

PCL

Introduction to the Software-PLC System Description



Edition

101



BOSCH
Automation

PCL

Introduction to the Software-PLC System Description

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1 Safety Instructions

Before you start working with the PCL, we recommend that you thoroughly familiarize yourself with the contents of this manual. Keep this manual in a place where it is always accessible to all users.

1.1 Intended Use


This instruction manual presents a comprehensive set of instructions and information required for the standard operation of the described products. It is an introduction to the technology of the PCL Software-PLC.

The products described hereunder

- were developed, manufactured, tested and documented in accordance with the relevant safety standards. In standard operation, and provided that the specifications and safety instructions relating to the project phase, installation and correct operation of the product are followed, there should arise no risk of danger to personnel or property.
- are certified to be in full compliance with the requirements of the
 - EMC Directives (89/336/EEC 93/68/EEC, and 93/44/EEC)
 - Low-Voltage Directive (73/23/EEC)
 - Harmonized standards EN 50081-2 and EN 50082-2
- are designed for operation in an industrial environment (Class A emissions). The following restrictions apply:
 - No direct connection to the public low-voltage power supply is permitted.
 - Connection to the medium and/or high-voltage system must be provided via transformer.

The following applies for application within a personal residence, in business areas, on retail premises or in a small-industry setting:

- Installation in a control cabinet or housing with high shield attenuation.
- Cables that exit the screened area must be provided with filtering or screening measures.
- The user will be required to obtain a single operating license issued by the appropriate national authority or approval body. In Germany, this is the Federal Institute for Posts and Telecommunications, and/or its local branch offices.

 **This is a Class A device. In a residential area, this device may cause radio interference. In such case, the user may be required to introduce suitable countermeasures, and to bear the cost of the same.**

Proper transport, handling and storage, placement and installation of the product are indispensable prerequisites for its subsequent flawless service and safe operation.

1.2 Qualified Personnel

This instruction manual is designed for specially trained personnel. The relevant requirements are based on the job specifications as outlined by the ZVEI and VDMA professional associations in Germany. Please refer to the following German-Language publication:

Weiterbildung in der Automatisierungstechnik
Publishers: ZVEI and VDMA Maschinenbau Verlag
Postfach 71 08 64
60498 Frankfurt/Germany

This instruction manual is specifically designed for PLC technicians. Basic knowledge regarding programmable logic controllers is preferable but not required.

Interventions in the hardware and software of our products not described in this instruction manual may only be performed by our skilled personnel.

Unqualified interventions in the hardware or software or non-compliance with the warnings listed in this instruction manual or indicated on the product may result in serious personal injury or damage to property.

Installation and maintenance of the products described hereunder is the exclusive domain of trained electricians as per IEV 826-09-01 (modified) who are familiar with the contents of this manual.

Trained electricians are persons of whom the following is true:

- They are capable, due to their professional training, skills and expertise, and based upon their knowledge of and familiarity with applicable technical standards, of assessing the work to be carried out, and of recognizing possible dangers.
- They possess, subsequent to several years' experience in a comparable field of endeavor, a level of knowledge and skills that may be deemed commensurate with that attainable in the course of a formal professional education.

With regard to the foregoing, please note our comprehensive training program. The professional staff at our training center will be pleased to provide detailed information. You may contact the center by telephone at (+49) 6062 78-258.

1.3 Safety Markings on Components



DANGER! High voltage!



DANGER! Corrosive battery acid!



CAUTION! Electrostatically sensitive components!



Disconnect mains power before opening!



Lug for connecting PE conductor only!



Functional earthing or low-noise earth only!



Screened conductor only!

1.4 Safety instructions for the described product

**DANGER**

Fatal injury hazard through ineffective Emergency-OFF devices! Emergency-OFF safety devices must remain effective and accessible during all operating modes of the system. The release of functional locks imposed by Emergency-OFF devices must never be allowed to cause an uncontrolled system restart! Before restoring power to the system, test the Emergency-OFF sequence!

**DANGER**

Danger to persons and equipment!
Test every new program before operating the system!

**DANGER**

Retrofits or modifications may interfere with the safety of the products described hereunder!

The consequences may be severe personal injury or damage to equipment or the environment. Therefore, any system retrofitting or modification utilizing equipment components from other manufacturers will require express approval by Bosch.

**DANGEROUS ELECTRICAL VOLTAGE**

Unless described otherwise, maintenance procedures must always be carried out only while the system is isolated from the power supply. During this process, the system must be blocked to prevent an unauthorized or inadvertent restart.

If measuring or testing procedures must be carried out on the active system, these must be carried out by trained electricians.

**CAUTION**

Only Bosch-approved spare parts may be used!

**CAUTION****Danger to the module!****All ESD protection measures must be observed when using the modules and components! Prevent electrostatic discharges!**

Observe the following protective measures for electrostatically endangered modules (EEM)!

- The employees responsible for storage, transport and handling must be trained in ESD protection.
- EEMs must be stored and transported in the protective packaging specified.
- Out of principle, EEMs may be handled only at special ESD work stations equipped for this particular purpose.
- Employees, work surfaces and all devices and tools that could come into contact with EEMs must be on the same potential (e.g. earthed).
- An approved earthing wrist strap must be worn. It must be connected to the work surface via a cable with integrated 1 M Ω resistor.
- EEMs may under no circumstances come into contact with objects susceptible to accumulating an electrostatic charge. Most items made of plastic belong to this category.
- When installing EEMs in or removing them from an electronic device, the power supply of the device must be switched OFF.

1.5 Documentation, Versions and Trademarks

Documentation

The present manual provides the user with comprehensive information about operation and installation of the PCL Software-PLC in combination with PC, operating system, software and peripherals in general. In addition, it contains information about installation, initial configuration and operation of the PCL.

Overview of available manuals:

Manuals	Language	Order no.
Programmierung der SoftSPS PCL	German	1070 072 425
Catalogue, Installation Engineering	English	1070 072 190

Release

 **This manual is applicable to the following versions:**
Software: 1.7

Trademarks

All trademarks referring to software that is installed on Bosch products when shipped from the factory represent the property of their respective owners.

At the time of shipment from the factory, all installed software is protected by copyright. Software may therefore be duplicated only with the prior permission of the respective manufacturer or copyright owner.

Windows™ is a registered trademark of Microsoft Corp.

PROFIBUS® is a registered trademark of the PROFIBUS Nutzerorganisation e.V.

INTERBUS-S® is a registered trademark of Phoenix Contact.

DeviceNet® is a registered trademark of ODVA (Open DeviceNet Vendor Association, Inc.).

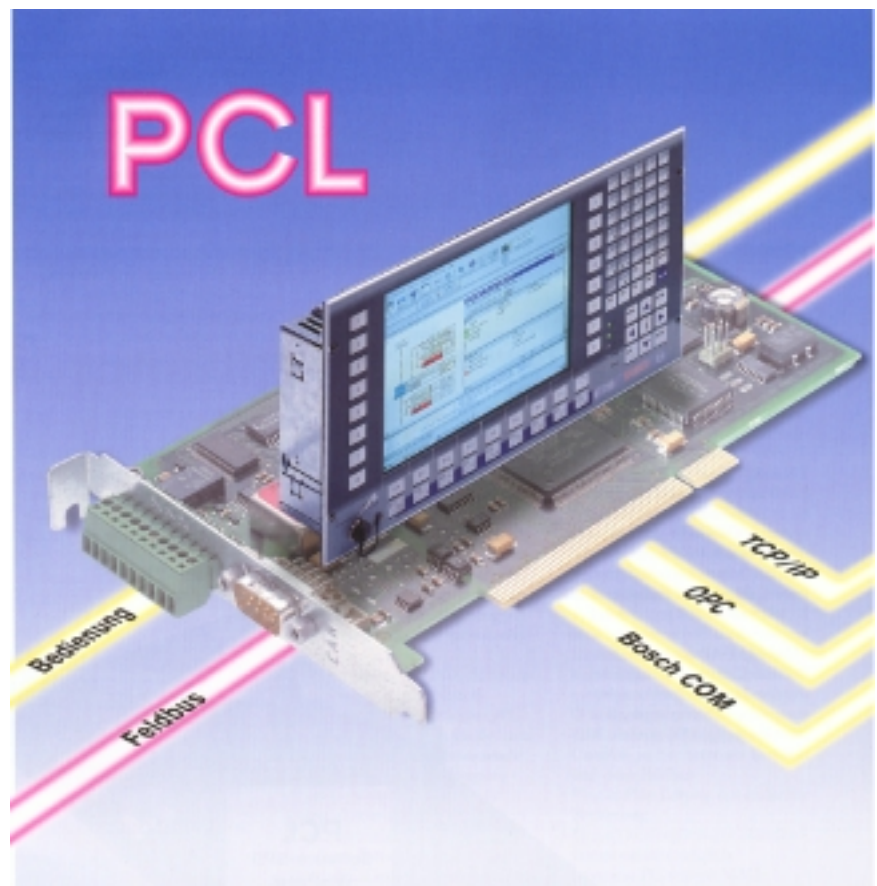
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2 Preface

In the last decades, programmable logic controllers have become one of the most important devices in automation technology. Today, the traditional PLCs are confronted with a PC-based control technology in many areas. Bosch meets the requirements of this new trend with its PCL Software-PLC.

The chapters 3 to 8 of this manual give a general description of how Bosch's PCL Software-PLC (also called SoftPLC) works in combination with PC, operating system, software and peripherals. The manual gives a general overview of the PCL's technical possibilities and demonstrates the PCL's areas of application in comparison to those of a traditional PLC.

The chapters 9 to 15 contain information about the single operational steps, starting with the PCL's installation and initial configuration and finally leading to its operation. In addition, the manual introduces extension possibilities and system solutions.



Further Information

This manual does not contain the kind of description required for a complete commissioning of the PCL or its components. Please refer to the current documentation that is included in the PCL in the form of data files or that can be obtained at Bosch Software Service; see chapter 16:

- Manual (available in German): Programmierung der SoftSPS PCL; order no.: 1070 072 425
- Catalogue: Installation Engineering; order no. 1070 072 190
- Description of installation: refer to the files "Readme.NT" or "Readme.95"
- Help menus of the WinSPS, WinDP and/or WinCAN software, and the WinPanel software.

More detailed information regarding the SoftPLC can be obtained at the following internet addresses:

- Current downloadable information and software by Bosch:
<http://www.bosch.de/AT>
- Information regarding COM, OPC, etc. by Microsoft:
<http://www.microsoft.com/japan/partners/industry/english/opctec.htm>
<http://www.microsoft.com/windowsdna/industry/vertical.asp>
- the OPC Foundation:
<http://www.opcfoundation.org>
- the user organizations of the fieldbusses:
<http://www.profibus.com>
<http://www.interbus.com>
<http://www.canopen.com>
<http://www.devicenet.org>

3 The PCL's Fields and Types of Application

3.1 Fields of Application

The open system design and the possibility of modular integration and extension are decisive factors, especially for the application fields of the PCL.

The PCL is mostly used in modern automation technology, especially for those applications whose processing is controlled, operated and monitored by one device only. Global data exchange of e.g. process visualization systems with the PCL can be realized by means of the PCL's standardized interfaces. For further information, please refer to chapter 13.

Applications where special runtimes must be observed are another field of the PCL. Optimal runtime performances can be reached by an adequate PC capacity and by scaling of the operating system.

3.2 Types of Application

Not only the field in which the PCL is intended to be used is an important factor, but also the type of application. The types of application of the PCL are divided into solutions that are based on one PC only and in systems with distributed components.

Single System

In single systems, the PCL and e.g. the process visualization are located on one single PC. Even the programming and configuration system can be installed on this PC. Please make sure though that the PC's capacity can fulfill the technical requirements of all components. The Windows NT operating system offers the possibility to operate several processors at the same time, which fulfills the requirement of increased computing power.

The advantages of the single system solution lie in the low costs for PC hardware and the saving of network hardware.

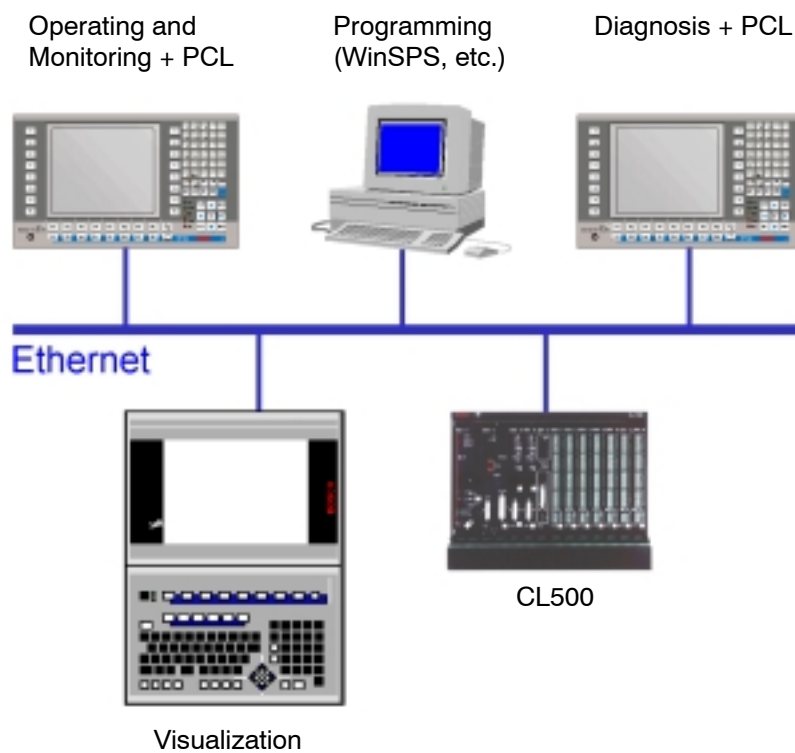
Distributed Components

Distributed automation solutions are preferable if several tasks are to be distributed on more than one platform. In such cases, interprocess communication functions over LAN networks (e.g. Ethernet).

With this solution, even traditional controllers like the CL500 can be linked via the network.

The advantage of distributed systems lies in the possibility to adapt the PC's hardware and its operating system to the individual requirements and thus, optimize both. System extensions can be realized quickly and easily by means of the already existing LAN network.

The following illustration is an example of a distributed system. Two industrial PCs with integrated operator terminals are used. Both are provided with the PCL. In addition, a traditional controller, a standard PC for programming, and a PC control panel for process visualization via Ethernet are linked to the distributed system.

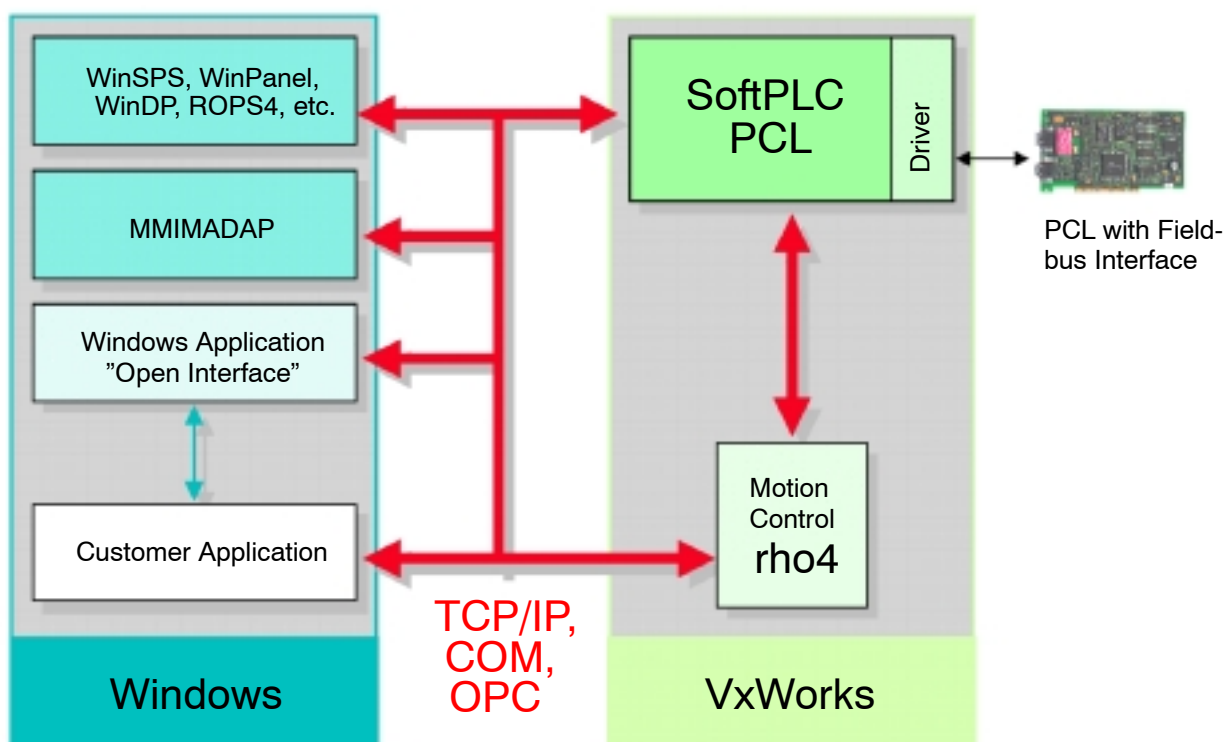


4 Structure and Functional Principle

In order to reach the high-level reliability of a traditional PLC and its typical response times, the PCL is based on a combination of the real time operating system VxWorks and Windows. The additional hardware contains components for supporting the real time operating system, safety functions, a permanent memory, and the interface for the connection to the fieldbus. In contrast to a pure software solution, the PCL guarantees short response times, real time processing as well as reliability, even in case of system failures.

The main task of the runtime system is the processing of the control program. The program is processed cyclically and is divided into three steps: "Loading the input data", "Processing of the data in the control program" and "Output of the output data". This process corresponds to the functionality of a traditional PLC; with the PCL though, the process is completely run by software.

Process interfacing is part of the runtime system as well and functions via an interface to the peripherals. The peripherals are connected via a fieldbus, e.g. PROFIBUS-DP, INTERBUS-S, CANopen or DeviceNet (in preparation).



Other components that make the data exchange with the PCL possible are connected via the standardized TCP/IP internet protocol. The communication with programming and configuration systems like WinSPS or WinDP e.g. is processed by this protocol. WinPanel contains operation and display functions regarding the PCL and is linked via TCP/IP to the runtime environment as well.

Additional standardized interfaces of the PCL like COM and OPC make manufacturer-independent process interfacing possible. For further information refer to chapter 13.

5 Performance Specifications

Capacity

The program is processed cyclically, time-, or error-interrupt controlled.

The command response time depends on the processor's clock pulse. For a 200 MHz Pentium PC, the clock pulse lies at

- approximately 55 ns for bit instructions
- approximately 30 ns for word/double-word instructions
- approximately 110 ns for data module access
- approximately 300 to 500 ns for floating point instructions.

Programs are generated and executed by means of modular technology, via organization, program, and data modules. The programming is done in Bosch programming languages, in the high-level language C, or according to EN 61131-3.

Up to 1024 program and 1024 data modules with a length of 512 byte each can be implemented with the PCL.

The size of the available RAM is, due to differing configuration levels, flexible; see below.

The same applies to the number of I/O points; see below.

The marker area comprises 8 kbyte.

Process interfacing is realized via the standardized fieldbusses PROFIBUS-DP, InterBus-S, CANopen or DeviceNet (in preparation).

The application of standardized interfaces like TCP/IP, COM and OPC is part of the PCL.

Configuration Levels

The PCL provides three configuration levels. They differ from each other with regard to the amount of available I/O points and the size of the available RAM for the control program.

Configuration Level	I/O area	RAM
PCL-S	16 byte each for I/O	16 kbyte
PCL-L	256 byte each for I/O	64 kbyte
PCL-X	8192 byte each for I/O	128 kbyte

Upon delivery, all PCLs are identical. The configuration level S, L or X is determined with the runtime license of the PCL. This way, the configuration level can be adapted to the individual performance requirements without an extension of the hardware.

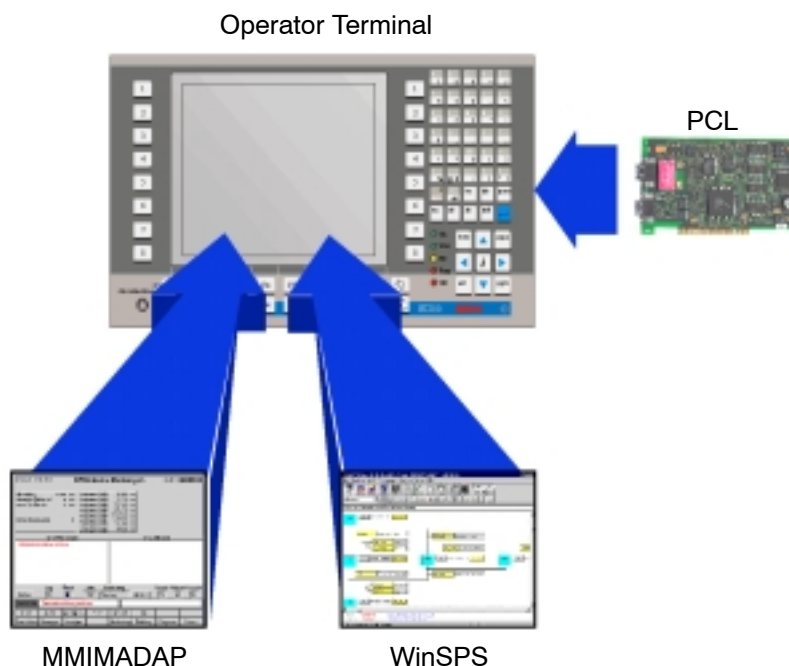
6 Prerequisites and Marginal Conditions

System Requirements

The PCL is installed in a free PCI bus slot of a standard personal computer (PC). The system requirements of the PC are as follows:

- Intel Pentium Processor
- Processor clock pulse: min. 200 MHz
- RAM: min. 32 MByte; in connection with MMIMADAP: at least 64 MByte
- Available harddisk capacity prior to installation of WinPanel: min. 15 MByte; MMIMADAP requires approx. 30 MBytes additionally.
- Operating system Windows NT starting with Version 4.0 Service pack 3 or Windows 95. We recommend the application of Windows NT. In order to guarantee Y2000-compatibility of the operating system, we recommend Windows NT Service pack 4 or 5.

Additional operating system components which are necessary for the operation of the PCL are provided when installing the PCL. During this process, the Windows installation disks or CDs are required. In addition, the TCP/IP network protocol must be set up manually for the communication between WinPanel and PCL. Detailed information regarding the installation can be found in the readme-files Readme.NT or Readme.95.



Industrial Suitability

The optimal functional safety of the PCL can be guaranteed in combination with the Bosch's PC operator terminals. The advantages of these industrial PCs in contrast to normal office PCs lie in their robust qualities in an industrial setting and in special monitoring functions. In addition, the operator control panels have been optimized for the combination with the MMIMADAP system.

Further information regarding the MMIMADAP is available in chapter 14.3. For information regarding the PC operator control panels, please refer to chapter 15.1.

7 PCL versus Traditional PLC

A comparison of the PCL with a normal traditional programmable logic controller reveals certain differences due to the different concepts of realization. This chapter deals with the advantages and disadvantages of the PCL.

Standard Components

The PC provides standardized open interfaces which are supported by the PCL. For process interfacing, for example, the PCL is based on the standardized TCP/IP transmission protocol. This makes simple networking via PC networks possible. Open communication with Windows applications is made possible by the PCL via Microsoft's COM (Component Object Model). In order to interface several diverse applications, the PCL supports the OPC data exchange method (OLE for Process Control) which is standardized under Windows. Thus, the PCL is, with regard to software and data connection, independent from special manufacturers and extendable.

For further information regarding data interfacing, please refer to chapter 13.

Programming

The programming of the application program as per EN 61131-3 and the configuration of the peripheral interfacing in the PCL are done the same way as in a traditional PLC. In order to do so, the WinSPS, WinDP and/or Win-CAN programming interfaces are available without any limitations.

Integrated Visualization

In contrast to the traditional PLC, the PCL provides, with its operating and file viewing program WinPanel, a visualization of the most important system and process statuses directly on the PC.

The WinPanel software is introduced in chapter 11.3.

Hardware

With regard to hardware, the PCL has improved essentially. Due to its robust hardware design and its industrial PCs that have become very reliable, the PCL can stand any comparison to a traditional PLC.

Reliability

The reliability of the PCL is particularly dependent on the stability of the Windows operating system. The missing stability of Windows can be compensated by connecting the standard Windows operating system to the real time operating system VxWorks.

Detailed information regarding the real time solution and the reliability of the PCL is available in chapter 8.

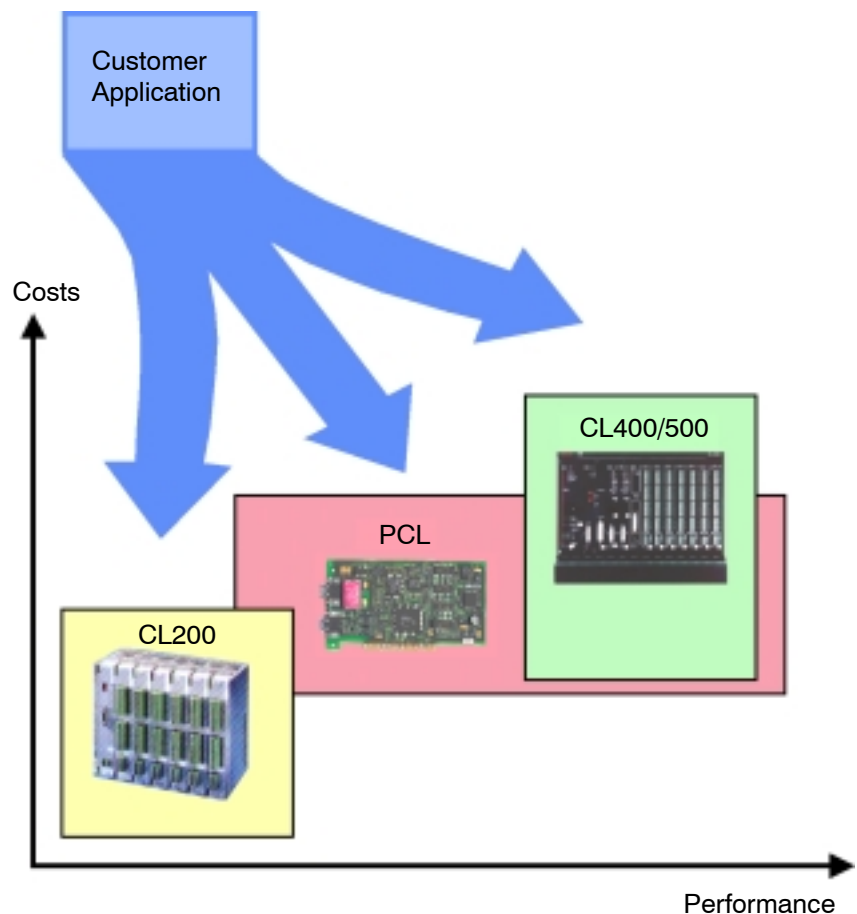
Security

For the accuracy and security of the runtime system, the PCL is equipped with a watchdog timer which monitors the control program's processing. In addition, the PCL controls the peripherals permanently and guarantees a restart after a system error or after a power supply failure.

In case of a restart, the current process values are loaded from the harddisk to the PCL. After a system error or after a crash of Windows though, it might happen that the data which has been stored last does not correspond to the current processing status. The PCL provides mechanisms to guarantee data security even under such circumstances. This way, the safety functions and the remanence (continuity) of the data that are essential characteristics of the traditional PLC are guaranteed for the PCL as well. More detailed information about the concept of restart and data security is available in connection with the Windows operating system in chapter 8.4.

Range of Performance

Due to the PCL's different configuration levels, its performance can be scaled flexibly. The possibility of adjusting the capacity according to the individual requirements guarantees an optimal price-performance ratio.



8 The PCL and Windows

8.1 Does Windows Comply with These Strict Requirements?

The characteristics that a SoftPLC requires from an operating system the most are multitasking and real time functions as well as the guaranteed restart after a crash or system error.

In case of multitasking operations, it is essential that running tasks of the PCL are safe from interventions of other tasks. In addition, the necessary computing time of a SoftPLC must be observed. Only the remaining computing time may be made available to other applications.

Real time means complying with the required short response times of the system. Thus, in a real time system, defined response times are guaranteed.

Windows fulfills all multitasking requirements, but not all real time requirements. In the PCL though, this deficiency is compensated by a special combination with the VxWorks real time operating system. How this works in combination with Windows is explained in chapter 8.3.

8.2 Windows NT, the Ideal Platform

Even though the PCL can be operated under Windows 95, there are several reasons for preferring Windows NT as a platform.

Reliability

Windows NT is an operating system that divides the different applications clearly from each other. Windows 3.1, Windows 95, and Windows 98 are not capable of doing so.

Interrupts and Priorities

Windows NT has a special administration function for interrupts (interruptions due to external events). The interrupts are organized in an hierarchic form. Interrupts with a very high priority are e.g. reserved for real time tasks. All other applications therefore receive lower priorities.

Unfortunately, this basically valuable solution cannot guarantee real time because it is Windows which controls the interrupts, which means that it can disable them any time. The specific hardware of the PCL is used to guarantee real time anyway. Further information is available in chapter 8.3.

8.3 Real Time Guaranteed!

As already mentioned, the Windows operating system cannot guarantee real time. Therefore, the PCL works under the real time operating system VxWorks.

Windows and VxWorks work "parallel". Both operating systems communicate via TCP/IP with each other. Every time when the system requires real time, VxWorks interrupts the operation of Windows. This interruption is triggered over the NMI (Non Maskable Interrupt). This makes secure response times of approximately 30 μ s possible.

The PCL and VxWorks function in combination with Windows deterministically. What does that mean? A system is deterministic if the repeatability of processes is guaranteed and a clear time statement exists. This is made clear by the following example: An access to the harddisk triggers a hardware interrupt under Windows. Because of such a harddisk access there is no processing time available for the PCL for about 100 ms. This alone could already endanger the compliance with the real time. With VxWorks though, it is guaranteed that the system works deterministically.

8.4 Security, Startup Characteristics and Remanence

The request for security regarding the system as a whole is fulfilled by monitoring the control program via watchdog timers, the continuous control of the peripherals and the capability of an automatic restart.

Restart

A failure of the power supply or a crash due to a system error can never be entirely prevented. This cannot be guaranteed even with a traditional PLC.

The concept of restart comprises the function to start the system without any intervention by the operator in order to continue processing the PCL with the last active process values. The startup characteristics of the PCL can be influenced with the OM2, OM5, and OM7 organization modules.

Concept of Data Backup

The PCL saves data and guarantees its remanence by means of a specific backup concept. The following is a list of data of the SoftPLC that is considered remanent:

- Markers
- Timers
- Counters
- Data field
- Data modules

When the system is started, the data of the current project is transferred from the harddisk of the PC to the memory of the PCL. When the system is shut down, the current data is transferred back from the PCL's memory to the harddisk. This process is managed by WinPanel.

Performance Characteristics in Case of Errors

In case of a system error or a crash of Windows it cannot be guaranteed that the data which has been saved last still corresponds to the current processing status. Even worse: In case of a crash, the harddisk can be damaged and data can be lost. For such events, the PCL is provided with additional functions in the static RAM. The organization of the static RAM can be determined in an application-oriented way by means of the organization modules OM2, OM8, and OM9. More detailed information is available in the German documentation: "Programmierung der Software-SPS PCL, Software-Handbuch", order no. 1070 072 425.

More Data Security

In order to counteract the consequences of a power failure, a UPS (uninterruptible power supply) can be implemented. The UPS signalizes a power failure to Windows, which triggers an automatic "shutdown" of the system without data loss.

Bosch offers powerful industrial PCs with operator terminals and integrated UPS. These PCs fall under the IP65 protection degree (front), are ideal for usage in an industrial environment, suitable for demanding operating and visualization tasks, and form therefore the optimal basis for the PCL. The industrial PCs are introduced in chapter 15.1.

In addition, a battery can be connected at the PCL plug-in board for extended backup of the static RAM. For further information, please refer to chapter 14.2.

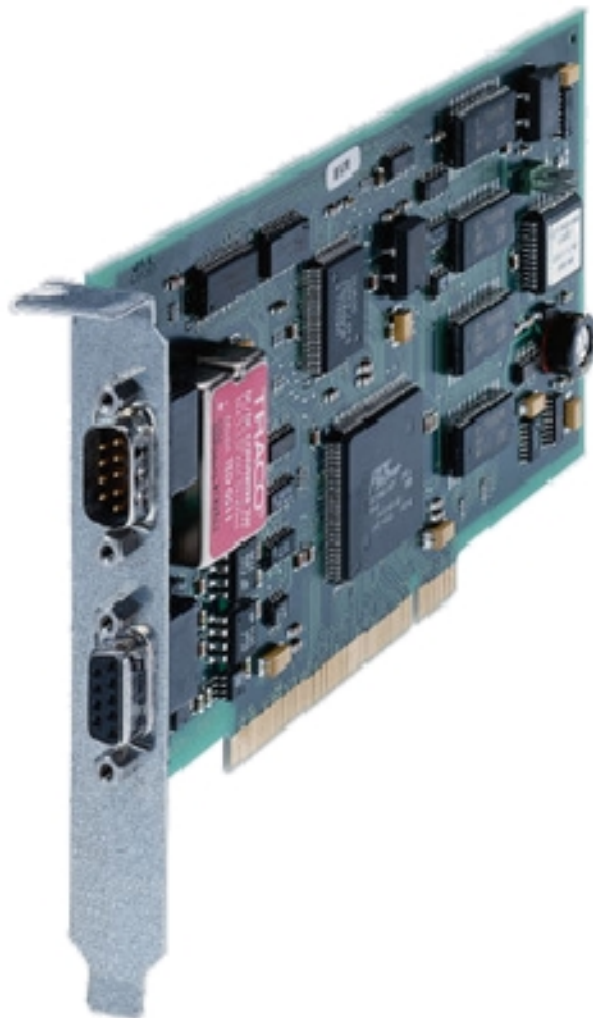
9 PCL and PC

9.1 Scope of Delivery and Equipment

The PCL will be delivered together with the following components:

- PCI bus plug-in board with integrated fieldbus connection
- Software for the operation of the PCL, including a driver for the PC plug-in board, the VxWorks operating system, and the program WinPanel.

The plug-in board is a Windows- and PC-compatible hardware which fits into a free slot of the PCI bus.



There are several fieldbus systems available for the integrated fieldbus connection. Please note the desired bus system on your order. The following bus systems are available:

- PROFIBUS-DP
- INTERBUS-S
- CANopen
- DeviceNet

Upon delivery, the configuration levels of each PCL are identical. The configuration level S, L or X is determined with the runtime license of the PCL.

9.2 Plug & Play

After the PCL's installation and start of the PC, the driver and the program WinPanel must be installed. Immediately after the installation, the PCL is ready for operation. A more detailed description of the installation process is available in the files Readme.NT or Readme.95 which are located on the installation disk.

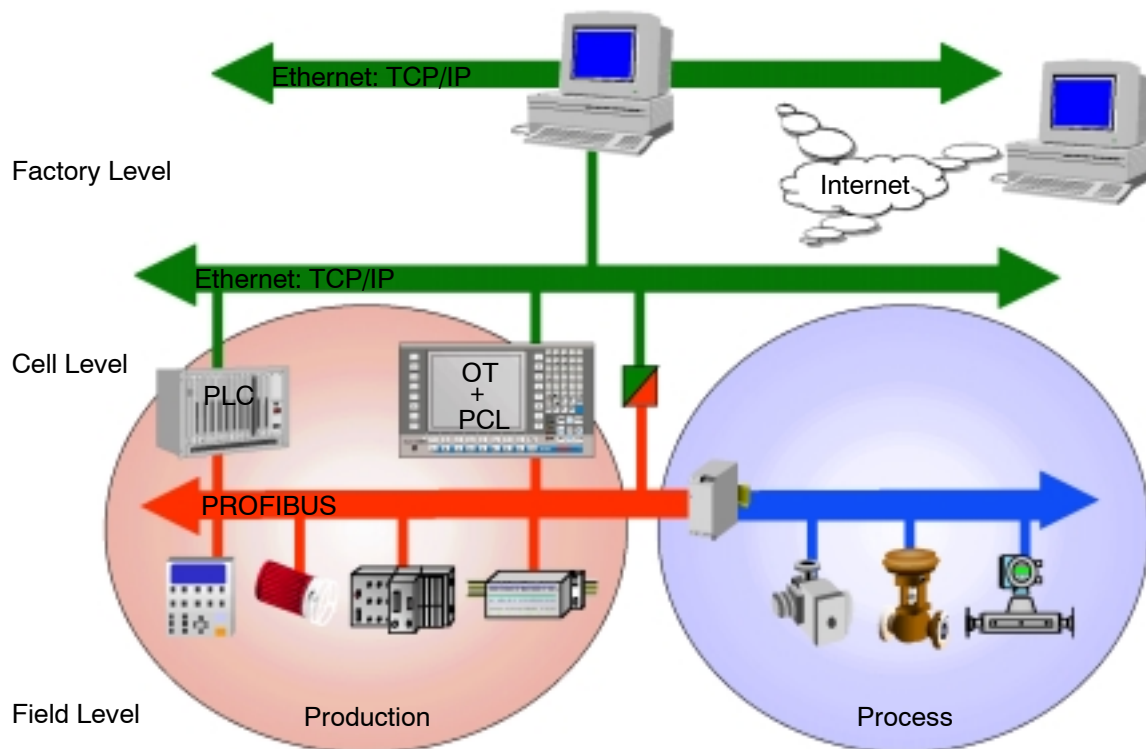
10 Connection of Peripherals

The peripherals are connected via standardized fieldbusses. This way, the in- and outputs are decentralized and complicated point-to-point wiring is not necessary. In addition, it makes manufacturer-independent connections of peripherals possible. You can choose between the following leading fieldbus standards:

- PROFIBUS-DP
- INTERBUS-S
- CANopen
- DeviceNet (in preparation)

The fieldbus connection takes over all communication tasks between the PCL and the peripherals, and is an integral part of the PCL plug-in board.

The following illustration shows the connection of the peripherals with PROFIBUS and a network with Ethernet and TCP/IP. In addition, an internet connection is indicated, which can be used e.g. for remote maintenance and diagnostic tasks.



10.1 Selection of a Suitable Bus System

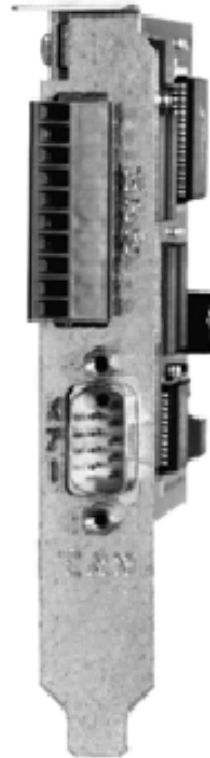
When selecting the most suitable bus system, several factors can be decisive. The following examples serve as potential criteria for the right decision.

- Fields of application; e.g. automated manufacturing technology, process automation, drive engineering, building services management systems
- Level of application; e.g. field, cell or factory level
- Technical or physical requirements; e.g. protection degree, EMC directives, usage in potentially explosive areas.
- Scope and type of application; e.g. amount of I/O data that is to be processed, analog value processing, data security
- Speed requirements, bus cycle times, response times
- Bus topology; e.g. line, tree, or ring topology
- Space requirements of the plant, maximum cable lengths
- Requirements regarding the transmission media; e.g. low-cost two-wire lines, fiber-optic cables, transmission security, easy installation
- Maximum number of bus stations
- Use of more than one master at one bus, multimaster
- Possibility of combination with other systems; e.g. transfer to Ethernet, gateways
- National and international distribution of the bus system
- Degree of standardization and certification of devices
- Availability of products of different manufacturers
- Availability of configuration tools on the market
- Easy and quick configuration or modification of the installed bus system
- Interchangeability of bus stations during active operation
- Possibilities of diagnosis
- Support
- Expenditures regarding training of project engineers and maintenance personnel

These aspects help to evaluate the different bus systems. A detailed comparison of the mentioned bus systems and an overview of the available Bosch products can be found in our catalogue "Installation Engineering", order no. 1070 072 190.

10.2 Linking of the Bus System

At the PCL plug-in board, the connection to the fieldbus is led to the outside. This way, the field devices can be directly connected to the PCL via the appropriate line. The bus system is ready for operation.



The bus system is linked to the runtime system of the PCL during the configuration process. The configuration contains the details regarding which I/O modules of a bus station are assigned to the I/O addresses of the control program. For the configuration, certain configuration tools like WinDP or WinCAN are used. Further information regarding configuration are available in chapter 11.2.

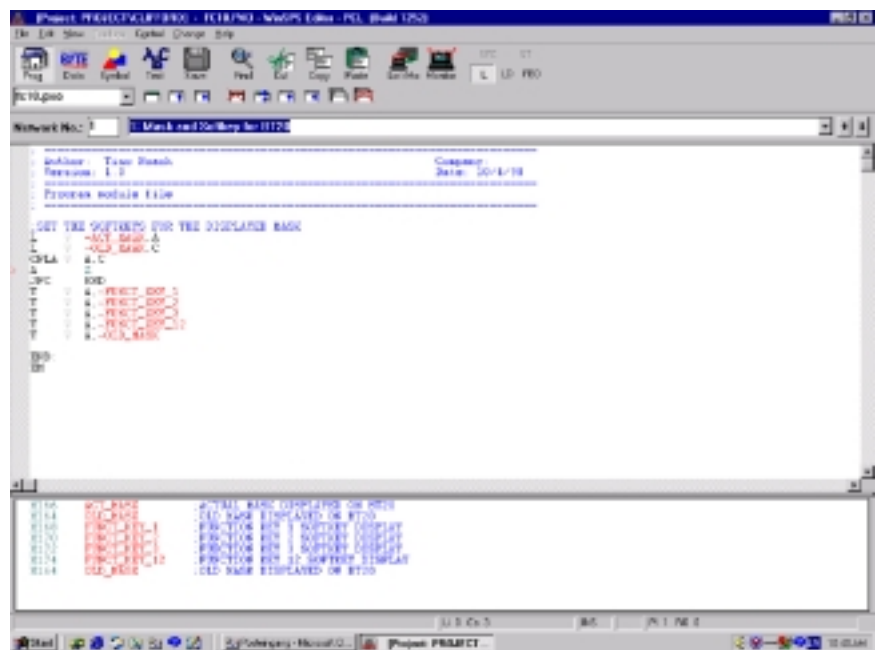
11 PCL Programming

Programming and commissioning of the PCL are divided into three steps:

- Generation of the control program with WinSPS
- Generation of the I/O configuration with e.g. WinDP or WinCAN
- Commissioning of the PCL by parameterization and starting with WinPanel

These steps can only be performed when the PCL and all drivers and WinPanel are installed.

11.1 Generation of the Control Program



WinSPS is provided with the future-oriented programming tool Windows "Look & Feel" for programming languages according to EN 61131-3. The program is generated by means of

- the instructions list
- the sequential function chart
- the function diagram
- the ladder diagram
- structured text

For special tasks like e.g. in processing data execution, the PCL can also be programmed in the high-level language C.

Program generation in the PCL is identical with program generation in the traditional PLC except for the following additional possibilities:

- In the presetting phase you can choose if communication with the PCL should be processed internally or externally.

Internal communication should be chosen if the PCL, WinPanel and WinSPS (and maybe WinDP or WinCAN) are installed on the same PC. A connection via cable to the PCL is not necessary.

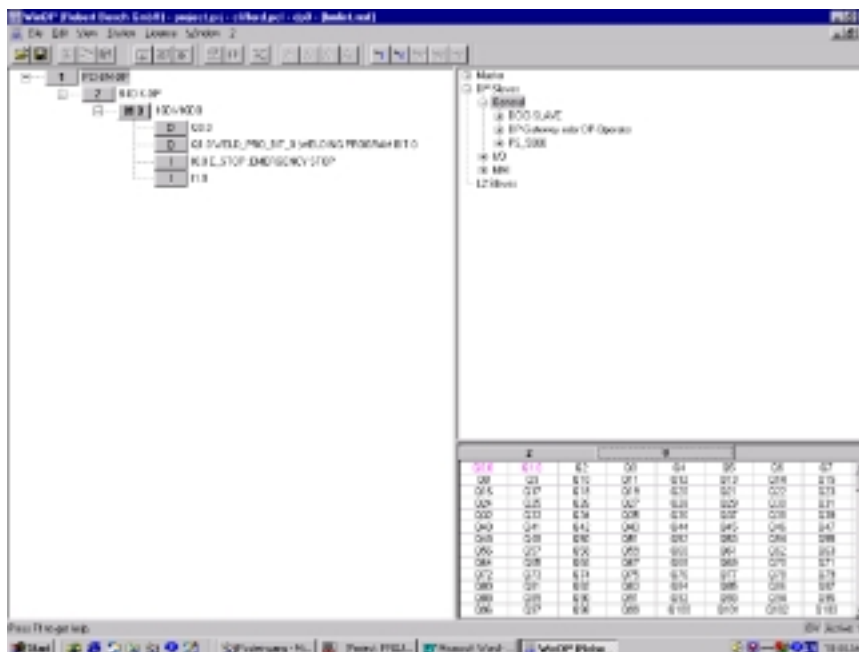
External communication should be chosen if you want to install WinSPS, etc. on another PC. With this setting, you can process e.g. a remote diagnosis over the internet.

- There is the possibility to assign specific remanence characteristics to single data modules. Data modules that are designated this way are stored in the static RAM. This guarantees remanence even in case of a crash of Windows or defects on the harddisk.

A special chapter in the help menu of WinSPS contains more detailed information about such possibilities and PCL programming.

Prior to downloading the control program into the PCL, WinPanel must be started, followed by the configuration of the fieldbus system.

11.2 Generation of the I/O Configuration

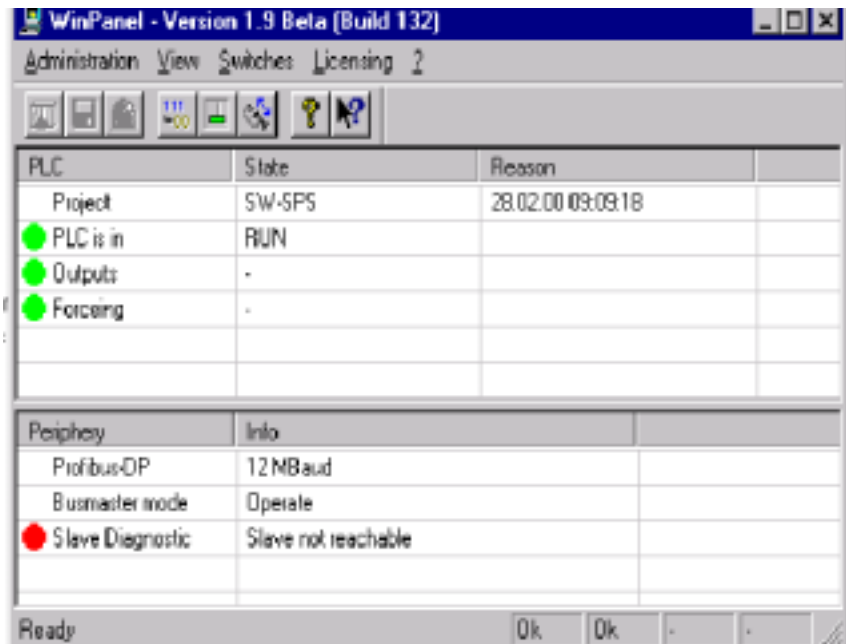


In chapter 10, the different fieldbus systems are listed. All bus systems have in common that the configuration is created in form of a list of all connected I/O devices and an assignment of the single I/O signals.

First, it is necessary to determine the topology of the I/O points. Configuration tools like WinDP or WinCAN support this by using tree structures for the editing, similar to Windows Explorer. After that, the I/O positions of a bus node are assigned to the I/O addresses of the control program. The structure and the I/O assignment in the configuration list must correspond to the actually connected devices.

The configuration is also transferred to the PCL with "Download". Now the PCL is ready to start.

11.3 Commissioning



The program WinPanel takes over a number of tasks in order to provide a smooth operation of the PCL:

- Visualization of the controller's and the bus system's status
- Operation unit for the controller, e.g. Run/Stop switching, delete fixation, disable outputs, intentional shutdown
- Communication between the Windows and the VxWorks operating systems via TCP/IP
- Parameterization possibility for a perfect cooperation between the two operating systems.

Start and Stop of the PCL

Prior to starting the PCL with the Run/Stop switch, check the status and peripheral display in WinPanel. Make sure that errors like e.g. "PLC program not found" do not appear.

With the Run/Stop switch, the PCL can be started and stopped any time. Closing WinPanel or shutting down the PC stops the PCL as well.

When installing WinPanel, the program call can also be copied into the 'Autostart' directory of Windows. This way, the PCL is automatically started when the PC is run up.

Time Characteristics

Depending on the type of application, the program processing time can vary. The requirements regarding the time characteristics of a system that is used for process automation are different e.g. from those of a system used for automated manufacturing. The following values have an influence on the processing time:

- Processor clock pulse
- System clock pulse, can be set in WinPanel
- Windows computing time, can also be set in WinPanel
- Time needed for transmission of the I/O data from/to the bus system

The time values that can be changed in WinPanel are set by default in a way that most applications can run perfectly. Only in a few cases, it might be necessary to change the default settings. Detailed information regarding the processing times are available in the German documentation "Programmierung der Software-SPS PCL, Software Handbuch", order no. 1070 072 425.

Search for Errors and Diagnosis

The display of WinPanel represents, in two windows, the statuses of the PCL and the peripherals. This way, errors can be quickly and comprehensively detected and localized.

In addition, the monitoring function in WinSPS and the comprehensive diagnostic possibilities in e.g. WinDP can be used in a supplementary way during commissioning and when searching for errors. These functions can also be applied over the internet.

Notes:

12 Networking

In particular, the PCL offers the possibility to create distributed control systems which can exchange data among each other. Due to the open and standardized communication concept, it is even possible to integrate components of other manufacturers.

The following demanding functions can be networked. They can also be combined with each other in varying modes:

- Communication between Bosch software components
- Communication with standard and customer applications
- Distributed control systems
- Remote maintenance and diagnosis via LAN or WAN networks

PC Networking via TCP/IP

With the PCL, the globally used TCP/IP internet transmission technology is used. The internal communication between the PCL and other components like e.g. rho4 or MMIMADAP as well as the linking of external components via a LAN network are processed over TCP/IP.

Further information regarding rho4 and MMIMADAP is available in chapter 15.

Distributed Systems

Distributed systems are characterized by the operation of more than one controller that exchange data among each other over the network. It is e.g. possible that the PCL is installed on one PC, process visualization on another. Additional controllers like the CL200, CL400 or CL500 can be linked via the COM-E interface board.

Remote Maintenance and Diagnosis

The PCL has advantages especially with regard to remote maintenance and diagnosis. The PCL can be accessed over the internet or intranet using the IP address. The address is entered in e.g. WinSPS or WinDP and status data, diagnostic information, configuration data, Run/Stop instructions, etc. can immediately be transferred. Of course, the access can be secured with a password.

13 Open Communication

Bosch offers open and under Windows standardized interfaces for data exchange between the PCL and any other application. It is not important if the data exchange is processed on one single PC or in a network system.

13.1 COM, Component Object Model

For the data exchange with other components, Microsoft developed the COM standard, Component Object Model. The Bosch-COM-server works according to this standard. It provides the possibility to establish a connection between Microsoft Excel, Access or even an HTML page and the control system. Bosch-COM makes all interfaces available in order to access the PCL or other Bosch controllers from Microsoft's BASIC, VBA, VBScript, Jscript but also from Borlands C++ and Delphi.

The Bosch-COM-server makes reading and writing of operands in data modules, data field and marker area and queries regarding the controller status and the peripherals possible.

13.2 OPC, OLE for Process Control

A number of companies in the automation industry develop in cooperation with Microsoft a concept on a COM basis, which make a uniform data exchange of automation components of different functions and objectives possible; like e.g. between controllers, visualization systems, host computers and peripherals. OPC puts its emphasis on process data access.

Bosch supports this concept with its OPC server. The PCL is provided with an OPC server which makes the process data available to any application or its clients.

The complete system for controlling, operating, diagnosis and visualization (MMIMADAP) is provided with an OPC-client interface. More information regarding MMIMADAP is available in chapter 14.3.

14 Operation and Visualization

14.1 Integrated Operation and Display

In combination with WinPanel, already the basic version of the PCL is provided with a powerful operating and display system.

The display of the operating statuses in plain text and the comprehensive diagnosis of the connected peripherals make a quick overview of the plant's condition possible.

The operating elements of WinPanel enable the PCL to do the following:

- Intentional startup or shutdown of the controller
- Switching of the Run and Stop operating states
- Disabling of all outputs
- Fixation of inputs, outputs and markers.

14.2 External Operation

The PCL can be externally operated via a 10-pin push-on terminal strip, even without keyboard and monitor.

The external operation makes Run/Stop switching and disabling of outputs possible. In addition, an external battery for backing up the static RAM, external display elements for the Run/Stop control statuses, and a ground conductor for inputs can be connected.

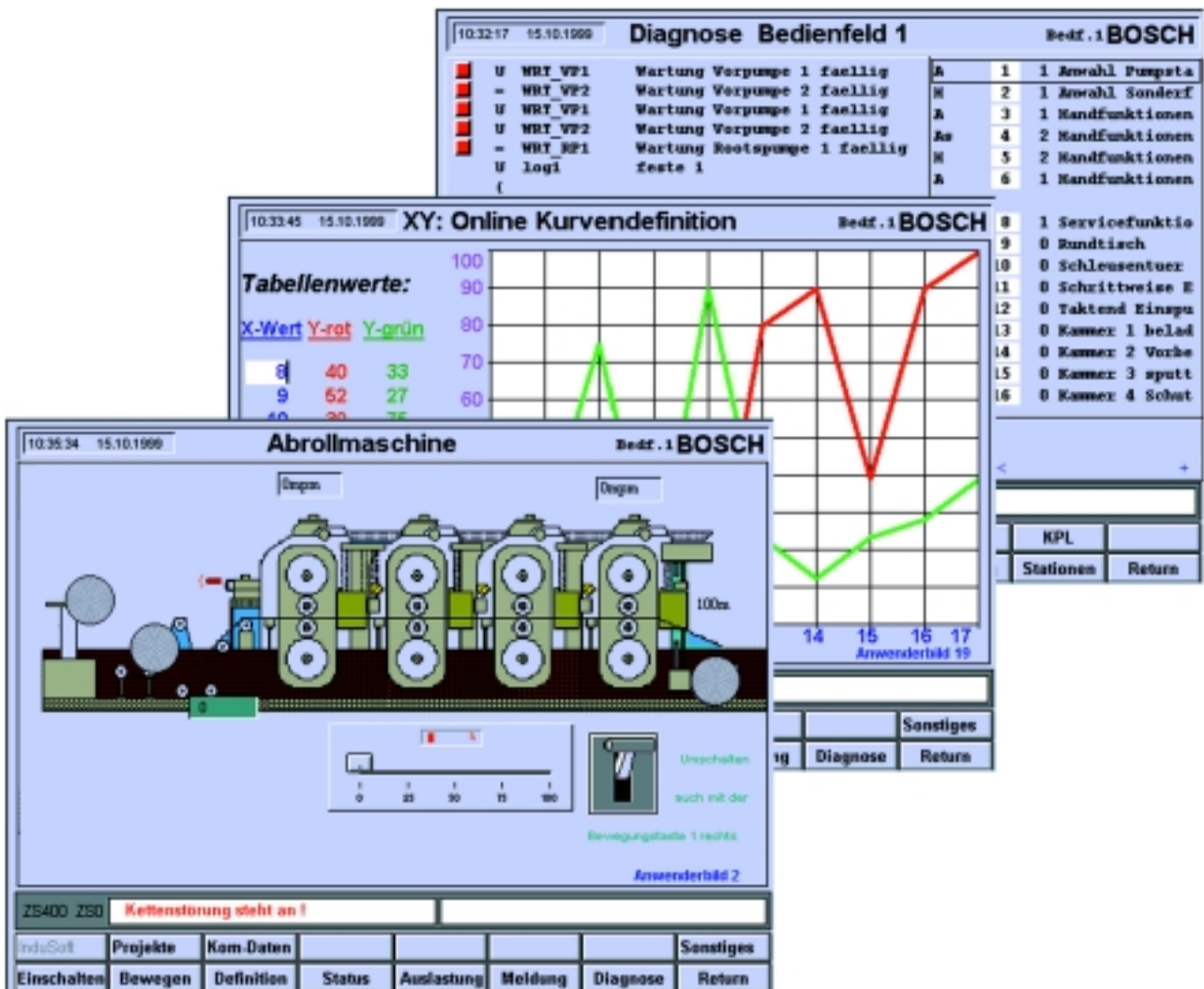
14.3 Visualization with MMIMADAP

The MMIMADAP software is a system for controlling, operating, diagnosis, and visualization. The basic functions of the MMIMADAP are the following:

- Total manual operation of all machine movements
- Automatic machine diagnosis
- Error listing
- Statistical functions
- Report system
- Signaling system
- Evaluation of machine utilization
- Visualization and setpoint inputs
- PLC diagnosis

The interfacing of the MMIMADAP with the PCL works via TCP/IP. With MMIMADAP the data exchange via OPC can be realized.

The MMIMADAP complete system is offered together with an operator terminal and the integrated PCL. For more information, please refer to chapter 15.2.



15 Complete Systems

With the PCL's open communication concept, it is possible to establish integrated complete systems. An example for such a system is the linking of a process visualization system or the linking of open-loop or closed-loop control systems with special tasks that a traditional PLC cannot fulfill.

15.1 Operator Terminals

The Bosch operator terminals consist of a powerful industrial PC and a flat screen display complete with a basic operator station. The PC is installed in a compact housing. The operator terminals feature a very high fault tolerance which is due to a spring-mounted harddisk, an uninterruptible power supply (UPS) and easy maintenance and interchangeability of the installed components.



The PCL can be integrated in the operator terminal via the extension slots of the PC. This combination is the perfect basis for the PCL's operation.

The operator terminals can also be used separately, and connected to the peripheral bus via the PROFIBUS-DP slave interface.

They can also be coupled via the integrated Ethernet interface with TCP/IP. This enables e.g. the data exchange via Bosch-COM or OPC. This way of communication is especially designed for connections with the MMIMADAP system.

15.2 The Complete System MMIMADAP

The MMIMADAP system consists of an operator terminal, PCL and the MMIMADAP software. With this combination, Bosch offers a robust, versatile, and easily extendable complete system.

Information regarding the MMIMADAP software are available in chapter 14.3.

15.3 Motion Control rho4.1

The motion control rho4.1 supports 24 axes and 16 kinematics. The basic version of the rho4.1 is already provided with a PCL. It takes over real time functions of the safety-relevant motion control. The PCL can either be operated as a permanently installed component of the rho4.1 or separately on a different PC. Via the PCL's communication interfaces, the rho4.1 can be easily integrated in a complete system.

rho4.1 and PCL on One PC

In this version, the rho4.1 operating system and the PCL are installed together on one PC hardware. I/O and user data are exchanged via the rho4.1 communication interface.

rho4.1 and PCL on Two Separate PCs

In this case, the PCL works on a separate PC. Data is transmitted to rho4.1 via TCP/IP. The rho4.1 interface is stored on the PCL's PC as an image. Thus, the user data of the rho4.1 interface is also available on the PCL's PC.

15.4 System Solutions

For individual system solutions, please refer to Bosch-Service. Further information is available in the following chapter.

16 Support, Service, and Training

Support with System Solutions

The Automation technology division comprises seven areas:

- Industrial hydraulics
- Vehicle hydraulics
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- Tightening and press-fit systems
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- PLC
- Drive engineering
- Robotics
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- Welding technology
- Hydraulics / Pneumatics
- Tightening/press-fit technology
- Assembly technology

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A Appendix

A.1 Glossary

Abbreviation	Explanation		
BASIC	Beginners All-purpose Symbolic Instruction Code, programming language	PCL	Software-PLC by BOSCH. The PCL is a product name and is composed of two computer components: PC for Personal Computer and CL for Control Logic.
C, C++	High-level programming language	PLC	Programmable Logic Controller
CAN	Control Area Network	RAM	Random Access Memory
COM	Component Object Model	Real time	Real time means compliance with the requested short response times of the system. A real time system, thus, guarantees defined response times.
DELPHI	Integrated programming environment by Borland Inprise	Shutdown	Closing down of the PCL or the operating system
EEM	Electrostatically endangered modules	Slot	PC plug-in station
EN 61131-3	same as IEC 1131-3, international standard for programmable logic controllers. Part 3 of this standard comprises programming languages.	TCP/IP	Transmission Control Protocol / Internet Protocol
ESD	Electrostatic discharge; abbreviation for all terms that concern electrostatic discharges, e.g. ESD protection, ESD danger	UPS	Uninterruptible Power Supply
Fieldbus	Connection of the peripherals (I/O level) to the field level via a network. The fieldbus makes a decentralized installation of sensors and actuators possible.	VBA	Virtual Basic for Applications, programming language by Microsoft
HTML	Hypertext Markup Language, wide-spread computer and platform-independent markup language on the internet used for preparing WWW pages	VBScript	Programming language by Microsoft for Internet applications; the language is a subset of VBA
I/O	Input / Output	VxWorks	Real time operating system of the PCL
IEC1131-3	refer to EN61131-3	WAN	Wide Area Network
JScript	Microsoft's version of the JavaScript programming language		
LAN	Local Area Network		
MByte	Megabyte		
Multitasking	A multitasking operating system makes it possible to process several application programs at the same time		
NMI	Non Maskable Interrupt		
OLE	Object Linking and Embedding		
OPC	OLE for Process Control		
PC	Personal Computer		
PCI	Peripheral Component Interconnect, bus system for PC		

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