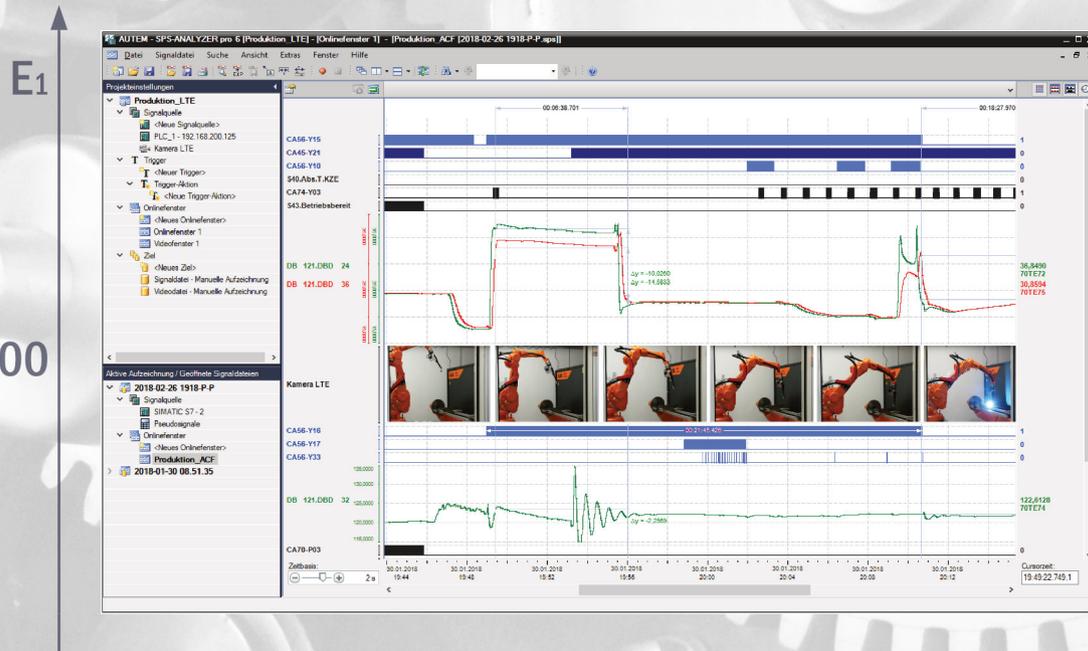


# PLC-ANALYZER pro 6

PLC-Logic analysis in no time

## Driver Addendum



E1

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QB

MW



Driver

AD\_USB-Box®

**AUTEM**  
www.autem.de

# PLC-ANALYZER pro 6 - Driver Addendum

## AD\_USB-Box

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1<sup>st</sup> Edition 2022

## Table of Contents

Signal source .....	3
AD_USB-Box .....	3
Installation .....	4
Installing additional hardware .....	4
Installing additional software .....	4
Configuration .....	5
Data acquisition .....	7
Recordable PLC addresses .....	7
Preparing the hardware for data recording .....	7
Time behaviour and particularities .....	10
Application examples .....	11
Voltage measurement .....	11
Differential voltage measurement .....	11
Measuring small currents .....	12
Measuring large currents .....	13
Event count .....	13
Rotational speed of a turbine .....	14
Digital measurement for 24-V facilities .....	15
Appendix A - Technical Data AD_USB-Box .....	16
Appendix B - Expansion Unit .....	17
Appendix C - 4-20 mA Current/voltage converter ET420 .....	18

## Signal source

### AD\_USB-Box

This driver addendum describes the particularities of the following PLC drivers and gives you hints on using them.

- AD\_USB-Box®

The listed driver enables recording of digital and analogue signals with the help of the AD\_USB-Box® over the Universal Serial Bus (USB).

It is important that you read through the driver addendum before using a PLC driver. Please pay attention to the WARNINGS that advise you on possible dangers when using PLC-ANALYZER pro.



#### **WARNING**

Errors that may occur in the automated facility, endangering humans or causing large-scale material damage, must be prevented by additional precautions. These precautions (e.g. independent limit monitors, mechanical interlocks) must guarantee safe operation, even in case of dangerous errors.



#### **WARNING**

When using the AD\_USB-Box®, voltage-carrying portions of the circuit/device being measured must be prevented from being touched. Touching voltage-carrying parts can lead to critical injury or significant material damage.



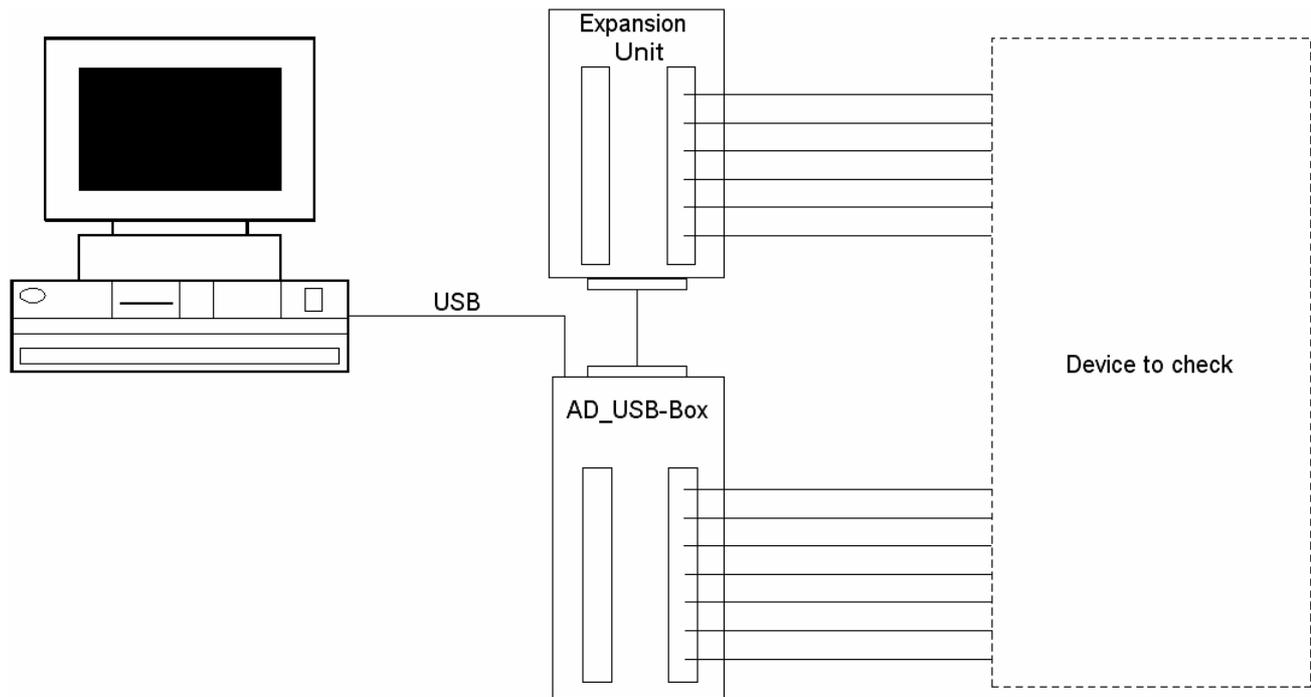
#### **REVOCATION OF GUARANTEE**

The AD\_USB-Box® and the Expansion Unit are guaranteed for 12 months. The guarantee no longer applies if the product is tampered with, or if the product is not handled properly, or if the product is stored under adverse conditions. The guarantee also no longer applies if the device is used in a fashion that does not correspond to the manufacturer's intended use, or if used after wear-and-tear has taken effect, or if used with incorrect current or voltage, or if used after damage by surge, lightning, fire, water (dampness). The guarantee no longer applies if the guaranty seal is removed or rendered unreadable.

## Installation

The AD\_USB-Box driver can be added to the project as a new signal source. If the driver you want is not yet in the list of available signal sources, you must first activate the license for the AD\_USB-Box driver with the AUTEM LicenseManager on your computer.

### Installing additional hardware



**Fig. 1-1 Hardware diagram**

Connect the supplied USB interface cable to the AD\_USB-Box®. With the PC on, connect the USB interface cable to the PC's USB socket. The required USB drivers will be automatically loaded by Windows. The AD\_USB-Box® is fed with voltage through the USB connection.

If you would also like to record digital signals, then connect the supplied Expansion Unit (see [Appendix B - Expansion Unit](#)) with the supplied 25-pin SUB-D interface cable to the AD\_USB-Box®.

The Expansion Unit's screw clamps can be used to easily access the additional 16 digital inputs of the AD\_USB-Box®. The Expansion Unit itself ensures a limited protection from surge.

### Installing additional software

No software is required in addition to the PLC-ANALYZER pro basic module and the PLC driver.

## Configuration

Open driver settings to set important parameters for data recording. If you have added the driver to the project several times, you can set the properties individually for each individual driver.

Every AD\_USB-Box® has been assigned an individual ID for the purpose of unique data assignment. By pressing the *Configure AD\_USB-Box(es)* button you call up the *Configure AD\_USB-Box(es)* window. Here you can assign a new ID to the AD\_USB-Boxes® connected to the PC.

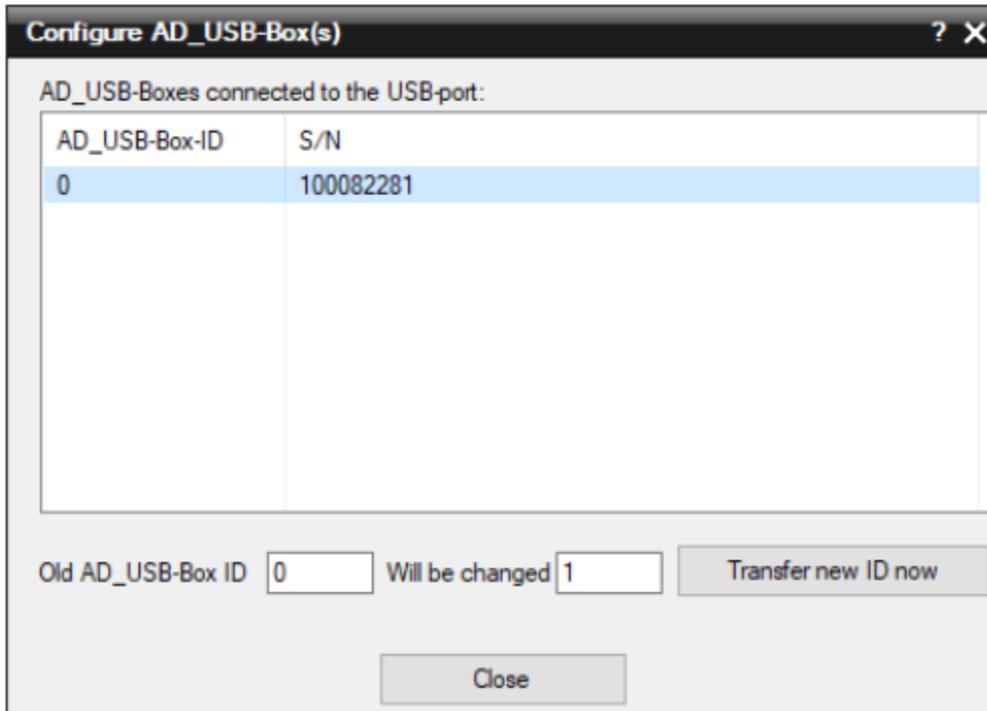


Fig. 1-2 Configure AD\_USB-Box®

First, set the *Old ID* of the AD\_USB-Box®. Only the IDs of connected AD\_USB-Boxes® can be selected. Enter the new ID for the selected AD\_USB-Box® in *New ID*. Press the button *Transfer new ID*, in order to assign the new ID to the AD\_USB-Box®.

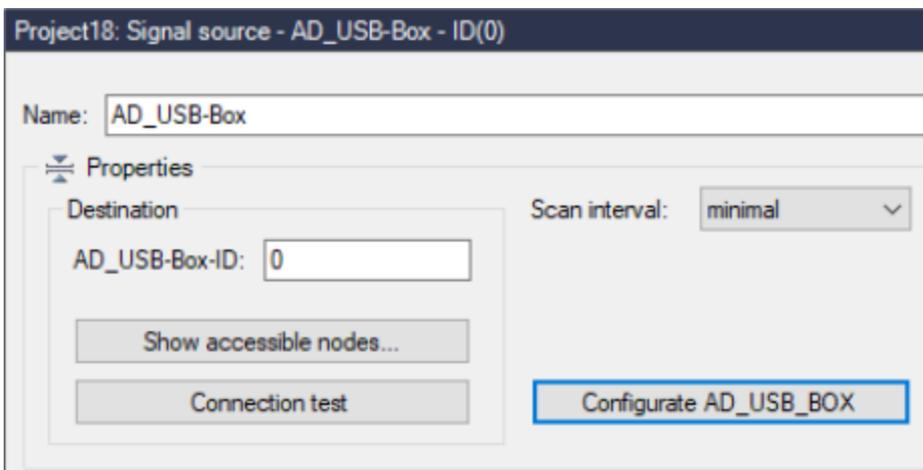


Fig. 1-3 Settings AD\_USB-Box®

First enter a meaningful name. Then enter the ID of the corresponding AD\_USB-Box® under *AD\_USB-Box-ID*. Pressing the button *Configure AD\_USB-Box(es)* displays the IDs assigned to the connected AD\_USB-Boxes®.

By selecting the *Show accessible nodes* button, you can find out which IDs are assigned to the connected AD\_USB boxes.

Press *Connection test* to check, whether a connection to the PLC can be established.

Under *Scan interval* you specify the time interval at which measured values are read out from the AD\_USB-Box. A longer sampling interval can be selected for signal paths that are not time-critical, e. g. temperature. As a result, the generated signal files become smaller.

After setting the communication properties, add the PLC signals to be recorded.

## Data acquisition

### Recordable PLC addresses

The following table shows the recordable signals and the corresponding syntax:

Input syntax	Address type	Screw terminal connector
IO x	Digital input	IO0 - IO3
D x	Digital input	D0 - D15
AI x	Analog input (single-ended)	AI0 - AI7
AID x	Analog input (differential)	AI0 - AI7
CNT	Impulse-Counter	CNT
CNTSx	Impulse-Counter per second / frequency	CNT

Table 1-1 Signals recordable by AD\_USB-Box®

For the CNTSx signal, a time span in ms is specified for "x", e.g. CNTS500. The impulses will be added within the time „x“ and then normalized to one second. The specified period of time “x” (max. 10.000) causes the “smoothing” of the signal. The higher the value of “x”, the stronger is the smoothing.

### Preparing the hardware for data recording

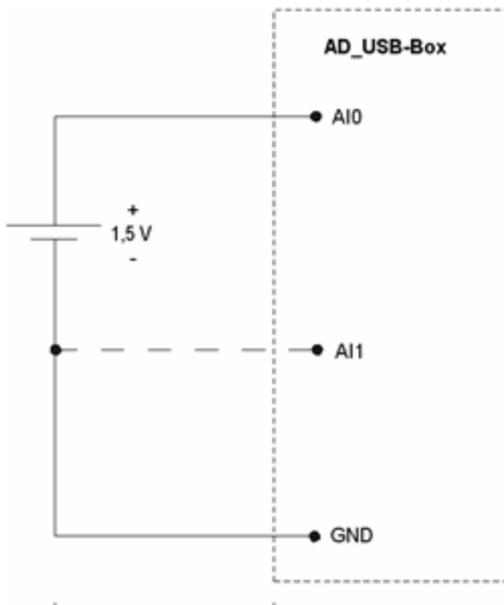
Before each measurement connect an earth terminal (GND) of the AD\_USB-Box® with earth of the circuit to be measured. Then connect the measurement points of the circuit to the corresponding inputs of the AD\_USB-Box®.



#### NOTE

Non-connected inputs may display random values during recording. In this case, set non-required inputs to ground (GND).

## Analog Inputs



**Fig. 1-4 Analog voltage measurement**

The AD\_USB-Box® has 8 screw clamps for analog input signals (AI0 - AI7). These can be used either as single-ended inputs (input syntax: AI0 - AI7) or as differential inputs (input syntax: AID0, AID2, AID4 or AID6). It is possible to combine both. Voltages up to  $\pm 10$  V from ground can be measured at the analog inputs. This means a voltage range of  $\pm 20$  V for differential measurements.

For single-ended analog measurements, connect at first an earth terminal (GND) of the AD\_USB-Box® to ground of the circuit to be analysed. Then connect the point to be analysed to an analog input of the AD\_USB-Box®.

For the differential analog measurement the voltage to be analysed is connected directly to two analog inputs. The clamps used must be directly next to each other (e.g. AI2 and AI3).

Fig. 1-4 shows the single-ended measurement of voltage from a battery. You can also undertake a differential voltage measurement by connecting the analog input AI1 to the minus pole of the battery. You can find further examples of application in chapter [Application examples](#).

## Digital inputs

The AD\_USB-Box® provides 20 digital inputs with which you can examine logical switch states (LOW = voltages < 0.8 volt; HIGH = voltages > 4 volts).

Four digital inputs are connected to the screw terminal connector of the AD\_USB-Box® (IO0 - IO3). Up to 15 volts can be applied to these digital inputs. 16 further digital inputs are present on the Expansion Unit. The inputs of the Expansion Unit (D0 - D15) can be loaded with up to 25 volts.

### NOTE



The digital inputs D13 - D15 (Expansion Unit) are Schmitt-Trigger-Inputs. These inputs are connected via diodes to +5 V and GND. In consequence of this all three inputs are „HIGH“ if the input voltage is more than +5.5 V or less than -0,5 V on one of the inputs.

If you like to impress voltage outside this range on input D13 - D15 you have to connect the input with a 5,1 Volt Zener-Diode and a 10 kΩ resistor in series to GND.

For digital state measurement connect an earth terminal (GND) of the AD\_USB-Box® to ground of the circuit to be examined. Then connect the measurement point to be examined to a digital input (IO0 - IO3 or D0 - D15) of the AD\_USB-Box®.

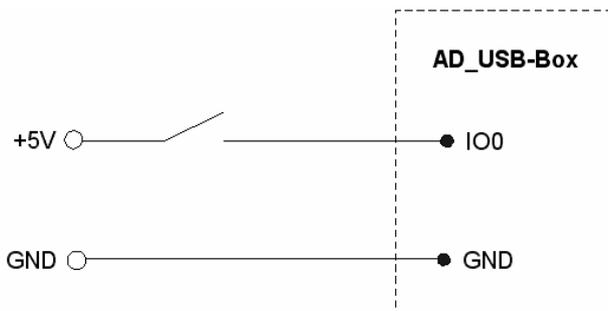


Fig. 1-5 Using a digital input

## CNT

The 32-bit impulse counter input CNT of the AD\_USB-Box® is designated for counting impulses. It can be used in two different ways:

- CNT - adding impulse counter. When PLC-ANALYZER pro is started for recording the counter is reset to 0.
- CNTSx - impulse counter per second / frequency counter. „x“ is a period of time in ms, e.g. CNTS500. The impulses will be added within the time „x“ and then normalized to one second. The specified period of time „x“ (max. 10.000) causes the „smoothing“ of the signal. The higher the value of „x“, the stronger ist the smoothing.

Every positive edge, i. e. the voltage rise at connector CNT from < 1 V .. > 4 V, increases the counter value by 1. The maximum input voltage is 15 V. Frequencies up to 1 MHz can be recorded.

The 32-bit counter CNT of the AD\_USB-Box® is a state-change counter. For each voltage rise at the screw clamp CNT from less than 1 volt to more than 4 volts, the counter is incremented by one. The maximum input voltage is 15 V. State changes can be recorded up to a frequency of 1 MHz.

## +5 V

The AD\_USB-Box® provides + 5 V at these connectors. The connectors are also connected to the +5 V connectors of the Expansion Unit. All + 5 V connectors together can be loaded with about 450 mA, as long as the AD\_USB-Box® is directly connected to a PC or to a USB hub with their own voltage supply. Some notebooks and USB-supplied hubs limit the output current to about 50 mA.

## CAL - STB

These connectors can be used for test and calibration purposes. The CAL connector is a 2.5 V precision voltage supply.

## GND

The earth terminals of the AD\_USB-Box® and the Expansion Unit provide general ground for all measurement operations.

## Time behaviour and particularities

The following section explains time behaviour and some particularities of communication.

Data recording takes place in two different modes: stream mode or command-response mode. Switching between these modes is done automatically and is dependent on the number and type of signals to be recorded.

The much faster stream mode is used only when the IO digital inputs and not more than 4 analog inputs are recorded. The sampling distance is affected only by the number of analog inputs and has a range beginning with 0.8 ms for one analog input and reaching 3.3 ms for 4 analog inputs.

The command-response mode is used when more than 4 analog inputs, or when counter (CNT) or D digital inputs (D0 - D15) are recorded. The sampling distance is in the range from 16 ms to 48 ms.

The following table gives an overview of time behaviour for recording various signals:

Desired data	Time
1 digital input (IO0 - IO3)	0.8 ms
1 analog input	0.8 ms
2 analog inputs	1.6 ms
4 analog inputs + 4 IO digital inputs	3.3 ms
1 counter	16 ms
1 digital input (D0 - D15)	16 ms
1 counter and 20 digital inputs	16 ms
8 analog inputs	32 ms
8 analog inputs, 20 digital inputs and one counter	48 ms

Table 1-2 Sampling distance for varying data volume

## Application examples

### Voltage measurement

The AD\_USB-Box® handles voltages up to ±10 V from ground. Higher voltages can be measured with the help of a voltage divider.

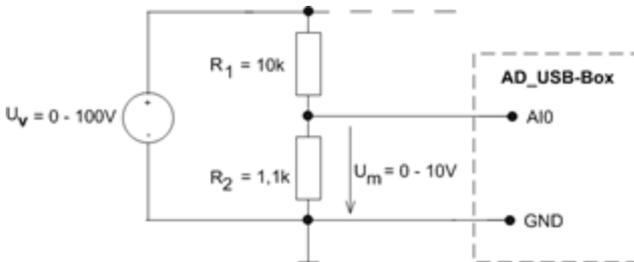


Fig. 1-6 Measuring a voltage divider

In Fig. 1-6 a voltage is measured that can vary between 0 and 100 V. This voltage is divided with the help of two resistors ( $R_1$  and  $R_2$ ) so that the voltage  $U_m$  across  $R_2$  can be measured with the AD\_USB-Box®. The resistances can be calculated as follows:

You specify  $R_1$  ( $\approx 10 \text{ k}\Omega$ ).

$$R_2 \leq \frac{10 \cdot R_1}{U_v - 10 \text{ V}}$$

To prevent measurement imprecision the total resistance ( $R_1 + R_2$ ) should be  $\leq 20 \text{ k}\Omega$ .

In PLC-ANALYZER pro you set a correction factor for the measurement point AI1 so that the correct value for the voltage  $U_v$  is displayed. The correction factor is determined as follows:

$$\text{Factor} = \frac{R_1 + R_2}{R_2}$$

### Differential voltage measurement

You do a differential voltage measurement when there is no direct earth terminal at the measurement point.

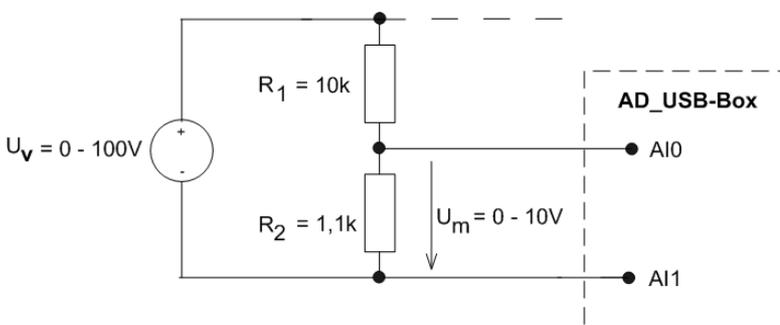
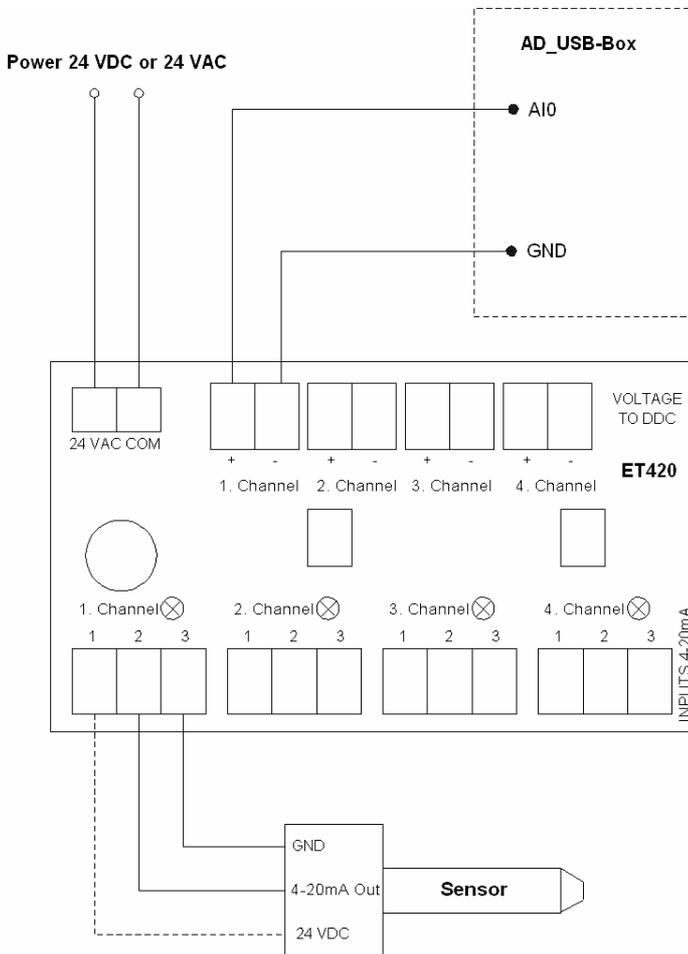


Fig. 1-7 Differential voltage measurement

In Fig. 1-7 the voltage across  $R$  is measured. If the voltage  $U_m$  does not exceed 20 V, then the voltage can be directly measured across  $R$ . Otherwise use a voltage divider ([Voltage measurement](#)). Now determine the address AID0 with PLC-ANALYZER pro.

## Measuring small currents

Currents up to 20 mA can be measured with the 4 - 20 mA current/voltage converter ET420 ( [Appendix C - 4-20 mA Current/voltage converter ET420](#)). The ET420 converts in each of four separate channels currents of 4 - 20 mA proportional to voltages from 1 - 5 V.



**Fig. 1-8 Measuring current with ET420**

The example in Fig. 1-8 shows a typical current measurement with the ET420. A pressure sensor supplies a current between 4 and 20 mA proportional to the pressure. This current is to be recorded with PLC-ANALYZER pro.

First, connect a 24 V voltage supply (direct or alternating current) to the 24 VAC COM clamps of the ET420.

Then connect the sensor to the ET420. There are 2-wire and 3-wire sensors. For 2-wire sensors the sensor ground (GND) is connected to clamp 3 and the current output of the sensor is connected to clamp 2 of the ET420 input.

Additionally, for 3-wire sensors, the 24 VDC supply voltage on clamp 1 is connected. This clamp is not required for 2-wire sensors.

Now connect the ET420 to the AD\_USB-Box®. Connect the clamp (+) of the ET420 output to the desired analog input (e.g. AIO) and the clamp (-) of the ET420 output to ground (GND) of the AD\_USB-Box®.

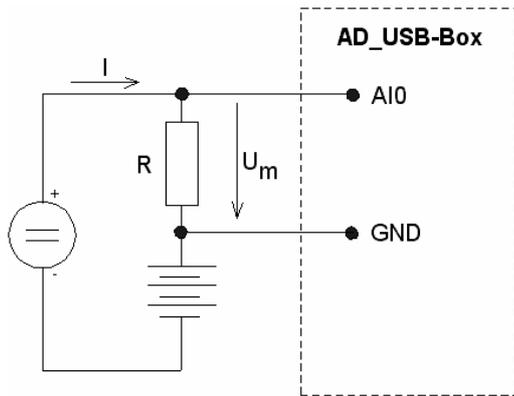
### NOTE



If you set in PLC-ANALYZER pro the multiplication factor "4" and unit "mA" for the measure point AIO, then the measured current is displayed correctly.

## Measuring large currents

Currents larger than 20 mA can be measured indirectly across a shunt.



**Fig. 1-9 Indirect current measurement**

Fig. 1-9 shows a typical indirect current measurement. The charge current  $I$  of a battery is to be monitored and recorded. The voltage is measured across a resistance  $R$ . The resistance of the shunt to be used can be calculated from the expected current  $I$ :

$$R = \frac{U_{\max}}{I}$$

The maximum input voltage of the AD\_USB-Box®  $U_{\max}$  is 10 V. For an expected current of 2 A the resistance is 5  $\Omega$ . The voltage  $U_m$  determined when measuring makes it possible to calculate the charge current.

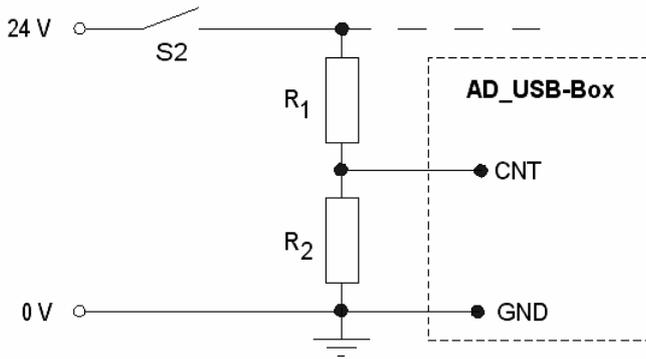
$$I = \frac{U_m}{R}$$

In PLC-ANALYZER pro you set a factor for the measure point AI0 so that the value of the charge current is automatically displayed. The factor is calculated as follows:

$$\text{Factor} = \frac{1}{R}$$

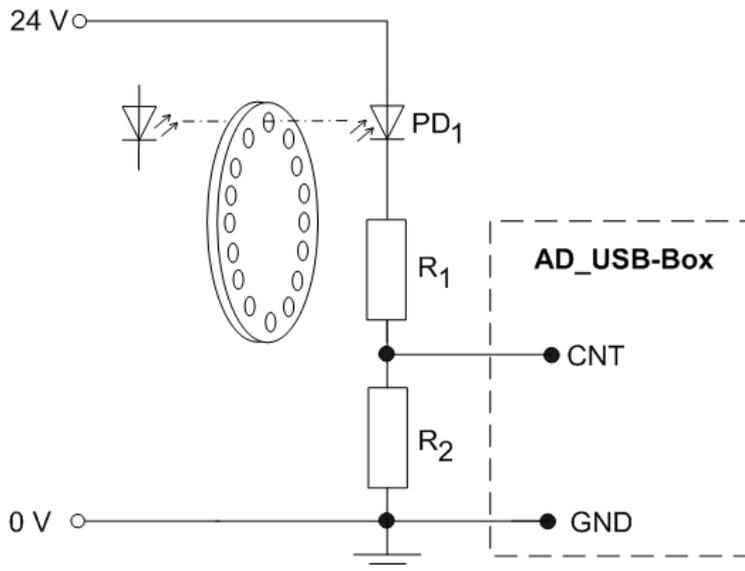
## Event count

The counter input CNT of the AD\_USB-Box® is to be used to count the number of passing bottles in a bottle-filling facility. Each bottle moves past a photoelectric switch S2. The 24 V switching voltage is divided by  $R_1/R_2$  to 12 V each. The voltage across resistor  $R_2$  is applied to the counter input (CNT) of the AD\_USB-Box®. After recording with PLC-ANALYZER pro, the number of bottles per time unit can easily be determined.



**Fig. 1-10 Event count using input CNT**

Rotational speed of a turbine



**Fig. 1-11 Measurement of rotational speed**

The rotational speed of a turbine has to be recorded. The turbine shaft is equipped with a perforated disk with 16 holes, which triggers the light barrier PD<sub>1</sub>.

PD<sub>1</sub> triggers 16 times per revolution of the turbine shaft. The 24 V switching voltage is divided by R<sub>1</sub>/R<sub>2</sub> to 12 V each. The voltage across resistor R<sub>2</sub> is applied to the counter input (CNT) of the AD\_USB-Box®.

Now e.g. CNTS500 is selected as input address in PLC-ANALYZER pro and a value of e.g. 160 is measured. In this case the turbine rotates with a speed of 10 revolutions per minute. By means of scaling register values in PLC-ANALYZER pro you can multiply the address CNTS500 by a multiplier so, that the rotational speed is displayed in min<sup>-1</sup>. The multiplier can be calculated as follows:

$$Multiplier = \frac{60}{n}$$

n = number of impulses per revolution

## Digital measurement for 24-V facilities

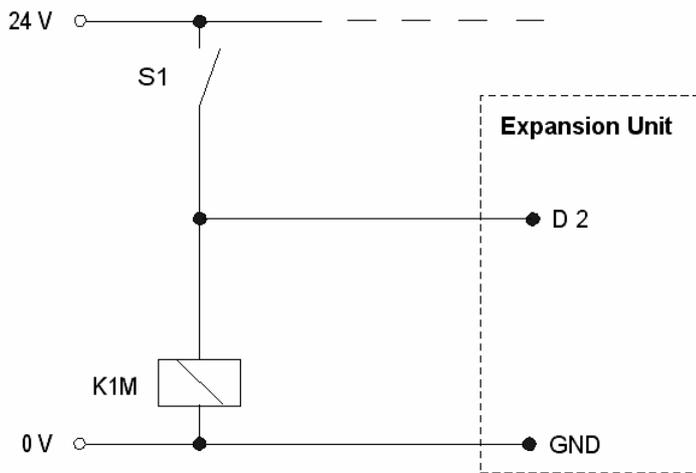
**Fig. 1-12 Digital measurement for 24 V**

Fig. 1-12 shows recording of a switch state in a 24-V circuit. Because the maximum input voltage of a digital input (D0 - D15) of the Expansion Unit is 25 V, the 24 V switching voltage can be applied directly to the D input. When using the IO input of the AD\_USB-Box® (maximum 15 V) a voltage divider would have to be used ([Voltage measurement](#)).

## Appendix A - Technical Data AD\_USB-Box

Parameter	Comments	Minimum	Typical	Maximum
<b>General</b>				
Supply voltage ( $V_s$ )	from USB	4.35 V		5.25 V
Supply current	from USB		20 mA	
Operating temperature		- 40 °C		85 °C
<b>Analog inputs (AI0 - AI7)</b>				
Measurable input voltage	from GND	- 10 V		+ 10 V
Maximum input voltage	from GND	- 40 V		+ 40 V
Input current	$V_{in} = + 10 V$ $V_{in} = 0 V$ $V_{in} = - 10 V$		70.1 $\mu A$ - 11.7 $\mu A$ - 93.5 $\mu A$	
Precision			12 bits	
<b>Digital inputs (IO0 - IO3)</b>				
Input voltage Low				0.8 V
Input voltage High		3 V		15 V
Input current			$\pm 1 \mu A$	
<b>Digital inputs (D0 - D15)</b>				
Input voltage Low	D0 - D12 D13 - D15			0.8 V 1 V
Input voltage High	D0 - D12 D13 - D15	2 V 4 V		$V_s + 0.3 V (25 V)$ $V_s + 0.3 V (25 V)$
Input current			$\pm 1 \mu A$	
(Values in brackets refer to operating with expansion unit - see Appendix B - Expansion Unit)				
<b>Counter (CNT)</b>				
Input voltage Low		GND		1 V
Input voltage High		4 V		15 V
Input current			$\pm 1 \mu A$	
Minimum high time		30 ns		
Minimum low time		30 ns		
Input frequency				1 MHz

<sup>1</sup> The input current can be calculated from the input voltage as follows:  $(8.181 * V_{in} - 11.67) \mu A$

<sup>2</sup> The CNT counter is a Schmitt-trigger input.



## Appendix C - 4-20 mA Current/voltage converter ET420



**Fig. 1-14 Current/voltage converter ET420**

The ET420 is used to measure small currents (*see 3.4.3 Measuring small currents*) up to 20 mA with the AD\_USB-Box®.

The ET420 converts in each of four separate channels currents of 4 - 20 mA proportional to voltages from 1 - 5 volts.

All four current inputs (screw clamps) are provided with a LED whose light intensity is proportional to the input current. The inputs are protected from short-circuit and incorrect poling.

The ET420 requires a 24-V voltage supply for operation (direct or alternating current), which is connected to the 24 VAC COM clamps.

For supplying the connected sensors, a 24-VDC supply voltage is provided for each current-measurement circuit. An additional voltage supply for the sensors is no longer required.

The jumpers can be used to easily cut off the supply voltage to the connected sensors. In addition, you can use a multimeter connected to the jumper pins to check the current load of the connected sensor.

The 24-VDC supply voltage is not required for the connection of 2-wire sensors.

### Technical data:

- Supply voltage: 24 VDC or 24 VAC
- Input/load: 4 - 20 mA / 250  $\Omega$  (2-wire or 3-wire)
- Output: 1 - 5 VDC
- Sensor voltage supply.: 24 VDC and 10 mA (electronically protected up to  $I_{\max} = 100$  mA)
- Dimensions: 70 mm x 75 mm x 37 mm