



ibaPADU-4-AI-U

Input module with 4 fast analog voltage inputs

Manual

Issue 1.2

Measurement Systems for Industry and Energy

www.iba-ag.com

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The content of this publication has been checked for compliance with the described hardware and software. Nevertheless, deviations cannot be excluded completely so that the full compliance is not guaranteed. However, the information in this publication is updated regularly. Required corrections are contained in the following regulations or can be downloaded on the Internet.

The current version is available for download on our web site <http://www.iba-ag.com>.

Protection note

Windows® is a label and registered trademark of the Microsoft Corporation. Other product and company names mentioned in this manual can be labels or registered trademarks of the corresponding owners.

Certification

The device is certified according to the European standards and directives. This device corresponds to the general safety and health requirements. Further international customary standards and directives have been observed.



Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

| Issue | Date | Revision | Chapter | Author | Version HW / FW |
|-------|---------|----------|---------|--------|--------------------|
| 1.2 | 01-2023 | FO cable | | | |

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1 About this manual

This manual describes the construction, the use and the operation of the device ibaPADU-4-AI-U.

1.1 Target group

This manual addresses in particular the qualified professionals who are familiar with handling electrical and electronic modules as well as communication and measurement technology. A person is regarded to as professional if he/she is capable of assessing safety and recognizing possible consequences and risks on the basis of his/her specialist training, knowledge and experience and knowledge of the standard regulations.

1.2 Notations

The following designations are used in this manual:

| Action | Notations |
|---------------------------|--|
| Menu command | Menu „Logic diagram“ |
| Call of menu command | „Step 1 – Step 2 – Step 3 – Step x“ Example: Select menu „Logic diagram – Add – New logic diagram“ |
| Keys | <Key name> Example: <Alt>; <F1> |
| Press keys simultaneously | <Key name> + <Key name> Example: <Alt> + <Ctrl> |
| Buttons | <Button name> Example: <OK>; <Cancel> |
| File names, Paths | „File name“, „Path“ Example: „Test.doc“ |

1.3 Used symbols

If safety instructions or other notes are used in this manual, they mean:



⚠ DANGER

The non-observance of this safety information may result in an imminent risk of death or severe injury:

- By an electric shock!
- Due to the improper handling of software products which are coupled to input and output procedures with control function!

If you do not observe the safety instructions regarding the process and the system or machine to be controlled, there is a risk of death or severe injury!



⚠ WARNING

The non-observance of this safety information may result in a potential risk of death or severe injury!



⚠ CAUTION

The non-observance of this safety information may result in a potential risk of injury or material damage!



Note

A note specifies special requirements or actions to be observed.



Tip

Tip or example as a helpful note or insider tip to make the work a little bit easier.



Other documentation

Reference to additional documentation or further reading.

2 Introduction

The ibaPADU-4-AI-U compact device has been developed for capturing and recording fast analog signals. The sampling rate can be adjusted freely up to 100 kHz max. The device offers 4 electrically isolated voltage inputs. The measuring ranges of these inputs are adjustable in several stages from ± 250 mV up to ± 24 V.

Antialiasing filters limit the bandwidth of the input signal in order to reduce disturbances. A digital filter can be activated per channel together with an analog antialiasing filter. The digital antialiasing filter is adjusted automatically to the configured sampling rate.

The signals are converted internally and are available via the fiber optics (FO) interface. By means of the ibaPDA online-data acquisition software, you can choose and configure the signals conveniently. The communication between ibaPDA and ibaPADU-4-AI-U is handled by the bidirectional fiber optic protocol 32Mbit Flex, which requires an I/O card from the ibaFOB-D generation, e. g. ibaFOB-2io-D.

In brief

- ☐ 4 electrically isolated analog inputs
- ☐ Input signal level ± 250 mV; ± 500 mV; ± 1 V; ± 2.5 V; ± 5 V; ± 10 V; ± 24 V, can be adjusted for each channel
- ☐ 16 bit resolution
- ☐ Sampling rate of 100 kHz max. freely adjustable in a point-to-point connection (if connected in a ring topology with 32Mbit Flex, max. sampling rate is 40 kHz)
- ☐ Real parallel measured value acquisition by an A/D converter per channel
- ☐ Antialiasing filters can be activated
- ☐ ibaNNet protocol 32Mbit Flex (FO)
- ☐ Rugged design, easy mounting

3 Scope of delivery

After unpacking check the completeness and intactness of the delivery.

The scope of delivery includes:

- ☐ ibaPADU-4-AI-U device
- ☐ 2-pin connector for power supply
- ☐ 12-pin connector for connecting the analog signals
- ☐ Manual

4 Safety instructions

4.1 Designated use

The device is electrical equipment. It may be used only in the following applications:

- ☐ Measurement data logging and analysis
- ☐ Applications of iba software products (ibaPDA)

The device is only to be applied as shown in the “Technical Data” chapter.

4.2 Special advices



Warning!

This is a Class A device. This equipment may cause radio interference in residential areas. In this case, the operator will be required to take appropriate measures.



Important note

Do not open the device!

There are no serviceable parts inside the device.

Opening the device will void the warranty.



Note

Cleaning

To clean the device, use a dry or slightly moistened cloth. A note specifies special requirements or actions to be observed.

5 System requirements

5.1 Hardware

For operation

- ☐ Power supply 24 V DC $\pm 10\%$

For parametrization of the device and for measuring:

- ☐ PC with the following minimum equipment
 - One free PCI, PCI Express or ExpressCard slot (Notebook).
 - At least 512 MB RAM
 - 4 GB free memory on the hard drive for measurement values

For further information about PC equipment, please see

<http://www.iba-ag.com>.

- ☐ A FO input card of the ibaFOB-D type:
 - ibaFOB-io-D / ibaFOB-io-Dexp
 - ibaFOB-2io-D / ibaFOB-2io-Dexp
 - ibaFOB-2i-D / ibaFOB-2i-Dexp with ibaFOB-4o-D add-on module
 - ibaFOB-4i-D / ibaFOB-4i-Dexp with ibaFOB-4o-D add-on module
 - ibaFOB-io-ExpressCard (for Notebooks)
- ☐ FO cable (bidirectional)

5.2 Software

- ☐ ibaPDA beginning with version 6.31.0

6 Mounting and dismounting

6.1 Mounting

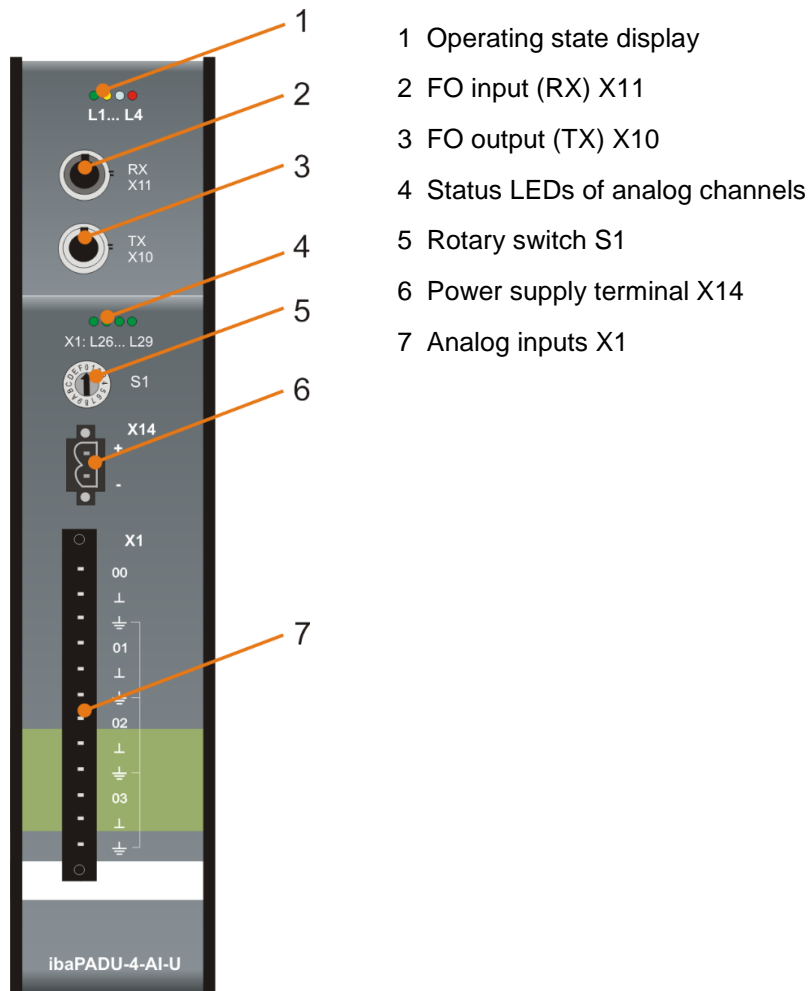
1. Locate the DIN rail mounting clip on the rear side of the device. Slowly push down and in so that the bottom part of the mounting clips snaps onto the bottom part of the rail and firmly fixes the device to the DIN rail.
2. Connect the 24 V DC power supply to the termination shown on the device. Ensure that the polarity is correct prior to applying power. Then connect the device to the ibaPDA system via a bidirectional FO cable.

6.2 Dismounting

1. Disconnect all external connections from the device.
2. Grasp the device with one hand firmly on the top side. With your free hand, grasp the bottom of the device and push it lightly down.
3. After that pull the device and lift it up. With this action, the device should free itself from the DIN rail.

7 Device description

7.1 Device view



- 1 Operating state display
- 2 FO input (RX) X11
- 3 FO output (TX) X10
- 4 Status LEDs of analog channels
- 5 Rotary switch S1
- 6 Power supply terminal X14
- 7 Analog inputs X1

Top view



Manufacturer: iba AG
 Support: iba@iba-ag.com
 Web: www.iba-ag.com
 Power supply: 24 V DC $\pm 10\%$ / 0.4 A
 Product name: ibaPADU-4-AI-U

7.2 Indicator elements

Operating state

| LED | Color | Status | Description |
|-----|--------|---------------------------------|--|
| L1 | green | off | no power |
| | | blinking slowly | ready for operation |
| | | blinking fast | Firmware update active |
| | | on | device is booting |
| L2 | yellow | on | TCP/IP telegrams detected |
| L3 | white | off | No 32Mbit Flex signal detected |
| | | blinking (rotary switch S1 ≠ 0) | 32Mbit signal detected, but it is not a valid 32Mbit Flex signal |
| | | on | 32Mbit Flex signal detected |
| L4 | red | off | device functioning properly |
| | | blinking | failure, internal applications do not run |
| | | on | device is defect, contact the iba support |

Status of analog inputs

| LED per channel | Status | Description (approx. values) |
|-----------------|--------|--|
| L26 ... L29 | off | voltage < ±1% of the selected input range |
| | green | voltage ±1% ... ±90% of the selected input range |
| | yellow | voltage ±90% ... ±100% of the selected input range |
| | red | voltage > ±100% of the selected input range |

7.3 Connections

7.3.1 Fiber optic connections X10 and X11

X11: Fiber optic reception interface (RX)

X10: Fiber optic transmission interface (TX)

Data is transmitted in 32Mbit Flex mode. ibaPDA requires a fiber optic card of the ibaFOB-D family to receive and transmit data.

Maximum distance of fiber optic connections

The maximum distance of fiber optic connections between 2 devices depends on various influencing factors. This includes, for example, the specification of the fiber (e.g. 50/125 μm , 62.5/125 μm , etc.), or the attenuation of other components in the fiber optic cable plant such as couplers or patch panels.

However, the maximum distance can be estimated on the basis of the output power of the transmitting interface (TX) or the sensitivity of the receiving interface (RX). A model calculation can be found in chapter 10.3.

The specification of the transmitter's output power and the receiver's sensitivity of the fiber optic components installed in the device can be found in chapter "Technical data" 10.1 under "ibaNet interface".

7.3.2 Power supply

The device requires an external DC 24 V $\pm 10\%$ power supply (unregulated) and should be operated at a maximum of 0.4 A. The operating voltage should be run through the provided 2-pin Phoenix threaded coupling connector. If desired, you can order DIN rails or plug-in power supply units from iba.

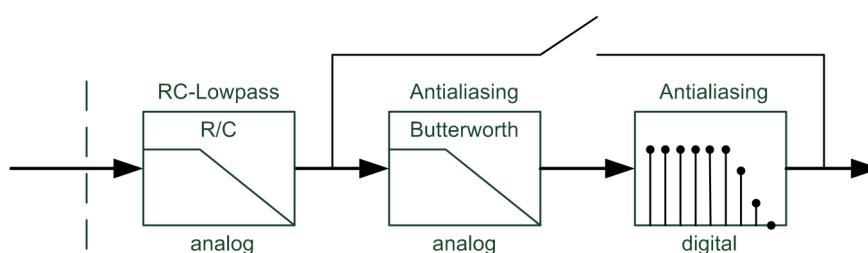
7.3.3 Analog inputs X1

7.3.3.1 Filter

There are the following analog filters per channel:

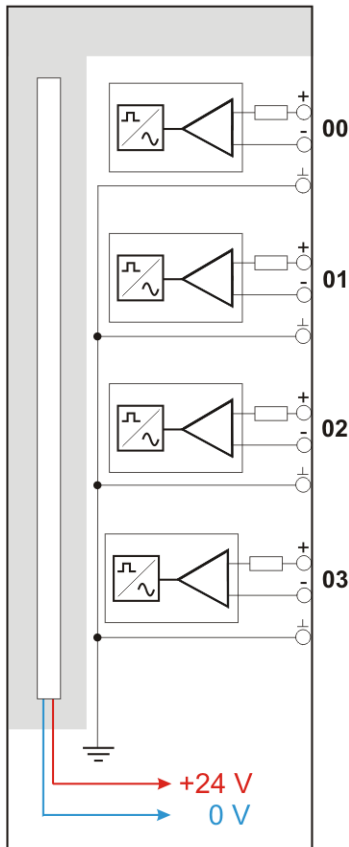
| Filter type | Order | Cutoff frequency | in addition / permanent |
|--------------------------|--------|-----------------------------------|--|
| R/C low pass | 1. | 72 kHz | permanent |
| Antialiasing Butterworth | 4. | 50 kHz | in addition (can be activated only together) |
| Antialiasing digital | 2 x 8. | 1/3 of the adjusted sampling rate | |

Filter sections:



7.3.3.2 Connection diagram / pin assignment

Here, you can connect 4 input signals (0...3), each bipolar and electrically isolated. Each channel is connected by means of two-wire connection.



Pin assignment

| X1: Pin | Connection | LED |
|---------|-------------------------------|-----|
| 1 | Analog input 00 + | L26 |
| 2 | Analog input 00 – | |
| 3 | Analog input 00 $\frac{+}{-}$ | |
| 4 | Analog input 01 + | L27 |
| 5 | Analog input 01 – | |
| 6 | Analog input 01 $\frac{+}{-}$ | |
| 7 | Analog input 02 + | L28 |
| 8 | Analog input 02 – | |
| 9 | Analog input 02 $\frac{+}{-}$ | |
| 10 | Analog input 03 + | L29 |
| 11 | Analog input 03 – | |
| 12 | Analog input 03 $\frac{+}{-}$ | |

7.4 Operating elements

7.4.1 Rotary switch S1

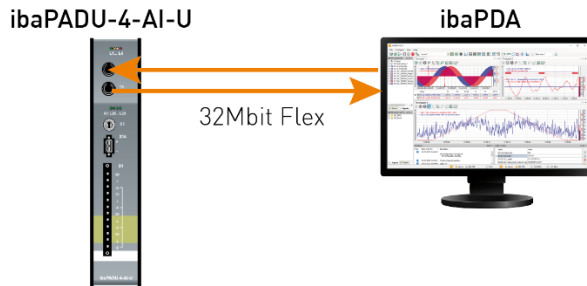
Up to 15 devices can be connected in a ring topology with 32Mbit Flex. The address of the device in a ring is set by the S1 rotary switch.

| Device number within the cascade | Rotary switch position |
|----------------------------------|------------------------|
| not allowed | 0 |
| Device 1 | 1 |
| Device 2 | 2 |
| ⋮ | ⋮ |
| Device 14 | E |
| Device 15 | F |

❑ Delivery status: rotary switch position 1

8 System integration

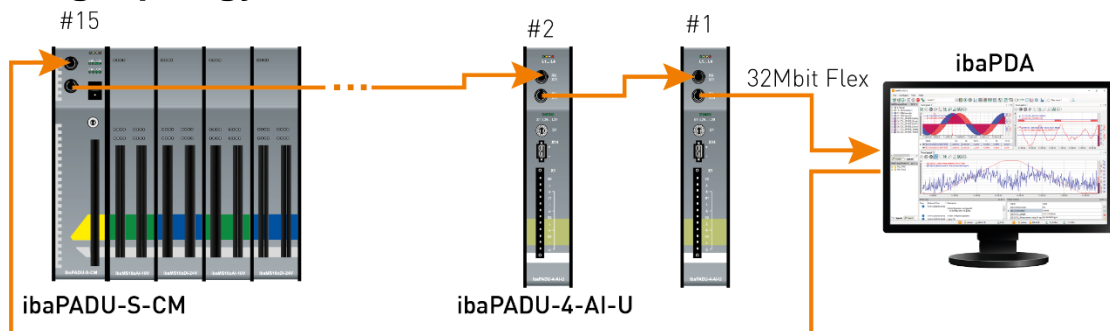
8.1 Point-to-point connection



The device is connected to the ibaFOB-D card in the ibaPDA PC via a bidirectional FO line to transfer configuration and process data. ibaPDA detects automatically the connected device.

The maximum sampling rate of 100 kHz is only possible with a bidirectional point-to-point connection to ibaPDA. If several devices are to capture at 100 kHz, each device requires a bidirectional connection to an ibaFOB-D card.

8.2 Ring topology



Up to 15 devices can be connected to a ring. Configuration and process data are transmitted in the ring.

Other 32Mbit Flex-enabled iba devices can be integrated into the ring as well. The devices in the ring are addressed via the S1 rotary switch.

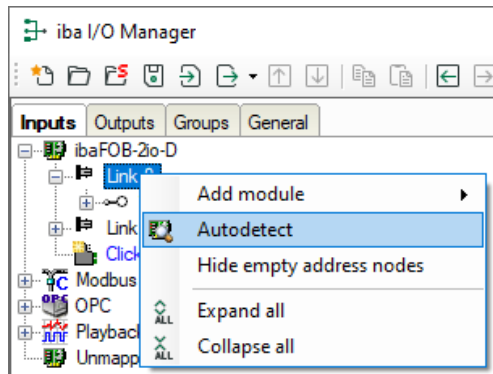
The amount of data per participant is allocated dynamically. According to the number of analog and digital signals configured in ibaPDA and the configured timebase the amount of data is calculated by ibaPDA. The maximum total data rate is determined by the fiber-optic links and must be divided through the number of devices and the amount of data per device. A reference value is approx. 3000 Bytes per ms (amount of data per analog channel: 2 Bytes). The devices can work with different cycle times, however the cycle time must be an integer multiple of the smallest cycle. If the maximum data rate is exceeded, ibaPDA displays an error message and recommends increasing the timebase or decreasing the amount of data. A sampling rate of 100 kHz cannot be adjusted in a ring, this is only possible with a point-to-point-connection.

9 Configuration in ibaPDA

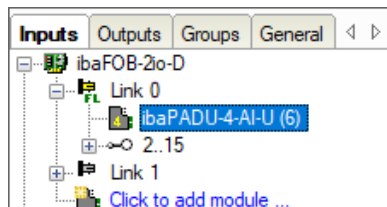
The ibaPADU-4-AI-U device requires ibaPDA version 6.31.0 or higher.

9.1 First steps

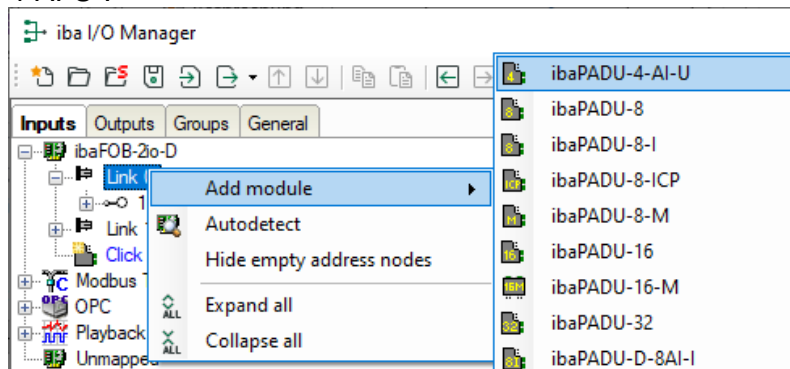
1. Start the ibaPDA client and open the I/O Manager
2. Choose the correct ibaFOB-D input card in the signal tree (on the left hand side) and mark the link ibaPADU-4-AI-U is connected to. Right-click on the link and choose “Autodetect”.



ibaPDA recognizes the device automatically. The device will be listed in the signal tree.



3. Alternatively you can manually add the device. Right-click on the link of the ibaFOB-D card the device should be connected to. Select “Add module...” and then “ibaPADU-4-AI-U”.



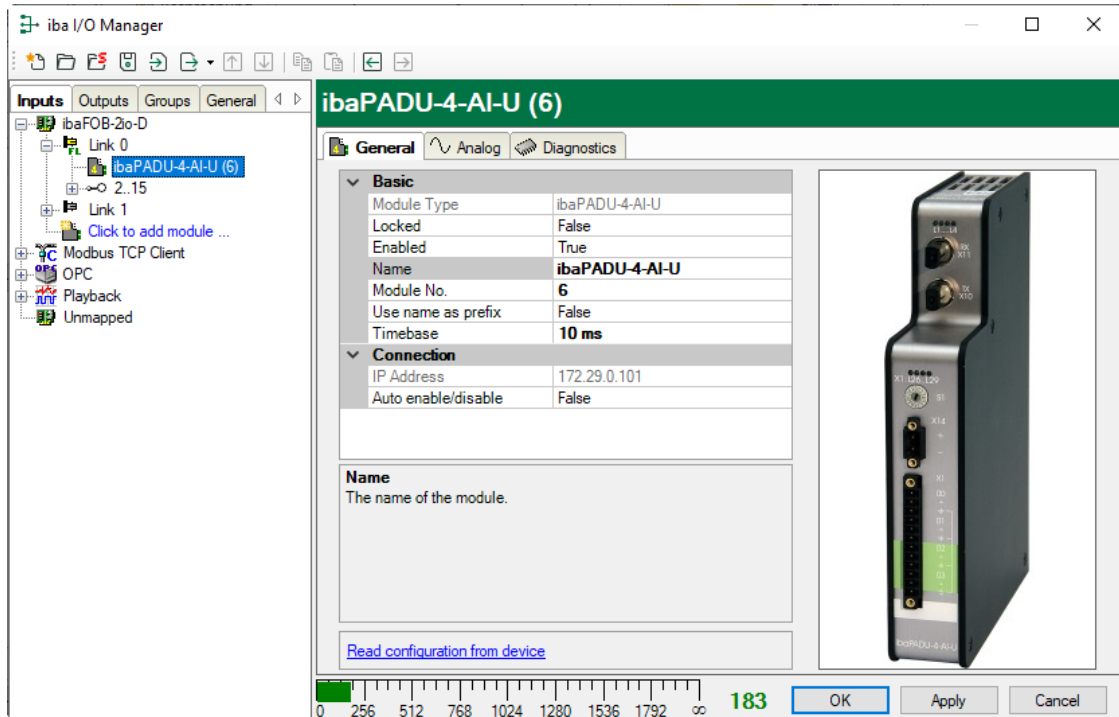
The device will be listed in the signal tree.

Hold down the mouse button and drag the device to the address (link 1 – 15 below the device), the device address switch is set to.

Position 1 – F refers to address 1 – 15.

4. Make your settings in the ibaPADU-4-AI-U module of the I/O Manager:

9.2 ibaPADU-4-AI-U – “General” tab



Basic

☐ Module type (information only)

Indicates the type of the current module.

☐ Locked

A module can be locked to avoid unintentional or unauthorized changing of the module settings.

☐ Enabled

Disabled modules are excluded from signal acquisition.

☐ Name

The plain text name should be entered here as the module designation.

☐ Module No.

Internal reference number of the module. This number determines the order of the modules in the signal tree of ibaPDA client and ibaAnalyzer.

☐ Use name as prefix

Puts the module name in front of the signal names.

☐ Timebase

Timebase that is used for the device, given in ms. It is possible to define smaller timebases than defined in the general acquisition timebase. Cycle times down to 0.01 ms are possible.

Connection

☐ IP Address

IP address or host name of the device (information only).

☐ Auto enable/disable

When this option is enabled and ibaPDA cannot connect to this device during the start of the acquisition then it will disable this module and start the acquisition without it. During the acquisition it will try to reconnect to the device. When it succeeds it will automatically restart the acquisition with this module enabled. If this option is not enabled then ibaPDA will not start the acquisition when it cannot connect to the device.

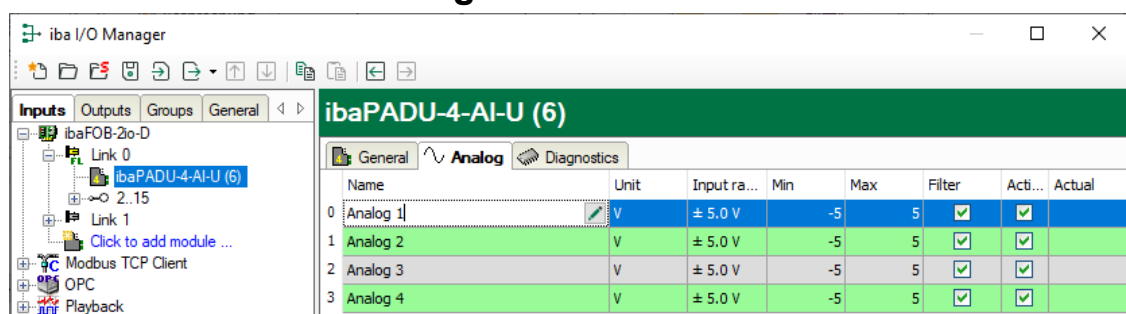
Further functions

☐ Read configuration from device


By means of this command, you can read the configuration from the device.

The changed settings become valid by clicking on <OK> or <Apply>.

9.3 ibaPADU-4-AI-U – “Analog” tab



☐ Name

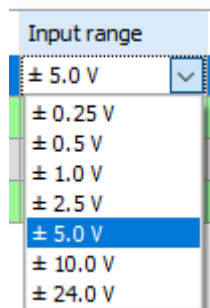
Assign a meaningful name to each signal and you can enter additionally two comments when clicking on the  symbol in the field “Name”.

☐ Unit

Here, you can enter the physical unit of the analog value, default value is “V”.

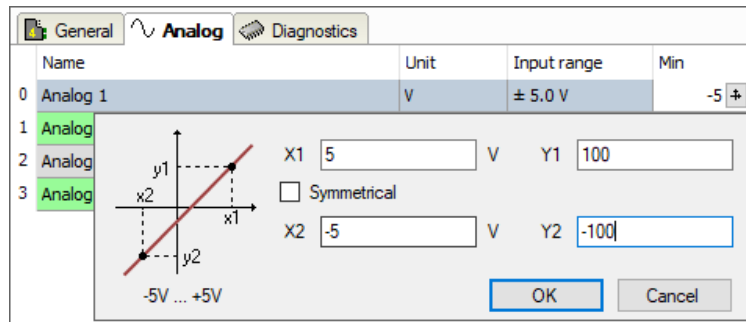
☐ Input range

You can select the input range for each signal from a drop-down menu.



☐ Min

You can define a lower limit for the measuring range. The analog normalized value of -5 V is assigned to a physical value, e. g. -100 V.



☐ Max

Here, you can define an upper limit for the measuring range. The analog normalized value of +5 V is assigned to a physical value, e. g. +100 V.

☐ Filter

You can activate the antialiasing filters (analog + digital).

☐ Active

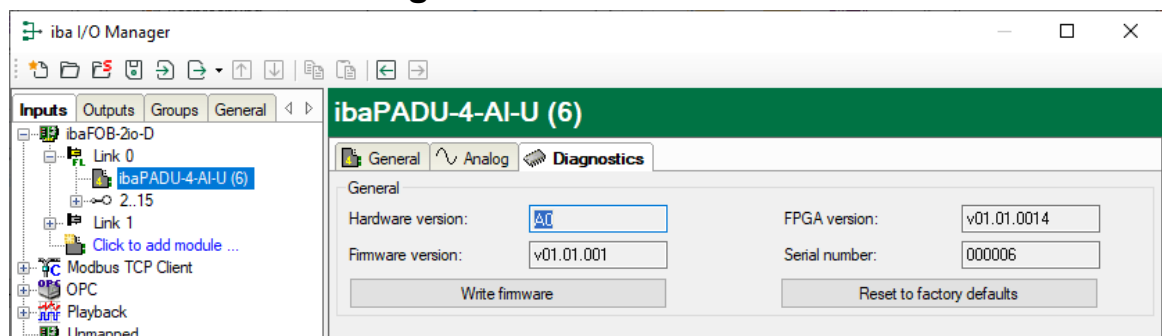
The signal will be measured when active.

☐ Actual

Displays the actual value of the signal (only available when the measurement is already running with the specified configuration).

Further columns can be shown or hidden by using the context menu (right mouse click in the table header).

9.4 ibaPADU-4-AI-U – “Diagnostics” tab



Here, you find information about the hardware version, firmware version, FPGA version and the serial number of your device.

☐ Write firmware

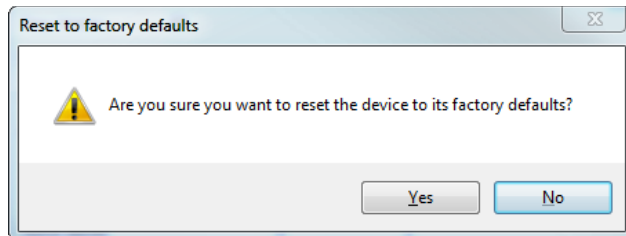
Using this button you can install a firmware update. Select the update file "padu4_v[xx.yy.zzz].iba" in the browser and start the update with <OK>.

**Important note**

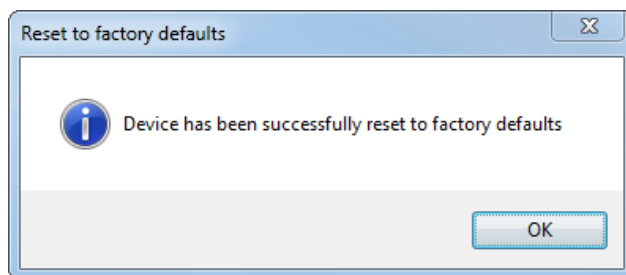
The update may take approx. 30 s and must not be interrupted. After an update the device will be automatically rebooted.

☐ **Reset to factory defaults**

Using this button all settings are reset to factory defaults after having confirmed the following request with <Yes>.



After the reset the following message appears and the device will be automatically rebooted.



10 Technical Data

10.1 Main data

| | | | |
|-----------------------------|--|--|--|
| Name | ibaPADU-4-AI-U | | |
| Description | Input module with 4 analog voltage inputs | | |
| Order no. | 10.121000 | | |
| Analog inputs | | | |
| Number | 4 | | |
| Design | Galvanically isolated, single ended | | |
| Resolution | 16 Bit | | |
| Filter | permanent | R/C low-pass, 1 st order, 72 kHz | |
| | in addition | Analog anti-aliasing filter (Butterworth) 4 th order, 50 kHz Digital anti-aliasing filter, 8 th order, cutoff frequency 1/3 of the adjusted sampling rate | |
| Input signal range | ±250 mV; ±500 mV; ±1 V; ±2.5 V; ±5 V; ±10 V; ±24 V | | |
| Input impedance | 100 kΩ | | |
| Sampling rate | Synchronous with ibaNet sampling rate | | |
| Frequency range | 0 Hz to 50 kHz | | |
| Accuracy | ± 250 mV; ±500 mV | < 0.5 % of total measuring range | |
| | ±1 V; ±2.5 V; ±5 V; ±10 V; ±24 V | < 0.1 % of total measuring range | |
| Electrical isolation | Channel-channel | AC 1.5 kV | |
| | Channel-housing/power supply | AC 1.5 kV | |
| Connector type | 1 x12-pin multi-pin connector; screw-type terminal (0.14 mm² bis 1.5 mm²) screw connection, included in delivery | | |
| ibaNet interface | | | |
| Number | 1 | | |
| ibaNet protocol | 32Mbit Flex (bidirectional) Can be used simultaneously for data, settings and service (e. g. updates) | | |
| Data transmission rate | 32 Mbit/s | | |
| Sampling rate | Up to 100 kHz, freely adjustable | | |
| Connection technology | 2 ST connectors for RX and TX; iba recommends the use of FO with multimode fibers of type 50/125 µm or 62.5/125 µm; For information on cable length, see chap. 10.3. | | |
| Transmitting interface (TX) | | | |
| Output power | 50/125 µm FO cable | -19.8 dBm to -12.8 dBm | |
| | 62.5/125 µm FO cable | -16 dBm to -9 dBm | |

| | | |
|---|---|------------------------|
| | 100/140 µm FO cable | -12.5 dBm to -5.5 dBm |
| | 200 µm FO cable | -8.5 dBm to -1.5 dBm |
| Temperature range | -40 °F to 185 °F (-40 °C to 85 °C) | |
| Light wavelength | 850 nm | |
| Receiving interface (RX) | | |
| Sensitivity ¹ | 100/140 µm FO cable | -33.2 dBm to -26.7 dBm |
| Temperature range | -40 °F to 185 °F (-40 °C to 85 °C) | |
| Power supply | | |
| Power supply | 24 V DC (±10%) | |
| Power consumption max | 10 W | |
| Connector type | 1 x 2-pin multi-pin connector; clamp-type terminal (0.2 mm² bis 2.5 mm²) screw connection, included in delivery | |
| Further interfaces, operating and indicating elements | | |
| Indicators (LEDs) | 8 status indicators for operation, channels and errors | |
| Switch | 1, address setting | |
| Operating and environmental conditions | | |
| Temperature range | | |
| Operation | 32 °F to 122 °F (0 °C to 50 °C) | |
| Storage/transport | -13 °F to 149 °F (-25 °C to 65 °C) | |
| Mounting | DIN rail according to EN 50022 (TS 35, DIN Rail 35) | |
| Cooling | Passive | |
| Humidity class | F, no condensation | |
| Protection class | IP20 | |
| Standards | EMC: EN 61326-1 FCC part 15 class A | |
| Dimensions (width x height x depth) | 1.46 in x 7.40 in x 5.71 in (37 mm x 188 mm x 145 mm) | |
| Weight / incl. box and documentation | 1.54 lbs (0.7 kg) / 2.42 lbs (1.1 kg) | |

¹ Data for other FO cable diameters not specified

**Supplier's Declaration of Conformity
47 CFR § 2.1077 Compliance Information**

Unique Identifier: 10.121000 ibaPADU-4-AI-U

Responsible Party - U.S. Contact Information

iba America, LLC
370 Winkler Drive, Suite C
Alpharetta, Georgia
30004

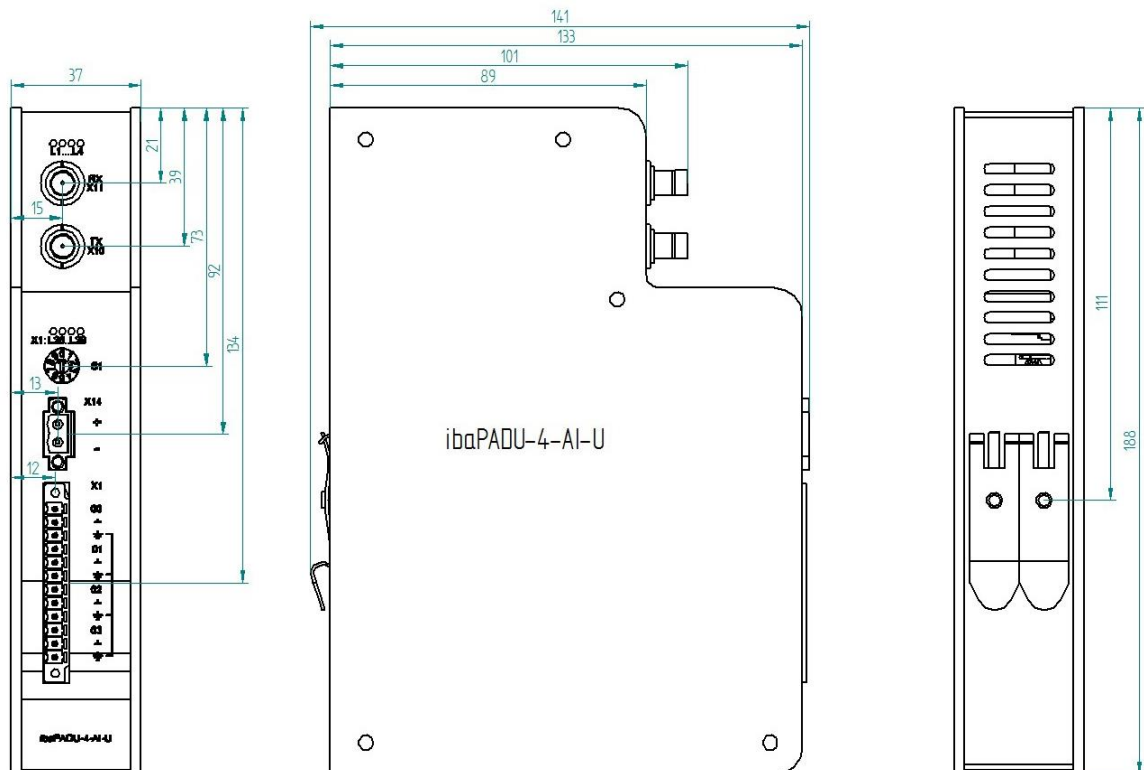
(770) 886-2318-102

www.iba-america.com

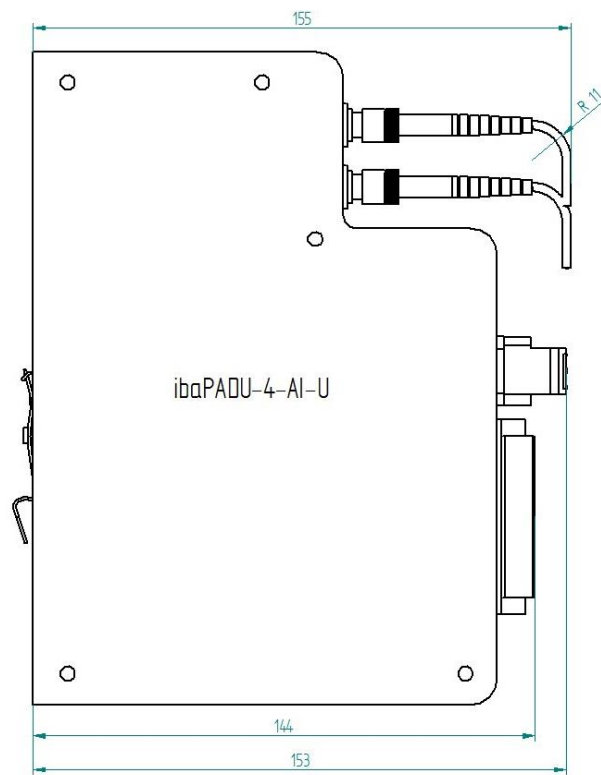
FCC Compliance Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

10.2 Dimension sheet



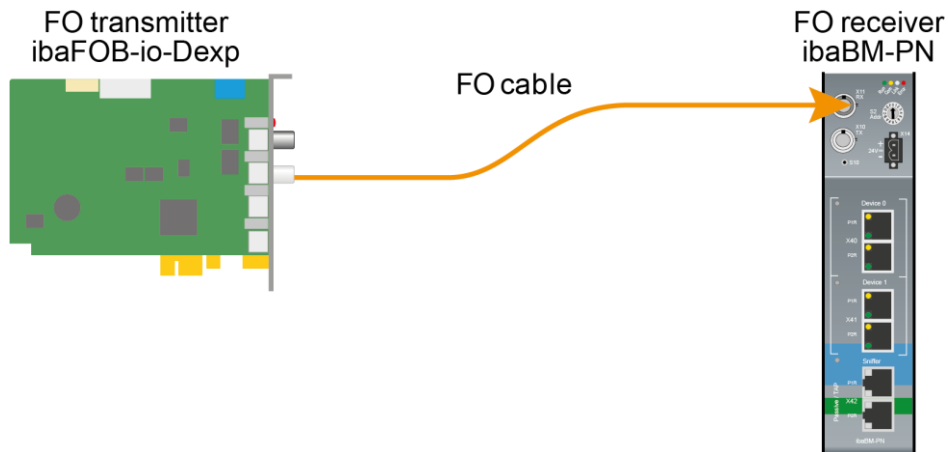
(Dimensions in mm)



Dimensions ibaPADU-4-AI-U with cable (Dimensions in mm)

10.3 Example for FO budget calculation

As an example, an FO connection from an ibaFOB-io-Dexp card (FO transmitter) to an ibaBM-PN device (FO receiver) is used.



The example refers to a point-to-point connection with an FO cable of type 62.5/125 μm . The light wavelength used is 850 nm.

The range of the minimum and maximum values of the output power or receiver sensitivity depends on the component and, among other things, on temperature and aging.

For the calculation, the specified output power of the transmitting device and on the other side the specified sensitivity of the receiving device must be used in each case. You will find the corresponding values in the respective device manual in the chapter "Technical data" under "ibaNet interface".

Specification ibaFOB-io-Dexp:

| Output power of FO transmitting interface | | |
|---|---------|--------|
| FO cable in μm | Min. | Max. |
| 62.5/125 | -16 dBm | -9 dBm |

Specification ibaBM-PN:

| Sensitivity of FO receiving interface | | |
|---------------------------------------|---------|------|
| FO cable in μm | Min. | Max. |
| 62.5/125 | -30 dBm | |

Specification FO cable

To be found in the data sheet of the fiber optic cable used:

| | |
|--|------------------------|
| FO cable | 62.5/125 μm |
| Connector loss | 0.5 dB connector |
| Cable attenuation at 850 nm wavelength | 3.5 dB / km |

Equation for calculating the FO budget (A_{Budget}):

$$A_{Budget} = |(P_{Receiver} - P_{Sender})|$$

$P_{Receiver}$ = sensitivity of FO receiving interface

P_{Sender} = output power of FO transmitting interface

Equation for calculating the fiber optic cable length (l_{Max}):

$$l_{Max} = \frac{A_{Budget} - (2 \cdot A_{Connector})}{A_{Fiberoptic}}$$

$A_{Connector}$ = connector loss

$A_{Fiberoptic}$ = cable attenuation

Calculation for the example ibaFOB-io-Dexp -> ibaBM-PN in the best case:

$$A_{Budget} = |(-30 \text{ dBm} - (-9 \text{ dBm}))| = 21 \text{ dB}$$

$$l_{Max} = \frac{21 \text{ dB} - (2 \cdot 0.5 \text{ dB})}{3.5 \frac{\text{dB}}{\text{km}}} = 5.71 \text{ km}$$

Calculation for the example ibaFOB-io-Dexp -> ibaBM-PN in the worst case:

$$A_{Budget} = |-30 \text{ dBm} - (-16 \text{ dBm})| = 14 \text{ dB}$$

$$l_{Max} = \frac{14 \text{ dB} - (2 \cdot 0.5 \text{ dB})}{3.5 \frac{\text{dB}}{\text{km}}} = 3.71 \text{ km}$$

**Note**

When connecting several devices as daisy chain (e.g. ibaPADU-8x with 3Mbit) or as ring (e.g. ibaPADU-S-CM with 32Mbit Flex), the maximum distance applies to the section between two devices. The FO signals are re-amplified in each device.

**Note**

When using fiber optics of the 50/125 µm type, a distance reduction of approx. 30-40% must be expected.

11 Support and contact

Support

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Note

If you require support, specify the serial number (iba-S/N) of the product.

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