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certified

ADDI-DATA GmbH
Airpark Business Center
Airport Boulevard B210
77836 Rheinmünster
Germany

Phone: +49 7229 1847–0
Fax: +49 7229 1847–222
E-mail: info@addi-data.com
www.addi-data.com

Technical description

APCI-3010, APCI-3016, APCI-3110 and APCI-3116

Analog I/O board, optically isolated

Edition: 02.04 -08/2016

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 status 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 board **APCI-3xxx**[1] must be inserted in a PC with PCI slots which is used as electrical equipment for measurement, control and laboratory pursuant to the standard EN 61010-1 (IEC 61010-1).

The used personal computer (PC) must fulfil the requirements of IEC 60950-1 or EN 60950-1 and EN 55022 or IEC/CISPR 22 and EN 55024 or IEC/CISPR 24.

The use of the board **APCI-3xxx** in combination with external screw terminal panels requires correct installation according to the series IEC 61439 or EN 61439 (Low-voltage switchgear and controlgear assemblies).

1.2 Usage restrictions

The **APCI-3xxx** board must not be used as a safety-related part (SRP).

The board must not be used for safety related functions, for example for emergency stop functions.

The **APCI-3xxx** board must not be used in potentially explosive atmospheres.

The **APCI-3xxx** 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-3xxx = APCI-3010**, **APCI-3016**, **APCI-3110** and **APCI-3116**

1.4 General description of the board

Characteristics

The board has up to 16 single-ended input channels or up to 8 differential input channels for processing analog signals.

Table 1-1: Overview

Characteristics	APCI-3010	APCI-3016	APCI-3110	APCI-3116
Analog inputs: Single-ended (SE) or differential (diff.)	Up to 16 (SE) Up to 8 (diff.)	Up to 16 (SE) Up to 8 (diff.)	Up to 16 (SE) Up to 8 (diff.)	Up to 16 (SE) Up to 8 (diff.)
Resolution	12-bit	16-bit	12-bit	16-bit
Optical isolation	Yes	Yes	Yes	Yes
Throughput	200 kHz	200 kHz	200 kHz	200 kHz
Analog outputs	-	-	4	4
Resolution	-	-	12-bit	12-bit
Optical isolation	-	-	Yes	Yes
Digital inputs/outputs	4 inputs 4 outputs	4 inputs 4 outputs	4 inputs 4 outputs	4 inputs 4 outputs
TTL inputs/outputs	24	24	24	24
Timer	3	3	3	3
Counter	3	3	3	3
Watchdog	1	1	2	2

Connection

Data exchange between the board **APCI-3xxx** board and the peripheral is to occur through a shielded cable. The cable must be connected to the 37-pin SUB-D connector of the board. Furthermore, there is a 50-pin male connector for the connection of the TTL I/O available, which must be connected to the ribbon cable.

The use of the board **APCI-3xxx** in combination with external screw terminal or relay boards is to occur in a closed switch cabinet.

The screw terminal panel **PX 901-AG** or the connection box **PX-BNC** allows the connection of the analog signals to the peripheral through the standard cable **ST010**. Through the screw terminal panel **PX 8000** or **PX8001**, the standard cable **ST 370-16** and the ribbon cable **FB 8001** the digital signals are connected to the peripheral.

The connection of 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.

2 USER

2.1 Qualification

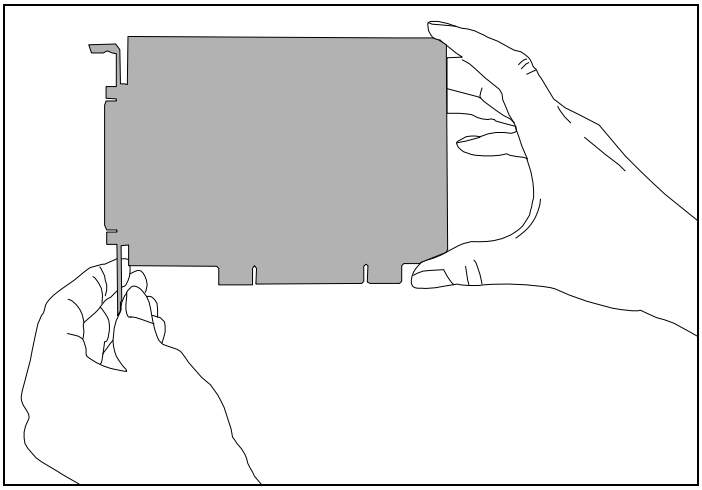
Only persons trained in electronics are entitled to perform the following works:
- installation
- commissioning
- use
- maintenance

2.2 Country-specific regulations

Consider the country-specific regulations about:
- 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)

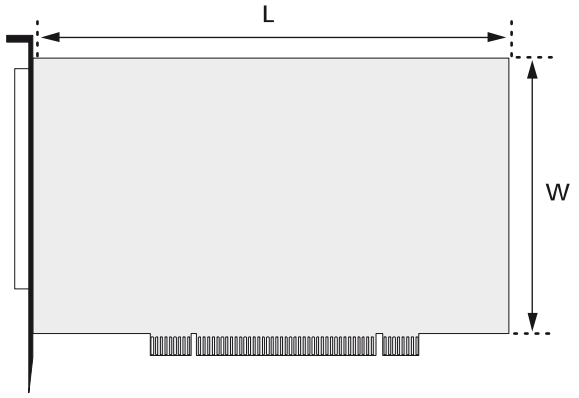
The board **APCI-3xxx** is suited for installation in personal computers (PCs) which comply with the European EMC directive.

The board **APCI-3xxx** complies with the European EMC directive. The tests were carried out by a certified EMC laboratory in accordance with the standard from the EN 61326 series (IEC 61326). 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):…….. 175 x 99 mm
Weight: ..... approx. 160 g
Installation in: ..... 32-/64-bit PCI slot 3.3 V / 5 V
Front connector: ..... 37-pin SUB-D male connector

Additional connectors:
APCI-3010, **APCI-3016**,
APCI-3110, **APCI-3116**: ..... 50 pin male connector for TTL I/O and 24 V optically isolated I/O

Accessories[1]:
For analog I/O:
Cable: ..... **- ST010**
Screw terminal panel: ..... **- PX 901-AG**
or connection box: ..... **- PX-BNC**

For digital I/O:
Cable: ..... **- FB 8001**
- ST370-16
Screw terminal panel: ..... **- PX8001**

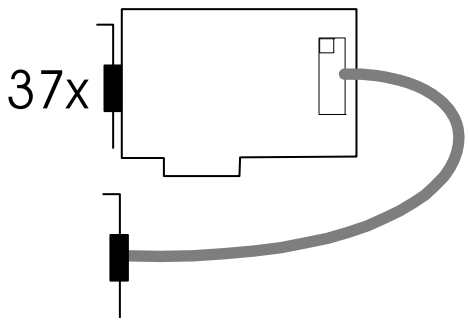
NOTICE!
The connection lines must be installed in such a way that they are protected against mechanical loads.

4.3 Limit values

Max. altitude: ..... 2000 m
Operating temperature: ..... 0 to 60°C (with forced ventilation)
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 8/7/XP, Linux
Slots: ..... 32-/64-bit PCI slot 3.3 V / 5 V + 1 slot opening for the connection of the TTL I/O or dig. I/O

Fig. 4-1: Required slots



1 Not included in standard delivery.

4.3.1 Analog inputs

Number of channels: ..... 16 analog inputs
Resolution (**APCI-3010** and **APCI-3110**): 12-bit
Resolution (**APCI-3016** and **APCI-3116**): 16-bit
Max. throughput rate: ..... 200 kHz (total sampling rate with all channels)
Optical isolation: ..... 1000 V (1 second tested)
Temperature drift: ..... 10 ppm/K
Linearity error of the ADC: ..... ±1.22 mV (typ.)
±2.44 mV (max.)

Calibration of the inputs:
Bipolar offset calibration value: ..... -0.00061 V (tolerance: ±0.0017 V)
Unipolar offset calibration value: ..... 0.01 V (tolerance: ±0.0017 V)
Bipolar gain calibration value: ..... 9.995 V (tolerance: ±0.0017 V)
Unipolar gain calibration value: ..... 9.995 V (tolerance: ±0.0017 V)
Calibration channel: ..... 0 (single-ended)
Measurement method: ..... Averaging of more than 200 values

4.3.2 Analog outputs

Analog outputs are available on the following boards:
- **APCI-3110**
- **APCI-3116**

Number of channels: ..... 4 analog outputs
Output type: ..... Voltage outputs: Single-ended
Resolution: 12-bit
Output range: ..... - 10 V to (+ 10 V – 1 LSB)
LSB: ..... 4.8828 mV
Precision: 11-bit
Time to ready (tr): ..... 5 µs
Settling time
(=tr + settling time des DACs): ..... typ. 15 µs (at 10 V interval)
Temperature drift: ..... max. 10 ppm/°C
Max. output current: ..... ± 5 mA
Short circuit current: ..... ± 20 mA
Optical isolation: ..... 1000 V (1 second tested)
Voltage after reset: ..... 0 V (see also chapter 8.3)

4.3.3 Digital inputs (24 V

Number of channels: ..... 4 digital inputs
Filter/protective circuit: ..... Low pass/transorbdidodes
Optical isolation: ..... 1000 V
Nominal voltage: ..... 24 V
Input voltage: ..... 0 V to 30 V
Input current: ..... 10.5 mA (at 24 VDC, typ.)

Logic input level:	UH (max.):	30 V
	UH (min.):	19 V
	UL (max.):	14 V
	UL (min.):	0 V
Input frequency:	1 MHz (max.) at 24 V	
Interruptible inputs:	Not available	

4.3.4 Digital outputs (24 V

Number of channels:	4 digital outputs
Optical isolation:	1000 V (1 s tested)
Output type:	High-Side (load to GND) (UDN2987)
Nominal voltage:	24 V
Supply voltage:	7 V - 35 V
Output current for each output:	50 mA
Output saturation voltage:	2 V (max.)
Switching-on time:	0.6 µs (max.) at R (load) = 480 ohm
Switching-off time:	4 µs (max.) at R (load) = 480 ohm
Overtemperature (shut-down):	165 °C (output driver)
Temperature hysteresis:	15 °C (output driver)

4.3.5 TTL inputs and outputs

NOTICE!

The TTL inputs and outputs are not optically isolated. Please make sure that no signal from the peripherals is connected to the inputs and outputs when the PC system is switched off or being booted up or shut down. This can be realised by means of a relay or tri-state circuit between the peripherals and the TTL inputs and outputs.

Number of I/O channels:	24 (3 ports with each 8 channels)
Type:	TTL

Logic input level:

UH (max.):	5.5 V
UH (min.):	2.0 V
UL (max.):	0.8 V
UL (min.):	0 V

Input frequency (max.): ..... 5 MHz[1]

[1] Measured with an Agilent function generator type 33220A with connection through the screw terminal panel **PX8001** and the connection cables **ST370-16** and **FB8001**

Logic output level:
UH (typ.) ..... 3.3 V at I_{out} = - 100 µA
UH (min.) ..... 2.4 V at I_{out} = -20 mA
UL (max.) ..... 0.55 V at I_{out} = 20 mA

4.3.6 Timer, counter and watchdog

Timer, interruptible:
Number: 3
Timer depth: 16-bit
Time base: ..... µs, ms, s (programmable)
Output: ..... Low/High (programmable)

Counter, interruptible:
Number: 3
Resolution: 16-bit
Input: ..... Low/High (programmable)
Output: ..... Low/High (programmable)
Operation mode: ..... Mode 2, Mode 3 (programmable)

Watchdog:
Number (**APCI-3010, APCI-3016**): 1
Number (**APCI-3110, APCI-3116**): 2
Watchdog depth: 16-bit
Programmability: ..... 1 µs to 65535 s
Time base: ..... µs, ms, s (programmable)
Monitoring period: ..... 1 to 4095 µs, ms, s
Tolerance: ..... ≤ 1 µs, ms, s

5 INSTALLATION OF THE BOARD

Risk of injury!
Please follow the safety precautions!
An improper handling of the board may cause property damage and injury.

5.1 Opening the PC

♦ Switch off your PC and all the units connected to it.

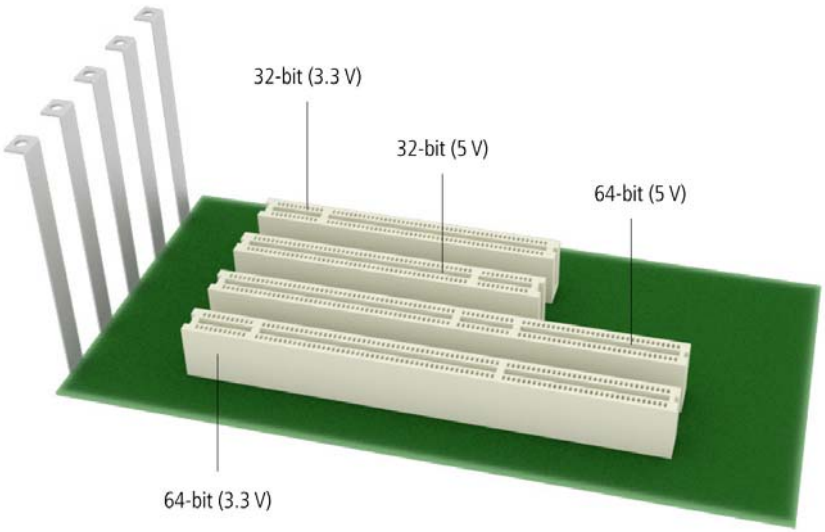
♦ Pull the PC mains plug from the socket.

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

5.2 Selecting a free slot

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

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.

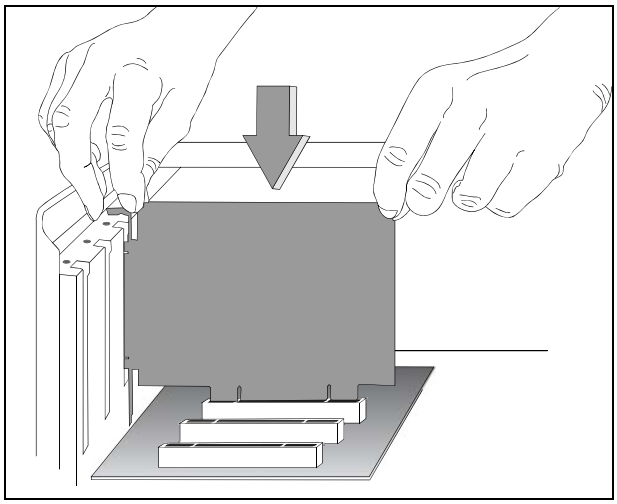
♦ Provide for potential equalisation.

♦ Take the board out of its protective packaging.

5.3 Plugging the board into the slot

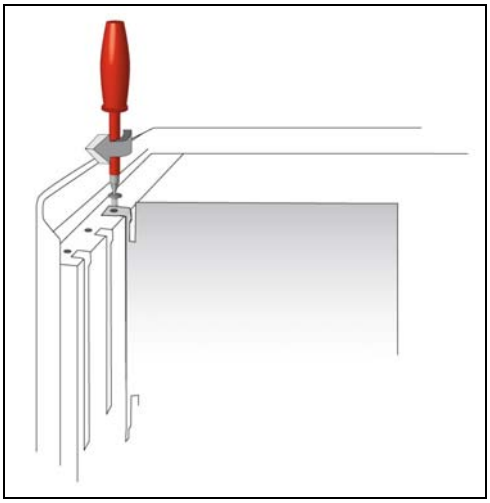
♦ Insert the board vertically into the chosen slot.

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-3xxx** can be downloaded for free at: www.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 Connector pin assignment

Fig. 7-1: 37 pin SUB-D male connector (analog inputs and outputs)

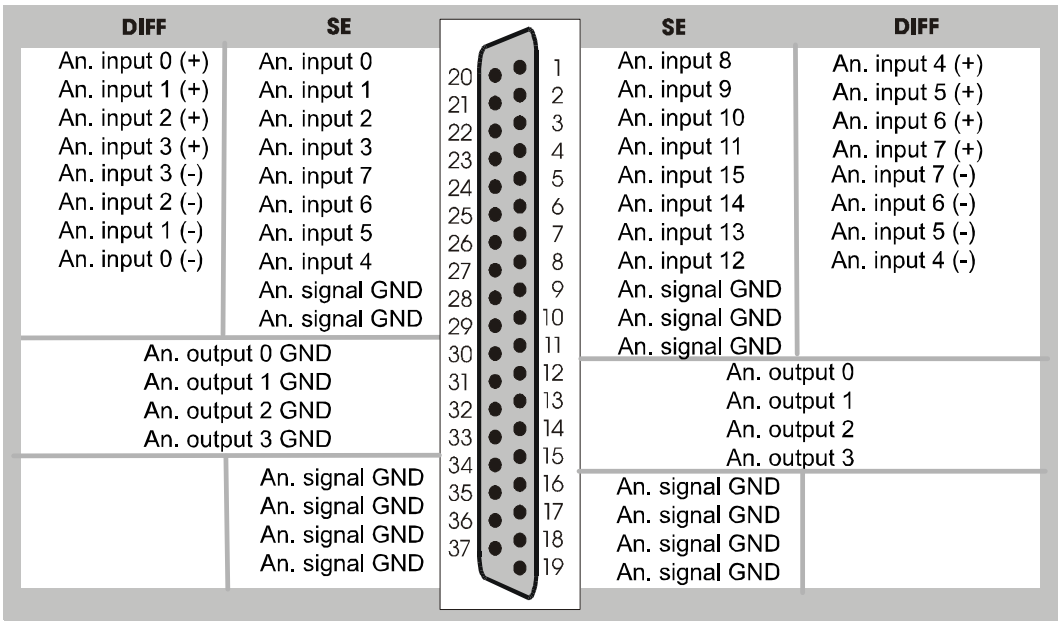
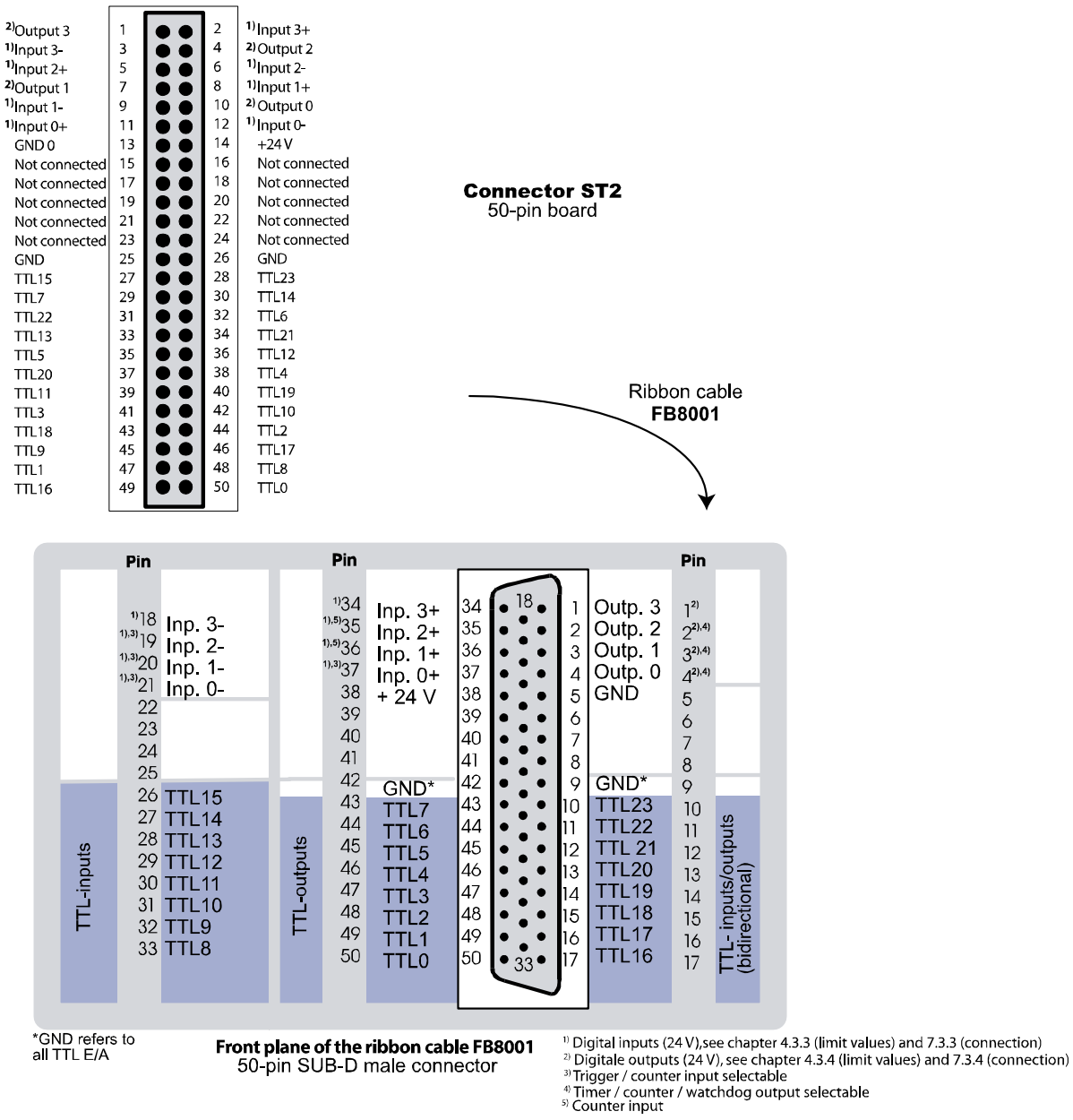


Fig. 7-2: 50-pin connector (TTL I/O)



NOTICE!

The numbering of the 50-pin SUB-D connector corresponds to the usual numbering as printed on the connector for the LP mounting. However, on the connector for the connection to a ribbon cable a different numbering is printed as on the connector (corresponds to the numbering of the ribbon cable).

Table 7-1: Connection of the digital inputs and outputs (24 V and TTL)

	FB8001	Board
Pin description	**Pin No. (50-pin SUB-D male connector)**	**Pin No. (50-pin header)**
+24 V	38	14
Output channel 0	4	10
Output channel 1	3	7
Output channel 2	2	4
Output channel 3	1	1
Input channel 0 (-)	21	12
Input channel 0 (+)	37	11
Input channel 1 (-)	20	9
Input channel 1 (+)	36	8
Input channel 2 (-)	19	6
Input channel 2 (+)	35	5
Input channel 3 (-)	18	3
Input channel 3 (+)	34	2
GND 0	5	13
Not connected	22	15
Not connected	6	16
Not connected	39	17
Not connected	23	18
Not connected	7	19
Not connected	40	20
Not connected	24	21
Not connected	8	22
Not connected	41	23
Not connected	25	24
TTL channel 0	50	50
TTL channel 1	49	47
TTL channel 10	31	42
TTL channel 11	30	39

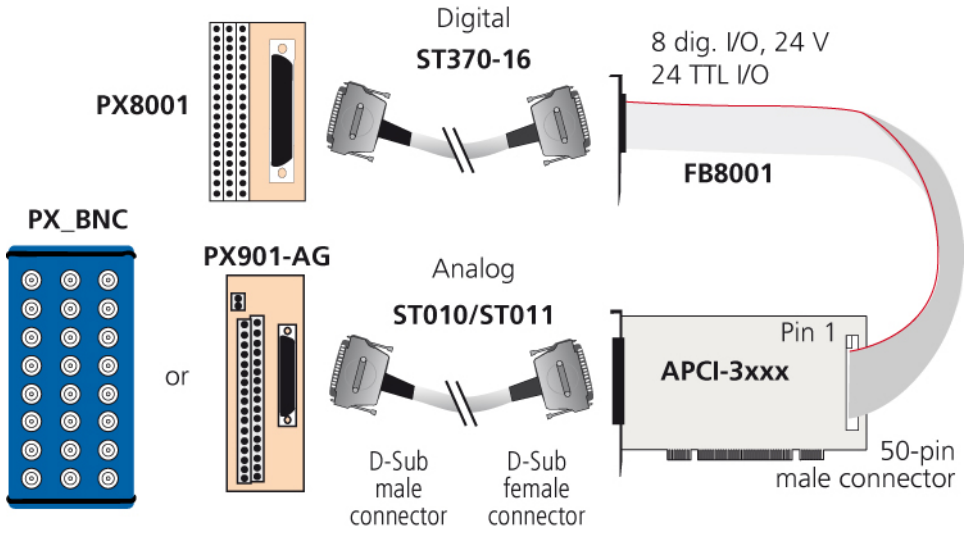
	FB8001	Board
Pin description	**Pin No. (50-pin SUB-D male connector)**	**Pin No. (50-pin header)**
TTL channel 12	29	36
TTL channel 13	28	33
TTL channel 14	27	30
TTL channel 15	26	27
TTL channel 16	17	49
TTL channel 17	16	46
TTL channel 18	15	43
TTL channel 19	14	40
TTL channel 2	48	44
TTL channel 20	13	37
TTL channel 21	12	34
TTL channel 22	11	31
TTL channel 23	10	28
TTL channel 3	47	41
TTL channel 4	46	38
TTL channel 5	45	35
TTL channel 6	44	32
TTL channel 7	43	29
TTL channel 8	33	48
TTL channel 9	32	45
TTL channel GND	9	25
TTL channel GND	42	26

7.2 Connection of the screw terminal panels

The TTL I/Os are connected through the screw terminal panel **PX8001**. The analog inputs are connected either through the screw terminal panel **PX901-AG** (see Fig. 7-3) or the connection box **PX-BNC**.

Our technical support will be pleased to answer your questions about our cables and screw terminal panels.

Fig. 7-3: Connection of the screw terminal panel

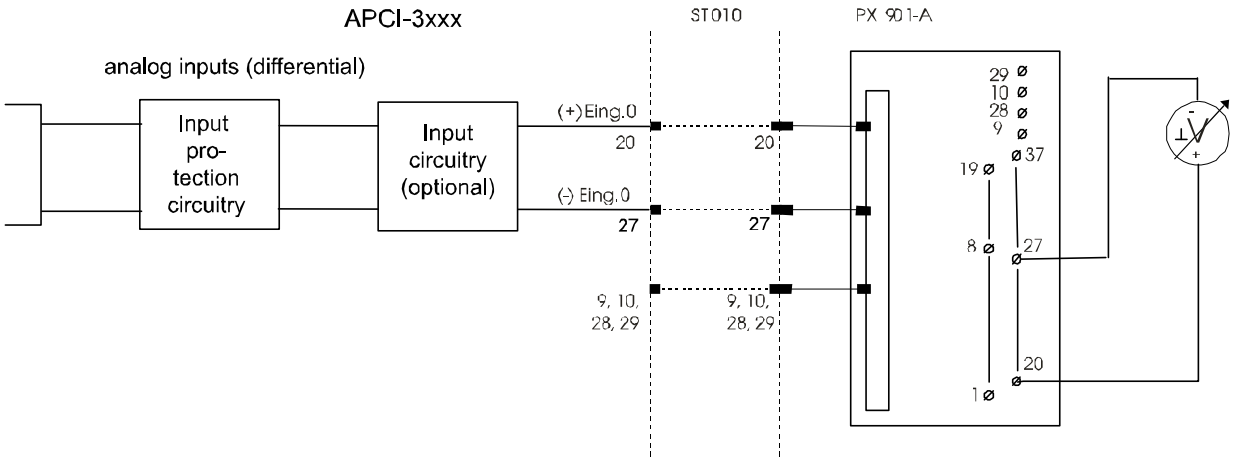


NOTICE!
Plug the **FB8001** cable into the connector of the board by inserting the red (or blue or black) cable line into pin 1.

7.3 Connection examples

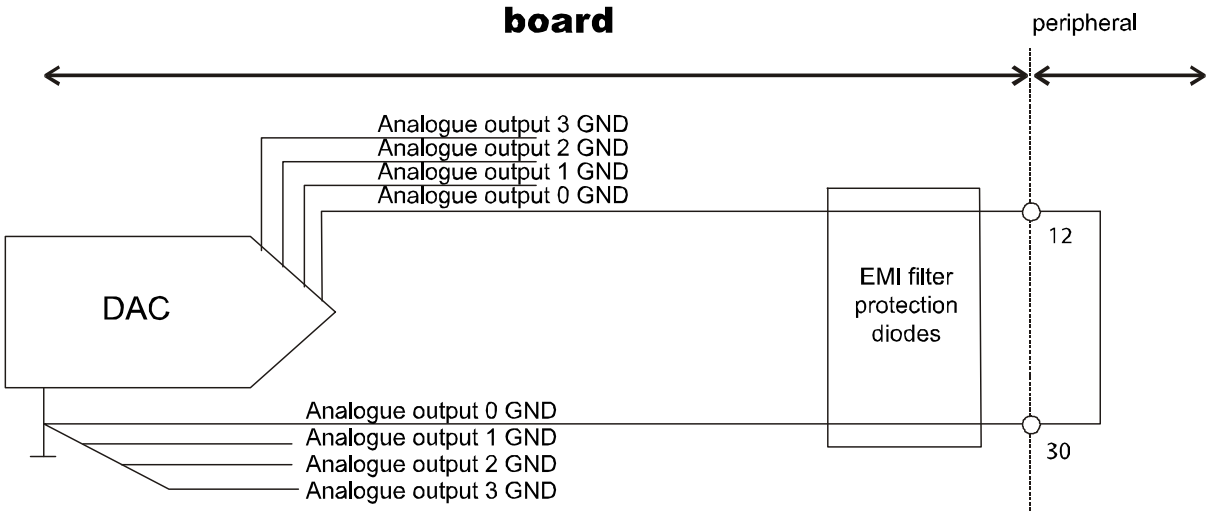
7.3.1 Analog inputs

Fig. 7-4: Connection example: Analog inputs



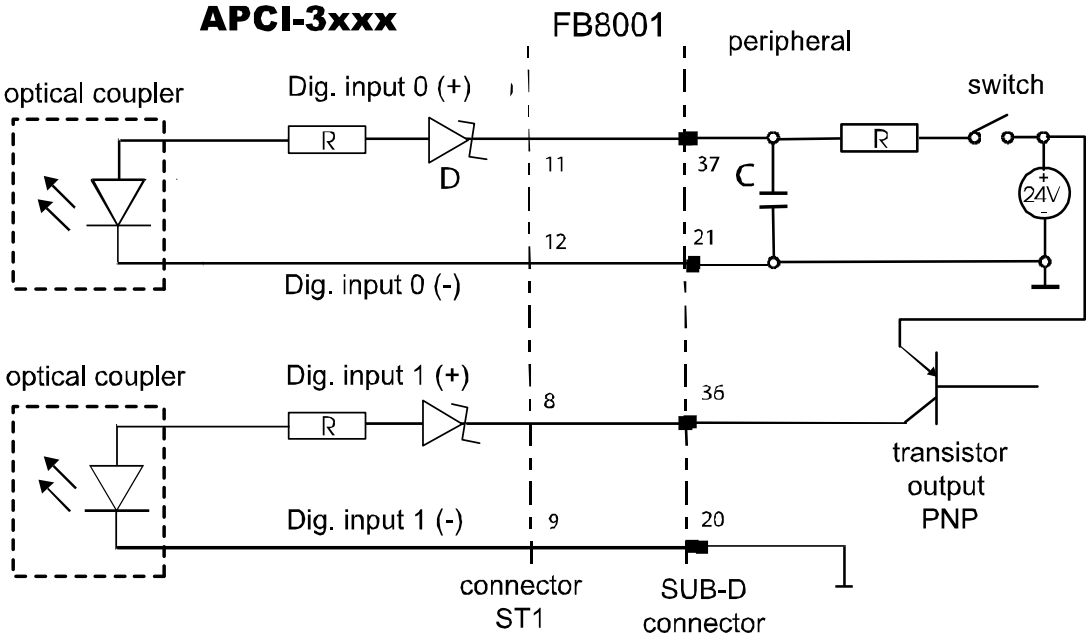
7.3.2 Analog outputs (only APCI-3110 and APCI-3116)

Fig. 7-5: Connection example: Analog outputs



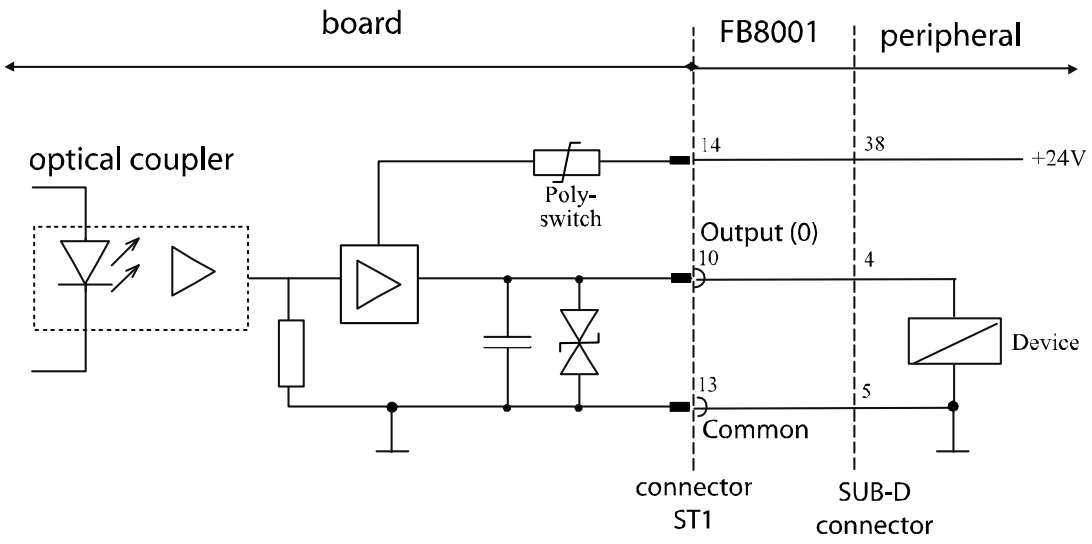
7.3.3 Digital inputs (24 V)

Fig. 7-6: Connection example: Digital inputs



7.3.4 Digital outputs (24 V)

Fig. 7-7: Connection example: Digital outputs



8 FUNCTIONS OF THE BOARD

8.1 Block diagram

Fig. 8-1: Block diagram: APCI-3010 and APCI-3016

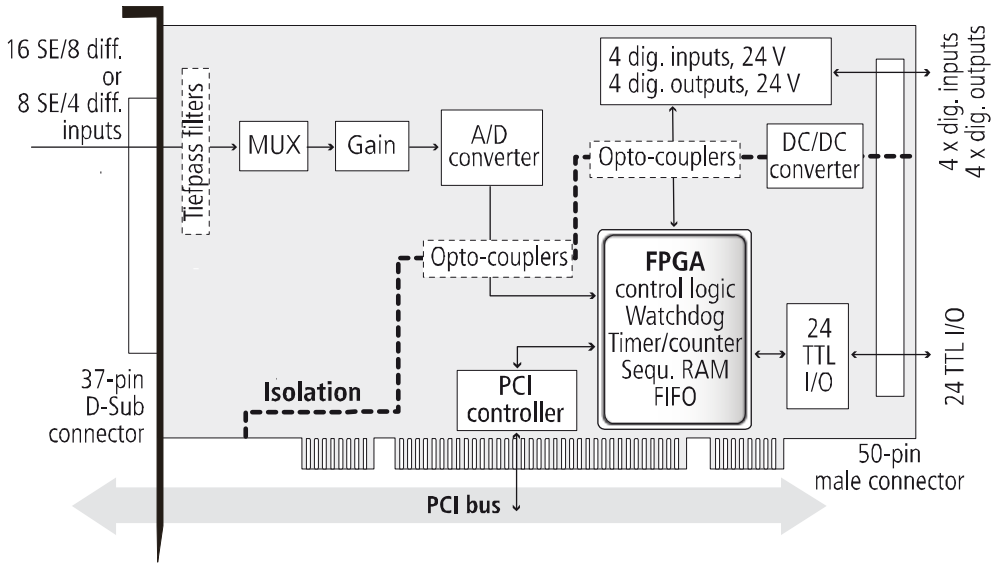
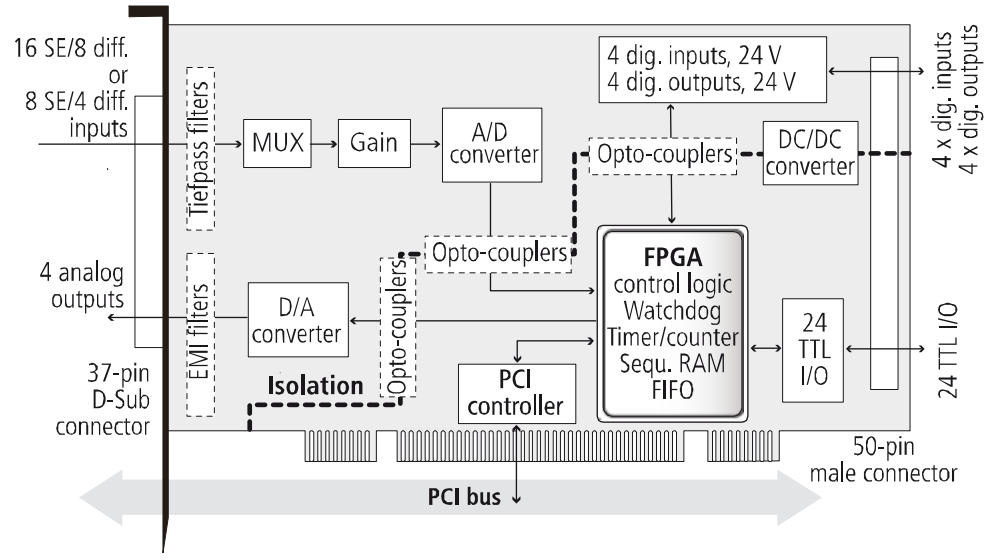


Fig. 8-2: Block diagram: APCI-3110 and APCI-3116

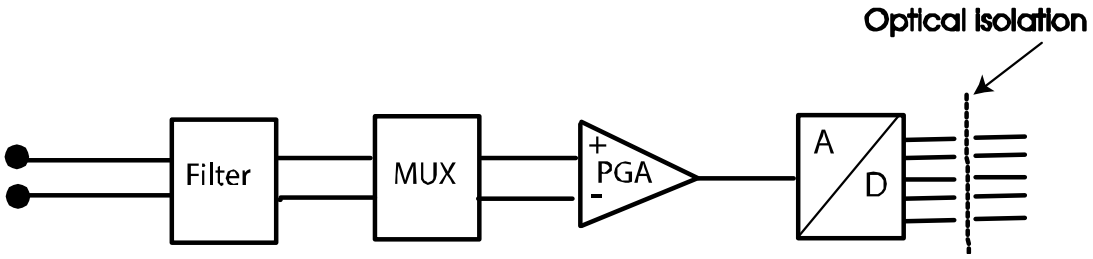


8.2 Analog inputs

There are 16 analog input channels on the boards – the resolution of the **APCI-3010** and **APCI-3110** is 12-bit and of the **APCI-3016** and **APCI-3116** 16-bit.

8.2.1 Overview

Up to 16 analog Single Ended or up to 8 analog differential signals can be connected to the board.



After the signals are transferred over a filter (RC-component) to a multiplexer (time multiplexed system), they are lead over a programmable instrumental gain to a 16-bit A/D converter (or 12-bit for **APCI-3010** and **APCI-3110**).

Data acquisition with the **APCI-3xxx** is based on a time-multiplex system. The board is equipped with a single A/D converter to which the channels are led through an analog multiplexer.

By switching from one channel to another, the output capacity of the multiplexer must be reloaded with the new value.

Therefore, a certain delay occurs from the moment the converter switches to a new channel and the moment the A/D converter starts.

This time delay corresponds to the settling time of an end value. This value depends on the resolution of the acquisition. (e.g.: 0.01 % at 12-bit).

The delay time depends on the following factors:
- Settling time of the amplifiers, approx. 3.5 µs (at 20 V interval)
- Maximum voltage bounce from one channel to another
- Source impedance of the sensors
- Filter option

Input impdance = 10^{12} Ω || 5 nF (differential input)

You can set this settling time (conversion time) in steps from 1 µs between 5 µs and 65535 µs. This is set through the driver.

8.2.2 Voltage ranges

The analog input ranges (0..10 V, ± 10 V, 0..5 V, ± 5 V, 0..2 V, ± 2 V, 0..1 V, ± 1 V and optional 0-20 mA) and the gain can be configured through software.

This enables to switch different voltages (or rather currents) for different channels to use the best resolution of the A/D converter.

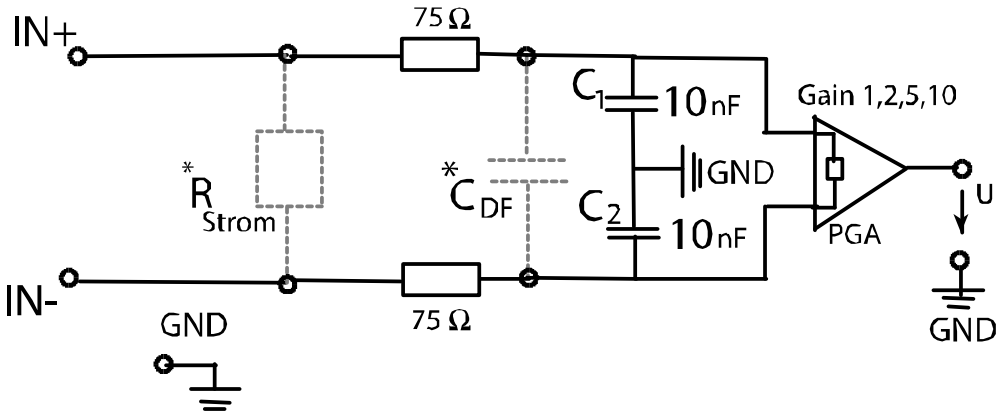
Please note: During the switching of the voltage range from unipolar to bipolar or from bipolar to unipolar there is a longer settling time of the measuring chain.

8.2.3 Analog input switch (differential inputs)

The input impedance is the input resistance (10^{12} Ω) of the PGA and the connected capacities (C_1 and C_2).

Input impedance= 10^{12} Ω || 5 nF

Fig. 8-3: Analog input switch (differential)



*R_{Strom} = optional component part for the version current.
*C_{DF} = optional component part for DF-filter

Limit frequency $f_g = \frac{1}{2\pi * (75\ \Omega + 75\ \Omega) * [C_{DF} + (C_1 || C_2]}$ = **212.2 KHz**

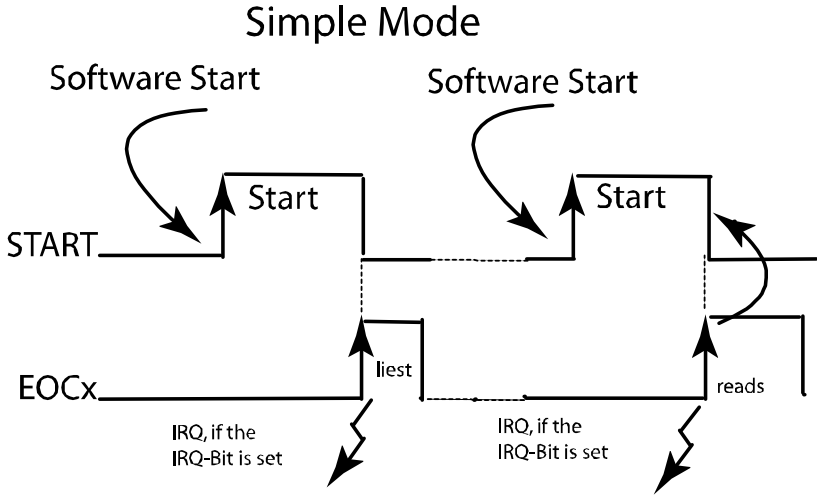
(C_{DF} not assembled)

8.2.4 Input modes of the analog inputs

16 differential channels are available on the board for the analogue inputs.
The acquisition can be realized in the following modes
1) Simple mode
2) Scan mode
3) Sequence mode
4) Auto refresh mode

1) Simple mode

The software initializes and starts the A/D conversion and after this step it reads the digital value of one or more channels.



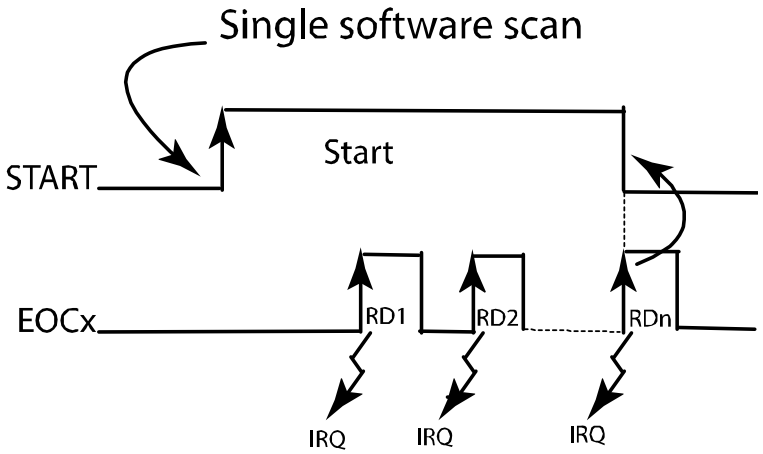
2) Scan modes

There are 6 different scan modes:
a) Single software scan
b) Single hardware triggered scan
c) Continuous software scan
d) Continuous software scan with timer delay
e) Continuous hardware triggered scan
f) Continuous hardware triggered scan with timer delay
The following section describes the above mentioned scan modes more detailed:

a) Single software scan

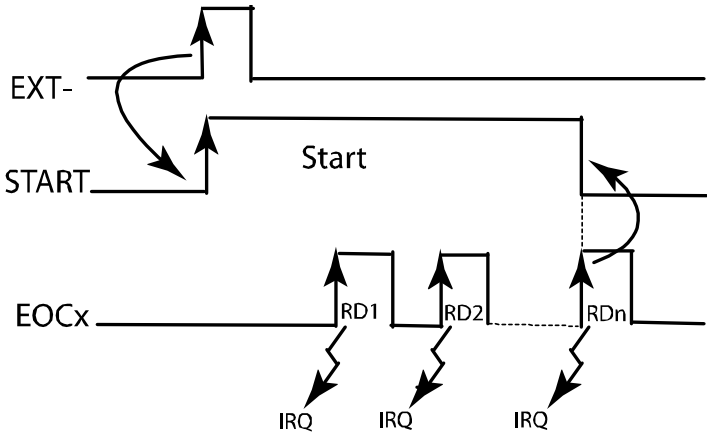
The user interrupt routine is called after the last IRQ (=ADDI-DATA driver).

Note: In the scan mode no DMA functionality is used!

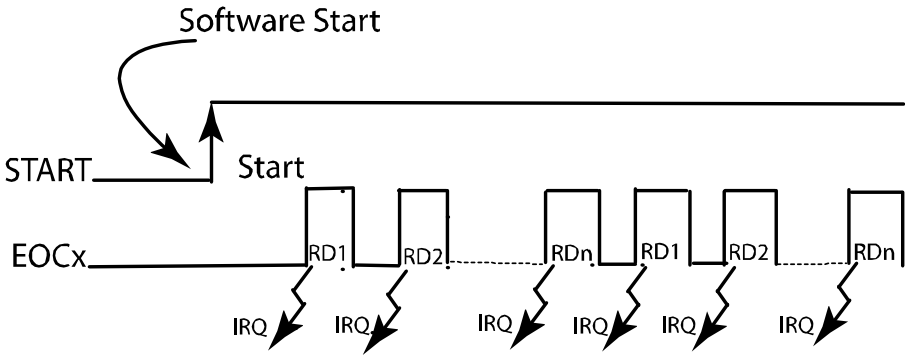


b) Single hardware triggered scan

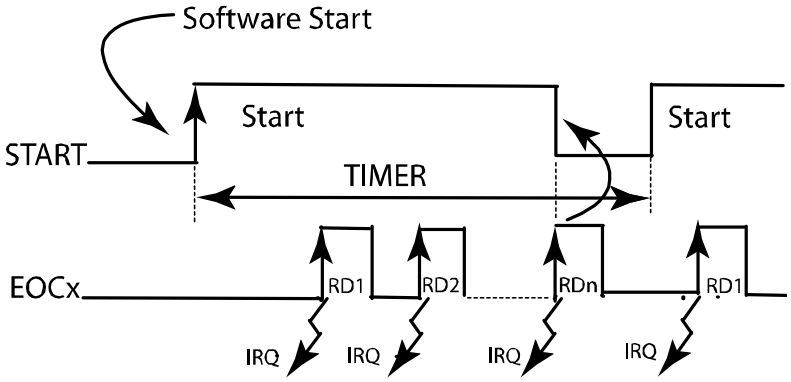
This scan can be triggered with rising or falling edge (software initializes it).



c) Continuous software scan

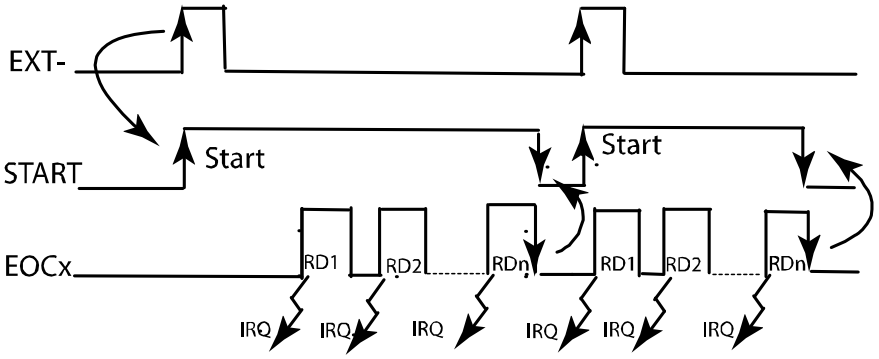


d) Continuous software scan with timer delay

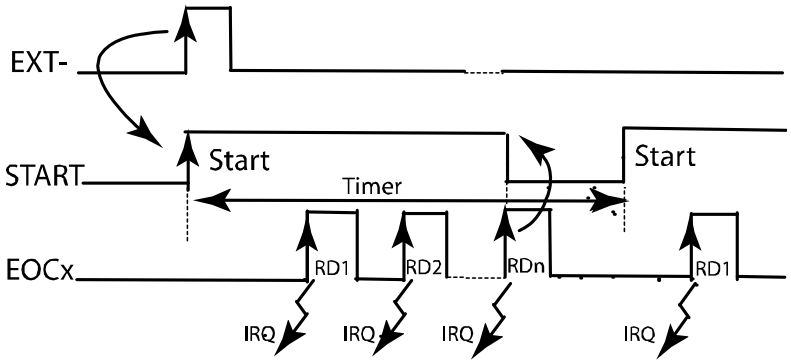


e) Continuous hardware triggered scan

Note: In this scan mode the external signal triggers only one scan at a time!



f) Continuous hardware triggered scan with timer delay



3) Sequence modes (with DMA)

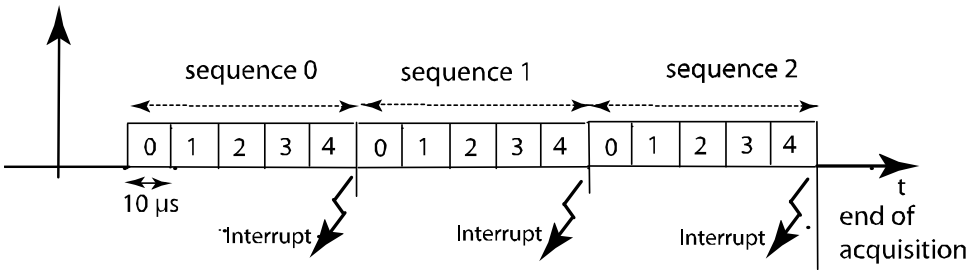
There are 2 sequence modes that are shown in the following two examples:

a) Simple sequence mode (example 1 and 2)
b) Sequence mode with delay (example 1 and 2)

Note: The sequence mode always uses DMA!

a) Simple sequence mode

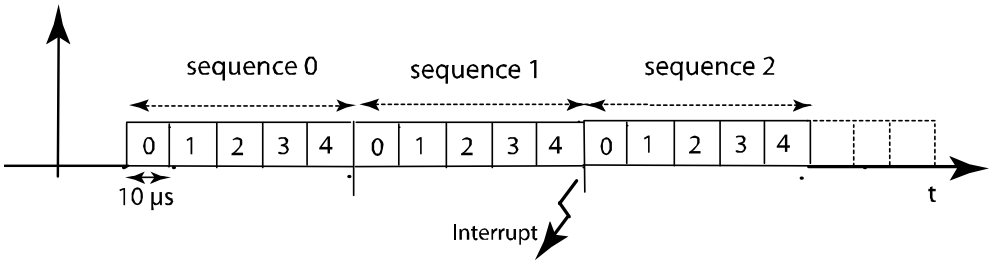
Simple sequence mode – Example 1
In this example the interrupt occurs at the end of each sequence (after 5 acquisitions) and the acquisition is stopped after 3 sequences.



dw_NbrOfChannel = 5
dw_SequenceChannelArray = 0, 1, 2, 3, 4
b_DelayTimeMode = ADDIDATAG_DELAY_NOT_USED
dw_SequenceCounter = 3
dw_InterruptSequenceCounter= 1

Simple sequence mode - example 2

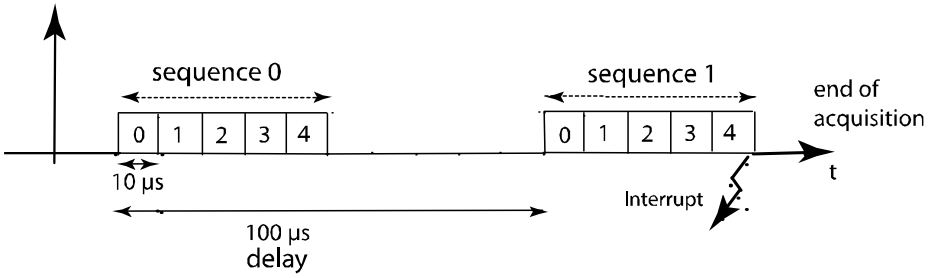
Here the interrupt occurs after 2 sequences (10 acquisitions) and the acquisition is stopped via the following function:
b_ADDIDATA_StopAnalogInputSequenceAcqusisition



dw_NbrOfChannel = 5
dw_SequenceChannelArray = 0, 1, 2, 3, 4
b_DelayTimeMode = ADDIDATAG_DELAY_NOT_USED
dw_SequenceCounter = 0
dw_InterruptSequenceCounter= 2

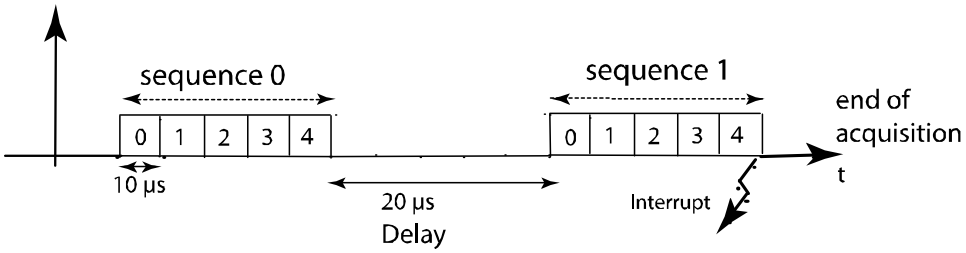
b) Sequence mode with delay

Sequence mode with delay - example 1
The interrupt occurs after the second sequence (10 acquisitions) and the acquisition is stopped. The total delay time from the start of one sequence to the next one is 100 µs.



dw_NbrOfChannel = 5
dw_SequenceChannelArray = 0, 1, 2, 3, 4
b_DelayTimeMode = ADDIDATAG_DELAY_MODE1_USED
b_DelayTimeUnit; = 1(µs)
dw_DelayTime = 100
dw_SequenceCounter = 2
dw_InterruptSequenceCounter= 2

Sequence mode with delay – example 2
The delay time after the end of one sequence to the start of the next sequence is in this example 20 µs.

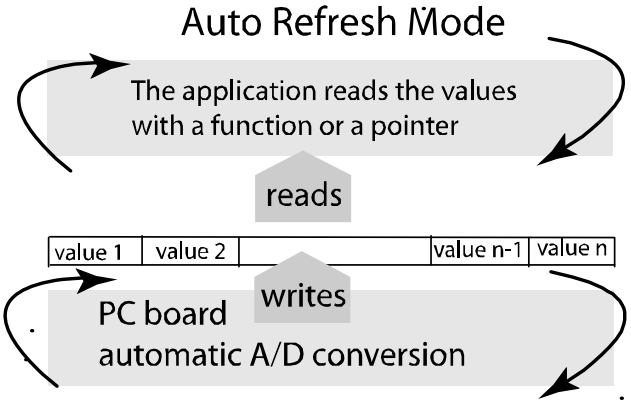


dw_NbrOfChannel = 5
dw_SequenceChannelArray = 0, 1, 2, 3, 4
b_DelayTimeMode = ADDIDATAG_DELAY_MODE2_USED
b_DelayTimeUnit; = 1(µs)

dw_DelayTime = 20
dw_SequenceCounter = 2
dw_InterruptSequenceCounter= 2

4) Auto refresh mode

The analog acquisition is initialized and writes the values of the channels into a storage location on the **APCI-3xxx**. The PC reads the data asynchronous to the acquisition.



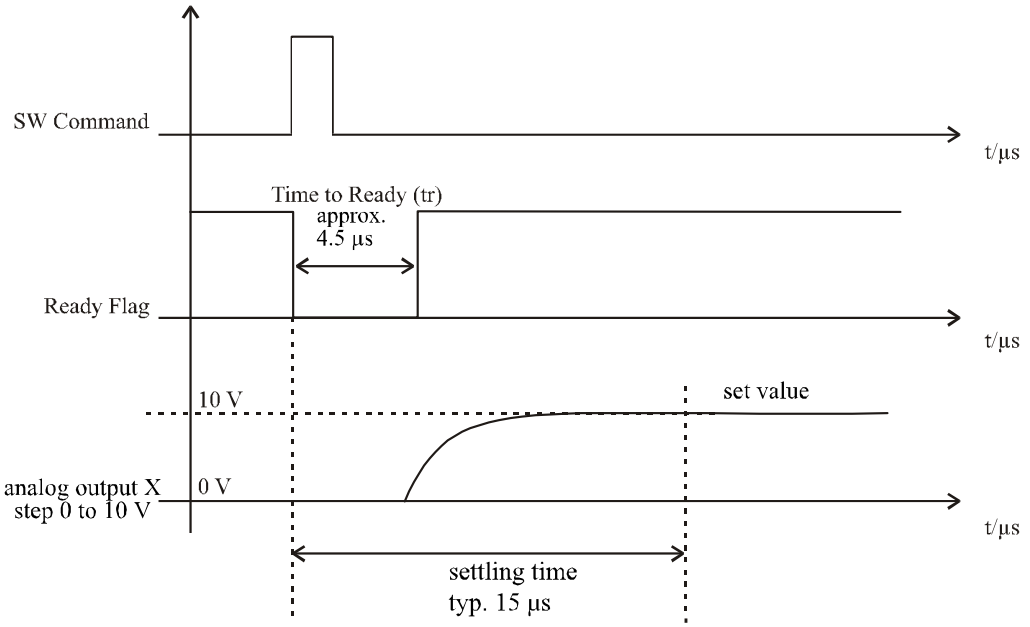
8.3 Analog outputs

There are 4 analog output channels with a resolution of 12-bit and a precision of 11-bit on the **APCI-3110** and **APCI-3116**.

The analog outputs are updated by 32-bit writing on the I/O addresses. The status bit (DAC Ready) indicates if the analog outputs are ready for a new update.

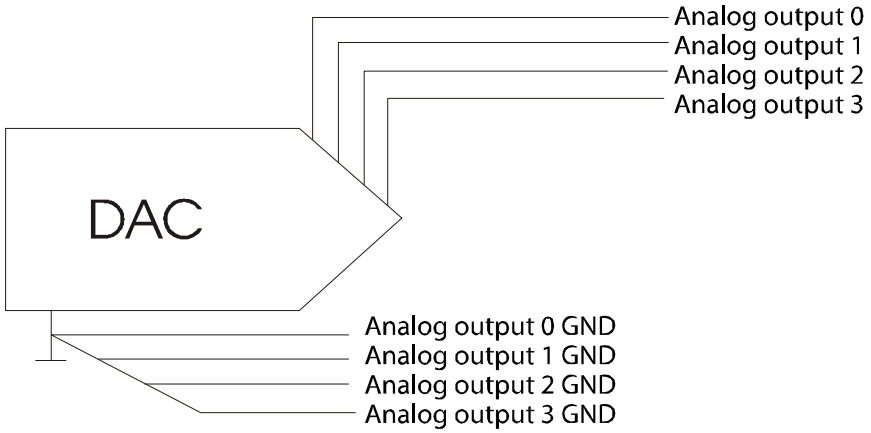
The time ("Time to ready") between the writing on the I/O addresses (DAC register) and the update of the analog outputs is 5 µs. Further accesses to the DAC register will not be considered in this period. The time between writing in the software command and reaching the set value for the analog outputs is 15 µs (settling time).

Fig. 8-4: Reaction time of the analog outputs



When the computer is switched on, the analog outputs are temporarily in an undefined state. It is thus essential that the computer is switched on before the connected peripherals.
After the Power ON reset of the computer, a voltage of 0 V is applied to all analog outputs.

Fig. 8-5: Wiring of the analog ground lines (voltage version)



8.4 Digital inputs

The inputs are designed for the acquisition of external signal states:
The input information is loaded as numerical value into a memory unit of the PC by software.
This numeric value calculates the state of the inputs signals.

24 V optically isolated inputs
They correspond to the 24 V industrial standard (IEC1131-2):
- logic"1" corresponds to an input voltage superior to 19 V
- logic"0" corresponds to an input voltage inferior to 14V.

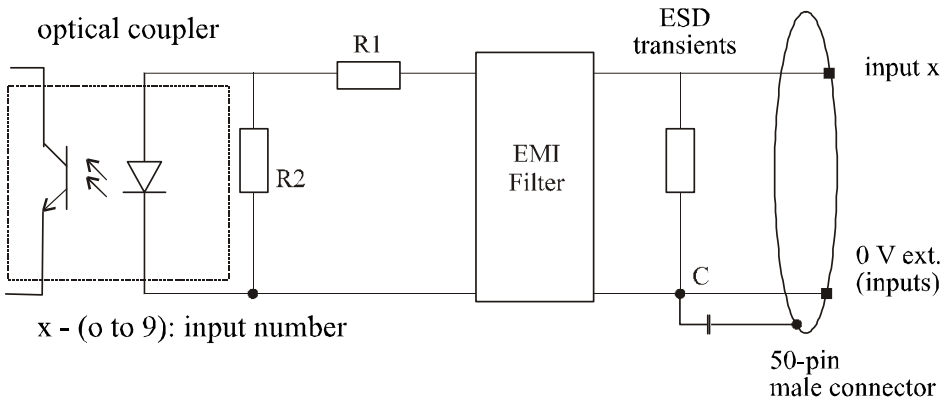
The current consumption for each input is 10.5 mA (when nominal voltage).
The max. input voltage is 30 V.

NOTICE!
The supply unit for the external voltage supply of the board must supply the power that is needed for your application.

The inputs signals are filtered by TRANSIL diodes, Z diodes, LC filer and optical couplers. Herewith the impacts of inductive and capacitive incoupled interferences are reduced.

The board has not to be initialised in order to read directly the digital information of the inputs. The data can be read right after Power ON.

Fig. 8-6: Input circuitry



8.5 Digital outputs

The **APCI-3xxx** has 4 optically isolated outputs.

The positive logic is applied:
- logic"1": Sets the output by software.
- logic"0": Resets the output.

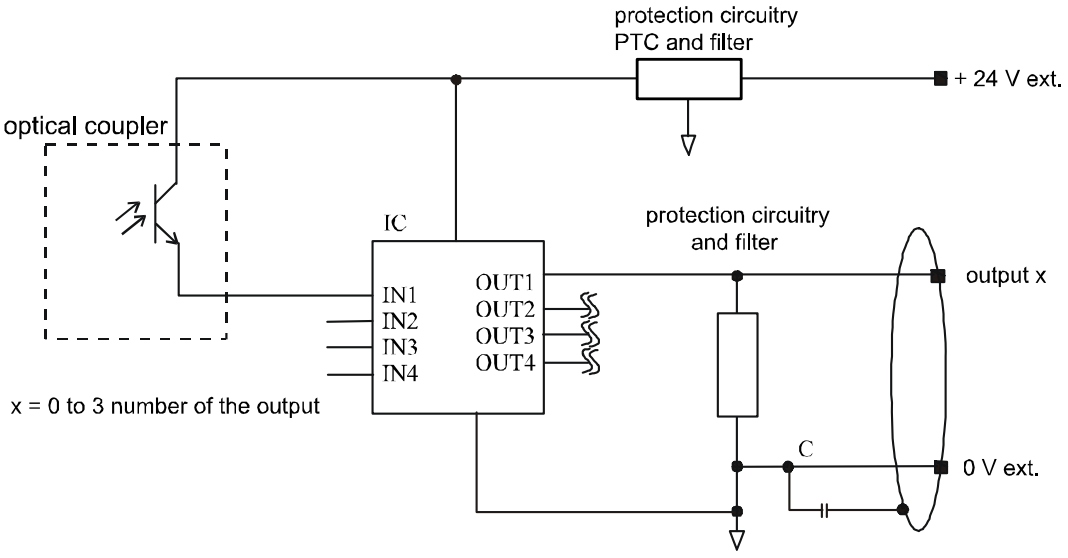
NOTICE!
The supply unit for the external voltage supply of the board must supply the power that is needed for your application.

The max. supply voltage is 35 V.
For each output a current of 50 mA can be set.

The total current for all outputs is limited through a Polyswitch protection piece to 300 mA:

Characteristics of the 24 V outputs:
- Short circuit proof: The output is switched off
- Overtemperature protection: The output driver is switched off
- Transil diodes, C filter and optical couplers reduce interferences from the peripheral to the system bus area. Inductive or capacitive incoupled interferences are reduced.

Fig. 8-7: Output circuitry (24 V)



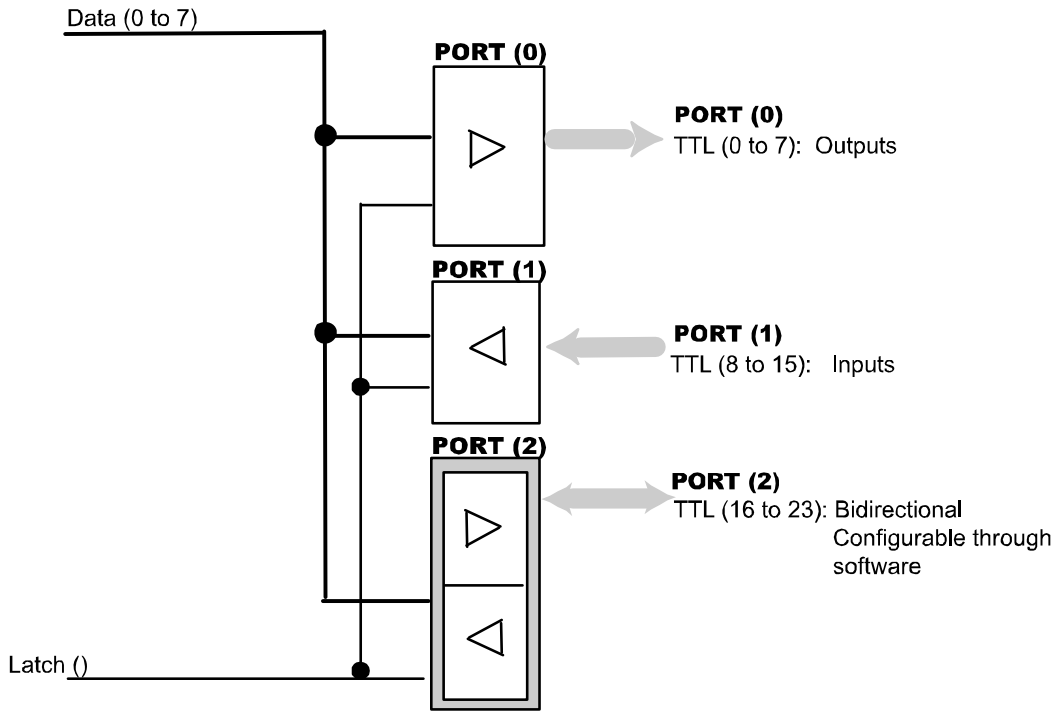
8.6 TTL inputs and outputs

The board **APCI-3xxx** has 24 TTL channels that are divided into three ports:

Table 8-1: TTL I/O (ports)

Port	Description	Channel
Port 0	Output	Channel 0-7
Port 1	Input	Channel 8-15
Port 2	Programmable I/O	Channel 16-23

Fig. 8-8: Block diagram of the TTL I/O



8.7 Watchdog

A 16-bit watchdog is available for the analog outputs and for the 24 V outputs. After its reload value (timeout) the watchdog resets the outputs.

When the watchdog is released, with each setting of the outputs the reload value is reloaded (triggering). The triggering also can be done directly through software command without resetting the outputs.

The operating mode can be read back. As time bases for the watchdog three different clock signals (µs, ms, s) can be used. You can select to release the wtachdog's status on the 24 V- outputs 1 and 2.

8.8 Timer

The 16-bit timer is a downwards counter that can generate an interrupt after the reload value (timeout). With the timer a time base is provided independent from the PC clock, with which for example operations can be synchronized.

The status of the counter value and of the reload value as well as the status and interrupt register can be read back through software.

The operation states can be read back. As time bases for the timer three different clock signals (µs, ms, s) can be used.

8.9 Counter

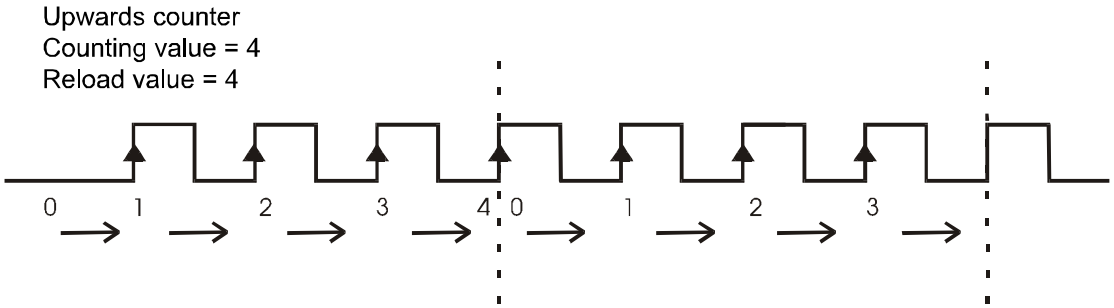
On the **APCI-3xxx** 3 x 16-bit counter inputs are available. Each of these counters can be programmed through software.

The counter inputs are called by the 24 V input channels 0 to 2. If the counter function is not used, the channels are available as standard digital inputs.

Each counter has the following characteristics:
- 2 counting modes: The counter is programmed as upwards or downwards counter.
- After reaching the reload value or when the counter ran off, an interrupt can be generated.
- Reload value: 16-bit
- Clock: The counter counts at falling or rising edge or with each edge.
- Trigger function: Sets the counter to its start value 0 in the upwards mode = clear function
  Reload value in the downwards mode
- Clear function: The counter state is deleted (reload and counting value are set on 0)
- The 3 counters can be initialized, started or stopped simultaneously through synchronous control.
- The status of the inputs 0 to 2 can be read through external clock.

Upward counter

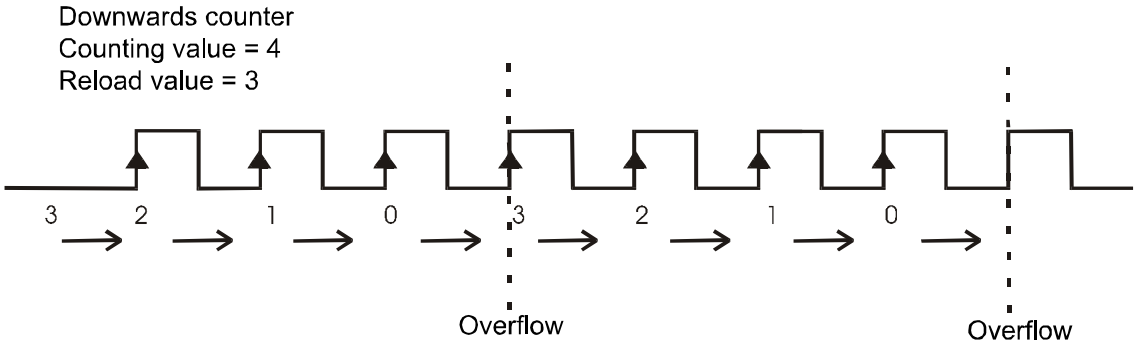
Fig. 8-9: Run down of the upward counter



After reaching the reload value, the counting value is set on 0 and continues to be counted. At an overflow an interrupt can be generated.

Downward counter

Fig. 8-10: Run down of the downward counter

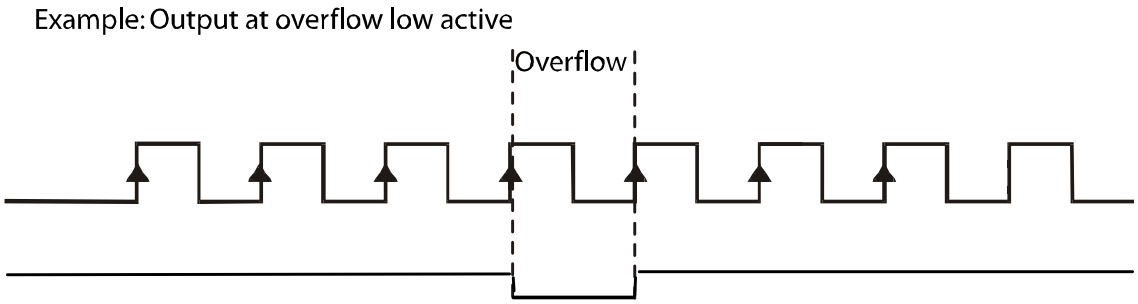


In order to get the same counting value as in the upwards mode, the reload value must be set on 3. The counter counts down to 0 and will be reset to the reload value from the next edge cycle on.

8.10 Setting a digital output

At the run down of the counter/timer/watchdog a digital output (24 V) can be set. Here also the output level can be defined. The output will be enabled for an (input) clock.

Fig. 8-11: Example: Setting a digital output



Allocation to counters/timers:

Timer/counter	=	Digital output 0
Timer/counter/watchdog 1 analog output	=	Digital output 1
Timer/counter/watchdog 2 digital outputs	=	Digital output 2

Table 8-2: Digital inputs and outputs (24 V)

I/O	Description
Output 0	Timer 0 / Counter
Output 1	Timer 1 / Counter 1 / Watchdog 0 (analog output)
Output 2	Timer 2 / Counter 2 / Watchdog 1 (digital outputs)
Input 0	Counter 0 / Trigger for analog acquisition
Input 1	Counter 1
Input 2	Counter 2

9 STANDARD SOFTWARE

The API software functions supported by the board are listed in an HTML document. A description on 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
  77836 Rheinmünster
  Germany

- If you have any questions, do not hesitate to contact us:

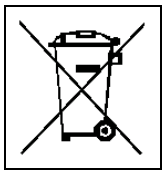
  Phone: +49 7229 1847-0
  E-mail: info@addi-data.com

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: rohs@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
Auto refresh mode	The analog acquisition is initialized and writes the values of the channels into a storage location on the board. The PC reads the data asynchronous to the acquisition.
Clock	A circuit that generates time and clock pulses for the synchronisation of the conversion
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.
Differential inputs (DIFF)	An analog input with two input terminals, neither of which is grounded, whose value is the difference between the two terminals.
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.
Edge	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.
FIFO	= *First In First Out* The first data into the buffer is the first data out of the buffer.

Term	Description
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.
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.
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.

Term	Description
Optical isolation	The technique of using an optoelectric transmitter and receiver to transfer data without electrical continuity, to eliminate high-potential differences and transients.
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.
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.
Protective diode	At the input of the integrated MOS (Metal Oxide Semi-Conductor)-circuits used diodes, which operates at the permitted input voltages in the reverse range, but at overvoltage in the transition range and therefore protects the circuits against damage.
Reference voltage	A point to which all further potentials of a series are referred (often ground potential). In the field of control and regulation, all voltages are measured against a reference voltage.
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.
Scan mode	Scan modes are: Single software scan, single hardware triggered scan, continuous software scan, continuous software scan with timer delay, continuous hardware triggered scan and continuous hardware triggered scan with timer delay.
Sensor	A device that responds to physical stimuli (heat, light, sound, pressure, motion, etc.) and produces a corresponding electrical output.
Sequence mode	A sequence consists of a certain number of acquisitions, and the sequence mode defines the mode of acquisition (simple sequence mode and sequence mode with delay)
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.
Short circuit	A short circuit of two clamps of an electric switch is when the concerning clamp voltage is zero.
Short circuit current	Short circuit current is the current between tow short-circuited clamps.

Term	Description
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.
Simple mode	The software initializes and starts the A/D conversion and after this step it reads the digital value of one or more channels.
Single Ended inputs (SE)	An analog input with one input terminal whose value is measured with respect to a common ground
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.
Trigger	Internal trigger: A software generated event that starts an operation. External trigger: An analog or digital hardware event from an external source that starts an operation. Digital trigger: An event that occurs at a user-selected point on a digital input signal. The polarity and sensitivity of the digital trigger can often be programmed.
TTL	*= transistor-transistor-logic* A popular logic circuit family that uses multiple-emitter transistors.

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