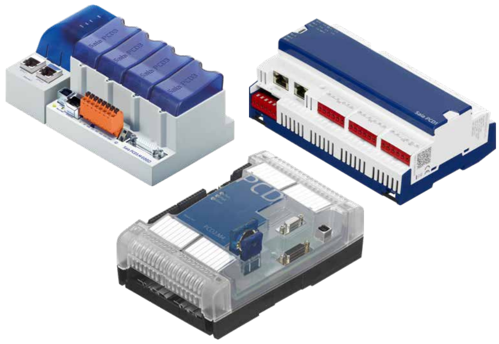
A1 Automation stations

Programmable for measuring, regulation and control devices. Modular series consisting of industrial quality CPU, I/O and communication modules with a service life that will last for decades.
The application software can be simply and reliably adapted and expanded throughout its service life.
It can be used for all device series (Saia PCD1, 2 and 3).



1.1 Basic system properties

Presentation of the Saia PCD COSinus control operating system – hardware structure – program execution – memory system and service capability.

1.2 PCD3 – modular cartridge construction

Up to 1023 I/Os – up to 13 simultaneously operated communication interfaces.

- Saia PCD3.Mxx6x as high power CPU
- Saia PCD3.M5xxx as standard control device
- Saia PCD3.T66x remote I/O stations
- Saia PCD3.M3xxx as the most compact base unit
- Saia PCD3.M2 with dedicated I/O level and function

1.3 Standby System

Standby system for highly available automation solutions.

- PCD3.M6880 standby controller
- PCD3.T668 smart RIO for standby system

1.4 PCD2 – modular technology with a compact design

External dimensions independent of the type and number of the integrated hardware modules. Expandable system up to 1023 I/Os – up to 15 simultaneously operated communication interfaces.

1.5 PCD1 – modular, expandable, compact CPU

18 basic I/Os which can be expanded to max. 50 I/Os with 2 optional I/O modules – up to 8 simultaneously operated communication interfaces.

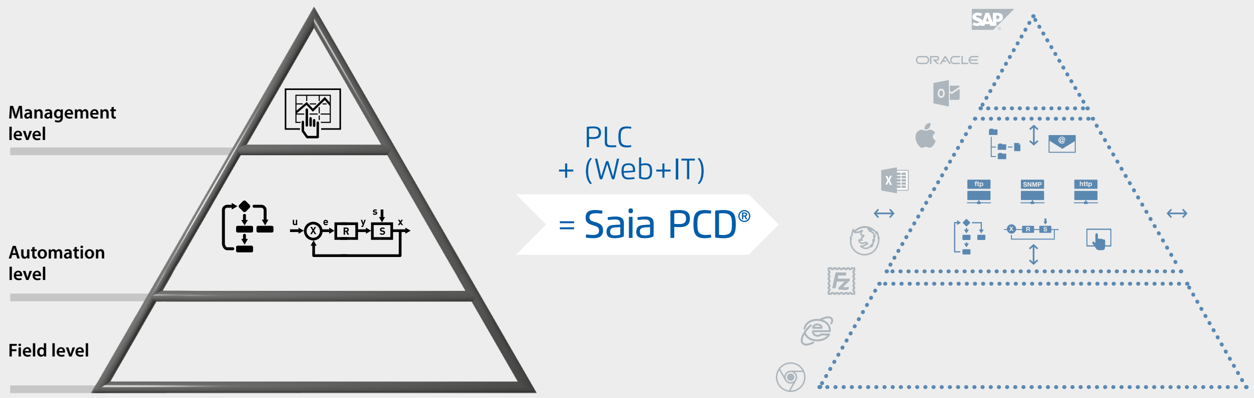
1.6 PCD1 E-Line – compact design for electrical distributors

E-Line product line for specific applications in very confined spaces.

- Programmable I/O modules
- I/O modules
- Communication modules and gateways

1.1 Saia PCD® System description
PLC + (Web + IT) = Saia PCD®

Saia PCDs combine PLC functionality with innovative web and IT technology in an industrial quality system.
The basic equation Saia PCD® = PLC + (web + IT) means that the conventional automation pyramid is becoming an open, transparent structure.



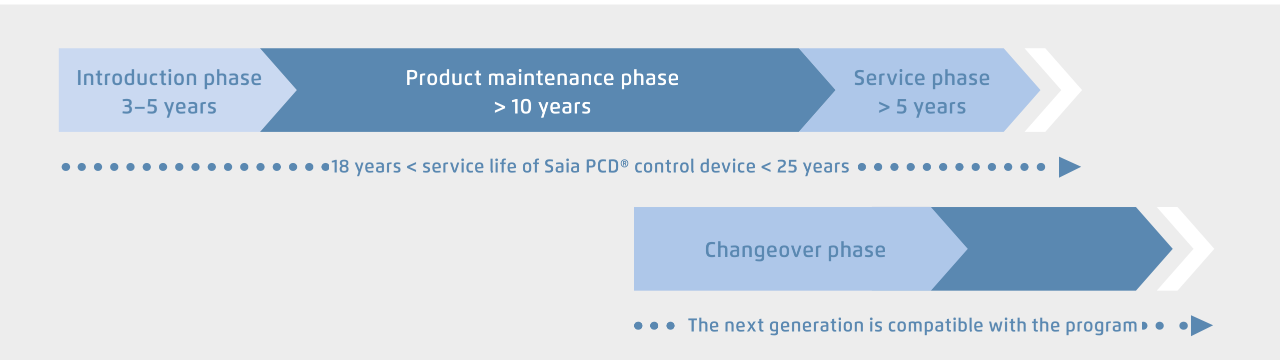
Automation pyramid by definition:
strictly separate levels; insulated from the outside world.

Automation pyramid Saia PCD opens up through standard technology

The Saia PCD system with its open technology stands for total transparency, combinability and openness. This applies between all the levels of the automation pyramid, the automation world and the actual operating environment of the user. To achieve this, all Saia PCD control and regulation devices generally include comprehensive web + IT functions. These functions do not require additional hardware and form an integral part of every device. Machines and systems can therefore be very easily integrated into the existing IT infrastructure.

<u>The service life of Saia PCD®:</u> Compatibility and portability guaranteed for all device types across generations.

We develop our products to provide customers with direct added value that enables them to generate sustainable revenue. This requires products with a long service life and flawless and reliable operation. Previously installed products must always be able to adapt to changing needs. Existing investments should not always be made obsolete by unwanted, forced innovations and incompatibilities. This is why we attach such great importance to PLC-based technology with its sustained customer benefit and ease of upgrade. Our company has remained true to these values for over 50 years. Moreover, we only use components that comply with industrial standards and which have a service life of at least 20 years.



▲ Service life planning of Saia PCD® control devices. Enables maximum profitability of your investment in expertise and systems.
Long service life without expensive reinvestment and no high service costs.

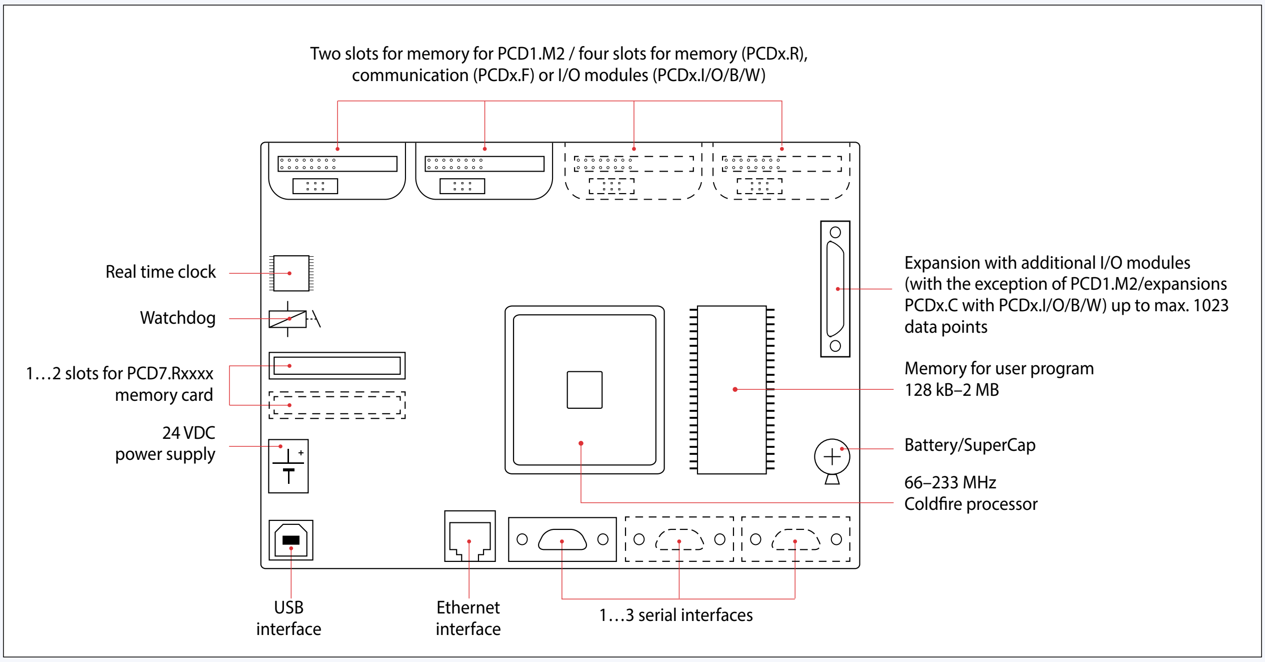
Standards

Saia PCD controllers comply with the IEC EN 61131-2 standard in terms of design and production quality. This standard defines in 150 pages how electronic items should be developed and produced to meet PLC quality standards. All the important topics for the applications are covered: From the environmental conditions (temperature, humidity, vibration), to functionality (fluctuations in the power supply, interruptions) and electromagnetic compliance depending on the area of application.

As application settings often fail to behave in accordance with the standards, our SBC control technology is more robust against interference than required by the CE standard. The majority of Saia PCDs are also approved for maritime applications, where increased demands are made on the devices.

The quality and robustness of the Saia PCD control technology is also evident in MTBF values, in the rates of returns from the field and in the feedback from our regular customer satisfaction surveys. See page 18 for more information on this topic.

Basic configuration of the Saia PCD® CPU modules



▲ Overview of the core elements of a Saia PCD controller

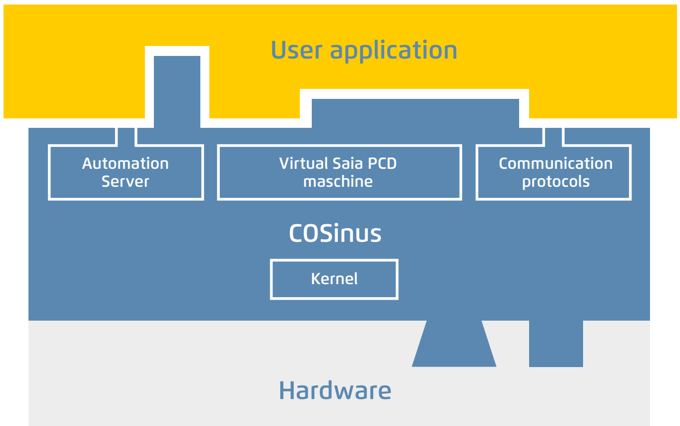
Saia PCD® hardware:

Common properties

- USB interface for configuration, programming and commissioning
- Ethernet interface with all the important web/IT protocols, including those for PG5 communication
- At least one onboard serial interface (Saia PCD3.M5/6: 3×)
- 24 VDC power supply
- Data remanence through battery and/or SuperCap
- Watchdog and fast interrupt inputs on the main CPU
- Slots for intelligent communication or memory modules
- Can be expanded in a modular way (except for Saia PCD1.M) up to 1023 data points

Saia PCD® COSinus – Control Operating System

We developed the core of the Saia PCD operating systems between 2001 and 2003 as part of a European cooperation project with Philips and Nokia. We then expanded the core and focused on an operating system for advanced, industry-quality measuring, control and regulation devices. A dedicated operating system for ICA technology – a control operating system (COS). Developed in-house and with all aspects fully covered.



Saia PCD COSinus connects user programs and various hardware

The main components of Saia PCD® COSinus

1 **Multi-tasking kernel:** Abstracts the hardware, incl. I/Os and communication interfaces, provides basic multi-tasking functionality on which the program processing of Saia PCD programming is also based.

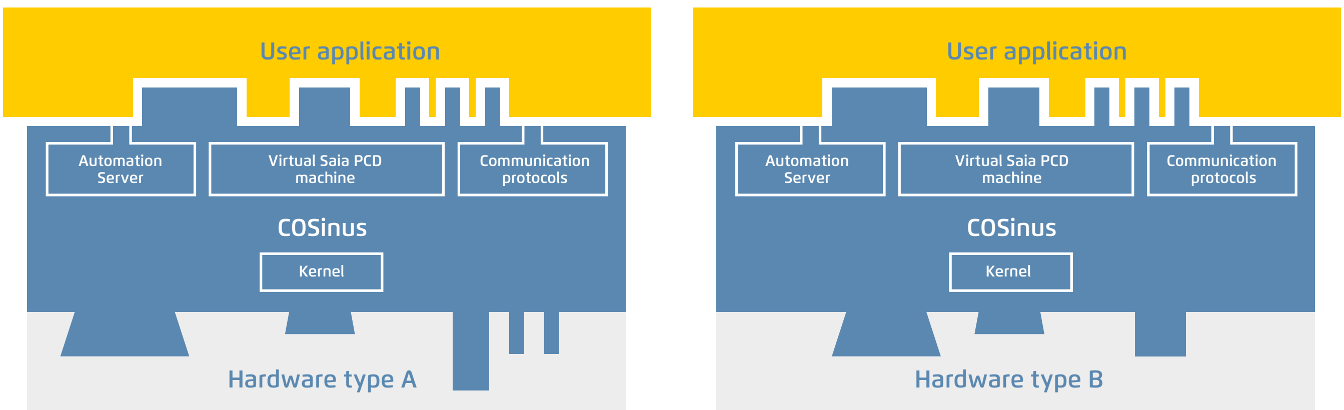
2 **Virtual Saia PCD machine:** This is the logic machine that executes the PG5 programs. The virtual Saia PCD code is interpreted and guarantees that programs are always executed in a consistent manner on different PCD controllers. The three hubs of the PG5 application program are the following:
- **Media:** Memory of the virtual PCD machine such as registers, flags, meters, etc.
- **Program execution:** Program and organisation blocks, text, monitoring, error processing, memory management, etc.
- **System functions:** Access to the hardware, I/Os, interfaces and drivers

3 **Automation Server:** The Automation Server includes widely used web/IT technologies and ensures data exchange between users and automation solutions with no proprietary hardware or software required.

4 **Communication protocols:** Various field and automation protocols such as BACnet®, Lon, Profibus, Modbus, DALI, M-Bus, and many others.

Why COSinus?

The control operating system (COS) ensures that customers' application software will always operate on all platforms, is portable across device generations and expandable over several decades. Hardware and the Windows® programming tools may change, but the customer will not have to modify the application code. The hardware, software tool and application software can be compared to the sides of a triangle. If hardware and/or software changes, the angles must adjust for the application software to remain unchanged. We expanded the abbreviation COS to the name COSinus due to the trigonometric relationships in triangles.

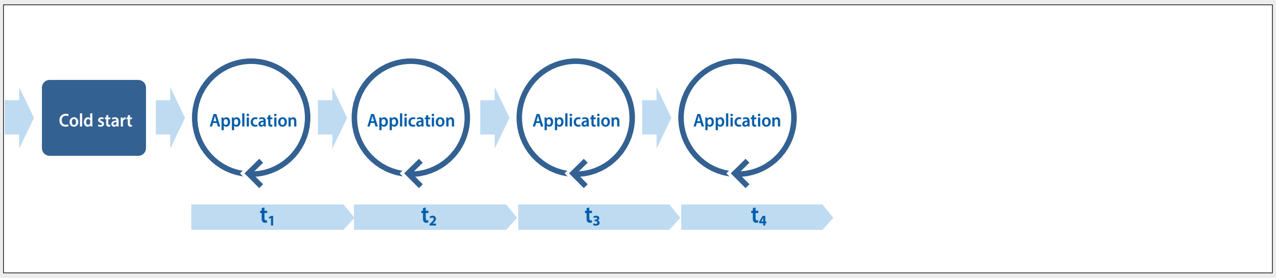


▲ The COSinus operating system always provides the application with the same infrastructure, regardless of the underlying hardware and processor. The key to this is the Saia virtual machine. It ensures that an application program created with PG5 works on all PCDs across generations.

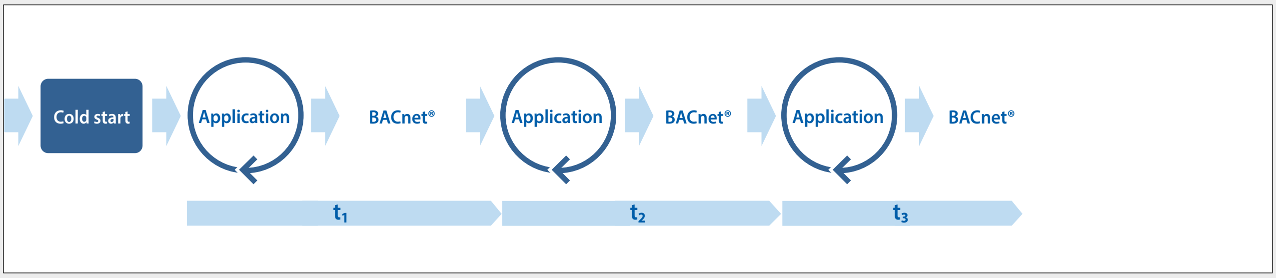
Execution of the user program

The user program consists of one or more organisation blocks that are executed by the PCD Interpreter. Each user program has at least one cyclical organisation block, COB, the COB0.
The PCDs are mono-processor systems. Saia PCD 1, 2, 3 control and regulation devices have a main processor that processes all the tasks. The user program has a special role here and is processed as a core task. In addition to the user program, any communication tasks and server functions (web, FTP) are processed. The CPU capacity is allocated accordingly. The cycle time for the user program not only depends on the length of the program itself, but also on the simultaneous additional load.

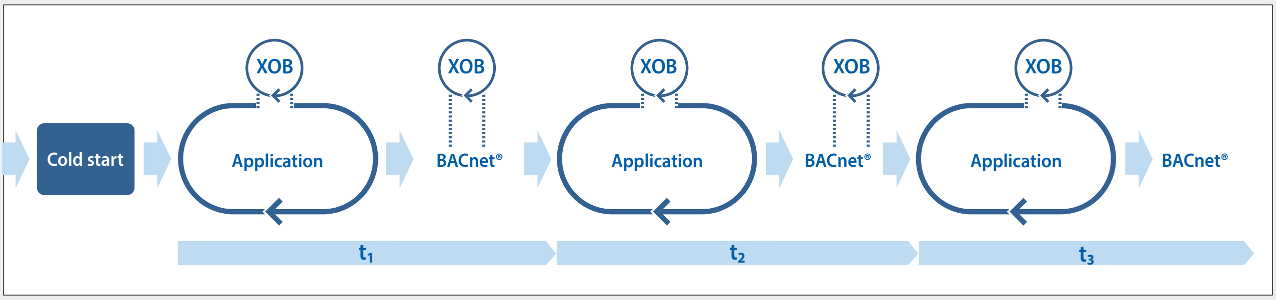
Examples:



▲ Cycle time with no additional communication



▲ Cycle time with BACnet® communication



▲ Cycle time with BACnet® communication and interrupt (XOB)

The more communication takes place, the longer the cycle time (t_x), which may result in variations in the cycle time. If this variation in the cycle time is not required, for example because regulation must take place in a fixed time period and ideally without jitters, make sure that this part of the program is executed in an XOB. The priority of the XOBs is higher than that of the COBs and higher than many other operating system tasks. The above example shows that a periodic XOB interrupts the cyclic program and the execution of the BACnet® task.

! The COSinus operating system ensures that all tasks are processed. An intelligent load balance must be maintained between the user program and communication. This actually occurs in planning practice. It is only problematic if the contractor uses a lower performing Saia PCD CPU than planned to save money or is "saving" on CPUs by concentrating tasks on one CPU.

The main XOBs and their priority levels

Priority 4

- XOB 0: Network out

Priority 3

- XOB 7: System overload – displayed if the interrupt XOB queue is overflowing
- XOB 13: Error flag – displayed in the event of communication or calculation errors or an invalid instruction

Priority 2

- XOB 16: Cold start
- XOBs 14, 15: Periodic XOBs
- XOBs 20…25: Interrupts

Priority 1

- XOB 2: Battery failure
- XOB 10: Nesting depth exceeded when PB/FBs are displayed
- XOB 12: Index register overflow

Data types and program blocks*

Register (32 bit)	16,384
Flags (1 bit):	16,384

Timers (31 bit) and meters (31 bit): 1600
(Partitioning configurable)

Cyclical organisation blocks COB:	0…31
“Exception” organisation blocks (XOB):	0…31

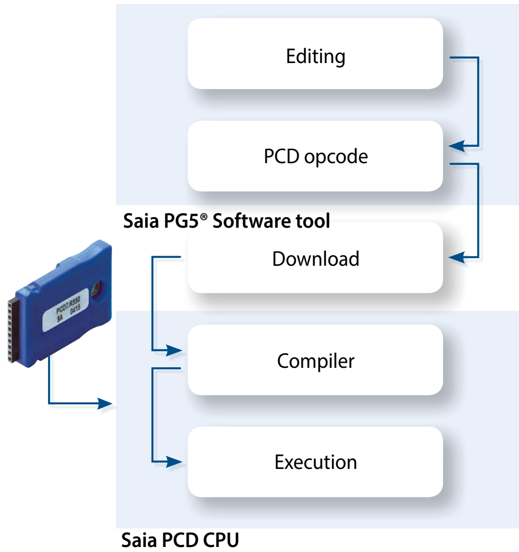
Program blocks (PB):	1000
Function blocks (FB):	2000
Text/data blocks DB:	8192
Sequential blocks (SB):	96

You can find a full list in the PG5 help section.

* This information is dependent on the hardware and the COSinus version.

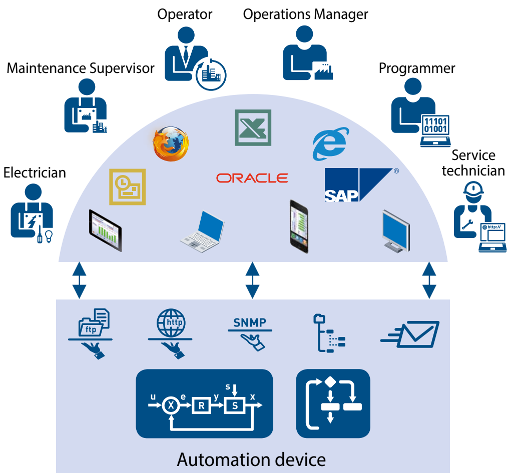
Saia PCD® Opcode

Saia PG5® generates a platform-independent opcode that is interpreted by the Saia PCD. As a result, the same program runs on different platforms. This also enables the user program to be updated with a flash card as the operating system of the Saia PCD performs the necessary actions to copy and execute the program from the flash card to the memory.
Code that is generated (= compiled) and optimised for the specific platform will of course run faster. This compiler is not integrated into the PC tool (Saia PG5®). Saia PCD COSinus knows how this code should be implemented into the relevant hardware most effectively. The program is compiled when it is loaded into the Saia PCD.



Automation server

The Automation Server is part of the COSinus operating system. It includes widespread web/IT technologies and ensures data exchange between users and automation solutions with no proprietary hardware or software required.
Specifically adjusted automation functions and objects form the relevant counterpart in the controller application. The web/IT functions can therefore be optimally and seamlessly integrated into the automation device and used efficiently.



▲ Target group-oriented data output

Automation Server components

Web server:
The system and process are visualised in the form of web pages and can be requested from the web server via browsers such as Internet Explorer, Firefox, etc.

File system:
Process data, records, etc. are stored in easy-to-access files. Standard formats make it easy to process them further, e.g. with Microsoft Excel

FTP server
Load files into the automation device over the network using FTP, or export files from it.

Email:
Critical system statuses, alarms and log data can be sent by email.

SNMP

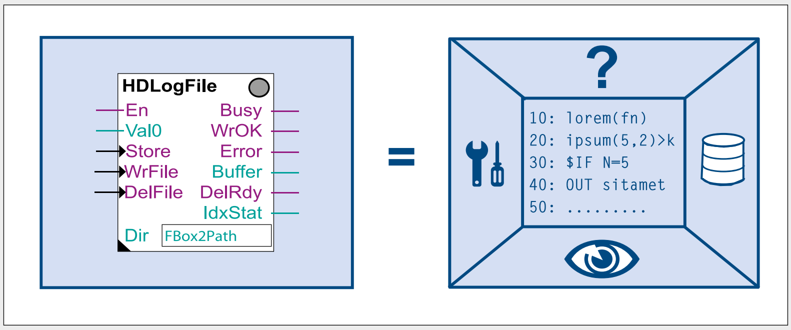
SNMP:
Messages and alarms are transmitted in accordance with IT standards. Access to automation data using the IT management system.

… SNTP, DHCP, DNS …

Memory management in the Saia PCD® systems

A user program may contain various data types. This includes data that is relevant for a fast regulation process and data records that must be collected over a long period or saved permanently. All these data types have different requirements in terms of hardware. For example, a regulation-relevant process requires a fast memory to calculate and provide current values. However, historical data records require sufficient remanent mass memory to cover a long period of time.

If a user program function is placed in PG5, various memory areas are required in the system. These areas can basically be divided into 3 groups. The parameter group controls the behaviour of the FBox that is processed in the user program. Defined statuses of the parameters result in responses in the FBox. Using the example of the HDLog function, the log data of the associated parameters is written to the file system in an Excel-compatible file format. Various templates are provided in the Web Editor to visualise this file in the web application. These can be easily connected to the FBox using a range of parameters. As the visualisation pages only change when the Saia PG5® project is created, these are stored in the file system.



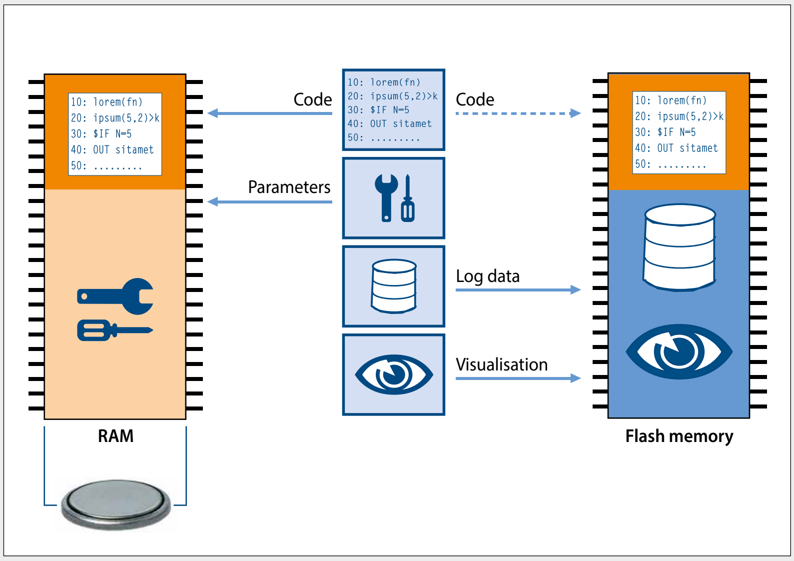
▲ Saia PG5® FBox shown as an object in the Saia PG5® Fupla engineering environment. To the right you can see which functions belong to the object.

Memory areas of the Saia PCD® systems

A distinction is made between two key memory areas.

The user memory, which ensures fast access for reading and writing, contains time-critical content such as media and the program code executed by the CPU. However, this memory is not a programmable read-only memory (PROM) and is buffered by a battery.

The flash memory, on the other hand, permanently saves data and provides space for historical data records or data that will not change during the operation of the system. The backup of the user application can be stored in a file system, which means that the processing of teh program is guaranteed.



▲ This is how the functions of a memory area belonging to the Saia PG5® FBox are mapped.

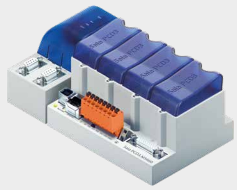
Memory management of the Saia PCD® systems with COSinus operating system

Automation devices with integrated µSD card

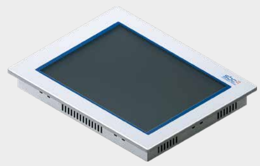
The automation devices Saia PCD3 Plus, Saia PCD1.M2 and the programmable panel are provided with an onboard µSD flash card. When loading a user application with Saia PG5®, all the necessary files in the internal flash memory are stored on the µSD card. If the operating voltage is connected to the automation device and there is no executable program in the user memory, COSinus attempts to load a valid program from the µSD card on startup.

Saia PCD1.M2220-C15

Saia PCD1.M2xxx



Saia PCD3.Mxx6x

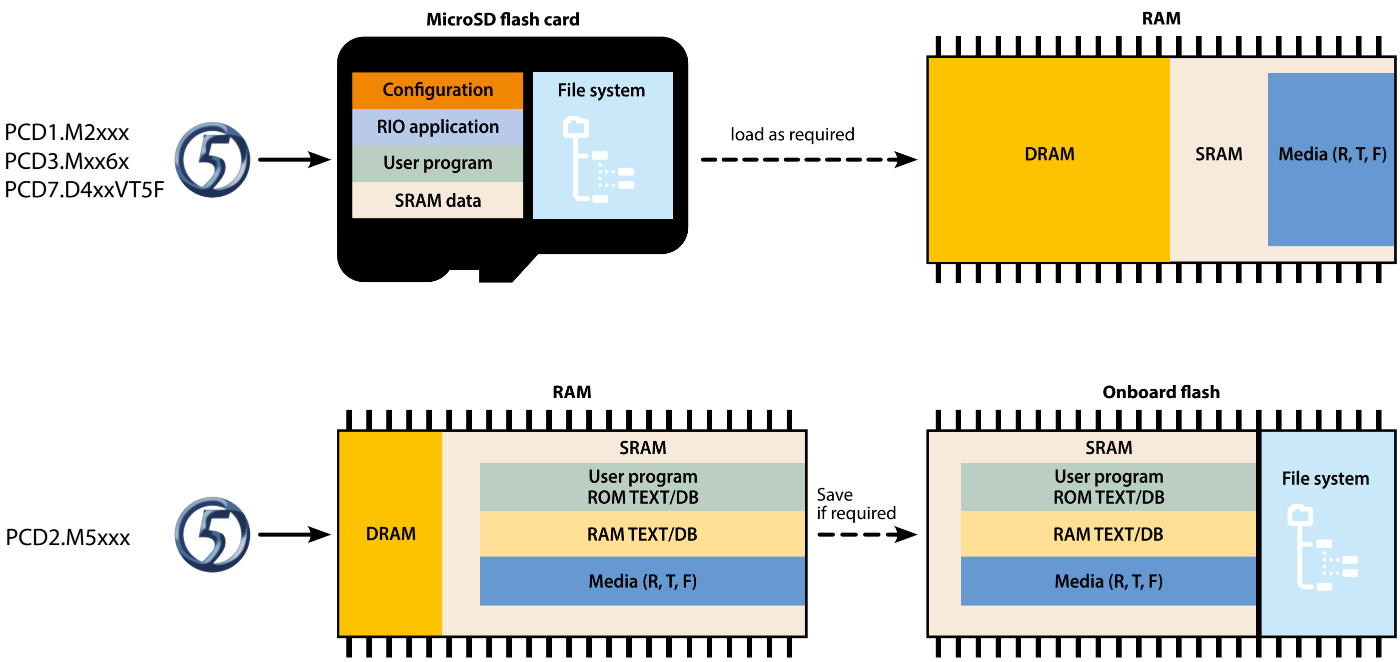


Saia PCD7.D4xxVT5F

Automation devices with no integrated onboard flash

In the case of automation devices with no integrated µSD card and which are equipped with the COSinus system, the user application is copied direct to the user memory from Saia PG5®. If no valid program is detected in the user program when the controller is started up, a search is executed for a backup program in the onboard flash or an optional memory module.

Saia PCD2.M554x



▲ Loading of the user program from Saia PG5® onto Saia PCD automation devices and allocation of different data between the storage media.

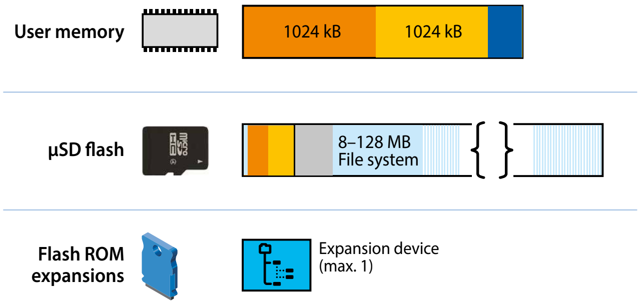
Memory expansion and resources of the Saia PCD® systems

Memory allocation of PCD1.M2xx0

RAM
- User program: 512 kByte … 1 MByte
- DB/text: 128 kByte … 1 MByte

Flash memory
- File system 8 … 128 Mbytes (maximum of 900 … 2,500 files or 225 … 625 directories)

Flash memory expansions
- 1 expansion module

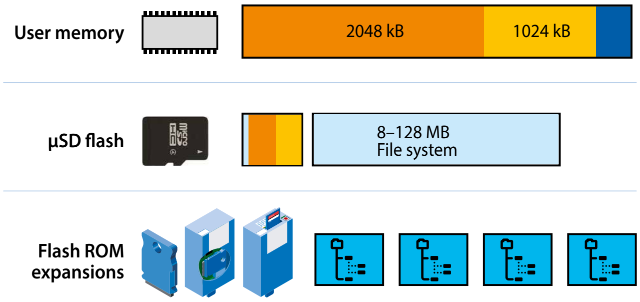


Memory allocation of PCD3.Mxx6x

RAM
- User program: 2 Mbyte
- DB/text: 1 Mbyte

Flash memory
- File system 128 Mbytes (maximum of 2,500 files or 625 directories)

Flash memory expansions
- 4 expansion modules

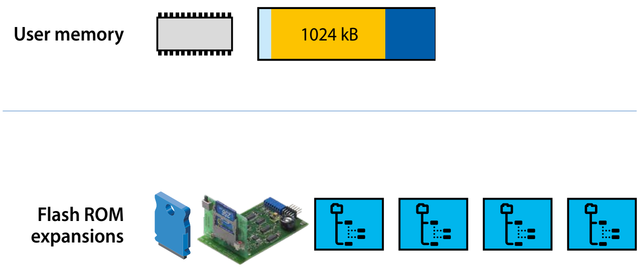


Memory allocation of PCD2.M5xx0

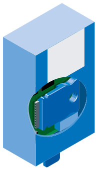
RAM
- User program and DB/text 1024 kbytes

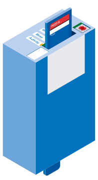
Flash memory
- Backup memory 1024 kbytes

Flash memory expansions
- 4 expansion modules



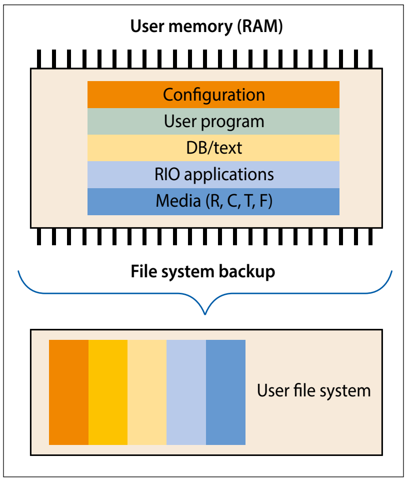
The system backup – entire automation project





▲ Memory media for external backups

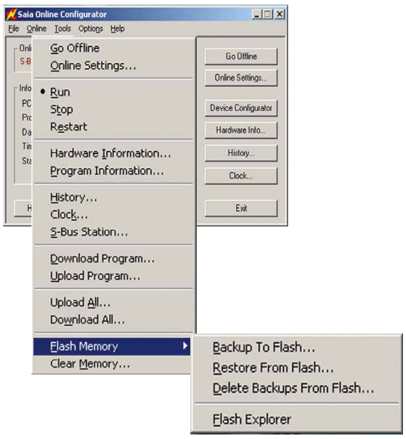
The application's system backup contains all the vital information and data that must be available to process the application. This enables users to easily and securely reset the controller to a saved and known state.
With the system backup function of the Saia PCD COSinus operating system, it is also possible to fully duplicate a system and copy it to an identical piece of hardware with no additional adjustments required (copy/paste).
The system backup can be created in the office on a Saia PCD memory module using an automation device of identical construction. Any technician (without training, a manual or software tools) can then perform a system restore or a system update direct on site should any changes be applied – totally within the meaning of lean automation.



▲ Content of a system backup created on an external module with a file system

Creating a system backup

A system backup can also be created by the licence-freeSaia PG5® software tool "Online Configurator".
The system can be backed up either on the internal flash memory module or on an optional memory module Saia PCD7.Rxxx.



▲ Creation of a system backup with the Online Configurator

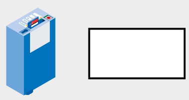
Using a system backup

No dedicated software tools are required to restore a system backup. This only requires an optional Saia PCD7.Rxxx memory module that contains a system backup for the target controller.
Press and hold the run/stop button for 3 seconds to restore the application contained in the backup memory module. The COSinus operating system automatically looks for a system backup of the application in all the storage media connected to the automation device.
If a valid system backup of the operating system is found, it is "automatically" loaded into the user memory. The automation device restarts.

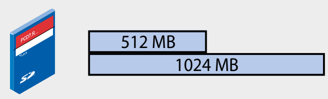
Expansion options of the user file system

Saia PCD systems can be expanded by at least 1 to a maximum of 4 external memory modules that contain a user system. An external file system is ideal as a backup for the entire user application and enables users to save trend data, alarms and event lists, as well as log files defined by the user. An external file system may contain up to 900 files or 225 directories.

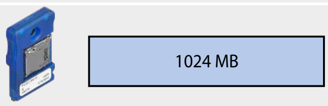
PCD3.R600
Module holder for SD flash memory cards
with 512 and 1024 MB



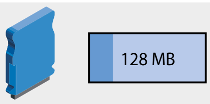
PCD7.R-SD512 / PCD7.R-SD1024
SD flash memory cards
with 512 MB / 1024 MB



PCD7.R610 with PCD7.R-MSD1024
Basic module with Micro SD flash card
with 1024 MB



PCD7.R562 BACnet®
128 MB for file system and firmware expansion for BACnet® configuration files with BACnet® applications



FAQs for the design of automation systems

FAQ

Can third-party local I/Os be connected via S-Bus?
In the manual we have excluded these for the Saia PCD controllers. SBC S-Bus is a proprietary protocol that is essentially designed for communication with engineering and debugging tools, to connect the management level or process control systems and for PCD to PCD communication. It is not suitable or approved for the connection of local I/Os from different manufacturers. I/Os from third-party manufacturers should be integrated professionally and safely using one of the many manufacturer-independent field bus systems.

Can the Saia PCD controllers connect direct to the Internet?
When Saia PCD controllers are connected direct to the Internet, they are also a potential target of cyber attacks. Appropriate protective measures must always be taken to guarantee secure operation.
PCD controllers include simple, integrated protection features. However, secure operation on the Internet is only ensured if external routers are used with a firewall and encrypted VPN connections. For more information, please refer to our support site: http://sbc.do/Me4r-LqwE

How do I connect a third-party device to the PCD if the protocol is not supported in the PCD firmware and there is not a corresponding FBox library either?
One of the greatest strengths of the Saia PCD is that, in addition to the numerous "off the shelf" communication protocols available, users themselves can implement any protocol required in the user program. This is possible via a serial interface and also via Ethernet.
You can find PG5 example programs on our support site on this topic.

What is the difference between centralised and decentralised I/Os?
When remote I/Os are accessed, a communications task always has to run. This task interrupts the processing of the actual ICA task, thus extending the cycle time (page 11). If cycle time is important and critical, it is more efficient to use central I/Os.

How many central I/Os per Saia PCD®?
The I/O capacity of a Saia PCD automation station depends on the maximum number of pluggable I/O modules, i.e. 64 modules for the Saia PCD2 and Saia PCD3 series. Each module requires 16 bits. This gives a maximum of 1024 binary signals overall. Each Saia PCD CPU in this system catalogue can read all 1024 binary signals in under 10 msec and make them available to the user program logic. For calculation purposes, assume a value of 0.01 msec per binary I/O and 0.03 msec per analogue value.

In practice, the number of I/Os is limited by the cycle time required for the user program (see explanation page 11). If the Saia PG5® IL Editor is used to write a resource-efficient user program in text form, the 64 I/O slots of the Saia PCD automation station will be fully usable. The cycle time will certainly be well below 100 msec.

If the graphic software engineering tool Saia PG5® Fupla and prefabricated system templates (Saia PG5® DDC Suite) are used to create the application software, then only half the 64 possible I/O modules should be equipped for a cycle time of <100 msec. Additional communication and data processing tasks will further increase cycle time.

In the case of fully graphic software engineering for control-intensive applications combined with additional tasks (e.g., BACnet®, gateway, management functions), it is inadvisable to use more than 300 I/Os per automation station.

How does communication influence the application cycle time?
If the PCD is set as the server (master station), it has little or no control over its partner stations. Should these partner stations send large amounts of data simultaneously, the PCD MUST receive them. The receiving/processing of these data packages will take priority over the application cycle time. The cycle time may consequently be increased depending on the workload. The PCD processing time may be significantly increased if several partner stations send large volumes of data simultaneously.
The impact will be minimal if the PCD is set as client (slave station).
The figures below are based on a PCD3.M5340 with a program cycle time of 100 ms, excluding additional communication.
Web server Displaying a page on a micro browser panel or PC does not have a major impact. Loading a large file such as a Java applet or an offline trend during the transfer can increase cycle time by 40…50%. The same applies when large files are transferred via FTP.
S-Bus or Modbus communication via Ethernet: Each partner station running under full load increases the cycle time by approx. 8%.
Serial S-Bus: Each slave-type communication at 38.4 kbit/s increases the cycle time by 5% (port #2). In the case of PCDx.F2xx modules, the increase is approx. 17%.
At 115 Kbits the cycle time is approximately 20% higher. ***Modbus RTU:*** A client at 115 kbit/s increases the cycle time by about 11% (port #2). In the case of PCDx.F2xx modules, the increase is approx. 45%.

What exactly does MTBF mean? Where can I find the MTBF values for Saia PCD® controllers?
MTBF stands for Mean Time Between Failures. The time referred to is the period of operation between two consecutive failures of a unit (module, device or system). The higher the MTBF value, the more "reliable" the device. On average, a device with a MTBF of 100 hours will fail more often than a similar device with a MTBF of 1,000 hours. The MTBF value can be calculated in purely mathematical terms or based on empirical values.
Please bear in mind that the MTBF value of the overall installation depends on the values of the individual switch cabinet components.
An overview of the MTBF values of the PCD controllers is included on our **support site.**
The return rate is of greater relevance in practice. We analyse all the devices that return from the field. The return rates of the current PCD controllers during the warranty period (30 months) are as follows:
- PCD2.M5xxx: 0.94%
- PCD3.M5xxx: 0.99%
- PCD3.M3xxx: 1.14%

What part of the memory will be lost if the battery fails, and how does the PDC react?
In theory, the user memory of the PCD, which contains the content of the media such as registers, counters, meters, flags, and the writeable part of the DB and text elements, will be lost in the event of a failure of the power supply with a battery that is also weak or defective. We now have to distinguish between two different types of PCDs.
Controllers equipped with an internal micro SD card store the user program and associated initial values of the media in a system partition. Should the user memory be lost with no backup, the data will be reloaded into the user memory and the program will be processed again with the parameters that were defined at the time of the download in PG5.
Controllers with no internal file system require a backup containing the user program and associated media. This backup can be created using PG5 when downloading the application. As a general rule, there should be a backup of the PCD of the last download of an application to an external file system of the PCD to restore the program and media content in the event of an empty memory.
If a backup of the application of a PCD is available and the content of the user memory is not feasible, the application will be restored from the point at which the backup was created.