PROFIBUS - Solutions from ABB

Reap all the benefits of proven digital technology

instrumentation

understanding  measurement  analysis  control  integration  optimization
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1 Introduction

Fieldbus for process automation offers a digital only method of communication between the field and process control system. It has allowed a shift in the hierarchy of control functions from the system towards the field device with the opportunity to take advantage of Asset Optimization functions at the higher system level. In this regard fieldbus technology is assuming a greater importance throughout industry.

This document provides an overview of the fieldbus technology to help you draw your own conclusions as to its suitability for your applications.

1.1 Application areas and advantages of the fieldbus technology

As fieldbus technology matures, the focus has shifted from development to implementation issues in concrete process automation projects and to the supply of all the necessary devices and peripherals.

Although much progress is still required regarding true interoperability between devices foreign hosts and in streamlining the engineering effort, fieldbus technology has acquired a momentum of its own. Its acceptance in the market has much improved and its implementation scope has moved from pilot plants to large-scale processes.

The expected benefits in installation costs, engineering and commissioning are now supplemented by those related to asset optimization. Digital communication enables real-time access and transfer of much field resident information, previously unavailable to the control system. Advanced procedures for preventive maintenance are now possible. Fieldbus is set to become the technology of choice for the future.

1.2 Automation fieldbusses and standards

PROFIBUS and Foundation Fieldbus dominate fieldbus for the automation industry. Both busses can offer power over the bus for field devices and provide digital only communications from the field to control systems.

In terms of organisation they are similar with many user groups and support world-wide by the major manufacturers. The PROFIBUS User Organisation has its headquarters in Karlsruhe Germany and Fieldbus Foundation has its headquarters in Austin Texas. Both systems are IEC 61158 approved.

The technologies of PROFIBUS and Foundation Fieldbus are different in several important areas although the installation guidelines of PROFIBUS PA and Foundation H1 are similar as they share the same physical layer (see section 2.1 ISO/OSI model).

PROFIBUS

PROFIBUS has evolved from the high-speed busses required between PLC and I/O racks (PROFIBUS-FMS and -DP). This has resulted in a large well-developed range of DP devices. Support for automation was completed with the extension of DP to intelligent field devices via the PROFIBUS PA protocol. PA can supply power over the bus for devices such as Transmitters and Positioners which can be extended into IS areas. PA segments are connected to the DP-Line via a coupler or links.

PROFIBUS operates as a Master Slave protocol with the master as typically a DP device and the slaves being either DP- or PA devices. Once the system has been commissioned cyclic access can be optimised for the number of devices concerned. Acyclic commands (engineering interaction) are allowed for as part of the network bandwidth.

Device Interoperability is via the use of profiles and certified products.

Foundation Fieldbus

Foundation has evolved from the intelligent fieldbus level with devices becoming available from 1999. This is the foundation fieldbus H1 level and can supply power over the bus for devices such as transmitters and positioners and can be extended into IS areas Foundation has a high speed bus based upon Ethernet technology and requires a Link Device to connect to the H1 level. Ethernet was chosen to enable the use of readily available and low cost networking components and will become the method of choice for the connection of complex externally powered devices to Foundation systems.

Foundation Fieldbus devices benefit from time distribution that allows for the following features
1. Alarm stamping at source
2. Deterministic communications allowing distributed functions to field devices (PID etc.)
3. Peer to Peer communication

Field devices contain standard function blocks in the User Layer. These function blocks include PID but can also provide for manufacturer innovation.

Interoperability is via Device Descriptions (DD) and independent testing.

Standards

The vision of a single fieldbus has been diluted as a result of the IEC fieldbus standards committee decision to append other protocols to its IEC61158 standard. In all there are now 8 protocols to be appended to this standard. They are shown below.

<table>
<thead>
<tr>
<th>Protocols</th>
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<tbody>
<tr>
<td>1. IEC 61158</td>
</tr>
<tr>
<td>(existing Foundation tracks this standard)</td>
</tr>
<tr>
<td>2. ControlNet</td>
</tr>
<tr>
<td>3. PROFIBUS</td>
</tr>
<tr>
<td>4. Interbus</td>
</tr>
<tr>
<td>5. P-Net</td>
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<tr>
<td>6. WorldFIP</td>
</tr>
<tr>
<td>7. SwiftNet</td>
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<tr>
<td>8. FF HSE</td>
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</table>

![Fig. 121 Protocols](image-url)
1.3 User Requirements

As an all encompassing communication technology for process automation, fieldbus must meet the stringent requirements of the process industry. These can be grouped in three categories:

On the concept and standardisation side, the general requirements are:

- Standardisation of the communication technology
- Comprehensive product availability in terms of both diversity of suppliers and required functionality
- Availability of engineering implementation tools and services, planning aids, technical training, maintenance services
- Standardised engineering interface for transportability of device configuration and engineering effort to different systems environments

On the technical performance side, fieldbus products and solutions must match the performance achieved today by traditional analogue methods for signal exchange between control system and field instruments:

- Reliable and timely transfer of information
- Complete data transfer redundancy
- Intrinsic safety and field devices power supply on the signal lines
- On line equipment substitution without interfering with plant operations
- Protection from electromagnetic interference from the environment
- Possibility to expand the control system with the freedom of choice of field device supplier
- True interoperability of field devices from different suppliers, between themselves and with foreign host control systems

On the future development side, the expectations are

- Significant life cycle cost reductions for; planning, procurement, engineering, installation, operation and maintenance
- Integration within the fieldbus based automation architecture of installed field inputs and outputs, whether conventional analogue or hybrid HART
- Integration of available field device based information for deployment of maintenance strategies

1.4 User Benefits

The application of fieldbus technology provides benefits throughout total plant lifetime. Cost savings to commissioning stage vary between 25% and 43% depending on the layout and the technology used as a reference, with Operational and Asset Optimisation benefits following thereafter.

Be aware of claims for higher cost savings, these are typically a result of extremely long cable runs and are not representative, however they make good headlines!

Pre-Commissioning

Savings here are generally made in reduced planning and documentation costs.

Installation & Commissioning

In this case savings are possible due to:

- Reduced cable requirements
- Reduced peripheral equipment such as IS barriers – I/O cards – Marshalling cabinet’s etc.
- Reduced engineering time. (Ability to cut and paste applications and engineer from a central location)

Operation and Management

With a greater view of process conditions Asset Optimization will allow operation closer to plant design limits and a switch from just in case maintenance to predictive maintenance.

Fig. 141 Fieldbus savings potential

1.5 The position of ABB

ABB supports both the major automation fieldbusses, namely PROFIBUS and foundation fieldbus and also LON for medium and low voltage systems.

We are an active driving force at all levels of Fieldbus Foundation and PROFIBUS policy and technical development.
2 Basics

2.1 General definition: Fieldbus in process automation

Fieldbus systems are used as a means of communications for serial data exchange between decentralized devices on the field level and the input/output periphery of the process supervision level (Fig. 211). In addition to intelligent sensors and actuators with a direct connection to the fieldbus, intelligent "remote I/O's" are also used as interface systems for conventional field devices to record process data on the field level.

Fig. 211 Fieldbus layout

All relevant signals such as input and output data, parameters, diagnostic information, configuration settings and – for a wide range of applications – the power required for operation can be carried over two wires. If a field device has a high-power requirement, then this device can be powered externally.

The unambiguous specification of the communications protocol makes it possible to keep the fieldbus open for all providers who use the protocol for their devices. As a result, the exchangeability common today for 4-20 mA devices is maintained for fieldbus devices.

This, along with other conditions, is the essential requirement for using fieldbus systems with the significant potential to provide benefits to users.

2.2 The PROFIBUS family

PROFIBUS is a manufacturer-independent fieldbus standard for applications in manufacturing, process and building automation. PROFIBUS technology is described in fixed terms in DIN 19245 as a German standard and in EN 50170 as an international standard. The PROFIBUS standard is thus available to every provider of automation product.

The PROFIBUS family is composed of three types of protocol, each of which is used for different tasks. Of course all three protocols can communicate with each other in a complex system by means of a PROFIBUS network. The basis for this is the compatibility of the protocol types.

The three types of protocols are: PROFIBUS-DP, PROFIBUS-PA and PROFIBUS-FMS. The two protocol types DP and PA are important for process automation.

PROFIBUS-DP: the bus for the decentralized periphery

The DP PROFIBUS version is responsible for communication between components that are close to the components of a process guidance system, process near components (PNC) and the decentralized periphery in the field. One feature of PROFIBUS DP is its high speed of transmission.

PROFIBUS-PA: extension for process automation

This Profibus variant was developed for the process industry. Intrinsic safety and power supply to field devices are possible and correspond to IEC Standard 1158-2. This version is used for sensors and actuators supplied with power via 2-line wires to communicate with each other in the field.

PROFIBUS-PA uses an extended DP protocol. The characteristics of devices and their behavior are described in profiles and are specified in the standard. Coupling components (segment couplers, link) are used to integrate PA bus lines into the PROFIBUS DP network. This ensures that all information is available in a continuously connected network through the complete PROFIBUS system (DP and PA).

PROFIBUS-FMS: Field Message Specification

PROFIBUS-FMS no longer has any essential significance on the field level. Available devices can be operated together with DP devices if the master supports both protocol types.

Fig. 221 PROFIBUS applications
2.3 Protocol architecture, protocol functions, profiles and interoperability

In accordance with the international ISO/OSI model, a fieldbus protocol can be uniquely described by means of up to 7 transmission levels. Specific tasks are assigned to each level in this system. PROFIBUS-DP and PROFIBUS-PA use only the first two levels as well as the user interface, which resides in level 7 and where application functions that can be utilized by the user are determined along with system and device behavior. Level 1 defines the physical aspect of transmission (physical layer). This includes, for example, the method of transmission, the transmission medium, and lengths of lines, while level 2 specifies the bus access protocol (data link layer). Direct access from the user interface to layer 2 is possible through the Direct Data Link Mapper.

The extended functions of PROFIBUS-DP/V1 are required to set parameters and operate the system. In addition to cyclical data traffic, these also facilitate non-cyclical read and write functions as well as alarm handling. These extended functions are optional so that it is still possible to continue using older PROFIBUS-DP devices. The extended functions and the PA profile are used both for PA field devices and for DP field devices. Both types of devices can be operated with the aid of simple couplers on a bus system.

Protocol functions and profiles

The function block model, which corresponds to international consideration, is used for profiles. One of the function blocks is the "Analog Input" block (Fig. 232). It describes the physical limit, measurement range and measurement value of the measurement converter, two upper and two lower threshold values as well as the corresponding status messages and alarms. These parameters and status messages can be effectively used with all measurement transformers. The analog input block thus represents the "lowest common denominator" linking all sensors. Until profile B (of which it is a component) was separated from it, the analog input block was designated as Profile A.

The exchangeability of PROFIBUS-DP or PROFIBUS-PA field devices is only achieved with the use of profiles. Profile A, however, covers only process visualization. Profile B is required for a more comprehensive characterization of devices. It consists of a frame data sheet with standard parameters for all blocks and device-specific data sheets (Fig. 233). A distinction is made between the physical block (hardware) the transmitter block (parameters of physical measurement size, present multiple times for multi-function sensors) and the function block (functions from the point of view of the SPS or PLS, for example analog input for sensors or analog output for actuators).

Figure 234 shows how extensively and in what great detail class B profiles describe the features of a transmitter.

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**Fig. 231** Log architecture

**Fig. 232** Analog Input Block

**Fig. 233** Framework data sheet and specific unit data sheets

**Fig. 234** Class B profiles

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- **Physical Block**
  - Manufacturer, name of unit, serial number, diagnosis (selftest), password, certification, factory setting, unit description, unit information, date of manufacture, software revision, hardware revision, TAG, configuration meter

- **Transmitter Block (e.g. pressure transmitter)**
  - Sensor calibration, test of the sensor limits, sensor alarms, conversion into physical units depending on the application, sensor type, process connection material, material of diaphragm, filtering fluid, pressure level, O ring material, ...

- **Control actuators:** electric actuator, electro-pneumatic and electro-hydraulic actuator

- **Function Block**
  - Input channel, filter, time constant, scaling of the process variables, conversion in % values, alarms (HI_HI, HI_LO, LO_LO, LO_HI, hysteresis), simulation, ...
Interoperability

Using PROFIBUS-PA profiles B, V 3.0 makes devices interoperable, in other words devices of different manufacturers can be physically connected to a single bus and are able to communicate with each other. In addition to this, however, they are also interchangeable, which means devices of different manufacturers can be exchanged one for another without having to change the configuration in the process guidance system.

2.4 Transmission technology

The transfer method of PROFIBUS-DP is RS 485, which has been used successfully for many years. This technology can always be used to advantage if high transfer rates and a simple method of installation are required without additional DP/PA segment couplers.

A twisted, shielded two-wire copper cable is used as the transfer medium. Depending on local conditions, the shield should be connected on one or both ends of the cable segment to the potential equalization system. The bus structure makes it possible to add devices step by step and also to extend or limit the number of subscribers in operation on the system.

You can select a transfer rate between 9.6 kBits and 12 Mb/s. When selecting uniform transfer rates for the system you should take into consideration that the usual distances of 500 m to 1000 m are only possible with the technology of the procedure by reducing the transfer rates (Fig. 241).

A twisted two-wire, shielded copper cable must again be used as the transfer medium. It is also possible to exchange and extend devices during operation. The uniform transfer rate is 31.25 kBit/s. At this rate, distances of up to 1900 m are possible in non Ex case, or 1000 m in Ex cases.

2.5 Bus topologies and installation notes

When a PROFIBUS-DP network is installed, boundary conditions of RS 485 transfer technology must be observed. All subscribers are connected in a line-shaped bus. To avoid reflections, the line structure must be terminated by a bus termination resistor network at either end (Fig. 251). This network must be provided with a ground-free voltage of 5 volts. Frequently the required bus termination is already integrated into the device so that it can be inserted into the circuit easily if the device is located at the beginning or end of the line structure. According to the rules of certification, a DP device must be available at a minimum of 5 V.

Subscribers should preferably be connected to the bus via 9-pin D-sub connectors. For transmission rates above 500 kBit/s, stub lines should be avoided. In this case the incoming and outgoing cable must be switched through in the connector. In this manner it is possible to ensure that communication with subscribers downstream is properly maintained if the device is replaced.

Up to 125 field devices can be addressed by PROFIBUS-DP with a connecting circuit of an SPS or a PLS. One additional restriction on the number of subscribers results from the fact that each subscriber on the bus weakens the bus signal. If there are more than 32 subscribers (including the master), a bus amplifier (a repeater) must therefore be used to maintain the viability of the bus signal (Fig. 252). The bus lines that are separated by bus repeaters are called segments. Each individual segment must again be closed off on both sides by a resistor network. The maximum length of the line can be increased by using as many as 3 bus amplifiers. For applications in strong electro-magnetic interference fields, fiber optical cables can be used (link segment).
PROFIBUS-PA networks are connected to PROFIBUS-DP segments via segment couplers. The segment couplers convert the physical nature of the RS 485 transfer to the IEC physical characteristics. They also make an optionally intrinsically safe supply current available for powering field devices. In contrast to the PROFIBUS-DP, the physical features of the PROFIBUS-PA bus also allow network topologies with long branches, such as tree structures (Fig. 253). The tree structure is comparable with the traditional field installation technique. Signals from the field devices are collected via stub lines in sub-distributors and are connected to the main bus cable in parallel. A passive line terminator (RC member) must be provided at both ends of the main bus cable for all topologies.

The number of subscribers that can be connected to a segment is also limited to 32. An additional restriction results from the supply current that is available, which is determined by the type of explosion protection selected. In addition to the basic currents of the field devices, the modulation signal of 9 mA, the maximum current in the case of error of the device with the greatest power consumption and a reserve for dynamic power on procedures when the power is restored to the DP/PA segment coupler must all be taken into account for calculating the required current. The assumption is also made here that the devices are equipped with an electronics system for limiting the current (FDE = Failure Detection Electronics). The maximum length of the line is restricted by the type of explosion protection and the drop in current over the bus line. The drop in current may result in a further limitation to the number of subscribers (Table 251).

<table>
<thead>
<tr>
<th>DP/PA segment coupler</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of usage</td>
<td>EEx ia/ib IIC</td>
<td>EEx ib IIC</td>
<td>EEx ib IIB</td>
<td>Non Ex</td>
</tr>
<tr>
<td>Power supply current $U_s$</td>
<td>13.5 V</td>
<td>13.5 V</td>
<td>13.5 V</td>
<td>24 V</td>
</tr>
<tr>
<td>Power supply current $I_s$</td>
<td>$\leq 110$ mA</td>
<td>$\leq 110$ mA</td>
<td>$\leq 250$ mA</td>
<td>$\leq 500$ mA</td>
</tr>
<tr>
<td>Loop resistance $R_s$</td>
<td>$\leq 40$ Ω</td>
<td>$\leq 40$ Ω</td>
<td>$\leq 18$ Ω</td>
<td>$\leq 30$ Ω</td>
</tr>
<tr>
<td>Length of line type B (0.5 mm²)</td>
<td>$\leq 500$ m</td>
<td>$\leq 500$ m</td>
<td>$\leq 250$ m</td>
<td>$\leq 400$ m</td>
</tr>
<tr>
<td>Length of line type A (0.8 mm²)</td>
<td>$\leq 900$ m</td>
<td>$\leq 900$ m</td>
<td>$\leq 400$ m</td>
<td>$\leq 650$ m</td>
</tr>
<tr>
<td>Number of subscribers at 10 mA</td>
<td>8</td>
<td>8</td>
<td>22</td>
<td>32</td>
</tr>
</tbody>
</table>

Table 251  Line lengths and number of subscribers per segment as a function of the power supply current and the cross section of the line, based on the FISCO model (FISCO = Fieldbus Intrinsic Safety Concept).
2.6 Bus access procedures and bus network configuration

All PROFIBUS variants use a uniform bus access protocol. All data backup as well as handling of transfer protocols are included in this. The PROFIBUS protocol facilitates a cyclical real-time based exchange of data between the active bus connecting circuit of a process-near component PNC, the master as it is called and the passive bus subscribers, which are also designated as slaves. The bus access control system of the master determines the point in time at which a slave may send data to the master. Only one subscriber may have authorization to transmit for this master/slave access procedure at any given time. The master, which has authorization to transmit, thus has the possibility of transmitting messages to the assigned slaves or of retrieving messages from the slaves. The cyclical transfer of user data between master and slaves allows for transfer of up to 244 bytes (DP) or 224 bytes (DP/V1) each of input and output data per telegram.

A cyclical master can transfer its bus access authorization to another master (token passing procedure). In this manner several masters can retrieve messages over a PROFIBUS network from the slaves that are assigned to them (multi-master principle). A distinction is made between two types of masters. Masters of Class 1 (cyclical masters) exchange information with the decentralized slaves in a specified message cycle. Master of Class 1 include for example PNC of process guidance systems. Masters of Class 2 (non-cyclical masters) include tools for programming, configuring and setting parameters. They are used for placing bus networks in service and for setting parameters of bus subscribers. Class 2 functionality may also be integrated into the PNC’s of the process guidance systems, or may be available as a standalone tool.

Profibus telegram formats ensure a high level of security for transfers. As a result of special start and end-characters, parity bits and control bytes as well as secure synchronization, a Hamming distance of HD = 4 is ensured.

Bus network configuration

For a PROFIBUS slave to be able to communicate cyclically with a master, it must first receive an address in the range 0...125. The address assignment is generally performed with the network configuration device of the Class 1 master. The network configuration device also determines the communication parameters of the master and the slaves and along with them the cycle time in the network.

The different communication parameters of the individual devices (slaves) are documented in the device-specific data files (GSD files) as they are called. This data describes the individual communication features of a device. This includes, for example, manufacturer and device name, the hardware and software version, baud rate as well as the number and nature of input and output procedures, status messages and diagnostic texts. The PROFIBUS user organization assigns device ID numbers and manages the associated GSD’s. All files are available for download at no cost on the World Wide Web Server of the Profibus User Organization (http://www.Profi-bus.com).

As a result of the file format determined, the network configuration tool is able to read the GSD files. In this manner, all special features of the devices to be configured that have been described are automatically taken into configuration (Fig. 261).

Fig. 261 Bus network configuration
DOC: Display and operating components
PNC: Prozess-near component
3 Configuring and observing field devices

3.1 Integration of field devices, standalone tools and process control systems = the FDT concept

With the proliferation of intelligent field devices with digital interfaces such as HART, PROFIBUS and FOUNDATION Fieldbus, there is a requirement for configuration tools using these protocols. It is desirable for this configuration tool to have a rich graphic user interface whilst provide access to devices from multiple manufacturers.

A common proposal for a solution has been worked out in the PNK work group “Device Description” and in the work group formed by ZVEI, “Field Device Tool (FDT)”. The goal is not a new device description language, but rather a device-independent interface. This allows for the integration of a device-specific software component into each engineering tool.

Similar to the driver software for a printer, a DTM (Device Type Manager) belongs to a field device. The DTM corresponds to the FDT tool interface and uses for example the ActiveX or COM/DTM technology that has been introduced by Microsoft. The actual device manufacturer makes the DTM available, since only the manufacturer knows the details of the device that go beyond the profile. A DTM might include for example user dialogs and plausibility checking for parameters.

Learning only one uniform ergonomic program operation system and a common representation for standard PC applications increases efficiency in working with the devices. Thus DTM is used when placing the standalone tool in service and then subsequently in the process control system, for example Symphony, Freelance or Advant. It is only necessary to learn to use the device with DTM once. This helps to reduce costs in administering and handling devices, tasks that often dramatically exceed the investment costs for the devices themselves.

3.2 Device management with control system structures

Communication with field devices has previously been characterized by a large number of individual solutions. Each manufacturer had its own application, which generally used RS 232 or RS 485 interfaces. All possible protocols and designs of the user interface in terms of appearance and operating philosophy were used, and this was exacerbated by the fact that different operating systems served as platforms. The result was a high cost for the user in terms of purchasing and using these tools including updates that were necessary and training for personnel. To put an end to these unfavorable circumstances, efforts were made to introduce standardization, which have led now to clear, acceptable results for the hardware, the protocols and the user interfaces.

In order to achieve a uniform design of a user interface with field devices, a working committee has hammered out guidelines in the context of the GMA which have been set forth in VDI/VDE 2187 (GMA = Organization for Measurement and Automation Technology, German Gesellschaft für Mess- und Automatisierungstechnik).

The specification for the protocols and corresponding profiles has served as the basis for developing communication with field devices from different manufacturers. Since no one communication standard emerged as the optimal one for all requirements, a communication software package must support the most important communication methods (HART, PROFIBUS, Fieldbus Foundation).

This section presents a communication software package that addressed all these requirements, which is equipped with all the communication methods listed above, and which supports them all simultaneously.

SMART VISION is an intelligent software package for complete field device management. Whether the task is configuration, parameterization, calibration, commissioning, diagnostics or maintenance, this is a central tool for all devices – independent of the manufacturer. The modular structure corresponds to the FTD/DTM statement (Field Device Tool/Device Type Manager) This ensures continuous compatibility – today and in the future.
SMART VISION allows for communication between field devices through the following communication protocols:

- **HART communication**
  - Via FSK modems with point-to-point or multi-drop operation or FSK bus
  - Via HART multiplexer
- **PROFIBUS communication**
  - Directly to PROFIBUS-DP devices
  - Via the S900 as a PROFIBUS node to HART field devices
  - Via segment couplers to PROFIBUS-PA devices
- **FOUNDATION Fieldbus**

SMART VISION is capable of running on modern standard PC’s or Notebooks with MS Windows with Version 3.1, MS Windows 95 or MS Windows NT 4.0.

SMART VISION offers management of all field devices independent of the protocol used. It provides the software environment for running the device DTM, and it is the DTM that creates the rich graphic user interface for device set-up and interrogation. The main areas of usage for SMART VISION are therefore found in:

- Diagnosis of field devices and calling up status reports
- Online display of device parameters (graphical/text) or printout.
- Storage of device configuration, device measurement and status data.
- Configuration or parameterization of field devices.
- Management of device data and planning and administration of device measurement stations
- Visual overview as a representation of devices connected to the system

SMART VISION has allowed working with field devices to become less complicated and more effective and reliable as a result of removing the necessity of learning several device management applications provided by individual device manufacturers. With the plug in concept of the DTM, SMART VISION supports all devices from manufacturers. SMART VISION uses standard Windows interface to assist user interface to the software and reduce the learning curve for new users.

Along with reliable handling of field devices and the multiple protocol support, SMART VISION will save time, and thereby money.

SMART VISION supports the entire ABB portfolio of devices, including flow, temperature, pressure measurement devices, remote I/O’s, positioners and actuators. Devices from other manufacturers can be integrated too. In addition, PROFIBUS-PA profiles are supported. Further functionalities include:

- Integrated project tree management
- A graphic editor for creating a project tree structure
- Testing of the project tree structure
- Sorting functions based on user measurement station description
- TAG number assignment by measurement device
- Automatic detection of field devices by type and number
- Cyclical verification of device data
- Parallel operation of PCs and analog value display
- Data upload/download

The use of SMART VISION results in a high level of benefits to the user. These are derived in particular from the following points:

- PC-supported device data management and central device access
- Online and offline configuration of devices or device data files
- Accelerated service actions with greater configuration convenience
- Intuitive software with excellent on-line help reduces references to manuals
- One single configuration tool for all field devices
- Only a small amount of time is required to learn how to run the program
- Open structure to integrate additional devices, which can be done in little time
- Use of many communication protocols and a wide variety of field devices
- A high level of development and extension of already-existing systems through parallel use of analog technology with HART and fieldbus communication by making use of FSK modems, multiplexers, segment couplers and EEx separation
- Development and expansion are possible at any time and in steps of any size

The requirements of users for communication tools are extensive and all too often include special functions. SMART VISION is built upon many years of experience with field device applications whose range is reflected in the following list:

SMART VISION offers the following function blocks or functions:

- Save a database of field devices to hard drive, upload from field devices and download back to field devices
- Online display of measurement values and counter status – numeric

- as bars with alarm thresholds
- as continuous line recorders with a scalable time axis

Fig. 322 Parameter definition for a meter
Configuring and observing field devices

- Measurement station documentation
- Direct data output of device/diagnosis data and information of the network
- Device storage in database files
- TAG No. assignment by measurement device and automatic generation of TAG No.
- Access to devices is via selection of the TAG number of a device in a graphical HART or fieldbus network tree and by activation of the connection structure.
- Online communication with several field devices simultaneously
- Automatic detection of field devices by type and number
- Cyclical verification of device data output
- Integrated network management for integrating devices
- Creation of a network structure with a graphical editor
- Automatic generation of numbers for addresses and channels
- Integrated diagnostics tool for continuous detection of changes in the status of field devices with storage of data in plain text in an ASCII file including a day/time stamp for the result in question, for all or for individual devices
- Integrated hypertext help
- Password setup with write-protection function for device data
- Selection of language or language switching at any time

The design of the user interface conforms to the Windows standard, in other words whenever it is possible, common design elements and available functions are taken over from Windows.

In connection with maintaining the GMA regulations of VDI/VDE 2187 as the basis, a highly functional interface, but one which is also clear and easy to understand is available. It requires only a minimum amount of training to use.

It is important to mention that the software goes beyond the requirements of GMA in two areas:
- The clear and easy-to-understand display of all devices in a system in a single tree structure that represents the connection paths from the PC to the field devices graphically and which serves as the beginning point for selecting devices with the corresponding TAG number.
- The user can decide at any time how many devices should run with.

---

**Fig. 323** On-line display of measured value and metering states

**Fig. 324** Calibration

- Characteristic user line with freely adjustable interpolation points
- Device status with error reporting function
- Different input/output windows for general and device-specific data

**Fig. 325** Sensor and output parameter definition

**Fig. 326** Tree structure with PROFIBUS connection
Integrated background diagnostics. This can be seen as a significant functionality that affords an overview of communications that have taken place with connected field devices. After the program starts, the diagnostic module continues to run in the background and stores all diagnostic data in an ASCII file with a date and time stamp.

As a multi-language communication tool, SMART VISION supports a wide range of field devices and also uses the important methods of communication that have been listed, HART/PROFIBUS/FOUNDATION Fieldbus. In order to design handling as simply as possible for the manufacturer and the user, SMART VISION is available in only two design versions:

- The HART version via FSK modem with point-to-point operation and FSK bus including all available drives for field devices.
- As above, but including all available additional methods of communication.

3.3 The fieldbus requires new control system structures

New technologies – such as fieldbus – are also opening up new structures in control technology. A control system of new structures consists on the automation level of only a few central processing groups for supervisory functions and of a larger number of interface assemblies that facilitate access to the fieldbus. The standardised fieldbus provides an open control system for devices of different manufacturers so that even input/output components no longer necessarily need to originate with the manufacturer of the control system.

The requirements already listed in Section 1.4 apply for the use of fieldbus systems as a supplement to traditional process control systems with the emphasis of reducing costs over the entire life cycle of a system. The availability and magnitude of the savings potential is as a result of implementation of decentralized input/output assemblies spread out over time, low-voltage circuit systems and complex positioners as well as measurement converters and pneumatic actuators included in the control systems of the new structure (Figure 331).

Along with the high expectations for economic advantages, operators of procedural-technical systems place requirements on a fieldbus system that originate from the particular features of the processes. These include:

- System-wide time synchronization and time stamping of events derived from it.
- High availability, implemented through redundancy structures.
- Thorough, complete engineering for the entire control system.

Future control system structures

The structures of modern process control systems from different manufacturers are similar to each other. The following section will illustrate the integration of the fieldbus using the Symphony process control system as an example. Symphony allows for division of general system functions into three areas:

- The process control level
- The bus network
- Automation

The process control level contains the system elements for:

- Operating and observing (Maestro)
- Engineering and diagnosis (Composer) and
- Management functions for optimization tasks of process procedures (Performer)

The automation level consists of automation stations that work independently of each other. Each station consists of a central processing unit in which all automation-technical functions for preparation of measured values, feedback and control are processed, and of I/O assemblies for recording and output signals. The superordinate bus network establishes the communication connection between the process control level and all assemblies on the automation level.

Figure 333 shows an automation station of the process control system described above, supplemented by a redundant PROFIBUS-DP interface.
As described in Section 2.2, complex field devices such as electrical feedback and control drives or "intelligent" circuit system modules can be linked directly or via high speed fieldbus to the processing unit. Field devices such as pressure or temperature measurement transmitters, receiving their power supply through the bus, are connected to the PROFIBUS-PA specified for this purpose, which in turn is connected with "DP/PA segment coupler", as it is called, to the DP segment.

The state of the art process control systems is a central engineering system for continuous planning and documentation of the entire control system. The field bus and the attached "intelligent" devices must now be considered in addition as part of the control technology.

All automation and input/output functions of a control system as well as the attached conventional devices are represented in the engineering system by function components that are linked to each other in the function diagram. The links represent communication functions, both within an automation station and between different stations. All configuration data for the process control system is derived from the function diagram and is loaded into the automation stations.

Introducing fieldbus results in new requirements arising for the library of function components:

- The standardized device profiles must be accepted as new function components
- The library of function components must be easily expandable (open) so that non-standardized devices can also be represented.

These new components represent the interface of field devices with the control system and the conversion of device-specific data formats to data formats that conform to the system. The engineering system generates the configuration data for the communication relationships on the field bus from the links between device components with the system function components and between themselves.

The adaptation of a field device to a specific application is accomplished by loading parameter sets, which in turn are generated and documented by the central engineering system. To make it possible to use the entire inventory of functions for field devices – thus including those that are manufacturer-specific – the engineering system must have access to the manufacturer-specific device characteristics.

The device manufacturer must formally describe the device functions in a uniform data-technically interpretable language (comparable with the DDL). The engineering system evaluates the description and converts it into a uniform interface for setting parameters that can be used by the user.

In many systems, a large number of independent configuration tools are required for fieldbus system engineering, for:

- Engineering of the process guidance system
- Configuration of the PROFIBUS
- Setting device-specific parameters of sensors and actuators

The HMI and Processor in the control system are connected to the PROFIBUS DP via a segment coupler. Smart Vision, as the bus configurator, is used for configuration and setting parameters for the field devices.

Complete engineering can only be implemented in a series of steps, through long-term integration of the individual tools that are available today into a central engineering platform (Fig. 336). The desired reductions in costs can only be achieved with a user-friendly engineering tool that is open to devices of other manufacturers.
4 The ABB PROFIBUS pilot plant

The pilot plant shows, for example, how a fieldbus system can be planned and set up. Just as would be expected in a typical application, field devices can be operated in an intrinsically safe and non-intrinsically safe area. On the field level, in addition to PROFIBUS-PA devices, PROFIBUS-DP devices can be connected.

The description of the system is intended to serve as the basis for components that are typically required, as well as boundary conditions that must be observed. With just a few modifications, the pilot system presented here can be adapted or expanded to different applications that are suitable for specific customers.

4.1 Description of the plant

A process-near component PNC (3) is used for process automation. The processing station functions as a Class 1 master and reads process values from the connected sensors and actuators cyclically. Actuators that are connected, such as positioners, also receive their software input through this cyclic communication. In addition to the actual measurement and set values, information related to the status of the device is also transmitted continuously. The PNC itself can be installed in an electrical cabinet or in the control room. The field devices are connected via a two-wire PROFIBUS-DP cable, and the transfer is based on RS 485 physical requirements.

A connection between the parameter station and the configuration station must be provided to set parameters of field devices in non-cyclical operation. Typically, this will be a Notebook or a PC (1) that contains a PCMCIA or plug-in card for PROFIBUS-DP/V1 directly. This makes it possible to monitor the individual field devices and set parameters for them in parallel to the ongoing cyclical operation of the PNC. SMART VISION that is used for this.

Different bus topographies are possible based on the PNC. In the example that is shown, the PROFIBUS-DP cable (5) is led into a switch box to the segment coupler (9) and is distributed from there.

The non-intrinsically safe area, devices that receive their power supply remotely and which are equipped with an RS 485/DP connection can be directly connected to the bus. These include, for example, actuators (7.3) or flow meters (7.2). Decentralized remote I/O systems such as the 5800 (7.1) or the S900 (7.4) are also usually connected directly to the DP bus directly in Ex Zone 1 via a DP/DP-Ex barrier (8) that collects binary and conventional analog process variables in the field and is able to transmit to the PNC by means of a DP control circuit. This also makes it possible to run a mixture of fieldbus devices and conventional analog (4-20 mA devices).

A DP/PA segment coupler is required for the transition of the physical features of the PROFIBUS-PA connection to PROFIBUS DP. The segment coupler creates a galvanic separation between the DP and the PA segment and serves simultaneously to feed power to the field transmitters connected to the two-wire line (14). Up to 31 field devices can be used per segment coupler for non-explosion protected applications. Theoretically, 10 field devices can be used in the Ex area (if the power consumption of the field devices is 10 mA), but in practical terms, about 6 to 8 field devices can be installed directly onto a corresponding segment coupler, depending on the requirement for current and voltage.

To increase the number of PA field devices that can be operated in the Ex area to 31, a system with multi-barriers (MB2x4-Ex) and explosion protection type EEx in [ia] a can be set up. The PA bus line is designed in explosion protection type EEx e and each of the 4 stub lines to the field devices are designed in explosion protection type EEx. Up to 16 multi-barriers can be set up per PA Bus segment, with a total length (=L0+ΣLd) of up to 1900 m (depending on the type of cable). The short-circuit proof PA outputs of the multi-barriers prevent a failure of the entire PA bus string in the case of field device errors.

The pilot system is equipped initially with measurement transmitters for temperature (14.1), pressure (14.2), and flow rate (14.3) actuators and positioners. All PA field devices are connected to the PA segment via T-pieces (13). Any field devices with a DP or PA connection can be used as long as the boundary conditions that apply for each segment are observed. Each PROFIBUS-PA segment must be provided with a termination resistor (2) on both ends.
4.2 Transfer rates

Different requirements and boundary conditions must be observed when planning and placing a PROFIBUS fieldbus system in service.

One significant requirement has to do with the uniqueness of the transfer rates in a PROFIBUS application. A PROFIBUS master is always able to transmit only at a fixed transfer speed. It is not possible to mix field devices with different transfer speeds. This means that the slowest component within a master/slave control circuit determines the transfer rate, and all other components must be set to this transfer rate.

The transfer rates of field devices whose power is supplied by the bus (PROFIBUS-PA) with transfer technology based on IEC 1158-2 is fixed at 31.25 kBit/s. A segment coupler is therefore required to connect to the PNC with PROFIBUS/DP/V1.

Only one rigid conversion of the transfer rates is permitted when using "passive" segment couplers. The transmission rate is assigned in this case on the DP/V1 side at 45.45 or at 93.75 kBit/s. This determines the transmission rate for the remainder of the bus at 45.45 or at 93.75 kBit/s. For "active" segment couplers, the PROFIBUS-DP/V1 transmission rate can be adjusted up to 12 Mbit/s. This is referred to as a DP/PA link.

The time for a complete cycle of data exchange depends essentially on the baud rate, the number of subscribers and the size of the measurement and status values to be transmitted cyclically. Delay times, which arise mainly through the segment coupler and the devices, must be taken into consideration as well. For a total of 8 or 31 field devices and at a transmission rate of 31.25 kBit/s on the PA-side and 93.75 kBit/s on the DP side, it is possible to reckon with the following system response times:

<table>
<thead>
<tr>
<th>System response times</th>
<th>System response times</th>
</tr>
</thead>
<tbody>
<tr>
<td>with 8 PA field devices</td>
<td>with 31 PA field devices</td>
</tr>
<tr>
<td>5 bytes</td>
<td>118 ms</td>
</tr>
<tr>
<td>10 bytes</td>
<td>122 ms</td>
</tr>
<tr>
<td>50 bytes</td>
<td>160 ms</td>
</tr>
</tbody>
</table>

Table 421  Minimal system response time with 8/31 subscribers, 31.25 kBytes (PA) and 93.75 kBit/s (DP).

ABB offers an Excel tool to calculate the cycle times precisely.

4.3 Planning criteria and design

In addition to the transmission rate, the permissible cable length also plays a significant role in planning Profibus systems. The entire length of the cable or the extent of the network within a PA segment is limited on the basis of the transmission and attenuation properties of the cable. Stub lines (Ls) are included in this figuring. Table 432 shows an overview of "Type A" cables as determined by IEC 1158-2 and their maximum extent in the network (Ld + ΣLs) per segment.

<table>
<thead>
<tr>
<th>Structure of cable</th>
<th>Cross-section of wire</th>
<th>Loop resistance (DC)</th>
<th>Extent of network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twisted, shielded wire pair</td>
<td>0.8 mm² (AWG 18)</td>
<td>44 Ω/km</td>
<td>≤1900 m</td>
</tr>
<tr>
<td>Twisted, shielded wire pair</td>
<td>1.5 mm²</td>
<td>25 Ω/km</td>
<td>≤1900 m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of stub lines</th>
<th>Max. length, intrinsically safe</th>
<th>Max length, not intrinsically safe</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 - 31</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>19 - 24</td>
<td>30 m</td>
<td>30 m</td>
</tr>
<tr>
<td>15 - 18</td>
<td>30 m</td>
<td>60 m</td>
</tr>
<tr>
<td>13 - 14</td>
<td>30 m</td>
<td>90 m</td>
</tr>
<tr>
<td>1 - 12</td>
<td>30 m</td>
<td>120 m</td>
</tr>
</tbody>
</table>

Table 432  Permissible lengths of stub lines

For intrinsically safe installations, a length shorter than 30 m must also be observed for the individual stub lines. The total of all stub lines and the line from the DP/PA segment coupler to the last T-piece (multi-barrier) must not exceed the limits from Table 431.

Both the DP and PA segments must be provided with the required termination networks in order to prevent line reflections. The termination resistors are already integrated into the segment couplers, multi-barriers and in various field devices, and can be switched into the circuit as needed.
The number of subscribers per fieldbus segment is limited to a maximum of 31, also to prevent reflections and weakening of the signal.

If power is supplied to field devices via the PA bus, partial voltage drops on the bus lines must also be taken into consideration. These depend on the type of cable, the length of the line and the power consumption. For non-intrinsically safe applications, a typical 24 V DC power supply is used, and there are only very minimal limitations on the total length of the line. For intrinsically safe applications, the voltage of the power supply is limited to 13.6 V DC. The resulting permissible line lengths must be observed so that the necessary minimum operating voltage to the devices is not exceeded (Table 251). The optimum design of a fieldbus segment requires detailed calculation of the partial voltage drops.

We refer you here to the literature published by the Profibus User Organization (PNO/PTO) for detailed planning and design of Profibus systems (PROFIBUS-PA Introduction to Commissioning: Part No. 2.091)

ABB offers a planning tool based on Excel for creating a PROFIBUS layout. It is used to estimate the bus cycle time and contains information on PROFIBUS devices and network components.

4.4 Troubleshooting

Are multiple devices with the default address 126, or with the same address connected to the bus?

- Make certain that there are no instances of multiple devices on the bus at the same time with the same address. In case of doubt, attach one device after the other to the bus and assign the address you desire to this device, with a software tool, for example. It is best to note the address on the device. If you proceed according to this method in assigning the address, make certain you can assign the physical device (installation location) to the address.

Have you made note of the polarity for PROFIBUS-DP?

- In contrast to PROFIBUS-A, you must ensure the correct polarity for PROFIBUS-DP. When using a 9-pin D-SUB connector, the connector assignment is Pin No. 3 RxD/TxD-P (Receive/Transmit data-Plus) and Pin No. 8 RxD/TxD-N (Receive/Transmit data-N).

The question comes up, simply try switching polarity.

Are the bus connections present and active?

- Make certain that the bus segments are present on both sides in each segment. (See also Section 2.5 Bus topographies and installation notes).

Do you have the appropriate GSD for your device?

- Please use the GSD that was delivered with your device. This will ensure optimal support for your device in all functions.

Why doesn’t the positioner respond when I write the target value?

- According to the PROFIBUS-PA profile, the PA target value consists of the value (40 byte float) and the status (1 byte unsig8). The SP value must be a value between 0% and 100%. SP status “good”, as OK, is the same as the value 128 decimal. This means the value and status must be transferred integrated together. You must also make certain that the automation system is not using a standardized value between 0 and 1, since this would then correspond to 1% in the maximum case.
5 Asset Optimization

Procedure technology and supply technology companies are constantly striving to optimize the life cycle costs of their operating investments. They search for ways to reduce the maintenance expense of technical outfitting, to increase the service life of important instruments with significant costs and to increase the usage derived from already existing systems, thereby raising the availability and productivity of the entire operation. There is always great urgency for managers of an operation to examine operational systems and to make continuous inquiries into key aspects such as the following:

- Efficiency
- Operating costs and trends associated with them
- Current operating conditions and their effects on service life
- Possibilities for simplifying the maintenance plan without safety and efficiency suffering as a result

ABB is conscious of this challenge and is aware that customers expect a comprehensive solution from their automation suppliers. As part of the Industrial IT Program, ABB offers Asset Optimization, a connection between the best knowledge databases in the industry and the most extensive spectrum of available items, combined with suggestions for increasing productivity and return on assets.

Asset optimization is one way in which companies can move forward together with ABB and work towards future opportunities, thus maximizing production while minimizing costs. ABB's experience in designing and manufacturing technical equipment – along with its leading position in process automation – is your guarantee for its capability of optimizing, analyzing and monitoring the output capacity of all operating systems.

Fig. 501 Asset Optimization with ABB
ABB has developed an innovative automation solution that uses cutting-edge technologies, including integrated fieldbus solutions, to create communication possibilities and products that facilitate access to all of the data in systems. ABB also offers a series of applications that facilitate the decision making process for optimizing systems through their entire life cycle. These additional applications allow for the optimization of operating systems, beginning with the operating design, through maintenance and until the end of service life.

What is the strength of this architecture? First, it supports the requirements of the customer for monitoring and optimization of systems in real time. The paradigm of today’s business world, namely the “Internet Era” is slowly penetrating through to operators. If managers are not conscious of increasing production costs and correspondingly rising revenues they will be at a disadvantage in wide-open future markets that will be characterized by stiff competition.

Secondly, this solution quickly and easily detects differences in performance between two or more similar systems (for example heat exchangers with comparable capacity) or groups of systems (for example production systems with similar structure). This “early warning system” avoids production downtime and makes it possible for operators to work closer to the limit, which it turns makes it possible to maximize the overall effectiveness of the equipment (OEE, Overall Equipment Effectiveness) and profit.

Third, this architecture delivers the necessary infrastructure for monitoring and recording the physical and financial performance capacity of systems as measured by their total service time. The collected information and knowledge forms the basis for supporting the decision making process of management in the question of when it is justified to take a system out of operation, since the decision is based on reliable performance data. Thanks to this information, managers now have the opportunity of striking out on new paths with ABB and setting new performance and profitability goals for the future.

Wide range of products

ABB has developed intelligent instruments with individual features in the area of field devices that make it possible to track the performance of the instrument and to perform preventive maintenance, since decreasing output capability can be detected early on.

In the area of automation systems, ABB has created a unique modern object-oriented infrastructure for the company’s automation platform that can be used to improve the industrial IT program.

This provides offers information for instruments on control, location and functions as objects and linked aspects (i.e. attributes). This infrastructure supports audit trails, object displays, maintenance overview, data query and consistency testing, access authorization and intelligent documentation.

In the area of communication systems, ABB supports the customer’s freedom to select the instruments and linked communication protocols that best fit the application. Thus customers can select the solution that corresponds to their own needs. Digital fieldbus is a high-performance technology thanks to which operators can make use of the benefits of asset organization. ABB supports the Fieldbus Standards (Profibus, Foundation Fieldbus, LON) and offers the customer products compatible with them (instruments, systems and engineering tools). The fieldbus architecture is only one possibility for implementing the many advantages of asset optimization; much can be achieved simply with conventional 4-20 mA or HART communication.

Information management is essential for understanding and achieving the highest level of performance capacity in a system and for developing procedures that contribute to optimizing the system throughout its entire life cycle. ABB has a series of applications in the program that provide different levels of support to asset optimization throughout the entire life cycle.

ABB already presented to its customers some time ago industry-specific application and The next way of thinking. Asset optimization and other structural elements of the industrial IT paradigm have led to a unique solution for automation questions. ABB is the leading supplier of automation systems and offers operations managers the experience, the resources, a wide range of available items and a global organization that are necessary to address the challenges of the next millennium.
6 Prospects

With further development in the direction of intrinsic safety and power supply via bus, fieldbus technology has now made considerable advances in significance in the area of process technology. User requirements have been largely satisfied. Fieldbus technology can thus already be used today in technical procedure systems. In spite of this, a warning against all-too-euphoric marketing pronouncements in the technical periodicals is appropriate in this context. Nothing but the shared experiences of suppliers and users will help to fully exploit the innovative potential of this technology in the midst of a revolution.

The other side of the coin from the savings on input/output cards in the PNC is the added expenses for bus control circuits, segment couplers and high-quality field devices (Fig. 611). The reduction in the cost of components that goes hand-in-hand with the proliferation of fieldbus technology will bring with it the desired savings in hardware.

The next steps in development and standardization of PROFI-BUS technology will need to provide a response to the requirement for time stamping and redundancy. Sufficiently high transfer rates on the DP/V1 side and thus reasonable cycle times in a PROFIBUS system will be achievable with the active system couplers that have already been announced, which will be equipped with temporary storage.

While it was previously believed that savings had to be achieved by reducing copper lines and hardware, overall costs are the center of attention today. The higher level of transparency achieved through fieldbus technology, the greater content of information in signals and the thorough configuration and parameterization on the field device level present new challenges: guidance system and device manufacturers must work together with systems operators in implementing new structures to fill in the gaps that still remain in the fieldbus application of today. Only then will it be possible for a homogeneous fieldbus structure with interoperability or even interchangeability to arise on the device side.

With the FDT interface (Field Device Tool) and DTM (Device Type Manager) as device drivers, a great stride has been made for thorough engineering and the operation of entire systems from the control room through to field devices. The complete graphically supported use of multimedia support for all field devices from the central engineering tool of the automation system or even access to maintenance information of individual field devices from the control room is thus possible. Asset Optimization, with the goal of reducing life cycle costs of the entire system is thus ensured as far as the field device.

7 Summary/Conclusion

The hard cost savings from fieldbus technology are estimated at about 24% for large installations (about 3000 I/O points). The first implementations are claiming even higher savings so the technology looks set to take off.

Rivalry between different fieldbus standards remains dynamic, but stable and certified products are emerging. For intelligent devices in the process control area choice has settled between PROFIBUS-DP/PA and Foundation Fieldbus. Of these, PROFIBUS-DP has a credible installed base while PROFIBUS-PA and Foundation Fieldbus are starting, and vying for installations. Foundation Fieldbus has High Speed Ethernet, which will become the choice for high-speed (10-100 Mbit/s) plant and control networks.

Sensor busses will continue to survive for low level applications such as bulk I/O because of their simplicity and low cost. They will be linked to PROFIBUS and Foundation Fieldbus through gateways.

LON will find applications in electrical equipment such as switchgear and motor control centres. Therefore, a multi-fieldbus strategy will provide customers with the best choice of product.

Abbreviations used

FF FOUNDATION™ fieldbus
(designation of the fieldbus, or Foundation Fieldbus Organization)

DD Device Description

DDL Device Description Language

FIP Factory Instrumentation Protocol

FISCO PROFIBUS ‘Fieldbus Intrinsically Safe Concept’. (Note that the I.S. guidelines for PROFIBUS & FOUNDATION are different.)

GSD-File Gerätetestammdaten – Device Communication Database File for PROFIBUS devices

HART Highway Addressable Remote Transducer

IEC International Electrotechnical Commission

ISO International Standards Organisation

ISP Interoperable Systems Project

LON Local Operating Network

OSI Open System Interconnection

PNO/PTO PROFIBUS Nutzerorganisation e.V.

PROFIBUS-DP PROFIBUS Decentralized Peripherals

PROFIBUS-PA PROFIBUS Process Automation