HARDWARE MANUAL

PiXtend eIO

POSSIBILITIES START HERE kontron S&T Group

Version History

Version	Date	Description	Editor
1.04	18 October 2019	First release	TG

Table of Contents

1. About this Documentation

Keep this documentation in a safe place for future reference!

This documentation is part of the product and is to be kept for the entire duration of the product's usage. If the product is passed on or sold, this document must be handed over to the next user; this also includes any updates and/or changes to this documentation.

1.1. Scope of Application

This documentation applies only to the software components specified in the table of contents and to the following PiXtend eIO devices types:

- PiXtend eIO Digital One Basic (Article 50199 007)
- PiXtend eIO - Digital One Pro (Article - PiXtend eIO Analog One Basic (Article
- PiXtend eIO Analog One Basic (Article 5019 009)
- PiXtend eIO - Analog One Pro (Article 50199 010)

The documents for the previous products can be found on our website at https://www.pixtend.de/downloads/.

1.2. Copyright

1.3. Trademarks

1.4. Symbols

1.4.1. General symbols

NOTICE	NOTICE indicates a particular characteristic.
⚠CAUTION	CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
⚠DANGER	DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

1.4.2. Special warning symbols

	HOT surface! Do NOT touch! Allow to cool before servicing.
	Electric Shock! This symbol and title warn of hazards due to electrical shocks (> 60V) when touching products or parts of products. Failure to observe the precautions indicated and/or prescribed by the law may endanger your life/health and/or result in damage to your equipment.
	ESD Sensitive Device! This symbol and title inform that the electronic boards and their components are sensitive to static electricity. Care must therefore be taken during all handling operations and inspections of this product in order to ensure product integrity at all times.

2. Important Information

This chapter contains information on legal principles, the intended use of the product described here, the technical condition at delivery and important safety instructions.

2.1. Subject to Change

Kontron Electronics GmbH reserves the right to revise or amend this documentation in whole or in part if this serves the technical progress or if existing software components are changed or new ones have been created. The latest version of this documentation is always available at https://www.pixtend.de/downloads/.

2.2. Intended Use

PiXtend eIO devices fulfill the function of input and output units for electrical signals. Sensor signals can be detected, evaluated and actuators can be activated. The specifications of the inputs and outputs comply with the international standard for programmable logic controllers, PLC - IEC / EN 61131-2. In addition, the devices comply with the EMC requirements of Zone B (general industrial environment) from the cited standard.

Communication between the PiXtend eIO and other devices a performed via a serial interface (RS485 / EIA485). It is a bus system in which up to 32 participants can communicate with each other. The PiXtend eIO fulfills the function of a “slave” in such a bus system (also known as a network). This means that information can be sent to or requested from devices. A slave device always only becomes active on the bus if it is addressed by a “master”, i.e. the master makes a communicate request. There is not a direct data transfer between the slave devices. Possible master devices for the PiXtend eIO devices are personal computers (PC), industrial controllers (PLC, IPC), Raspberry Pi computers, Arduino computers, embedded devices, specially equipped smartphones and tablets and many more computer systems that have an RS485 interface or can be retrofitted with this kind of interface.

Of particular importance is the combination of PiXtend eIO devices with the PiXtend V2 -L- controller. This is the reference bus master recommended by Kontron Electronics. The PiXtend eIO devices are able to use two protocols - “Modbus RTU” and the “PiXtend eIO ASCII protocol”. Basic settings for operation on the bus (baud rate, parity, stop bits, address, protocol and terminator) are set using mechanical switches on the device before use. The intelligence of the modules, data processing, bus communication, I/O control, etc. is provided by a central micro-controller installed on each of the devices.
The programming of inputs, outputs and special functions can be done, among other things, with the software “CODESYS V3” from the company 3S Smart Software Solutions GmbH.

Kontron Electronics also offers other automation, IT and home automation programming languages and systems that customers can use to control PiXtend eIO devices (C, C ++, C #, Python, Java, FHEM, Node-RED). Instructions and examples have been created by Kontron Electronics for this purpose. Both protocols are disclosed and can be implemented by the customer - in their own responsibility - in other programming languages and systems.

Unlike previous Kontron Electronics products, the PiXtend eIO devices are delivered exclusively as finished devices that are ready for use and do not require final assembly by the customer.

PiXtend eIO devices are designed for dry indoor environments - protection classes IP20 (ePLC Pro) and IP00 (Basic). Operation outdoors and in humid/wet rooms is not permitted, except when devices are installed in a suitable housing. The devices are not designed for hazardous areas or safety critical systems / installations with particularly high requirements.

PiXtend eIO devices can be used in industrial/commercial environments, in educational facilities and in residential areas alike.

Intended uses are:

- Mechanical, plant and equipment engineering and construction
- Testing equipment
- Laboratory and production automation
- Home automation / smart home
- Prototyping in industry (development departments)

- Use in education (technical schools, colleges and universities)
- IoT (Internet of Things), IIoT (Industrial Internet of Things) concepts and solutions
- Industry 4.0 concepts and solutions
- Mobile applications - auxiliary functions in the automotive sector

Apart from this, PiXtend eIO devices are suitable for all persons aged 14 and over who have read and understood the safety data sheet and the manuals.

Use in educational facilities must be supervised by qualified and authorized personnel. Power supplies and accessories used must be approved for the country in which the PiXtend eIO system is to be installed and used.

2.3. Technical Condition

Each PiXtend eIO device is supplied with a pre-defined configuration, independent of its model:

PiXtend eIO Digital One

- All digital inputs are configured for 24V (no jumper is set).
- Address: 1, Baud rate 19,200 baud, Parity bit: even, Stop bit: 1 (8E1)
- Termination inactive, Mode/Protocol: Modbus RTU
- The microcontroller firmware is always the latest version released by Kontron Electronics. The current version and information about changes ("change log") can be found on our website.

PiXtend eIO Analog One

- All analog voltage inputs are configured for 0 to 10V (no jumper is set).
- Address: 3, Baud rate 19,200 baud, Parity bit: even, Stop bit: 1 (8E1)
- Termination inactive, Mode/Protocol: Modbus RTU
- The microcontroller firmware is always the latest version released by Kontron Electronics. The current version and information about changes ("change log") can be found on our website.

Each device is available in two different versions:

Basic

- Basic version without housing

Pro

- Professional version with stainless-steel cover and DIN rail housing

If you need another version or a different hardware and software combination, please send your request directly to us (info@pixtend.de).

2.4. Certifications

This product has been designed and manufactured in accordance with applicable European directives and is therefore marked with the CE symbol. The intended use is described in this document. A safety data sheet is included with each product in paper form (multilingual).

Warning:
Changes and modifications to the product, as well as a non-compliance with the information contained in the manuals and safety data sheets, will lead to the loss of certification.

The symbol of the crossed-out waste bin (WEEE symbol) means that this product must be recycled separately from any household waste as electrical waste. Ask your local municipal administration to find the nearest recycling station.

2.5. Safety information

Read the complete document and the safety and connection instructions before connecting or operating PiXtend eIO devices. Save this document even after you have set up all components.

⚠CAUTION

Kontron Electronics GmbH does not accept any liability for damage of any kind resulting from disregarding the data sheets and operating instructions. The guarantee and warranty claim will be void if the data sheets and operating instructions are disregarded.

- PiXtend eIO devices may only be operated with the specified voltage (24V DC ±20%) and a power supply with the VDE and CE mark (for Europe). The power supply must comply with the legal requirements of the country in which PiXtend eIO is used.
- The device is only designed for use in dry and clean rooms and is not suitable for outdoor use or in damp areas.
- The permissible operating temperature is between 0° C and 60° C.
- PiXtend eIO devices as well as all cables, connectors and power supplies must be kept away from liquids.
- PiXtend eIO devices must not be used in the vicinity of flammable liquids, gases or dusts.
- Only original or recommended spare parts may be used for repairs. If anything is unclear, contact Kontron Electronics – support@pixtend.de
- No 230V, 115V alternating voltage or any other dangerous voltage greater than 50V may be connected to the PiXtend eIO. **Caution: Dangerous to life!**
- PiXtend eIO and the accessories are to be kept out of reach of children under 14.
- The operation in schools, hobby workshops and educational facilities is to be supervised by trained personnel.

2.6. Disclaimer

The information contained in this documentation has been compiled, checked and tested with the greatest possible care with the software and hardware described herein. Nevertheless, discrepancies cannot be ruled out completely. Kontron Electronics GmbH is not liable for any damages that may result from the use of the software, software components, hardware or the steps described in this documentation.

2.7. Contact Information

Our postal address:

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Kantstrasse 10
72663 Grossettlingen, Germany

How to reach us:

Telephone: +49 7022 40570
info@kontron-electronics.de
www.kontron-electronics.de

2.8. Assistance

A lot of information, tips and tricks can be found in our support forum at: https://www.pixtend.de/forum/.
If any questions remain unanswered, please first check the manuals and the FAQs on our website.

If your question is still not answered, contact us by e-mail (support@pixtend.de). You will receive an answer as soon as possible.

The latest versions of all documents and software components can be found in the download section of our website: https://www.pixtend.de/downloads/.

3. Basic knowledge

This chapter covers the basic knowledge that is needed to use the PiXtend eIO. Power supply, Bus topology, wiring and bus lines are described in detail below.

Especially if you have no or only little experience with RS485 bus systems, the following information is important for the safe and reliable operation of PiXtend eIO devices.

3.1. Power supply

All PiXtend eIO devices are operated with a nominal supply voltage of 24V (DC). The exact specifications and connection instructions for a suitable power supply can be found in chapters 5.4 Connecting the power supply and 7 Technical Data and Connection Instructions.
This chapter deals with the topology of the power supply of several eIO devices connected in an RS485 bus/network.

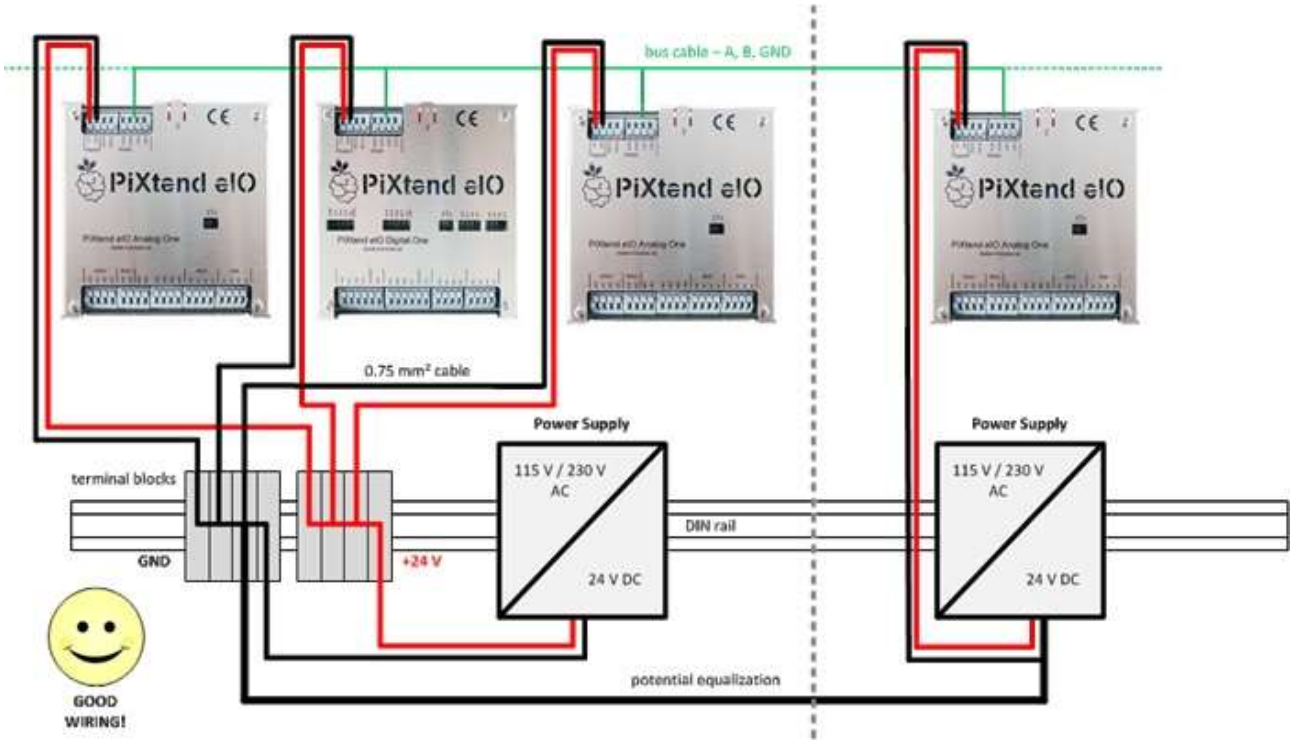


Figure 1: Topology of the power supply

Figure 1 shows the correct wiring, power supply topology for several PiXtend eIO devices. Each device is connected separately to a common supply or ground point with its own lines.

The cable cross-section, especially of the ground cables, should be much larger than the signal lines for the RS485 bus. The reason for this is that the supply current of the modules (comparatively large current) should be discharged via the supply connection and not via the GND connection, which belongs to the RS485 network.

Ideally, a separate power supply is used for the digital outputs of the PiXtend eIO Digital One device. A separate fuse for the supply of the outputs is also a legitimate option. In any case the supply connections of the outputs are connected to the power supply and a GND line.

If the modules in a network are spatially separated, or if it is necessary for other reasons to use several power supplies for all bus participants, the ground (GND) of all power supply units must be connected to each other at a central ground point via a suitable line - potential equalization.
Figure 2 shows typical wiring mistakes with regard to the power supply of the modules.

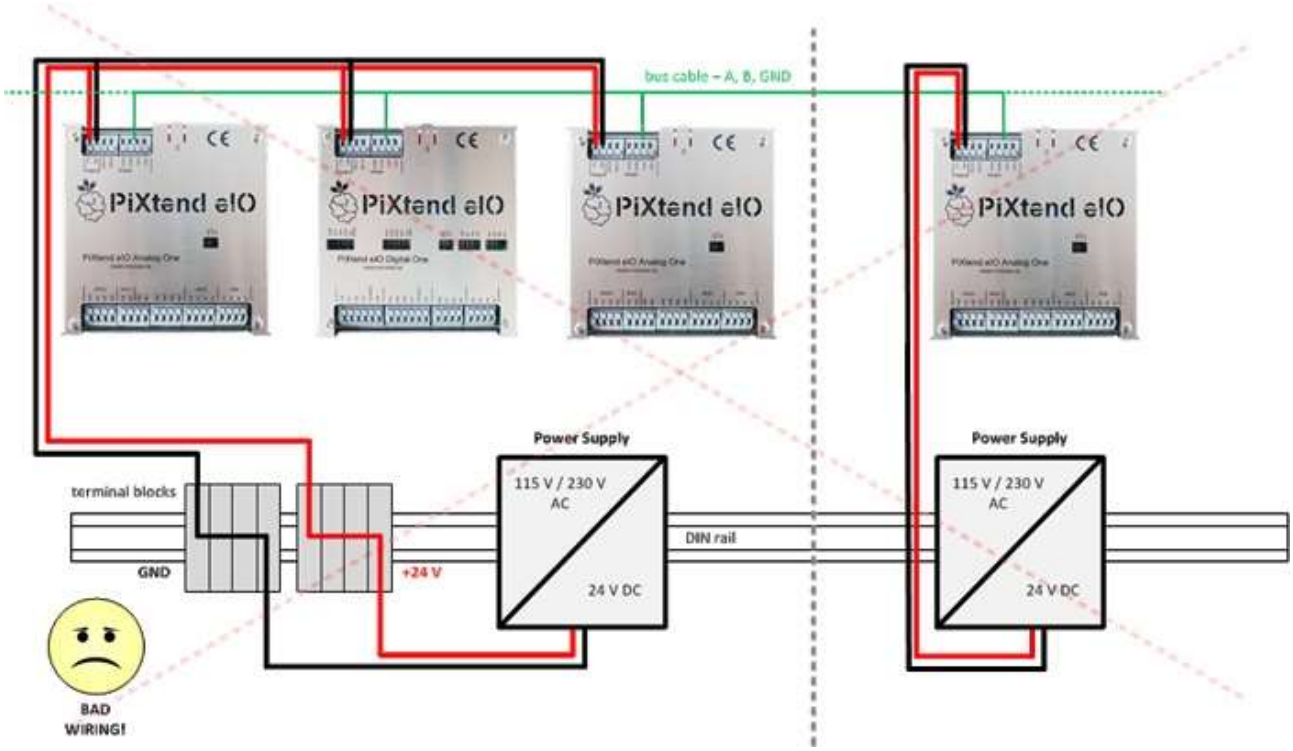


Figure 2: Topology of the power supply – typical mistakes

At first glance, it may make sense to bridge (to loop) the supply voltage and GND from one module to the next. However, this leads to voltage drops on the lines, especially when using small cable cross-sections and many devices. The result may be that the required minimum voltage is no longer applied to a part of the modules and the devices do not or no longer fully fulfill their function.

A particularly serious error occurs when the GND line is “saved” at the supply connection. One could come up with this idea since a GND connection is already made at the RS485 connections. However, under no circumstances may the supply current of the modules be routed via this connection. This may cause transmission errors, erratic communication behavior and possibly overloading, especially with thin bus lines.

Similarly, the potential equalization between several power supplies (GND connection between all power supplies powering devices on the bus) must not be omitted!

Summary:

- If in doubt, increase the cable cross-section for the supply connections

  (we recommend 0.75 or 1.00 mm^2)

- Separate wiring of each module from the supply point / ground point
- Supply of the digital outputs also with two lines that have an external fuse
- Connect GNDs of all power supplies together (central ground point)
- Separate GND line for supply - independent of the RS485 lines

3.2. Bus topology and wiring

PiXtend eIO devices communicate via a 2-wire RS485 network. This must be done as a line structure / bus structure. The topology (see figure 3) must be adhered to in order to ensure error-free bus operation - over longer transmission distances and baud rates. In order to implement the bus structure in the best possible way, PiXtend eIO provide each of the RS485 signals twice on terminal blocks. This reduces the "stub lines" to a minimum and enables high transmission rates.
The recommended structure of the RS485 network with PiXtend eIO slaves and a PiXtend V2 -L- master is shown in the following figure.

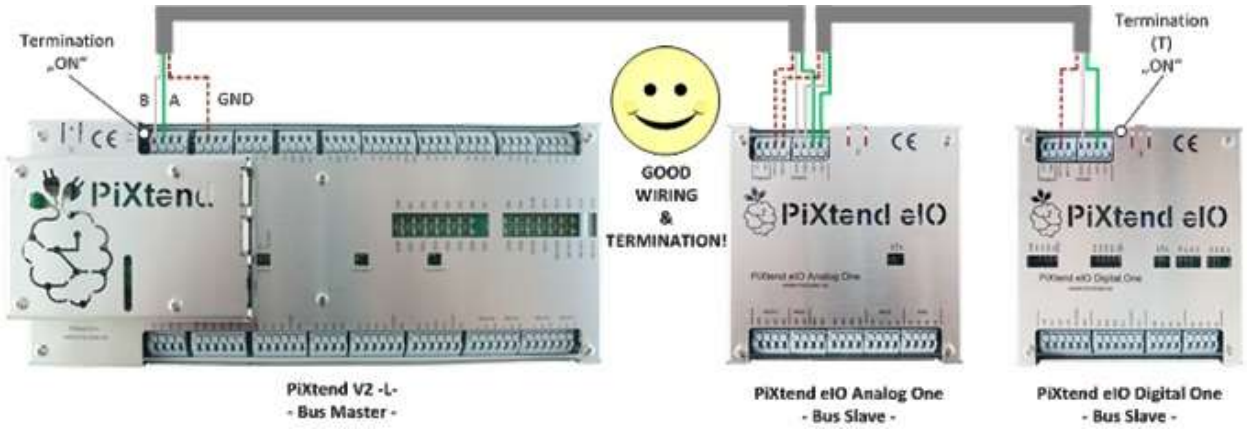


Figure 3: Bus topology – RS485

A terminating resistor is activated at the beginning and at the end of the bus structure.
This bus structure is no longer so widespread in use today. Usually, networks are setup as a star (example: Ethernet with RJ45 connectors and switches/hubs). A star connection could also be setup with RS485, but this should be avoided! These and other typical wiring mistakes are shown in figure 4.

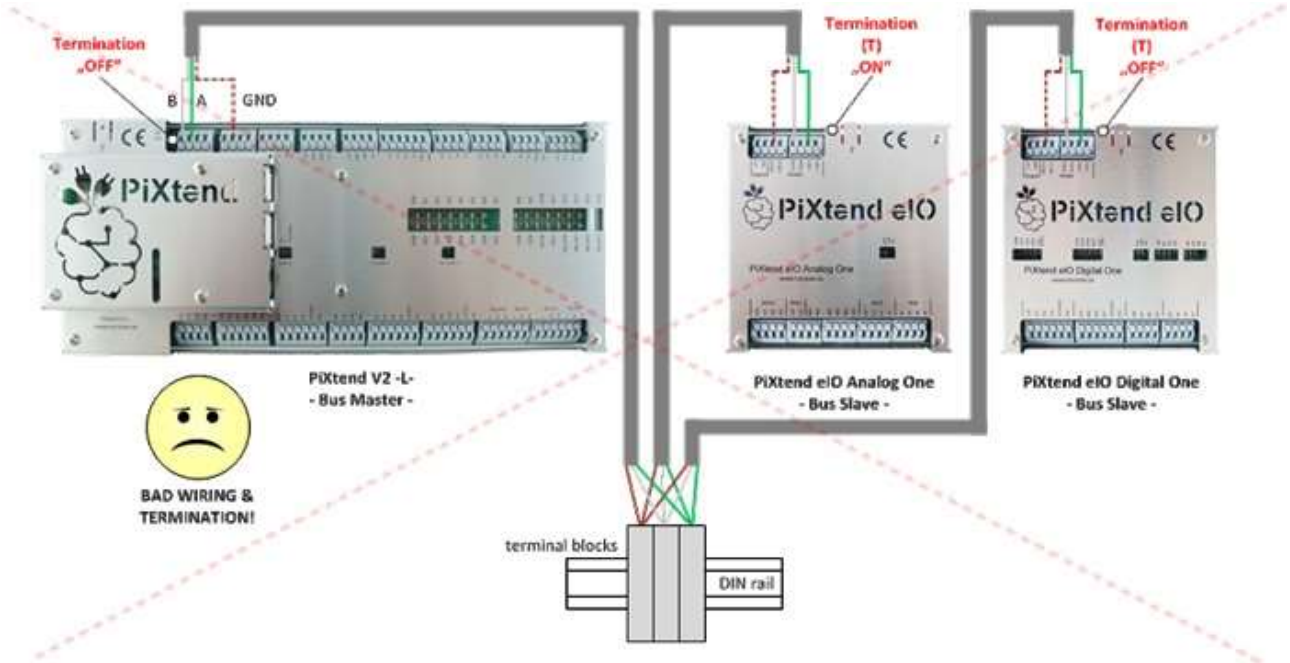


Figure 4: Bus topology – RS485 – typical mistakes

There are different network topologies. However, star, tree, ring and mesh networks are not suitable for RS485 and therefore also not for PiXtend eIO connections. RS485 is always set up as a line or in a bus structure.

All participants within a PiXtend eIO network need the same ground reference. Without a common ground, there can be transmission problems and, in the worst case, a defect in the RS485 driver. If in doubt, please contact PiXtend support via email with a detailed description, sketch and wiring diagram at support@pixtend.de, to prevent such problems from occurring.

The GND connection (GND/C) of the RS485 interface is not suitable for potential equalization. Cables on these connections serve only to increase interference immunity and are optional (not optional for Modbus). Equalizing currents, as an example between different parts of an industrial plant, must never be routed via the GND/C connections of the RS485 interface. Similarly, these connections are not intended or suitable for the shielding of cables.

Another common mistake has to do with the termination resistors (termination). Either no terminators are used or they are in the wrong place on the network. Too many (more than two) terminating resistors have a negative effect on the data transmission. The correct way to terminate is with two resistors with 120Ω - one at each end of the bus line structure.

Summary:

- A line or bus structure has to be used
  - “Loop” the signal lines to the PiXtend eIO
  - No stub or star structures
- All devices on the bus / network require a common ground reference
- GND (3-wire RS485) is mandatory for Modbus, otherwise usually mostly useful for other protocols, but not mandatory
- Termination resistors (120Ω) exactly 2x per bus - at the beginning and at the end of the bus structure

3.3. Bus lines

If an RS485 bus is operated over large distances and in industrial environments (large currents, many, varying disturbances), we recommend the use of shielded cables. For a Modbus compliant structure, shielded cables must always be used. The shield must be connected to PE (protective earth / ground) at one point, usually at or near the bus master.

Unshielded cables can only be used practically and reliably in moderate EMC areas - office, laboratory, partly in the building services, within small machines or devices.

Basic specifications for cable lengths and cross-sections for the RS485 bus can be found in chapter 6.3.

It is not possible to provide a generally applicable solution for shielding, shield connection and wiring that is suitable for every application. At this point, we only give tips and suggestions so that you can assess your specific application.

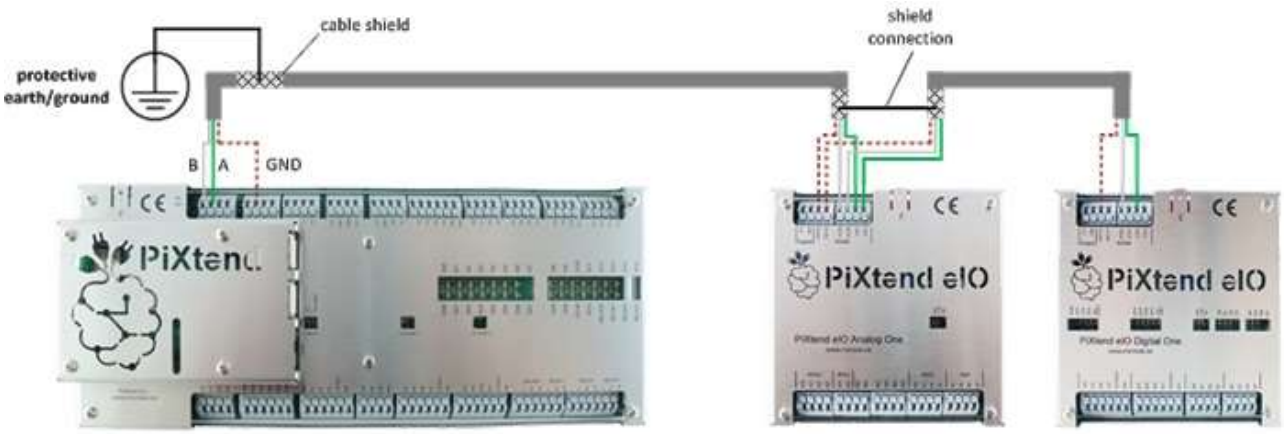


Figure 5: Shielded bus cables - shield connection

The shielding of the cables used is connected to PE (protective earth / ground) / FE (functional earth). Special earthing clamps and shielding connections exist for this, which are connected, for example, on a DIN rail - close to the bus master.

Whether the shield is necessary at one or both ends of the line depends on the type of interference that is to be reduced. A general statement or recommendation is not possible here. We usually start with the one-sided shield connection and adapt it later if necessary. For serial devices/machines, which are always constructed in the same way, different combinations can be tested and compared during the test phase.

The minimum cable cross-section (wire size) is 0.2 mm² (AWG24), but we recommend using 0.25 mm² (AWG23) - for the differential pair (A and B) and for the bus GND. Twisted pair cables are very well suited for the differential pair, but are not necessary. In general, control cables without shielding (LIYY) and with shielding (LIYCY) are recommended. These can be purchased cheaply from various manufacturers.

Summary:

- Modbus compliant structure
  - At one point, there must be a connection between GND of the devices and the grounding connector (PE)
  - Shielded cables must be used
  - The shield of the bus line must be connected to the grounding connector (PE) at one point - ideally at the bus master
- The design of the shielding must be re-evaluated for each application
- Shield connections for DIN rails from electronic dealers
- Use at least 0.2 mm² (AWG24) cables
- Use LIYY or LIYCY cables or twisted pair cables

4. Package contents

Please check the package contents after receiving PiXtend eIO devices and accessories.
On the following pages, you will find lists of contents and images with an overview of the contents.

Be careful when unpacking and handling electronic components such as the PiXtend eIO (without housing parts). Electronic components on the modules can be damaged by electrostatic discharge.

The components may only be touched at the edges of the circuit boards, on mechanical screw connections or plug connectors. Avoid direct contact with electronic components and solder contacts / soldering surfaces.

We check each device and accessory before delivery (function tests, quality control, weight check). If a piece is missing, please let us know by e-mail (info@pixtend.de) and we will immediately send you a replacement.

It is not necessary to return the product due to a missing component.

4.1. PiXtend eIO Digital One Basic

Article number: 50199 007, PiXtend eIO Digital One Basic version without housing

Pieces	Description	Additional Information	Part Below
1	PiXtend eIO Digital One Basic device		1
8	Jumper	Standard, black	2
1	Safety data sheet	multi-lingual	3

Table 1: Package contents: PiXtend eIO Digital One Basic (Article 50199 007)

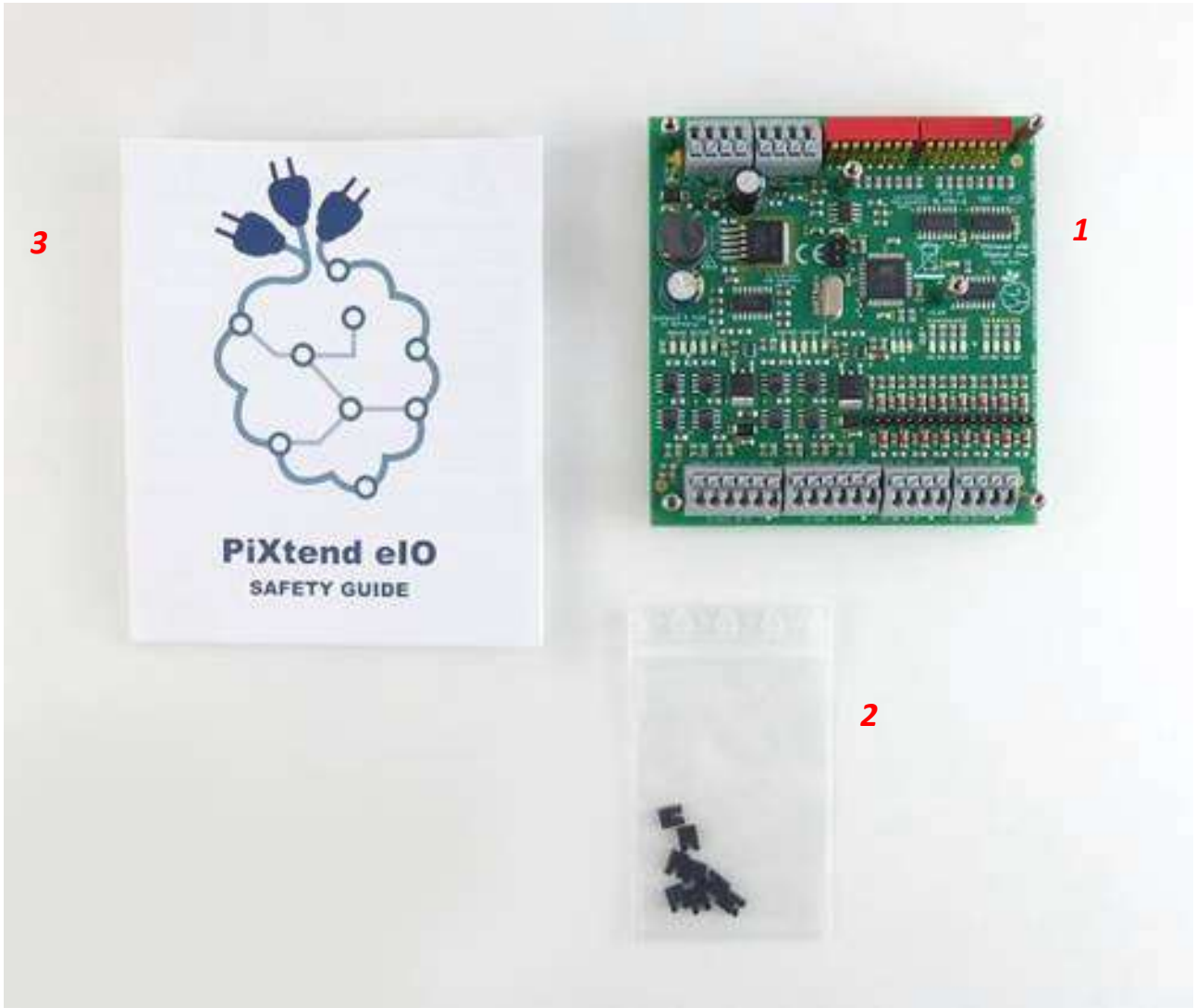


Figure 6: Package contents:
PiXtend eIO Digital One Basic (Article 50199 007)

4.2. PiXtend eIO Digital One Pro

Article number: 50199 008, PiXtend eIO Digital One Pro version with housing

Pieces	Description	Additional Information	Part Below
1	PiXtend eIO Digital One PRO device – with housing		1
8	Jumper	Standard, black	2
1	Safety data sheet	multi-lingual	3

Table 2: Package contents: PiXtend eIO Digital One Pro (Article 50199 008)

Figure 7: Package contents: PiXtend eIO Digital One Pro (Article 50199 008)

4.3. PiXtend eIO Analog One Basic

Article number: 50199 009, PiXtend eIO Analog One Basic version without housing

Pieces	Description	Additional Information	Part Below
1	PiXtend eIO Analog One Basic device		1
4	Jumper	Standard, black	2
1	Safety data sheet	multi-lingual	3

Table 3: Package contents: PiXtend eIO Analog One Basic (Article 50199 009)

Figure 8: Package contents:
PiXtend eIO Analog One Basic (Article 50199 009)

4.4. PiXtend eIO Analog One Pro

Article number: 50199 010,PiXtend eIO Analog One Pro version with housing

Pieces	Description	Additional Information	Part Below
1	PiXtend eIO Analog One PRO device – with housing		1
4	Jumper	Standard, black	2
1	Safety data sheet	multi-lingual	3

Table 4: Package contents: PiXtend eIO Analog One Pro (Article 50199 010)

Figure 9: Package contents:
PiXtend eIO Analog One Pro (Article 50199 010)

4.5. Accessories

The following accessories can be used with PiXtend eIO devices. The combination of the cable set and RS485 USB dongle allows for the easy connection of two PiXtend eIO devices to a computer with a USB port. This is particularly suitable for test setups in offices and laboratories.

4.5.1. Cable set without termination

Article number: 30199 010

Pieces	Description	Additional Information	Part Below
1	Connection cable 3-pin with D-SUB 9 connector (compatible with all PiXtend eIO devices and accessories Article 30199 011 – RS485 USB dongle)	2 m, LiYY, 0.25 mm²	1
1	3-pin connection cable	0.3 m, LiYY, 0.25 mm²	2

Table 5: Package contents: Cable set without termination (Article 30199 010)

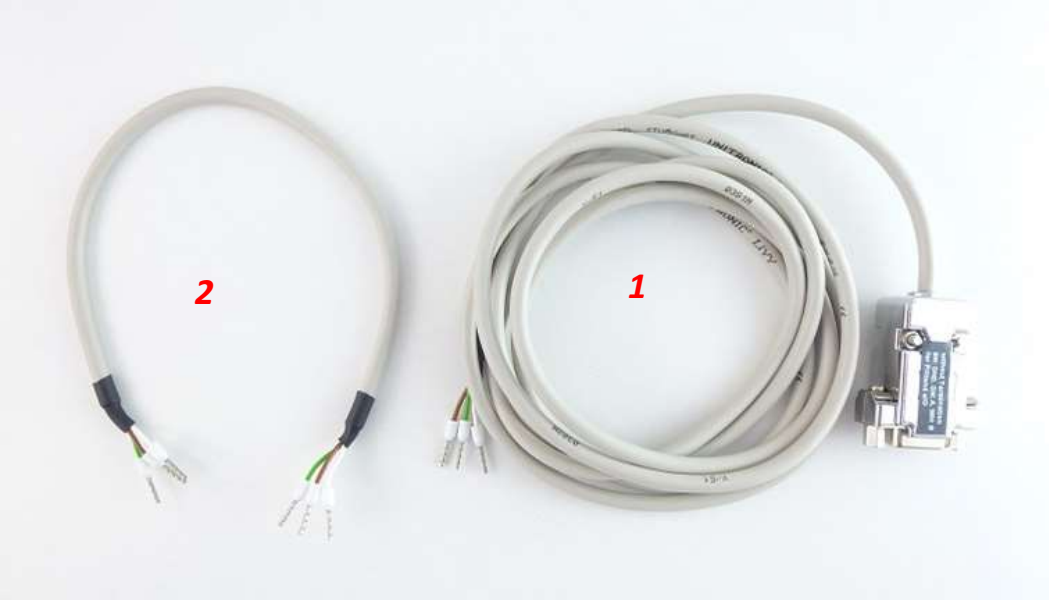


Figure 10: Package contents: Cable set without termination (Article 30199 010)

The cable set without a terminating resistor is the right choice if the RS485 USB dongle is not at one of the bus ends.

4.5.2. Cable set with termination

Article number: 30199 009

Pieces	Description	Additional Information	Part Below
1	Connection cable 3-pin with D-SUB 9 connector and 120Ω terminating resistor (compatible with all PiXtend eIO devices and accessories Article 30199 011 – RS485 USB dongle)	2 m, LiYY, 0.25 mm² 120 Ω terminating resistor	1
1	3-pin connection cable	0.3 m, LiYY, 0.25 mm²	2

Table 6: Package contents: Cable set with termination (Article 30199 009)

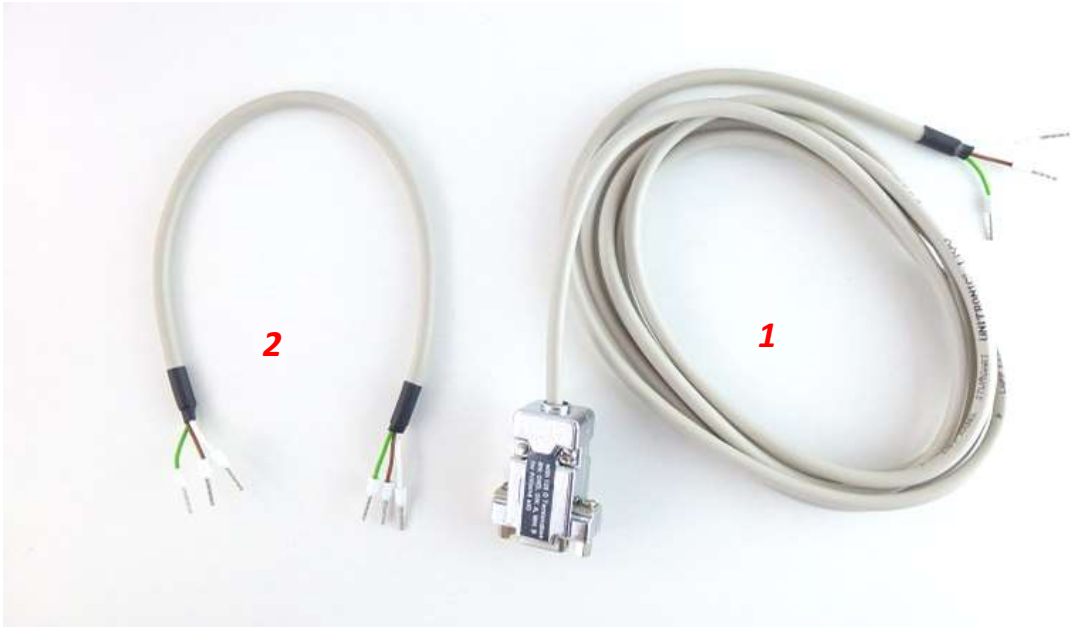


Figure 11: Package contents: Cable set with termination (Article 30199 009)

The cable set with a terminating resistor is the right choice if the RS485 USB dongle is at one of the bus ends. An external connection of a terminating resistor is therefore not necessary.

4.5.3. RS485 USB dongle

Article number: 30199 011

Pieces	Description	Additional Information	Part Below
1	RS485 USB dongle (for the connection of PiXtend eIO devices to a computer with an UBS port)	USB 2.0 Standard FTDI chip	1
1	Connection adapter with screw terminals		2
1	USB connection cable/extension	0.8 m	3

Table 7: Package contents: RS485 USB dongle (Article 30199 011)

Figure 12: Package contents: RS485 USB dongle (Article 30199 011)

This can be perfectly combined with the PiXtend eIO cable sets (article 30199 009, 30199 010) and is compatible with the most computers (Raspberry Pi, other embedded devices, PCs with Windows or Linux operating system, smartphones and tablets with Android operating system and (micro)USB OTG cable etc.

5. Installation

This chapter describes step-by-step all points to install your PiXtend eIO. Please read the entire chapter first and observe the relevant connection notes in chapter 7 Technical Data and Connection Instructions before you work with your PiXtend eIO system.

See section 5.1 for information on jumpers and switches on the PiXtend eIO. The PiXtend eIO board can be configured with just a few simple steps. If necessary, a suitable ground connection is also attached to the device in section 5.3.

After the preparatory work, your PiXtend eIO system is ready to start and can be connected to a suitable power supply (section 5.4). Here are some important tips for the correct and secure connection.

Finally, two examples are used to show how PiXtend eIO devices are connected to the bus master (section 5.6) This means that - from a hardware point of view - the first test run is about to be performed.

In section 5.7, there are tips for troubleshooting in case something does not work as expected.

5.1. Setting switch positions

The switches determine the function and the configuration of PiXtend eIO. For initial installation and tests, all switches are preset at the factory (see page 11). It is not necessary to adjust the factory settings.

All PiXtend eIO devices have two switch blocks with a total of 16 individual switches. All basic settings are made via these switch blocks.

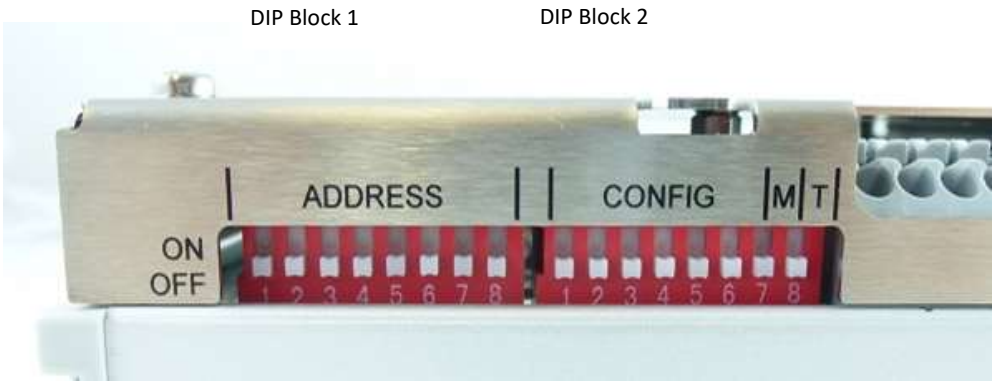


Figure 13: All 16 DIP switches

- Switch “T” - terminating resistor:
  In a RS485 bus system, a terminating resistor is always required at the two bus ends. PiXtend eIO devices have an integrated terminating resistor, which can be activated with the “T” switch:

  Position “ON”: Termination active - device is at the bus end
  Position “OFF”: Termination inactive - device is not located at the end of the bus (factory setting)

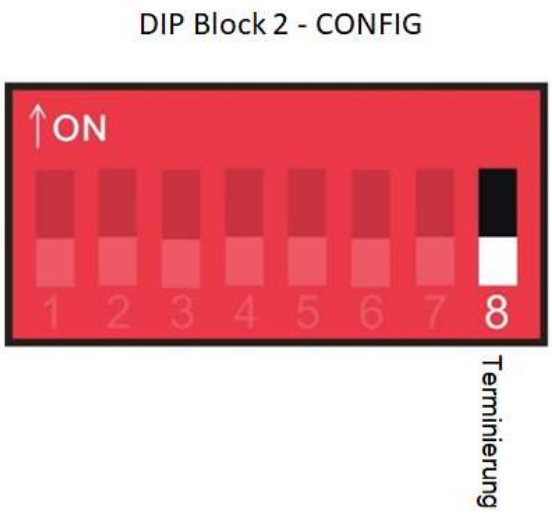


Figure 14: DIP block 2 - CONFIG – bus termination – setting: off

The following switches must be set before starting. Adjusting the switches during operation will not result in the desired change. The change is applied only after a restart of the device (power cycle).

- Switch “M” - Mode:
  This switch determines the protocol with which the device is communicate.

  Position “ON”: PiXtend eIO ASCII protocol
  Position “OFF”: Modbus RTU protocol (default)

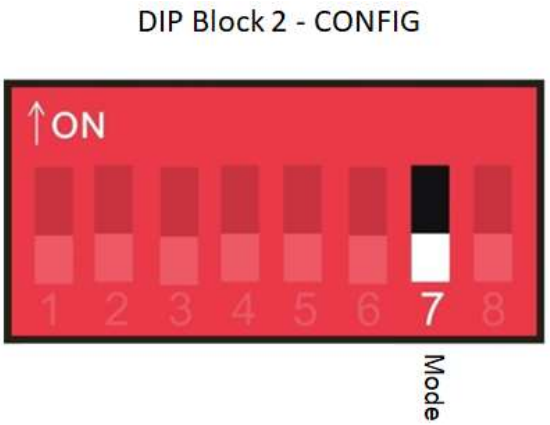


Figure 15: DIP block 2 - CONFIG – mode – setting: Modbus RTU

- Switch “CONFIG” - serial device configuration:
  The configuration of the serial interface consists of a total of six switches. The configurations of the baud rate, number of stop bits and parity are available for various bus requirements.

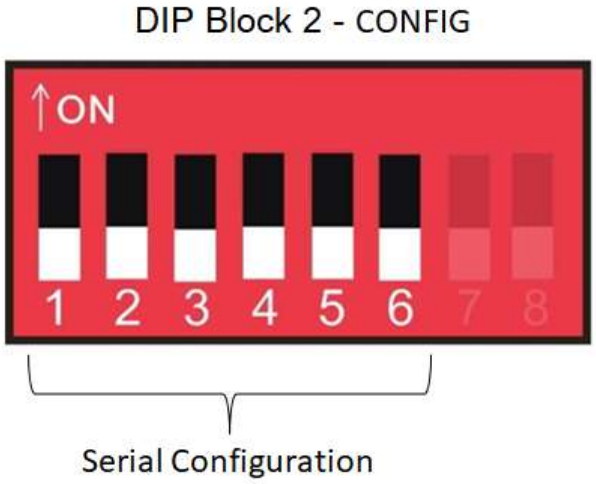


Figure 16: DIP block 2 - CONFIG – serial configuration

Select the desired combination of baud rate, parity and stop bit(s) from the following table and then transfer the corresponding switch order of the table to the switches of DIP block 2 from left to right according to the assignment 1 = switch 1 to 6 = switch 6.

A "0” corresponds to the “Off” position when the switch is in the lower position and a “1” corresponds to the “On” position when the switch is in the upper position. The order of the switches goes from left to right, numbers 1 - 6.

Overview of possible serial device configurations:

Number	Baud rate	Parity	Stop bit	1	2	3	4	5	6
0	19200	even	1	0	0	0	0	0	0
1	2400	none	1	1	0	0	0	0	0
2	4800	none	1	0	1	0	0	0	0
3	9600	none	1	1	1	0	0	0	0
4	14400	none	1	0	0	1	0	0	0
5	19200	none	1	1	0	1	0	0	0
6	28800	none	1	0	1	1	0	0	0
7	38400	none	1	1	1	1	0	0	0
8	57600	none	1	0	0	0	1	0	0
9	76800	none	1	1	0	0	1	0	0
10	115200	none	1	0	1	0	1	0	0
11	230400	none	1	1	1	0	1	0	0
12	2400	none	2	0	0	1	1	0	0
13	4800	none	2	1	0	1	1	0	0
14	9600	none	2	0	1	1	1	0	0

Number	Baud rate	Parity	Stop bit	1	2	3	4	5	6
15	14400	none	2	1	1	1	1	0	0
16	19200	none	2	0	0	0	0	1	0
17	28800	none	2	1	0	0	0	1	0
18	38400	none	2	0	1	0	0	1	0
19	57600	none	2	1	1	0	0	1	0
20	76800	none	2	0	0	1	0	1	0
21	115200	none	2	1	0	1	0	1	0
22	230400	none	2	0	1	1	0	1	0
23	2400	even	1	1	1	1	0	1	0
24	4800	even	1	0	0	0	1	1	0
25	9600	even	1	1	0	0	1	1	0
26	14400	even	1	0	1	0	1	1	0
27	19200	even	1	1	1	0	1	1	0
28	28800	even	1	0	0	1	1	1	0
29	38400	even	1	1	0	1	1	1	0
30	57600	even	1	0	1	1	1	1	0
31	76800	even	1	1	1	1	1	1	0
32	115200	even	1	0	0	0	0	0	1
33	230400	even	1	1	0	0	0	0	1
34	2400	odd	1	0	1	0	0	0	1
35	4800	odd	1	1	1	0	0	0	1
36	9600	odd	1	0	0	1	0	0	1
37	14400	odd	1	1	0	1	0	0	1
38	19200	odd	1	0	1	1	0	0	1
39	28800	odd	1	1	1	1	0	0	1
40	38400	odd	1	0	0	0	1	0	1
41	57600	odd	1	1	0	0	1	0	1
42	76800	odd	1	0	1	0	1	0	1
43	115200	odd	1	1	1	0	1	0	1
44	230400	odd	1	0	0	1	1	0	1

Table 8: Selection table - serial device configuration

- Switch “ADDRESS” – device address / bus address:

  A total of eight switches allow addresses to be set in the range from 0 to 255.

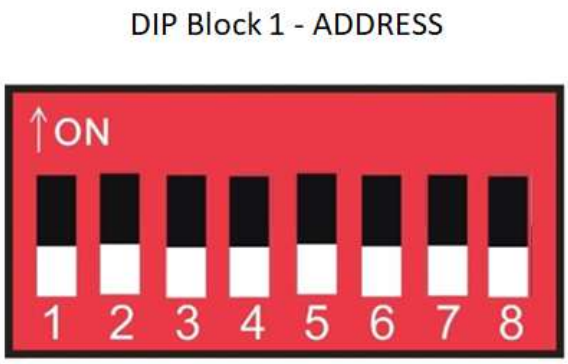


Figure 17: DIP block 1 - ADDRESS – device address, setting: Address 0

Please note the address range limitation of the ModBus RTU protocol, only addresses in the range “1” to “247” are allowed. However, all addresses are allowed with the PiXtend eIO protocol.

The following table lists all 255 possible device addresses, together with the corresponding switch position on DIP block 1 for all 8 switches. A "0” corresponds to the “Off” position when the switch is in the lower position and a “1” corresponds to the “On” position when the switch is in the upper position. The order of the switches goes from left to right. Note the numbering, this goes from “1 = switch 1” to “8 = switch 8”.

Overview of possible serial device addresses:

Device address	1	2	3	4	5	6	7	8
0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0
2	0	1	0	0	0	0	0	0
3	1	1	0	0	0	0	0	0
4	0	0	1	0	0	0	0	0
5	1	0	1	0	0	0	0	0
6	0	1	1	0	0	0	0	0
7	1	1	1	0	0	0	0	0
8	0	0	0	1	0	0	0	0
9	1	0	0	1	0	0	0	0
10	0	1	0	1	0	0	0	0
11	1	1	0	1	0	0	0	0
12	0	0	1	1	0	0	0	0
13	1	0	1	1	0	0	0	0
14	0	1	1	1	0	0	0	0
15	1	1	1	1	0	0	0	0
16	0	0	0	0	1	0	0	0
17	1	0	0	0	1	0	0	0
18	0	1	0	0	1	0	0	0

Device address	1	2	3	4	5	6	7	8
19	1	1	0	0	1	0	0	0
20	0	0	1	0	1	0	0	0
21	1	0	1	0	1	0	0	0
22	0	1	1	0	1	0	0	0
23	1	1	1	0	1	0	0	0
24	0	0	0	1	1	0	0	0
25	1	0	0	1	1	0	0	0
26	0	1	0	1	1	0	0	0
27	1	1	0	1	1	0	0	0
28	0	0	1	1	1	0	0	0
29	1	0	1	1	1	0	0	0
30	0	1	1	1	1	0	0	0
31	1	1	1	1	1	0	0	0
32	0	0	0	0	0	1	0	0
33	1	0	0	0	0	1	0	0
34	0	1	0	0	0	1	0	0
35	1	1	0	0	0	1	0	0
36	0	0	1	0	0	1	0	0
37	1	0	1	0	0	1	0	0
38	0	1	1	0	0	1	0	0
39	1	1	1	0	0	1	0	0
40	0	0	0	1	0	1	0	0
41	1	0	0	1	0	1	0	0
42	0	1	0	1	0	1	0	0
43	1	1	0	1	0	1	0	0
44	0	0	1	1	0	1	0	0
45	1	0	1	1	0	1	0	0
46	0	1	1	1	0	1	0	0
47	1	1	1	1	0	1	0	0
48	0	0	0	0	1	1	0	0
49	1	0	0	0	1	1	0	0
50	0	1	0	0	1	1	0	0
51	1	1	0	0	1	1	0	0
52	0	0	1	0	1	1	0	0
53	1	0	1	0	1	1	0	0
54	0	1	1	0	1	1	0	0
55	1	1	1	0	1	1	0	0
56	0	0	0	1	1	1	0	0
57	1	0	0	1	1	1	0	0
58	0	1	0	1	1	1	0	0
59	1	1	0	1	1	1	0	0
60	0	0	1	1	1	1	0	0

Device address	1	2	3	4	5	6	7	8
61	1	0	1	1	1	1	0	0
62	0	1	1	1	1	1	0	0
63	1	1	1	1	1	1	0	0
64	0	0	0	0	0	0	1	0
65	1	0	0	0	0	0	1	0
66	0	1	0	0	0	0	1	0
67	1	1	0	0	0	0	1	0
68	0	0	1	0	0	0	1	0
69	1	0	1	0	0	0	1	0
70	0	1	1	0	0	0	1	0
71	1	1	1	0	0	0	1	0
72	0	0	0	1	0	0	1	0
73	1	0	0	1	0	0	1	0
74	0	1	0	1	0	0	1	0
75	1	1	0	1	0	0	1	0
76	0	0	1	1	0	0	1	0
77	1	0	1	1	0	0	1	0
78	0	1	1	1	0	0	1	0
79	1	1	1	1	0	0	1	0
80	0	0	0	0	1	0	1	0
81	1	0	0	0	1	0	1	0
82	0	1	0	0	1	0	1	0
83	1	1	0	0	1	0	1	0
84	0	0	1	0	1	0	1	0
85	1	0	1	0	1	0	1	0
86	0	1	1	0	1	0	1	0
87	1	1	1	0	1	0	1	0
88	0	0	0	1	1	0	1	0
89	1	0	0	1	1	0	1	0
90	0	1	0	1	1	0	1	0
91	1	1	0	1	1	0	1	0
92	0	0	1	1	1	0	1	0
93	1	0	1	1	1	0	1	0
94	0	1	1	1	1	0	1	0
95	1	1	1	1	1	0	1	0
96	0	0	0	0	0	1	1	0
97	1	0	0	0	0	1	1	0
98	0	1	0	0	0	1	1	0
99	1	1	0	0	0	1	1	0
100	0	0	1	0	0	1	1	0
101	1	0	1	0	0	1	1	0
102	0	1	1	0	0	1	1	0

Device address	1	2	3	4	5	6	7	8
103	1	1	1	0	0	1	1	0
104	0	0	0	1	0	1	1	0
105	1	0	0	1	0	1	1	0
106	0	1	0	1	0	1	1	0
107	1	1	0	1	0	1	1	0
108	0	0	1	1	0	1	1	0
109	1	0	1	1	0	1	1	0
110	0	1	1	1	0	1	1	0
111	1	1	1	1	0	1	1	0
112	0	0	0	0	1	1	1	0
113	1	0	0	0	1	1	1	0
114	0	1	0	0	1	1	1	0
115	1	1	0	0	1	1	1	0
116	0	0	1	0	1	1	1	0
117	1	0	1	0	1	1	1	0
118	0	1	1	0	1	1	1	0
119	1	1	1	0	1	1	1	0
120	0	0	0	1	1	1	1	0
121	1	0	0	1	1	1	1	0
122	0	1	0	1	1	1	1	0
123	1	1	0	1	1	1	1	0
124	0	0	1	1	1	1	1	0
125	1	0	1	1	1	1	1	0
126	0	1	1	1	1	1	1	0
127	1	1	1	1	1	1	1	0
128	0	0	0	0	0	0	0	1
129	1	0	0	0	0	0	0	1
130	0	1	0	0	0	0	0	1
131	1	1	0	0	0	0	0	1
132	0	0	1	0	0	0	0	1
133	1	0	1	0	0	0	0	1
134	0	1	1	0	0	0	0	1
135	1	1	1	0	0	0	0	1
136	0	0	0	1	0	0	0	1
137	1	0	0	1	0	0	0	1
138	0	1	0	1	0	0	0	1
139	1	1	0	1	0	0	0	1
140	0	0	1	1	0	0	0	1
141	1	0	1	1	0	0	0	1
142	0	1	1	1	0	0	0	1
143	1	1	1	1	0	0	0	1
144	0	0	0	0	1	0	0	1

Device address	1	2	3	4	5	6	7	8
145	1	0	0	0	1	0	0	1
146	0	1	0	0	1	0	0	1
147	1	1	0	0	1	0	0	1
148	0	0	1	0	1	0	0	1
149	1	0	1	0	1	0	0	1
150	0	1	1	0	1	0	0	1
151	1	1	1	0	1	0	0	1
152	0	0	0	1	1	0	0	1
153	1	0	0	1	1	0	0	1
154	0	1	0	1	1	0	0	1
155	1	1	0	1	1	0	0	1
156	0	0	1	1	1	0	0	1
157	1	0	1	1	1	0	0	1
158	0	1	1	1	1	0	0	1
159	1	1	1	1	1	0	0	1
160	0	0	0	0	0	1	0	1
161	1	0	0	0	0	1	0	1
162	0	1	0	0	0	1	0	1
163	1	1	0	0	0	1	0	1
164	0	0	1	0	0	1	0	1
165	1	0	1	0	0	1	0	1
166	0	1	1	0	0	1	0	1
167	1	1	1	0	0	1	0	1
168	0	0	0	1	0	1	0	1
169	1	0	0	1	0	1	0	1
170	0	1	0	1	0	1	0	1
171	1	1	0	1	0	1	0	1
172	0	0	1	1	0	1	0	1
173	1	0	1	1	0	1	0	1
174	0	1	1	1	0	1	0	1
175	1	1	1	1	0	1	0	1
176	0	0	0	0	1	1	0	1
177	1	0	0	0	1	1	0	1
178	0	1	0	0	1	1	0	1
179	1	1	0	0	1	1	0	1
180	0	0	1	0	1	1	0	1
181	1	0	1	0	1	1	0	1
182	0	1	1	0	1	1	0	1
183	1	1	1	0	1	1	0	1
184	0	0	0	1	1	1	0	1
185	1	0	0	1	1	1	0	1
186	0	1	0	1	1	1	0	1

Device address	1	2	3	4	5	6	7	8
187	1	1	0	1	1	1	0	1
188	0	0	1	1	1	1	0	1
189	1	0	1	1	1	1	0	1
190	0	1	1	1	1	1	0	1
191	1	1	1	1	1	1	0	1
192	0	0	0	0	0	0	1	1
193	1	0	0	0	0	0	1	1
194	0	1	0	0	0	0	1	1
195	1	1	0	0	0	0	1	1
196	0	0	1	0	0	0	1	1
197	1	0	1	0	0	0	1	1
198	0	1	1	0	0	0	1	1
199	1	1	1	0	0	0	1	1
200	0	0	0	1	0	0	1	1
201	1	0	0	1	0	0	1	1
202	0	1	0	1	0	0	1	1
203	1	1	0	1	0	0	1	1
204	0	0	1	1	0	0	1	1
205	1	0	1	1	0	0	1	1
206	0	1	1	1	0	0	1	1
207	1	1	1	1	0	0	1	1
208	0	0	0	0	1	0	1	1
209	1	0	0	0	1	0	1	1
210	0	1	0	0	1	0	1	1
211	1	1	0	0	1	0	1	1
212	0	0	1	0	1	0	1	1
213	1	0	1	0	1	0	1	1
214	0	1	1	0	1	0	1	1
215	1	1	1	0	1	0	1	1
216	0	0	0	1	1	0	1	1
217	1	0	0	1	1	0	1	1
218	0	1	0	1	1	0	1	1
219	1	1	0	1	1	0	1	1
220	0	0	1	1	1	0	1	1
221	1	0	1	1	1	0	1	1
222	0	1	1	1	1	0	1	1
223	1	1	1	1	1	0	1	1
224	0	0	0	0	0	1	1	1
225	1	0	0	0	0	1	1	1
226	0	1	0	0	0	1	1	1
227	1	1	0	0	0	1	1	1
228	0	0	1	0	0	1	1	1

Device address	1	2	3	4	5	6	7	8
229	1	0	1	0	0	1	1	1
230	0	1	1	0	0	1	1	1
231	1	1	1	0	0	1	1	1
232	0	0	0	1	0	1	1	1
233	1	0	0	1	0	1	1	1
234	0	1	0	1	0	1	1	1
235	1	1	0	1	0	1	1	1
236	0	0	1	1	0	1	1	1
237	1	0	1	1	0	1	1	1
238	0	1	1	1	0	1	1	1
239	1	1	1	1	0	1	1	1
240	0	0	0	0	1	1	1	1
241	1	0	0	0	1	1	1	1
242	0	1	0	0	1	1	1	1
243	1	1	0	0	1	1	1	1
244	0	0	1	0	1	1	1	1
245	1	0	1	0	1	1	1	1
246	0	1	1	0	1	1	1	1
247	1	1	1	0	1	1	1	1
248	0	0	0	1	1	1	1	1
249	1	0	0	1	1	1	1	1
250	0	1	0	1	1	1	1	1
251	1	1	0	1	1	1	1	1
252	0	0	1	1	1	1	1	1
253	1	0	1	1	1	1	1	1
254	0	1	1	1	1	1	1	1
255	1	1	1	1	1	1	1	1

Table 9: Selection table - device address (bus address)

5.2. Jumper settings

The jumpers determine the voltage ranges of the PiXtend eIO inputs (digital or analog). For initial installation and tests, all jumpers are preset at the factory. It is not necessary to adjust the factory settings.

To adjust the jumpers, the stainless-steel cover may need to be removed (for the “Pro” versions). For “Basic” version, the jumpers are directly accessible.

Disassembly and assembly of stainless-steel cover
If the module has already been installed and the cables have been connected, disconnect the power supply and all other cables again. PiXtend eIO devices must never be opened during operation.

Unscrew the four M2.5 screws to remove the stainless-steel cover. Use a Phillips PH1 screwdriver. The aluminum DIN rail housing does not need to be removed to gain access to the jumpers.

Figure 18: Disassembly and assembly of stainless-steel cover

Completely unscrew the four screws and set them aside. The cover can now be easily removed.

After removing the stainless-steel cover, be careful not to touch any electronic components or internal contacts. Electronic components could be damaged by electrostatic discharge.

The components may only be touched at the edges of the circuit boards, on mechanical screw connections or plug connectors. Avoid direct contact with electronic components and solder contacts / soldering surfaces.

On the following pages, there are the descriptions of the jumpers and their effects - separately for each PiXtend eIO device.

Once you have set the jumpers to your requirements, the cover can be placed back on the spacers of the assembly and attached with the four screws. When a screwdriver with torque adjustment is available, tighten the screws to a torque of 0.4 Nm.

5.2.1. Jumper for PiXtend eIO Digital One

Each PiXtend eIO Digital One device - regardless of which version - is supplied with eight jumpers. These jumpers can be plugged in if required:

- Jumper 5V/24V (digital inputs)
  Each digital input has two pins, which can be connected to each other by a jumper. The two left pins belong to DI0, the next two pins to the right belong to DI1, etc.

  If two pins of different channels are incorrectly connected, this does not lead to a defect. However, signals from one input are transmitted to the other input, which can lead to unexpected behavior. Check the correct jumper setting before a signal is connected to the inputs.

  If no jumper is plugged in, the digital input is in the 24V range (factory default setting). If a jumper is plugged in, the input is in the 5V range. The switching levels of the inputs are adapted according to this setting.

If you are unsure which voltages are connected to the digital inputs, do not insert a jumper and remain in the 24V range.

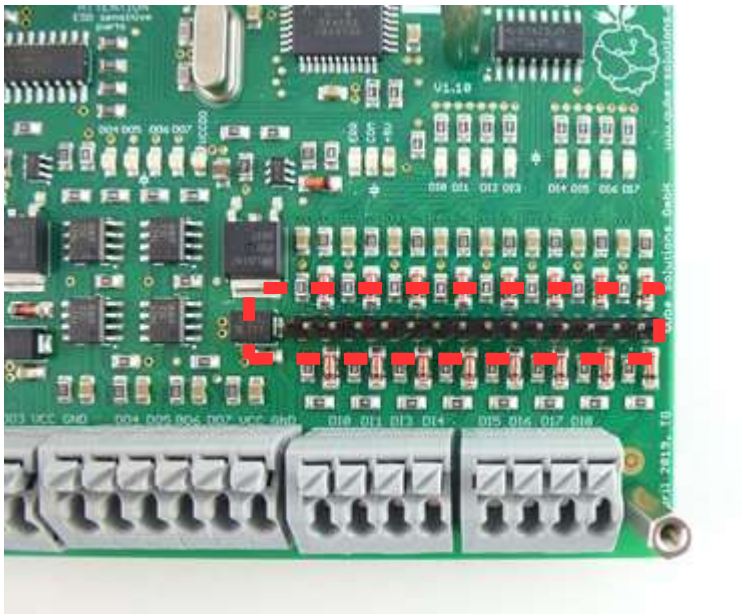


Figure 19: Jumper - digital inputs in 24V range (factory default)

5.2.2. Jumper for PiXtend eIO Analog One

Each PiXtend eIO Analog One device - regardless of which version - is supplied with four jumpers. These jumpers can be plugged in if required.

- Jumper 5V/10V (analog voltage inputs)

  Each analog input has two pins, which can be connected to each other by a jumper. The both left pins belong to AI0, the other two pins belong to AI1.

  If no jumper is plugged in, the analog voltage input is in the 0 – 10V range (factory default setting). If a jumper is plugged in, the range of the input changes to 0 – 5 V.
  The reduction of the voltage range makes sense if only small signals up to a maximum of 5V are to be measured. In this case, the full resolution is available for the reduced measuring range.

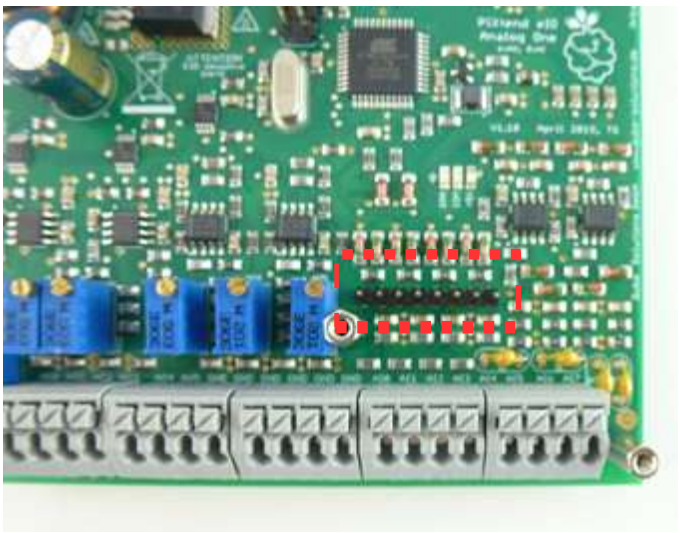


Figure 20: Jumper - analog voltage inputs in 10V range (factory default)

If you are still unsure how high the voltage at the analog inputs can be, do not insert a jumper and remain in the 0 – 10V range.

5.3. Grounding connection (PE)

PiXtend eIO devices are supplied with or without housing depending on the version. If the devices are to be used in an area in which dangerous voltages[1] can also occur (example: control cabinet of a machine), we recommend the “Pro” versions with a stainless-steel cover.

The stainless-steel cover has a special grounding connection (PE). This is marked with the designation "PE" and is designed for common cable lugs or flat blade receptacles (width 6.35 mm).

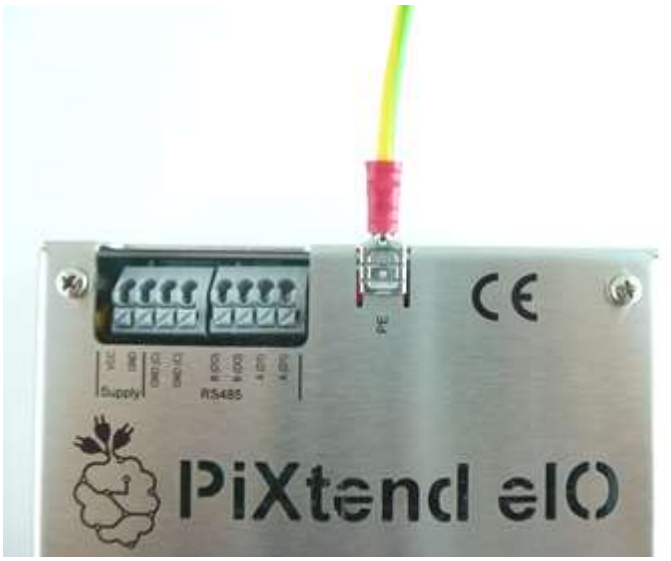


Figure 21: Grounding connection (PE) on the PiXtend eIO cover

A further grounding connection is also available on the underside of the aluminum DIN rail housing. For safe operation, both the cover and the DIN rail housing must be provided with a grounding connection.

[1]Generally, voltages greater than 50V (DC or AC) are referred to as dangerous voltages. The most common dangerous voltage is the mains voltage with 230 or 115V AC. There are also other dangerous voltages.

Figure 22: Grounding connection (PE) on the PiXtend eIO DIN rail house (bottom)

⚠CAUTION

The grounding of the DIN rail housing only via the mounting connection housing ← → DIN rail is not sufficient and does not represent a reliable PE connection. The grounding connection (flat receptacle) must be used!

In the event of a fault in which a dangerous voltage could be applied to metal parts of the PiXtend eIO, the current flow via the grounding connection is reliably ensured. The safety mechanisms (miniature circuit breaker, personal protective switch/fault current switch FI) are able to trip and restore the entire system to a safe state.

The following points must be observed for the reliable connection of the grounding connection to the cover and for safe use of the PiXtend eIO:

- Dangerous voltage greater than 50V may not be connected anywhere on the PiXtend eIO during normal operations. Always connect both metal parts of PiXtend eIO Pro devices with the grounding connector (DIN rail housing and stainless-steel cover).
- Plan the cable cross-section for PE according to the connection cross-sections carrying dangerous voltages (at least one cable with a cross-section of 1.5 mm²).
- Use a cable (stranded wire or wire) with the typical green/yellow color coding to connect the grounding terminal.
- Use flat receptacles with a "snap-in nose", which snaps into the cover and protects against unintentional loosening/removal.
- Check that the flat receptacle has a tight fit and an electrical connection.
- The grounding connection must meet the legal requirements of the respective country in which PiXtend is to be used.
- If you are unsure, contact a locally certified electrician or contact your local authorities.

5.4. Connecting the power supply

The PiXtend eIO can be operated with a wide range of power supplies that provide a stabilized output voltage of 19 - 30V DC (DC)[2]. When working directly at a desk with the device, it is easiest to just use a simple plug-in power supply. If the PiXtend eIO is installed in a control box or cabinet, a power supply for DIN rail mounting is recommended.

Please refer to section 5.5 Connection of alternative power supplies if you want to use power supplies other than those described below.

The exact requirements for a power supply can be found in chapter 7 Technical Data and Connection Instructions.

NOTICE

Always ensure that the power supply used complies with the legal requirements of the country in which it is used!

On the following pages, we will show you how to connect a standard plug-in power supply to the PiXtend eIO.

Figure 23: Package contents of a power supply from our online shop

[2]It is also possible to work with 12V DC supply voltage with some restrictions. Further information in chapter 6.6 Operation with 12V supply voltage.

Most of the plug-in power supplies are equipped with a female connector socket 2.1 mm (inside) x 5.5 mm (outside). This means that connection to the terminals on the PiXtend eIO is not directly possible.
We therefore have put together a set which contains all the required individual lines for the connection to the PiXtend (V2 controls and eIO expansions – figure 23). The set can be ordered from our online shop.

The set contains the following components:

- Plug-in power supply - fixed output voltage - 24V DC, 1.04 A
- Adapter from female socket to terminal blocks
- Connection wires red and blue - 0.75 mm², 10 cm length

The adapter is plugged into the female connector socket. The two wires can be plugged into the adapter without tools. To do this, the buttons on the adapter must be pressed down.

Figure 24: Wire connection to the adapter

Connect the red wire (+) to the connector with the red button, and the blue wire (-) to the connector with the black button.

The colors and the polarity of the power supply match the power supply and adapter from our shop. If you are using your own power supply and adapter, check which connection is + (24V DC ±20%) and - (GND). The assignment of the plug connectors is not always the same.

NOTICE

Please note the polarity when using your own power supply. The polarity can be found in the operating manual of the power supply unit or can be checked with a voltage measuring device.

Now the connection cables can be connected to your PiXtend eIO. The red wire is connected to one of the terminals labeled “VCC SUPPLY” (cover) / “VCC 24V DC” (board), the blue wire to “GND” - see figure 25.

Figure 25: Power connection to the PiXtend eIO

Figure 26: Power supply connected to the PiXtend eIO

If the connection cables are reverse-poled, the device will not be damaged. The PiXtend eIO has polarity protection, which prevents damage to components. However, the PiXtend eIO only works if the cables are connected correctly.

NOTICE

Check the enclosed safety instructions of the respective manufacturer before using the power supply for the first time!

The power supply can now be plugged into a 115 or 230V AC socket.

The green LED with the label “+5V” starts to light up and signals the presence of the operating voltage.

5.5. Connection of alternative power supplies

Apart from the plug-in power supply described in detail in the previous section, other power supplies can also be used with the PiXtend eIO. Another example - a DIN rail power supply - will be shown in the following section. Please always observe the associated safety instructions before applying voltage to power supplies or your PiXtend eIO module.

NOTICE

Please ensure that the power supply complies with the legal requirements of your country before purchase. If in doubt, ask the manufacturer or dealer for approval. Always observe the safety instructions of the respective power supply, which must be enclosed in printed form.

⚠DANGER

While you are working on the connection wires of a power supply, the power supply must never be plugged in! Caution: Dangerous to life!

If the PiXtend eIO is to be used in a control box, cabinet or laboratory set-up, a DIN rail power supply is suitable for the voltage supply. This type of power supply usually has to be connected or wired to mains voltage.

⚠CAUTION

Because the power supply usually is connected to mains voltage, be sure to observe the manufacturer's safety and connection instructions. Work on the power supply (115/230V AC) is only permitted by authorized personnel!

The following figure shows a 60 W DIN rail power supply, which can be used with the PiXtend eIO:

Figure 27: 24V; 2.5A DIN rail power supply connected to the PiXtend eIO

With the illustrated power supply (figure 27), the voltage can still be set exactly to 24.0 V with a small screwdriver. This should be done before the voltage is applied to the PiXtend eIO. To do this, measure the output voltage of the power supply using a voltmeter or multimeter.

5.6. Connection to a bus master

You have learned on the previous pages how to check the delivery, set jumpers and switches and connect the power supply. Now your PiXtend eIO can be used.

PiXtend eIO devices (slaves) are always operated in conjunction with a bus master, which sends data to the slave devices and polls them. Many different devices can perform the tasks of a bus master.

Below we will show you two possible configurations in detail:

1. PiXtend V2 -L- as master
2. PC with USB RS485 dongle as master

At the end of this section, you will have prepared the devices to the extent that initial testing with appropriate software is the next step. At this point, installation continues in the PiXtend eIO Software Manual.

If you have problems during installation, you will find approaches to solve them in chapter 5.7.

5.6.1. PiXtend V2 -L- as master

The setup described here is suitable as a test setup in the office or laboratory area and should only be seen as an example. A real installation in an industrial environment, for example, has completely different requirements and must be designed accordingly. All important information on this can be found in the chapter Basic knowledge and in the chapter Technical Data and Connection Instructions.

We use the following components:

- 1x PiXtend V2 -L- ePLC Pro (Article 50199 012)
- PiXtend eIO - Digital One Pro (Article 50199 008)
- - PiXtend eIO - Analog One Pro (Article 50199 010)
- ca. 1-2 meters control wire with 2x or 3x 0.2 mm² / 0.25 mm²
- ca. 3 meters stranded wire – red – (1x 0.75 mm²)
- ca. 3 meters stranded wire – black or blue – (1x 0.75 mm²)
- Laboratory power supply with settings to 24V, min. 1 A

We assume here that all devices have the default settings. You will find the settings for PiXtend eIO devices in this document and for PiXtend V2 -L- in its hardware manual in the download section of our website.

NOTICE

Make sure that all the devices listed are disconnected from the supply voltage before wiring and further work is started.

All three devices are powered by a common power supply. We connected each 24V and GND directly from the power supply or a common terminal block to the devices. We do not recommend further “looping” of the power supply - from one device to the next (refer to the chapter Basic knowledge for details on power supplies).

Now the bus lines can be connected, either with 2-pin or 3-pin cable. The cable is split into two parts so that we can connect one line between the master and the first slave and another between the two slaves.

Here we used a 3-pin cable with the following colors:

- brown (BN) → use as GND connection
- green (GN) → bus signal A (D1)
- white (WH) → bus signal B (D0)

In this setup, it is irrelevant whether 2-pin or 3-pin cables are used. With 2-pin cables, the GND is omitted. The current path for GND is provided by the common power supply and sufficient for the test setup. If the bus is to be Modbus compliant, use a 3-pin cable with GND (C - common) and shielding.

The colors for the individual signals are not required. However, at Kontron Electronics, we always use exactly these colors (LIYY cable with DIN 47100 color coding). These can also be found in the “PiXtend eIO cable set” (chapter 4.5.1).

We start from the bus master (PiXtend V2 -L-) and connect the control line with the mentioned terminals. At the other end of the wires, we connect to the first eIO device. From this device, we loop with the remaining piece of the control line on to the second eIO device. The bus connections on the eIO modules are doubled - this results in the required line structure of the bus and a simple and quick setup. It does not matter which connections are used as an “input” and which as an “output”.

In our example, the wiring now corresponds to the following table:

PiXtend V2 -L- Bus master	Line #1	PiXtend eIO Analog One		Line #2	PiXtend eIO Digital One	
GND	brown (BN)	GND (C)	GND (C)	brown (BN)	GND (C)	-
A	green (GN)	A (D1)	A (D1)	green (GN)	A (D1)	-
B	white (WH)	B (D0)	B (D0)	white (WH)	B (D0)	-

The setup is graphically shown again in figure 28.

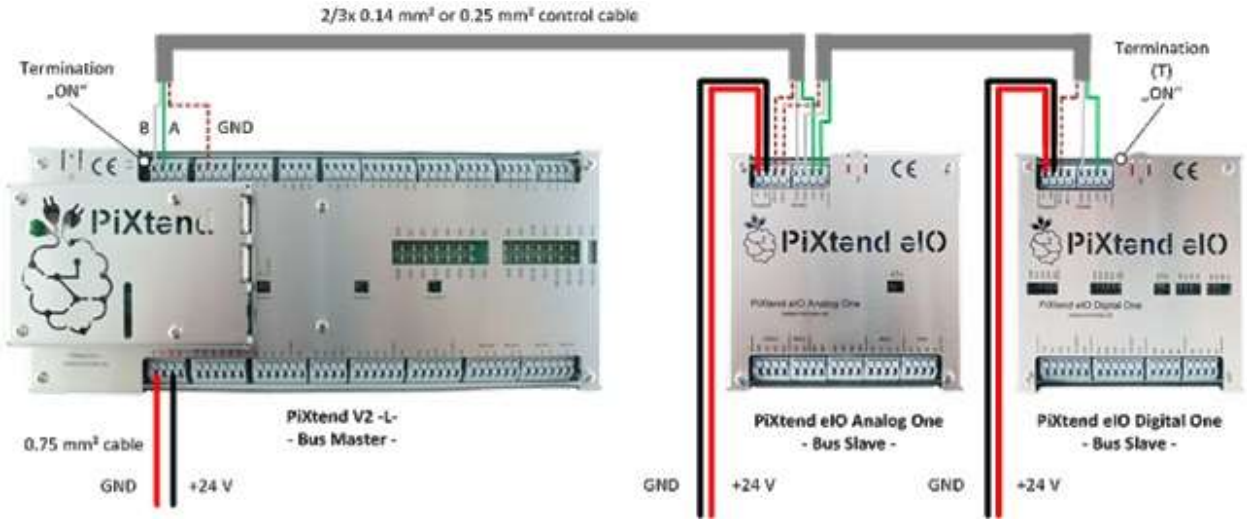


Figure 28: Test setup - PiXtend V2 -L- as master

In the last step, we activate the bus terminating resistors on the first and last bus node of the line structure. In our setup, this means that the master is PiXtend V2 -L- and the PiXtend eIO Digital One.

With the PiXtend V2 -L-, the terminating resistor is activated with the help of a jumper, directly next to the RS485 connection block. We set the jumper to the “ON” position. For the PiXtend eIO Digital One, only the “T” switch has to be switched to “ON”. Now everything is ready to work with the devices.

Installation with software – in the first step with a small test program – can be found in the PiXtend eIO Software Manual.

If the digital outputs of the PiXtend eIO Digital One are to be used in this configuration, then the supply connections of the outputs must also be wired.

5.6.2. PC with USB RS485 dongle as master

The setup described here is suitable as a test setup in the office or laboratory area and should only be seen as an example. A real installation in an industrial environment, for example, has completely different requirements and must be designed accordingly. All important information on this can be found in the chapter's Basic knowledge and Technical Data and Connection Instructions.

Now the test setup can begin!

We use the following components:

- 1x computer with USB connection
- PiXtend eIO - Digital One Pro (Article 50199 008)
- - PiXtend eIO - Analog One Pro (Article 5019 010)
- 1x USB RS485 dongle (Article 30199 011)
- 1x PiXtend eIO Cable set with termination (Article 30199 009)
- ca. 2 meters stranded wire – red – (1x 0.75 mm²)
- ca. 2 meters stranded wire – black or blue – (1x 0.75 mm²)
- Laboratory power supply with settings to 24V, min. 1A

NOTICE

We assume here that all eIO devices have the default settings. The default PiXtend eIO settings are described in this document.

Make sure that all the devices listed are disconnected from the supply voltage before wiring and further work is started. For the USB dongle, it is sufficient that it is removed from the computer or USB hub.

The USB dongle used here can be combined with many different computer systems – Raspberry Pi computer, Windows computer, computers with Linux or iOS operating systems and a variety of embedded devices.

Both eIO devices are powered by a common power supply. We connected each 24V and GND directly from the power supply or a common terminal block to the devices. We do not recommend further “looping” of the power supply - from one device to the next (refer to the chapter Basic knowledge for more information).

The USB dongle is powered by the USB port of the computer being used. Now the bus lines can be connected. The cable set makes this step quick and easy. The adapter included with the USB dongle is not needed. If this is already plugged in on the dongle, remove it and set it aside.

The longer cable from the cable set has a D-SUB 9 socket at one end. This can be connected directly to the USB dongle.

At the other end of the wires, we connect to the first of the two eIO devices. From this device, we loop the short cable from cable set to the second eIO device. The bus connections on the eIO modules are doubled - this results in the required line structure of the bus and a simple and quick setup. It does not matter which connections are used as an “input” and which as an “output”.

In our example, the wiring corresponds to the following table:

USB RS485 Bus master		Line #1	PiXtend eIO Analog One		Line #2	PiXtend eIO Digital One	
Pin 5	D-SUB 9 connector of the cable set	brown (BN)	GND (C)	GND (C)	brown (BN)	GND (C)	-
Pin 2		green (GN)	A (D1)	A (D1)	green (GN)	A (D1)	-
Pin 1		white (WH)	B (D0)	B (D0)	white (WH)	B (D0)	-

The setup is graphically shown again in figure 29.

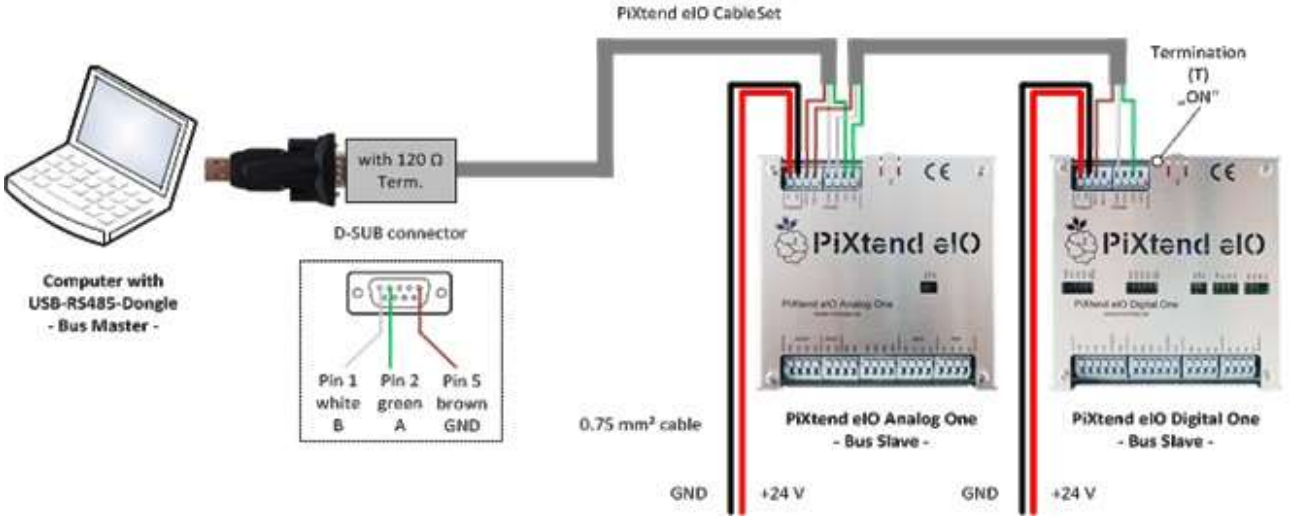


Figure 29: Test setup - PC with USB RS485 dongle as master

In the last step, we activate the bus terminating resistor on the last bus node of the line structure. In our setup, this is the PiXtend eIO Digital One. At the other end, the bus master (USB RS485 dongle), we have already attached the plug of the cable set with integrated terminating resistor.

For the PiXtend eIO Digital One, only the “T” switch has to be switched to “ON”. Now everything is ready to work with the devices.

Installation with software – in the first step with a small test program – can be found for several platforms in the PiXtend eIO Software Manual.

NOTICE

If you want to use with your own connectors and cables, it is possible. Make sure that the GND cable is also connected. The ground reference between the eIO devices and the computer must always be established. Especially if it is a laptop computer. Without a reliable GND reference, transmission errors or non-transmission may occur.

If the digital outputs of the PiXtend eIO Digital One are to be used in this configuration, then the supply connections of the outputs must also be wired.

5.7. Troubleshooting

If the PiXtend eIO system does not behave as expected, you can find troubleshooting tips in this section.

Problem
After connecting the power supply to the PiXtend eIO, nothing happens. The green LED “+5V” does not light up.

Troubleshooting
Check that the power supply is correctly polarized and set to a voltage between 19 and 30V DC. It must be a power supply that outputs a stabilized direct voltage (DC). The exact requirements for power supplies can be found in chapter 7 Technical Data and Connection Instructions.

Problem
After connecting the power supply with the PiXtend eIO, the red ("ERR") and orange "COM" LED blinks briefly. Is that normal?

Troubleshooting
Yes, that is completely normal. This is a visual check that signals that the micro-controller of the device is programmed. We need this functionality for production and quality control.
The red LED "ERR" should blink continuously, this is a sign that you have selected the Modbus protocol as the mode and have set an invalid address. Change the address using the DIP block "ADDRESS" and restart the device.

Problem
The digital outputs appear not to work. In the “1” or “true” state, there is no voltage at the output or the connected device does not react. However, the LED of the respective output lights up.

Troubleshooting
The digital outputs must be supplied separately with voltage (connections “VCC DO” (+) and “GND” (-) on the respective connector “DIGITAL OUT”). Four digital outputs each have a single supply connection (VCC DOx-x).

If no voltage is applied here, there is no voltage at the outputs. The respective LED "VCC-DOx-x" on the PiXtend eIO signals the presence of voltage at the associated connection (range 5 - 30V).

The status LEDs of the digital outputs also light up in the active state if no voltage was applied to VCC-DOx-x.

Problem
Despite correct settings (DIP switches and software configuration), there is no communication with the device. What could be causing the error?

Troubleshooting
Check the connection of the power supply and the bus lines again and ask yourself the following questions:

- Does the power supply meet the requirements or is it possibly overloaded or defective?
- Are all devices on the bus configured correctly? Maybe two devices have the same address? (This is not allowed and causes problems.)
- Are the connections of the data lines correctly connected or inadvertently exchanged?
    - There are often confusions with the designations A and B on the RS485 bus. An explanation can be found in chapter 6.3.
- Has the bus termination been set correctly? Are there too few or too many activated bus terminations in the overall system?
- Did you double check the DIP switches and software configuration?!

6. Technical Data and Connection Instructions

This chapter describes the technical data for the entire PiXtend eIO system.

6.1. Overview – Connections and Functions

General - for all eIO devices

- Entire system
- Mechanics
- Voltage regulator
- LED Signals
- Serial (bus) interface RS485

PiXtend eIO Digital One

- 8x digital inputs
- 8x digital outputs

PiXtend eIO Analog One

- 4x analog voltage inputs
- 4x analog current inputs
- 4x analog voltage outputs
- 2x analog current outputs

6.2. Information about the entire system

Some of the information on the entire system is identical for all eIO devices. When information differs, the information includes the device that it pertains to.

Property	Value	Comment
Product group	Completely assembled device – without housing Completely assembled device – with housing	eIO Digital/Analog One Basic eIO Digital/Analog One Pro
Ambient temperature	0 – 60° C -20 – +70° C	in operation during transport and storage
Relative humidity	0 – 85% (not condensing)	In operation or during transport and storage
Dimensions	96.3 x 101.8 x 21 mm 106 x 105 x 45 mm	eIO Digital/Analog One Basic eIO Digital/Analog One Pro
Weight	ca. 81 g ca. 293 g ca. 83 g ca. 294 g	eIO Digital One Basic eIO Digital One Pro eIO Analog One Basic eIO Analog One Pro
Power consumption	typical 15–30[3] mA, max. 0.2 A typical 25–105[4] mA, max. 0.2 A	eIO Digital One Basic/Pro eIO Analog One Basic/Pro
Protection class	IP00 IP20	eIO Digital/Analog One Basic eIO Digital/Analog One Pro
Pollution (according to EN 61010-1)	Pollution degree 1 Pollution degree 2	eIO Digital/Analog One Basic eIO Digital/Analog One Pro
Max. altitude	2000 meters about sea level	in operation

Table 10: Technical specifications – PiXtend eIO devices

During operation, PiXtend eIO Basic devices must be installed in a suitable housing to avoid direct or unintentional contact with the electronic components and conductor paths. This manual provides all the information you need to operate your device reliably and safely.

[3] 15 mA idle (bus communication only), 30 mA with activated outputs (DO LEDs), but without loads on the digital outputs. The loads always have to be added.

[4] 25 mA idle (bus communication only), 105 mA with nominal load on all analog outputs

6.2.1. Mechanics

Every PiXtend eIO has 6 holes for M2.5 screws (diameter 2.5 mm). For of them are for mounting the stainless-steel cover. This cover is pre-mounted on Pro devices.

With all PiXtend eIO versions, spacers (M2.5 thread with external width across flats SW 4) enable the devices to be screwed onto a mounting plate.

The external dimensions of the circuit boards are designed for insertion into an aluminum DIN rail housing – pre-mounted for Pro devices.

If the PiXtend eIO is used without the above-mentioned housing parts (for Basic versions), the spacers ensure a safe distance or serve as a mounting option in your control box or device.

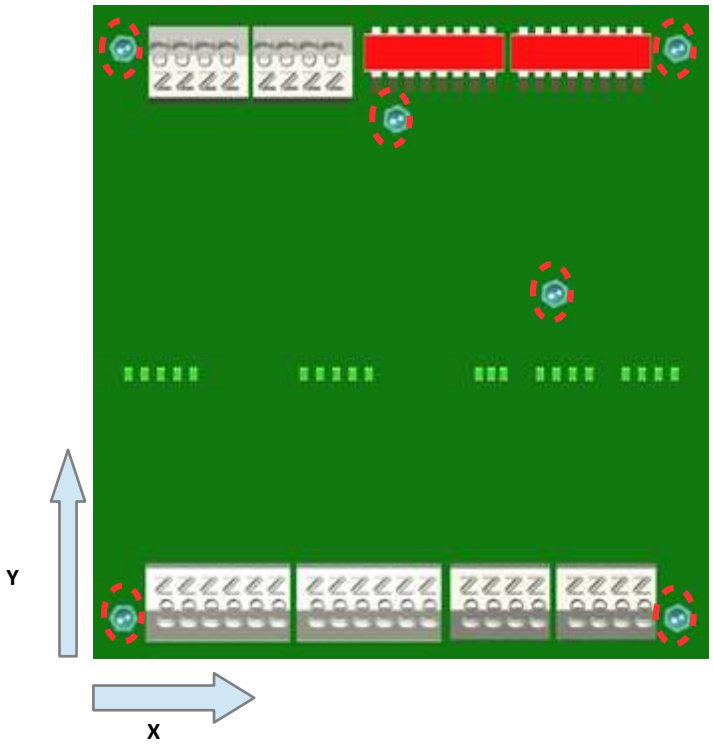
Below you will find the coordinates of the holes that you need to plan the position for mounting the PiXtend eIO into your device or machine.

It is even easier with the 3D CAD data, which can be downloaded free of charge on our website (in the STEP format).

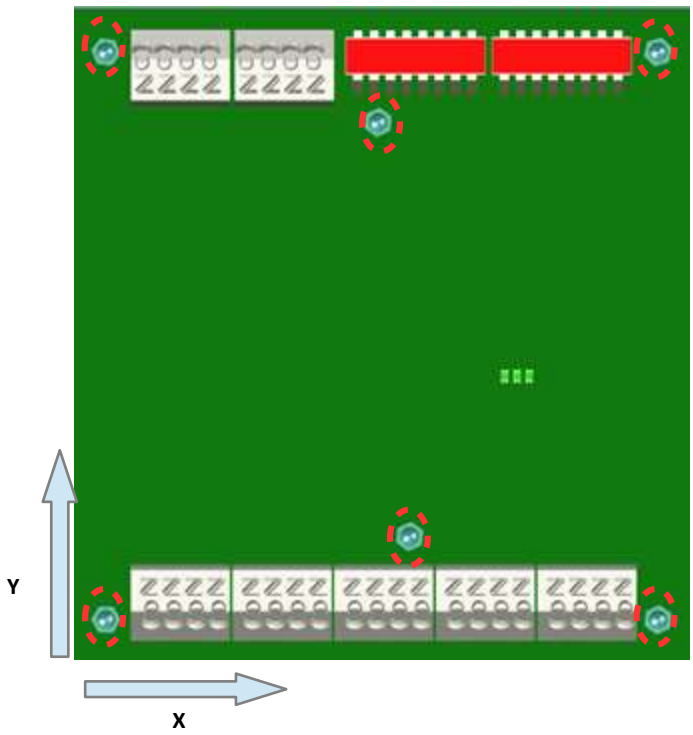
Property	Value	Comment
Thickness of the circuit board	1.55 mm	
Dimensions [X x Y]	96.3 x 101.8 mm	
Printed circuit board	Yes	white, on top side
Holes	X axis	Y axis
for mounting the stainless-steel cover: (all eIO devices) additional holes – eIO Digital One: additional holes – eIO Analog One:	5 mm 5 mm 91.25 mm 91.25 mm 47.525 mm 72.139 mm 47.525 mm 54.613 mm	6.5 mm 95 mm 6.5 mm 95 mm 84.04 mm 56.925 mm 84.04 mm 22.635 mm

Table 11: Technical data – PiXtend eIO circuit board

PiXtend eIO Digital One:



PiXtend eIO Analog One:



6.2.2. Terminal block connectors

The terminal blocks on the PiXtend eIO are industrial terminals with push-in technology (tool-free) and defined contact force, which ensure a long-term stable connection.

Cables with wire end ferrules or rigid wires can be plugged in directly (without tools or push buttons). The lines are always released via the push button.

Connection data	Value	Comment
Cable cross-section min. - max.	0.2 mm² – 1.5 mm²	for rigid and flexible cables
Cable cross-section with ferrules min. - max.	0.25 mm² – 1 mm²	for flexible cables ferrules without plastic collar
	0.25 mm² – 0.75 mm²	for flexible cables ferrules with plastic collar
Cable cross-section AWG min. - max.	16 - 24	

Table 12: Technical data - Terminal block connectors

The clamps come from German production (WAGO or Phoenix Contact).

6.2.3. Power supply

Figure 30: Terminal block for the power supply

The central power supply on the PiXtend eIO is established via the directly adjacent connections labeled "VCC" and "GND" (additionally labeled "Supply" on the stainless-steel cover of Pro units).

An external power supply provides the PiXtend eIO with a voltage of 19 - 30V DC and a maximum current of 0.2A via this connection. The nominal voltage is 24V DC. The internal voltage regulator produces stabilized and short-circuit-proof 5V DC voltage. This 5V voltage is only used within the module to supply the microprocessor, the RS485 bus driver and many other circuit parts.

NOTICE

The 5V DC voltage is only intended for the internal supply of the PiXtend eIO device and must not be used for external purposes!

If your application requires 5V DC in addition to 24V DC, use an external power supply (115/230V AC to 5V) or a DC/DC converter (24V to 5V).

PiXtend eIO Digital One devices have additional connectors marked "VCC" (on the circuit board) or "VCC-DOx-y" (on the stainless-steel cover) on the terminal strips of the digital outputs. These are only intended to supply the digital outputs and are not suitable for supplying other electronic devices.

Property	Value	Comment
Type of voltage regulator	switching regulator	Step-down/buck converter
Switch frequency	52 kHz	fixed frequency, internal oscillator
Input voltage	24V DC	Rated input voltage
	19V DC[5]	Minimum input voltage
	30V DC	maximum input voltage
Output voltage	5V DC	±5% of the rated voltage
Output current	max. 0.9A	
Output ripple	typical < 10 mV	
Power reserve according to IEC 61132-2	min. 10 ms	with rate input voltage
Short circuit and overload protection	Yes	thermal, self-resetting
Cooling	Yes	passive heat sink (circuit board)
Reverse polarity protection	Yes	up to -30V
EMC surge/burst protection	Yes	transil diode, bidirectional
Electrical isolation	No	
Status display	LED (green)	labeling: “+5V”
Permissible cable length	< 30 m	

Table 13: Technical data – voltage regulator (internal)

⚠CAUTION

Operate the PiXtend eIO only within the defined voltage and load ranges. A continuous overload can lead to permanent damage of electronic components!

Depending on the load and ambient temperature, the voltage regulator, circuit board and diodes of the voltage regulator can have temperatures of up to 75° C. Avoid direct contact!

[5] It is possible to operate the devices with 12V DC, but with certain restrictions, which are documented in chapter 6.6 Operation with 12V supply voltage.

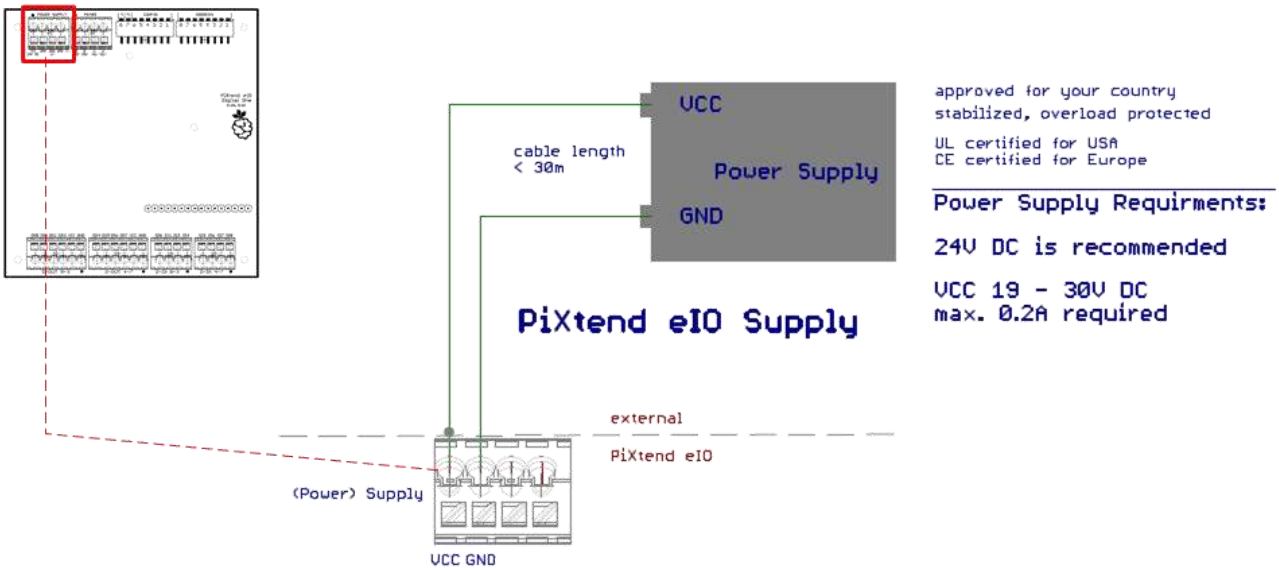


Figure 31: Simplified wiring diagram: connection of the central power supply

The PiXtend eIO uses a regulated and short-circuit-proof power supply with an output voltage between 19 and 30V DC. The power supply must comply with the legal requirements of the particular country in which the system is used. When purchasing a power supply, please check the corresponding approval marks.

You can find compatible power supplies in our online shop.

The internal voltage regulator of the PiXtend eIO devices has an energy reserve. This ensures an uninterrupted power supply for voltage drops at the supply input of 10 milliseconds. The energy reserve is designed to ensure the backup power time throughout the life of the device.

If several PiXtend eIO devices are operated in a system, each device must be connected with separate lines - from a central point (e.g. from the power supply or a central terminal block). Looping the power supply from one module to the next is not recommended. This can lead to an undesirable voltage drop, as a result of which the modules are no longer supplied correctly.

The separate wiring of each module power supply becomes more important the more modules are used in a system.

6.2.4. LED Signals

Figure 32: Status LEDs “ERR”, “COM” and “+5V” on PiXtend eIO modules

6.2.4.1 Signaling: supply voltage LED “+5V”

The green LED labeled “+5V” indicates the presence of the internal supply voltage of 5V DC.

State (Signal)	Designation	Meaning
Off / faint light	not ready	supply voltage not available or insufficient
On	ready	supply voltage available

Table 14: LED “+5V” - signaling of the supply voltage

If this LED does not light or only glows slightly, then the power supply to the device is not available or insufficient. In this case, check the wiring, the voltage between the terminals “VCC” and “GND” and check again the requirements of the power supply according to chapter 6.2.3.

6.2.4.2 Signaling: communication LED “COM”

The orange LED with the label “COM” indicates data transmissions on the RS485 bus. It is irrelevant whether the transmitted data is intended for the respective device or not. All communication on the bus causes blinking. If there are no data transmission, this LED remains dark.

State (Signal)	Designation	Meaning
off	idle	
blinking	communication	There is data transmissions / communication on the RS485 bus.

Table 15: LED “COM” - signaling of communication

In regard to the blinking frequency, a tendency can be observed (the higher the frequency, the more data or the faster data is being transferred on the bus). However, the exact baud rate or amount of data cannot be determined by this LED.

The one-time orange blinking when starting the devices is normal and does not indicate communication. Similarly, the red “ERR” LED blinks briefly during startup.

6.2.4.3 Signaling: error LED “ERR”

Some error states that may occur with the PiXtend eIO may not be able to be reported back to the bus master via RS485, e.g. in case of faulty communication or if the watchdog of the PiXtend eIO has been activated. For these situations, a red “ERR” LED has been placed on the PiXtend eIO device to help the user to determine the source of a problem.

The meaning of the different LED (L1) signals can be found below:

State (Signal)	Designation	Meaning
off	ready, no errors	-
on (continuous)	telegram errors	Modbus RTU protocol: Incorrect function code (FC) Number of registers, coils or discretes is wrong
	Message error	PiXtend eIO ASCII protocol: frame error, parity Error, overrun error, incorrect baud rate defined
Blinking fast (0.05 s)	Communication error Configuration error	With Modbus RTU and PiXtend eIO ASCII protocol: data transfer error Configuration via DIP switch not permitted or changed during operation
blinking (0.1 s)	command error	Only with PiXtend eIO ASCII protocol: the command sent is unknown or is not supported
Blinking slow (0.2 s)	I/O error	Only with PiXtend eIO ASCII protocol: the desired input or output is not available (e.g. when trying to set output 9, but there are only 8 outputs)
Blinking 3x fast, 3x slow, 1 second break	Watchdog	With Modbus RTU and PiXtend eIO ASCII protocol: triggered by the device’s Watchdog timer

Table 16: LED “ERR” – signaling of error states

The one-time red blinking when starting the devices is normal and does not indicate an error. Similarly, the orange “COM” LED blinks briefly during startup.

6.3. RS485

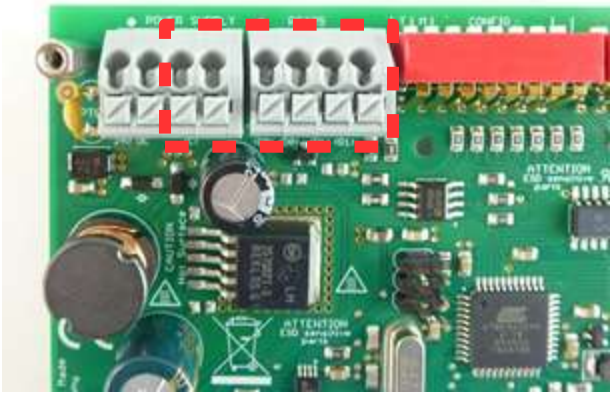


Figure 33: Terminal block connector - RS485 interface

The RS485 interface is the central data interface of PiXtend eIO devices. It enables participation in a bus system and thus data exchange with other devices and modules.

The PiXtend eIO fulfills the function of a “slave” in such a bus system (also known as a network). This means that information can be sent to or requested from devices. A slave device always only becomes active on the bus if it is addressed by a “master”, i.e. the master makes a communicate request. There is no direct communication between slave devices.

The interface works with differential signal levels and is therefore particularly insensitive to interference. It is designed according to RS485 or EIA485 standards and meets the requirements of the “MODBUS over Serial Line” specification.

Controlled by...

- Modbus RTU master
  - PiXtend V2 -L-
  - Logic controllers (PLC) and industrial PCs (IPC) with RS485
  - Embedded devices like Arduino, Raspberry Pi with RS485 shield/dongle

- PiXtend eIO ASCII protocol
  - Every device with an integrated RS485 interface or RS485 USB dongle
  - PC, Mac, laptop, server, IPC, Android tablet/smartphone

The RS485 transceiver on the PiXtend eIO is short-circuit proof and robust against interference. The DIP switch “T” (termination) can be used to switch an 120Ω terminating resistor on or off as desired. The double implementation of the connections A (D1) and B (D0) allows the bus to be simply “looped” (“daisy chain” - direct feed-through), thus enabling simple, reliable and economical wiring.

Baud rates from 2400 to 230,400 bauds, 1 or 2 stop bits and parity control (even, odd, none) are supported.

Property	Value	Comment
Type of interface	serial interface, symmetric (differential)	wired half-duplex
Type of connection	Data bus/fieldbus	
Norm / Standard	RS485/EIA485 MODBUS	meets the requirements and specifications of the “MODBUS over Serial Line” specification V1.02[6]
Minimum transmission rate	2,400 baud	
Maximum transmission rate	230,400 baud	
Maximum number of participants on the bus	32	depending on: – the nature, environment and length and cross-section of the cables used – the software used – the circuit technology of other participants on the bus
Differential output voltage	min. 1.5V max. 8V	with maximum load (27Ω) without load
Minimum differential input voltage	0.2V	input threshold
Maximum voltages	-7V – +12V	A or B to GND
Short-circuit protection	Yes	Short circuit against GND
Short circuit current	max. 250 mA	
Overload protection	Yes	thermal
EMC surge/burst/ESD protection	Yes	TVS diode - bidirectional
Electrical isolation	No	
Status display	No	only indirect over “COM” LED
Bias network (“line polarization”)	No	not available and is not necessarily required in the network
Terminating resistor	Yes	120Ω, per DIP switch
Min. cable cross section of the bus lines / differential pair	0.20 mm² (AWG24)	
Recommended cable cross section of the bus lines / differential pair	0.25 mm² (AWG23)	
Permissible cable length	< 30 m > 30 m	unshielded cables shielded cables for Modbus, shielded cables must always be used and connected to PE at one point
Permissible bus length (trunk cable)	max. 1000 m*	at 9,600 baud and 0.20 mm² (AWG24) cable cross section or larger *the maximum bus length is generally dependent on: – the nature, environment and cross-section of the cables used – the software used – the circuit technology of other participants on the bus – maximum number of participants on the bus

[6]Available from http://www.modbus.org

		That is why it cannot be stated generally.

Table 17: Technical data – RS485 interface

⚠CAUTION If the specified maximum values are exceeded, transmission errors, functional errors and component defects can occur.

Connection instructions

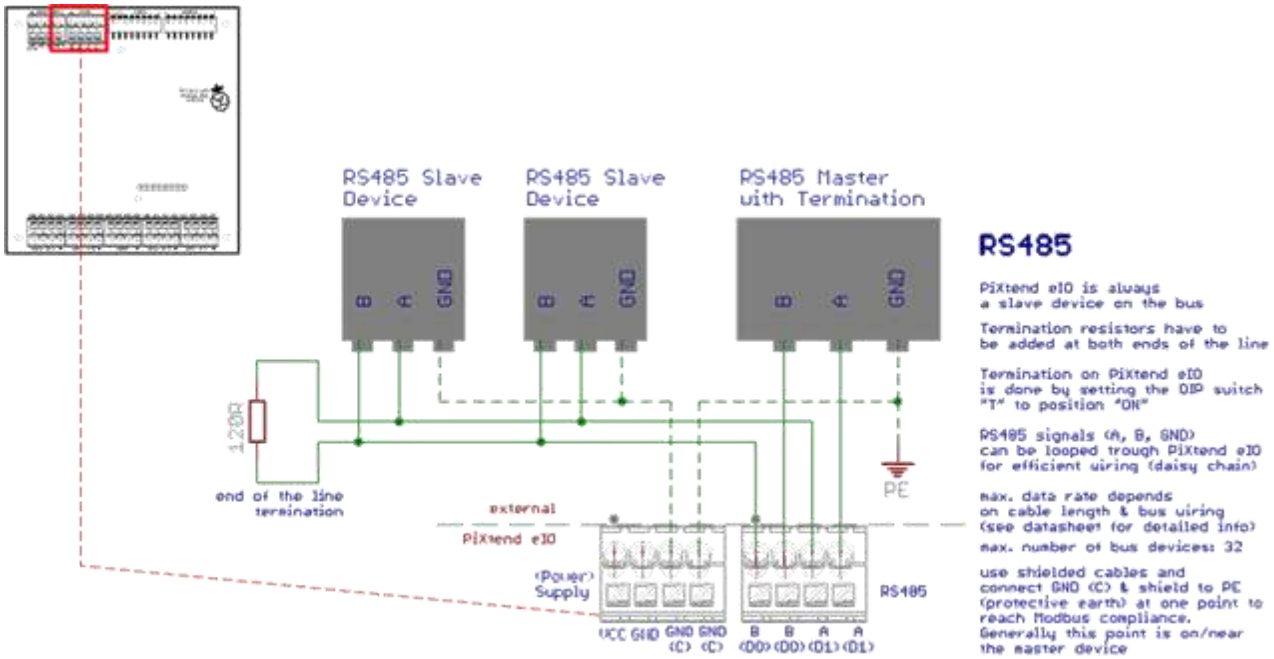


Figure 34: Simplified wiring diagram: connection of the RS485 interface

With RS485 interfaces there is always confusion because of the labeling of the connections. The labels A and B may vary depending on the manufacturer. As a rule, incorrect wiring does not lead to permanent problems or defects, as is the case with PiXtend controllers and eIO's.

In the case of the PiXtend eIO, we adhere to the labels according to the “MODBUS over Serial Line specification V1.02”: D1, D0, C. Additionally, we use the labels of the transceiver chip manufacturers with A, B, GND, printed on the devices.

The A and B labels from the integrated circuits (chips) are always exactly the opposite as from the RS- / EIA-485 standard. This circumstance is the reason for all the confusion.

For PiXtend V1.x, V2 -L and eIO devices, the labels A and B are always the same - so A is connected to A and B to B.

For a Modbus compliant bus configuration, the GND must be routed between the individual bus subscribers via the “C” (common) connections and connected to the PE (protective earth / ground) at one point. The connection is usually established anyway, which therefore causes no additional effort.
The connection between “C” and “PE” is usually made at or near the bus master. Shielded cables must be used with Modbus, and the shield must be connected to PE.

In the RS485 bus, a terminating resistor of 120 Ω must be connected at the both ends of the line structure (first and last bus node).

If the PiXtend eIO is at one of these bus ends, the DIP switch “T” (termination) be set to “ON”.

6.4. PiXtend eIO Digital One

PiXtend eIO Digital One has digital inputs and outputs. This chapter contains all relevant technical data as well as connection and safety instructions. Always read the relevant sections before you begin wiring and working on inputs or outputs.

6.4.1. Digital inputs

Figure 35: Terminal block - digital inputs

The eight digital inputs (DI0 - DI7) are implemented in 1-wire connection technology and have a reference to the general ground (GND) of the device.

Application examples

- Switches, buttons, limit switches
- Sensors with switching output (proximity switches, light barriers)
- Outputs of other control units
- Outputs of integrated circuits (TTL level, CMOS level)
- Fast digital logic functions (“Hyper Logic” - HL)
- Counting functionality of the digital inputs (UP/DOWN counter, 2-channel counter)

Two different voltage ranges can be set (one jumper per input). In the 24V range, the inputs correspond to the specifications of the PLC standard IEC/EN 61131-2. Signals with a 12V level (for example, in the car / automotive applications) are reliably detected, over-voltages and polarity reversals up to ±30V cannot affect the inputs.

The 5V range is designed for 5V TTL and 3.3V CMOS levels.

How the voltage range can be changed is explained in the chapter on Installation.

Analog filter stages increase the immunity to interference and ensure the reliable signal processing by the PiXtend eIO micro-controller. LEDs indicate the state of the inputs.

Property	Value	Comment
Type of inputs	digital input, ohmic	for DC voltage
	type 1 according to IEC 61131-2	
	positive switching	
	1-wire connection method	with GND reference
Throughput time (Hyper Logic)	< 1 ms	typical: 750 µs
counting frequency CNT	max. 400Hz	max. frequency only achievable with push-pull outputs
Nominal voltage	24V	
Voltage for high level	min. 10V	logic “1”, high level
Voltage for low level	max. 5V	logic “0”, low level
Hysteresis	min. 0.1V	
Input current at nominal voltage	4.2mA	
Maximum voltage	30V	Input current: 5.6 mA
Reverse polarity protection	Yes	up to -30V
Electrical isolation	No	
Status display	LED (orange)	Label “DI0” to “DI7”
Permissible cable length	< 30 m	unshielded cables

Table 18: Technical data - digital inputs - “24V range”

⚠CAUTION

Voltages greater than 30V DC can lead to overheating and the defect of components.
The inputs are designed for DC voltages only. Do not connect alternating voltages (AC). The LEDs indicate the high state (logic “1”) of the input at nominal voltage. In the transition areas between guaranteed low and high levels, the LED is not meaningful.

Property	Value	Comment
Type of inputs	digital input, ohmic	for DC voltage
	positive switching	
	1-wire connection method	with GND reference
Throughput time (Hyper Logic)	< 1 ms	typical: 750 µs
counting frequency CNT	max. 400Hz	max. frequency only achievable with push-pull outputs
Nominal voltage	5V	
Voltage for high level	min. 2V	logical “1”
Voltage for low level	max. 0.8V	logical “0”
Input current at nominal voltage	6.6mA	
Maximum voltage	9V	Input current: 17mA
Reverse polarity protection	Yes	up to -9V
Electrical isolation	No	
Status display	LED (orange)	Label “DI0” to “DI7”
Permissible cable length	< 30 m	

Table 19: Technical data - digital inputs - “5V range”

⚠CAUTION

Voltages greater than 9V DC can lead to overheating and the defect of components.
The inputs are designed for DC voltages only. Do not connect alternating voltages (AC).

The LEDs indicate the high state (logic “1”) of the input at nominal voltage. In the transition areas between guaranteed low and high levels, the LED is not meaningful.

Connection instructions

The following circuit diagram illustrates the connection of different signal sources to one digital input.

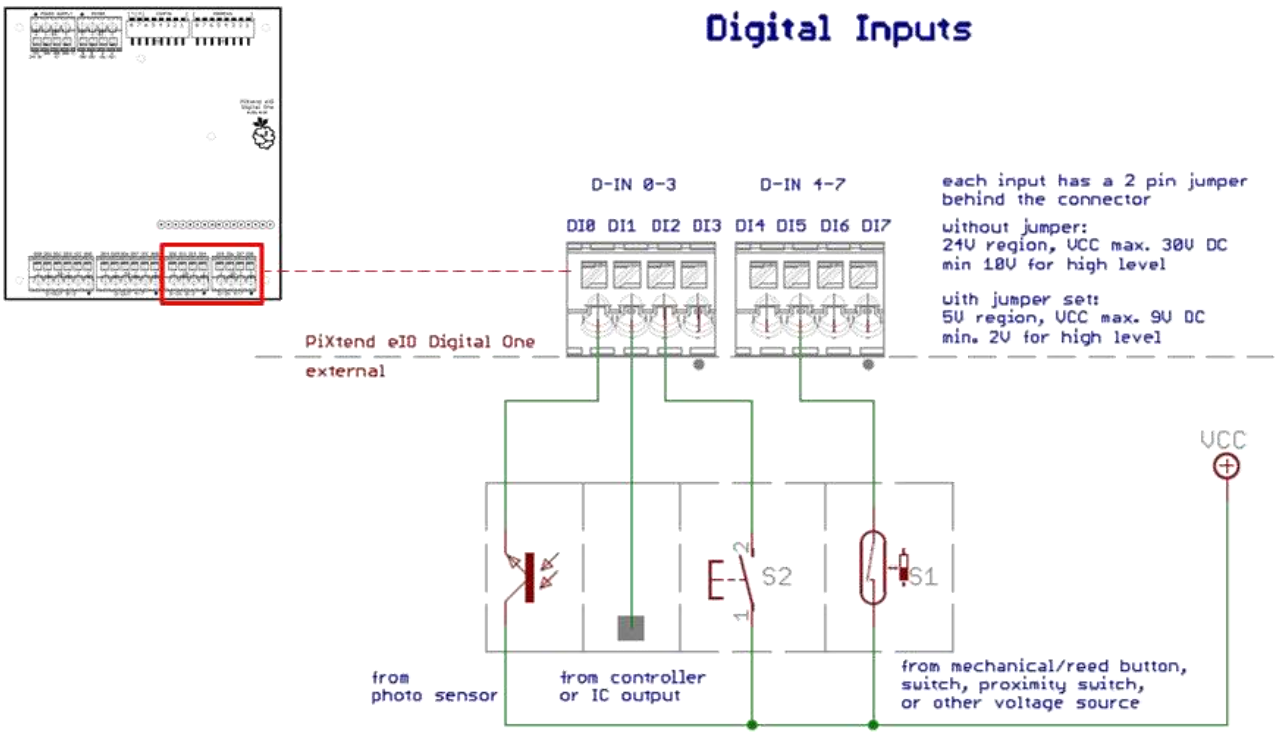


Figure 36: Simplified wiring diagram: connection of the digital inputs

The digital inputs are always logic “0” / “low” levels when idle (e.g., no voltage applied - no connection). The inputs have a ground reference (pull-down), which prevents an undefined state (“floating input”).

The digital inputs can be used to read a wide range of sensors, switches and buttons. The input voltage to the inputs can be in the range from 3.3V to 30V. In order to be able to cover this large range, a jumper is provided for each input, which allows the selection between two voltage ranges (adaptation of the switching level).

The pin headers on which the jumpers can be inserted are located behind the connection terminals of the digital inputs on the PiXtend eIO. Two pins of the pin strip header are assigned to one input. The first two pins (from left to right) belong to DI0, the two subsequent pins DI1, etc.
With the jumper, the two pins are short-circuited, thus adapting the input circuit to the other input voltage range.

By default, the PiXtend eIO V2 -L- is supplied in the 24V range (12 / 24V) - no jumper plugged in. With the jumper is plugged in, the input is set to the 5V range (3.3/5V).

The different specifications of the voltage ranges must be observed.

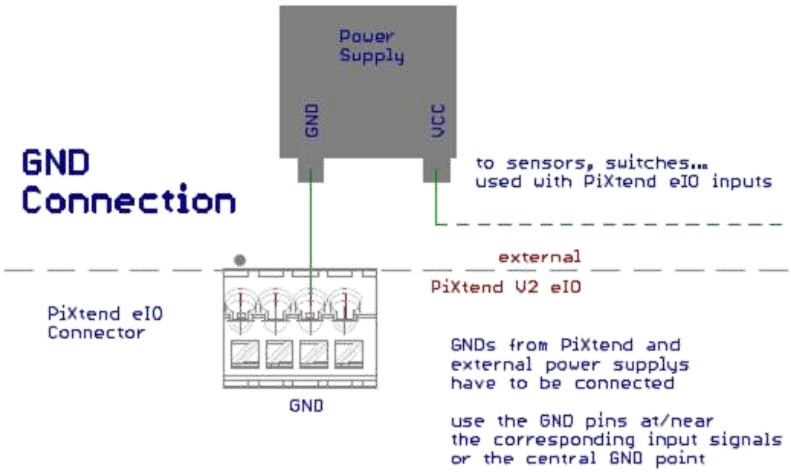


Figure 37: Simplified wiring diagram: GND connection

When using external power supplies (for sensors, switches, etc.), the GND of the PiXtend eIO must be connected to the GNDs of the other power supply units. We recommend connecting the ground potentials of all power supplies used at a central point (bridged terminal block) to avoid ground loops.

6.4.2. Digital Outputs

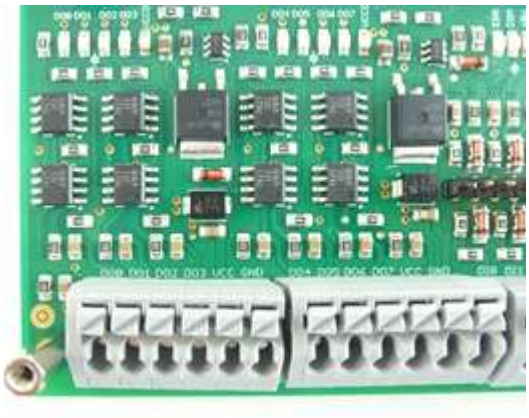


Figure 38: Terminal block - digital outputs

Eight digital outputs (DO0 - DO7) enable the switching of DC devices with voltages up to 30V and currents up to 0.5 A.

Application examples

- Switching external power relays
- Operation of small DC motors and RC model servos
- Connection to the inputs of other control units
- Heating and Peltier elements
- Fans and blowers
- Lamps for DC and power LEDs

All eight digital outputs are short-circuit and overload-proof. The outputs correspond to "protected and short-circuit proof outputs" as specified in the PLC standard (IEC/EN 61131-2).

These are high-side switches which are supplied with energy via a separate feed-in (four outputs per feed-in).

Each feed-in has an LED which informs about the presence of the supply voltage. The digital outputs and their supply are each located on a shared 6x terminal block.

Further LEDs signal the states of the outputs.

Property	Value	Comment
Type	supply connection	auxiliary supply
Rated current	2.0A	Four outputs on rated load
Short-circuit current	< 10A	Short-circuit on all four outputs
Rated input voltage	24V	
Min. input voltage	5V	
Max. input voltage	30V	
Reverse polarity protection	Yes	electronically
Backpowering protection	Yes	electronically
Short circuit and overload protection	No	a 4 A (slow) fuse must be provided externally
EMC surge/burst protection	Yes	transil diode, bidirectional
Electrical isolation	No	
Status display	LED (green)	Label “VCC DO0-3” and “VCC DO4-7”
Permissible cable length	< 30 m	

Table 20: Technical data – DO feed-ins (“VCC DOx-y”)

⚠CAUTION

Voltages greater than 30V DC can lead to the defect of components. **The outputs and the circuitry of the feed-in is designed exclusively for DC voltages (DC). Do not connect alternating voltages (AC).**

Depending on the load and ambient temperature, the components of the feed-in can have temperatures of up to 65° C. Avoid direct contact.

Property	Value	Comment
Type of outputs	digital output, semiconductor according to IEC 61131-2	for DC voltage
	Normally open contact for each DO, positive switching (high side switch)	SPST
Rated current	0.5A	
Short-circuit current	max. 2.5A	
Rated output voltage	24V	
Min. output voltage	5V	Depending on the respective feed-in “VCC DOx-x”
Max. output voltage	30V	
Max. switching power	2.5W 6W 12W	at 5V DC at 12V DC at 24V DC
“ON” resistor	ca. 350 mΩ	with logic “1” and rated load
Short-circuit protection Current limiter Overload protection	Yes Yes Yes	thermal
Electrical isolation	No	
Status display	LED (orange)	Name: “DO0...DO7”
Permissible cable length	< 30 m	unshielded cables

Table 21: Technical data - digital outputs

⚠CAUTION

Voltages greater than 30V DC can lead to the defect of components. The outputs are designed for DC voltages only. Do not connect alternating voltages (AC).

Depending on the load and ambient temperature, the power transistors can have temperatures of up to 85° C. Avoid direct contact!

Output currents greater than 0.5 A are not permitted in normal operation.

Connection instructions

The following circuit diagram illustrates the connection of different loads to the digital outputs and the connection of the power supply to the DO supply.

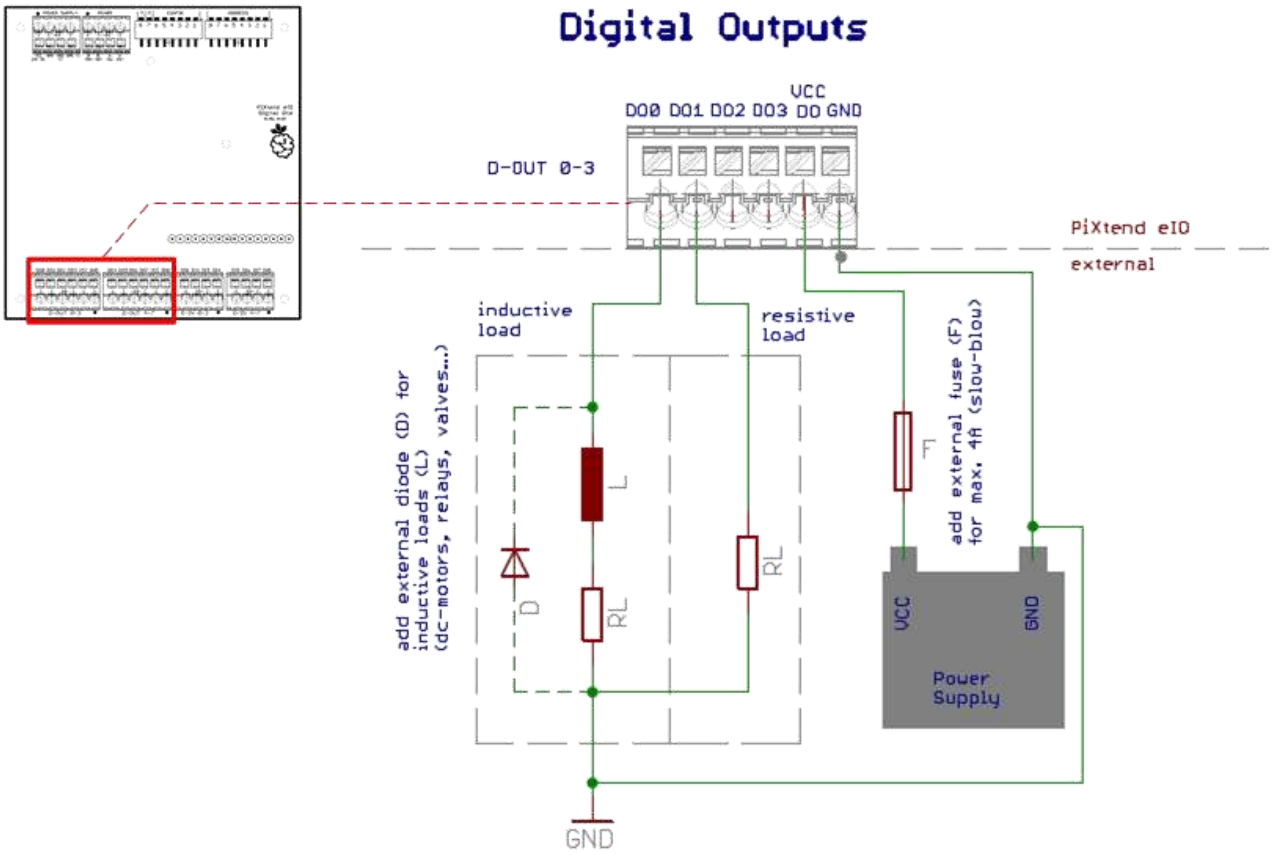


Figure 39: Simplified wiring diagram: connection of the digital outputs

For inductive loads, it must be ensured externally that the voltage at the output is never higher than 40 V. This can be achieved, for example, with a free-running diode (1N4004) as shown in figure 39.

Inductive loads are DC motors, relays, magnetic coils, etc.

The ground connections (GND) of external power supplies must be connected directly to the GND terminals on the terminal strip.

6.5. PiXtend eIO Analog One

Figure 40: Terminal blocks - analog inputs and outputs

The PiXtend eIO Analog One has the following analog inputs and outputs:

- Four voltage inputs (AI0 – AI3)
- Four current inputs (AI4 – AI7)
- Four voltage outputs (AO0 – AO3)
- Two current outputs (AO4 – AO5)

The analog channels correspond to the standard for programmable logic controllers (IEC 61131-2) and are therefore suitable for a large number of industrial sensors and measuring devices.

Further information and details about these analog I/Os can be found on the following pages.

6.5.1. Analog inputs

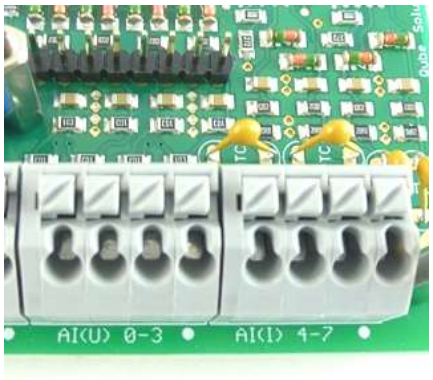


Figure 41: Terminal block - analog inputs

The PiXtend eIO Analog One has four analog inputs for voltage measurements (AI0 - AI3) in the ranges 0 – 5V / 0 – 10V and another four for current measurements (AI4 - AI7) in the range 0(4) – 20mA.

Application examples

- Read industrial sensors with analog outputs
- Detecting potentiometer positions (rotary control)
- Current and voltage measurements in the laboratory and in experimental setups
- Voltage monitoring of batteries (for example, in a robot)
- Current measurement with an external shunt (voltage at the resistor)
- Read PT100/1000 sensors (with external pre-amplifier)
- Connection to the analog outputs of other control units
- Sink/measure input for the current loop
- can be used for active and passive sensors

The inputs are robust and can withstand overvoltages of up to 30V DC. The voltage ranges can be easily modified and adapted to the conditions by means of jumpers.

Analog filter stages ensure low-noise measurements with the 10-bit analog-to-digital converter.

6.5.1.1 Voltage inputs

Before use, check the jumper position and adjust if necessary. Of course, you can always stay in the 10V range (no jumper – default) and thus enjoy the greater flexibility and robustness of the inputs. In the 5V range (jumper plugged in), however, the same resolution is available for a smaller measuring range. When it comes to accuracy, that can be very helpful.

There is an explanation in chapter 5.1 on how to set the jumper correctly and, if necessary, open the device.

Property	Value	Comment
Type of inputs	analog input according to IEC 61131-2	for DC voltage
	single-ended	with GND reference
Operating mode	voltage input (AI-U)	
Measuring range	0 – 10V DC	
Input resistance	20 kΩ	
Analog filtering	Cut-off frequency 275 Hz	low-pass 2nd order
RF attenuation:	52 dB 95 dB 151 dB	at 10 kHz at 100 kHz at 1 MHz
Conversion method	successive approximation	one converter with multiplexer
Conversion time	45 µs	averaging 5 values (225 µs)
Digital resolution	10 bit	
Smallest digital step (LSB)	9.77 mV	
Max. measurement error at 25° C **	±0.5% (±50mV)	of the range of values
Temperature coefficient	±0.01% per °C	in the range 0 – 60° C ambient temperature
Data format	16-bit integer	raw value (right-justified)
Maximum input voltage	30V	
Reverse polarity protection	Yes	up to -30V
Electrical isolation	No	
Status display	No	
Permissible cable length	< 3 m < 30 m	unshielded cables shielded cables

Table 22: Technical data - analog voltage inputs - “10V range”

Property	Value	Comment
Type of inputs	analog input	for DC voltage
	single-ended	with GND reference
Operating mode	voltage input (AI-U)	
Measuring range	0 – 5V DC	
Input resistance	10 kΩ	
Analog filtering	Cut-off frequency 500 Hz	low-pass 1st order
RF attenuation	26 dB 49 dB 85 dB	at 10 kHz at 100 kHz at 1 MHz
Conversion method	successive approximation	one converter with multiplexer
Conversion time	45 µs	averaging 5 values (225 µs)
Digital resolution	10 bit	
Smallest digital step (LSB)	4.88 mV	
Max. measurement error at 25° C **	±0.5% (±25 mV)	of the range of values
Temperature coefficient	±0.01% per °C	in the range 0 – 60° C ambient temperature
Data format	16-bit integer	raw value (right-justified)
Maximum input voltage	30V	
Reverse polarity protection	Yes	up to -30V
Electrical isolation	No	
Status display	No	
Permissible cable length	< 3 m < 30 m	unshielded cables shielded cables

Table 23: Technical data - analog voltage inputs - “5V range”

The analog voltage inputs can measure DC and AC voltages. When using ac voltages, the input filters must be observed, only measurements in the positive range are possible. Negative voltages can be applied within the specified maximum values, but cannot be measured.

The PiXtend eIO cannot automatically evaluate the jumper state (plugged / unplugged) of the analog voltage inputs. If you insert the jumper, the software must react accordingly (adjust the conversion factor).

⚠CAUTION Voltages greater than ±30V DC can lead to overheating and the defect of components.

** Deviations up to 2% (relative to the scale end value) are possible under EMC exposure.

Connection instructions

The following diagram illustrates the connection of analog voltage sensors and analog outputs to the analog voltage inputs of the PiXtend eIO Analog One.

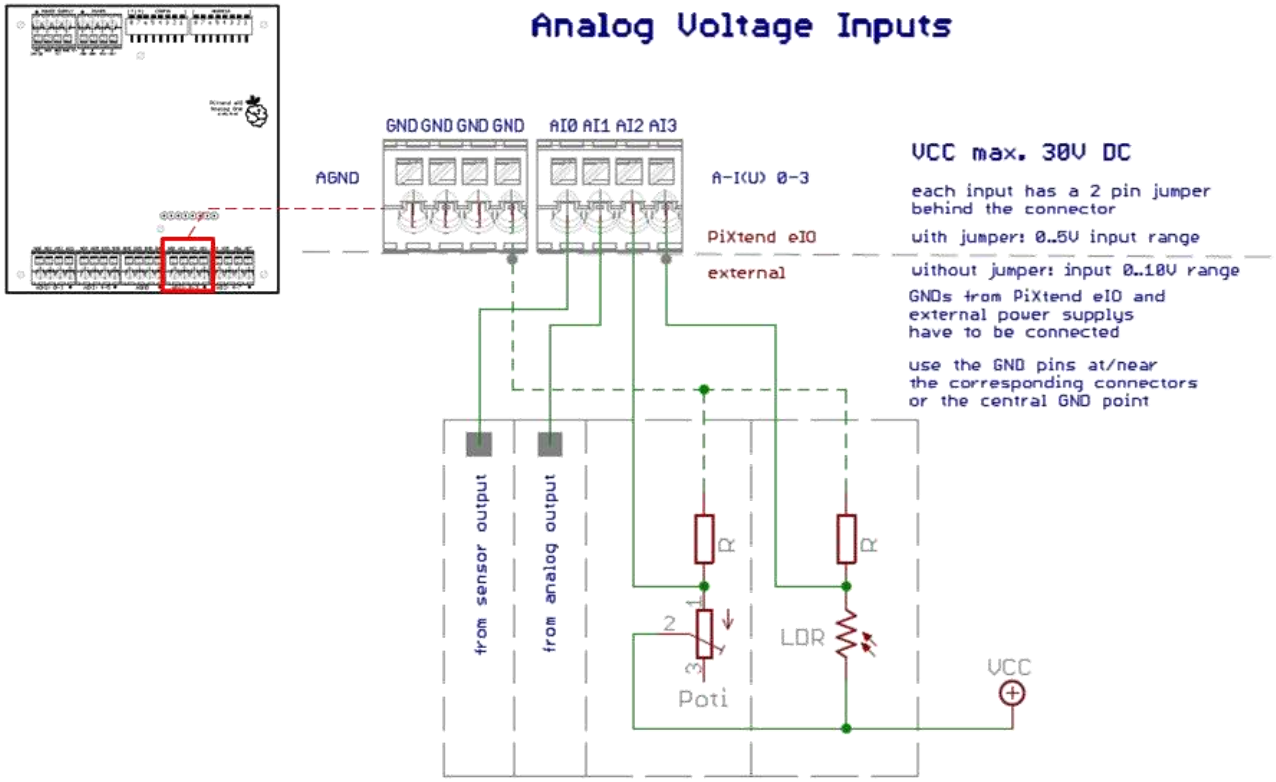


Figure 42: Simplified wiring diagram: connection of the analog voltage inputs

The voltage inputs can be used for various tasks which require measuring a voltage. Figure 42 shows a simple circuit with a light-sensitive resistor (LDR) or also the evaluation of a rotary potentiometer.

The ground connections (GND) of external power supply units must be connected directly to the GND terminals of the terminal block of the analog inputs.

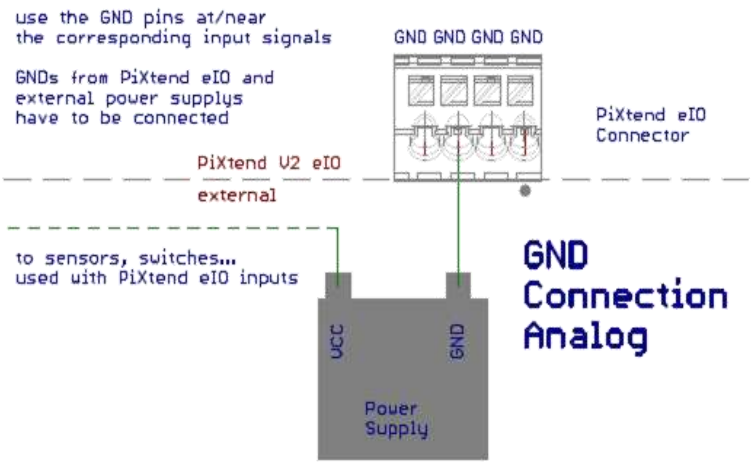


Figure 43: Simplified wiring diagram: GND connection

In the case of analog signals, we strongly advise using shielded connection cables. This is particularly important when the cables are

routed in the direct vicinity of large pulsed currents (e.g., motors or transformers) or other sources of interferences.

If the PiXtend eIO Analog One is used in a metal housing or cabinet, the shield must be placed on a grounded and bare metal surface (grounding clamps and screw connections from a hardware store or electronics dealer). An electrically conductive connection between the GND and the housing / cabinet (usually PE shielded) must be available or established.
The shield connection should be placed as close as possible to the eIO inputs.

For cables less than three meters, unshielded cables can also be used.

6.5.1.2 Current Inputs

Property	Value	Comment
Type of inputs	analog input according to IEC 61131-2	for DC in the range 0 – 20 mA
	single-ended	with GND reference
Operating mode	current input (AI-I)	
Measuring range	0 – 20mA DC	also usable for 4 – 20 mA sensor outputs measurement possible up to max. 20.65 mA
Input resistance	< 25Ω	
Analog filtering	Cut-off frequency 500Hz	low-pass 1st order
RF attenuation:	26 dB 49 dB 85 dB	at 10 kHz at 100 kHz at 1 MHz
Conversion method	successive approximation	one converter with multiplexer
Conversion time	45 µs	averaging 5 values (225 µs)
Digital resolution	10 bit	
Smallest digital step (LSB)	20.17 µA	
Max. measurement error at 25° C **	±0.75% (±150µA)	of the range of values
Temperature coefficient	±0.025% per °C	in the range 0 – 60° C ambient temperature
Data format	16-bit integer	raw value (right-justified)
Max. Input current	150mA	in case of error - should not occur in normal operation
Maximum input voltage	30V	in case of error - should not occur in normal operation
Reverse polarity protection	Yes	up to -30V
Overload protection	Yes	thermal, self-resetting fuse (Polyfuse)
Electrical isolation	No	
Status display	No	
Permissible cable length	< 3 m < 30 m	unshielded cables shielded cables

Table 24: Technical data- analog current inputs

The analog current inputs can measure DC and AC currents. When using alternating currents, the input filters must be observed, only measurements in the positive range are possible. Although negative currents can be created, they cannot be evaluated.

⚠CAUTION Voltages greater than 30V DC can lead to the defect of components.

** Deviations up to 2% (relative to the scale end value) are possible under EMC exposure.

Connection instructions

The following circuit diagram illustrates the connection of analog current sensors to the analog current inputs of the PiXtend eIO Analog One.

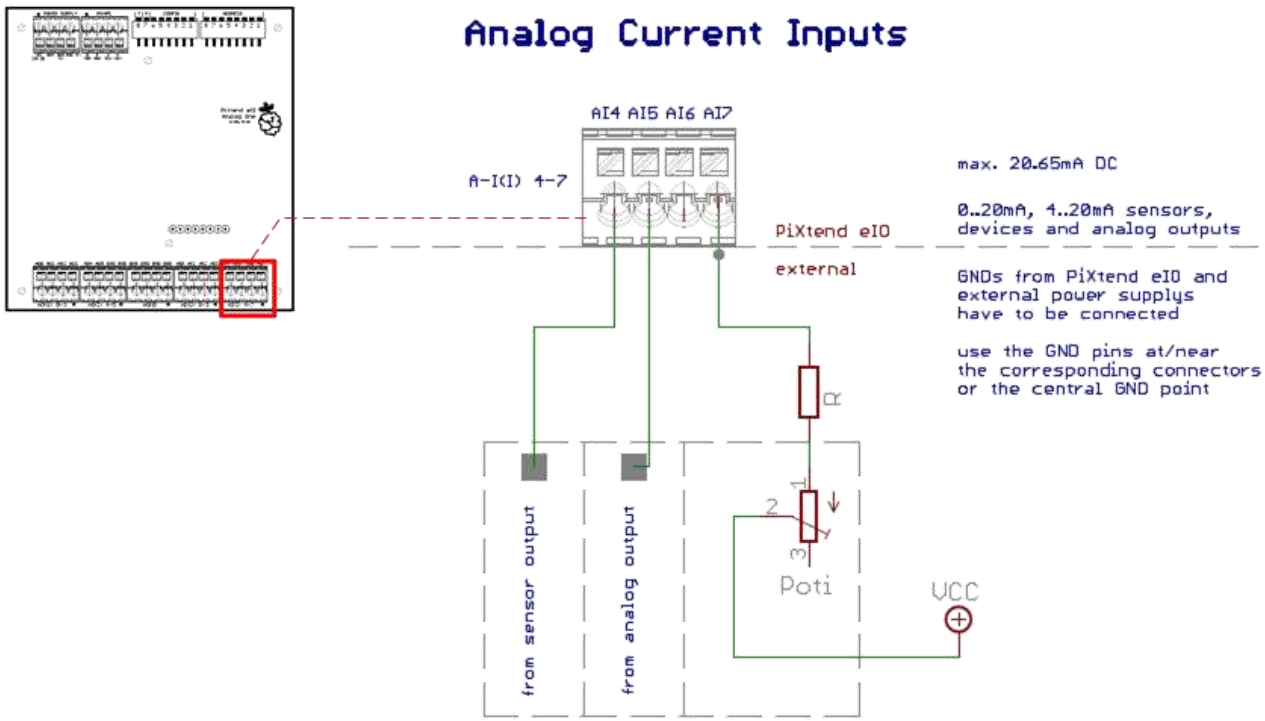


Figure 44: Simplified wiring diagram: connection of the analog current inputs

The measuring current flows through a shunt resistor with a value of 20Ω. If a voltage sensor is connected to the output, the maximum permissible measuring current of 20 mA flows even at very low voltages:

Umax = 20Ω * 20 mA = 0.4V

If larger voltages are applied to the input, the current flow increases rapidly over the permitted range and is limited at approximately 100 - 150 mA by a self-resetting fuse.
Even if such defects are avoided, it is not recommended to let the input currents rise permanently or in normal operation above 20 mA.

Currents greater than 20.65 mA cannot be evaluated in the software.

The ground connections (GND) of external power supplies must be connected directly to the GND terminals on the terminal strips of the analog inputs.

6.5.2. Analog outputs

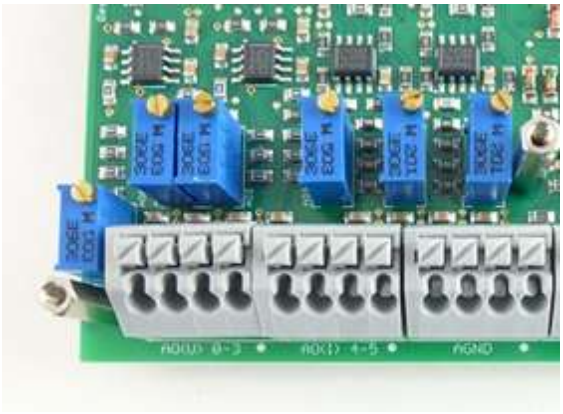


Figure 45: Terminal block – analog outputs

The PiXtend eIO Analog One has four analog voltage outputs (0 – 10V) and two analog current outputs (0 – 20 mA - true zero / 4 – 20 mA - live zero). All analog outputs on the PiXtend eIO Analog One have a resolution of 12 bits (value range 0 – 4095).

Application examples

- Supply and control of small loads: mini-DC motor, LED(s)
- Function generator (output of sine, rectangle and triangle voltages, etc.)
- Connection to analog inputs of other control units, power amplifiers and frequency converters
- Lighting solutions in building technology
- Can be used with active and passive inputs of the remote terminal
- Control analog and digital display devices
- Reliable and robust signal transmission over long distances (4 – 20 mA)

The two voltage outputs are short-circuit-proof and can drive a current of 20 mA in normal operation. The current outputs withstand loads from a short circuit to a wire break and can drive a load of up to 600Ω. The electronics on the PiXtend eIO monitor the current outputs and can detect overload/wire break and inform the bus master.

All six analog outputs are supplied via the central power supply of the PiXtend eIO and do not require a separate power supply.

All analog inputs on the PiXtend correspond to the specifications of the PLC standard IEC/EN 61131-2.

6.5.2.1 Voltage outputs

Property	Value	Comment
Type of outputs	analog output according to IEC 61131-2	for DC voltage (DC) in the positive range
Operating mode	Voltage output (AO-U)	
Conversion method	String DAC	one converter per channel
Nominal voltage range	0 - 10V	
Load impedance range	≥ 500Ω	
Rated output current	20 mA	At 500Ω load, 10V
Digital resolution	12 bit	
Smallest digital step (LSB)	2.44 mV	
Max. Error at 25°C **	±0.25% (±25 mV)	of the range of values
Temperature coefficient	±0.01% per °C	in the range 0 – 60° C ambient temperature
Data format	16-bit integer	raw value (right-justified)
Short-circuit protection	Yes	Short circuit against GND
Permissible cable length	< 3 m < 30 m	unshielded cables shielded cables

Table 25: Technical data- analog current outputs

** Deviations up to 1% (relative to the scale end value) are possible under EMC exposure.

⚠CAUTION

The external supply of voltages (e.g. 24V) to analog outputs is not permitted and can lead to output failure. Always make sure that there are no wiring errors before connecting the analog outputs.

Connection instructions

The following circuit diagram illustrates the connection of loads and devices to the analog voltage outputs of the PiXtend eIO Analog One.

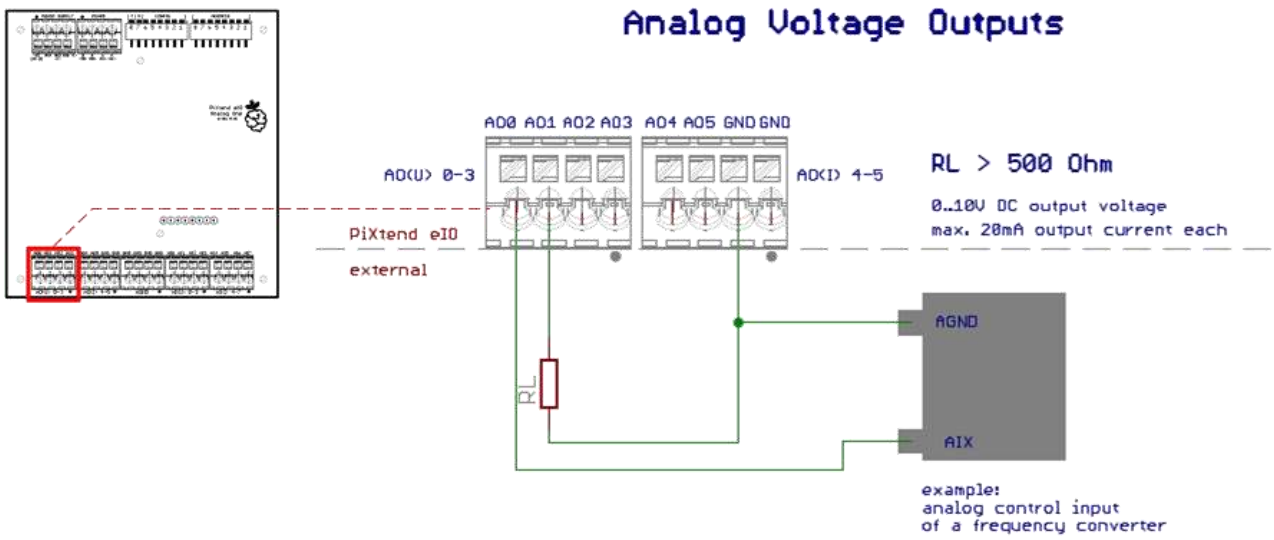


Figure 46: Simplified wiring diagram: connection of the analog voltage outputs

If the outputs are connected to analog inputs of other control units, power amplifiers (also frequency converters) or similar, the ground connections (GNDs) of the devices and PiXtend eIO must be connected. A GND connection is located on the terminal strip between the analog outputs and inputs.

As with the analog inputs, shielded cables should be used for analog outputs.

The six blue potentiometers on the PiXtend eIO Analog One are used during production for the calibration/fine trimming of the analog outputs and are then sealed with lacquer.

⚠CAUTION

The adjusting screws of the potentiometers are not to be adjusted and the lacquer seal must not be broken. Otherwise the accuracy and specification from this data sheet can no longer be guaranteed.

6.5.2.2 Current outputs

Property	Value	Comment
Type of outputs	analog output according to IEC 61131-2	DC in the positive range
Operating mode	Current output (AO-I)	
Conversion method	String DAC	one converter per channel
Rated current range	0-20 mA	also usable for 4 – 20 mA outputs
Load impedance range	≤ 600Ω	
Digital resolution	12 bit	
Smallest digital step (LSB)	4.88 µA	
Max. Error at 25°C **	±0.25% (±50 µA)	of the range of values
Temperature coefficient	±0.01% per °C	in the range 0 – 60° C ambient temperature
Data format	16-bit integer	raw value (right-justified)
Overload protection	Yes	until it stops
Overload detection	Yes	Overload and wire breakage evaluable by software
Permissible cable length	< 3 m < 30 m	unshielded cables shielded cables

Table 26: Technical data – analog outputs

** Deviations up to 1% (relative to the scale end value) are possible under EMC exposure.

⚠CAUTION

The external supply of voltages (e.g. 24V) to analog outputs is not permitted and can lead to output failure. Always make sure that there are no wiring errors before connecting the analog outputs.

Connection instructions

The following circuit diagram illustrates the connection of loads and devices to the analog current outputs of the PiXtend eIO Analog One.

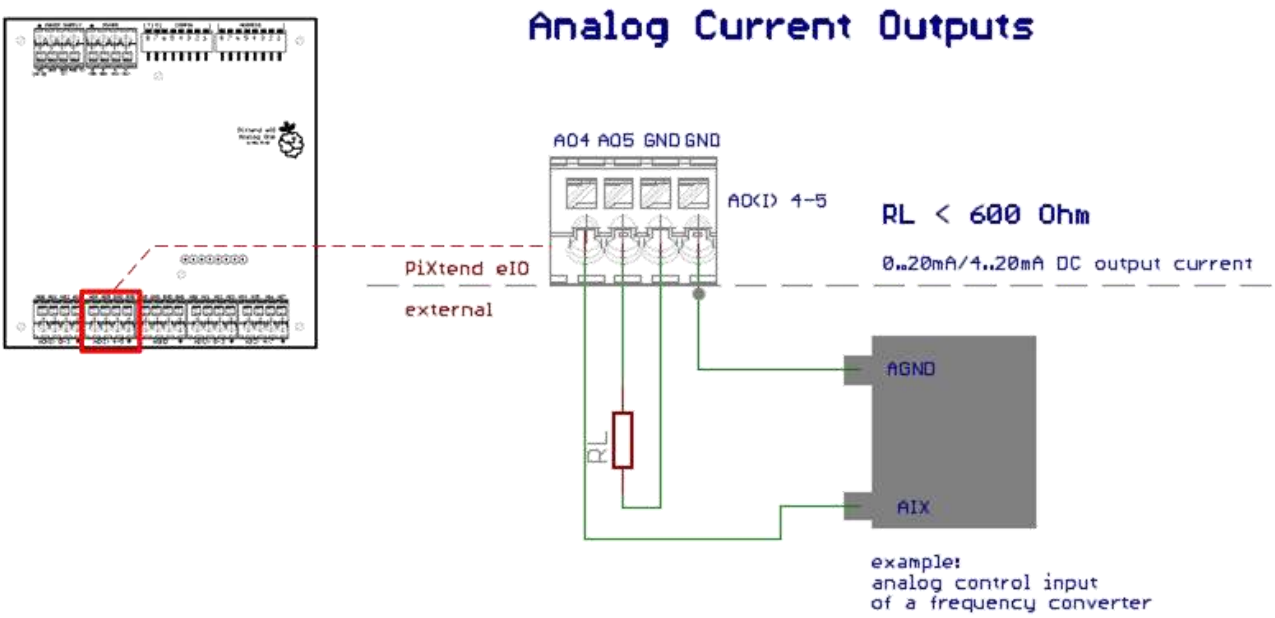


Figure 47: Simplified wiring diagram: connection of the analog current outputs

If the outputs are connected to analog inputs of other control units, power amplifiers (also frequency converters) or similar, the ground connections (GNDs) of the devices and PiXtend eIO must be connected. A GND connection is located on the terminal strip between the analog outputs and inputs. Furthermore, there are two GND connections directly beside the current outputs.

As with the analog inputs[7], shielded cables should be used for analog outputs.

The overload detection (also called “AO-OL” - “analog output overload”) monitors the current flow from the outputs. Each of the two channels is monitored separately and can pass on an overload message to the bus master. For further details of the evaluation in the software, please refer to the PiXtend eIO Software Manual.

Already when it is in the idle state of the current output (output value 0.0 mA), a wire break or the absence of correct wiring can be detected. With the output of 20 mA, the overload detection starts from a load of 500Ω. This value should not be exceeded with a correctly designed signal path with sensor and cables.
Reliable operation is still guaranteed up to a load of 600Ω.

The six blue potentiometers on the PiXtend eIO Analog One are used during production for the calibration/fine trimming of the analog outputs and are then sealed with lacquer.

⚠CAUTION

The adjusting screws of the potentiometers are not to be adjusted and the lacquer seal must not be broken. Otherwise the accuracy and specification from this data sheet can no longer be guaranteed.

[7]The cable shield is, however, connected as near as possible to the remote station.

6.6. Operation with 12V supply voltage

PiXtend eIO devices are designed for supply voltages of nominal 24V DC (19 - 30V). Thus, the devices comply with the industry standard. Power supplies with 24V DC output voltage are available worldwide in countless versions - from power adapters for home or office environments to DIN rail power supplies for installation in control cabinets.

Nevertheless, some applications may also require the operation of the devices with 12V DC, i.e. automotive, outdoor and island operation.

The supply with 12V is possible in principle, but has limitations. These limitations are discussed below. You can decide for your application whether to use PiXtend eIO devices with 12V or not.

Effects on the entire system (all PiXtend eIO devices):

- Energy reserve of 10 ms according to IEC 61131-2 is no longer ensured

Effects on analog outputs (PiXtend eIO Analog One):

- Analog voltage outputs have a maximum load of 3kΩ, a maximum output current of 3 mA
- Analog current outputs can drive a maximum load of 250Ω and the wire break detection function does not work

The reduced supply voltage to 12V DC has no effect on digital inputs and outputs (PiXtend eIO Digital One), as well as on the analog inputs (PiXtend eIO Analog One).

7. List of Figures

8. List of Tables