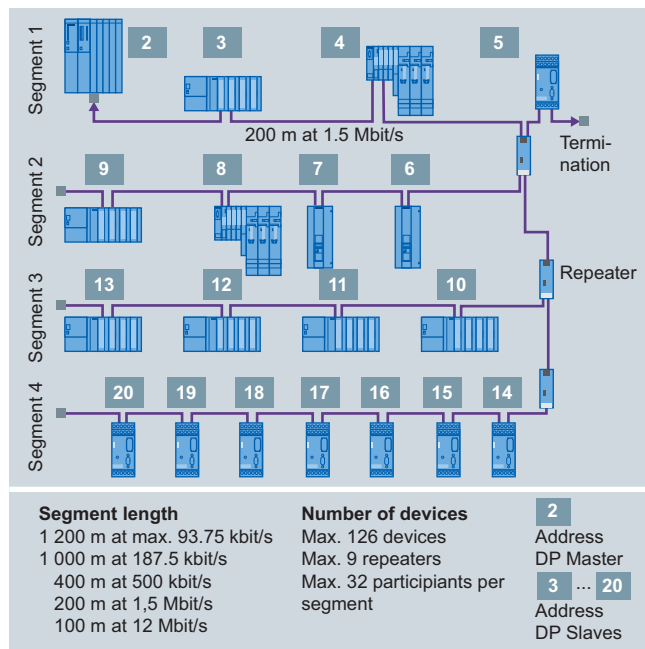
Electrical RS 485 network with linear/tree structure

Length between 2 OLM's	Number of devices
Plastic: 80 m	Max. 32 electrical participants per OLM
PCF: 400 m	Max. 122 OLM's per OLM Ring (depending on PROFIBUS DP bus parameters)
Glass: 2 - 3 km (15 km - single mode)	
Max. 12 Mbit/s	

Configuration example of an optical ring combined with an electrical network

Electric RS 485 network

The simple and cost-effective two-wire RS 485 transmission technology is exceptionally suitable for networks with a linear/tree structure and high data transmission rates. The total size of the network is smaller than with an optical network, but can also reach distances up to 1 km (at 12 Mbit/s) or up to 10 km (at 187.5 kbit/s) by using segments and by boosting the signal with up to 9 repeaters.

Special diagnostic repeaters can also be used instead of standard repeaters, and permit online monitoring of the connected bus segment in addition to boosting of the signal.

A segment can have up to 32 participants (master/slaves), and the total network up to 126 participants. The start and end of each segment must be terminated by an active bus resistor which is typically pre-integrated in the device (e.g. repeater) or is available as an active RS 485 termination element.

The configuration example (figure at top right) shows a typical addressing scheme for a PROFIBUS DP network made up of multiple segments.

Although repeaters are electrical participants on the PROFIBUS, they are not assigned a slave address since they are not directly addressed by the master.

Optical ring

Although optical bus cables are more expensive than electrical RS 485 networks, they are immune to electromagnetic interference and can cover distances > 15 km at a data transmission rate of 12 Mbit/s when using glass fiber-optic cables.

In addition to purely optical networks, the combination of electrical and optical networks has been established in practice, providing users with the advantages of the respective transmission technologies.

A ring structure of the optical network provides fault tolerance since communication is not interrupted in the event that the cable is damaged at one point or interrupted. The electrical bus segments are incorporated into the optical ring using optical link modules (OLM). Up to 122 OLMs can be integrated in an optical ring, where the max. distance between two OLMs can be up to 15 km. A maximum of 32 electrical bus participants can be operated on one OLM.

The configuration example shows a typical addressing scheme with mixed transmission technologies. Although OLMs are electrical participants within their respective segment, they are not assigned a slave address on the PROFIBUS.

PROFIBUS PA architecture

Bus configuration with DP/PA coupler or DP/PA link

To create a smooth network transition between PROFIBUS DP and PROFIBUS PA, the SIMATIC product range offers the following two components:

- DP/PA coupler
  for small signal quantities and low time requirements
- DP/PA link
  for a large number of participants and high cycle time requirements

Both are operated with 24 V DC and can be installed in operating environments up to Ex zone 2. They can be mounted on an S7-300 rail.

DP/PA coupler

The DP/PA coupler is also an integral component of the DP/PA link. It is available in two versions:

- DP/PA coupler Ex [i] (max. 110 mA output current) for implementation of PROFIBUS PA networks with linear and tree topologies in environments up to Ex zone 1, not for redundant architectures
- DP/PA coupler FDC 157-0 (max. 1 000 mA output current) for implementation of PROFIBUS PA networks with linear, tree and ring topologies in environments up to Ex zone 2; can be used for redundant architectures "Ring" and "Coupler redundancy"

When operating as a stand-alone router, the DP/PA coupler limits the data transfer rate on the PROFIBUS DP to 45.45 Kbit/s. Although it is an electrical station, it is transparent for the communication between the master and the PROFIBUS PA stations. The PROFIBUS master addresses the PROFIBUS PA stations directly.

DP/PA couplers FDC 157-0 configured as PROFIBUS diagnostics slaves provide comprehensive diagnostics and status information over PROFIBUS for fast fault locating and elimination. They each require a different PROFIBUS address for this operating mode.

DP/PA link

The DP/PA link is a modular combination of S7-300 design, comprising:

- PROFIBUS DP interface module IM 153-2 High Feature (redundant as option)
- Up to 5 DP/PA couplers (Ex[i] or FDC 157-0)

Use of active bus modules on the backplane allows hot swapping of individual modules and a redundant design of the PROFIBUS DP interface module.

PS 307 or PS 305 load power supplies can be used for the 24 V DC supply – one single or two redundant supplies depending on the configuration.

The DP/PA link connects PROFIBUS DP and PROFIBUS PA together, while decoupling the transmission rates. In this manner, a data transfer rate of up to 12 Mbit/s can be achieved on the PROFIBUS DP.

High Speed solution with DP/PA link

PROFIBUS master S7-400
up to 12 Mbit/s
DP/PA link
PROFIBUS PA
31.25 kbit/s

DP/PA link
- IM 153-2 interface module (single/redundant)
- DP/PA couplers (max. 5 per IM 153-2)
- Slave on DP side - master on PA side
- Max. 64 PA devices (244 bytes I/O data)

Low-cost solution with direct addressing

45.45 kbit/s   PROFIBUS DP
DP/PA coupler
PROFIBUS PA

DP/PA coupler
- transparent for communication
- Ex version 13.5 V / 110 mA
- Non-Ex version 31 V / 1000 mA

Configuration examples with DP/PA link and DP/PA coupler

PROFIBUS PA architecture
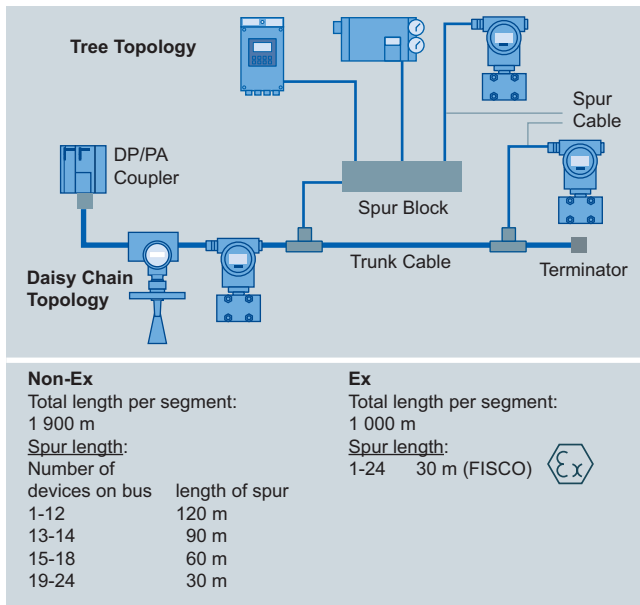
PROFIBUS PA topologies: linear and tree

Example of PROFIBUS architecture with field barriers

The DP/PA link functions as a slave on the PROFIBUS DP and as a master on the PROFIBUS PA. From the viewpoint of the host controller, the DP/PA link is a modular slave whose modules are the devices connected on the PROFIBUS PA. Addressing of these devices is carried out indirectly via the DP/PA link which itself only requires one DP address.

When considering the speed and number of PA devices per PROFIBUS master (controller), this solution provides significant advantages compared to the solution with only a DP/PA coupler. The host PROFIBUS master can scan devices connected to the DP/PA all at once. The speed on the PROFIBUS DP is not influenced by the subordinate PROFIBUS PA, and DP devices can therefore be operated together with the PA devices on the same segment without a loss in performance.

With 123 DP/PA links per PROFIBUS master and 64 PA devices per link, the data pool permits operation of up to 7 872 PA devices on just one PROFIBUS DP master.

One PROFIBUS PA ring or PROFIBUS PA segment each with coupler redundancy can be operated on a DP/PA link in addition to PROFIBUS PA segments with single couplers.

Topologies

The PROFIBUS PA can be designed with tree, linear or ring topologies.

Architecture with field barriers

Through electrical isolation of intrinsically-safe and non-intrinsically-safe PROFIBUS PA segments, field barriers from various vendors permit operation of intrinsically-safe devices on the non-intrinsically-safe DP/PA coupler in the DP/PA link. In this manner a high supply current can be implemented in the fieldbus segment. This results in advantages such as:

- More fieldbus nodes can be configured per fieldbus segment
- More cost-effective power supplies/routers can be used
- Longer bus distances are possible

The field barrier shown as an example in the figure can be installed in the Ex zones 1, 2, 21 or 22. It offers 4 intrinsically-safe (EEx i), short-circuit-proof feeders with 40 mA each which are suitable for connection of spur lines with a maximum length of 120 m. Limiting of the short-circuit current at the output prevents the failure of further outputs.

PROFIBUS PA architecture for high availability and safety

Components for PROFIBUS PA ring architecture

Linear architecture with single coupler

Each PROFIBUS PA segment (line) is connected by a DP/PA coupler Ex [i] (PA segment up to Ex zone 1) or FDC 157-0 (PA segment up to Ex zone 2) of a DP/PA router. This router can be operated on a single or redundant PROFIBUS DP.

Linear architecture with coupler redundancy

The active field splitter AFS connects a PROFIBUS PA segment (line) to two DP/PA couplers FDC 157-0 of a DP/PA router which can be operated on a single or redundant PROFIBUS DP. The AFS switches over the PROFIBUS PA segment to the active coupler.

Ring architecture

Active field distributors AFD integrate PROFIBUS PA field devices via 4 short-circuit-proof spur line connections in a PROFIBUS PA ring with automatic bus termination. The PROFIBUS PA ring is connected to two DP/PA couplers FDC 157-0 of a DP/PA router which can be operated on a single or redundant PROFIBUS DP.

Up to zu 8 AFDs and up to 31 PROFIBUS PA devices can be configured per ring.

Hot swapping of an AFD is possible. Correct functioning of the PROFIBUS PA devices on the AFDs is not influenced by this.
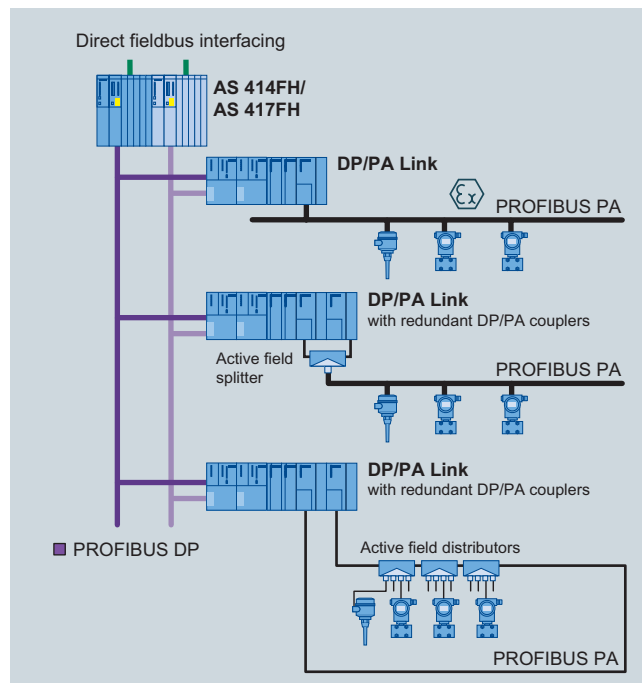
PROFIBUS PA architectures for high availability

Special advantages of ring architecture in comparison:

- Maximum availability
- Transparent redundancy management of the intelligent DP/PA couplers for the host system
- Active bus terminators for automatic bus termination in the DP/PA couplers and AFDs permit:
  - Automatic, bumpless isolation of faulty subsegments in event of short-circuit or open-circuit
  - Modification of ring configuration and instrumentation during operation; addition or removal of ring segments
- Safety-related and fault-tolerant applications with low device and cabling overheads

PROFIBUS PA architecture – Calculation examples

Technical specifications

DP/PA coupler

Voltage at coupler output	
■ Version for hazardous area	13.5 V
■ Version for non-hazardous area	31 V
Max. current at coupler output	
■ Version for hazardous area	110 mA
■ Version for non-hazardous area	1 000 mA

PROFIBUS PA device

Min. supply voltage	9 V
Typical current consumption	Approx. 12 mA

PROFIBUS PA cable

Line resistance	Approx. 44 Ω/km

The number of devices which can be operated within one PROFIBUS PA segment depends on their current consumption and the line resistance.

Depending on the current or voltage at the output of the DP/PA coupler, the maximum number of devices as well as the maximum network size can be easily determined using Ohm's law.

Number of devices

Max. number of PA devices per segment =

$$\frac{\text{Current at coupler output [mA]}}{\text{Typical current consumption per PA device [mA]}}$$

■ DP/PA coupler for Ex area (110 mA / 12 mA): 9 devices

■ DP/PA coupler for non-hazardous area (1 000 mA / 12 mA): 83 devices, limited by PROFIBUS standard to: 31 devices

Max. cable length based on fully loaded PA segments

Cable length per segment [km] =

$$\frac{\text{Voltage at coupler output [V] - Min. supply voltage for PA device [V]}}{\Sigma \text{ Current consumption of PA devices [A]} \cdot \text{Line resistance [Ω/km]}}$$

Examples:

■ DP/PA coupler for Ex area	(13.5 V - 9 V) / (0.11 A · 44 Ω/km)	Approx. 0.92 km
■ DP/PA coupler for non-Ex area	(31 V - 9 V) / (**500 mA** · 44 Ω/km)	Approx. 1.00 km
	(31 V - 9 V) / (**1 000 mA** · 44 Ω/km)	Approx. 0.50 km
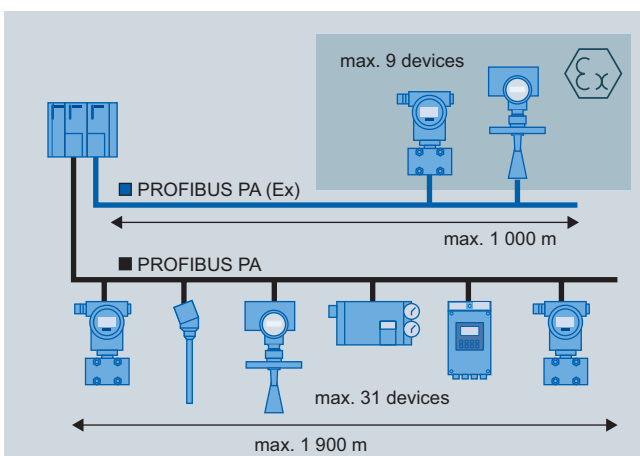
Maximum lengths per bus segment

Smaller loads permit correspondingly greater cable lengths.

Depending on the number of PA devices and their actual current consumption, the PROFIBUS standard allows the following maximum lengths:

- DP/PA coupler for Ex area: 1.0 km
- DP/PA coupler for non-Ex area: 1.9 km

Technical specifications

	PROFIBUS DP			PROFIBUS PA
Data transmission	RS 485	RS 485-iS	Fiber-optic	MBP
Transfer rate	9.6 Kbit/s ... 12 Mbit/s	9.6 Kbit/s ... 1.5 Mbit/s	9.6 Kbit/s ... 12 Mbit/s	31.25 Kbit/s
Cable	Two-wire shielded	Two-wire shielded	Plastic as well as multi-mode and single-mode glass fiber	Two-wire shielded
Type of explosion protection		EEx(ib)		EEx(ia/ib)
Topology	Linear, tree	Linear	Ring, star, linear	Linear, tree, ring
Nodes per segment	32	32 [1]	–	32
Nodes per network (with repeater)	126	126	126	–
Cable length per segment depending on transmission rate	1 200 m at max. 93.75 Kbit/s 1 000 m at 187.5 Kbit/s 400 m at 500 Kbit/s 200 m at 1.5 Mbit/s 100 m at 12 Mbit/s	1 000 m at 187.5 Kbit/s [1] 400 m at 500 Kbit/s [1] 200 m at 1.5 Mbit/s [1]	Max. 80 m (plastic) 2-3 km (multi-mode glass fiber) >15 km at 12 Mbit/s (single-mode glass fiber)	1 900 m: standard 1 900 m: EEx(ib) 1 000 m: EEx(ia)
Repeater for signal boosting with RS 485 networks	Max. 9	Max. 9 [1]	Not relevant	Not relevant

[1] In accordance with PROFIBUS installation guideline 2.262

Configuration and diagnostics

Configuration
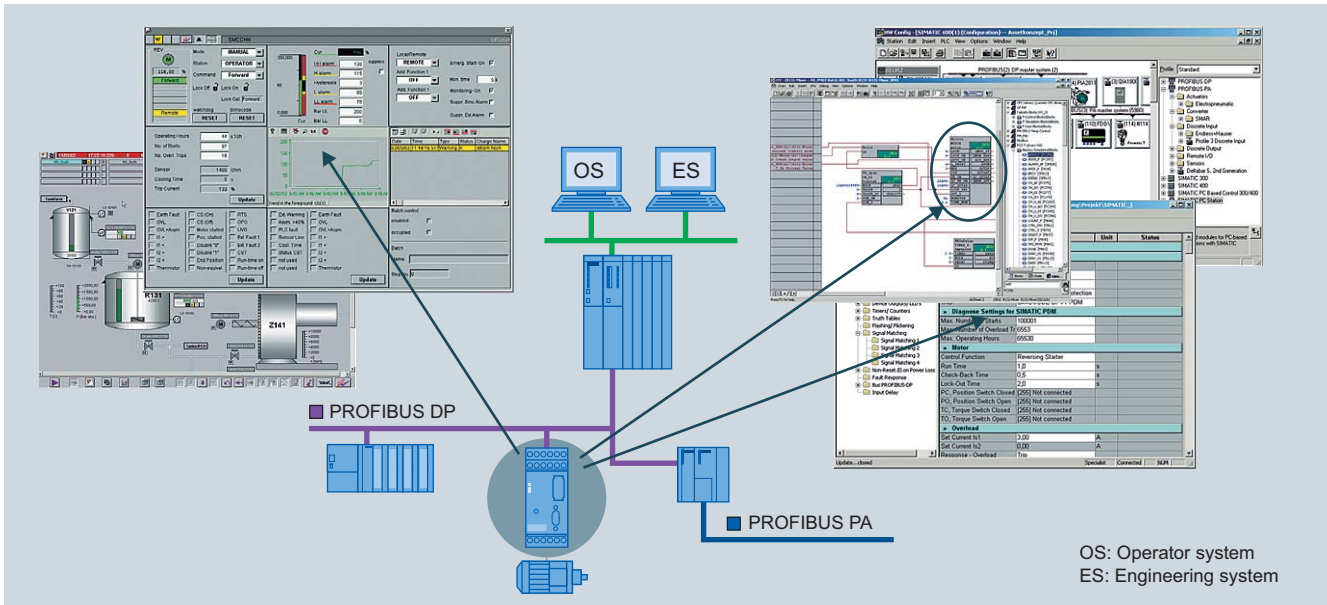
Configuration and diagnostics facilities

Configuration with HW-Config and SIMATIC PDM

When used in a SIMATIC PCS 7 project, field devices and distributed I/O components are configured using the HW-Config tool for communication with the PROFIBUS master (controller). If they are not already integrated in the supplied hardware catalog, they can be subsequently added to the configuration environment by importing their GSD file. The GSD file is provided by the vendor, e.g. via PROFIBUS International on the Internet (www.profibus.com).

To implement the control strategy, a predefined function block representing the device function is linked in the CFC editor to other blocks. This block usually includes a faceplate for operation of the field device from the operator system.

The SIMATIC PDM Process Device Manager is used for enhanced configuration and online diagnostics. With support for more than 1 200 devices from Siemens and more than 100 vendors worldwide, SIMATIC PDM is a true multi-vendor configuration tool with the widest range of devices. Devices which are not yet supported can be integrated in a simple manner by importing their device descriptions (EDD).

Various diagnostics possibilities

PROFIBUS offers numerous diagnostics facilities which fall into the following categories:

- Communications and line diagnostics of the PROFIBUS network, especially for detecting wiring faults
- Diagnostics information of the intelligent field devices for maintenance or troubleshooting

Diagnostics

Communications and line diagnostics

Numerous software tools from different vendors are available for communications and line diagnostics. These can be directly connected via a PC/notebook interface to the PROFIBUS network (e.g. Amprolyzer), and offer commissioning or servicing engineers comprehensive functions for bus diagnostics and analysis, including:

• Recording and interpretation of telegrams
• Automatic detection of transmission rate
• Lifelist of all bus participants
• Summary of current statuses of all bus participants
• Statistical evaluation of bus events

The diagnostics repeater available for the connection of PROFIBUS DP segments with RS 485 technology combines two functions in one device:

• Connection and expansion of electrical networks including signal boosting and electrical isolation of the segments
• Online fault monitoring of the electrical bus lines of connected segments

The diagnostics message transferred by the diagnostics repeater to the PROFIBUS master in the event of a fault contains:

• Cause of fault
  - Open-circuit
  - Short circuit
  - Terminating resistor missing
  - Too many or too distant stations, etc.
• Detailed information on fault location

DP/PA couplers FDC 157-0 configured as PROFIBUS diagnostics slaves provide comprehensive diagnostics and status information over PROFIBUS for fast fault locating and elimination:

• I&M data (Identification & Maintenance)
• Current and voltage value on the main conductor
• Redundancy status
• Wire break
• Short circuit
• Signal level

To this end, each of these DP/PA couplers FDC 157-0 requires its own PROFIBUS address.

Diagnostics of intelligent field devices

The standardized diagnostics mechanism of the PROFIBUS permits the user to rapidly recognize and eliminate faults in the devices connected to the bus.

The diagnostics messages from the field devices can also be utilized e.g. for early initiation of preventive maintenance measures as a result of abnormalities detected long before a device fails. If a fault occurs on the field device or if maintenance is necessary, e.g. because of contamination on a capacitive level sensor, diagnostics information is transferred, and a message sent to the operator station and the maintenance station for the SIMATIC PCS 7 asset management.

Enhanced diagnostics information providing details about the devices on the PROFIBUS can be provided by the vendor's EDD through SIMATIC PDM. These include:

• Production date
• Operating hours counter
• Manufacturer's data

To prevent unnecessary loading of the cyclic data exchange between devices, this information is controlled by acyclic mechanisms and automatically distributed among several bus cycles if the data quantities are large.

PROFIBUS cycle times and their calculation
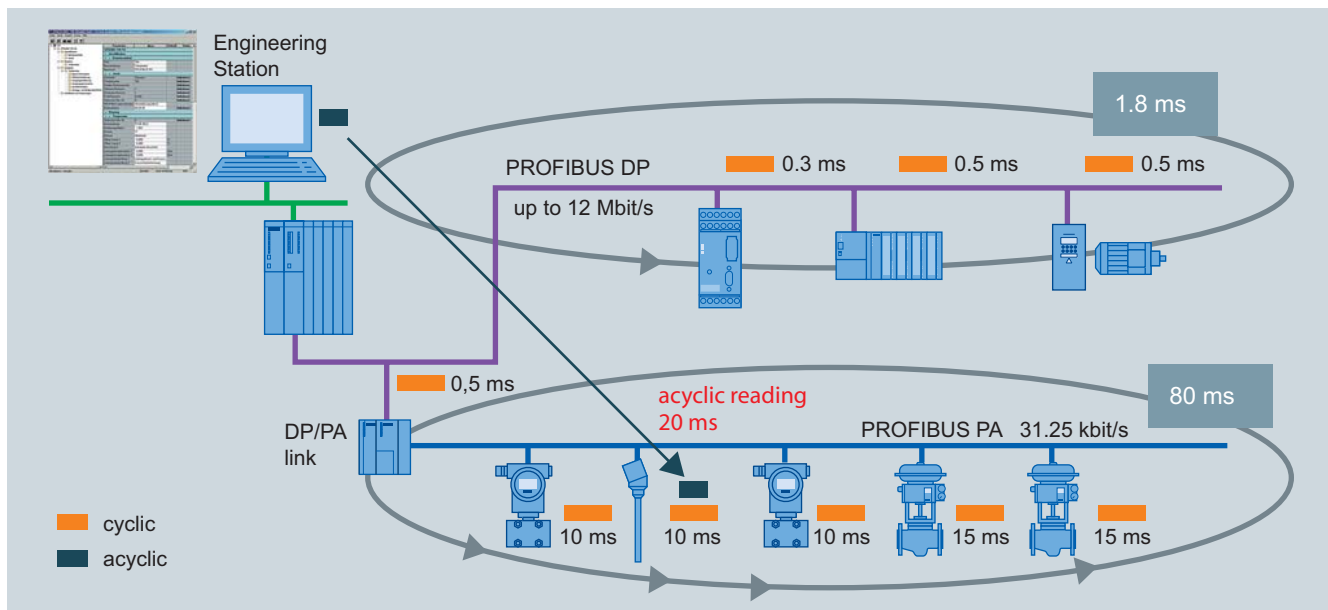
Practical example of cycle times with PROFIBUS PA

PROFIBUS cycle times and response times of the devices

Fast recording of measured values is particularly important with sensitive controls. In order to permanently guarantee chronological processing of measured values (input, processing, output), it is necessary for the PROFIBUS communications cycle to be twice as fast as the controller's processing cycle. As a result of its high data transfer rate and the correspondingly low cycle time for process operations, the PROFIBUS DP cycle can be neglected when calculating the total communication cycle since this is primarily dependent in systems with DP and PA segments on the cycle time of the PROFIBUS PA segment.

The PROFIBUS PA cycle time depends on the total number of devices connected to a DP/PA link and the transmission time that each device requires to communicate its cyclic device data. In addition, a window is reserved within a cycle for acyclic communication. Equations and examples for calculation of PROFIBUS cycle times are shown on the right.

In the practical example (see figure above), the total PROFIBUS PA cycle time is calculated to be 80 ms. As a result, the controller can be set to a minimum processing cycle of 160 ms, or higher depending on the process requirements. In the example, 20 ms are reserved in addition to the cyclic communication for the transmission of acyclic parameter data or diagnostics data from the master. The transmission of one variable, e.g. pressure or temperature, is 10 ms, each additional variable approx. 1 to 2 ms.

PROFIBUS DP cycle time (DPt):

$DPt = NbDP \cdot [OvPB + BitDP \cdot (NbE + NbA)] / BdsDP$
e.g. for 30 DP slaves:
DPt = 14.2 ms
$= 30 \cdot [317\ bit + 11\ bit/byte \cdot (244\ byte + 244\ byte)] / 12\ Mbit/s$

PROFIBUS PA cycle time (PAt):

$PAt = NbPA \cdot [OvPB + BitPA \cdot NbByte] / BdsPA$
e.g. for 1 PA slave:
PAt = 11.4 ms
$= 1 \cdot [317\ bit + 8\ bit/byte \cdot 5\ byte)] / 31.25\ kbit/s$

Calculation of the PROFIBUS cycle times

		PROFIBUS DP	PROFIBUS PA
Number of slaves		NbDP	NbPA
Overhead PROFI-BUS message frame		OvPB = 317 bit	OvPB = 317 bit
Data format		BitDP = 11 bit/byte	BitPA = 8 bit/byte
Number of bytes			
	Typical	–	NbByte = 5 byte
	Input	NbE = max. 244 byte	–
	Output	NbA = max. 244 byte	–
Transmission speed		BdsDP = 12 Mbit/s	BdsPA = 31.25 kbit/s

Application examples

Norsk Hydro Energy – oil & gas platform, Norway

Requirements

Norsk Hydro Energy operates the largest platform in the North Sea for oil and gas exploitation. This platform was to be modernized with the continuation of operation.

The objective was to convert an existing TELEPERM M system step-by-step to SIMATIC PCS 7.

Solution

Norsk Hydro Energy automates its oil platform using the SIMATIC PCS 7 process control system. Communication is implemented with PROFIBUS. The configured plant structure is thus uniform down to the field level. In addition to distributed standard I/Os, safety-oriented I/Os are also used on the PROFIBUS. PROFIBUS' profile structure satisfies all prerequisites for the field of application described.

Benefits

The complete modernization of the plant was carried out with the continuation of operation. It was not necessary to switch off the extraction processes.

A large number of measuring points were connected over the PROFIBUS. Since it was possible to use the SIMATIC S5 I/Os further, the investments of Norsk Hydro Energy could be highly safeguarded.

Picture source: Terje Knudsen for Norsk Hydro

Bitburger – brewery, Germany

Requirements

Approximately 200 000 bottles of beer of different types are produced at Bitburger every day. The Bitburger brewery Th. Simon GmbH has already been using automation solutions with PROFIBUS since 1992.

PROFIBUS PA was to be used for the modernization of a plant, since this had been applied successfully to the automation of fermenting and storage procedures since 1997.

Solution

The plant is automated with SIMATIC. Communication between these PLCs and the process I/O is over PROFIBUS. The intelligent field devices are integrated using PROFIBUS PA.

Benefits

PROFIBUS was highly suitable for the project because of its possibilities for implementing multimaster systems. To safeguard previous investments, existing plant components could be readily linked to the new ones. The connection and disconnection of PROFIBUS PA devices was possible without influencing other components involved in communication.

Through the use of PROFIBUS, the costs compared to conventional technology could be reduced by more than 50%. The uniform field communication over PROFIBUS provides Bitburger with even more advantages. In addition to the high measuring accuracy and consistent data management throughout the plant, these advantages primarily concern more effective diagnostics, maintenance and repair.

Siemens process I/O for PROFIBUS

Distributed I/O devices

	PA DP PDM Safety			Description	Functions
Distributed I/O devices					
	●		●	ET 200M	Modular remote I/O system with multi-channel modules; IP20 degree of protection ■ Transmission rates on the PROFIBUS up to 12 Mbit/s ■ Redundant PROFIBUS interfaces possible ■ Can be installed in Ex zone 2 or 22, and the connected actuators and sensors also in Ex zone 1 or 21	I/O modules of S7-300 design (up to 12 per station): ■ DI, DO, DI/DO, AI, AO signal modules (simple, with diagnostics capability, redundant and Ex version) ■ Function modules (controllers, counters) ■ HART modules (AI, AO; also as Ex version) ■ F modules for safety-related applications: F-DI, F-DO and F-AI Supports online modifications: ■ Addition of station ■ Addition of I/O modules ■ Parameter assignment
	●			ET 200iSP	Intrinsically-safe, modular remote I/O system with permanent wiring; IP30 degree of protection ■ Transmission rates on the PROFIBUS up to 1.5 Mbit/s ■ Redundant PROFIBUS interfaces possible ■ Can be installed directly in Ex zones 1, 2, 21 or 22, connected sensors/actuators also in Ex zone 0 Replacement of individual modules during operation without fire certificate	Electronic modules (up to 32 per station): ■ DI NAMUR and DO ■ AI for temperature measurements using resistance thermometer/thermocouple ■ AO ■ AI HART (for two-wire and four-wire transmitters) and AO HART Supports online modifications: ■ Addition of station ■ Extension of station with modules ■ Reparameterization of modules
	●		●	ET 200S	Bit-modular, extremely compact remote I/O system with permanent wiring; IP20 degree of protection ■ Transmission rates on the PROFIBUS up to 12 Mbit/s ■ Can be installed in Ex zone 2 or 22	Electronic modules (up to 63 per station) and motor starters up to 7.5 kW: ■ DI, DO, AI and AO signal modules ■ Motor starters ■ Integral frequency converters up to 4 kW ■ F modules F-DI, F-DO and F motor starters for safety-related applications Supports online modifications ■ Addition of station
	●		●	ET 200pro	Small, modular remote I/O system with permanent wiring via connection modules; IP65/66/67 degree of protection ■ Transmission rates on the PROFIBUS up to 12 Mbit/s	Electronic modules (up to 16 per station) ■ DI, DO, AI and AO signal modules ■ F modules for safety-related applications: F-DI and F-DI/DO ■ Motor starters ■ Frequency converters up to 1.1 kW

Abbreviations for columns 2-5:
PA: can be connected to PROFIBUS PA
DP: can be connected to PROFIBUS DP

PDM: parameters can be assigned using SIMATIC PDM
Safety: with PROFIsafe profile

Drives

	PA DP PDM Safety	Description	Field of application
Motor management			
	● ●	Motor management and control devices SIMOCODE pro Can be integrated in SIMATIC PCS 7 using PCS 7 block library	Modular motor management system for motors with constant speeds in the low-voltage range ■ Power range 0.1 to 700 kW ■ Voltages up to 690 V AC ■ Rated motor currents up to 820 A Functional extensions possible using expansion modules.	Can be used where solid, liquid or gaseous materials are moved, conveyed, pumped or compressed, e.g. for: ■ Pumps and fans ■ Compressors ■ Extruders and mixers ■ Mills
Frequency converter			
	●	MICROMASTER 4 Can be integrated in SIMATIC PCS 7 using PCS 7 block library	Standard frequency converter with high dynamic response for variable-speed AC motors and gearmotors ■ Power range 0.12 to 250 kW ■ Voltages from 200 to 600 V	For universal use, especially for: ■ Operation of pumps and fans ■ Conveyor systems
	●	SIMOVERT MASTERDRIVES VC and MC	Modular frequency converters for highly exact variable-speed AC motors (individual and multi-motor drives) ■ Three-phase drives with vector control for continuous processes ■ Servo drives for cyclic machines with high dynamic performance ■ Power range 0.55 to 2 300 kW ■ Voltages up to 690 V	Can be used for highly efficient drive solutions in all sectors (also in harsh operating environments), e. g. for: ■ Steel and rolling mill works ■ Paper industry ■ Plastics industry ■ Woodworking and textile processing ■ Conveyor systems
	●	SIMOREG DC Master	High dynamic response converters for DC motors ■ Power range 6.3 to 2 000 kW ■ Voltages from 400 to 830 V ■ Current or torque rise time < 10 ms ■ Redundant drive solutions up to 18 000 A	Can be used for standard applications as well as high-performance solutions, in particular: ■ Paper and printing industry ■ Rubber and plastics industry ■ Drives of hoisting gear ■ Steel industry (shear drives) ■ Rolling mill drives
	● ●	SINAMICS G120/G120D	Modular frequency converter for variable-speed AC motors and gearmotors ■ Power range 0.37 to 132 kW ■ Voltage range 380 to 690 V ■ Vector control ■ Safety Integrated functions ■ Line-commutated energy recovery ■ G120D in IP65 up to 7.5 kW	For universal use in many sectors, e.g. machine construction, automotive and textile industries. Particularly suitable for: ■ Pumps and fans ■ Conveyor systems ■ Packaging machines

Drives

	PA DP PDM Safety	Description	Field of application
Frequency converter			
	● SINAMICS G130/G150	Converter for variable-speed single-motor drives of high power ■ Simple operation ■ Low noise, compact ■ As standard control cabinet or rack-mountable model ■ Power range 75 to 1 500 kW	Can be used to advantage wherever solid, liquid or gaseous materials have to be moved, conveyed, pumped or compressed, i.e. for: ■ Pumps and fans ■ Extruders, mixers, compressors ■ Mills
	● SINAMICS S120	Modular drive system for complex drive tasks ■ Single-axis and multi-axis applications ■ Energy recovery if required ■ Liquid-cooled version for corrosive atmospheres ■ Power range 0.12 to 4 500 kW	Multi-axis applications with high dynamic response such as: ■ Mill trains ■ Paper machines ■ Test bays Liquid-cooled devices: locations with corrosive or saline ambient air, such as process industry or ships
	● SINAMICS S150	Converter cabinet unit for complex single-motor drives ■ Energy recovery as standard, 4Q operation ■ Resistant to variations in line voltage ■ Almost without feedback to power supply ■ Power range 75 to 1 200 kW	Suitable for applications such as: ■ Test bays ■ Elevators, cranes ■ Cross cutters ■ Conveyor belts ■ Presses ■ Cable winches ■ Centrifuges
	● DYNAVERT T	Converter specifically for the chemical and petrochemical industries ■ PTC switch-off for Ex motors in zones 1 and 2 ■ ATEX-certified for Ex motors in zones 1 and 2 ■ Power range 4 to 3 800 kW	Sector solution for drive tasks in: ■ Chemical industry ■ Petrochemical industry ■ Oil & gas industry
	● ROBICON Perfect Harmony	Extremely compact medium-voltage converter ■ Maximum availability through redundant cell concept ■ Friendly to power supply and motor, minimum harmonics ■ Power range 150 kW to above 100 MW	Suitable for pumps, fans, compressors, extruders, kneaders, mixers, mills, vibrators, belt systems, propellers, presses

Drives

	PA DP PDM Safety	Description	Field of application
Frequency converter			
	●	SINAMICS GM150 Converter for single-motor drives in the medium-voltage range ■ Space-saving cabinet device ■ Simple operation ■ Maintenance functions ■ Power range 600 kW to 27 MW	Suitable for pumps, fans, compressors, extruders, kneaders, mixers, mills, vibrators, belt systems, propellers, presses
	●	SINAMICS SM150 The solution for complex drive tasks in the medium-voltage range ■ Single-motor and multi-motor drives ■ Energy recovery as standard, 4Q operation ■ Cable replacement possible between regenerative and running drive axes ■ Power range 5 to 30 MW	Main applications for: ■ Rolling mill drives ■ Conveyor baskets ■ Belt systems ■ Test bay drives
	●	SINAMICS GL150 The single-motor drive for synchronous machines of maximum power ■ Specially for synchronous machines to above 100 MW ■ Compact design ■ High operational safety, and almost maintenance-free	Suitable for: ■ Compressors ■ Pumps ■ Extruders ■ Blast furnace blowers ■ Propellers ■ Mills

Measuring equipment

	PA DP PDM Safety	Description	Field of application
Flow rate			
	● ● ●	**SITRANS F C MASSFLO MASS 6000** — Universal flowmeters of Coriolis design. Measurements independent of changes in process conditions and parameters such as temperature, density, pressure, viscosity, conductivity and flow profile	Mass flowmeter for measuring all types of liquids and gases. Main areas of use: ■ Water and wastewater ■ Chemical plants and pharmaceuticals ■ Oil and gas industries ■ Food and beverages industry
	● ● ●	**SITRANS F M MAGFLO MAG 6000** — Universal flowmeters of electro-magnetic design	For almost all electrically conducting liquids, suspended matter, slurries and sludges. Main areas of use: ■ Water and wastewater ■ Chemical plants and pharmaceuticals ■ Food and beverages industry ■ Steel industry
	● ●	**SITRANS FM Transmag 2** — Universal flowmeters of electromagnetic design with pulsed alternating field	Thanks to the high magnetic field strength, particularly suitable for media with high solids content, e.g.: ■ Paper and cellulose masses with concentrations > 3% ■ Mining sludges (highly concentrated/ with magnetic particles)
	● ●	**SIFLOW FC070** — Coriolis flow transmitter for exact multi-parameter measurements of mass flow, volume flow, density, temperature and fractional flow ■ S7-300 module for operation in the ET 200M ■ Direct integration in SIMATIC S7/PCS 7 ■ Plug-and-Play functionality based on SENSORPROM	Universal use for flow measurements of liquids and gases at high accuracy. Main areas of use: ■ Food and beverages industry ■ Chemical plants and pharmaceuticals ■ Oil and gas industries ■ Water and wastewater
Pressure			
	● ● ●	**SITRANS P DS III** — Digital pressure transmitter with high accuracy and comprehensive diagnostics and simulation functions. Measuring range from 1 mbar (DS III) or 8 mbar (P300) to 400 bar. Series P300 satisfies the special design requirements of the food and pharmaceutical industries as well as biotechnology	Measurement of: ■ Relative pressure, absolute pressure and level (P300) as well as additive ■ Differential pressure and flow (DS III) For corrosive and non-corrosive gases, vapors and liquids, also under extreme chemical and mechanical loads or strong electromagnetic influences. Also for hazardous areas Zone 1 or 21
	● ●	**SITRANS P300**	

Measuring equipment

	PA	DP	PDM	Safety	Description	Field of application

Temperature

	PA	DP			Description	Field of application
	●	●		SITRANS TH400 PA	Digital transmitter with various diagnostics and simulation facilities Recording of signals from: ■ Resistance thermometers ■ Resistance-based sensors ■ Thermocouples ■ Voltage sensors	Temperature transmitter for use in all sectors Suitable for mounting in the connection head type B Also for hazardous areas Zone 1 or 21 Suitable for redundant measurements

Level, radar

	PA	DP			Description	Field of application
	●	●		SITRANS LR 200	2-wire pulse radar (loop current) for cost-effective level measurements	Non-contact level measurement of liquids in storage tanks or simple process containers under harsh environmental conditions, particularly in the chemical and pharmaceutical industries
	●	●		SITRANS LR 250	Two-wire pulse radar for level and volume measurements ■ Measuring range up to 20 m ■ LUI (Local User Interface), comprising: – Graphic display – Handheld programming device	Continuous monitoring of liquids and sludge in tanks with high temperatures and pressures Ideal for small tanks and media with low dielectric constant
	●	●		SITRANS LR 300	Powerful pulse radar for non-contact level measurement of liquids and sludges under extreme process conditions ■ Measuring range up to 20 m	For liquids and sludges in storage tanks, process containers, reactors or digestion tanks, also under extreme process and environmental conditions Main areas of use: chemical/petrochemical plants and pharmaceuticals
	●	●		SITRANS LR 400	Powerful FMCW level radar for large measuring ranges and extreme process conditions ■ For measurement of liquids under difficult conditions ■ Measuring range up to 50 m ■ Optional purging system	Non-contact level measurement of liquids and bulk materials, especially where large amounts of dust are produced or liquids with low dielectric constant Main areas of use: manufacture and processing of products generating dust, e.g. cement, coal, flour
	●	●		SITRANS LR 460	Powerful FMCW level radar for large measuring ranges and extreme process conditions, two different versions ■ For level measurement of liquids ■ Particularly suitable for use with bulk materials ■ Measuring range up to 100 m ■ Optional purging system	Non-contact level measurement of liquids. Main areas of use: High storage tanks with liquids, process tanks with mixers, liquids emitting vapors, high temperatures, media with low dielectric constant.

Measuring equipment

	PA DP PDM Safety	Description	Field of application
Level, capacitive			
● ●	Pointek CLS 200/300	Capacitive level switch with inverse frequency shift technology, extremely resistant to chemicals, for use in harsh environments, e. g. at relatively high pressures and temperatures	Level measurements (level limit) for: ■ Liquids and interfaces ■ Fine bulk material (powders, granulates) ■ Sludges and foams ■ Sticky materials (CLS 300) ■ Simple pump control (CLS 200)
● ●	SITRANS LC 300	Low-cost capacitive level meter with high precision	For liquids and bulk materials, also with moisture, steam, foam, temperature/pressure variations as well as deposits, particularly in: ■ Chemical plants and pharmaceuticals ■ Food and beverages industry
Level, ultrasonic			
● ●	SITRANS Probe LU	Compact 2-wire ultrasonic meter for level and volume measurements of liquids in storage tanks and simple process containers as well as for flow measurements in open canals ■ Continuous measurement up to 12 m	Non-contact level, volume and flow measurement of liquids, especially in the water and wastewater industry and with the storage of liquid materials in almost all industrial sectors
● ●	MultiRanger 100/200	Universal single-channel or multi-channel ultrasonic transmitter for small to medium measuring ranges ■ Compatible with the chemically resistant Echomax sensors for temperatures up to 145 °C	Non-contact level, volume and flow measurement as well as enhanced pump control for liquids, sludges and bulk materials in almost all industrial sectors
● ●	HydroRanger 200	Ultrasonic transmitter for up to six pumps, permitting level control, difference measurement and flow measurements in open canals.	For monitoring water and wastewater of any consistency down to a depth of 15 m Main areas of use: monitoring of pump shafts, weirs and canals, and for screen control
●	SITRANS LU 01/02/10	Ultrasonic transmitter for level measurements of liquids and bulk materials in a range of max. 60 m ■ Sensor distance up to 365 m ■ Compatible with Echomax sensors	Non-contact measurement of level, empty space, distance, volume or mean/difference value, especially for the storage of liquids, bulk materials or their mixtures in containers of different shape, size and configuration
●	SITRANS LUC 500	Complete system for monitoring and control of water/wastewater with exact ultrasonic level measurement up to 15 m and reliable flow measurement in open canals	Monitoring and control of water supply plants and wastewater collection systems

Process controllers and positioners, process monitoring, weighing and dosing systems

	PA	DP	PDM	Safety	Description	Field of application
Process controllers						
		●	●		SIPART DR 19/21	Compact controllers designed as standard as continuous and step controllers	Wide range of predefined functions for controlling industrial processes, and their application does not require any programming knowledge or auxiliary equipment
Positioners						
	●		●		SIPART PS2	Electropneumatic positioners ■ Numerous integral diagnostics functions provide information on the status of valve and drive ■ Automatic startup function with self-adjustment for fast adaptation to the respective fitting	Highly exact control of valves and dampers using linear and rotary actuators, also in hazardous areas Zone 1 or 21
Process monitoring						
	●	●	●		SITRANS DA400	Acoustic sensor for monitoring diaphragm piston pumps	Continuous, simultaneous and independent leak monitoring of up to four conveyor valves of a pump, as well as monitoring of standard signals via four further inputs The state of an oscillating positive displacement pump can therefore be monitored in every phase of operation.
Weighing and dosing systems						
		●			SIWAREX M/U/FTA/FTC	SIWAREX weighing system comprising: ■ SIWAREX M, U, FTA or FTC weighing processor (can be operated in the ET 200M) ■ One or more load cells	Can be used in the complete manufacturing process: ■ Hopper, platform, vehicle and dosing scales ■ Weighing bridges ■ Filling plants ■ Conveyor belts
		●			Milltronics BW 500	Powerful transmitter for belt scales and weighfeeders	Can be used for all belt scales with up to four strain gauge load cells Processing of weight and speed signals for exact display of the transferred quantity and total quantity of bulk materials.
		●			Milltronics SF 500	Powerful transmitter for solids flowmeter	Suitable for all solids flowmeters with up to two strain gauge load cells or LVDT sensors Processing of sensor signals to achieve exact calculation of throughput and total quantity

Gas analyzers

	PA DP PDM Safety	Description	Field of application
Gas analyzers			
	CALOMAT 6	Exact determination of composition and concentration of process gases using thermal conductivity procedure	e.g. measurement of hydrogen and inert gas concentrations in blast furnace gas and carbon dioxide mixtures
	ULTRAMAT 23	Low-price multi-component NDIR analyzer for a wide variety of standard applications	e.g. flue gas monitoring, furnace optimization or room air monitoring, can be equipped with additional electrochemical cell for oxygen measurements
	ULTRAMAT 6	Analyzer for measurement of up to four components which are IR-active	Can be used in all sectors from emission measurements up to production procedures, even under the influence of highly corrosive gases
	OXYMAT 6	Corrosion-resistant oxygen analyzer for use in harsh atmospheres	Suitable for emission measurements, for guaranteeing product quality, or for monitoring production processes, in particular with safety-relevant plants
	ULTRAMAT/ OXYMAT 6	ULTRAMAT/OXYMAT combination with ■ one infrared channel for measurement of one or two IR components and ■ one channel for measurement of oxygen	
	OXYMAT 61	Low-price oxygen analyzer for standard applications	
	FIDAMAT 6	Gas analyzer for measuring hydrocarbons in pure and ultra-pure gases ■ Four freely-parameterizable measuring ranges ■ Very low sensitivity to interfering gases	Suitable for: ■ Pure gas measurements in O_2, CO_2, inert gases and cold sample gases (except helium and hydrogen) ■ Quality monitoring ■ Process optimization ■ Research and development

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