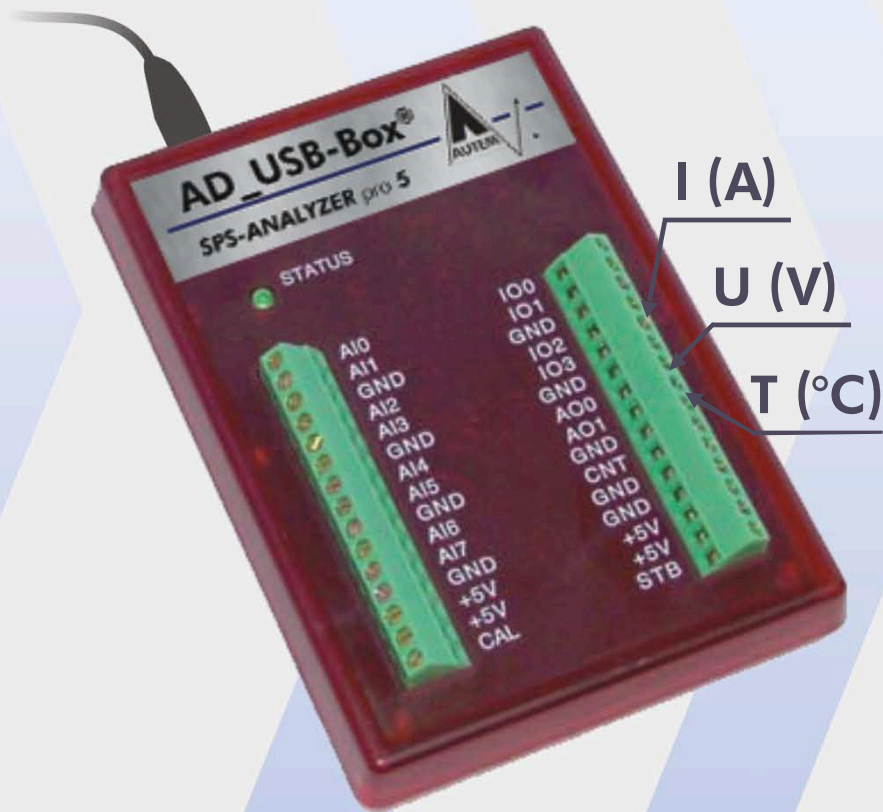


AD_USB-Box[®]

for PLC-ANALYZER *pro 5*



PLC-ANALYZER *pro 5*

The logic analyzer for
programmable logic controls

Driver Addendum AD_USB-Box®

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We are thankful for any comments, suggestions, or ideas you may be willing to write us.

2nd Edition 2010

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1 Installation

This Driver Addendum is a supplement to the PLC-ANALYZER pro User Manual. It explains the details and provides you with important information for using:

- AD_USB-Box[®]

The listed driver enables recording of digital and analog signals with the help of the AD_USB-Box[®] over the Universal Serial Bus (USB).

You should be sure to read the driver addendum before using the driver. Please pay attention to the clearly indicated warnings informing you of possible dangers when using PLC-ANALYZER pro and the AD_USB-Box[®].



WARNING

Everywhere that errors may occur in an automated facility endangering humans or causing large-scale material damage must be prevented by additional external measures or devices. These measures (e.g. independent limit monitors, mechanical interlocks) must guarantee safe operation even in the 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.

1.1 Hardware installation

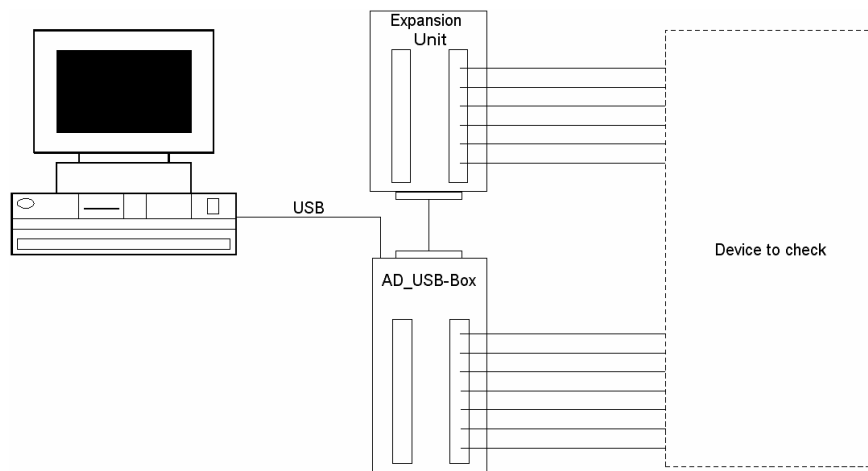


Fig. 1-1 Hardware diagram

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.

1.2 Software installation

You can install the AD_USB-Box[®] driver when PLC-ANALYZER pro is running. Select *PLC driver* in the menu *Extras*. In the window PLC driver click the button *Add*. If the desired driver is not in the list, then you have to install a new driver by activation via the License-Key management (*look also manual PLC-ANALYZER pro content 2-2 Installation*).

PLC-ANALYZER pro also allows loading several equivalent or different PLC drivers. For example, if you have connected several AD_USB-Boxes[®] to your PC, then you must load a driver for each AD_USB-Box[®]. This allows recording signal data from several AD_USB-Boxes[®] in parallel. The signals are identified by the AD_USB-Box[®] ID.



Note

To operate the AD_USB-Box[®] you need Windows version 4.10.2222 or higher. This version includes Windows 98SE, ME, 2000, XP and 7.

2 Configuration

After installation you set important parameters of the AD_USB-Box[®] under *Properties*. You can also assign new IDs to the AD_USB-Boxes[®] connected to the PC.

2.1 Configure AD_USB-Box

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.

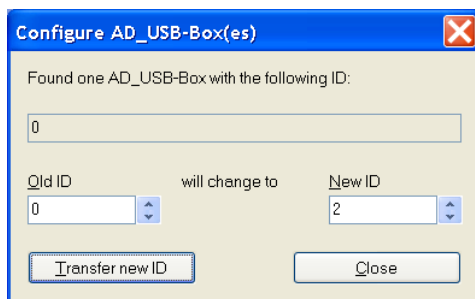


Fig. 2-1 Configure AD_USB-Box[®]

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[®].

2.2 Configure drivers

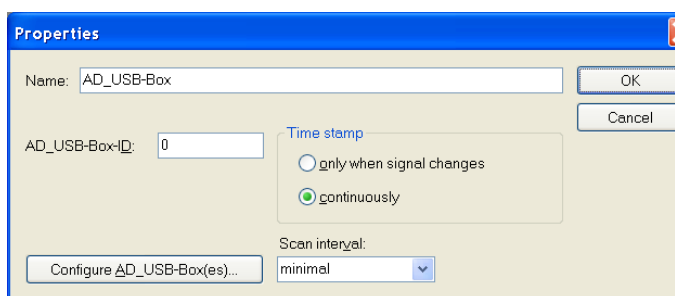


Fig. 2-2 Properties of the AD_USB-Box[®] driver.

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[®] (cf. 2.1 *Configure AD_USB-Box[®]*).

Use *Time stamp* to specify whether the time stamp is written to the signal file continuously (at each sample point) or only when the signal changes. For continuous time stamps the exact scan

points are protocolled even when the signal does not change. This causes the signal files to become larger.

You use *Scan interval* to specify the time intervals for recording measured values. For signals that are not time-critical, a longer sampling interval can be selected. The signal files resulting are smaller.

3 Recording Data

This chapter describes the procedure for recording analog and digital signals with the AD_USB-Box[®]. You can record up to 8 single-ended or 4 differential analog inputs and 20 digital inputs. There is also a counter.

3.1 Recordable signals

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 ¹	CNT

Table 3-1 Signals recordable by AD_USB-Box[®]

3.2 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).

¹ „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 is the smoothing.

3.2.1 Analog inputs

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 ± 10 V from ground can be measured at the analog inputs. This means a voltage range of ± 20 V for differential measurements.

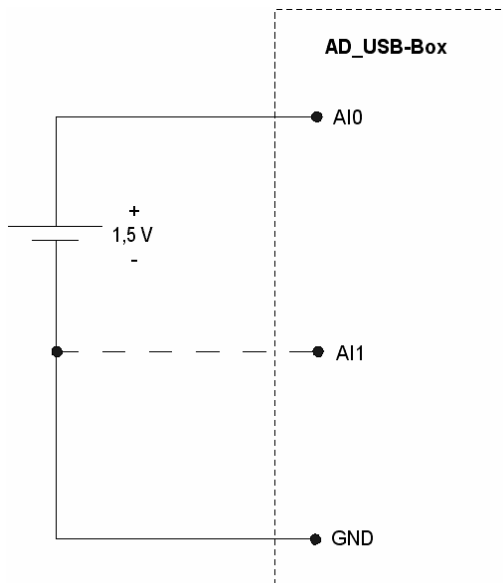


Fig. 3-1 Analog voltage measurement

For single-ended analog measurements, connect at first an earth terminal (GND) of the AD_USB-Box[®] to ground of the circuit to be analyzed. Then connect the point to be analyzed to an analog input of the AD_USB-Box[®].

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

Fig. 3-1 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 3.4 Application examples.

3.2.2 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 k Ω 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[®].

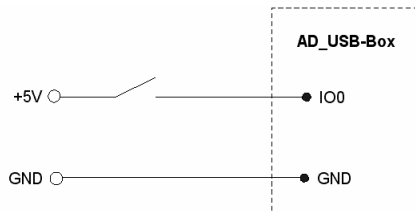


Fig. 3-2 Using a digital input

3.2.3 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 is the smoothing.

Every positive edge, i. e. the voltage rise at connector CNT from $< 1\text{ V} \dots > 4\text{ V}$, 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.

3.2.4 +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.

3.2.5 CAL - STB

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

3.2.6 GND

The earth terminals of the AD_USB-Box[®] and the Expansion Unit provide general ground for all measurement operations.

3.3 Time behaviour and particularities when recording

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 3-2 Sampling distance for varying data volume

3.4 Application examples

Presenting several examples, this chapter explains how you can use the AD_USB-Box[®] to carry out measurements.

3.4.1 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. In Fig. 3-3 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:

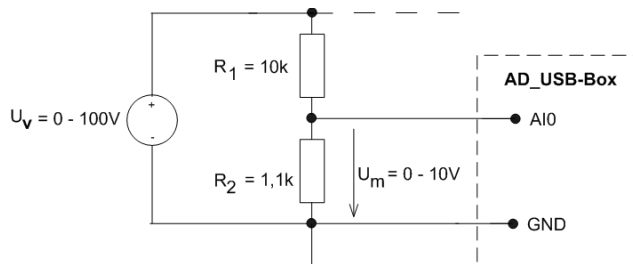


Fig. 3-3 Measuring a voltage divider

You specify R_1 (≈ 10 k Ω).

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

To prevent measurement imprecision the total resistance ($R_1 + R_2$) should be ≤ 20 k Ω .

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:

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

3.4.2 Differential voltage measurement

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

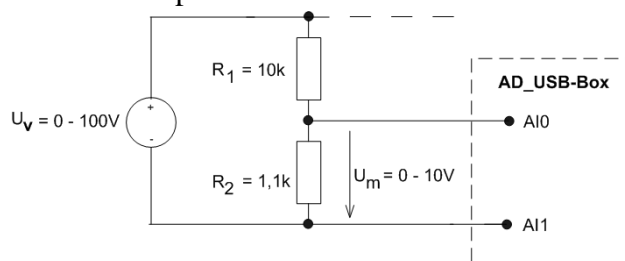


Fig. 3-4 Differential voltage measurement

In Fig. 3-4 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 (see 3.4.1 Voltage measurement).

Now determine the address AID0 with PLC-ANALYZER pro.

3.4.3 Measuring small currents

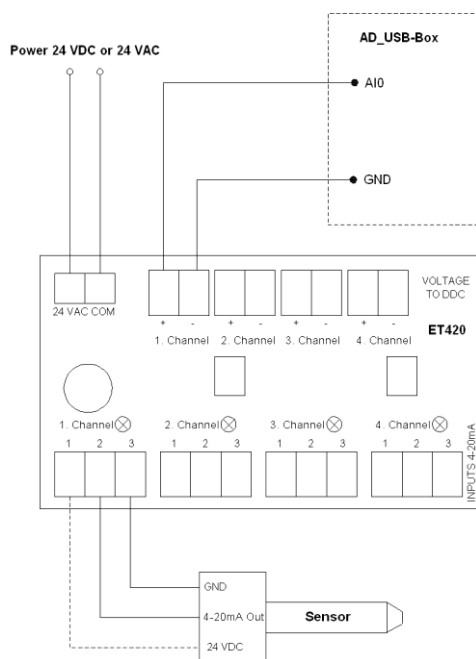


Fig. 3-5 Measuring current with ET420

Currents up to 20 mA can be measured with the 4 - 20 mA current/voltage converter ET420 (see 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.

The example in Fig. 3-5 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. AI0) 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 AI0, then the measured current is displayed correctly.

3.4.4 Measuring large currents

Currents larger than 20 mA can be measured indirectly across a shunt. Fig. 3-6 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 Ω . The voltage U_m determined when measuring makes it possible to calculate the charge current.

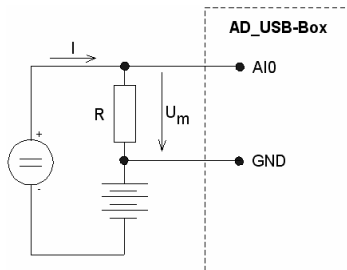


Fig. 3-6 Indirect current measurement

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

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:

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

3.4.5 Event count

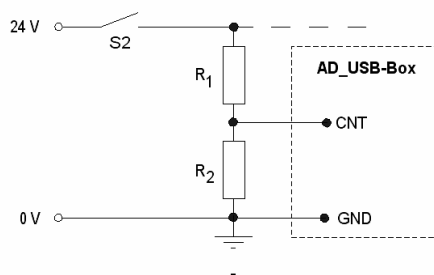


Fig. 3-7 Event count using input CNT

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.

3.4.6 Rotational speed of a turbine

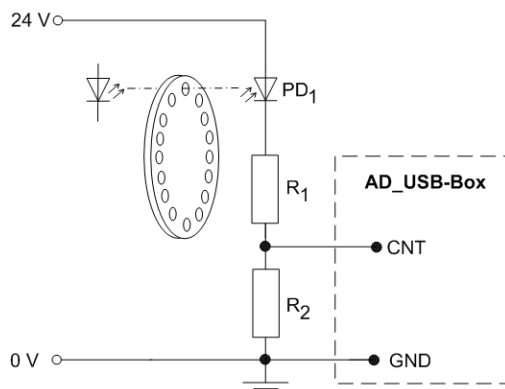


Fig. 3-8 Measurement of rotational speed

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^{-1} . The multiplier can be calculated as follows:

$$\text{Multiplier} = \frac{60}{n} \quad n = \text{number of impulses per revolution}$$

3.4.7 Digital measurement for 24-V facilities

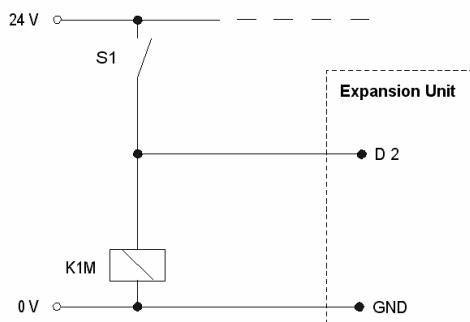


Fig. 3-9 Digital measurement for 24 V

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 PD₁.

PD₁ triggers 16 times per revolution of the turbine shaft. The 24 V switching voltage is divided by R₁/R₂ to 12 V each. The voltage across resistor R₂ 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

Fig. 3-9 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 (cf. 3.4.1 Voltage measurement).

Appendix A - Technical Data AD_USB-Box®

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

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

² The CNT counter is a Schmitt-trigger input.

Appendix B - Expansion Unit



The additional 16 digital inputs of the AD_USB-Box[®] are made easily available with the screw clamps of the Expansion Unit. The Expansion Unit also provides limited surge protection.

The green LED on the Expansion Unit is lit when the Expansion Unit is correctly connected with an active AD_USB-Box[®].

Expansion Unit for AD_USB-Box[®]



Note

Make sure that the jumpers **J0 – J15** are open during operation.

D0 - D15: The clamps for the 16 digital inputs. The input voltage in normal operation must not be more than -20 V .. +25 V from GND.

+5 V: The clamps for +5 V are connected with the clamps +5 V of the AD_USB-Box[®]. These are 5-V voltage supplies (*see 3.2.4 +5 V*). **Never connect these clamps with other voltage supplies!**

GND: The earth terminals (GND) of the Expansion Unit are connected the ground clamps (GND) of the AD_USB-Box[®].

Technical data:

- Digital inputs: Low max. 0.8 V
 High min. 3 V .. max. 25 V
- Dimensions: 102 mm x 100 mm x 35 mm

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



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 Ω (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