ADDI-DATA®
PARTNER FÜR PRÄZISION

Technical Description

APCIe-1500

Digital I/O board, optically isolated

DIN EN ISO 9001:2015 certified

Edition: 02.03-03/2022

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**.

Contents

Figures

Tables

Chapter overview

In this manual, you will find the following information:

Chapter	Content
1	Important information on the application, the user and on handling the board
2	Brief description of the board (features, block diagram)
3	Detailed information on the insertion of the board, connection of the accessories (including pin assignment) and driver installation **Tip:** Print out this chapter to have help at hand for inserting and installing the board.
4	Description of the individual functions of the board
5	Standard software: Information on the API software functions
6	Procedure for returning (repairing, etc.) or disposing of the board
7	List of technical data and limit values of the board
8	Appendix with glossary and index
9	Contact and support address

1 Definition of application, user, handling

1.1 Definition of application

1.1.1 Intended use

The board **APCIe-1500** must be inserted in a personal computer (PC) with PCI Express 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 board **APCIe-1500** in combination with external screw terminal panels requires correct installation according to the standard DIN EN IEC 61439-1 (Low-voltage switchgear and controlgear assemblies).

1.1.2 Usage restrictions

The **APCIe-1500** board must not be used as a safety-related part (SRP).

The board **APCIe-1500** must not be used for safety-related functions, such as emergency stop functions.

The **APCIe-1500** board must not be used in potentially explosive atmospheres.

The **APCIe-1500** board must not be used as electrical equipment according to the Low Voltage Directive 2014/35/EU.

1.1.3 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.

1.2 User

1.2.1 Qualification

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

- Installation
- Commissioning
- Use
- Maintenance.

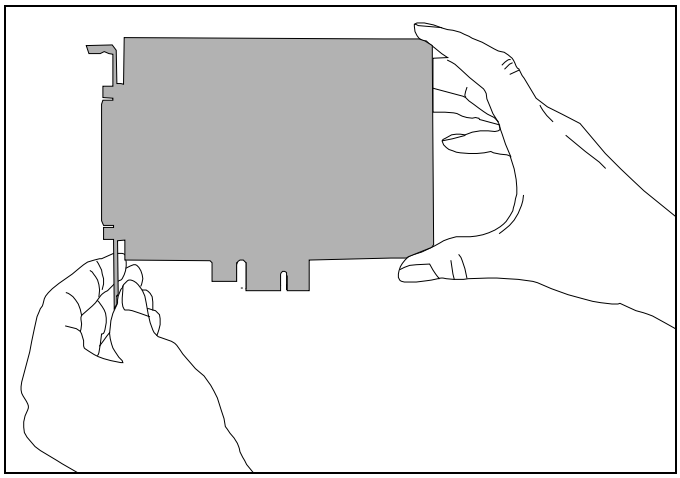
1.2.2 Country-specific regulations

Do observe the country-specific regulations regarding

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

1.3 Handling of the board

Fig. 1-1: Correct handling



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

1.4 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 **APCIe-1500** 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.

2 Brief description

2.1 Technical features

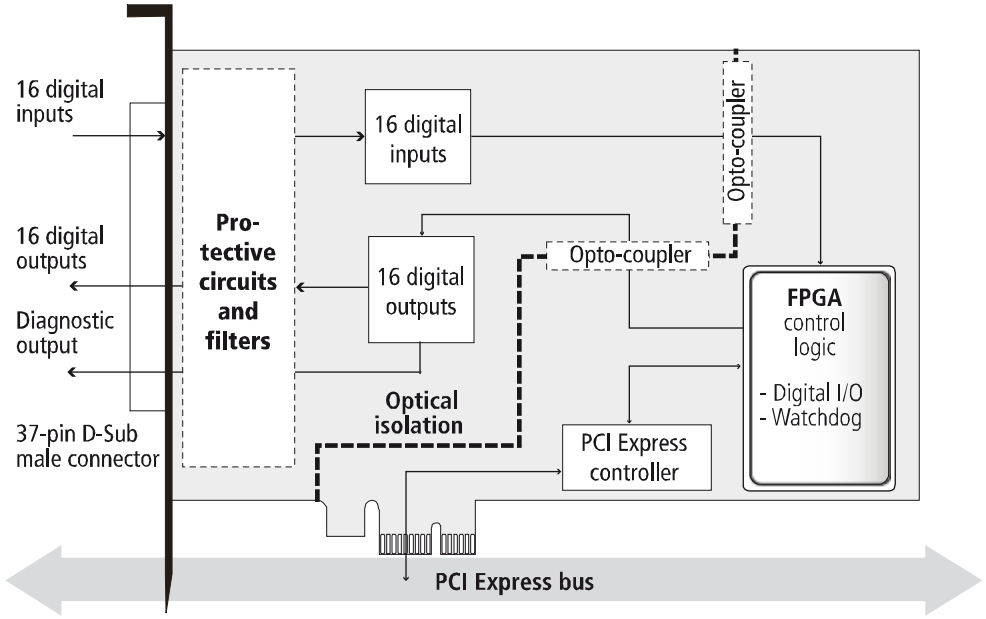
Technical features	APCIe-1500
Digital inputs (24 V or 12 V)	16
Interruptible inputs	14
Digital outputs (11-36 V)	16
Counter (16-bit)	3
Timer (16-bit)	2 (counters 1 and 2)
Watchdog (16-bit)	1 (counter 3)

Other features:

- Input and output filters
- Inputs: Reverse polarity protection
- Outputs: Shutdown logic when the external 24 V supply voltage drops below 7 V
- Watchdog for resetting the outputs to "0" (these are set to "0" at power-on)
- Optical isolation
- Separate ground line for inputs and outputs
- Overtemperature and overvoltage protection
- Protection against fast transients (burst), electrostatic discharge and high-frequency EMI
- **APCIe-1500-FC:** Fast counter inputs with filters

2.2 Block diagrams

Fig. 2-1: APCIe-1500: Block diagram



3 Insertion and installation of the board

3.1 Insertion 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.

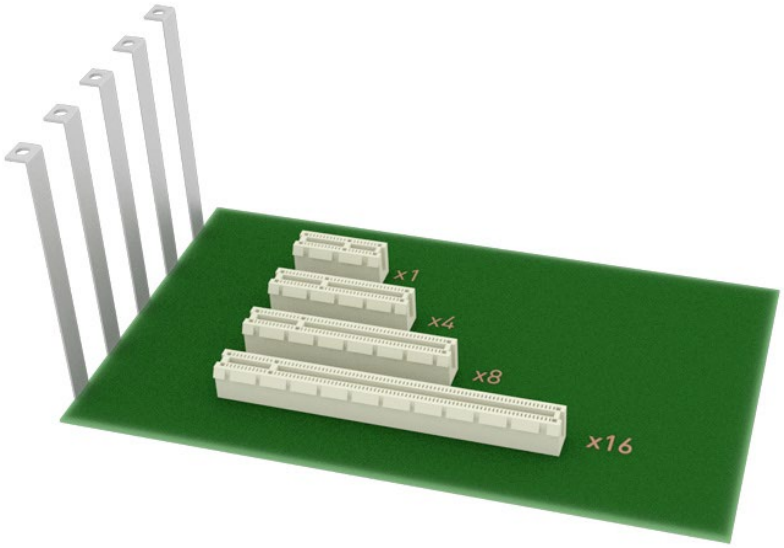
3.1.1 Opening the PC

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

3.1.2 Selecting a slot

- Select a free 1-lane (x1), 4-lane (x4), 8-lane (x8) or 16-lane (x16) PCI-Express slot for the board.

Fig. 3-1: PCI Express slot types

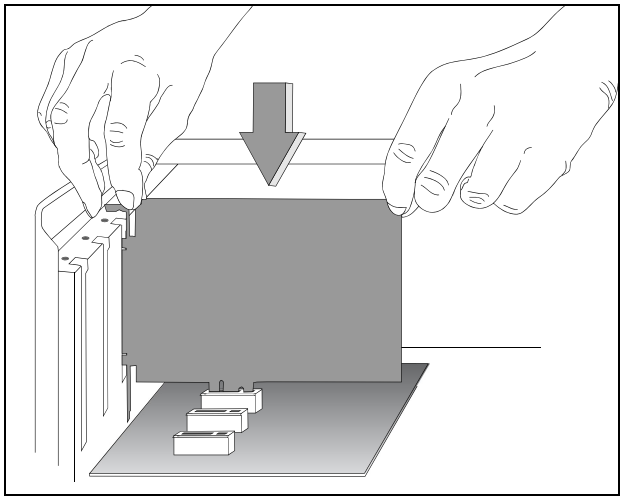


- Unscrew the back cover from the selected slot. For this, follow the operating instructions provided by the PC manufacturer!
  Keep the back cover in a safe place. You will need it if you remove the board.
- Provide for potential equalisation.
- Take the board out of its protective packaging.

3.1.3 Inserting the board

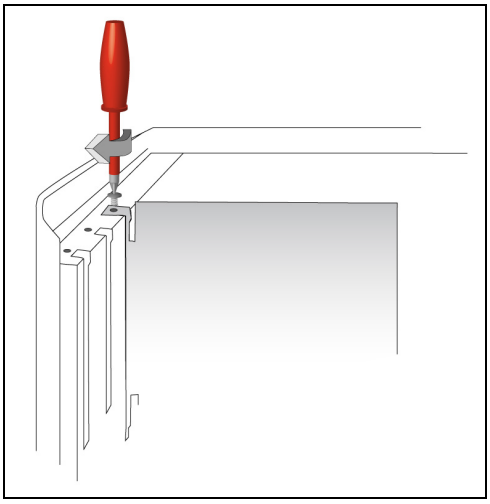
- Insert the board vertically from above into the selected slot.

Fig. 3-2: Slot: Insert the board



- Fasten the board to the rear of the PC housing using the screw which held the back cover in place.

Fig. 3-3: PC housing: Fasten the board



- Tighten all loose screws.

3.1.4 Closing the PC

- Close the PC as described in the manual of the PC manufacturer.

3.2 Connecting the accessories

3.2.1 Connection of the screw terminal panel

Between the board **APCIe-1500** and the peripherals, digital signals are exchanged via the screw terminal panel **PX901-DG** or the relay output board **PX8500-G** and the cable **ST010** or **ST011,** or **ST021**, which needs to be connected to the 37-pin D-Sub connector of the board. In terms of electromagnetic compatibility (EMC), these cables have the following properties:

- Metallised connector housing
- Shielded cable
- Cable shield folded back over insulation and firmly screwed on both sides to the connector housing.

To operate the digital outputs of the board, an external supply voltage is required. The screw terminal panel **PX901-DG** and the relay output board **PX8500-G** enable this supply voltage to be connected.

Fig. 3-4: Connection of the screw terminal panel PX901-DG

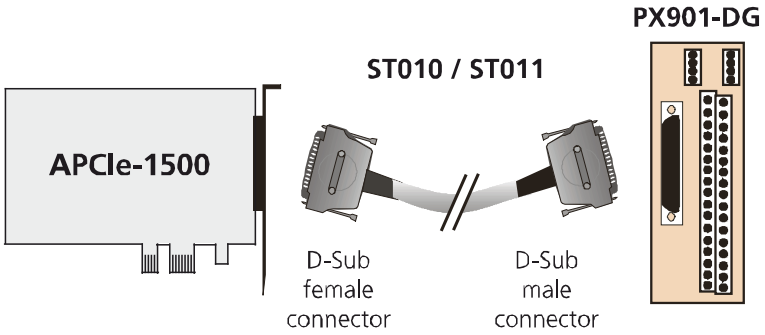
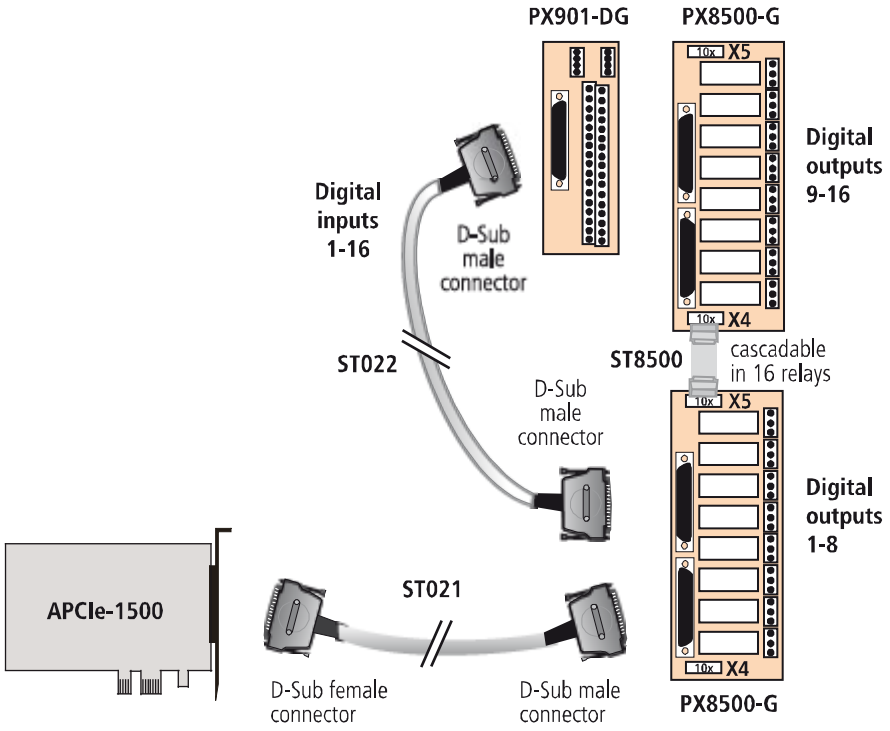
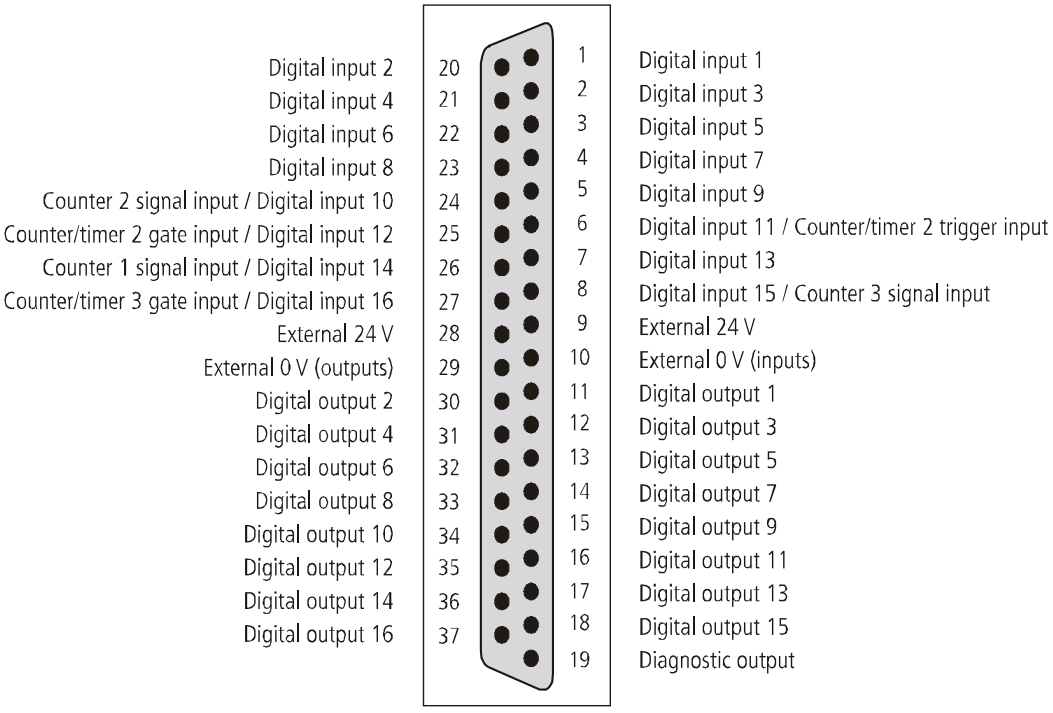


Fig. 3-5: Connection of the relay output board PX8500-G



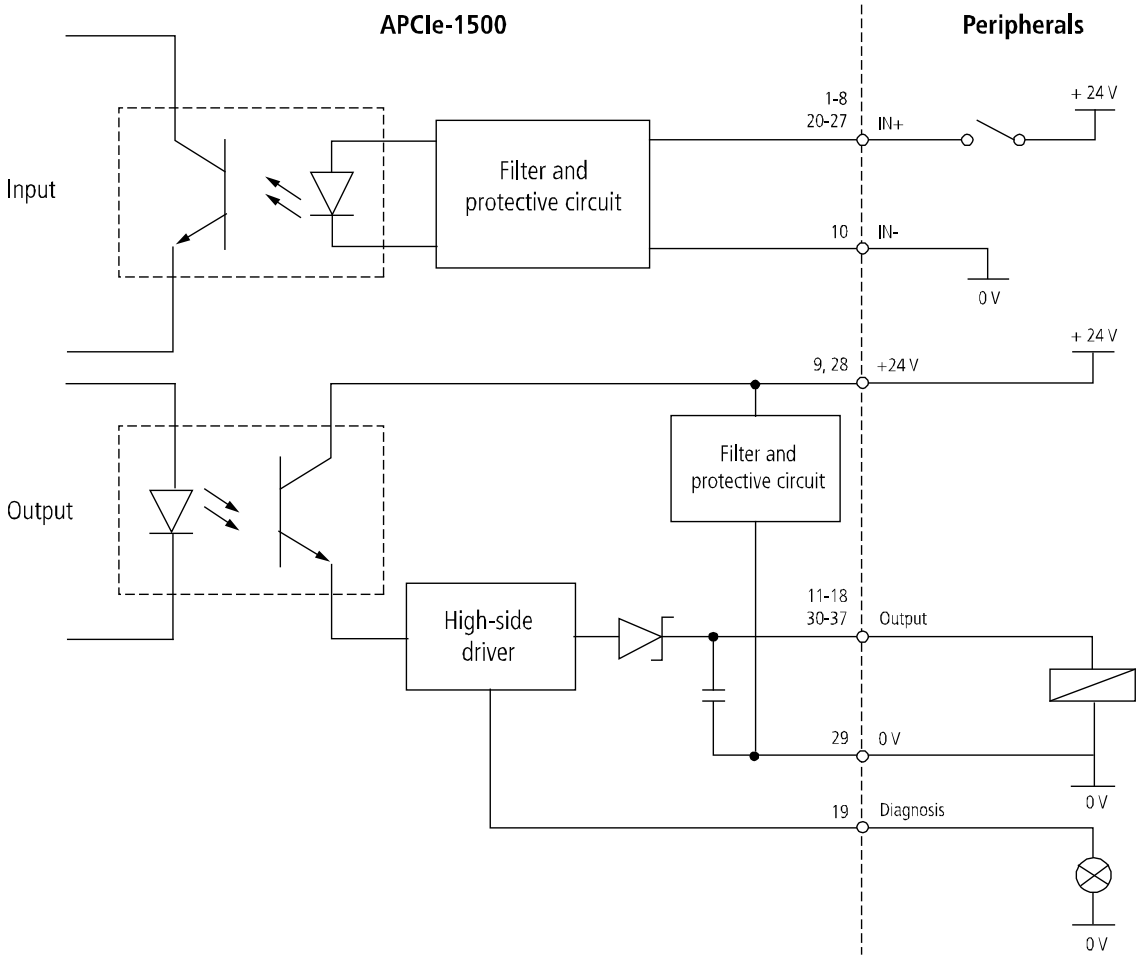
3.2.2 Pin assignment

Fig. 3-6: 37-pin D-Sub male connector



3.2.3 Connection example

Fig. 3-7: Connection example



NOTICE!
Please note that an external voltage source is required for the digital outputs (see Chapter 7.4.2).

3.3 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).

4 Function description

4.1 Digital inputs

The digital inputs acquire external signal states. The input information is loaded as a numeric value in a memory cell of the system via the driver function. This numeric value represents the status of the input signals.

The inputs correspond to 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 of the **APCIe-1500** have a common ground line: “External 0 V” (pin 10 of the 37-pin D-Sub connector).

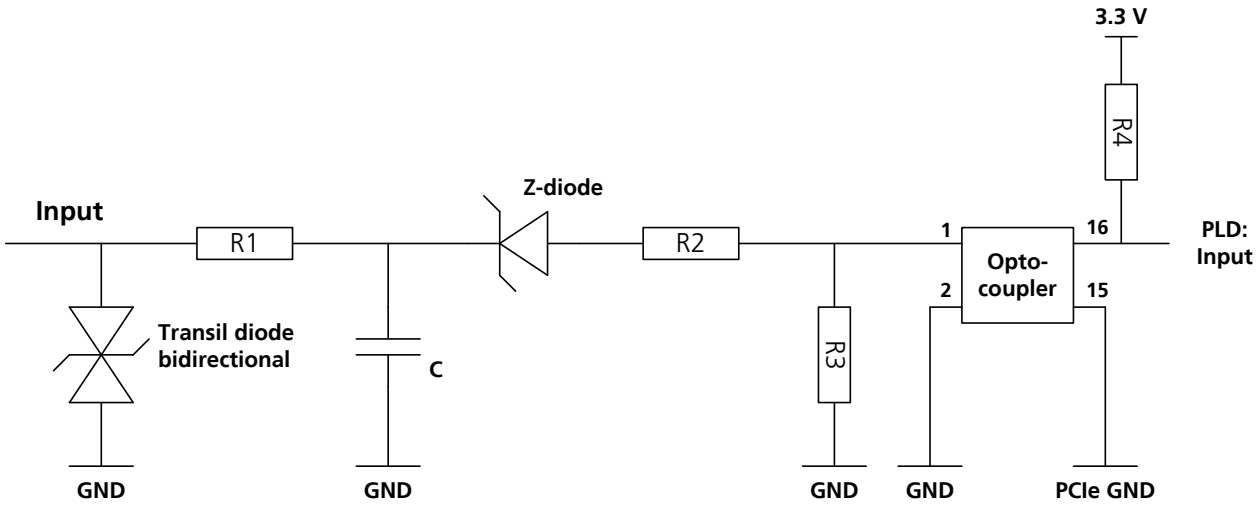
The current demand for each 24 V input is 2 mA at nominal voltage (see Chapter 7.4.1). The maximum input voltage is 30 V.

NOTICE!
The mains supply for the external power supply of the board must deliver at least the power that is required for your application.

The input signals are filtered by TVS diodes, Z-diodes, RC filters and opto-couplers. In this way, the effect of inductive and capacitive noise is reduced.

The board does not require initialisation to directly read the digital input information. The data is immediately available after power-on.

Fig. 4-1: Digital input stage



4.2 Digital outputs

For the digital outputs, positive logic is used:

- Logic “1”: Set output through software
- Logic “0”: Reset output

The outputs switch the “External +24 V” outwards to the load. One end of the load is connected to “External 0 V (outputs)”. All outputs have a common ground line: “External 0 V” (pin 29 of the 37-pin D-Sub connector).

The maximum supply voltage is 36 V. Each output can switch a current of 500 mA. The current per eight outputs is limited to 1.5 A by a polyswitch fuse element.

NOTICE!
The mains supply for the external power supply of the board must deliver at least the power that is required for your application.

Characteristics of the outputs:

- Short-circuit protection relating to ground: The output is switched off.
- Protection against overtemperature: The output driver is switched off.
- If the supply voltage drops, the outputs are switched off (shutdown logic).
- Diagnostic feedback: Short-circuit, overtemperature
- The outputs are suited for switching ohmic, capacitive and inductive loads.

TVS diodes, C-filters and opto-couplers filter noise on the peripheral side. In this way, the effect of inductive and capacitive noise on the system bus side is reduced or eliminated. Possible noise emitted by the output driver is also reduced by C-filters.

The board does not require initialisation to output the digital information. The outputs are reset to “0” after power-on (reset) and can be immediately programmed.

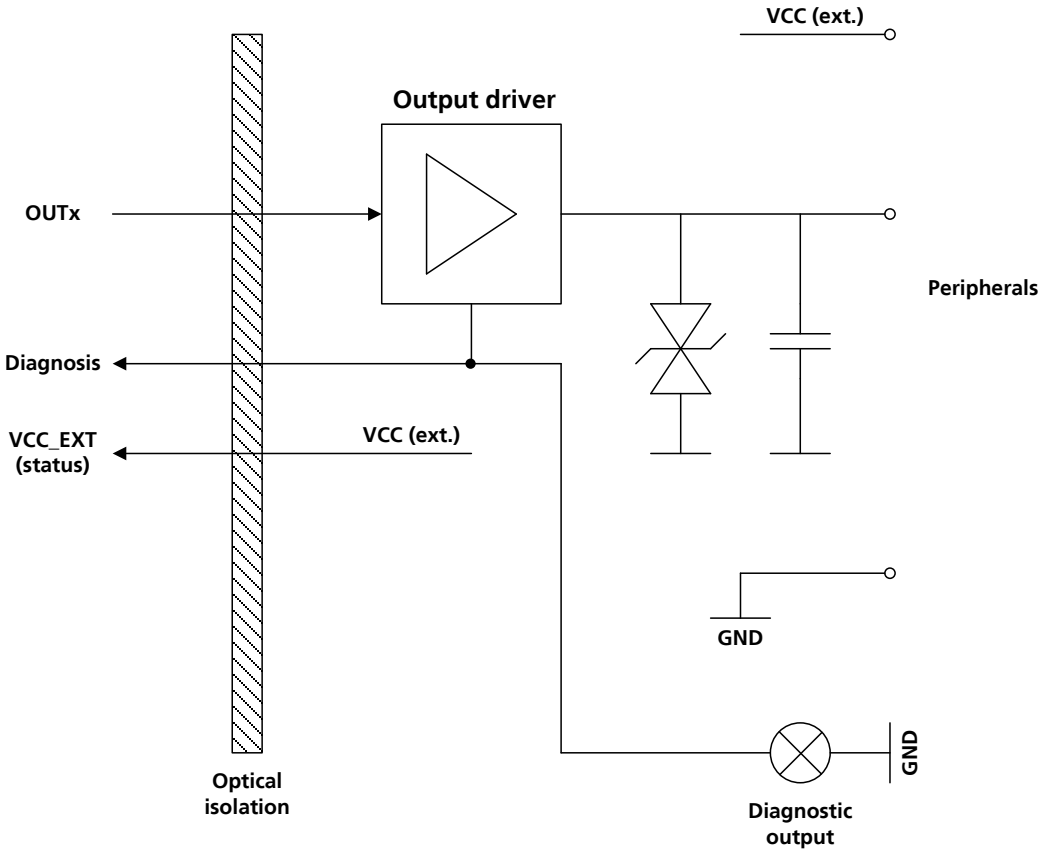
Diagnostic function

There are two diagnostic bits available:

- The CC diagnosis (ϑ-diagnosis) indicates that an output is short-circuited or that an output driver detects overtemperature. In these cases, the diagnostic output (pin 19 of the 37-pin D-Sub connector) is switched in addition.
- The V_{CC} diagnosis indicates that the external voltage supply is not available.

This error information is provided to the user program via an interrupt routine.

Fig. 4-2: Digital output stage



4.3 Interrupt

The board **APCIe-1500** has an interrupt line, which is assigned by the BIOS. Interrupt sources are the following:

- Interruptible inputs: Event 1 (inputs 1-8), event 2 (inputs 9-14)
- Counter overflow or timer
- Watchdog: The outputs are reset.
- Voltage error (external voltage supply not available)
- Short-circuit, overtemperature (outputs).

The information from the interrupt sources is provided to the user program via an interrupt routine.

4.3.1 Interruptible inputs: Event logic

It is possible to mask an AND and OR event with a rising or falling edge. To control the event logic, the following functions (set through software) are available:

- Activate/deactivate the interrupt function
- The interrupt source can be read back.
- The IRQ status register can be read back.

4.3.2 Interrupt control

The event logic is blocked after an interrupt has been released. At the end of the interrupt routine, the interrupt logic is enabled again. During the interrupt routine, the board does not react to changes to the input channels.
Another interrupt is released only after the original interrupt service routine has been processed and if an interruptible edge or status change takes place.

4.3.3 AND and OR logic

The AND and OR logic reacts to rising or falling edges. An interrupt is released if the following conditions are fulfilled:

- All interruptible inputs fulfil the conditions defined in the event mask (low level, high level, falling edge, rising edge, both edges).
- After an interrupt, a change of levels must occur at the interruptible inputs so that the event logic can detect an event again.

Example: Initialisation with OR logic

Interrupt if input 2 detects a falling edge or if input 3 detects a rising edge
(Event logic mode: PCI1500_Logic_OR)

Table 4-1: OR logic: Initialisation (event mask)

Digital input (port 0)	8	7	6	5	4	3	2	1
Digital input (port 1)			14	13	12	11	10	9
Event mask (port 0)[a]	x	x	x	x	3	2	x	x
Event mask (port 1)[b]			x	x	x	x	x	x

[a] 8-character string
[b] 6-character string

x: No event
0: Low level, 1: High level
2: Falling edge, 3: Rising edge, 4: Both edges

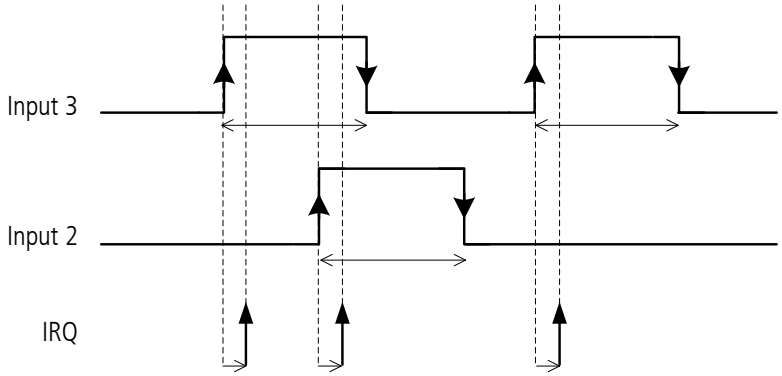
Example: Edge change interrupt

In the figures below, the following parameters are set:

1st condition:

Inputs 2 and 3 react to rising edges.
(Event logic mode: PCI1500_Logic_OR; event mask: 0x33)

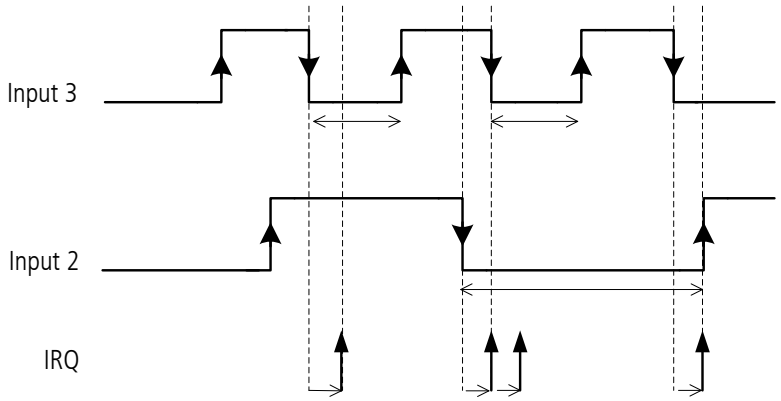
Fig. 4-3: OR logic: Edge change interrupt: 1st condition



2nd condition:

Inputs 2 and 3 react to falling edges.
(Event logic mode: PCI1500_Logic_OR; event mask: 0x22)

Fig. 4-4: OR logic: Edge change interrupt: 2nd condition



4.4 Timer, watchdog and counter

The board **APCIe-1500** has three counters (1-3). Two of them can be programmed as timers and counter 3 can be programmed as a watchdog.

4.4.1 Timer

Independently from the PC clock, the timer provides a time base to synchronise operations, for example. The 16-bit timer is a downward counter which can release an interrupt after the programmed cycle time has elapsed (time-out).
After the start of the timer, the start value (reload value) is reloaded (triggering) or the counter is activated (gate) every time the digital inputs are set. Reloading or activating can also occur directly through a software command without setting the digital inputs again.
The current timer value and the reload value as well as status and interrupt registers can be read back through software. Three frequencies are available as time bases for the timer:

- 111.86 kHz ± 100 ppm
- 3.49 kHz ± 100 ppm
- 1.747 kHz ± 100 ppm

4.4.2 Watchdog

The watchdog is a downward counter. It is used to monitor the digital outputs of the board.

After the start of the watchdog, the start value (reload value) is reloaded every time the digital outputs are set (triggering). Triggering can also occur directly through a software command without setting the digital outputs again. The watchdog resets the digital outputs after the complete cycle time has elapsed (time-out), i.e. if the watchdog has not been triggered anew.
The operating states of the watchdog can be read back. Three units (µs, ms, s) are available as time bases for the watchdog.

Table 4-2: Watchdog times

Frequency	Watchdog time (approx.)
111.86 kHz	17.9 µs to 1.175 s
3.49 kHz	574 µs to 37.65 s
1.747 kHz	1.14 ms to 74.95 s

4.4.3 Counter

The board is equipped with three 16-bit counter inputs whose function is comparable to that of the Intel counter module 82C54. Each of these counters can be programmed through software.

Table 4-3: Counter inputs

Counter No.	Digital input	Counter function
1	14	Signal input
2	10 11 12	Signal input Counter/timer trigger input Counter/timer gate input
3	15 16	Signal input Counter/timer gate input

Independently from the counter function, these channels can be used as normal digital inputs.
The cut-off frequency is 10 kHz.
Optionally, the signal input of counters 1-3 can be fitted with fast opto-couplers. The maximum input frequency then is 140 kHz **(APCIe-1500-FC)**.

Counter function

The counter starts with "counter value = reload value - 2" (2 clock pulses are required to load the reload value) and decrements with every valid clock edge. When the counter value is "0", the reload value will be reloaded with the next valid clock edge. In case of an overflow, an interrupt can be released.

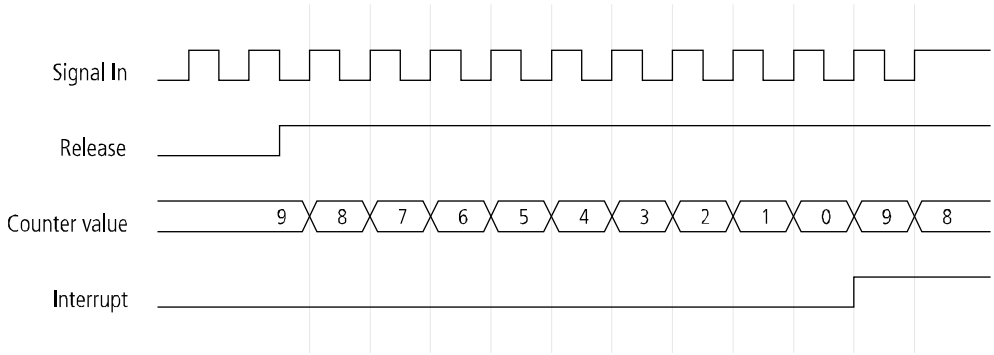
- Clear function: Deletes the counter value (= 0).
- Trigger function: Sets the counter value (= reload value).

Example

Reload value = 9
Initialisation with a rising edge
Interrupt enabled

When the counter value is "0", the reload value "9" will be reloaded with the next valid edge and an interrupt will be released.

Fig. 4-5: Downward counter cycle



5 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”.

6 Return or disposal

6.1 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. 6-1: 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
  77836 Rheinmünster
  Germany
- If you have any questions, do not hesitate to contact us:

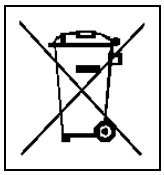
  Phone: +49 7229 1847-0
  E-mail: info@addi-data.com

6.2 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. 6-2: 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.

7 Technical data and limit values

7.1 Electromagnetic compatibility (EMC)

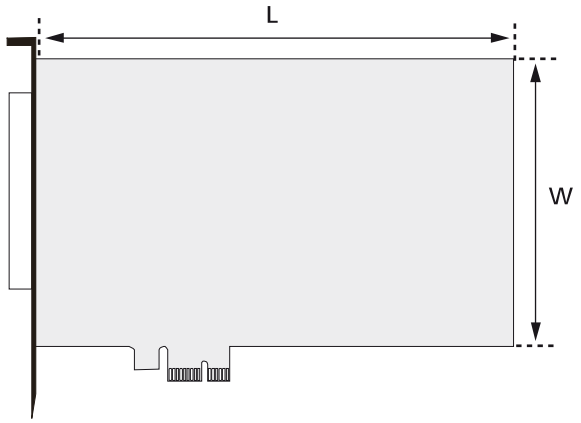
The board **APCIe-1500** is suited for installation in personal computers (PCs) which comply with the European EMC directive.

The board **APCIe-1500** 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.

7.2 Mechanical structure

Fig. 7-1: APCIe-1500: Dimensions



Dimensions (L x W):	149 x 99 mm	
Weight:	105 g	
Insertion into:	PCI Express slot	
Connection to peripherals:		
Front connector:	37-pin D-Sub male connector	
Accessories: [1]	see Chapter 3.2	
for digital I/O:	Cables:	**ST010, ST011, ST021, ST022, ST8500**
	Screw terminal panel:	**PX901-DG**
	Relay output board:	**PX8500-G**

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

[1] Not included in standard delivery

7.3 Versions

The board **APCIe-1500** is available in the following versions:

Table 7-1: Versions

Version	Features
APCIe-1500	16 digital inputs (24 V), 16 digital outputs (11-36 V)
APCIe-1500-FC	16 digital inputs (24 V), 16 digital outputs (11-36 V), fast counter inputs with filters
APCIe-1500-12V	16 digital inputs (12 V), 16 digital outputs (11-36 V)

The specific version name can be found on the type label at the slot bracket of your board.

7.4 Limit values

Height:	2000 m over NN
Operating temperature:	0-60 °C (with forced ventilation)
Storage temperature:	-25 °C to +70 °C
Relative air humidity at indoor installation:	50 % at +40 °C 80 % at +31 °C
Minimum PC requirements:	
System bus:	1-/4-/8-/16-lane PCI Express according to PCI Express Base Specification, Revision 1.0a (PCI Express 1.0a)
Link speed:	2.5 Gbit/s
Required space:	1 PCI Express slot
Operating system:	Windows 10, Windows 7, Linux
Safety:	
Optical isolation:	1000 V
Shutdown logic (V_{CC} diagnosis):	when the external 24 V supply voltage drops below 7 V
Energy demand:	
Operating voltage from the PC:	3.3 V
Current consumption (typ., without load)	see the following table ± 10 %

Table 7-2: Current consumption (typ., without load)

	Current consumption (mA)
Inputs/outputs inactive	320
8 inputs/outputs active	400
16 inputs/outputs active	470

7.4.1 Digital inputs

Number of inputs:	16 (common GND according to DIN EN IEC 61131-2)
Nominal voltage:	24 V
Interruptible inputs:	14 (inputs 1-14)
Event logic:	AND and OR logic
Filter/Protective circuit:	input filter, TVS diode, RC filter, Z-diode, opto-coupler
Optical isolation:	1000 V (via opto-couplers)
Input voltage:	0-30 V
Input current (at nominal voltage):	2 mA typ.
Max. input frequency (at nominal voltage):	5 kHz **APCIe-1500-FC:** 140 kHz (counter signal input)
Logic input levels:	UH_{max}: 30 V UH_{min}: 19 V UL_{max}: 14 V UL_{min}: 0 V
APCIe-1500-12V:	
Nominal voltage:	12 V
Input current (at nominal voltage):	1.5 mA typ.
Logic input levels:	UH_{max}: 16 V UH_{min}: 9 V UL_{max}: 6 V UL_{min}: 0 V

7.4.2 Digital outputs

Number of outputs:	16
Output type:	high-side (load to ground according to DIN EN IEC 61131-2)
Nominal voltage:	24 V
Filter/Protective circuit:	output filter, TVS diode, C-filter, opto-coupler
Optical isolation:	1000 V (via opto-couplers)
Supply voltage:	11-36 V
Current limit:	1.5 A (per 8 channels, via PTC)
Output current per output:	500 mA typ.
Short-circuit current per output:	1.5 A typ. (pulse current) shutdown logic at 24 V, R_{Load} < 0.1 Ω
R_{DS} ON resistance:	max. 0.2 Ω at 25 °C
Start-up time:	I_{out} = 0.5 A load = resistance: 50 µs
Shutdown time:	I_{out} = 0.5 A load = resistance: 75 µs
Overtemperature (shutdown):	135 °C (output driver)
Temperature hysteresis:	15 °C (output driver)
Diagnosis:	at overtemperature of one or more outputs

7.4.3 Timer, watchdog and counter

Timer (interruptible)

Number:	2 (counters 1 and 2)
Resolution:	16-bit
Time base:	17.9 µs 574 µs 1.14 ms
Cycle time range:	17.9 µs to 1.175 s 574 µs to 37.65 s 1.14 ms to 74.95 s

Watchdog

Number:	1 (counter 3)
Resolution:	16-bit
Time base:	17.9 µs 574 µs 1.14 ms
Cycle time range:	17.9 µs to 1.175 s 574 µs to 37.65 s 1.14 ms to 74.95 s

Counter (interruptible)

Number:	3
Resolution:	16-bit
Counter inputs:	counter 1: input 14 counter 2: input 10 (trigger input: input 11 gate input: input 12) counter 3: input 15 (gate input: input 16)
Max. input frequency (at nominal voltage):	5 kHz **APCIe-1500-FC:** 140 kHz (signal input)
Cut-off frequency:	10 kHz
Reload value:	software-programmable
Counter type:	downward counter

8 Appendix

8.1 Glossary

Data bus
The data bus basically consists of several lines (or pins) through which the processor sends and receives data. The volume of data that can be transmitted simultaneously depends on the number of data lines. In other words: The more pins the bus has, the more efficient it is.

Driver
A driver is a series of software instructions written specifically to manage particular devices.

Edge
Edges can either be rising or falling.
Logic levels are defined for processing and displaying information. In binary switches, voltages are used for digital values. Here, the two voltage ranges “H” (high) und “L” (low) represent the information. The “H” range is closer to plus infinity; the “H” level corresponds to digital 1. “L” denotes the range closer to minus infinity; the “L” level corresponds to digital 0. The rising edge is the transition from the status “0” to “1”; the falling edge is the opposite transition.

EMC
= Electromagnetic Compatibility

According to the European EMC Directive, electromagnetic compatibility is “the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to other equipment in that environment.”

ESD
= Electrostatic Discharge

On non-conductive surfaces, an electric charge is conducted away very slowly. If the dielectric strength is overcome, there is a fast potential equalisation between the surfaces involved. The often very sudden equalisation process is referred to as electrostatic discharge (ESD).

Currents of up to 20 A may occur in this process.

Ground line
Ground lines should not be seen as potential-free return lines. Different ground points may have small potential differences. This is always true with large currents and may cause inaccuracy in high-resolution circuits.

Input level
The input level is the logarithmic ratio between two electrical values of the same type (voltage, current or power) at the signal input of any receiving unit. This unit is often configured as a logical level related to the input of the circuit. The input voltage corresponding to logic “0” is between 0 V and 15 V and the voltage corresponding to logic “1” is between 17 V and 30 V.

Interrupt
= IRQ

An external event indicating that the CPU should suspend its current task to service a designated activity.

Level
Logic levels are defined for processing and displaying information.
In binary switches, voltages are used for digital values. Here, the two voltage ranges “H” (high) und “L” (low) represent the information.

The “H” range is closer to plus infinity; the “H” level corresponds to digital 1. “L” denotes the range closer to minus infinity; the “L” level corresponds to digital 0.

Limit value
Exceeding the limit values, even for a short time, can easily result in the destruction of the component or the (temporary) loss of functionality.

Operating voltage
The operating voltage is the voltage to the device in sustained operation. It must not exceed the maximum sustained voltage, and all unfavourable operating conditions, such as possible mains power surges for over a minute when the device is switched on, must be taken into account.

Optical isolation
Optical isolation means that there is no flow of electrical current between the circuit to be measured and the measuring system.

PCI Express
This is a parallelisable serial process for switched point-to-point connections. Unlike PCI bus, PCIe is not a parallel bus but a serial point-to-point connection. Data transfer is via so-called lanes comprising a line pair for transmission and a second pair for receiving. Individual components are connected via switches. PCIe is also hot-plug compatible, which allows (defective) expansion boards to be replaced in operation – a feature much in demand in the server area.

Protective circuit
A protective circuit is set up on the actuator side to protect the control electronics and provide adequate EMC safety. The simplest protective circuit involves connecting a resistor in parallel.

PTC
= Positive Temperature Coefficient

The best-value resistance sensors are either specified as PTC or NTC thermistors. A PTC thermistor has a positive temperature coefficient, hence, “PTC”.

Resolution
The resolution indicates how precisely a signal or value is held within the computer.

Short-circuit
A short-circuit exists between two terminals of an electric circuit if the relevant terminal voltage is zero.

Short-circuit current
A short-circuit current is the current between two short-circuited terminals.

Timer
A timer is used for adjusting time-dependent program processes between the processor and peripheral devices. It contains counters that are mostly independent of each other and can be programmed like a programmable I/O module via a control word register for different operating types.

Trigger
A trigger is a pulse or signal for starting or stopping a special task. Triggers are often used for controlling data acquisition.

TVS
= Transient Voltage Suppression

8.2 Index

9 Contact and support

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