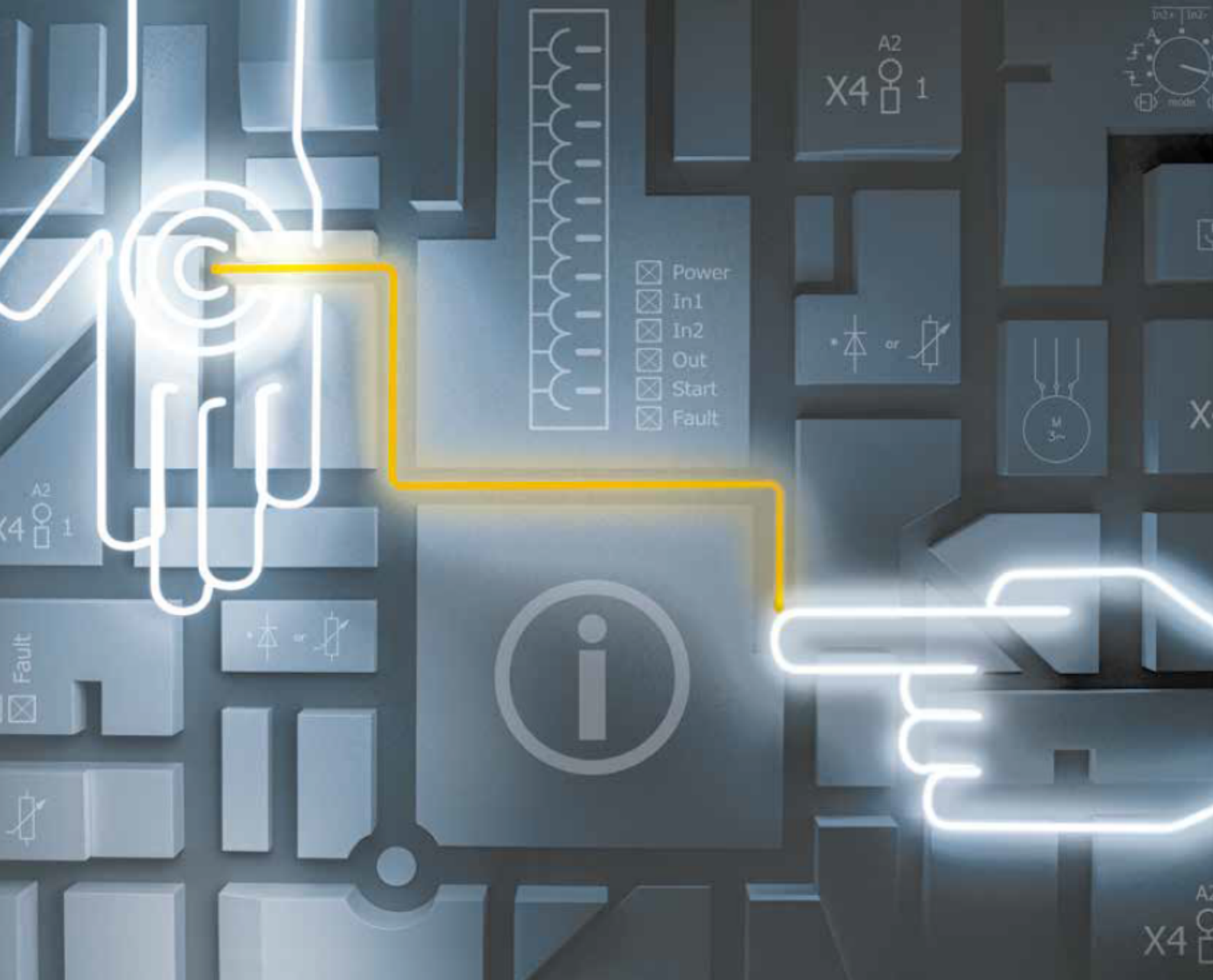




► IndustrialPI 4

PILZ
THE SPIRIT OF SAFETY

Operating Manual-1006970-EN-02
- IndustrialPI



This document is the original document.

Where unavoidable, for reasons of readability, the masculine form has been selected when formulating this document. We do assure you that all persons are regarded without discrimination and on an equal basis.

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SD means Secure Digital

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1 Introduction IP4

1.1 Validity of documentation

This documentation is valid for the product IndustrialPI 4. It is valid until new documentation is published.

This operating manual explains the function and operation, describes the installation and provides guidelines on how to connect the product.

1.2 Using the documentation

This document is intended for instruction. Only install and commission the product if you have read and understood this document. The document should be retained for future reference.

1.3 Definition of symbols

Information that is particularly important is identified as follows:



DANGER!

This warning must be heeded! It warns of a hazardous situation that poses an immediate threat of serious injury and death and indicates preventive measures that can be taken.



WARNING!

This warning must be heeded! It warns of a hazardous situation that could lead to serious injury and death and indicates preventive measures that can be taken.



CAUTION!

This refers to a hazard that can lead to a less serious or minor injury plus material damage, and also provides information on preventive measures that can be taken.



NOTICE

This describes a situation in which the product or devices could be damaged and also provides information on preventive measures that can be taken. It also highlights areas within the text that are of particular importance.



INFORMATION

This gives advice on applications and provides information on special features.

1.4

Symbols used on the product

	Functional earth (FE)
---	-----------------------

2 Overview

The automation system IndustrialPI is an open, modular Industrial PC based on the familiar Raspberry Pi. IndustrialPI 4 is the automation system's base module. Various I/O modules are available for connecting sensors and actuators. Configuration is via the graphical configuration tool PiCtory.

2.1 Product features

- ▶ Compute Module 4
- ▶ Operating system: adapted version of the Raspberry Pi OS
- ▶ 2 Ethernet interfaces
- ▶ 1 connection for sensors for Modbus RTU, for example
- ▶ 2 USB-A interfaces
- ▶ 1 Micro USB interface for connecting a USB host system
- ▶ 1 Micro HDMI connection
- ▶ 1 relay output
- ▶ 1 digital input
- ▶ Order no. A1000003: Antenna connection for WLAN antenna or Bluetooth device
- ▶ Max. 10 expansion modules can be connected

3 Safety

3.1 Intended use

IndustrialPI 4 is the base module of the automation system IndustrialPI. IndustrialPI 4 is designed for use in non-safety-related applications.

Intended use includes making the electrical installation EMC-compliant. Please refer to the guidelines stated in the "PSSuniversal Installation Manual". The module is designed for use in an industrial environment. It is not suitable for use in a domestic environment, as this can lead to interference.

The following is deemed improper use in particular:

- ▶ Any component, technical or electrical modification to the module
- ▶ Use of the module outside the areas described in this manual
- ▶ Any use of the module that is not in accordance with the technical details.

Guidelines for UL approval

UL Markings

- ▶ If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

3.1.1 Third-party manufacturer licence information

The product contains open source software, whose terms of use could further limit the product's application area. It is essential to refer to the third-party manufacturer licence information "IndustrialPI_Third-party_manufacturer_license_information_-_1007005-EN-01.txt" in the /boot directory on the IndustrialPI.

3.2 Safety regulations

3.2.1 Use of qualified personnel

The products may only be assembled, installed, programmed, commissioned, operated, de-commissioned and maintained by persons who are competent to do so.

A competent person is a qualified and knowledgeable person who, because of their training, experience and current professional activity, has the specialist knowledge required. In order to inspect, assess and handle products, devices, systems, plant and machinery, this person must be familiar with the state of the art and the applicable national, European and international laws, directives and standards.

It is the company's responsibility only to employ personnel who

- ▶ Are familiar with the basic regulations concerning health and safety / accident prevention,
- ▶ Have read and understood the information provided in the section entitled Safety
- ▶ Have a good knowledge of the generic and specialist standards applicable to the specific application.

3.2.2 Warranty and liability

All claims to warranty and liability will be rendered invalid if

- ▶ The product was used contrary to the purpose for which it is intended,
- ▶ Damage can be attributed to not having followed the guidelines in the manual,
- ▶ Operating personnel are not suitably qualified,
- ▶ Any type of modification has been made (e.g. exchanging components on the PCB boards, soldering work etc.).

3.2.3 Disposal



NOTICE

The product IndustrialPI 4 is supplied with an integrated lithium battery. This battery has a guaranteed service life of 10 years. The lithium battery is not designed to be replaced by the customer. Contact customer services at: support@pilz.com

- ▶ Dispose of the product in accordance with local regulations for electronic waste.

4 Security

To secure plants, systems, machines and networks against cyberthreats it is necessary to implement (and continuously maintain) an overall industrial security concept that is state of the art.

Perform a risk assessment in accordance with VDI/VDE 2182 or IEC 62443-3-2 and plan the security measures with care. If necessary, seek advice from Pilz Customer Support.

4.1 Implemented security measures

- ▶ The web application is protected against unauthorised access by a password prompt.
- ▶ If a password is changed, you will be prompted to enter the old password for authentication.
- ▶ A user is automatically logged out of the web application after 30 minutes of session time.
- ▶ If an external Client is connected to the web server via HTTP it will automatically be rerouted to HTTPS.
- ▶ An external Client can only be connected to the web server via HTTPS.
- ▶ The password is saved in an encrypted format.

4.2 Required security measures

- ▶ After logging in for the first time, change the default password immediately in the command line and in the web application.
- ▶ Only assign strong passwords and handle the passwords carefully. Be guided by generally accepted guidelines such as NIST 800-63b for example.
- ▶ The product is not protected from physical manipulation or from reading of memory contents during physical access. Use appropriate measures to ensure that there is no physical access by unauthorised persons. You should also use security seals so that you can detect any manipulation of the product or interfaces. Installation inside a lockable control cabinet is recommended as a minimum measure.
- ▶ Protect the product from unauthorised data exchange via the network by using a firewall or providing other appropriate measures. Only allow the data exchange that's required for the application. Any data exchange that is not required for the application must be prevented by the firewall.
- ▶ The configuration computer that accesses the product has to be protected from attacks by a firewall or other suitable measures. We recommend that a virus scanner is used on this configuration computer and updated regularly.

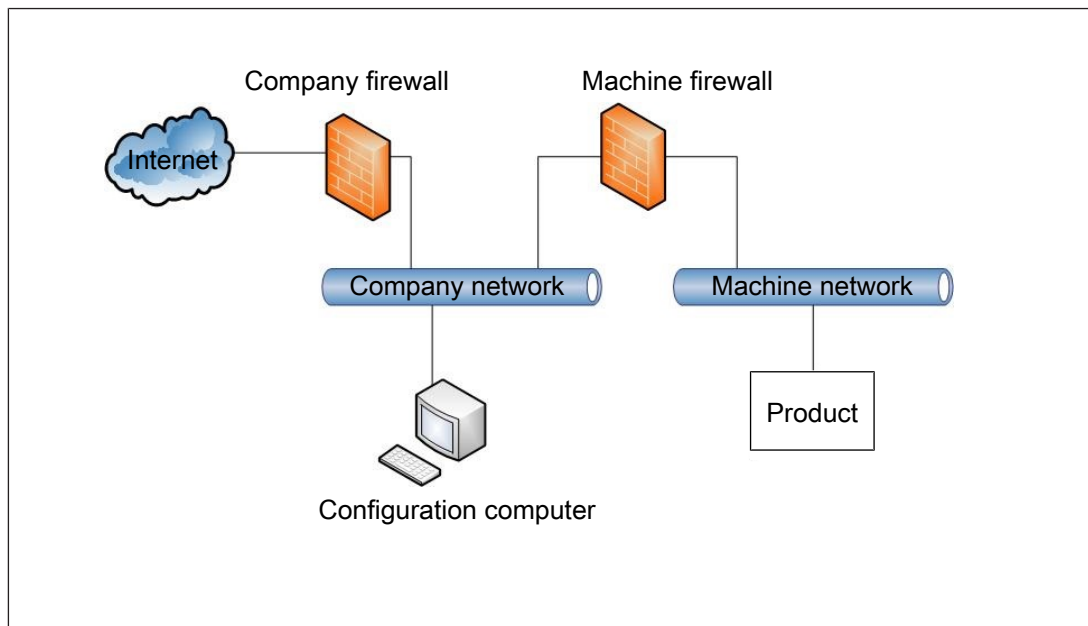


Fig.: Example network topology

- ▶ Update the software packages weekly. If this is not possible, take other measures to protect the IndustrialPI from attacks, with the help of a security expert.
- ▶ For software packages from Debian Distribution, go to <https://www.debian.org/security/> regularly to check if a new security advisory has been published for the product. Take the required countermeasures.
- ▶ Check the product's log data regularly for security-relevant entries.
- ▶ Log data may contain personal data. Only store exported logs on a storage medium that is adequately protected.
- ▶ If the operation allows it, we recommend disabling WLAN and Bluetooth or turning them off completely (see [Permanently disable WLAN and Bluetooth \[46\]](#)).
- ▶ To protect against unauthorised access, no cable may be plugged into the Micro USB connection during normal operation.
- ▶ The IndustrialPI must be safely decommissioned prior to disposal. To do this, all the data must be deleted from the device. Overwrite the existing data by installing a new image of the IndustrialPI (see [Backup and install image \[40\]](#)).
- ▶ Report any security issues at <https://www.pilz.com/security>. You'll find the contact address and further information there.

Should the product have a security vulnerability, this will be published in a security advisory. You'll find the security advisories under www.pilz.com/security. You can also report any security problems there.

- ▶ Note the [network data \[50\]](#) for risk analysis and the security measures.

5 Function description

5.1 Watchdog

The IndustrialPI 4 has two independent watchdogs.

A watchdog is a timer that runs for 60 seconds after power on and then restarts the IndustrialPI 4. Therefore, as long as the automation system is functioning properly, the timer must be restarted again and again. If an error occurs (e.g. if the application process crashes), this restart does not take place and the watchdog restarts the system.

The first watchdog is part of the BCM2837 SoC, which is also used on the Raspberry Pi. The second is the external watchdog module PCF2129T.

BCM2837

The BCM2837 watchdog is the preferred watchdog. You can access it either via the device file `/dev/watchdog0` or as a default watchdog via the device file `/dev/watchdog`.

PCF2129T

The PCF2129T can be accessed via the device file `/dev/watchdog1`.

Watchdog under Linux

There are several ways to use a watchdog under Linux. The IndustrialPI 4 Image and Raspbian rely on “systemd”. This is the preferred method of using the watchdog. “systemd” can be used to trigger a hardware watchdog. Applications that are to be monitored by the watchdog are then monitored by “systemd”. The advantage here is that several applications can be monitored. It is not necessary to restart the entire system, just the individual application.

5.2 Relay output

There is a relay contact on each of the X2 connections on the IndustrialPI 4.

These are free to use, to interrupt the power supply on connected hardware for example (e.g. IndustrialPI DIO, wireless router...).

The relay can switch a maximum of 30 V and 300 mA.

The relay contact is open after start-up.

You can open and close it in the process image via the status byte `IndustrialPIOutput`, Bit 0.



INFORMATION

The device may only be supplied by circuits that comply with Class 2 or Safety Extra Low Voltage (SELV) in accordance with UL 61010-1.

5.3 Input for UPS

The IndustrialPI 4 has a digital input, to which you can connect the status output from a UPS (uninterruptible power supply).

A UPS ensures that the modules continue to operate in the case of a malfunction. Depending on the type of UPS, it can protect the modules from the following malfunctions:

- ▶ Power failure
- ▶ Overvoltage
- ▶ Undervoltage
- ▶ Frequency changes
- ▶ Harmonics

Modules from the IndustrialPI range are developed for low voltage operation. They can apply voltages up to 30 V or currents up to 2 A.

To connect a UPS to your IndustrialPI 4, you must connect your power supply, the UPS, the IndustrialPI 4 and I/O modules in accordance with the specifications of the UPS. You can connect the status output on the UPS to the digital input on the connector X2. Please refer to the installation instructions provided by the UPS manufacturer.

In the process image, Bit 6 of the variable IndustrialPI status is 0 or 1, depending on whether 0 V or 24 V is applied to the input. Your application must read this bit as part of each cycle. If the UPS reports a problem, your application must take appropriate action. Which action depends on:

- ▶ The size of the battery you are using
- ▶ The power consumption of the IndustrialPI 4
- ▶ The power consumption of all the additional components connected to the UPS.

Run a test. Establish the following requirements:

- ▶ The UPS battery is charged.
- ▶ Your IndustrialPI 4 and the UPS are connected correctly.

Now unplug your power supply. If the power LED on the IndustrialPI 4 remains green and the application responds as expected, the UPS is working.



INFORMATION

The device may only be supplied by circuits that comply with Class 2 or Safety Extra Low Voltage (SELV) in accordance with UL 61010-1.

5.4 WLAN and Bluetooth

You can either connect a WLAN rod antenna directly to the antenna connection or an external antenna via an antenna cable. When selecting the antenna, bear in mind that the antenna connection is an RP-SMA socket ("reverse-polarity").

The WLAN interface operates at 2.4 and 5 GHz and complies with the IEEE802.11a/b/g/n/ac specification. It is included on the Compute Module 4. A Cypress CYW43455 (formerly Broadcom BCM43455) WLAN/BT chip is used.

Under Linux, you can address the interface as “wlan0” (by default, without other WLAN devices).

A Bluetooth interface is available via the same SMA socket as for the WLAN interface. This complies with the Bluetooth standard 5.0 and is connected on the Compute Module 4.



INFORMATION

To use WLAN and Bluetooth you will need to enable it once in the web status.

5.5

PiCtory

PiCtory is a browser-based application that enables you to use a configuration file to communicate between the IndustrialPI 4 and connected modules. This configuration file is created using PiCtory.

You can use PiCtory on all standard web browsers (e.g. Internet Explorer, Mozilla, ...). We recommend Chrome.

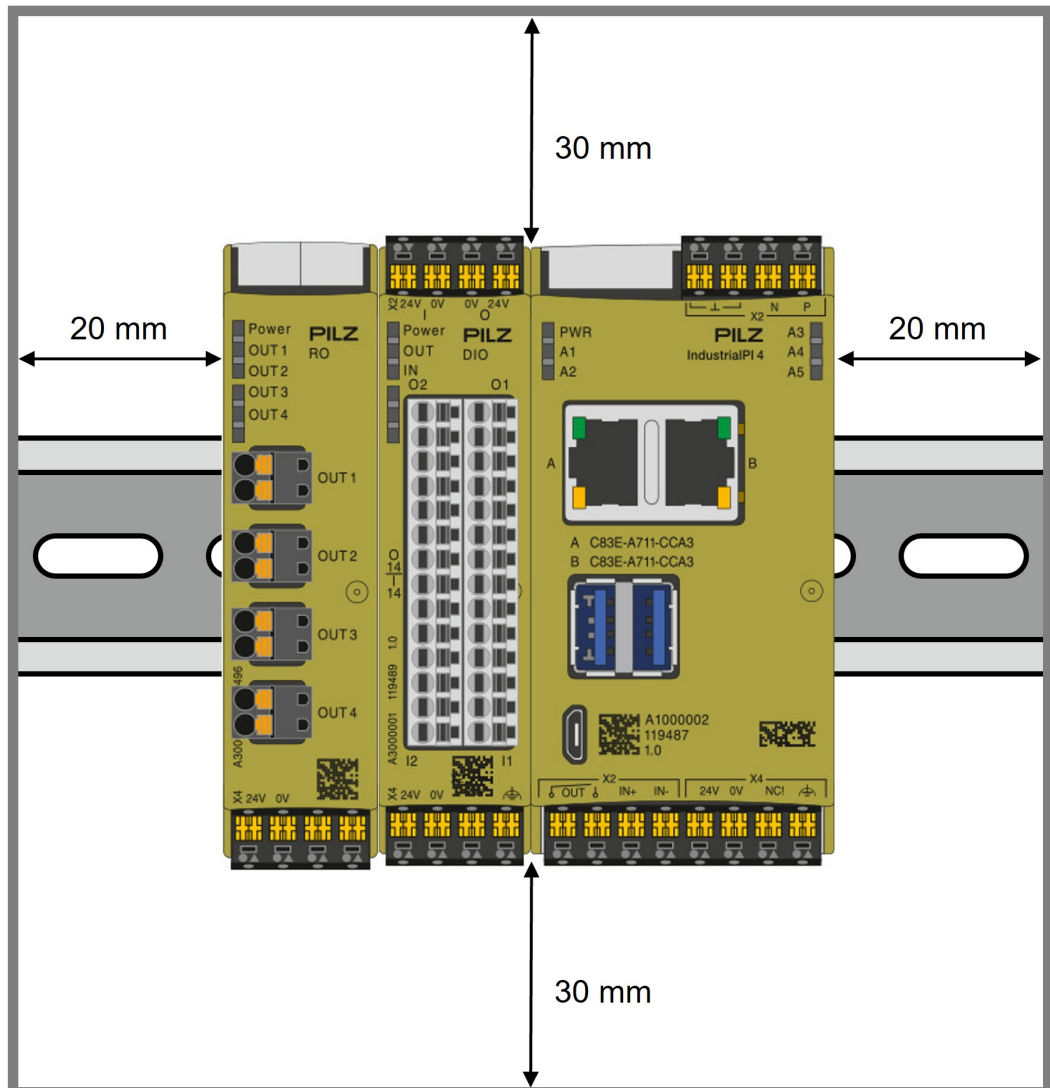
Main functions of a configuration file:

- ▶ Informing the base module about which expansion modules are in which position.
- ▶ Informing both parties of the basic settings on your IndustrialPI 4 and connected devices.
- ▶ Using the configuration values of your IndustrialPI 4 in other programs

6 Installation

IndustrialPI modules were developed for use in a control cabinet. To operate them as intended in an industrial environment, you must observe the following:

- ▶ The protection type and protection class of the control cabinet must comply with the standards provided for the intended use.
- ▶ Protection from mechanical hazards, spread of fire and direct contact must be guaranteed.
- ▶ For control cabinet installation you will need a mounting rail 35 x 7.5 mm (EN 50022).
- ▶ Install the mounting rail horizontally in the control cabinet, in accordance with the manufacturer's instructions. Only when installed horizontally is it guaranteed that air flows through the IndustrialPI modules from bottom to top, and can thereby cool the electronics (stack effect).
- ▶ Ensure that the IndustrialPI is at a sufficient distance from other products to guarantee sufficient airflow.



Procedure:

- ▶ Hold the latching element on the IndustrialPI module up to the mounting rail.
- ▶ Press the locking mechanisms towards the IndustrialPI module.
- ▶ Ensure that the IndustrialPI module is firmly connected to the mounting rail.



NOTICE

Excessive temperatures can damage the module!

Ensure that the ambient temperature in the control cabinet is less than 55 °C.

6.1 Connect expansion modules

PiBridge connects the IndustrialPI 4 to the I/O modules.

Up to 10 expansion module (e.g. I/O modules) can be connected; 5 expansion modules on the left and 5 expansion modules on the right.

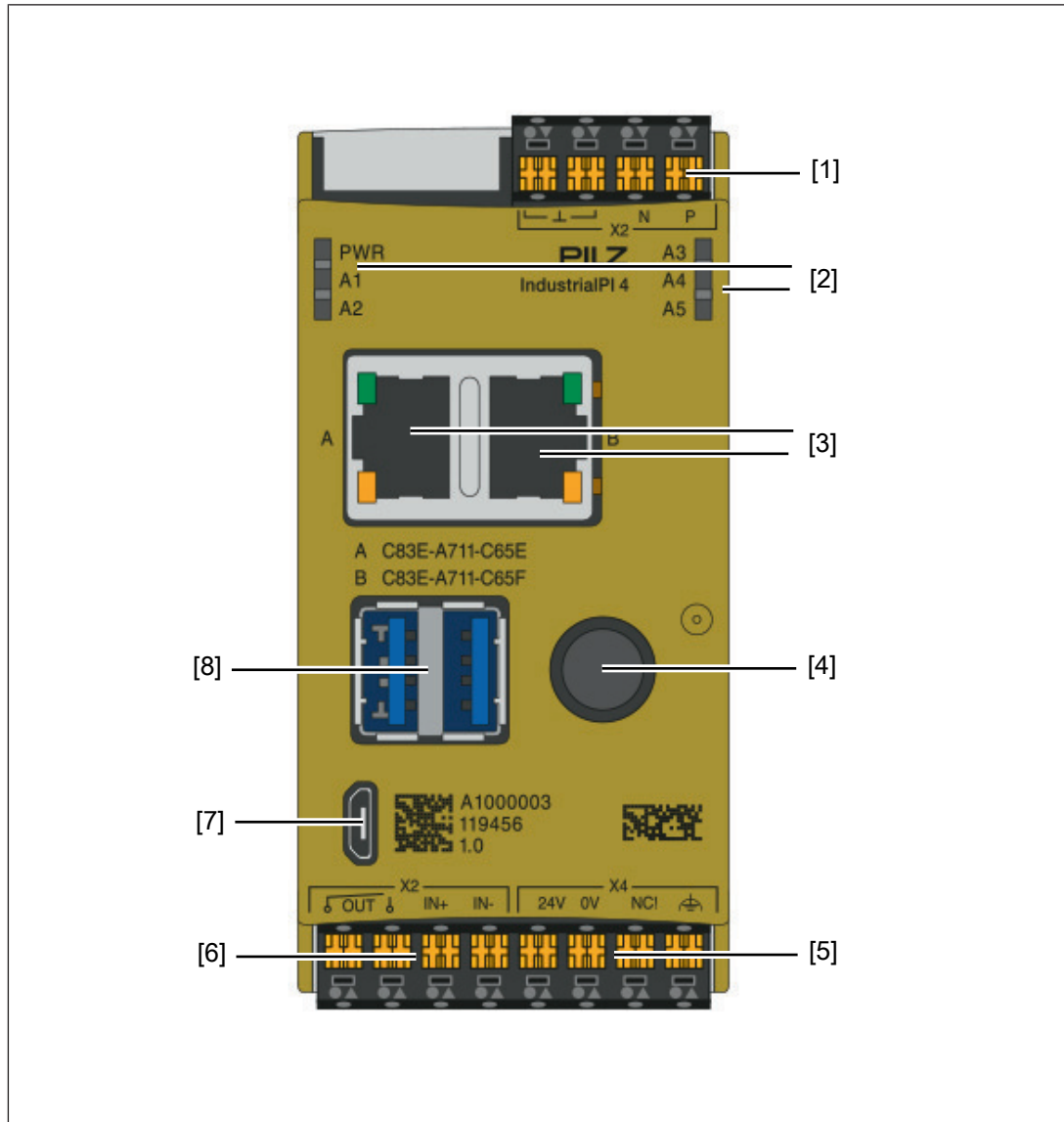


- ▶ Insert PiBridge [1], as shown, on to the PiBridge connections on the modules you wish to connect.

Data is transmitted by signal lines from one module to the other via the PiBridge.

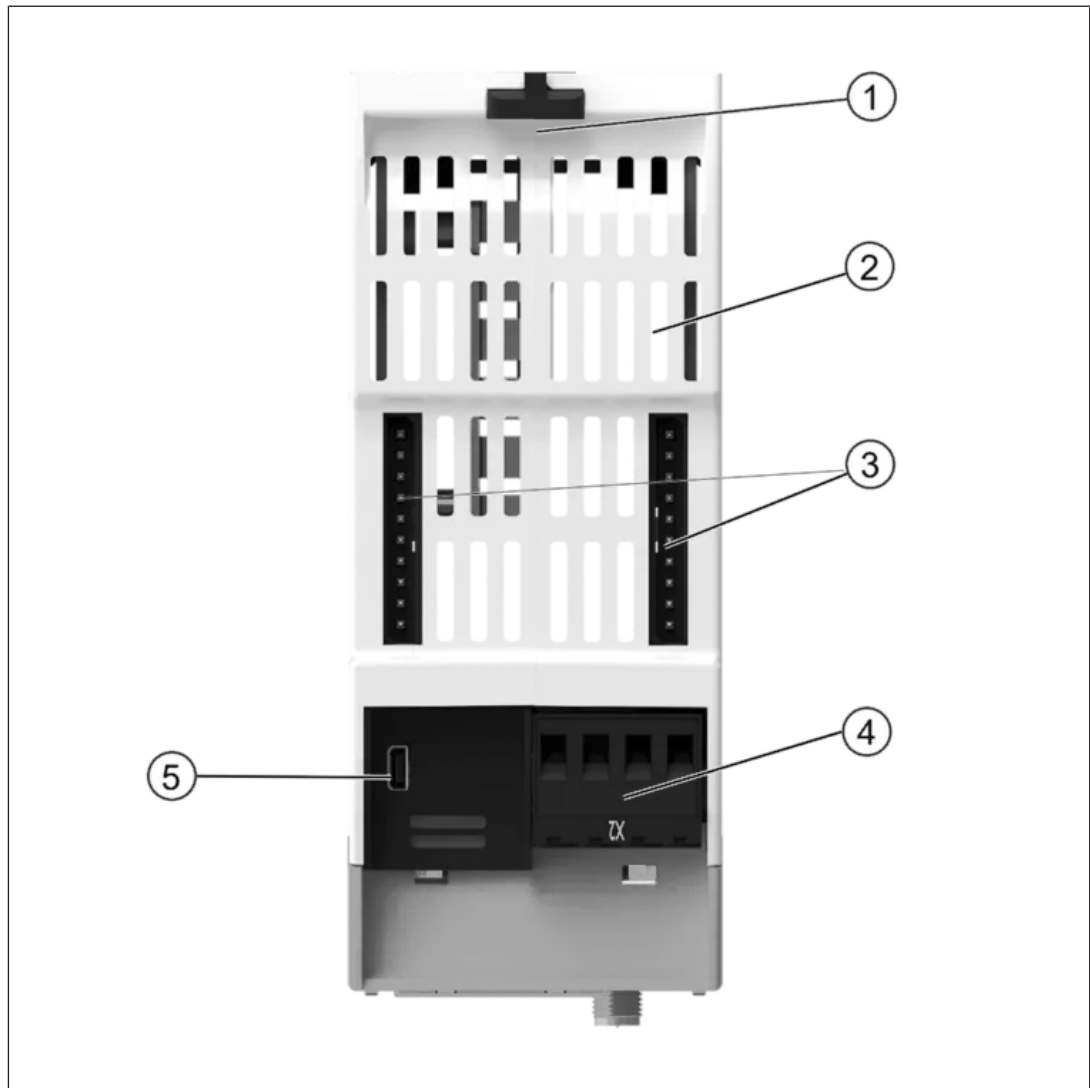
7 Wiring

7.1 Terminal configuration



Position	Connection	Description
1	X2 connector	4-pin, connection of sensors for Modbus RTU, for example, see Connect serial devices [21].
2	Status LEDs	Display of device status, see Display elements and messages [35]
3	RJ-45 sockets	Two independent Ethernet connections enable integration into two different networks. In Linux, socket A can be addressed via eth0, and B via eth1.
4	Antenna connection WLAN/ Bluetooth	Connection of a WLAN antenna or Bluetooth device. Only on Industrial 4 with WLAN See Configure WLAN and Bluetooth [33]

5	X4 connector	Voltage supply for IndustrialPI 4 For connection assignment see Supply voltage [19].
6	X2 connector	Relay contact output (connections 1 and 2). Input with digital input signal (+24 V) (connection 3) Internal pull-down resistor (connection 4).
7	Micro-USB connection	Connection of a USB-Host system (e.g. a PC, to load software on to the device).
8	USB connections	2 USB-A connections for USB 3.2 Client devices (e.g. USB hard drives, surf sticks, keyboard or mouse). Both sockets together may be loaded with a maximum of 900 mA. Power distribution is not an issue. However, a socket may be loaded with a maximum of 800 mA. A USB Hub may be connected if more than two USB-A connections are required.



Position	Connection	Description
1	Locking clamp	Fixes the device to the mounting rail.
2	Venting slots	To cool the electronics, air flows from bottom to top through the device (stack effect)
3	PiBridge connections	For connecting I/O modules
4	RS485 female connector	4-pin, for connecting sensors for Modbus RTU, for example. See Connect serial devices [ 21]
5	Micro-HDMI connection	For connecting an HDMI monitor.

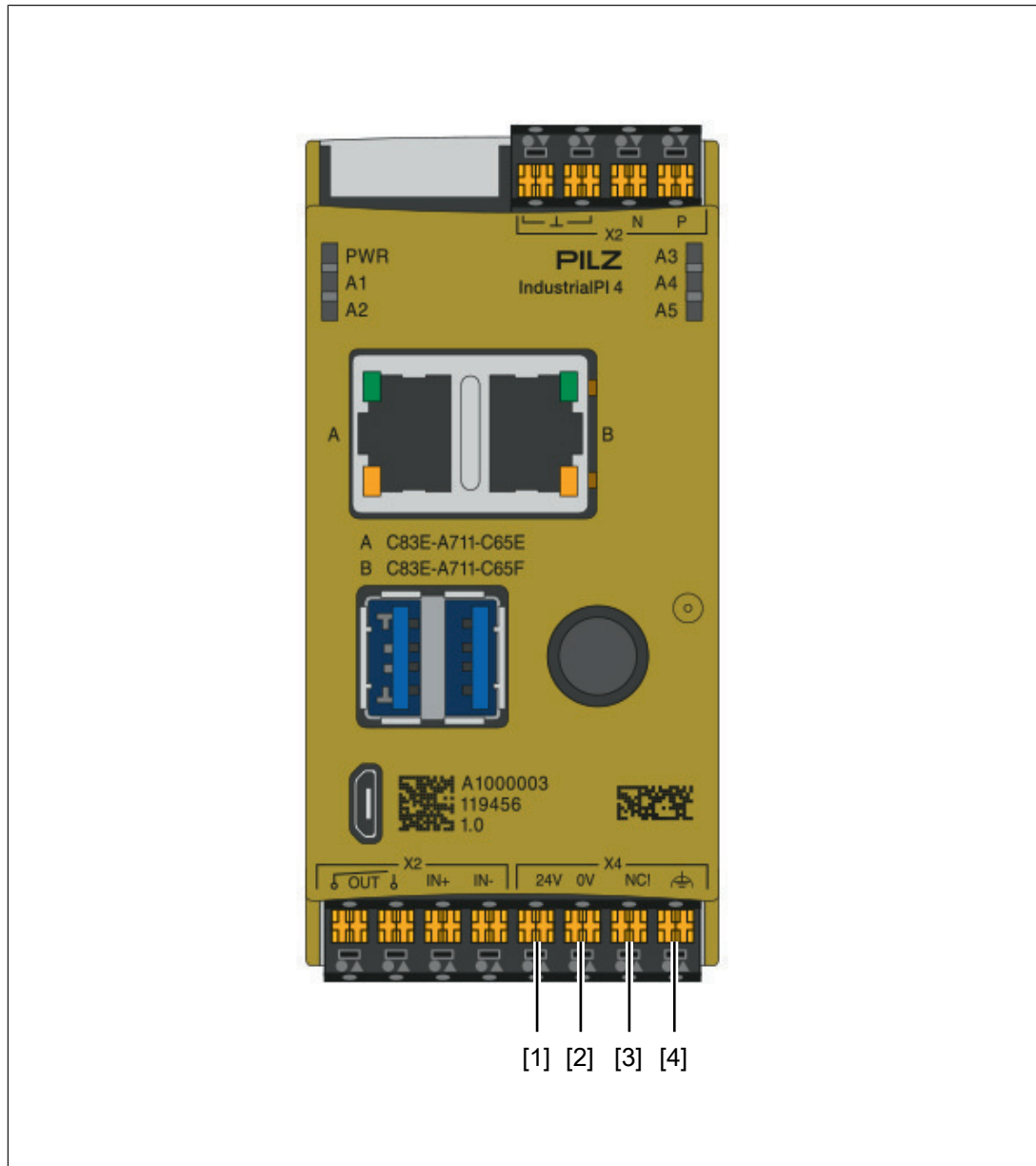
7.2 Supply voltage



NOTICE

Do not connect the IndustrialPI 4 to the voltage supply until you have connected all the devices and connectors.

If the IndustrialPI 4 is already connected to the power source and you subsequently connect a device, your devices may be damaged.



Connector pin assignment

Connection	Description
1	24 V infeed for the supply to the IndustrialPI 4 and connected modules
2	0-V infeed (earth)
3	Not assigned
4	Functional earth (connection to improve EMC characteristics)

Connect power supply

Voltage supply requirements:

- ▶ A power supply with minimum 11 W.
- ▶ Cable with a cross section of 0.35 – max. 2.5 mm²

- The spring-loaded terminals are suitable for 24-12 AWG.

UL Markings



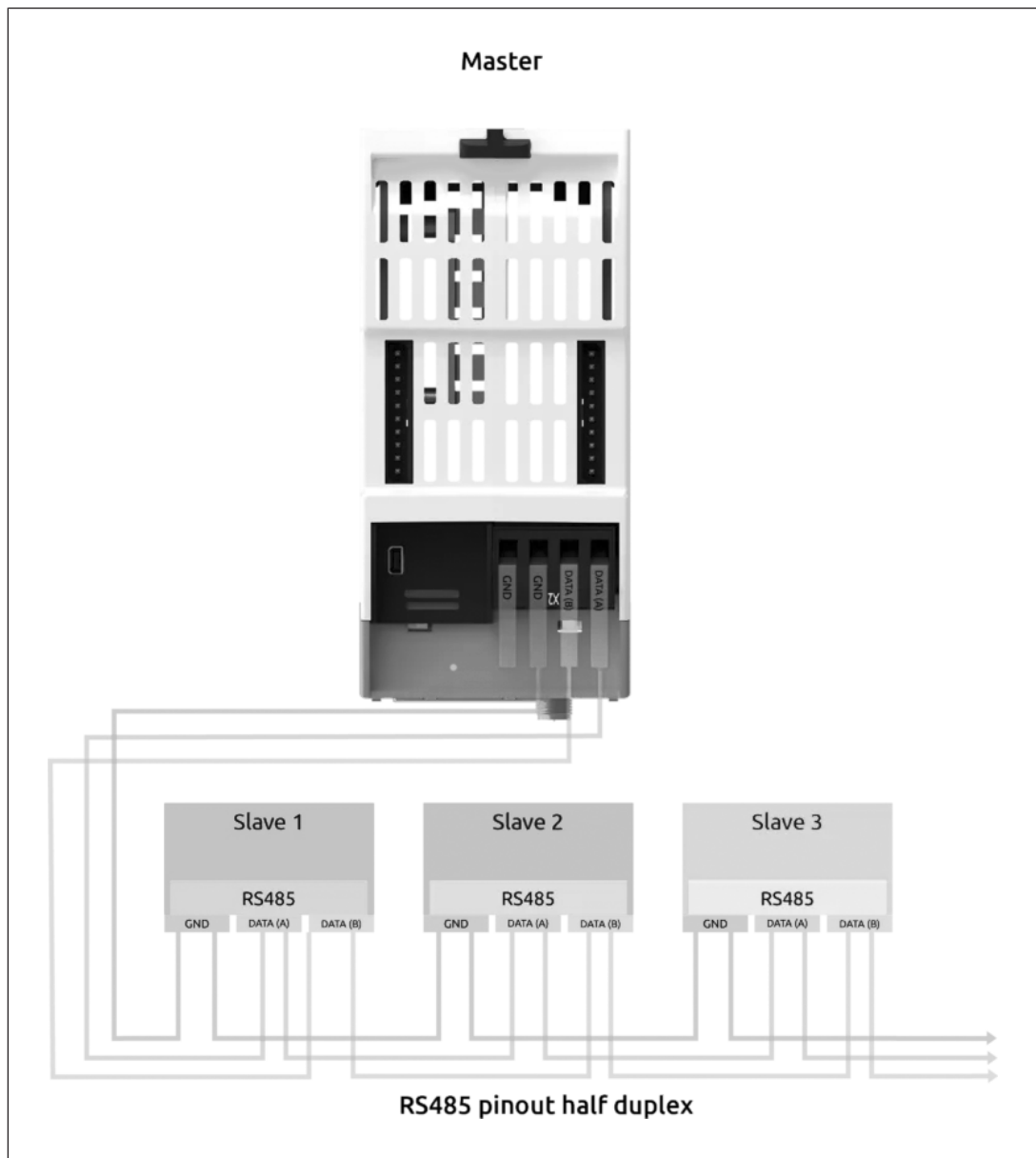
INFORMATION

The device may only be supplied by circuits that comply with **Class 2 or Safety Extra Low Voltage (SELV)** in accordance with **UL 61010-1**.

7.3 Connect serial devices

With the RS485 connection you can connect serial devices, such as a sensor, to the IndustrialPI 4.

The socket has differential data line terminals P/N (sometimes also called D+/D- or A/B) and reference terminals (internal GND and functional earth via 1 MOhm RC network)



How to best use this connection depends on your project environment. The network you are working with or the EMC load are individual factors that influence how you use this connector.

For this reason we cannot show you the optimum solution for your individual project. However, we have compiled a list of the problems that can arise, with tips on how to solve them.

RS485 is a fully differential line and normally does not require a third GND line. Due to the limitations of the input receivers ("maximum common mode voltage"), problems with signal quality may arise if no potential reference is used between transmitter and receiver. On the other hand, connecting the internal GND to a line that is subject to electromagnetic interference can cause EMC problems within the IndustrialPI 4.

For this reason we recommend you use a common functional earth between all RS485 network subscribers. That way you will achieve a good, common reference potential for the differential bus signal.

Otherwise, connect the FE terminal on the RS485 connector to the third (GND-) line of the bus.

You can also try to resolve signal problems with the GND terminal.

From Linux, the interface is addressed via the device driver node `/dev/ttyRS485`.

8 Configuration

8.1 Overview

The web status is the browser-based user interface of the IndustrialPI 4.

Here you can enable various services and functions and view device information.

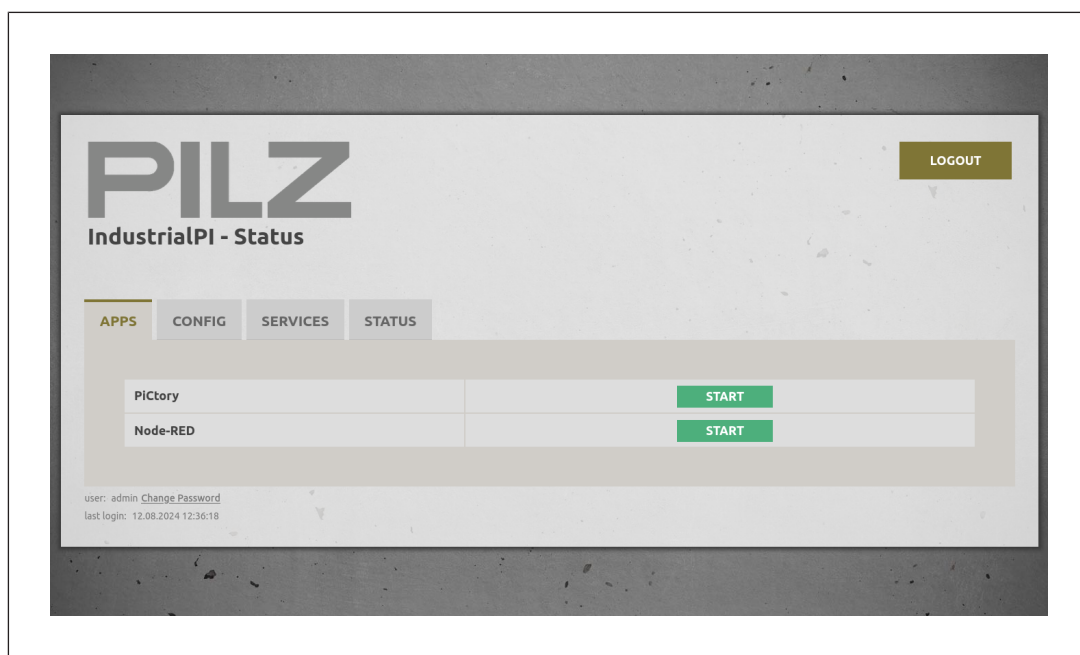
Log in to the web browser

- ▶ Open the browser.
- ▶ If Ethernet port A is connected and no DHCP service is active, enter the static IP address (169.254.60.5) of your IndustrialPI 4 in your browser's address bar.
Alternatively, if the Avahi service is active, enter the hostname: industrialpiXXXXXX.local.
For XXXXXX, enter the six-digit serial number of the IndustrialPI 4.

The login window opens.

- ▶ Log in with the user name “admin”.
- ▶ Enter your password. You'll find it on the sticker on the side of the IndustrialPI 4.
- ▶ Click on **Login**.

The status page opens.



Apps

In the **Apps** tab you'll find browser applications that you can start from this page.

Config

You can configure various functions in this tab.

Save all saves the settings. It can take up to 10 s for the change to be saved and the status to be updated.

If the changes have been saved successfully, the status message “...saved” appears.

Function	Description
Max CPU clock rate	Select maximum CPU frequency. Depending on the temperature, the CPU clock frequency may be reduced automatically. To guarantee a consistent system behaviour, this can be reduced in advance.
Enable/Disable time synchronisation daemon	Enable/disable time synchronisation via the Internet.
Enable/Disable SSH daemon to prevent remote login	Enable/disable headless access via secure shell host protocol.
Boot to GUI	Enable/disable automatic start of the graphical user interface.
Swap	To reduce access to the eMMC memory, the swapping of RAM data to the eMMC can be disabled.
Store logs on	To reduce access to the eMMC memory, logging data can be redirected to a RAM disk (tmpfs). ☐ tmpfs: Use RAM disk. ☐ eMMS: Use permanent memory.
Enable/Disable built-in Bluetooth	Switch Bluetooth on/off
Enable/Disable built-in WLAN	Switch WLAN on/off
Select antenna	Use internal or external antenna

Reset Driver resets the driver and re-reads the module configuration.

Services

In this tab you can see the services that are available. They can be enabled and disabled using **Enabled** and **Disabled**.

After each change, the status “changed” is displayed in the relevant line.

Save all saves the settings. It can take up to 10 s for the change to be saved and the status to be updated

If the changes have been saved successfully, the status message “...saved” appears.

Status

In this tab you'll find device information about the IndustrialPI 4.

8.2 Create configuration

If you wish to connect several IndustrialPI modules to each other, you will need a configuration file in addition to the PiBridge, which physically connects the modules. This configuration file tells the IndustrialPI 4 which modules are in which position, and which basic settings these modules have.

You can create the configuration file using PiCtory.

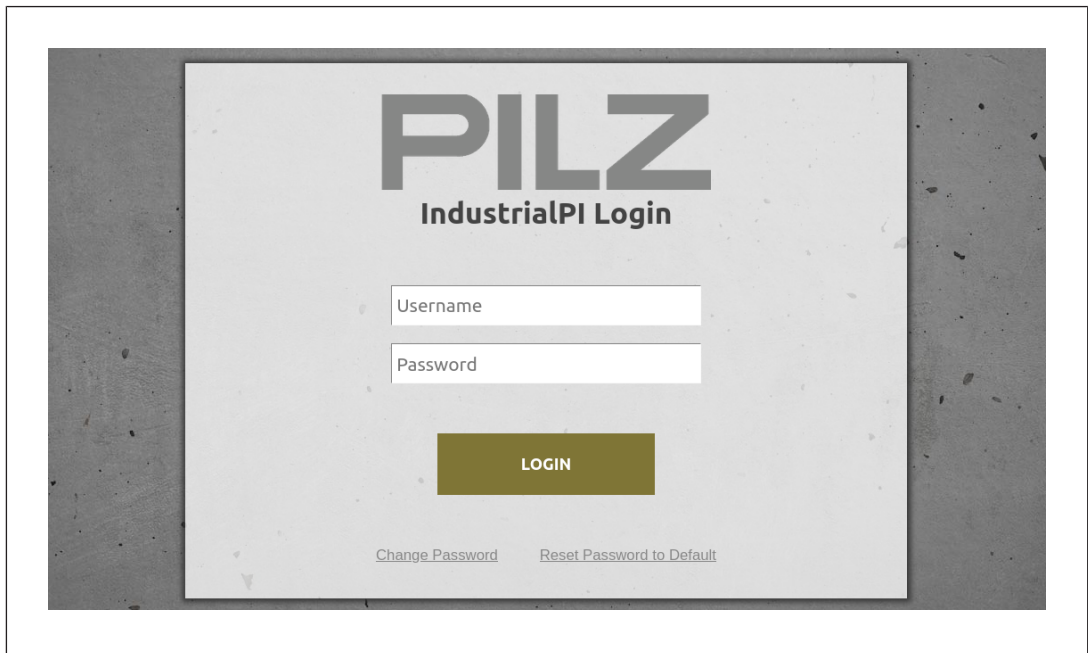
In this section we will explain PiCtory's user interface and create a configuration file.

Prerequisites:

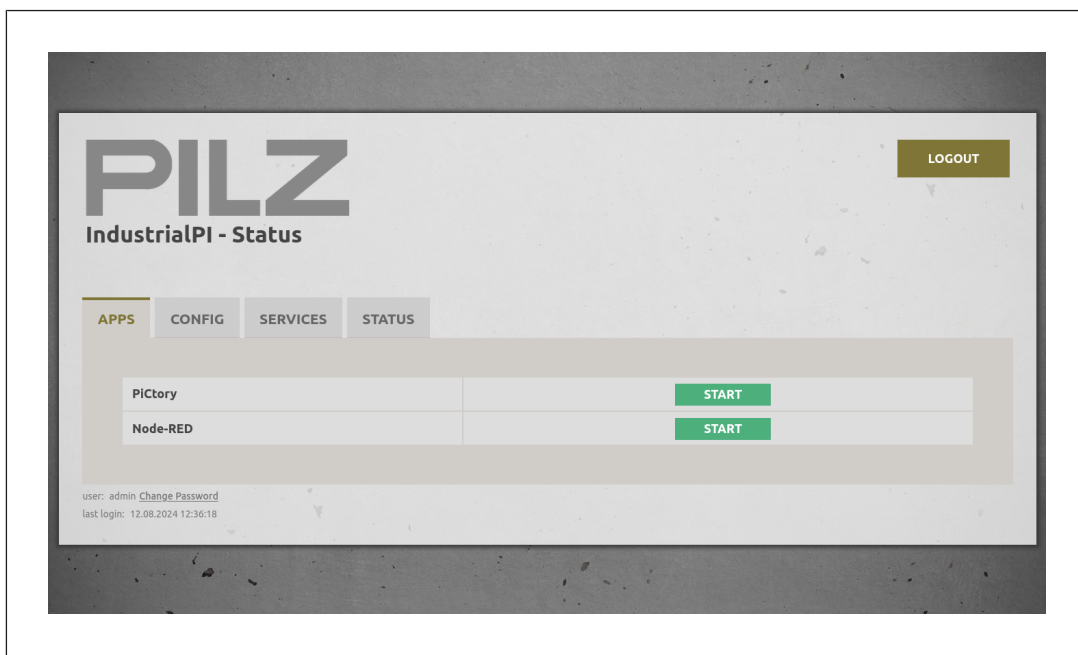
- ▶ You have a browser installed on your PC (e.g. Chrome).
- ▶ The module's IP address is configured and known.

Open PiCtory

- ▶ Open your browser.
- ▶ If Ethernet port A is connected and no DHCP service is active, enter the static IP address (169.254.60.5) of your IndustrialPI 4 in your browser's address bar.
- ▶ Alternatively, if the Avahi service is active, enter the hostname: industrialpiXXXXXX.local, where XXXXXX is the six-digit serial number of the IndustrialPI 4.
The login window opens.



- ▶ Log in with the user name "admin".
- ▶ Enter your password. You'll find it on the sticker on the side of the IndustrialPI 4.
- ▶ Click on **Login**.
You'll now see the current module status of the IndustrialPI 4.



- ▶ Click on the **Apps** tab.
- ▶ To open PiCtory, click on the **Start** button under “PiCtory”.

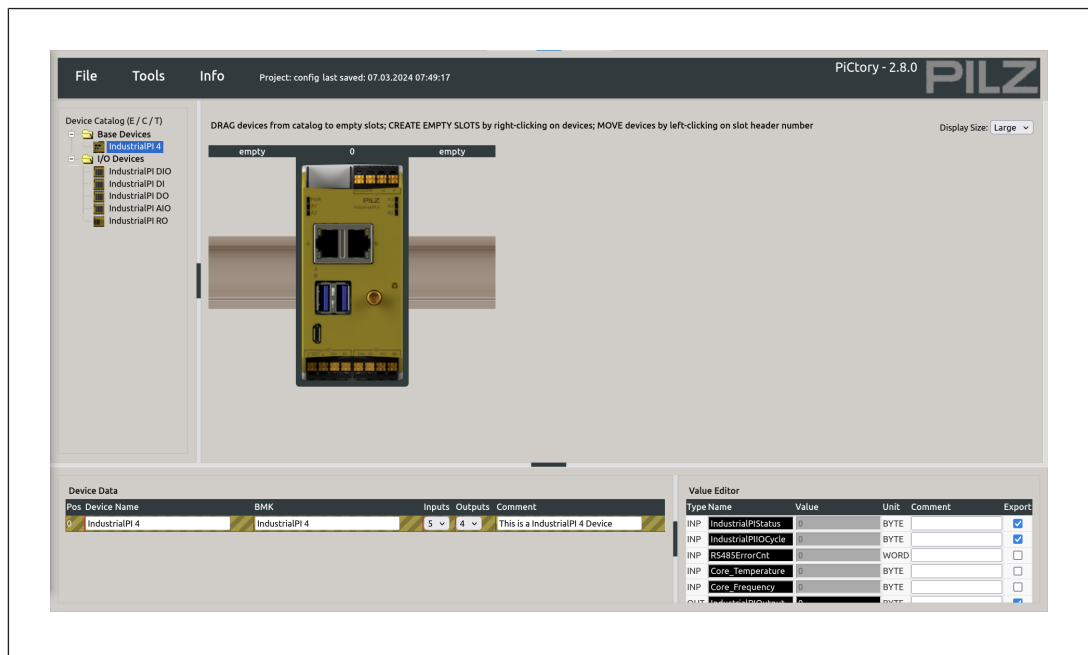
The options in the individual work areas are explained in the section below. The configuration file is then explained.

Set up configuration area

In the configuration area, you can arrange the adapters in the same way as they will later be arranged on the mounting rail. An adapter can be a module that is connected to the IndustrialPI 4 via the PiBridge, or driver software for which memory space is reserved in the process image. PiCtory will provide feedback if your module combination is impossible.

The following rules apply when combining modules:

- ▶ An IndustrialPI 4 forms the basis of each project.
- ▶ To add a new module to this virtual mounting rail, you must first create a new slot. You can then insert a module from the device catalogue (see next section).



Device Data

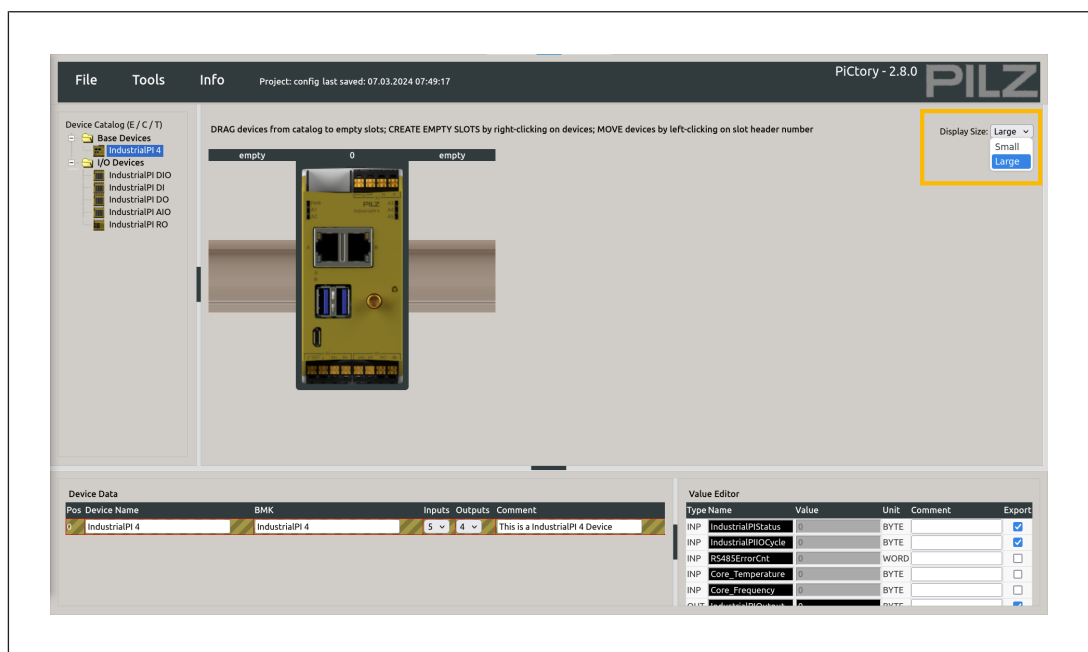
In this window you can define the basic settings for the adapters/modules (e.g. module name).

Value Editor

In the Value Editor you can define the input and output connections you wish to use. You can also name the individual connections.

Set up workspace

The workspace can be adapted via the **Display Screen** menu.

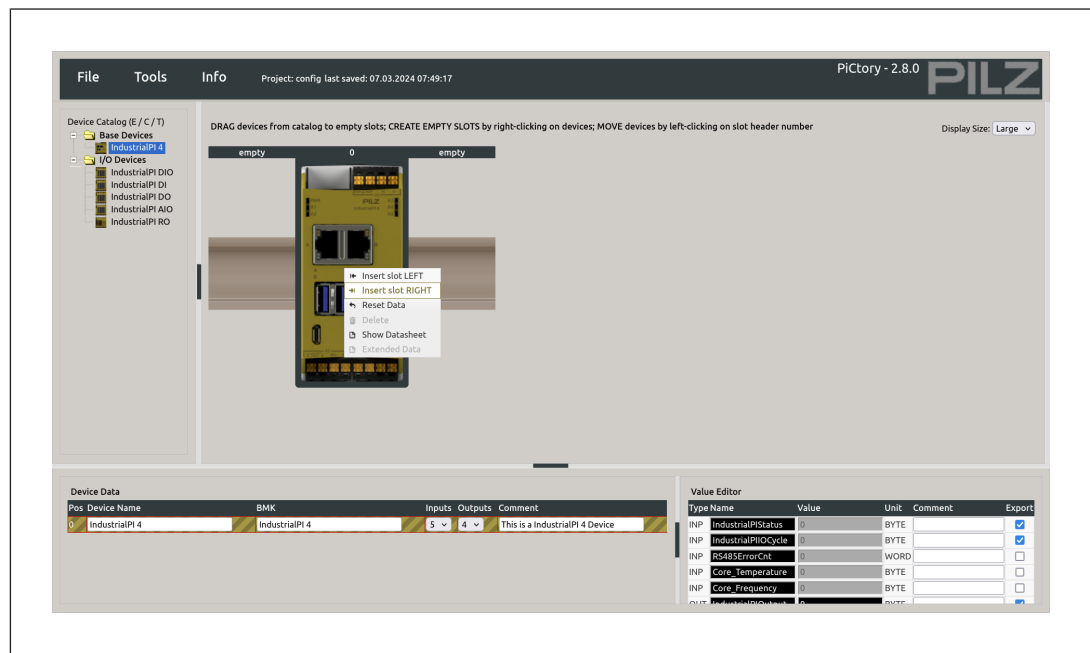


- Change the size of the modules on the configuration board:
 - Click on the **Display Size** drop-down menu.
 - Set the size in which the modules are to be displayed.
- Show and hide window
 - Click on the black button to hide a window.
 - You can restore the window by clicking again on the same button.
- Change window size
 - Place the cursor on the window frame that you wish to enlarge.
 - Hold down the left mouse button and adjust the window size according to your needs.

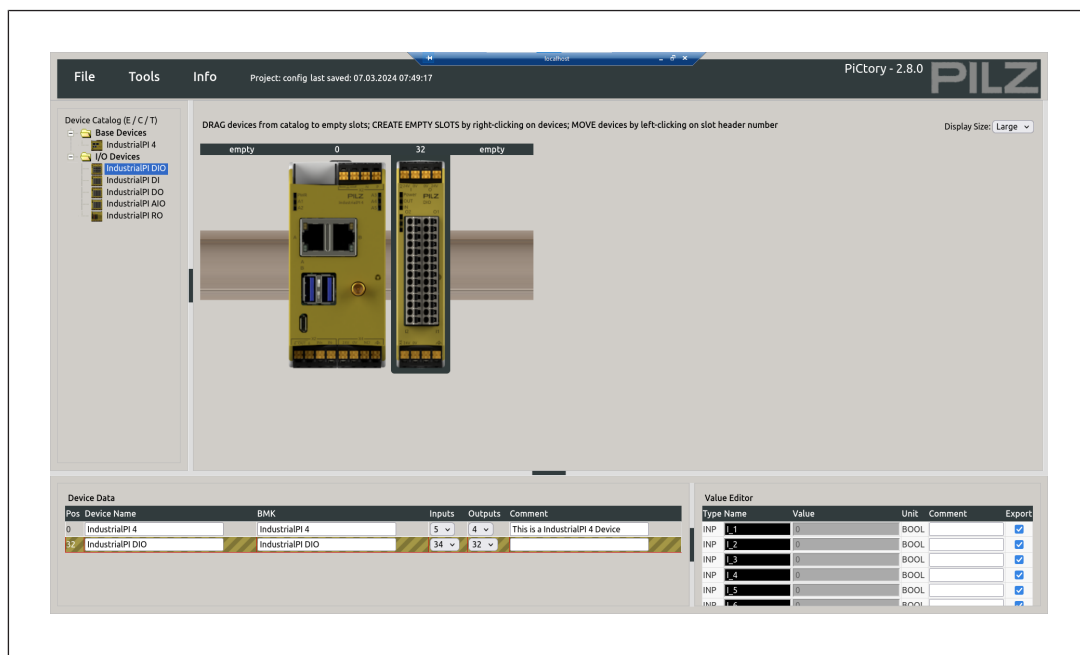
Perform configuration

The configuration is explained using the example of the IndustrialPI 4 and IndustrialPI DIO.

- Right-click on the IndustrialPI 4 that's on the configuration board.
 - Select **Insert Slot LEFT** in the context menu.
- An empty column (Empty) is created to the left of the IndustrialPI 4.



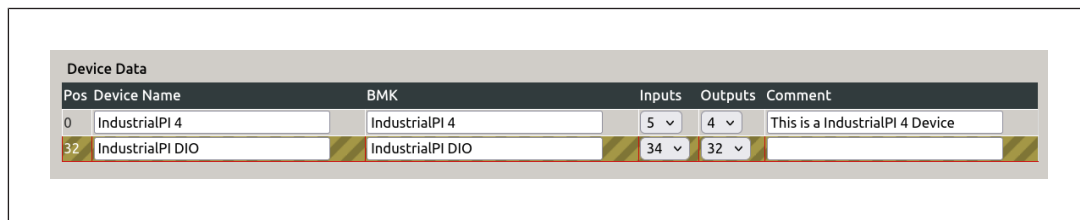
- Select the IndustrialPI DIO from the device catalogue.
- Drag & drop it into the empty column on the configuration board.



- Click on the IndustrialPI 4.

There are 2 workspaces below the configuration boards. This is where you can configure the modules.

- Define the basic settings for your modules under **Device Data**.
 - Module name (Device Name)
 - Equipment identifier (BMK)
 - Comment



- Define your inputs and outputs in the **Value Editor**. These values determine whether the inputs and outputs are addressed via a Bool variable or a 16-Bit variable. Select the higher value for the Bool variable and the lower value for the 16-Bit variable.

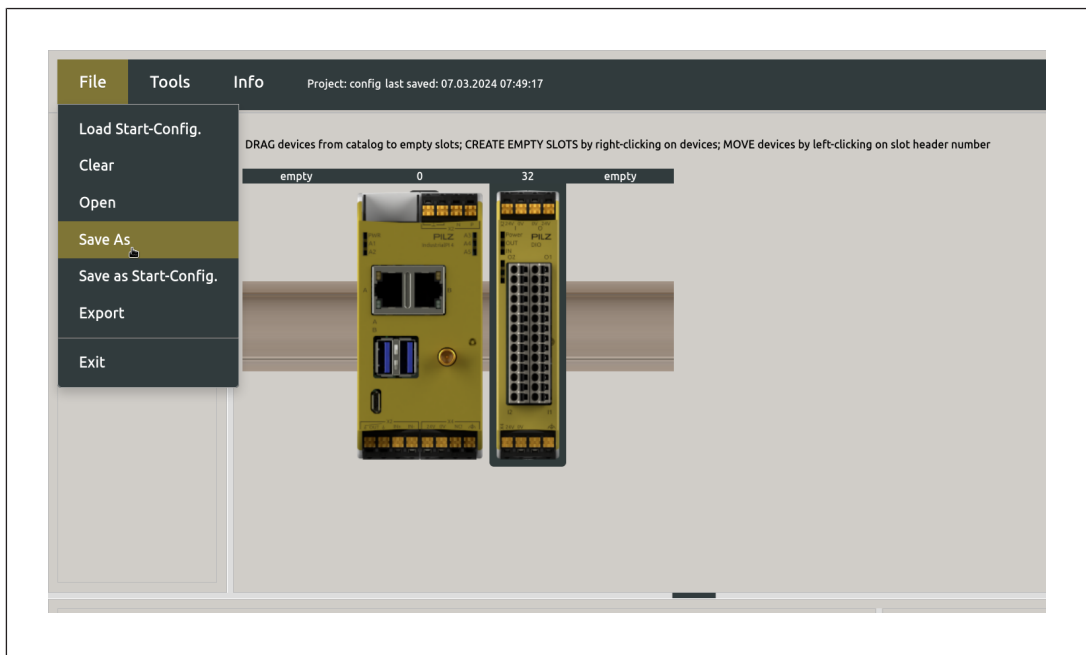
Value Editor					
Type	Name	Value	Unit	Comment	Export
INP	IndustrialPIStatus	0	BYTE		☒
INP	IndustrialPIIOCycle	0	BYTE		☒
INP	RS485ErrorCnt	0	WORD		☐
INP	Core_Temperature	0	BYTE		☐
INP	Core_Frequency	0	BYTE		☐
OUT	IndustrialPIOutput	0	BYTE		☒
OUT	RS485ErrorLimit1	10	WORD		☐
OUT	RS485ErrorLimit2	1000	WORD		☐
OUT	IndustrialPILED	0	WORD		☒

Example for configuration of the IndustrialPI DIO:

- ▶ Give the input I_1 (or Input_Pin_1) the name "Sensor1".
- ▶ Check the box under **Export**.

Value Editor					
Type	Name	Value	Unit	Comment	Export
INP	Sensor1	0	BOOL		☒
INP	I_2	0	BOOL		☒
INP	I_3	0	BOOL		☒
INP	I_4	0	BOOL		☒

- ▶ Click on **File>Save As** to save the file.



- ▶ Enter the project name:
- ▶ Click **OK**.
- ▶ Click on **Tools>Reset Driver** to enable the changes for the adapter.



- ▶ If you are sure, click **OK**.
- ▶ Click on **File>Export**.
- ▶ A window opens.
Here you can specify the format of the file and enter the file name.



Select a format that you wish to continue working with.

- ▶ Select **Download** to save the export file as a json file

or

- ▶ Select **Show Only** to view the export file.
- ▶ Enter a file name under **Export Filename**.
- ▶ Click **OK**.

8.3 Configure WLAN and Bluetooth

Configure WLAN

You can configure the WLAN interface via the command line.

- ▶ Enter the following command to search for networks in the vicinity:

```
sudo iw wlan0 scan
```

- ▶ Use the following command to connect to an unencrypted network:

```
sudo iw dev wlan0 connect <YOUR ESSID>
```

To avoid the command appearing in the command line history, start the command line with a space.

- ▶ Enter the following command to display the link status:

```
sudo iw dev wlan0 link
```

Set up WLAN via the command line:

The **wpa_supplicant** tool can configure network interfaces and connect to wireless networks.

Set up WLAN via the command line tool **nmtui**.

Starting from image version Bullseye you can use the command line tool nmtui. This manages the network connections via the NetworkManager.

Configure Bluetooth

A Bluetooth interface is available via the same SMA socket as for the WLAN interface. It complies with the Bluetooth standard 5.0 and is connected on the Compute Module 4.

- ▶ Enter the following commands to configure the HCI interface on startup and start the service immediately:

```
sudo systemctl enable hciuart
```

```
sudo systemctl start hciuart
```

- ▶ Start the Bluetooth daemon with:

```
sudo systemctl start bluetooth
```

BlueZ is the Bluetooth system for Linux, which allows an IndustrialPI 4 to communicate with classic and energy-saving Bluetooth devices.

"bluetoothctl" is the command line interface to BlueZ.

Enter `bluetoothctl -v`.

9 Operation

9.1 Display elements and messages

LED	LED	LED
PWR (Power)	Green	The device is ready for operation.
	Red	An error occurred. Check that all cables are plugged in correctly.
A1 ... A5	Freely assignable, can be controlled with status bytes	

9.2 Status messages in the process image

On the IndustrialPI 4 devices, status bytes are used to enter multiple functions or information at a specific location in the process image. You can read and write status bytes.

Status byte for LEDs

Bit	Component	Status information
2:0	LED A1	000 = Off 001 = Red 010 = Green 100 = Blue 011 = Orange 110 = Cyan 101 = Magenta 111 = White
5:3	LED A2	
8:6	LED A3	
11:9	LED A4	
15:12	LED A5	

Status byte IndustrialPI

The "IndustrialPIStatus" byte contains the status of the piControl driver. Please note that a distinction is made here between I/O modules (DIO, DI, DO, AIO, MIO) and IndustrialPI gateways.

Bit	Meaning
0	piControl driver is running.
1	At least one I/O module is connected that was not configured with PiCtory.
2	At least one I/O module has been configured with PiCtory, but is not connected.
3	One I/O module occupies more or fewer bytes in the process image than specified in the configuration. This can only happen if the version of the configuration file or the device description files you are using do not match the firmware in the I/O module. Get an update from PiCtory.
4	Unused

5	Unused
6	Digital input on terminal X2

The program piTest -d shows in detail which modules are connected and whether they have been configured in PiCtory.

Status byte RS485ErrorCnt and RS485ErrorLimit

The status byte "RS485 ErrorCnt" controls communication with the I/O modules. This is important if you want to integrate devices into the system.

The I/O modules exchange data with the IndustrialPI 4 via a serial line. The data is transmitted electrically in accordance with the RS485 standard.

The driver piControl scans the connected modules during startup and reset. It then communicates cyclically with the modules in the order in which they are mounted on the DIN rail next to the IndustrialPI 4, from left to right. First, piControl reads the output values for the respective module from the process image and sends them to the I/O module. The input values are written to the process image in response. This procedure is repeated with the next module, and so on in sequence.

It can happen that data is disturbed during transmission between the IndustrialPI 4 and I/O module. piControl has an internal error counter for each module. If a transmission error has occurred, the counter is incremented. The maximum value of the counter is 255. As soon as a telegram has been transferred back and forth correctly between the IndustrialPI 4 and I/O module, the counter is reset to 0. The first error is ignored. If two or more errors occur in succession, the following error handling becomes active.

The value RS485ErrorCnt contains the sum of all errors. Where n I/O modules are connected, the value can be between 0 and 255*n. At the end of each cycle, the error counter is compared with the two limit values RS485ErrorLimit1 and RS485ErrorLimit2. If it has reached RS485ErrorLimit1, a message is logged in kern.log. If the error counter has reached RS485ErrorLimit2, piBridge communication is stopped.

If one of the values is set to 0, the respective check is disabled.

By default, RS485ErrorLimit1 is set to 10 and RS485ErrorLimit2 to 1000.

9.3 Process image with piTest

piTest is a tool that allows you to access your system's process image. The code for this tool can be found on the IndustrialPI 4 in the folder "/home/pi/demo".

You can use piTest in the command line. Open with the command "piTest".

Commands

In the following table you will find a list of all the commands you can use with piTest.

Command:	Application
-1	Single output, not continuous.
-d	Displays a list of the devices used. Useful if a device has not been configured in the web browser.

-f	Update firmware
-g <o>,	Read Bit b starting from offset 0.
-l	Wait for the driver to reset.
-q	Only the value is output, no text.
-r <var_Name> [<f>]	Read variable and output value. f optional parameter for the output format (h = hexadecimal, d = decimal (default), b = binary).
-r <o>,<l> [<f>]	Read l Bytes starting from offset o. f optional parameter for the output format (h = hexadecimal, d = decimal (default), b = binary).
-R <addr>,<bs>	Reset the counters or encoders of a DIO or DI module. <addr> address of the module as displayed with -d <bs> is a bit field for selecting the affected inputs. If the counter is to be reset at input pin N, bit number N must be set to 1. For example: -R 32,0x0014 Reset the counters for inputs I_3 and I_5 of the module to address 32.
-s <o>,,<0 1>	Set bit b (0-7) starting from byte offset b with the value 0 or 1.
-v <var_Name>	Provides information about a variable, e. g.: offset and length
-w <var_Name>,<v>	Write the value to the variable.
-w <o>,<l>,<v>	Write l Bytes starting from offset o in hexadecimal format with the value v. Length can be 1, 2 or 4.
-x	Driver reset, corresponds to restarting the piControl process.

9.4 Images

9.4.1 Logins and passwords

The passwords for the command line and web application can be found on the sticker on the side of the IndustrialPI 4. Users are called

- ▶ Command line: pi
- ▶ Web application: admin

Change password

Each IndustrialPI 4 is delivered with its own login data, which was randomly generated during production. This can be found on the sticker on the side of the IndustrialPI 4. You can change the password.

Change password for the command line

Prerequisites:

- ▶ You have access to your IndustrialPI 4
- ▶ Enter the command "passwd".
- ▶ Enter the current password.
- ▶ Enter the new password. You are prompted to enter the new password twice.



INFORMATION

On Linux, your password entry is not displayed. If the password was entered correctly, it is accepted.

Change password on the web application

Prerequisites:

- ▶ You have access to your IndustrialPI 4.
- ▶ Enter your user name and password.
- ▶ Log in to the web application
- ▶ In the footer, click on the **Change Password** link.
- ▶ Enter the current password and the new password.
- ▶ Select the option **Remove -Reset Password to Default- option**. This prevents the password from being reset to the default password without logging in.

**NOTICE**

If network access is available, the IndustrialPI 4 can be accessed via the Internet. Depending on how this network access is secured, in certain circumstances it may also allow strangers to log on to the device and thus gain access to data and all the functions. For this reason you should always choose a “strong” password and work in “headless” mode, i.e. access across the network only from devices that you know. For example, unknown devices could log keystrokes and thereby spy on your login information.

9.4.2 Firmware update

Updating the IndustrialPI 4

Procedure:

Connect the IndustrialPI 4 to the Internet.

Call up the command line of the IndustrialPI 4.

Enter the following command to read and update all available package lists:

```
sudo apt-get update
```

Enter the following command to install all available updates:

```
sudo apt-get upgrade
```

Updating I/O modules

Procedure:

- ▶ Switch off the automation system.
- ▶ Remove all the I/O modules, except for the module you wish to update.
- ▶ Switch on the automation system.
- ▶ Adjust the configuration in PiCtory so that it only contains one IndustrialPI 4 and the I/O module.
- ▶ Reset the driver via the menu or on the command line using piTest -x.
- ▶ Check which firmware version your module was before the update. You can do this by entering the following command:

```
piTest -d
```

```
Found 2 devices:
```

```
Address: 0 module type: 95 (0x5f) RevPi Connect V1
```

```
Module is present
```

```
input offset: 0 length: 6
```

```
output offset: 6 length: 5
```

```
Address: 32 module type: 98 (0x62) RevPi DO V1.0
```

```
Module is present
```

```
input offset: 11 length: 70
```

```
output offset: 81 length: 18
```

In this example, a DO module is connected with Version 1.0.

- Enter the following command to update the module's firmware:

```
$ sudo apt-get update
```

```
$ sudo apt-get install revpi-firmware
```

```
$ piTest -f
```

```
update firmware: 1.0 --> 1.3
```

The version was updated.



INFORMATION

On an IndustrialPI DIO, DI or DO, it takes about 20 seconds between calling `piTest -f` and outputting the firmware update.

- Switch off the IndustrialPI4 with the following command:

```
sudo shutdown
```

- Disconnect the IndustrialPI4 and the module from the supply voltage.

- Wait a few seconds.

- Switch both devices back on.

- Enter this command again to check that the version was updated:

```
piTest -d
```

```
Found 2 devices:
```

```
Address: 0 module type: 95 (0x5f) RevPi Connect V1
```

```
Module is present
```

```
input offset: 0 length: 6
```

```
output offset: 6 length: 5
```

```
Address: 32 module type: 98 (0x62) RevPi DO V1.3
```

```
Module is present
```

```
input offset: 11 length: 70
```

```
output offset: 81 length: 18
```

9.4.3 Backup and install image

If you want to back up a hard drive on your PC, backup programs write a complete image of the memory contents to a backup medium (e.g. a second hard drive). Such a memory image is called an “image”. The IndustrialPI 4 does not have a hard drive as a storage medium. An “eMMC”, i.e. a type of memory card that is permanently installed (“embedded multimedia card”), replaces the hard drive and permanently stores the operating system and all user files. If the contents of this eMMC are overwritten or deleted due to an error, your IndustrialPI 4 will no longer have an operating system and will no longer be able to start. For such an eventuality, you should take precautions and back up the complete image of the

eMMC on an external storage medium. For this purpose there are Raspberry utilities, which you can use to save the image to a PC and also restore it from the PC back to the IndustrialPI 4.

Here we demonstrate how to back up an image on to a USB stick. Alternatively, you can save the image on the hard drive of a PC or on an external hard drive, for example.

In this case we use a PC with a Windows operating system. But the backup also works with Linux. You will find the relevant tools and help on the Raspberry Pi homepage.

You need:

► Hardware

- PC
- IndustrialPI 4
- Power supply for the supply voltage
- Cable USB 2.0 A-male to Micro-USB-female
- USB stick

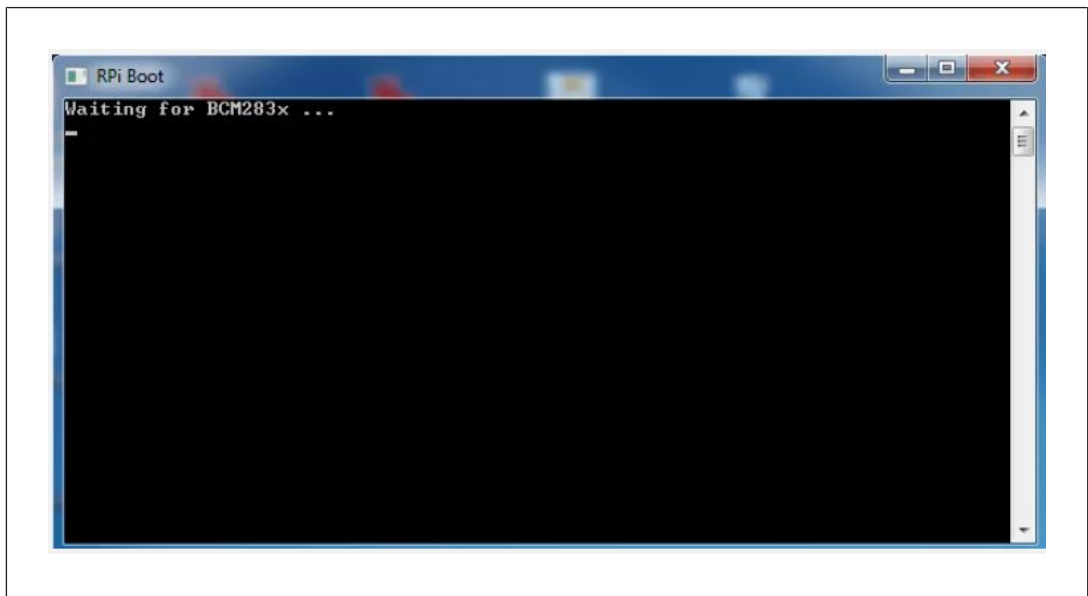
► Software:

Download these files/programs and install the programs on the PC:

- Image
- RPi Boot (Windows Installer): https://github.com/raspberrypi/usbboot/raw/master/win32/rpiboot_setup.exe
- Win32 Disk Imager

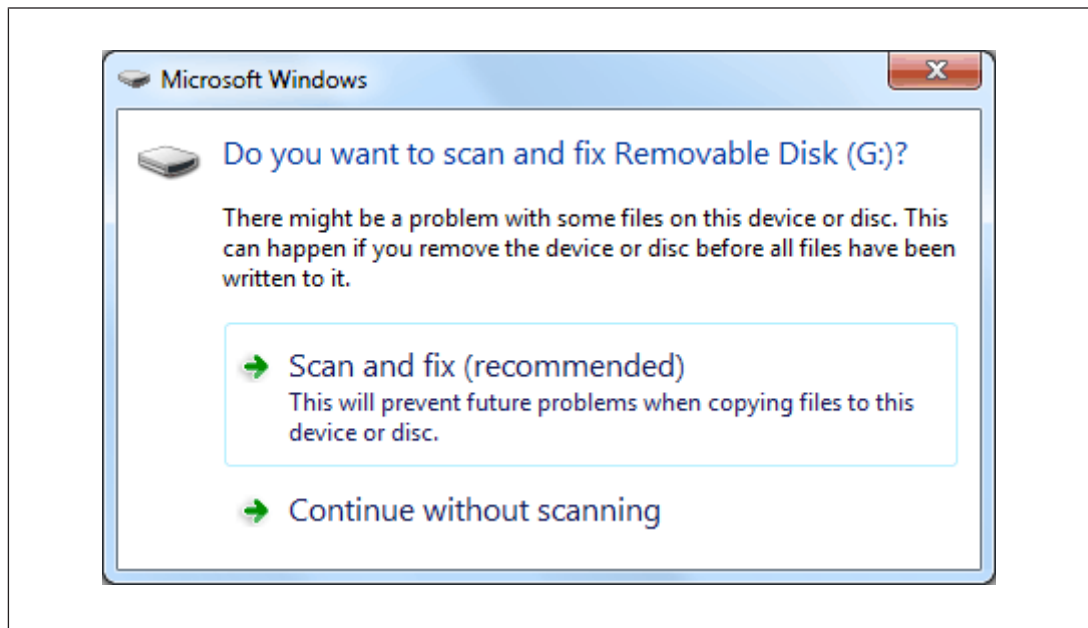
Back up image on to a USB stick

- Connect the Micro-USB socket on the IndustrialPI 4 to a USB-A socket on your PC.
- Open **RPi Boot**.



- ▶ Connect the IndustrialPI 4 to the supply voltage.

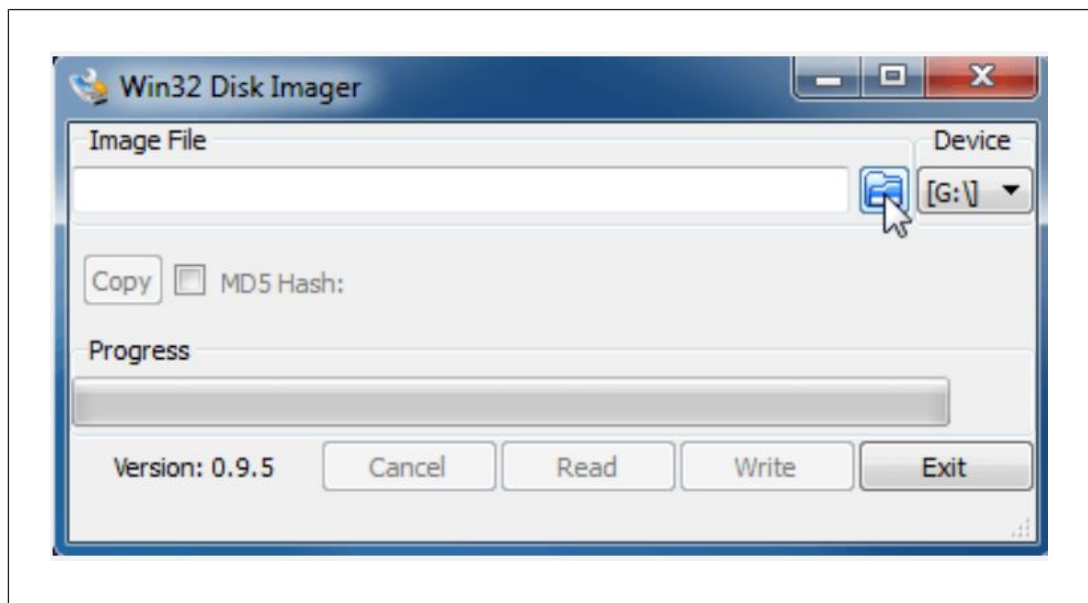
RPI Boot will now search for the IndustrialPI 4. The following window opens:



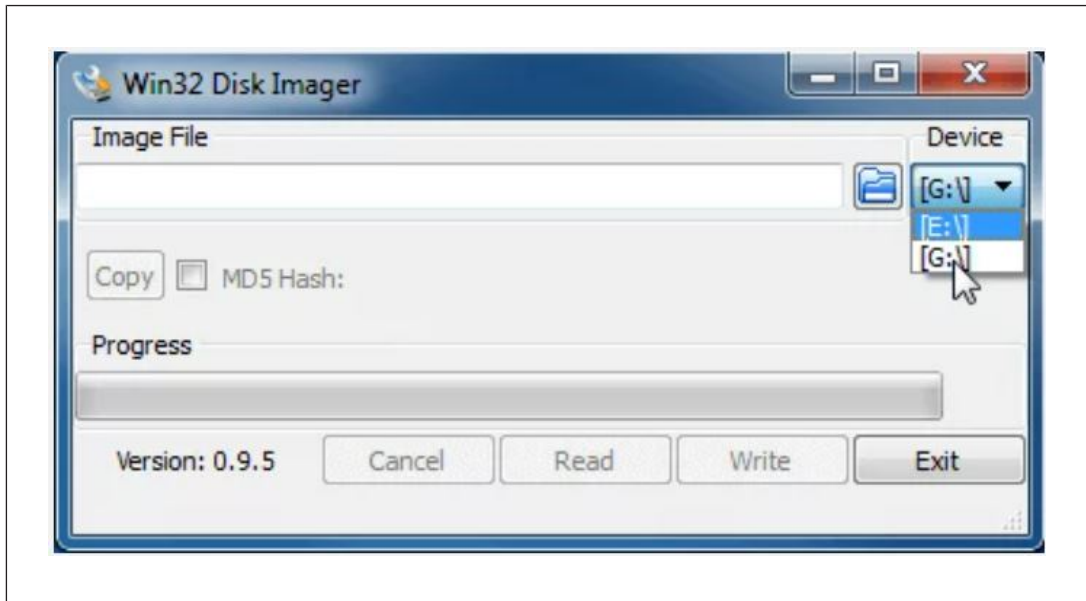
The IndustrialPI 4 was detected.

- ▶ Click on **Continue without checking**.
- ▶ Open **Win32 Disk Imager**.

The following window opens:



- ▶ Click on the folder icon.
- ▶ Select the USB stick, to back up the image.
- ▶ After selecting, enter the required file name. The name must have the file extension ".img".



- ▶ Select the IndustrialPI 4 from the drop down list. Only the drive letters are displayed for selection. If the drive letter is no longer known, then look in Explorer. You'll find the IndustrialPI 4 under **Devices with removable media**. It will be displayed as "boot".
- ▶ Click on **Read**.

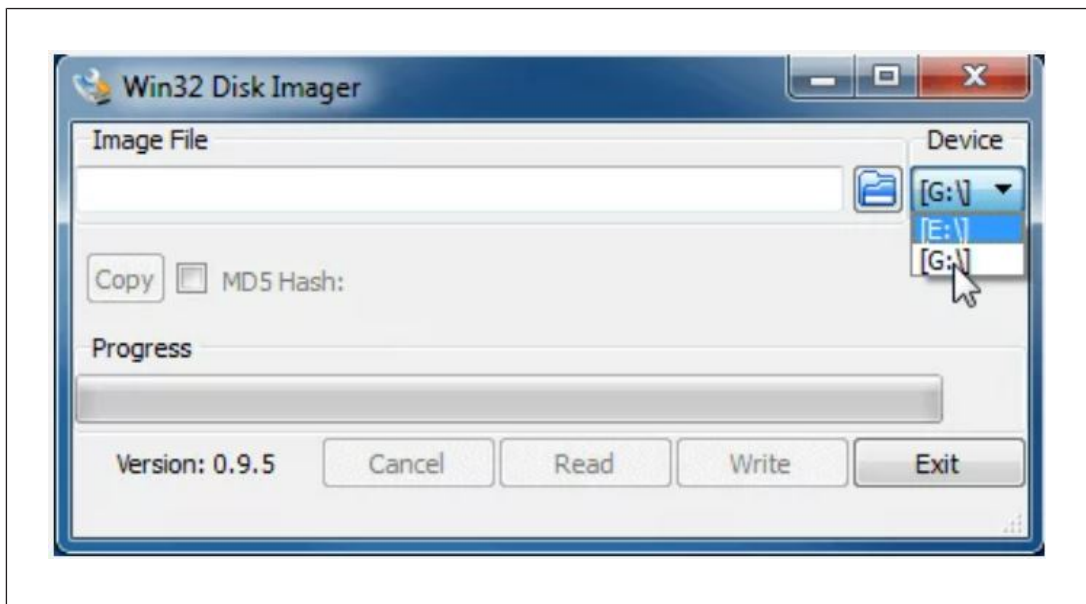
The backup of the image will now be created. This process may take a few minutes. You will receive confirmation that the file was created.

Install new image

- ▶ Unpack the image file downloaded from our homepage.
- ▶ Generate the MD5 check sum to check the validity of the image file:
 - In the Windows search window, enter "command prompt" and open the window.
 - Navigate to the directory in which the image file is stored.
 - Enter the following command:


```
CERTUTIL -hashfile <name-of-image-file> MD5
```

 Replace <name-of-image-file> MD5 with the name of the image file (e.g. 2024-02-15-revpi-bullseye-arm64.img)
- ▶ Check that the generated check sum matches the supplied *.MD5 file.
If the check sum does not match, download the image file again and repeat the process.
- ▶ If the check sums match, open **Win32 Disk Imager**.
- ▶ Select the IndustrialPI 4 from the drop down list. Only the drive letters are displayed for selection. If you don't remember which it is, then look in Explorer. You'll find the IndustrialPI 4 under **Devices with removable media**. It will be displayed as "boot".

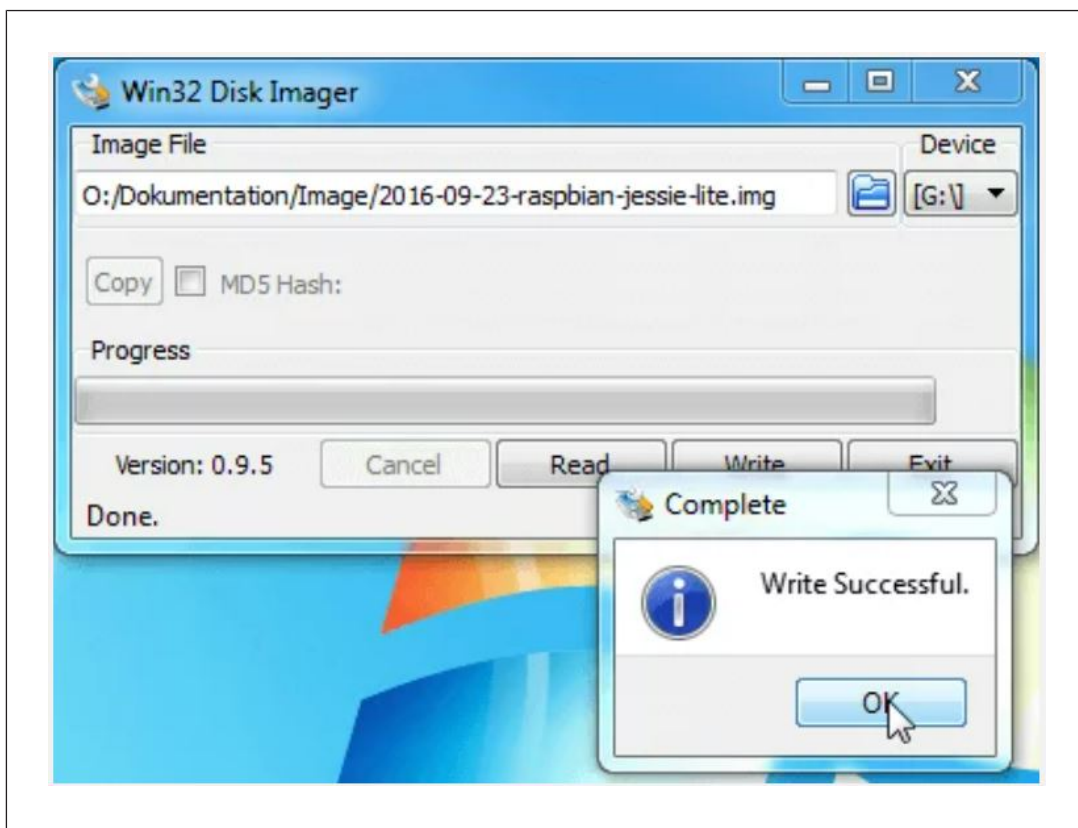


NOTICE

Check that you have actually selected your IndustrialPI 4. Data may be destroyed if you accidentally select the wrong device.

- ▶ Click on the folder icon.
- ▶ Select the image file.
- ▶ Click on **Write**.

The image is loaded on to the IndustrialPI 4. This process may take a few minutes. You will receive confirmation when the file has been transferred:

**NOTICE**

While the USB connector is connected to the IndustrialPI 4, it is in flash mode and can only be put into operating mode by restarting.

First remove the USB cable and switch the IndustrialPI 4 off and on.

You can log in to the IndustrialPI 4. The first time you log in, the login name is **pi** and the password is **raspberry**.

If you are using Stretch as an image, the first time you log in you will be asked which IndustrialPI device you are using.

- State that you are using an IndustrialPI 4.

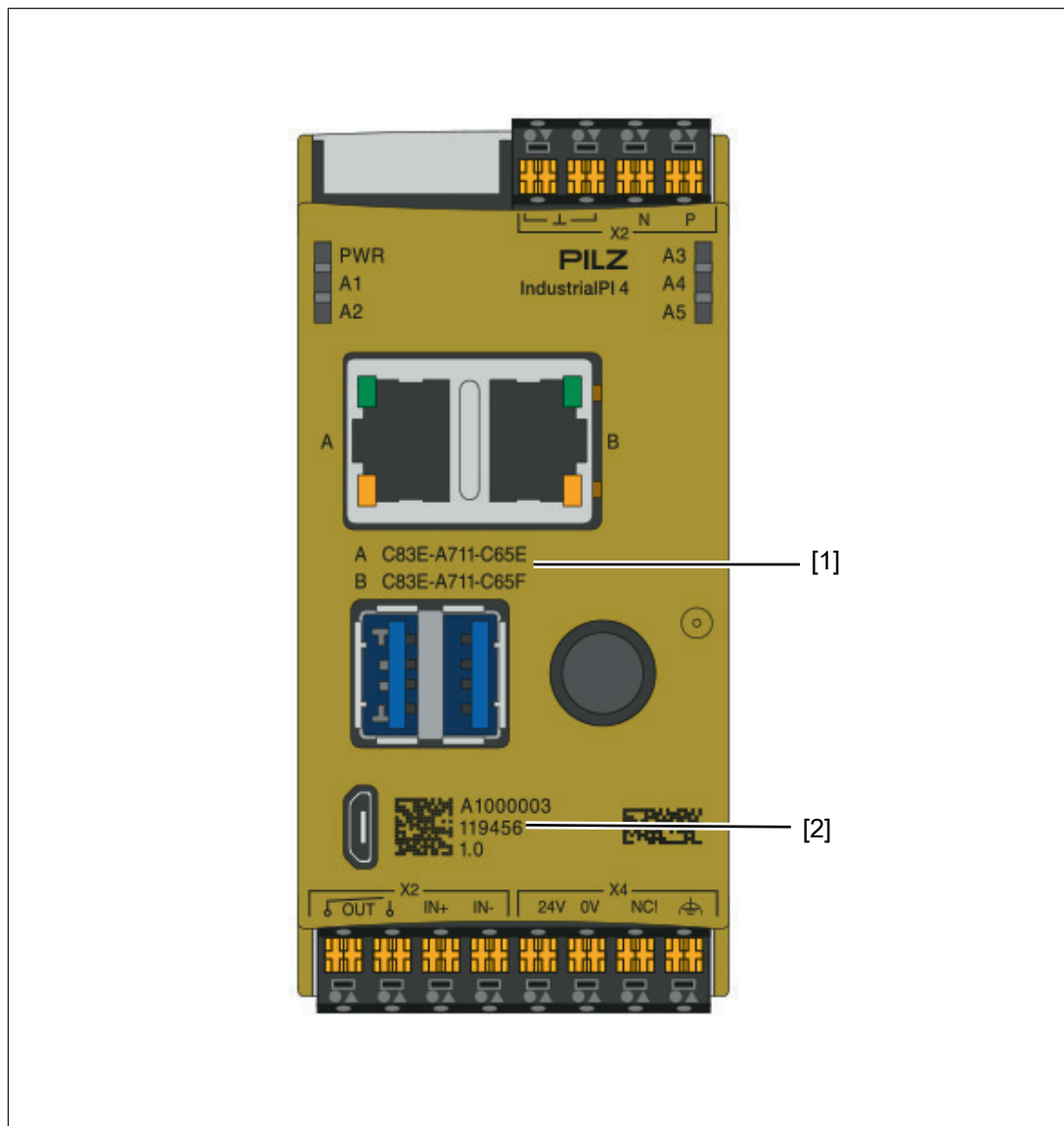
The data that you need for the device is then stored in the image. If you enter the wrong device, your device may not work properly.

- Enter the serial number and MAC address that's printed on the front of the housing.

1: MAC address

2: Serial number

The password for the next login is automatically reset to the default password, which is printed on the sticker on the side of the IndustrialPI 4.



- Restart the IndustrialPI 4 with `sudo reboot`. It can only be used to its full extent once it has been restarted.

9.5 Permanently disable WLAN and Bluetooth

WLAN is only available with order number A1000003. WLAN and Bluetooth can be switched off and on via the web application.

WLAN and Bluetooth can be permanently disabled as the device is booted.

Permanently disable WLAN

Add the following entry to the configuration file `config.txt` in the `/boot` directory under `[all]`:

```
dtoverlay=disable-wifi
```

Permanently disable Bluetooth

Add the following entry to the configuration file config.txt in the /boot directory under [all]:

```
dtoverlay=disable-bt
```

The option to turn on Bluetooth still appears on the web interface,
but it cannot be enabled this way.

10 Technical details

Housing dimensions (H x W x D)	96 x 45 x 110.5 mm
Attachment	Mounting rail in accordance with EN 50022 (35 x 7.5 mm)
Housing material	Polycarbonate
Weight	Approx. 197 g / 224 g (incl. connector)
Protection type	IP20 Self Declared
Voltage supply	10.8 ... 28.8 V DC1
Maximum power consumption	20 Watts (incl. 2 x 800 mA USB output current) ²
Permitted operating temperature	-25 ... +55 °C
Permitted storage temperature	-40 ... +85 °C
Max. relative humidity (at 40 °C)	93 % (non-condensing)
Interfaces	2 x USB A 3.2 Gen 1 2 x RJ45 Gbit Ethernet 1 x RS485 screw terminal connection 1 x Micro-USB socket (exclusively for transferring the image to eMMC) 1 x Micro-HDMI 2.0a (4K) 2 x PiBridge (connections left and right) 1 x RP-SMA socket to connect an external WLAN/BT antenna (2.4 / 5 GHz) (order no.: A1000003)
Plug-in connector	1 x 4-pin spring-loaded terminal for RS485 1 x 4-pin spring-loaded terminal for relay contact and signal input 1 x 4-pin spring-loaded terminal for supply voltage
Processor	Broadcom BCM2711 with Quad-Core processor Arm Cortex-A72
Clock frequency	1.5 GHz
Processor cooling	Passive with heat sink
RAM	4 GB LPDDR4 (order no.: A1000002), 8 GB LPDDR4 (order no.: A1000003)
eMMC Flash memory	32 GB
WLAN / Bluetooth	2.4 GHz, 5.0 GHz IEEE 802.11 b/g/n/ac wireless; Bluetooth 5.0, BLE (order no.: A1000003)
Number of digital inputs	1

Type of digital input	24 VDC control voltage, galvanically isolated (e.g. for power good signal on a UPS)
Input threshold	Approx. 10 VDC (0 -> 1) or 7 VDC (1 -> 0); input current 2.4 mA (in accordance with IEC 61131-2)
Number of digital outputs	1
Type of output	Opto-decoupled semiconductor relay, N/O, max. 30 V, 300 mA DC, any polarity
Software connection of input and output	Via GPIOs or process image
Hardware watchdog	Watchdog in RTC module, freely configurable watchdog character device
Compatible IndustrialPI modules	All IndustrialPI I/O modules can be connected via the system bus PiBridge. Up to 5 modules each can be connected to the left and right side of the device
EMC emission	In accordance with IEC 61000-6-4, emissions for industrial environments
EMC immunity	In accordance with IEC 61000-6-2, immunity for industrial environments
Mean time between failures (MTBF) at 25 °C	30.7 Years
Mean time between failures (MTBF) at 50 °C	20.5 Years
RTC buffer	Service life approx. 10 years
Optical display	6 Status LEDs; 5 x red/green/blue, freely programmable, 1 x red/ green
Conformity	CE, UKCA, UL

¹ The bridging time of voltage dips lasting at least 10 ms, as required by EN 61131-2, and the maximum USB output current are only guaranteed when supplied with 24 VDC -15 % / +20 %.

² The average power consumption without USB load varies greatly and depends on the use of the interfaces, the GPU and the CPU. Without HDMI it is usually well under 4 Watts.



NOTICE

The product IndustrialPI 4 is supplied with an integrated lithium battery. This battery has a guaranteed service life of 10 years. The lithium battery is not designed to be replaced by the customer. Contact customer services at: support@pilz.com

- ▶ Dispose of the product in accordance with local regulations for electronic waste.
- ▶ Do not dispose of the product in household waste.

11 Supplementary data

11.1 Network data

Protocol	Direction [*]	Transport protocol	Port no.	Can be disabled	Description
HTTP	In	TCP	80	Command line def.: an	Web application: Forwarding to port 41080
HTTPS	In	TCP	443	Command line def.: an	Web application: Forwarding to port 41443
HTTP	In	TCP	41080	Command line def.: an	Web application: Forwarding to port 41443
HTTPS	In	TCP	41443	Command line def.: an	Web application
HTTP	In	TCP	1880	Console def.: port open and service off	Node RED Forwarding to port 41880
HTTPS	In	TCP	41880	Console def.: port open and service off	Node RED Application
SSH	In	TCP	22	Web application def.: an	SSH Access via the command line from IndustrialPi across the network
mDNS	In	UDP	5353	Web application def.: an	Avahi Zeroconf
mDNS	In	UDP	30000 ... 65535	Web application def.: an	Avahi Zeroconf
Modbus	In	TCP	502	Web application and PiCtory def.: off	Modbus/TCP Set up Modbus Slave
Web-socket	In	TCP	8000	Web application def.: off	Python3 Communication between Node-RED RevPi nodes and I/O pins

[*]

in:

out:

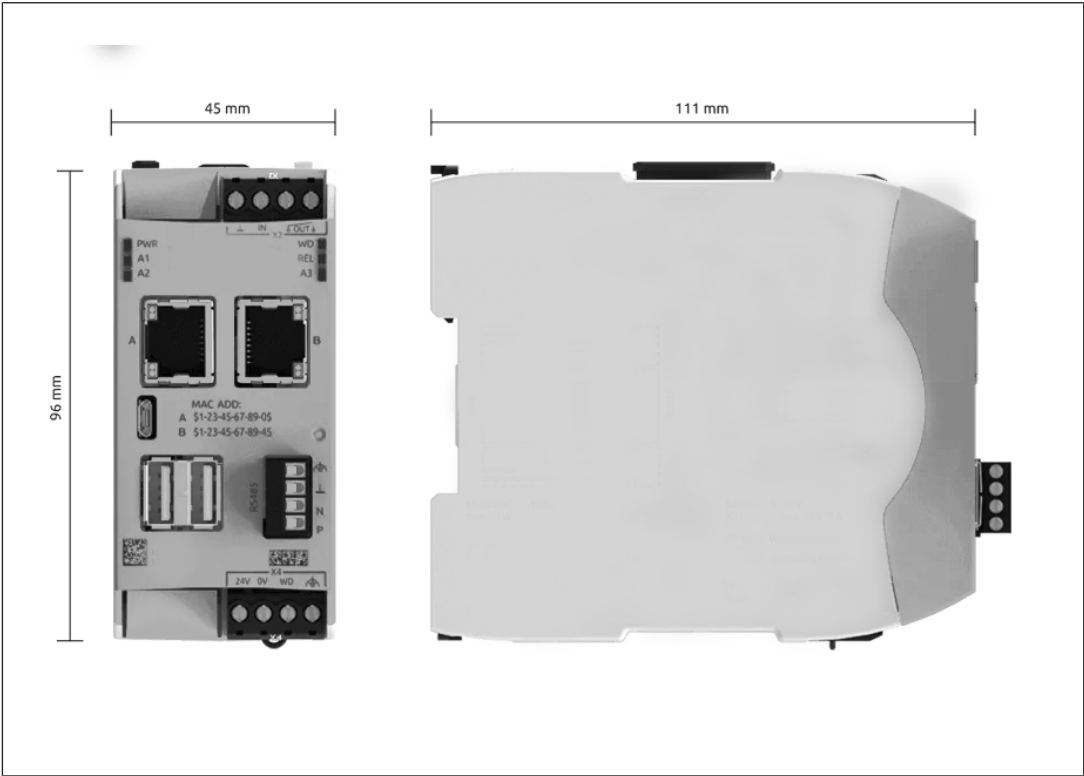
The communication partner starts communication with the product.

The product starts communication with the communication partner.

12 Order reference

IndustrialPI 4 4GB 32GB	Industrial PI 4 for automation and IIOT tasks, based on the Raspberry Pi Computer Module 4, Quad core Cortex-A72 with 1.5 GHz, 4 GB RAM and 32 GB eMMC flash memory, interfaces: 2 x USB 3.2 Gen 1 Type A, 2x RJ45 GBit Ethernet, 1 x RS485, 1 x Micro USB socket, 1 x Micro HDMI 2.0a (4K), 2 x PiBridge, operating system: adapted version of the Raspberry Pi OS with real-time patch with pre-installed Open Source Node-RED software.	A1000002
Industrial PI 4 8GB 32GB Wifi	Industrial PI 4 for automation and IIOT tasks, based on the Raspberry Pi Computer Module 4, Wifi, Quad core Cortex-A72 with 1.5 GHz, 8 GB RAM and 32 GB eMMC flash memory, interfaces: 2 x USB 3.2 Gen 1 Type A, 2x RJ45 GBit Ethernet, 1 x RS485, 1 x Micro USB socket, 1 x Micro HDMI 2.0a (4K), 2 x PiBridge, 1x RP-SMA socket for connecting an external WLAN/BT antenna (2.4/5 GHz), operating system: adapted version of the Raspberry Pi OS with real-time patch with pre-installed Open Source Node-RED software.	A1000003

13 Dimensions



► Support

Technical support is available from Pilz round the clock.

Americas

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Canada

+1 888 315 7459

Mexico

+52 55 5572 1300

USA (toll-free)

+1 877-PILZUSA (745-9872)

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Japan

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South Korea

+82 31 778 3390

Australia and Oceania

Australia

+61 3 95600621

New Zealand

+64 9 6345350

Europe

Austria

+43 1 7986263-444

Belgium, Luxembourg

+32 9 3217570

France

+33 3 88104003

Germany

+49 711 3409-444

Ireland

+353 21 4804983

Italy, Malta

+39 0362 1826711

Pilz develops environmentally-friendly products using ecological materials and energy-saving technologies. Offices and production facilities are ecologically designed, environmentally-aware and energy-saving. So Pilz offers sustainability, plus the security of using energy-efficient products and environmentally-friendly solutions.



We are represented internationally. Please refer to our homepage www.pilz.com for further details or contact our headquarters.

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