Analog Outputs I/O PCIe card PCA-8288/8688 User Guide

My DAQ Card Details:

type of card:	. . . .	(e.g. PCA-8288)
serial number:	. . . .	(e.g. 86010108)
purchase date:	. . . .	
card owner:	. . . .	

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- Electromagnetic Compatibility (EMC) Directive 2014/30/EU

- RoHS Directive (EU) 2015/863 amending Annex II to Directive 2011/65/EU

The CE Declaration of Conformity original document is stored at the manufacturer and its copy may be provided on request.

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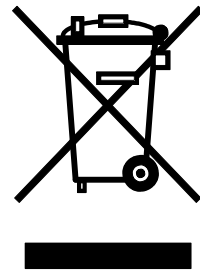
1. Introduction

1.1 Description

The PCA-8288/8688 are add-on PCI Express cards intended especially for laboratory and industrial automation and measuring systems.

The PCA-8288/8688 cards provide especially these features:
- eight isolated analog outputs equipped alternatively with 12-bit or 16-bit D/A converters
- three 8-bit bidirectional digital ports, software configurable as input or output
- IRQ logic with interrupt sources derived from rising or falling edge of each digital port signal (i.e. 48 individually programmable interrupt sources) and internal timer

Available types and versions of cards:

PCA-8288   standard format card, eight 12-bit D/A converters

PCA-8288/LP   low-profile format card of PCA-8288

PCA-8688   standard format card, eight 16-bit D/A converters

PCA-8688/LP   low-profile format card of PCA-8688

In the following text, unless otherwise stated, the designation **PCA-8x88 applies to all types and versions of card.**

1.2 General instructions for use

The PCA-8x88 card is suitable for installation in either office or industrial computers that are fitted with the PCI Express bus (Gen 1 compatible).

Cable types and their maximum length are described in paragraph 2.4 General data.

Caution:
The cards are designed for DAQ&C applications and may be used only according to the manufacturer's recommendations and precautions given in this manual and other general standards and terms and may be used only such a way, that its failure caused by any reason will not be dangerous to any person or property.

1.3 Note on the contents of the manual

This manual contains all information related to card features, I/O connectors etc., but does not include a description of installing and using drivers.

For information about drivers and programming check the dedicated documentation.

1.4 New firmware versions and customer´s firmware

The PCA-8x88 card is based on a FPGA unified core providing implementation of PCI Express bus and all peripheral circuitry, e.g. solution that gives maximum control and supervision over full functionality. High concentration of control algorithms within FPGA allows to add or modify functions without redesign the board (e.g. firmware with added special custom features or a build completely new custom firmware).

A simple software utility for user-friendly firmware upgrade is available.

2.   Specifications

2.1   Analog outputs

Number of outputs:	8	
D/A converters resolution:	12 bits	(PCA-8288)
	16 bits	(PCA-8688)
Output ranges:	±10 V with software max./min. limiting thresholds	
Output voltage error:	±0.15 % max.	(PCA-8288)
(see note below)	±0.08 % max.	(PCA-8688)
Settling time:	10 µs typ.	
Output impedance:	<1 Ohm	
Load impedance:	>2 kOhm	(see note below)
Isolation voltage:	1000 V_{DC}	(standard version of the card)
	600 V_{DC}	(card with ESD-X1 option)

Note: *The output voltage error is related to the range (not to the output value) and after full signal setling. Calibration constants are stored in the on-board EEPROM separately for each channel to compensate for offset and gain.*
Achieving the error defined above requires periodical adjustment/calibration.

Note: *The output can be loaded with a current of up to 5 mA (ie. 10 V with a load of 2 kOhm), but the current consumption of all outputs is limited to 20 mA in total. The outputs are short-circuit resistant to AGND.*

Note: *ESD-X1 option includes Surge Arrester (protection of the isolation barrier).*

2.2   Digital ports

Number of ports:	three 8-bit bidirectional ports
Operating levels:	HC/HCT/TTL
Load impedance of outputs:	500 Ohm min.

Note: *Digital bidirectional ports are not protected against overvoltage, stresses outside the range 0÷5 V will may cause permanent damage.*
The digital ports in the output mode are durable to permanent short-circuit against GND while maintaining the maximum current of the 5V power source (see paragraph 2.4 General data).

2.3   Interrupt logic

Interrupt sources:	timestamp IRQ generator (1÷255 ms), all digital ports
Interrupt trigger event:	timestamp generator overflow, any combination of rising or falling edges on all digital ports

2.4　General data

Bus type:	PCI Express (x1, Gen 1)	
PCI ID:	VID=1760_H, DID=0860_H	(PCA-8288, PCA-8288/LP)
	VID=1760_H, DID=0861_H	(PCA-8688, PCA-8688/LP)
Bus power consumption:	300 mA typ. @ 3.3 V	(500 mA max.)
	300 mA typ. @ 12 V	(500 mA max.)
Internal power supply:	700 mA max. @ 5 V	(see note below)
Board dimensions::	56 x 128 mm approx.	(PCE-8019 not included)
Connectors:	D-Sub 25 - male	(analog outputs)
	10 pin header type	(DIO ports 0, 1 a 2)
Operating temperature:	0÷60 °C	
Storage temperature:	-20÷70 °C	
Operating humidity:	10÷90 %, noncondensing	
Recommended cable length:	shielded cables, 2 m max.	

Note: *The internal 5V power supply voltage is generated by the on-board circuits from the 12V PCI Express bus power source and is used to supply the DIO ports and also to supply PCE-16xx series external boards (see description of KX1÷KX3 connectors). The total current of all 24 DIO signals when output mode is selected, including the current consumption of PCE-16xx boards, must not exceed the permitted value.*

3.   Installation

3.1   Introduction

Attention has been focused on achieving a high quality and reliability during the manufacturing process and attention was also paid to an inspection of the card before being shipped to you. Detailed reading of this guide and following the instructions precisely are highly recommended for achieving full quality and to prevent any damage during installation. For further information see manufacturer's website http://www.tedia.eu.

3.2   Hardware configuration

The PCA-8x88 card contains a single configuration element - a two-segment DIP switch (the status of this switch can be read by the program to identify multiple cards as CardID value). Check Figure 1 in Appendix of this manual for more information.

3.3   Installation

Important Warning:
While installing the card, please follow the principles for handling the circuits, which are sensitive to the electrostatic discharge damage. Touch the card carefully only by the edges, and do not touch the components or metal contacts on the bottom of the card.
The computer must be switched off before the card is installed. Always disconnect the power supply cord and other cables connected to the PC!
The cards may be stored only in an antistatic wrapper outside of the computer. Failure to comply with the rules listed above may lead to damage of the sensitive circuits of the card, or even of the whole computer.

After removing the slot cover plate, plug the configured card into a free slot for expansion PC cards and fix it in place.

If you plan to use the digital ports DIO1 and DIO2 of standard format card, install the PCE-16xx series board (not included in the delivery package of the card) into the next position and connect the flat cables. Similarly, if you plan to use the digital ports DIO0, DIO1 and DIO2 of low-profile card, install the PCE-8025/LP adaptor board (not included in the delivery package) into the next position and connect the flat cables.

Note: *In the event of any queries, please contact the manufacturer's technical support. See http://www.tedia.eu for more contact information.*

3.4   Location of switches and connectors

See the Appendix, Figure 1 for location of configuration switches and connectors.

3.5   Connector pin assignment

The connector pin layouts are shown in Table 1 through Table 4, the connector pin assignment is shown in Figure 2 (all in Appendix of this manual).

4. Analog Outputs

4.1 Introduction

The PCA-8x88 cards offer eight analog outputs together isolated from the computer (ie. all outputs are created by one isolated circuit block).

All outputs use the D-Sub 25 connector located on the card bracket.

4.2 Description of analog outputs

The analog outputs are controlled by eight D/A converters (alternatively 12 or 16 bits) allowing the PC program to make single writing the values of the generated signals; the current firmware does not support block transfer with FIFO memory.

All outputs operate in a single bipolar range ±10 V, if necessary, configurable threshold limiters can be used and the real operating range can be set individually for each output (each channel allows to set the minimum and maximum value).

The initial output values and threshold limiters data after computer is turned on or restarted are stored in the on-board EEPROM memory and can modify by the software utility (by default, all ports are set to ±10 V ranges and zero output voltage).

Check the Appendix, Figure 3 for detail information.

4.3 Adjustment and calibration

The analog outputs are calibrated numerically by the card's internal circuits and the card therefore does not contain any potentiometers or other hardware calibration elements.

After writing the value of the analog output, these data are processed by the procedure...

- the data are compared with the value of the minimum threshold limiter; if the entered data value is lower (or "more negative") than the value of the limiter, the data is replaced by the value of the limiter;
- the data are compared with the value of the maximum threshold limiter; if the entered data value is lower (or "more positive") than the value of the limiter, the data is replaced by the value of the limiter;
- the data are processed by calibration constants compensating offset and gain of the D/A converter and amplifiers;
- the data is written to the D/A converter.

Everything mentioned above takes time less than 1 μs.

Each output is equipped with its own set of calibration constants.

The calibration constants are stored in the on-board EEPROM and are automatically transferred to the calibration circuits after each start or restart. Calibration constants can be modify by the software utility.

Note: *The cards are adjusted/calibrated during production by the manufacturer, for recalibration contact the manufacturer's technical support for details.*

5.   Digital Ports

5.1   Introduction

The PCA-8x88 card provides three 8-bit bidirectional digital ports.

All digital ports (identified as DIO0, DIO1 and DIO2) use header type connectors located at the back edge of the card.

In case of the standard format card (ie. PCA-8x88), the DIO0 port is accessed on the card bracket via adapter cable PCE-8019 terminated with D-Sub 9 connector. Remaining two ports (ie. DIO1 and DIO2) can be accessed via adapter cable PCE-1620 (card bracket with D-Sub 9 connector), or other types from the PCE-16xx series adapter boards.

Note: *Unlike the adapter cable PCE-8019, the PCE-16xx boards are not included in the delivery package of the card.*

In case of the low-profile format card (ie. PCA-8x88/LP) all three ports DIO0, DIO1 and DIO2 can be accessed via adapter cable PCE-8025/LP (low-profile card bracket with D-Sub 25 connector); there are currently no other option available.

Note: *The PCE-8025/LP adaptor board is not included in the delivery package of the card.*

The signal direction of DIO port (ie. input or output option) can be selected independ for each 8-bit port (it is not possible to select direction individually for each of the eight signals of one DIO port) from the user software.

The port direction and output data after computer is turned on or restarted are stored in the on-board EEPROM memory and can modify by the software utility (by default, all ports are set as input).

5.2   Description of digital ports

Drivers and receivers based on HCTMOS technology were used for digital ports.

In the output mode (ie. driver mode), the HCTMOS circuits provide true 5 V signal levels with a high output current with low voltage drop and can therefore be used for direct control of LEDs, optocouplers, or miniature relays (coil parameters 5 V, 500 Ohm).

In the input mode (ie. receiver mode), the HCTMOS circuits provide not only TTL signal compatibility, but moreover high input impedance, very low leakage current and protection diodes. The unconnected state of inputs represents the H logic level generated by pull-up resistors 10 kOhm against a voltage of 5 V, and the inputs can be therefore also used to direct connecting of floating contacts.

Check the Appendix, Figure 4 for detail information.

Note: *Unfortunately, the concept of bidirectional ports does not provide the overvoltage protection available to other ports of PCI/PCIe TEDIA cards.*

5.3   Interrupt logic

The PCA-8x88 card allows to trigger an interrupt (simultaneously with the timestamp IRQ generator) by any combination of rising or falling edges of the signals of all digital ports.
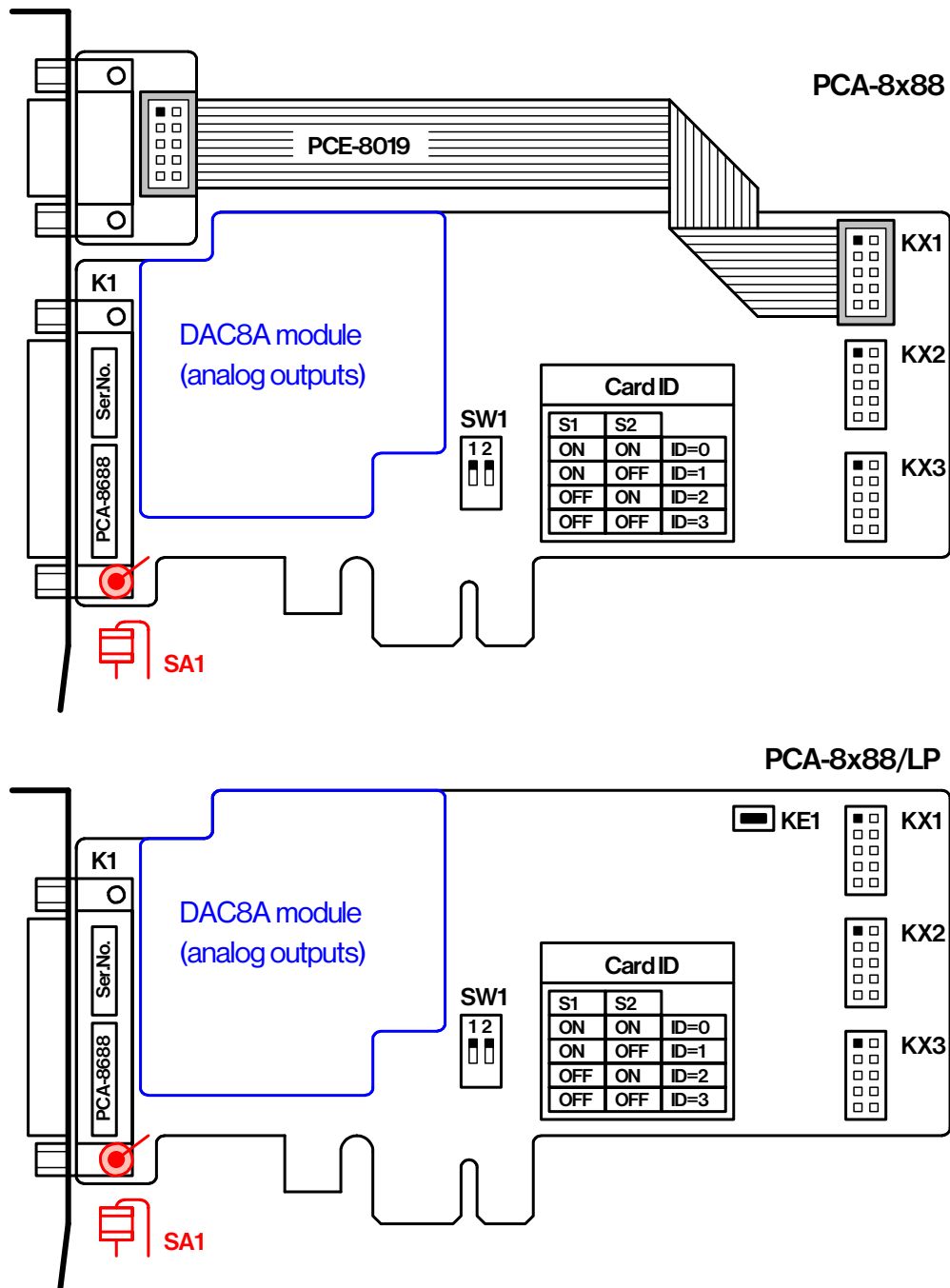
Figure 1. Location of switches and connectors on both version of cards.

K1	connector of analog outputs (D-Sub 25 - male)
KX1	connector of digital port DIO0, ie. DIO00÷07 signals (2x5 pin header type)
KX2	connector of digital port DIO1, ie. DIO08÷15 signals (2x5 pin header type)
KX3	connector of digital port DIO2, ie. DIO16÷23 signals (2x5 pin header type)
SW1	DIP switch for identifying multiple cards (CardID value)
PCE-8019	adapter cable PCE-8019 terminated with D-Sub 9 male connector (included in the delivery package of the standard format card)
KE1	button for activating backup firmware (intended for service purposes)
SA1	Surge Arrester (cards with ESD-X1 option)

K1 signal	pin	pin	K1 signal
- - -	C1	C14	- - -
- - -	C2	C15	- - -
- - -	C3	C16	- - -
- - -	C4	C17	- - -
AGND	C5	C18	AOUT7
AGND	C6	C19	AOUT6
AGND	C7	C20	AOUT5
AGND	C8	C21	AOUT4
AGND	C9	C22	AOUT3
AGND	C10	C23	AOUT2
AGND	C11	C24	AOUT1
AGND	C12	C25	AOUT0
AGND	C13		

Table 1.   D-Sub 25 (male) connector pin assignment.

KX1/KX2/KX3 signal	pin	pin	KX1/KX2/KX3 signal
DIO00/08/16	D1	D2	DIO01/09/17
DIO02/10/18	D3	D4	DIO03/11/19
DIO04/12/20	D5	D6	DIO05/13/21
DIO06/14/22	D7	D8	DIO07/15/23
GND	D9	D10	5V (viz. technické parametry)

Table 2.   Header type connector pin assignment.

Note: *In case of the standard format card, the DIO0 port is accessible on the card bracket via adapter cable PCE-8019 terminated with D-Sub 9 connector. Remaining two ports (ie. DIO1 and DIO2) can be accessed via adapter cable PCE-1620 (card bracket with D-Sub 9 connector), or other types from the PCE-16xx series adapter boards.*
In case of the low-profile format card all three ports DIO0, DIO1 and DIO2 can be accessed via adapter cable PCE-8025/LP (see Table 4).

signal	pin	pin	signal
DIO00/08/16	C1	C6	DIO01/09/17
DIO02/10/18	C2	C7	DIO03/11/19
DIO04/12/20	C3	C8	DIO05/13/21
DIO06/14/22	C4	C9	DIO07/15/23
GND	C5		

Table 3.   D-Sub 9 (male) connector pin assignment located on PCE-8019 (single DIO port adapter cable) and PCE-1620 (dual DIO port adapter cable).

signal	pin	pin	signal
DIO00	C1	C14	DIO01
DIO02	C2	C15	DIO03
DIO04	C3	C16	DIO05
DIO06	C4	C17	DIO07
DIO08	C5	C18	DIO09
DIO10	C6	C19	DIO11
DIO12	C7	C20	DIO13
DIO14	C8	C21	DIO15
DIO16	C9	C22	DIO17
DIO18	C10	C23	DIO19
DIO20	C11	C24	DIO21
DIO22	C12	C25	DIO23
GND	C13		

Table 4.   PCE-8025/LP adapter board, D-Sub 25 (male) connector pin assignment.
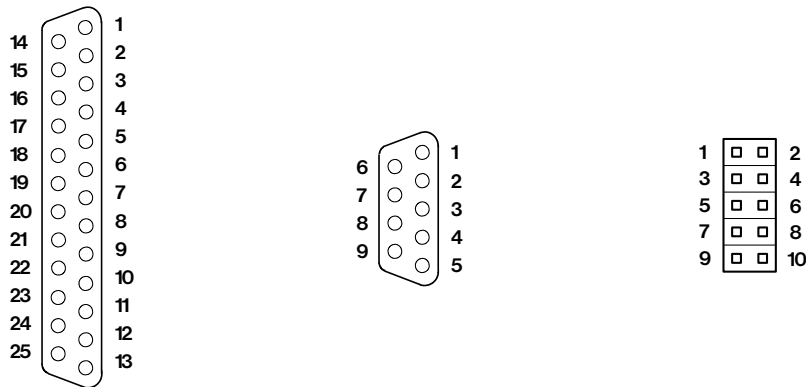
Figure 2.   Pin layout on D-Sub 25 (male), D-Sub 9 (male) and header type connectors (2x 5 pins, 2.54 mm pitch).
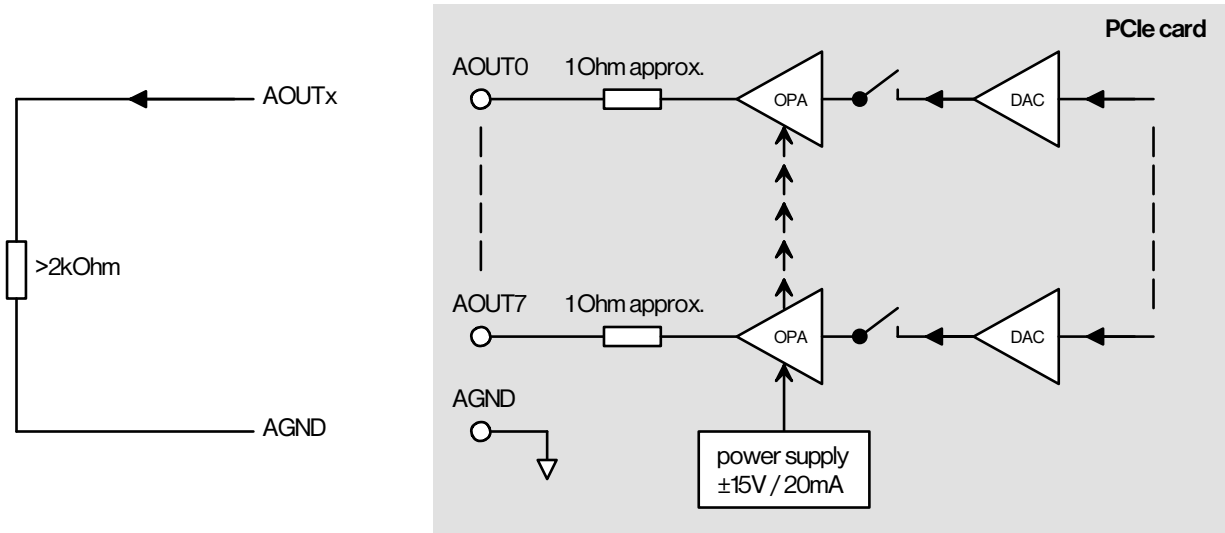
Figure 3.   Simplified schematic of analog outputs.

The schematic shows eight D/A converters (DAC) and eight output amplifiers (OPA).
The output amplifiers are separated from the D/A converters (in the schematics shown by switches) providing zero voltage at the outputs until the power-up procedure is completed. All output amplifiers are powered from a single source; the maximum current of each output must not exceed 5 mA and the total current of all eight outputs together of the current 20 mA. In addition, the load impedance should not be less than 2 kOhm.
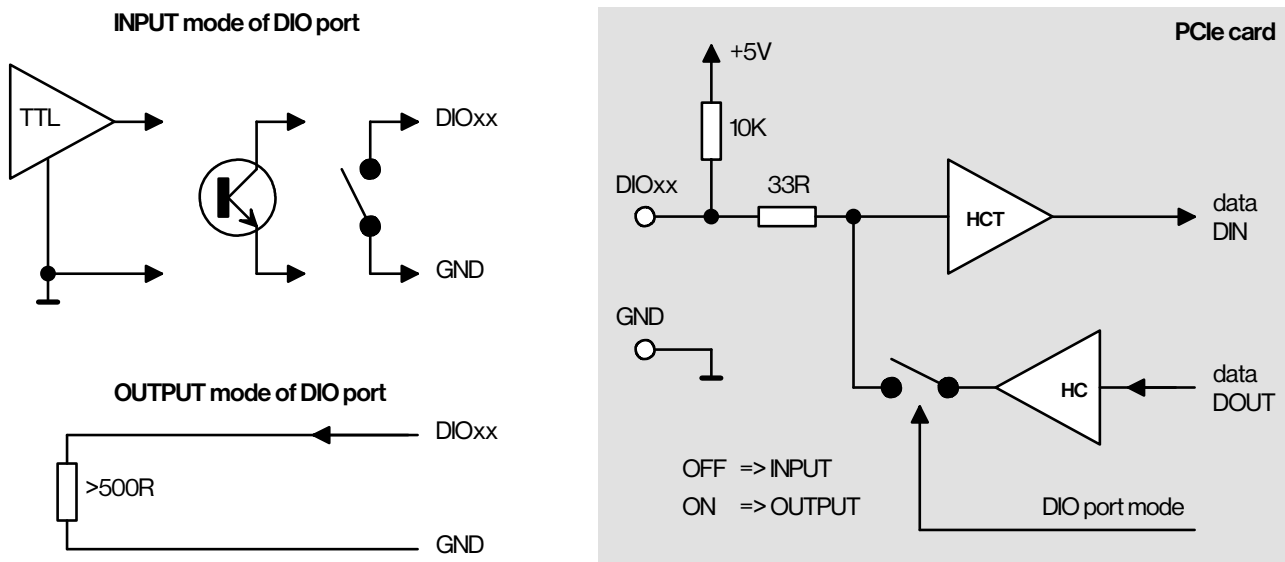
Figure 4.   Simplified schematic of DIO ports.

The diagram shows one bidirectional I/O channel.
The signal direction of DIO port (ie. input or output option) can be selected independ for each 8-bit port, but it is not possible to select direction individually for each of the eight signals of one DIO port.

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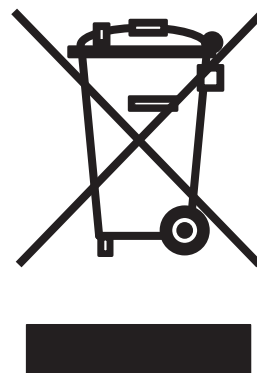..
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