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Technical description

APCI-1016, APCI-1516, APCI-2016

Digital I/O boards, optically isolated

Edition: 05.12-03/2022

Product information

This manual contains the technical installation and important instructions for correct commissioning and usage, as well as production information according to the current state before printing.
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Warning!

The following risks result from the improper implementation of the board and from use contrary to the regulations:

Personal injury

Damage to the board, the PC and peripherals

Pollution of the environment.

- Protect yourself, others and the environment!
- Read the safety precautions (yellow leaflet) carefully!

  If this leaflet is not enclosed with the documentation, please contact us and ask for it.
- Observe the instructions of this manual!

  Make sure that you do not forget or skip any step!
  We are not liable for damages resulting from the wrong use of the board.
- Pay attention to the following symbols:

NOTICE!
Designates hints and other useful information.

NOTICE!
Designates a possibly dangerous situation.
If the instructions are ignored, the board, the PC and/or peripherals may be **destroyed**.

WARNING!
Designates a possibly dangerous situation.
If the instructions are ignored, the board, the PC and/or peripherals may be **destroyed** and persons may be **endangered**.

Figures

1 DEFINITION OF APPLICATION

1.1 Intended use

The boards **APCI-1016, APCI-1516** and **APCI-2016** must be inserted in a PC with PCI slots which is used as electrical equipment for measurement, control and laboratory pursuant to the standard DIN EN IEC 61010-1.

The used personal computer (PC) must fulfil the requirements of DIN EN IEC 62368-1 and DIN EN 55032 or IEC/CISPR 32 and DIN EN 55024 or IEC/CISPR 24.

The use of the boards **APCI-1016, APCI-1516** and **APCI-2016** in combination with external screw terminal panels requires correct installation according to the standard DIN EN IEC 60439-1 (Low-voltage switchgear and controlgear assemblies).

1.2 Usage restrictions

The **APCI-xx16**[1] board must not be used as a safety-related part (SRP).

The board **APCI-xx16** must not be used for safety-related functions, such as emergency stop functions.

The **APCI-xx16** board must not be used in potentially explosive atmospheres.

The **APCI-xx16** board must not be used as electrical equipment according to the Low Voltage Directive 2014/35/EU.

1.3 Limits of use

All safety information and the instructions in the manual must be followed to ensure proper intended use.

Uses of the board beyond these specifications are considered as improper use.
The manufacturer is not liable for damages resulting from improper use.

The board must remain in its anti-static packaging until it is installed.

Please do not delete the identification numbers of the board or the warranty claim will be invalid.

[1] **APCI-xx16** = **ACPI-1016, APCI-1516** and **APCI-2016**

1.4 General description of the board

Data exchange between the **APCI-xx16** board and the peripherals occurs through a shielded cable. This cable must be connected to the 37-pin D-Sub male connector of the **APCI-xx16** board.

An external 24 V supply voltage is necessary to run the output channels. The screw terminal panel **PX901** and the relay output board **PX8500** allow connecting the 24 V supply voltage through a shielded cable.

The boards are used for acquiring digital 24 V signals.

- The board **APCI-1016** has 16 digital inputs.
- The board **APCI-1516** has 8 digital inputs and 8 digital outputs.
- The board **APCI-2016** has 16 digital outputs.

The screw terminal panel **PX901** enables the digital signals to be connected to the peripherals via the cable **ST010**.

The connection with our standard cable **ST010** complies with the following specifications:

- metallised plastic hoods
- shielded cable
- cable shield folded back and firmly screwed to the connector housing.

The **functions of the boards** are to be used as follows:

Outputs (APCI-1516 and APCI-2016):
They can be read back at any time through software.
In case of overtemperature or overload, the output channels switch off. The use without misfunction is ensured through an appropriate cabling and an adapted program control.

Watchdog:
The watchdog function is particularly recommended when the output channels execute control functions. When setting up the control program, make sure that the outputs are updated at least once before a time out occurs.

Diagnosis:
The diagnosis (pin 19) is meaningful when the output channels are used for controlling. The diagnostic signals must be analysed especially in case of an increasing temperature of the site, of important charges or of charges with high starting currents. The diagnostic function is not supported by the software.

2 USER

2.1 Qualification

Only persons trained in electronics are entitled to perform the following works:

- installation
- commissioning
- use
- maintenance

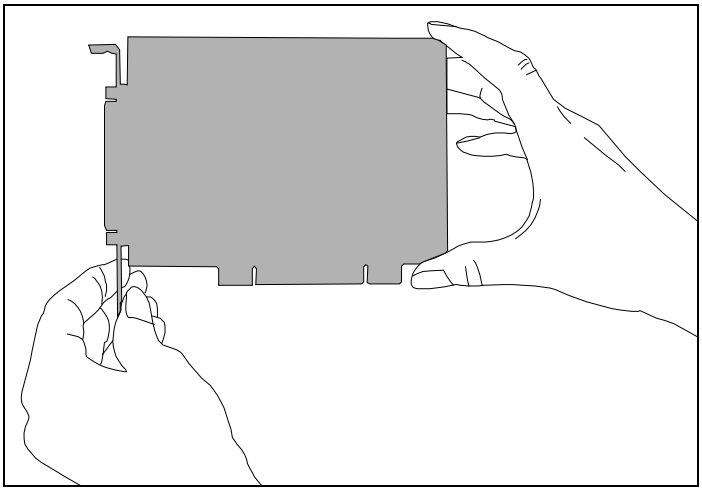
2.2 Country-specific regulations

Do observe the country-specific regulations regarding

- the prevention of accidents
- electrical and mechanical installations
- Electromagnetic compatibility (EMC).

3 HANDLING OF THE BOARD

Fig. 3-1: Correct handling



Hold the board cautiously at the outer end and at the slot bracket.
Do not touch the surface of the board!

4 TECHNICAL DATA

4.1 Electromagnetic compatibility (EMC)

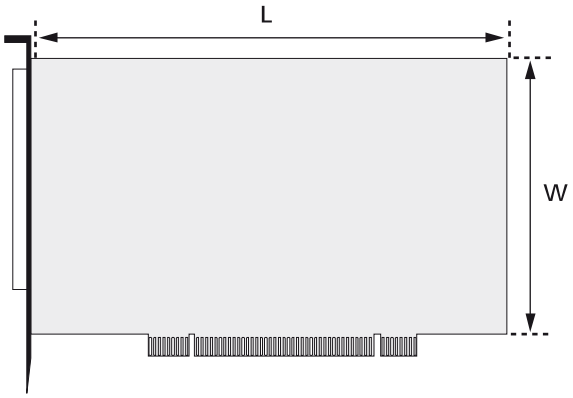
The board **APCI-xx16** is suited for installation in personal computers (PCs) which comply with the European EMC directive.

The board **APCI-xx16** complies with the European EMC directive. The tests were carried out by a certified EMC laboratory in accordance with the standard DIN EN IEC 61326-1. The limit values as set out by the European EMC directive for an industrial environment are complied with.

The respective EMC test report is available on request.

4.2 Physical set-up of the board

Dimensions:



Dimensions (L x W): ..... 131 x 99 mm
Weight: ..... approx. 160 g
Installation in: ..... 32-/64-bit PCI slot 3.3 V / 5 V
Connection to the peripherals: ..... 37-pin D-Sub male connector

Accessories[1]:
Standard cable: **ST010**
Screw terminal panel: **PX901**
Relay output board: **PX8500**

NOTICE!
The connection lines must be installed in such a way that they are protected against mechanical loads.

1 Not included in standard delivery.

4.3 Limit values

Max. height: ..... 2000 m
Operating temperature: ..... 0 to 60 °C
Storage temperature: ..... -25 to 70 °C
Relative humidity at indoor installation:
50 % at +40 °C
80 % at +31 °C

Minimum PC requirements:
Bus speed: ..... < 33 MHz
Operating system: ..... Windows 10, Windows 7, Linux

Energy requirements:
- Operating voltage from the PC: ..... 5 V ± 5 %
- Current consumption (without load): ..... typ., see table ± 10 %

	APCI-1016	APCI-1516	APCI-2016
+5 V from the PC	216 mA	220 mA	233 mA

Digital 24 V inputs (APCI-1016, APCI-1516)
Input type: ..... common ground according to DIN EN IEC 61131-2
Number of input channels: ..... 16 for the **APCI-1016**
8 for the **APCI-1516**
Nominal voltage: ..... 24 VDC
Input current at nominal voltage: ..... 6 mA
Logic input level: ..... U_H[1)] max.: 30 V
U_H min.: 19 V
U_L[2)] max.: 14 V
U_L min.: 0 V
Signal delay: ..... 70 µs (at nominal voltage)
Maximum input frequency: ..... 5 kHz (at nominal voltage)

Digital 24 V outputs (APCI-1516, APCI-2016)
Output type: ..... high-side (load to ground)
Number of outputs: ..... 8 for the **APCI-1516**
16 for the **APCI-2016**
Nominal voltage: ..... 24 VDC

[1] U_H: input voltage (= logic "1")

[2] U_L: input voltage (= logic "0")

Supply voltage range:	10 V to 36 VDC (over 24 V ext. pins)
Max. output current for all output channels:	3 A typ. (fused through PTC resistors)
Max. output current / output channel:	500 mA
Short-circuit current / output channel at 24 V, R_{load} < 0.1 R:	1.5 A max. (switches off the output channel)
ON resistor of the output channel (R_{DS} ON resistor):	0.4 Ω max.
Overtemperature:	170 °C (switches off the component, i.e. the outputs)
Temperature hysteresis:	20 °C
Switch ON time at 24 V, R_{load} 500 mA: ...	100 µs typ.
Switch OFF time at 24 V, R_{load} 500 mA: .	60 µs typ.

Safety

Optical isolation:	1000 V (from the PC to the external peripherals)
Logic:	positive

APCI-1516 and APCI-2016:

24 V failure or drop under 5 V min.:	The output channels are switched off.
Watchdog:	resets all outputs if no software trigger
.....	has occurred
.....	Times from 20 ms to 5 s in steps
.....	of 20 ms are available.
Diagnosis:	The transistor output switches off at overtemperature or overload.

5 INSTALLATION OF THE BOARD

Risk of injury!
Be sure to follow the safety precautions!
Improper use of the board may lead to property damage and personal injury.

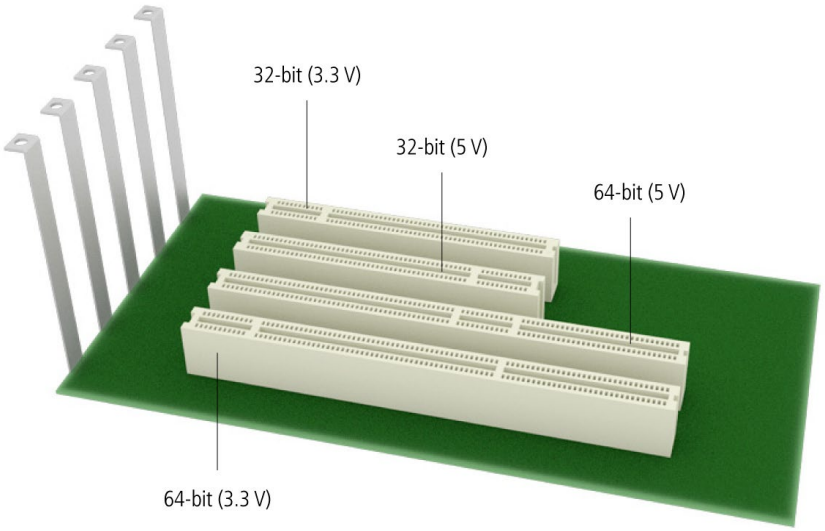
5.1 Opening the PC

- ♦ Switch off your PC and all the units connected to it.
- ♦ Pull the PC mains plug from the socket.
- ♦ Open your PC as described in the manual of the PC manufacturer.

5.2 Selecting a slot

- ♦ Select a free 32-/64-bit PCI slot (3.3 V or 5 V) for the board.

Fig. 5-1: PCI slot types

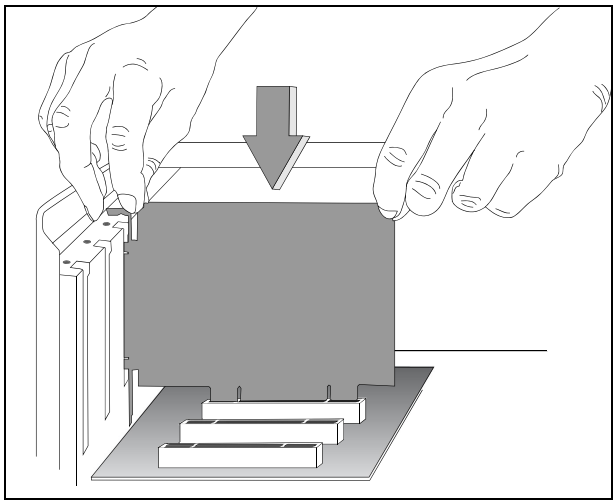


- ♦ Unscrew the back cover from the selected slot. For this, follow the operating instructions provided by the PC manufacturer!
  Keep the back cover in a safe place. You will need it if you remove the board.
- ♦ Provide for potential equalisation.
- ♦ Take the board out of its protective packaging.

5.3 Inserting the board

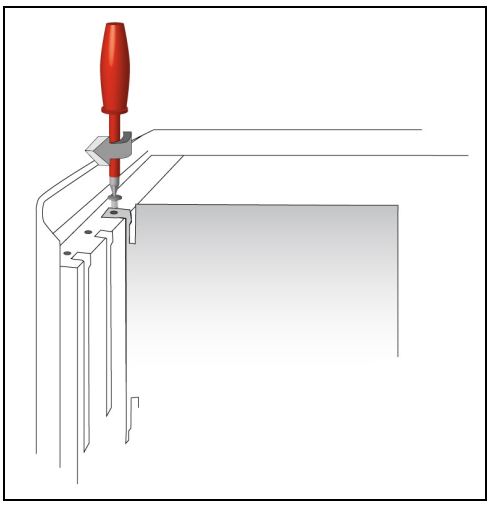
♦ Insert the board vertically from above into the selected slot.

Fig. 5-2: Inserting the board



♦ Fasten the board to the rear of the PC housing with the screw which was fixed on the back cover.

Fig. 5-3: Fastening the board at the back cover



♦ Tighten all loose screws.

5.4 Closing the PC

♦ Close your PC as described in the manual of the PC manufacturer.

6 DRIVER INSTALLATION

Information on how to select and download the appropriate driver can be found in the document “Quick installation PC boards” (see PDF link).

The installation of drivers of the type “ADDI-DATA Multiarchitecture Device Drivers 32-/64-Bit for x86/AMD64” as well as the installation of the corresponding samples is described in the installation instructions (see PDF link).

6.1 Questions and updates

If you have any questions, do not hesitate to call us or to send us an e-mail:

Phone: +49 7229 1847-0
E-mail: info@addi-data.com

Manual and software download from the Internet

The latest versions of the technical manual and the standard software for the board **APCI-xx16** can be downloaded for free at: https://drivers.addi-data.com.

NOTICE!
Before using the board and in case of malfunction during operation, check if there is an update (manual, driver) available. Current data can be found on our website or contact us directly.

7 CONNECTING THE PERIPHERALS

7.1 Pin assignment

Fig. 7-1: Pin assignment: APCI-1516

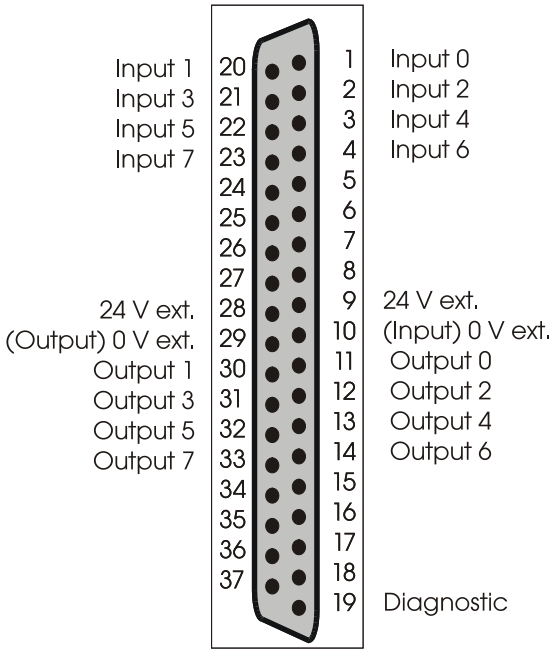


Fig. 7-2: Pin assignment: APCI-1016

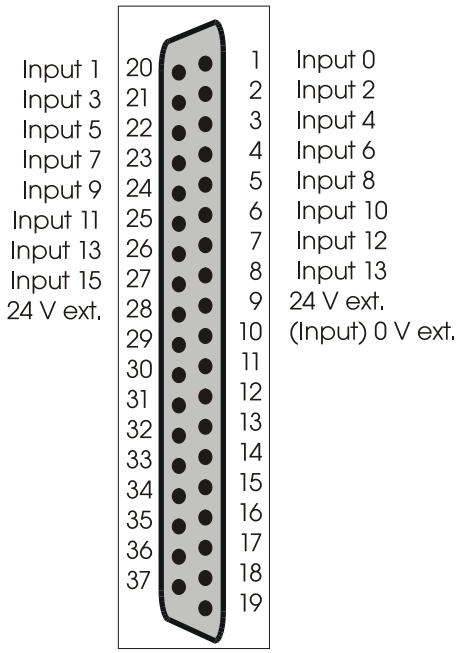
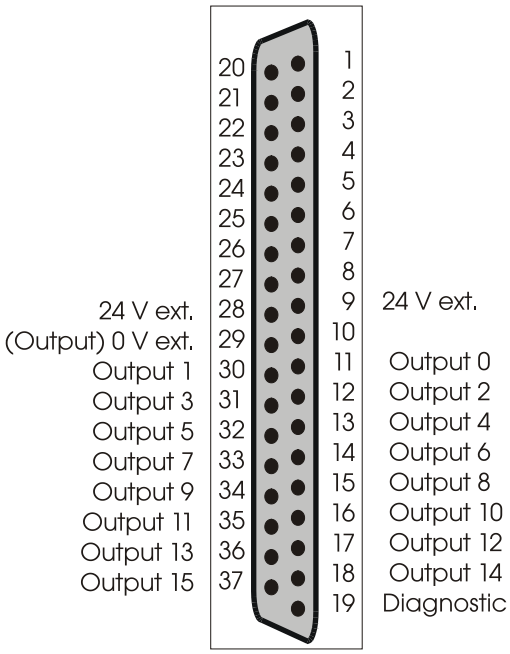


Fig. 7-3: Pin assignment: APCI-2016



7.2 Connection principle

Fig. 7-4: Connection principle of the digital inputs

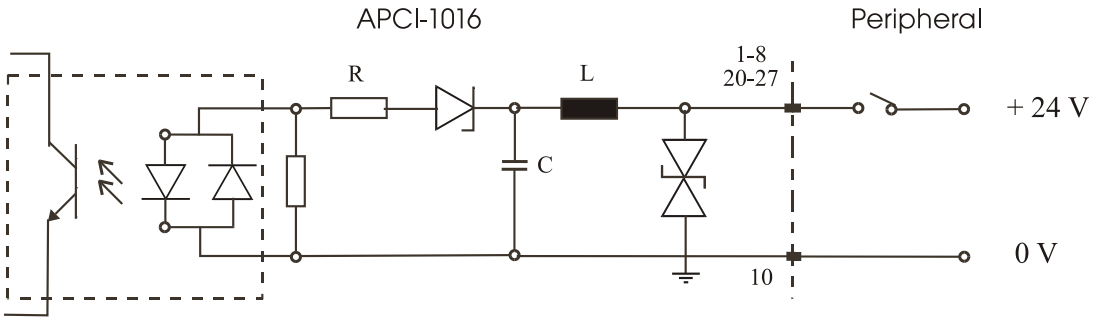


Fig. 7-5: Connection principle of the digital inputs and outputs

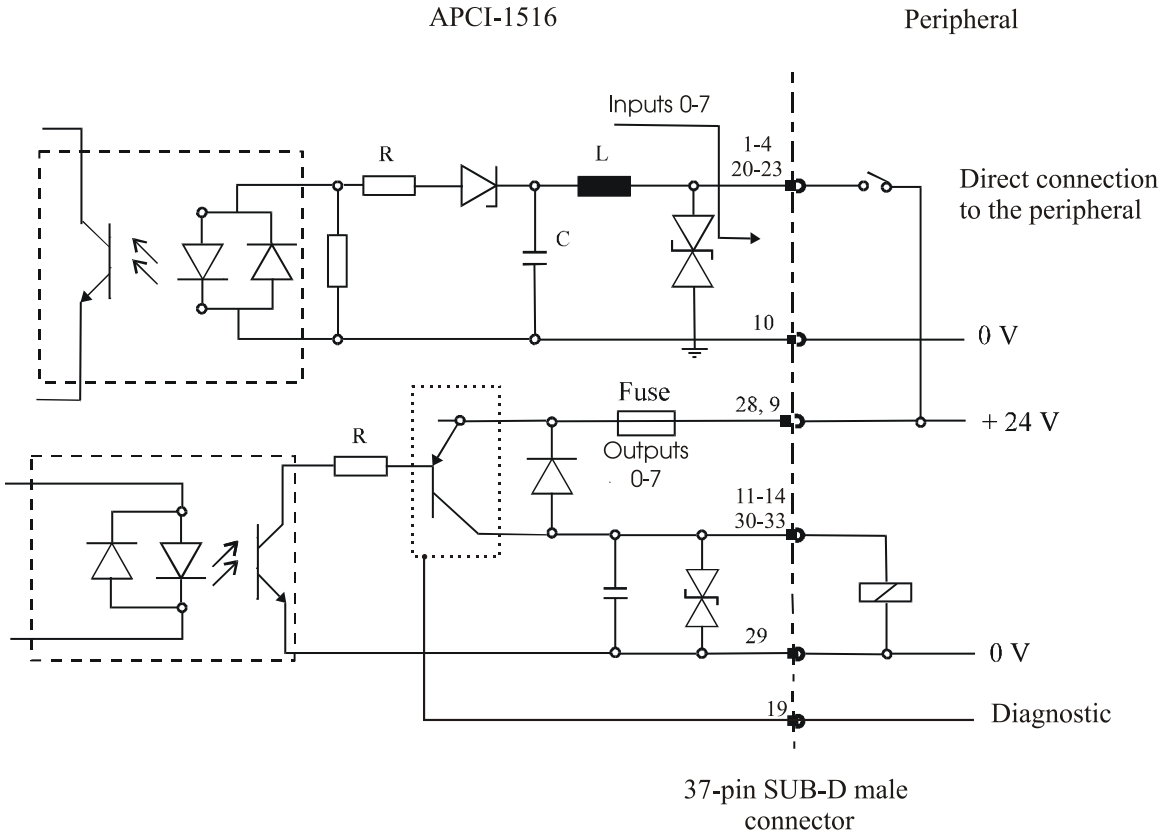
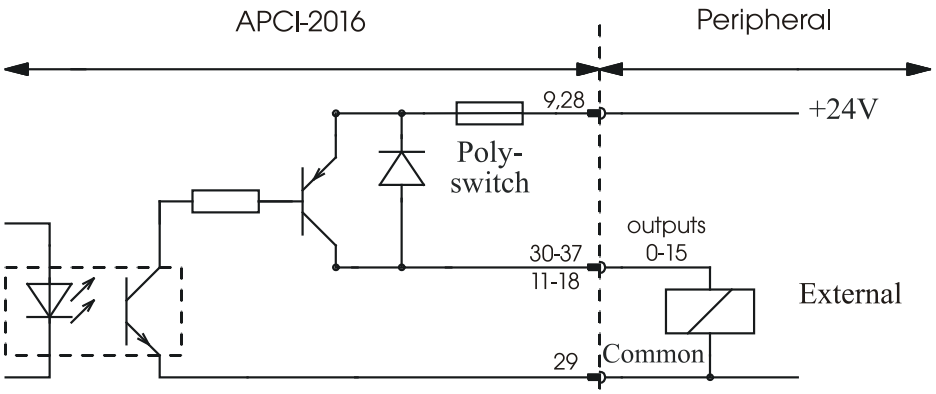


Fig. 7-6: Connection principle of the digital outputs



7.3 Connection examples

Fig. 7-7: Connection example: APCI-1016

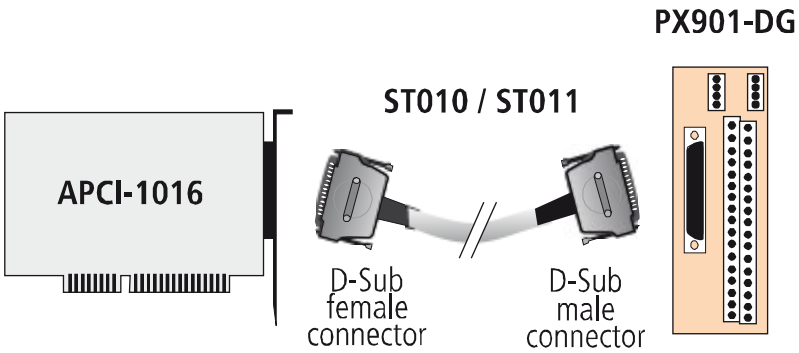
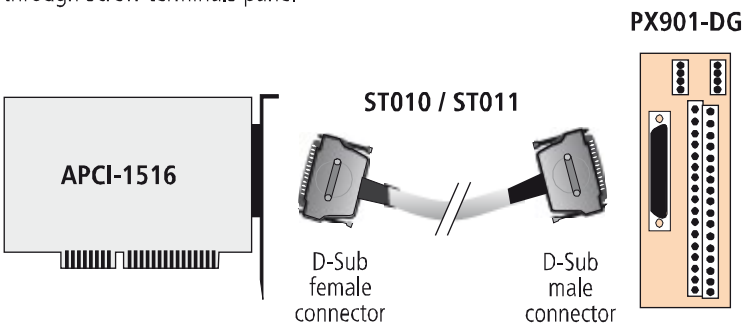


Fig. 7-8: Connection example: APCI-1516

Example 1
Connection of the inputs and outputs
through screw terminals panel



Example 2
- Connection of the inputs
  through screw terminal panel **PX901-DG**
- Connection of the outputs
  through relay output board **PX8500-G**

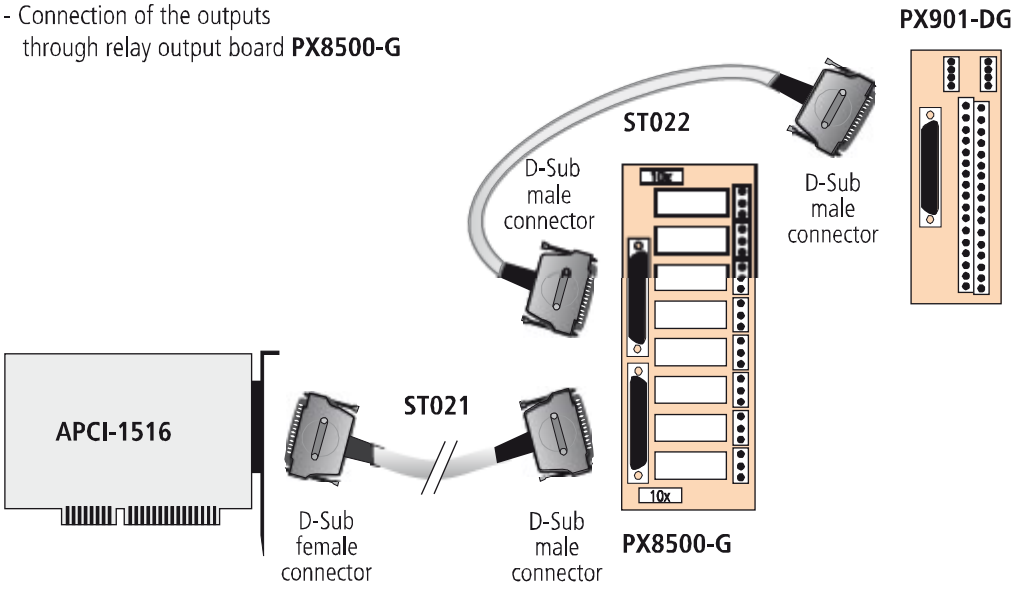
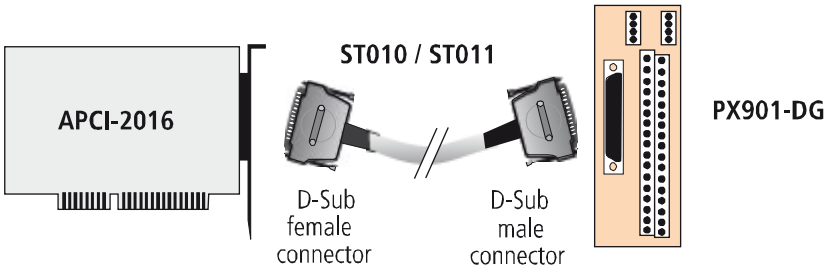
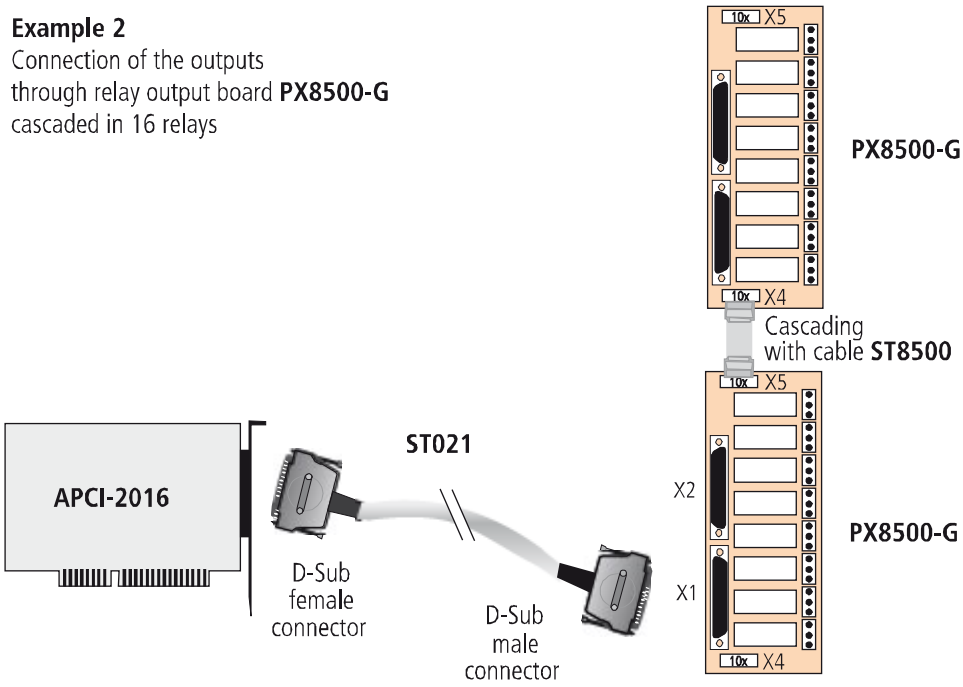


Fig. 7-9: Connection example of the APCI-2016

Example 1
Connection of the outputs through screw terminal panel



Example 2
Connection of the outputs through relay output board **PX8500-G** cascaded in 16 relays



8 FUNCTIONS OF THE BOARDS

8.1.1 Block diagrams

Fig. 8-1: Block diagram: APCI-1016

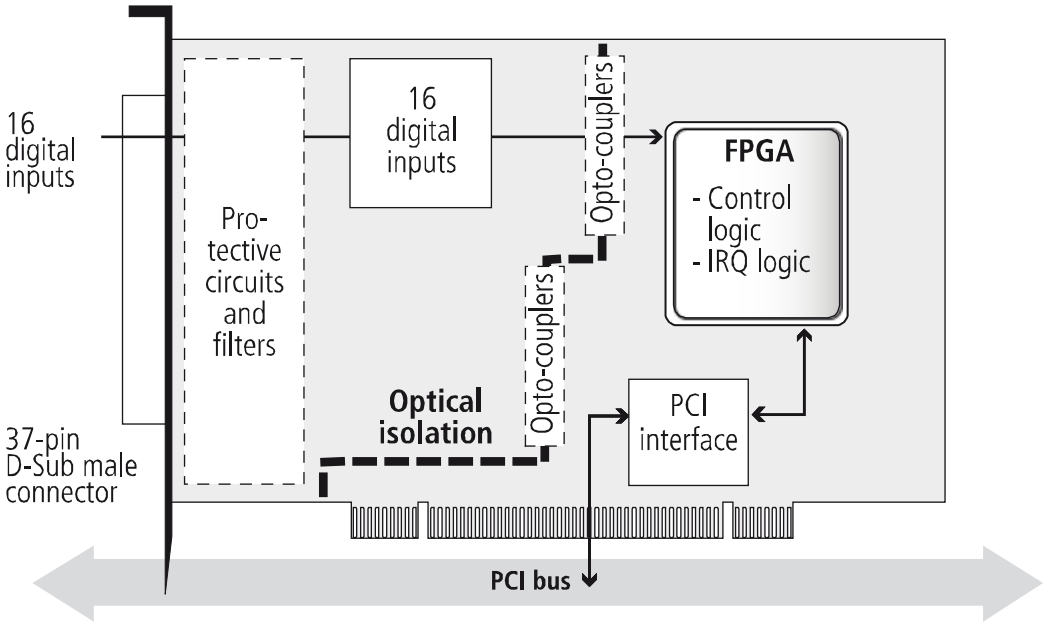


Fig. 8-2: Block diagram: APCI-1516

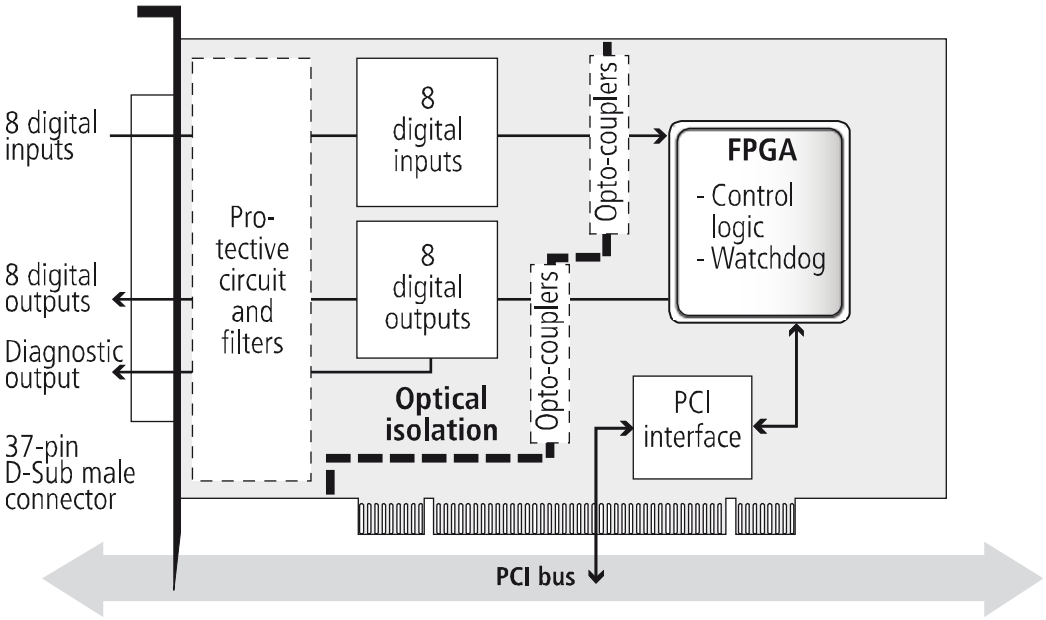
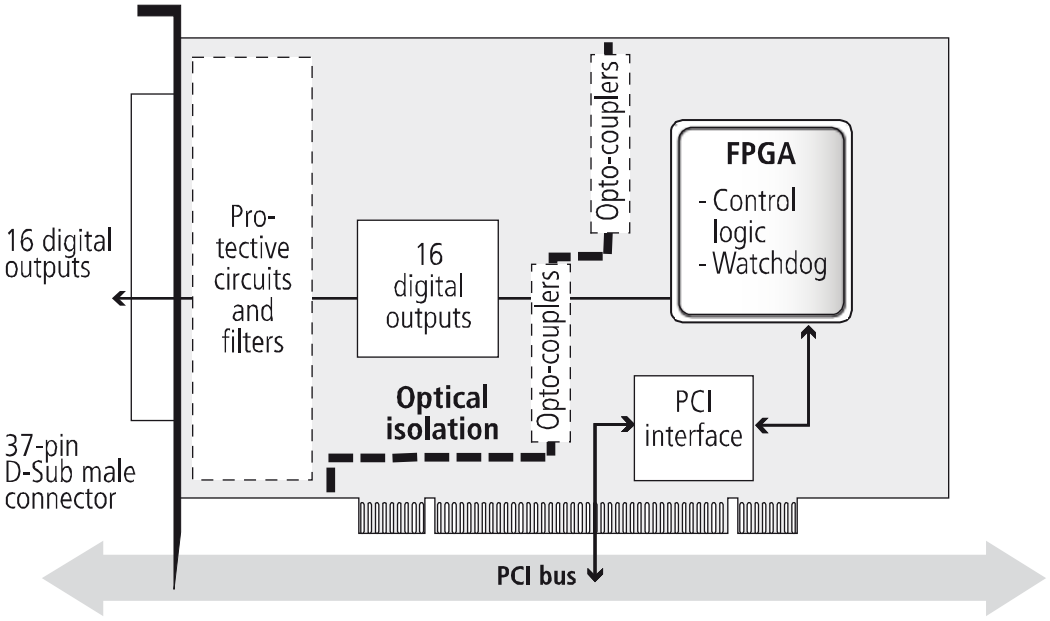


Fig. 8-3: Block diagram: APCI-2016



8.2 Description of the board

The boards are intended for parallel input (**APCI-1016** and **APCI-1516**) and/or parallel output (**APCI-1516** and **APCI-2016**) for digital signals in 24 V industrial environment. The peripherals and the system have a simultaneous optical isolation.

On the **APCI-1016** are available:
- 16 digital inputs.

On the **APCI-1516** are available:
- 8 digital inputs
- 8 digital outputs; can be read back
- short-circuit protection relating to GND
- protection against overtemperature
- small ON resistor
- wide supply voltage range
- diagnosis and watchdog (16-bit access) for the output channels.

On the **APCI-2016** are available:
- 16 digital outputs, can be read back
- short-circuit protection relating to GND
- protection against overtemperature
- small ON resistor
- wide supply voltage range
- diagnosis and watchdog (16-bit access)

For all boards:
The base address is automatically set through the BIOS.
EMC: design in accordance with CE regulations.

8.3 Functions

8.3.1 Digital inputs

The board **APCI-1016** has 16 optically isolated inputs and the board **APCI-1516** has 8 isolated inputs.
The inputs comply with the 24 V industry standard (DIN EN IEC 61131-2):

- logic "1" corresponds to an input voltage ≥ 19 V
- logic "0" corresponds to an input voltage ≤ 14 V.

All inputs have a common current ground: 0 V Ext. (inputs), pin 10 of the 37-pin D-Sub male connector.

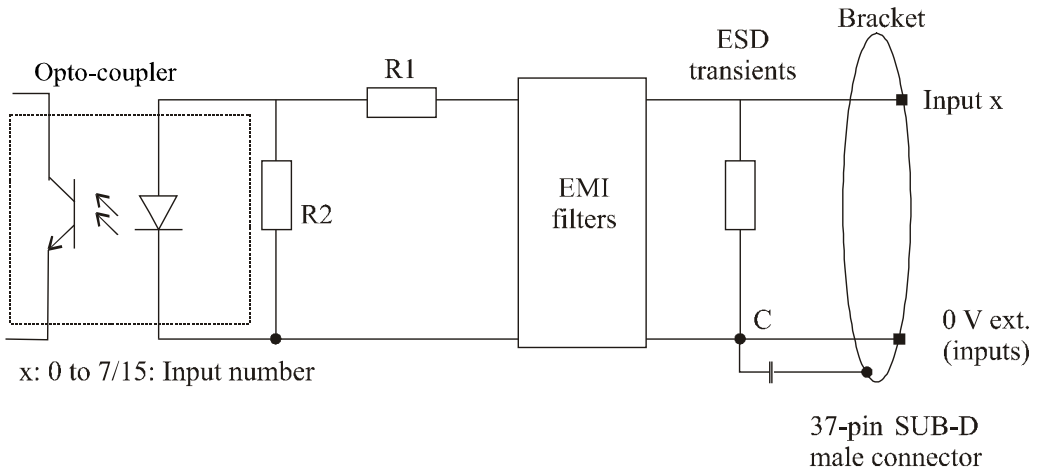
The current input is at 6 mA with a nominal voltage of 24 V. The maximum input voltage is 30 V.

NOTICE!
If you operate all inputs with the same voltage supply, this must deliver at least 16 x 6 = 96 mA.

TVS diodes, Z diodes, C filters and opto-couplers protect the system bus from noise emitted by the peripherals. The effects of inductive and capacitive noise are thus reduced.

The board requires no initialisation to read the digital 24 V information.
After successful power-on (reset), data is immediately available on the board.

Fig. 8-4: Protective circuit of the inputs



8.3.2 Digital outputs

The board **APCI-1516** has 8 optically isolated outputs and the board **APCI-2016** has 16 isolated outputs. The outputs comply with the 24 V industry standard (DIN EN IEC 61131-2).

Positive logic is used
- logic "1": sets the output via software (switch set to ON)
- logic "0": resets the output (switch set to OFF).

The outputs switch the **+24 V Ext.** outside to the load. One end of the load is connected to the ground of 0 V EXT (outputs). All outputs have a common ground line: 0V Ext. (outputs) at the 37-pin D-Sub male connector.

NOTICE!
If you use all outputs with the same voltage supply, the voltage supply must deliver at least the power required for your application.

The maximum supply voltage is 36 V. Each output can switch a current of 500 mA. The current for all outputs is limited to approx. 3 A by a polyswitch fuse element.

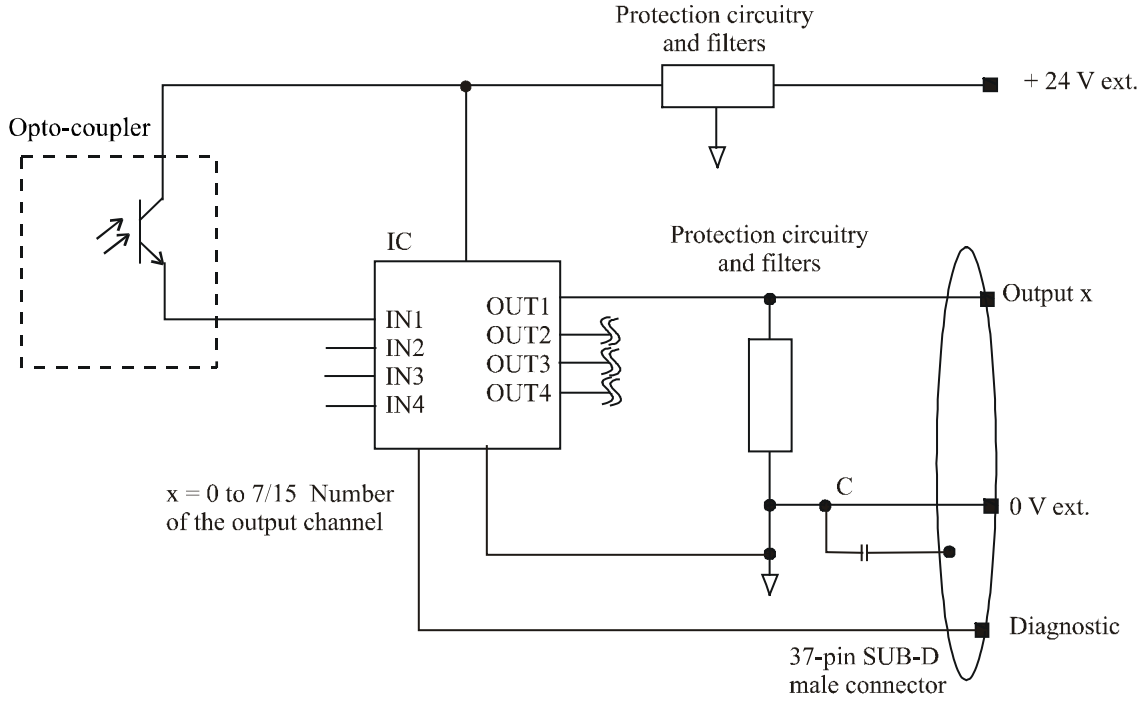
Features of the outputs:
- Short-circuit protection relating to GND. The output is switched off.
- Protection against overtemperature: shut-down logic. Each group of 4 outputs is switched off: 0 to 3, 4 to 7, 8 to 11, 12 to 15.
- The outputs are switched off if the supply voltage drops.
- Diagnostic report in case of short-circuit or overtemperature.

TVS diodes, C filters and opto-couplers filter noise from the peripherals to the system bus. Thus, the effects of inductive and capacitive noise are reduced. Possible noise emissions are also reduced by C filters.

The board requires no initialisation to output the digital 24 V information. You can program the outputs immediately after successful power-on (reset). **State after power-on (reset):** All outputs are reset (switch set to OFF).

Diagnosis:
There is a diagnostic function at pin 19 of the boards **APCI-2016** and **APCI-1516** (not via software). At short-circuit or overtemperature at pin 19, a clocked 24 V voltage is output (approx. 400 Hz). The sampling ratio depends on the time of overload.

Fig. 8-5: Protective circuit of the outputs



8.3.3 Watchdog

The watchdog is a downward counter which resets the digital outputs after the reload value has run down (time out).

Three different states are available for the watchdog function:

"OFF" The watchdog is switched off. It has no influence on the output states.

"ON" The watchdog has been switched on by a trigger command (software trigger or function "b_ADDIDATA_SetxxDigitalOutputsOn").
It now monitors the program flow and influences the output states when there is a time out.

"Alarm" The watchdog sets an alarm by resetting all outputs.

The operating states can be read back.

9 STANDARD SOFTWARE

The API software functions supported by the board are listed in an HTML document. A description of how to access the respective file can be found in the document “Quick installation PC boards” (see PDF link), in the chapter “Standard software”.

10 RETURN OR DISPOSAL

10.1 Return

If you need to return your board, you should read the following checklist before.

Checklist for returning the board:

- Specify the reason for returning your board (e.g. exchange, modification, repair), the serial number of the board, the contact person in your company including his/her telephone extension and e-mail address, as well as the mailing address for a potential new delivery. You do not have to indicate the RMA number.

Fig. 10-1: Serial number

- Note down the serial number of the board.
- Place the board in an ESD protective cover. Then pack it in a cardboard box so that it is well-protected for shipping. Send the packed board together with your details to:

  ADDI-DATA GmbH
  Airpark Business Center
  Airport Boulevard B210
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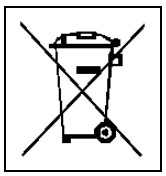
10.2 Disposal of ADDI-DATA waste equipment

ADDI-DATA organises the disposal of ADDI-DATA products that were put on the German market after 13 August 2005.
If you want to return waste equipment, please e-mail your request to:
info@addi-data.com.

Boards that were delivered after 13 August 2005 can be recognised by the following label:

Fig. 10-2: Disposal: Label



This symbol indicates the disposal of waste electrical and electronic equipment. It is valid in the European Union and in other European countries that have a separate collection system. Products carrying this symbol must not be treated as household waste.
For more detailed information on the recycling of these products, please contact your local citizens' office, your household waste collection service, the shop where you bought this product or the distributor you purchased this product from.

If you dispose of this product correctly, you will help to prevent damage that could be caused to the environment and to human health by inappropriate disposal.
The recycling of materials will help to conserve our natural resources.

Disposal in other countries than Germany
Please dispose of the product according to the country-specific regulations.

11 APPENDIX

11.1 Glossary

Table 11-1: Glossary

Term	Description
A/D converter	= *ADC* An electronic device that produces a digital output directly proportional to an analog signal output.
Acquisition	The process by which data is gathered by the computer for analysis or storage.
Analog	Continuous real time phenomena
Bus	The group of conductors that interconnect individual circuitry in a computer. Typically, a bus is the expansion vehicle to which I/O or other devices are connected. Examples of PC buses are PCI, PC Card (PCMCIA), ISA (AT), and EISA bus.
Clock	A circuit that generates time and clock pulses for the synchronisation of the conversion
Creeping distance	In order to avoid the danger of the effects of electrical voltages and currents for electrical-mechanical components, it is required to keep minimum isolation distances. The creeping distance is the shortest distance alongside of an isolation surface between two reference points (contact elements).
D/A converter	= *DAC* A device that converts digital information into a corresponding analog voltage or current.
Data acquisition	Gathering information from sources such as sensors and transducers in an accurate, timely and organized manner. Modern systems convert this information to digital data which can be stored and processed by a computer.
DC voltage	= *Direct current voltage* DC voltage means that the voltage is constant respecting the time. It will always fluctuate slightly. Especially at switching on and switching off the transition behaviour is of high significance.
Digital signal	A signal which has distinct states. Digital computers process data as binary information having either 1 or 0 states.
Disturb signal	Interferences that occur during the transfer caused by reduced bandwidth, attenuation, gain, noise, delay time etc.
Driver	A part of the software that is used to control a specific hardware device such as a data acquisition board or a printer.
FIFO	= *First In First Out* The first data into the buffer is the first data out of the buffer.
Gain	The factor by which an incoming signal is multiplied.
Ground	A common reference point for an electrical system.
Impedance	The reciprocal of admittance. Admittance is the complex ratio of the voltage across divided by the current flowing through a device, circuit element, or network.

Term	Description
Inductive loads	The voltage over the inductor is U=L.(dI/dt), whereas L is the inductivity and I is the current. If the current is switched on fast, the voltage over the load can become very highly for a short time.
Input impedance	The measured resistance and capacitance between the high and low inputs of a circuit.
Input level	The input level is the logarithmic relation of two electric units of the same type (voltage, current or power) at the signal input of any receive device. The receive device is often a logic level that refers to the input of the switch. The input voltage that corresponds with logic "0" is here between 0 and 15 V, and the one that corresponds with logic "1" is between 17 and 30 V.
Instrumentation amplifier	= *IA* Instrumentation amplifiers (IA) are precise measuring amplifiers with high input impedance, low output impedance, significantly high common-mode suppression and adjustable gain with high continuity respecting the time.
Interrupt	A signal to the CPU indicating that the board detected the occurrence of a specified condition or event.
Level	Logic levels are defined in order to process or show information. In binary circuits voltages are used for digital units. Only two voltage ranges represent information. These ranges are defined with H (High) and L (Low). H represents the range that is closer to Plus infinite; the H level is the digital 1. L represents the range that is closer to Minus infinite; the L level is the digital 0. The rising edge is the transition from the 0-state to the 1-state and the falling edge is the transition from the 1-state to the 0-state.
Limit value	Exceeding the limit values, even for just a short time, can lead to the destruction or to a loss of functionality.
MUX	= *Multiplexer* An array of semiconductor or electromechanical switches with a common output used for selecting one of a number of input signals.
Noise immunity	Noise immunity is the ability of a device to work during an electromagnetic interference without reduced functions.
Noise suppression	The suppression of undesirable electrical interferences to a signal. Sources of noise include the ac power line, motors, generators, transformers, fluorescent lights, CRT displays, computers, electrical storms, welders, radio transmitters, and others.
Operating voltage	The operating voltage is the voltage that occurs during the continuous operation of the device. It may not exceed the continuous limit voltage. Furthermore, any negative operation situations, such as net overvoltages over one minute at switching on the device must be taken in consideration.
Optical isolation	The technique of using an optoelectric transmitter and receiver to transfer data without electrical continuity, to eliminate high-potential differences and transients.
Opto-coupler	With an opto-coupler direct current voltage can be transferred. The advantage is the small size.
Output current	The maximum amount of current the sensor can supply across the output signal, expressed as amps DC (A DC).

Term	Description
Output voltage	The nominal voltage output reading when shaft is rotated to full range, expressed in volts DC /Vo DC)
Parameter	The parameters of a control comprise all for the control process required numeric values, e.g. for limit values and technological number.
PCI bus	PCI bus is a fast local bus with a clock rate up to 33 MHz. This bus is used for processing a great number of data. The PCI bus is not limited like the ISA and EISA systems.
PLD	= *Programmable Logic Device* Prorammable logic circuitry
Protective circuitry	A protective circuitry of the active part is done in order to protect the control electronic. The simplest protective circuitry is the parallel switching of a resistance.
Reference voltage	Reference voltages are stable voltages that are used as reference unit. From them voltages can be derived that are required for example in current supplies and in other electronic circuitries.
Resolution	The smallest significant number to which a measurement can be determined. For example, a converter with 12-bit resolution can resolve 1 part in 4096.
Sensor	A device that responds to physical stimuli (heat, light, sound, pressure, motion, etc.) and produces a corresponding electrical output.
Settling time	The time required, after application of a step input signal, for the output voltage to settle and remain within a specified error band around the final value. The settling time of a system includes that of all of the components of the system.
Signal delay	The change of a signal affects the following circuitries with finite velocity; the signal will be delayed. Besides the signal delay times that are not wanted, the signal delay can be extended by time switches and delay lines.
Synchronous	In hardware, it is an event that occurs in a fixed time relationship to another event. In software, it refers to a function that begins an operation and returns to the calling program only when the operation is complete.
Throughput rate	The maximum repetitive rate at which data conversion system can operate with a specified accuracy. It is determined by summing the various times required for each part of the system and then by taking the inverse of this time.
Timer	The timer allows the adaptation of program processes between processor and peripheral devices. It usually contains from each other independent counters and can be programmed for several operation types over a control word register.
Diagnostic program	A utility program used to isolate hardware malfunctions on-board, or software malfunctions in the program.

11.2 Index