DIN EN ISO 9001:2000
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Preliminary version

Technical description

APCI-3000, APCI-3006, APCI-3100, APCI-3106, APCI-3500

Analog I/O board

Edition: 01.10 - 10/2006

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.
The content of this manual and the technical product data may be changed without prior notice.
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WARNING

In case of wrong uses and if the board is not used for the purpose it is intended:

- **people may be injured**

- **the board, PC and peripheral may be destroyed**

- **the environment may be polluted**

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

  If this leaflet is not with the documentation, please contact us and ask for it.

- **Observe the instructions of the manual.**

  Make sure that you do not forget or skip any step. We are not liable for damages resulting from a wrong use of the board.

- **Used symbols:**

IMPORTANT!
designates hints and other useful information.

WARNING!
It designates a possibly dangerous situation.
If the instructions are ignored the board, PC and/or peripheral may be destroyed.

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1 DEFINITION OF APPLICATION

1.1 Intended use

The board **APCI-3xxx**[1] must be inserted in a PC with PCI 3.3 V/5V (32-/64-bit) which is used as electrical equipment for measurement, control and laboratory use as defined in the norm IEC 61010-1.

1.2 Usage restrictions

The board **APCI-3xxx** must not to be used as safety related part for securing emergency stop functions.

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

1.3 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. The following table shows the most significant characteristics of your board:

Table 1-1: Overview

	APCI-3000	APCI-3006	APCI-3100	APCI-3106	APCI-3500
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	-
Throughput	100 kHz	100 kHz	100 kHz	100 kHz	-
Analog outputs	-	-	4	4	4
Resolution	-	-	12-bit	12-bit	12-bit
TTL inputs/outputs	24	24	24	24	24
Timer	3 (16-bit)	3 (16-bit)	3 (16-bit)	3 (16-bit)	3 (16-bit)
Counter	3	3	3	3	3

[1] Common name for the boards **APCI-3000**, **APCI-3006**, **APCI-3100**, **APCI-3106** und **APCI-3500**.

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 panels is to occur in a closed switch cabinet.

The screw terminal panel **PX 901-AG** allows the connection of the analog signals to the peripheral through the standard cable **ST010**. The analog signals also can be connected through the connection box **PX-BNC**. Through the screw terminal panel **PX 8000**, the standard cable **ST370-16** 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:
- metallized plastic hoods
- shielded cable
- cable shield folded back and firmly screwed to the connector housing

Remarks

The use of the board in a PC could change the PC features regarding noise emission and immunity. Increased noise emission or decreased noise immunity could result in the system not being conform anymore.

Check the shielding capacity of the PC housing and of the cable prior to putting the device into operation.

The use of the board according to its intended purpose includes observing all advises given in this manual and in the safety leaflet.

Uses beyond these specifications are not allowed. The manufacturer is not liable for any damages which would result from the non-observance of this clause.

Make sure that the board remains in its protective blister pack **until it is used**.

Do not remove or alter the identification numbers of the board.
If you do, the guarantee expires.

2 USER

2.1 Qualification

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

- installation
- use
- maintenance

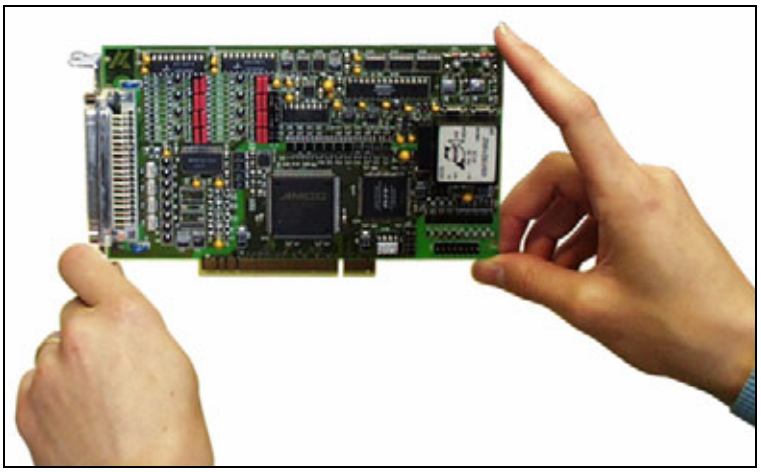
2.2 Personal protection

Consider the country-specific regulations about:

- the prevention of accidents
- electrical and mechanical installations
- radio interference suppression.

3 HANDLING OF THE BOARD

Fig. 3-1: Correct handling



4 TECHNICAL DATA

4.1 Electromagnetic compatibility (EMC)

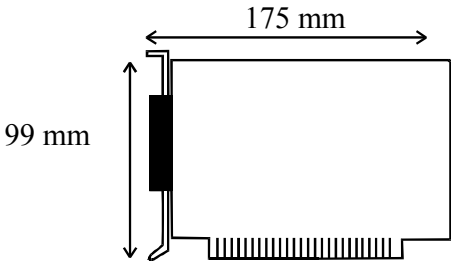
The board has been subjected to EMC tests in an accredited laboratory. The board complies with the limit values set by the norms IEC61326 as follows:

	True value	Set value
ESD (Discharge by contact/air)	4/8 kV	4/8 kV
Fields	10 V/m	10 V/m
Burst	4 kV	2 kV
Conducted radio interferences	10 V	10 V

4.2 Physical set-up of the board

The board is assembled on a 4-layer printed circuit card.

Dimensions:



Weight: ..... approx. 160 g
Installation in: ..... 32-/64-bit PCI slot 3.3 V/5 V
Connection to peripheral:
Front connector: ..... 37-pin SUB-D male connector

Additional connector:
APCI-3000, **APCI-3006**, **APCI-3100**,
APCI-3106, **APCI-3500**: .....50-pin male connector for the TTL 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:
Cables:.....**- FB 8001**
.....**- ST370-16**
Screw terminal panel:..... **- PX 8000**

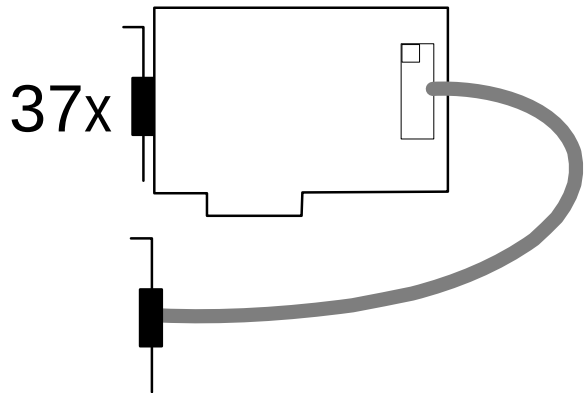
1 Not contained in the standard delivery.

4.3 Limit values

Max. altitude: ..... 2000 m
Operating temperature: ..... 0 to 60°C
Relative humidity: ..... 30% to 99% without condensing
Storage temperature: ..... -25 to 70°C

Minimum PC requirements::
PCI BIOS up from version 1.0
Bus speed: ..... ≤ 33 MHz
Operating system: ..... Windows 2000, XP (further on request)
Slots: ..... PCI 5 V or PCI 3.3 V, 32-bit + 1 slot opening for the connection of the TTL I/O or digital I/O

Fig. 4-1: Required slots



4.3.1 Analog inputs

Number of channels: ..... 16 analog inputs
Resolution (**APCI-3000** and **APCI-3100**): 12-bit
Resolution (**APCI-3006** and **APCI-3106**): 16-bit

Please note that there are no analog inputs are available on the board **APCI-3500**.

4.3.2 Analog outputs

Analog outputs are available on the following boards:
- **APCI-3100**
- **APCI-3106**
- **APCI-3500**

Number of channels: ..... 4 analog outputs
Output type:..... Voltage outputs: Single-Ended
Resolution: 12-bit
Output range: ..... 0 to 10 V - LSB (- 10 V -1LSB)
LSB: ..... 4.8824 mV
Precision: 11-bit
Time to ready (tr): ..... 5 µs
Settling time
(=tr + Settling time of the DAC): ..... 15 µs (at 10 V intervals)
Temperature drift: ..... max. 10 ppm/°C
Max. output current: ..... ± 5 mA
Short circuit current: ..... ± 20 mA

4.3.3 TTL I/O

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]

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

4.3.4 Timer and counter

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

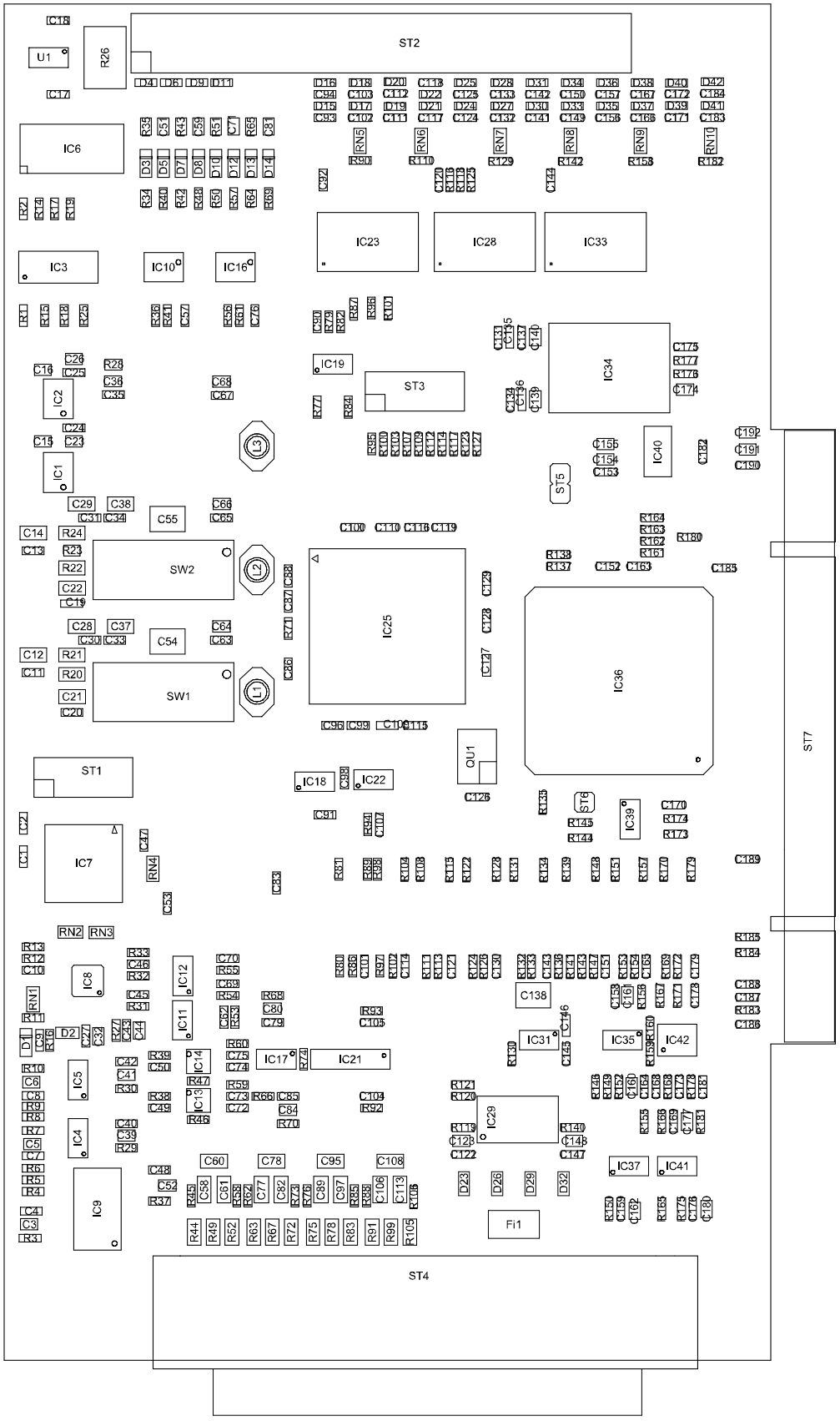
[1] Measured with an Agilent function generator type 33220A with connection through the screw terminal panel **PX8000** and the connection cables **ST370-16** and **FB8001**

Counter, interruptible

Number:	3
Counter depth:	16-bit
Reload value:	16-bit (programmable)
Input:	Low/High (programmable)
Output:	Low/High (programmable)
Operation mode:	Mode 2, Mode 3 (programmable)

4.4 Component scheme

Fig. 4-2: Component scheme



5 INSTALLATION OF THE BOARD

IMPORTANT!
Do observe the safety precautions!

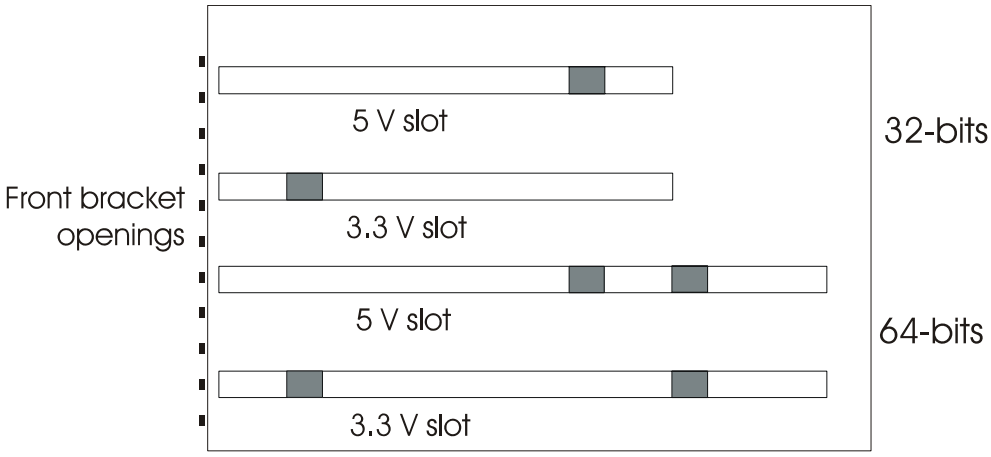
5.1 Opening the PC

- **Switch off your PC and all the units connected to the PC**
- **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 slot PCI 5 V or PCI 3.3 V (32-/64-bit).**

Fig. 5-1: PCI-5V slot (32-bit)



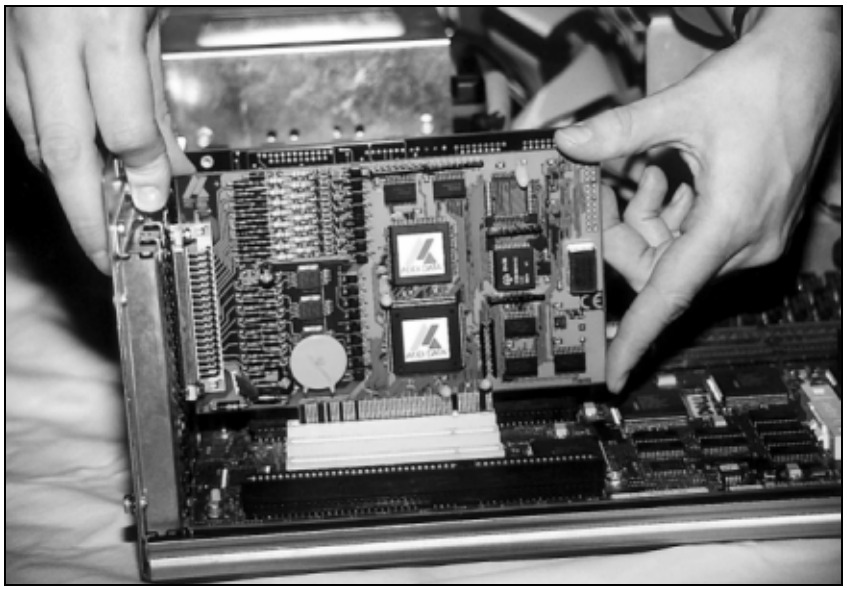
Remove the back cover of the selected slot according to the instructions of the PC manufacturer. Keep the back cover. You will need it if you remove the board

- **Discharge yourself from electrostatic charges.**
- **Take the board out of its protective pack.**

5.3 Plugging the board into the slot

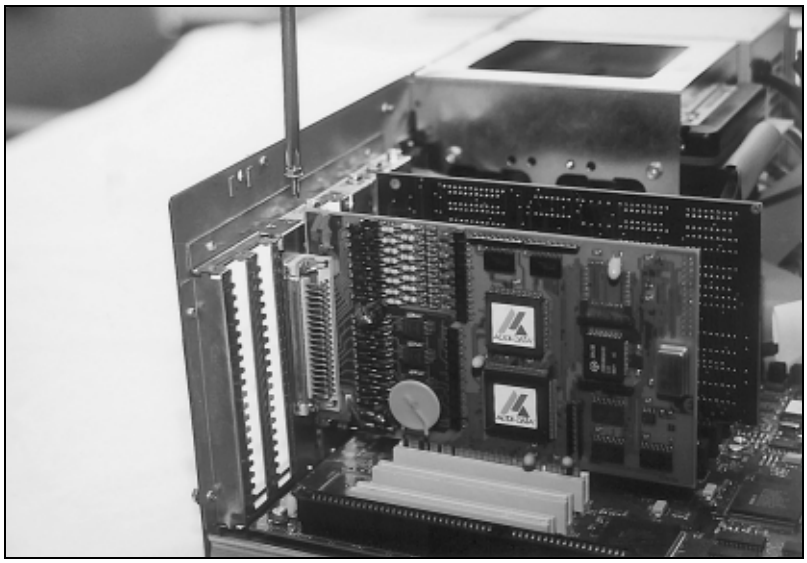
♦ Insert the board **vertically into the chosen slot.**

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 the loosen screws.**

5.4 Closing the PC

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

6 SOFTWARE

In this chapter you will find a description of the delivered software and its possible applications.

IMPORTANT!
Further information for installing and uninstalling the different drivers is to be found in the delivered description **"Installation instructions for the PCI/ISA bus".**

A link to the corresponding PDF file is available in the navigation pane (Bookmarks) of Acrobat Reader.

IMPORTANT!
The supported software functions for the **APCI-3xxx** are listed in chapter 9.

The board is supplied with a CD-ROM containing the ADDIPACK software package for Windows NT 4.0 and Windows XP/2000/98.

ADDIPACK is composed of following programs:

- **ADDIREG:** The ADDIREG registration program is a 32-bit program for Windows NT 4.0 und Windows XP/2000/98. The user can register all hardware information necessary to operate the ADDI-DATA PC boards.

- **ADDIDRIVER** contains API functions to operate the ADDI-DATA boards in 32-bits.

- **ADDevice Manager** configures the resources of the ADDI-DATA virtual board (see below).

- **ADDI-DATA virtual board:**
  ADDI-DATA software is based on the principle of a virtual board**:** it transposes the different functions (e.g. digital inputs, analog outputs, timer, ...) of all inserted ADDI-DATA boards as the functions of a single (virtual) board. The virtual board features a pool of functions, the functionality of which can be called up without calling a specific board.

- **ADDEVICE MAPPER** was specifically developed for the ADDIPACK boards to facilitate the management of the virtual board. With this program you can optimally adapt the virtual board to your application requirements.

  IMPORTANT!
  For some functions of the **ADDEVICE MAPPER** program the browser Internet Explorer 6 or higher has to be installed on your PC.

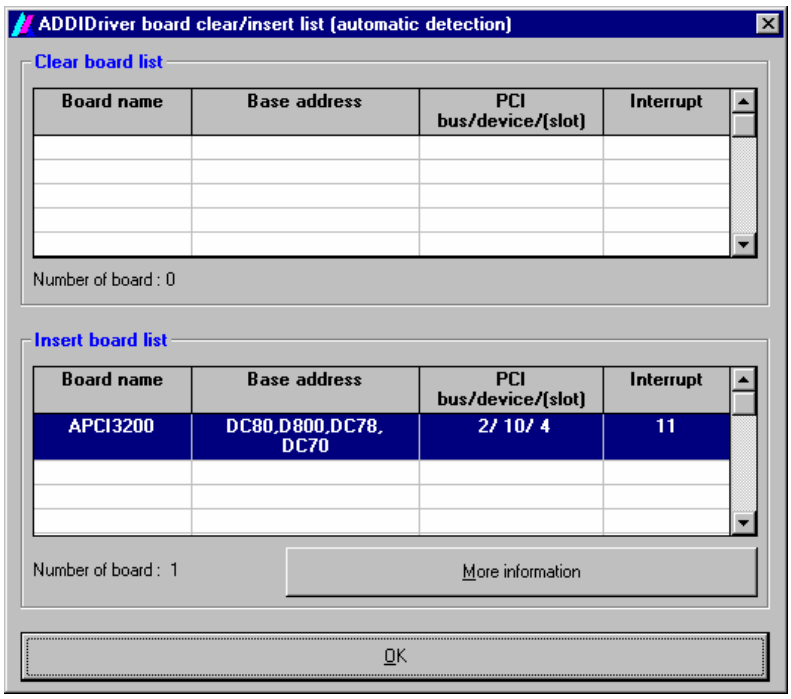
6.1 Board registration

When starting the set-up of ADDIREG, the **APCI-3xxx** is automatically recognised and registered.

6.1.1 Installation of a new board

If a new board is recognised, the following window is displayed:

Fig. 6-1: New inserted board



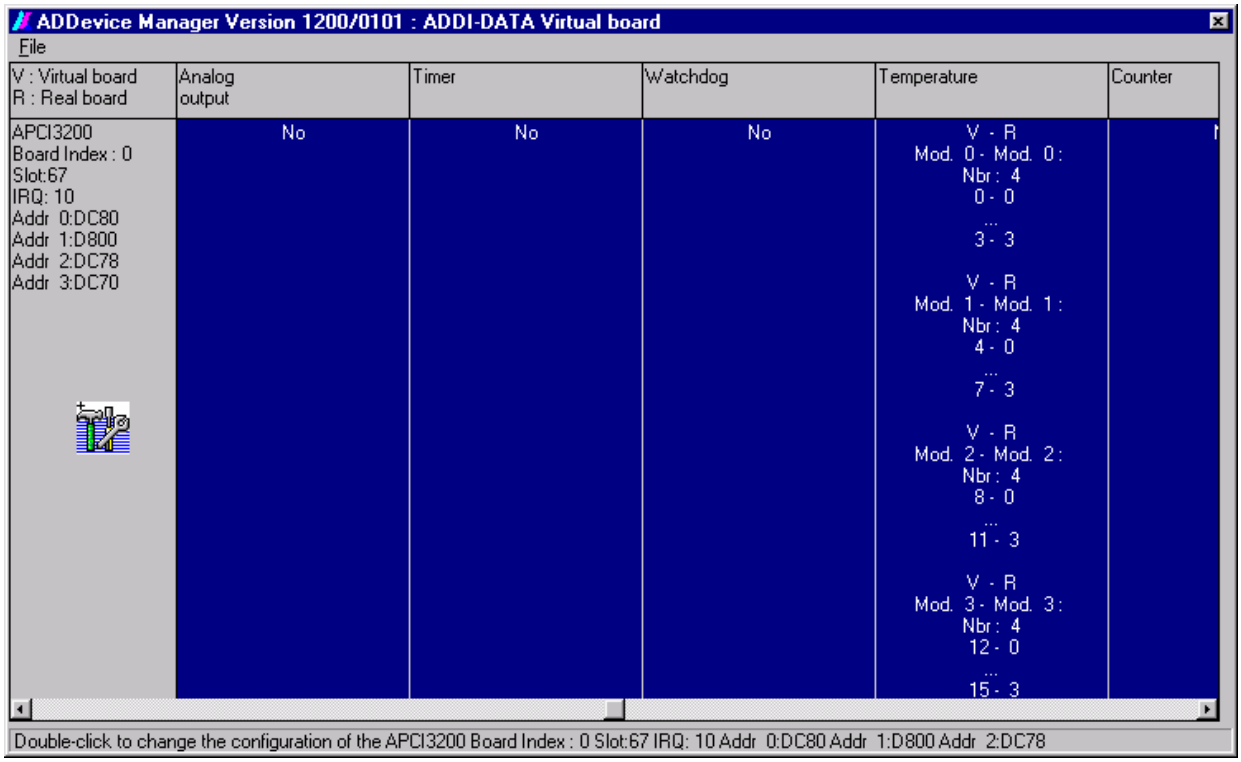
The boards which have been removed from the PC since the last ADDIREG start are listed in the upper table

The new inserted boards are listed in the lower table.

In case further information is required for the operation of the board, click on "More Information". ADDevice Manager is started.

ADDevice Manager

Fig. 6-2: ADDevice Manager



The following parameters are displayed for every inserted board:

First column:

- Board name
- Board index: Number allocated to the board when it is registered in ADDIREG.
- Slot number
- IRQ line
- Different addresses which are automatically allocated to the board by the BIOS.

Other columns:

The program distinguishes between the resources (Analog/digital input/output, watchdog, ...) of the virtual board (**V,** software) and the real board (**R,** board).

The following parameters are listed

- Module number,
- Number of resources
- Index: The first index line represents the number of the first resource (left: virtual resource - right: real board) The second index line represents the number of the last resource (left: virtual resource - right: real board).
- Type (24 V/5 V, voltage/current, HS/OC - High-Side/Open collector).
- IRQ: if the input channels are interruptible, the program displays the number of the first and of the last input channel

By clicking twice within a column, the connection principle and the technical data of the resource are displayed. This function is only possible if a question mark appears with the cursor.

You can export the set configuration as a text file. Click on "file" and save the configuration as a .txt file with "Export information to file...". You can then print the configuration or use it for other boards.

Once you have controlled the registration, you can quit the window of ADDevice Manager. The board is ready to operate.

6.1.2 Changing the registration of a board

You can change the current board configuration with ADDIREG

Description of the ADDIREG program

The program is automatically installed with ADDIPACK.
Start ADDIREG under Start/Programme/ADDIPACK/ADDIREG.

IMPORTANT!
First quit all the applications (programs) which use the board before starting the ADDIREG program.

In the main window of ADDIREG the fields "Insert" and "Clear" are not available for the board.

Fig. 6-3: ADDIREG registration program (example)

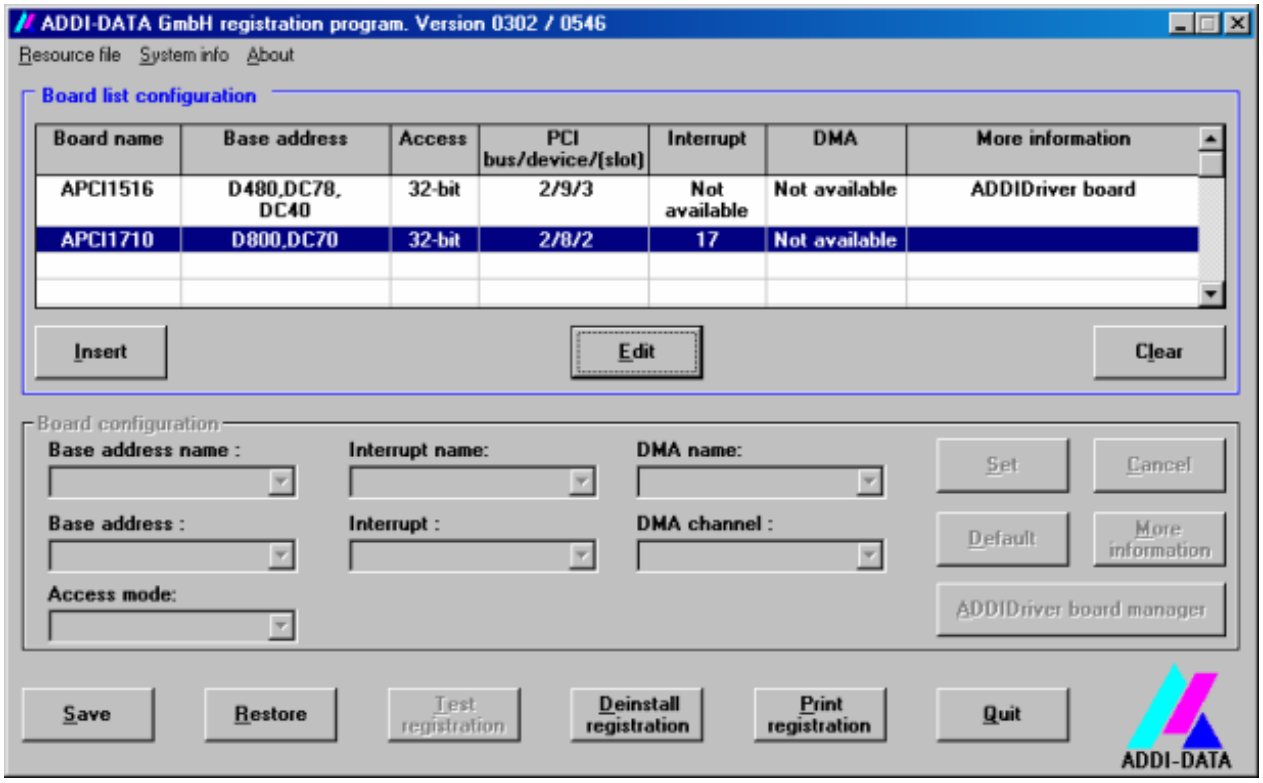


Table:

Board name:
Names of the different registered boards (e.g.: APCI-3200).

Base address:
Selected base address of the board. For PCI boards the base address is allocated through BIOS.

Access:
Selection of the access mode for the ADDI-DATA digital boards.
Access in 8-bit or 16-bit or 32-bit mode.

PCI bus/device/(slot):
Number of the used PCI bus, slot, and device. If the board is no PCI board, the message "NO" is displayed.

Interrupt:
Used interrupt of the board. If the board supports no interrupt, the message "Not available" is displayed. **For PCI boards the interrupt is allocated through BIOS.**

DMA (ISA boards only):
Indicates the selected DMA channel or "Not available" if the board uses no DMA or if the board is no ISA board.

More information:
Additional information like the identifier string or the installed COM interfaces. It also displays whether the board is programmed with ADDIDRIVER or if a **PCI DMA** memory is allocated to the board.

Text boxes:

Base address name:
Description of the used base addresses for the board. Select a name through the pull-down menu. The corresponding address range is displayed in the field below (Base address).

Interrupt name:
Description of the used IRQ lines for the board. Select a name through the pull-down menu. The corresponding interrupt line is displayed in the field below (Interrupt).

DMA name (for ISA boards only):
When the board supports 2 DMA channels, you can select which DMA channel is to be changed.

DMA channel (for ISA boards only):
Selection of the used DMA channel.

Buttons:

Edit:
Selection of the highlighted board with the different parameters set in the text boxes.

Set:
Sets the parametered board configuration. The configuration should be set before you save it.

Cancel:
Reactivates the former parameters of the saved configuration.

Default:
Sets the standard parameters of the board.

More information (not available for the boards with ADDIPACK)
You can change the board specific parameters like the identifier string, the COM number, the operating mode of a communication board, etc...
If your board does not support these information, you cannot activate this button.

ADDIDriver Board Manager:
Under Edit/ADDIDriver Board Manager you can check or change the current settings of the board set through the ADDEVICE Manager. ADDevice Manager starts and displays a list of all resources available for the virtual board.

Test registration:
Controls if there is a conflict between the board and other devices installed in the PC. A message indicates the parameter which has generated the conflict. If no conflict has occurred, "Test of device registration OK" is displayed.

Deinstall registration:
Deinstalls the registrations of all boards listed in the table and deletes the entries of the boards in the Windows Registry.

Print registration:
Prints the registration parameter on your standard printer.

Quit:

Registration test

Under "Test registration" you can test if the registration is "OK".
This test controls if the registration is right and if the board is present. If the test has been successfully completed you can quit the ADDIREG program. The board is initialised with the set parameters and can now be operated.

In case the registration data is to be modified, it is necessary to boot your PC again. A message asks you to do so. When it is not necessary you can quit the ADDIREG program and directly begin with your application.

6.2 Questions and software downloads on the web

Do not hesitate to e-mail us your questions.
by e-mail: info@addi-data.de or
hotline@addi-data.de

Free downloads of standard software

You can download the latest version of the software for the board APCI-**3xxx**

http://www.addi-data.com

IMPORTANT!
Before using the board or in case of malfunction during operation, check if there is an update of the product (technical description, driver). The current version can be found on the internet or contact us directly.

7 CONNECTING TO THE PERIPHERAL

7.1 Connector pin assignment

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

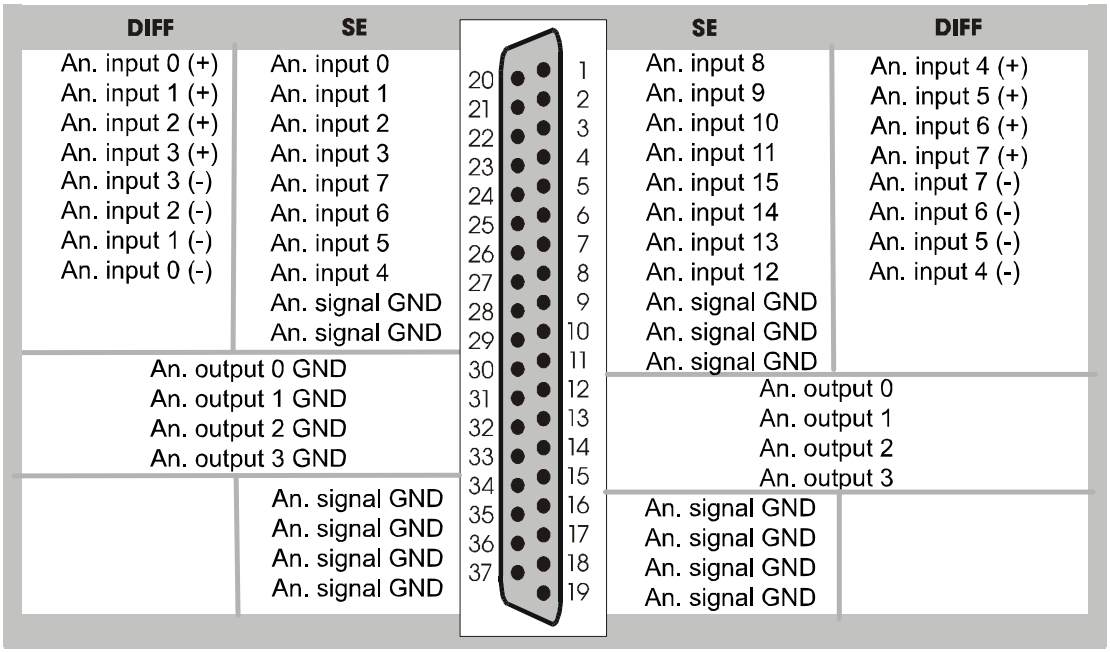
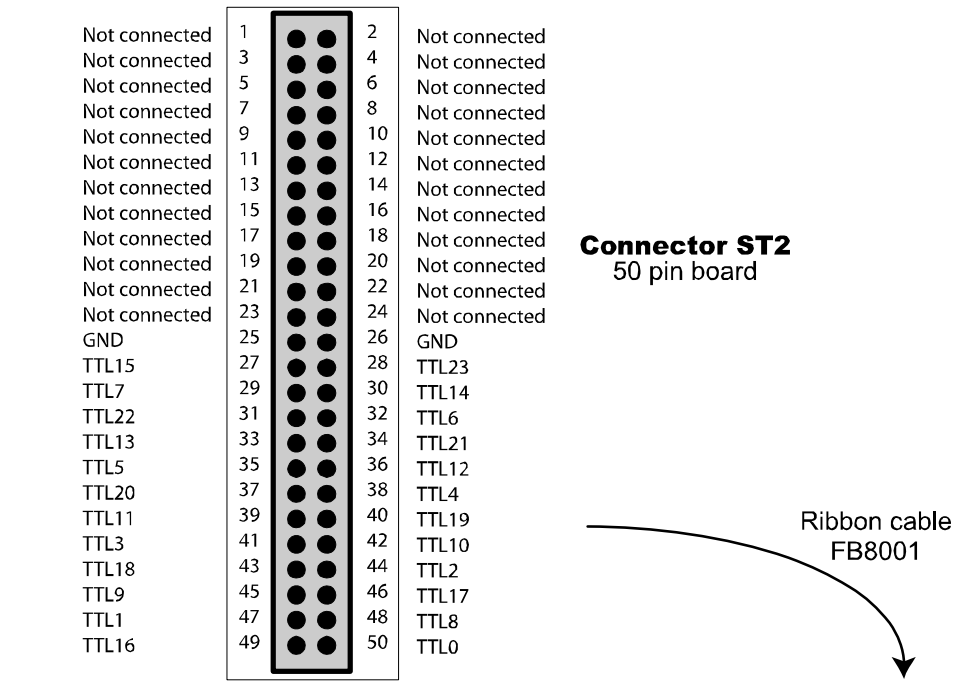
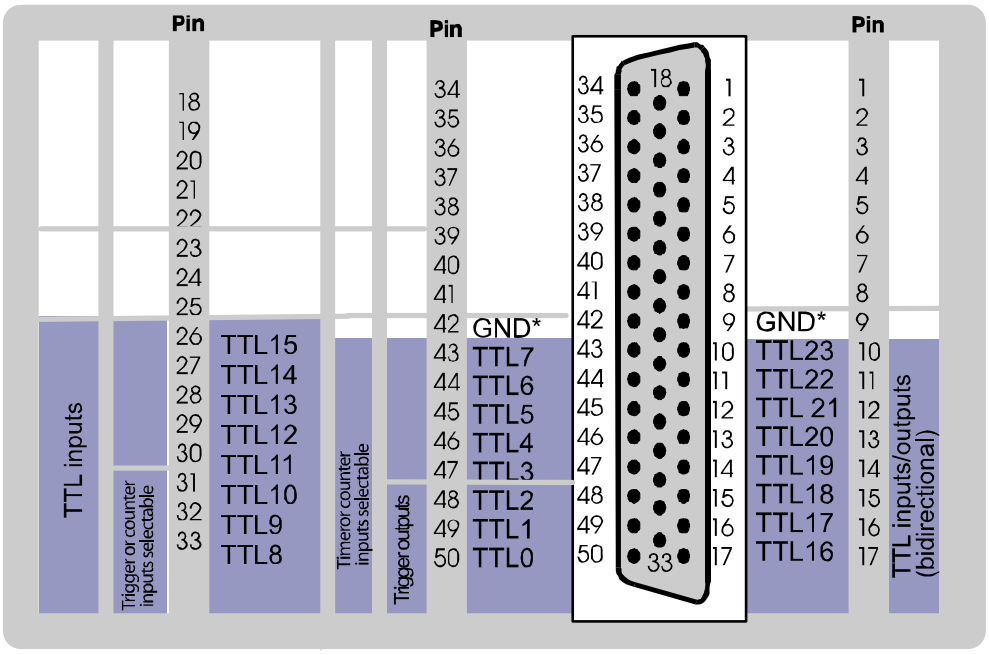


Fig. 7-2: 50 pin connector (TTL I/O)





*GND refers to all TTL I/O

Front plane of the ribbon cable FB8001
50 pin SUB-D male connector

IMPORTANT!
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/outputs (24 V and TTL)

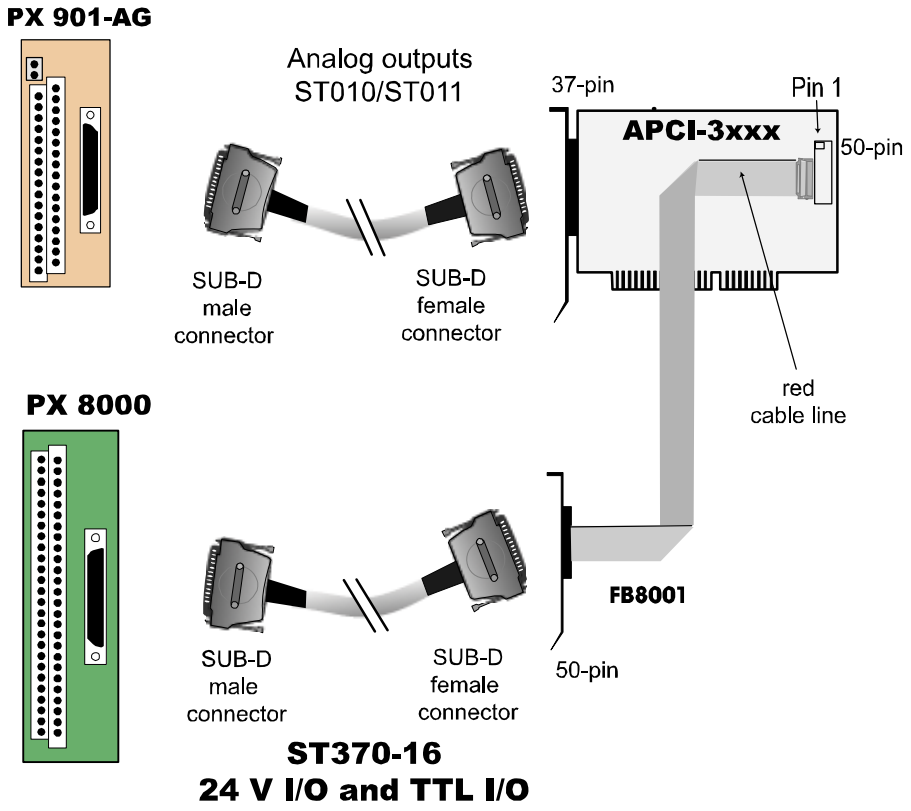
Pin number at the 50 pin connector	Description	Pin number at the front plane of the FB8001 (50 pin SUB-D male connector)
Pins 1-24	Not connected	-
25	TTL channel GND	9
26	TTL channel GND	42
27	TTL channel 15	26
28	TTL channel 23	10
29	TTL channel 7	43
30	TTL channel 14	27
31	TTL channel 22	11
32	TTL channel 6	44
33	TTL channel 13	28
34	TTL channel 21	12
35	TTL channel 5	45
36	TTL channel 12	29
37	TTL channel 20	13
38	TTL channel 4	46
39	TTL channel 11	30
40	TTL channel 19	14
41	TTL channel 3	47
42	TTL channel 10	31
43	TTL channel 18	15
44	TTL channel 2	48
45	TTL channel 9	32
46	TTL channel 17	16
47	TTL channel 1	49
48	TTL channel 8	33
49	TTL channel 16	17
50	TTL channel 0	50

7.2 Connection to the screw terminal panels

The TTL I/O are connected through the screw terminal panel **PX 8000**. The analog inputs are connected either through the screw terminal panel **PX 901-AG** (see Fig. 7-3) or the connection box **PX-BNC** (see Fig. 7-4).

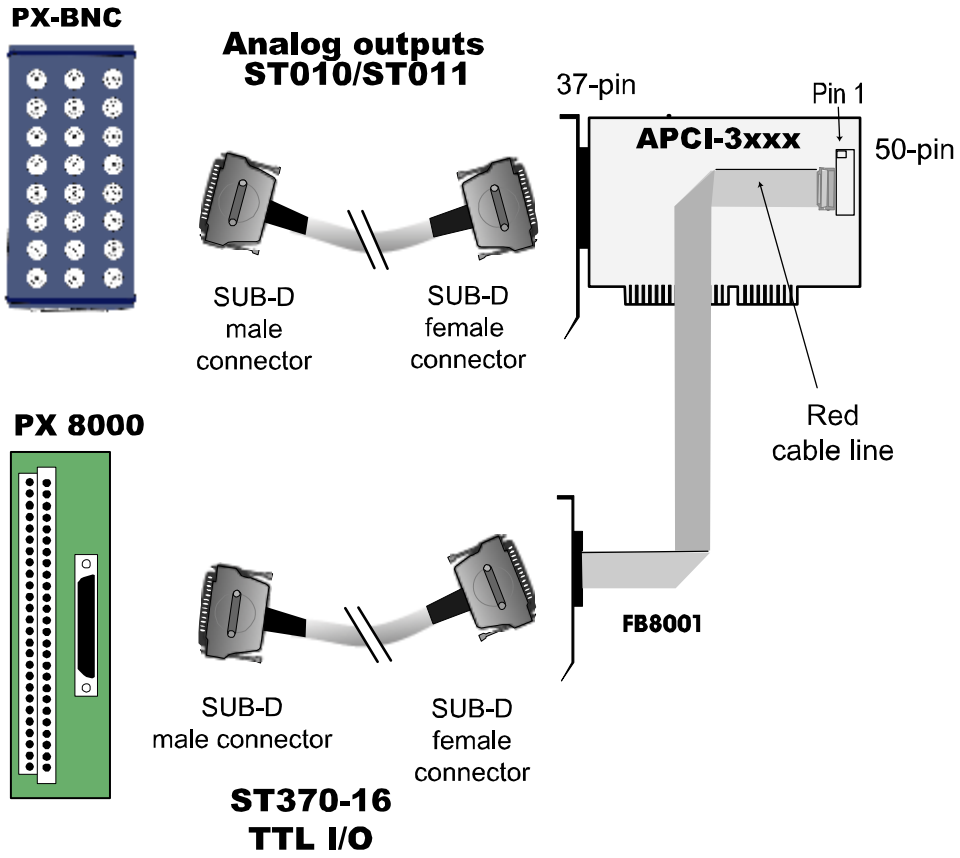
Our technical support will be pleased to answer your questions about our cables and screw terminal panels/boxes.

Fig. 7-3: Connection of the APCI-3xxx to the screw terminal panels



IMPORTANT!
Plug the ribbon cable **FB8001** with the **red cable line on the side of pin 1.**

Fig. 7-4: Connection to the screw terminal panel and connection box

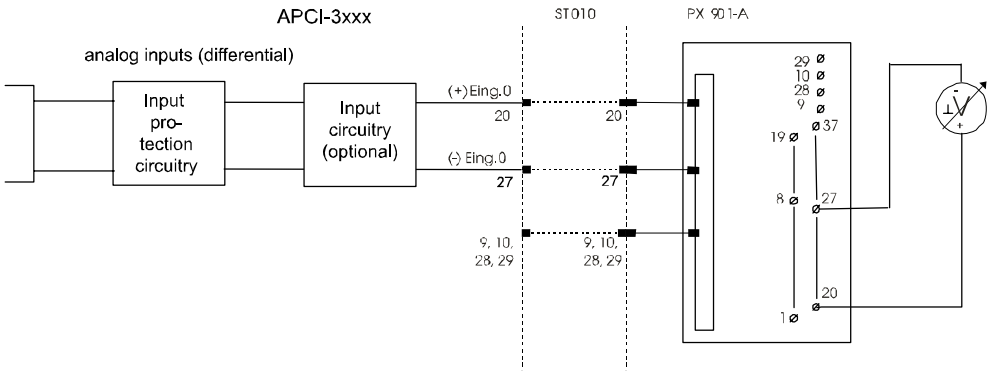


IMPORTANT!
Plug the ribbon cable **FB8001** with the **red cable line on the side of pin 1.**

7.3 Connection examples

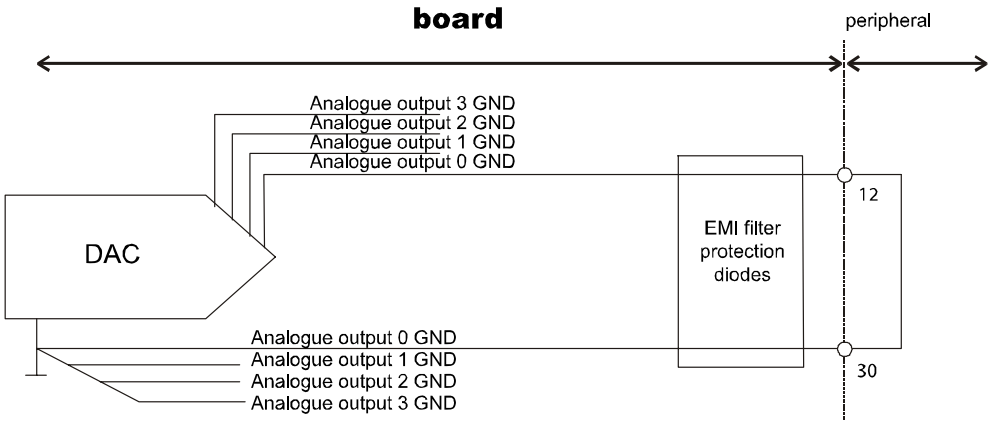
7.3.1 Analog inputs

Fig. 7-5: Connection example: Analog inputs



7.3.2 Analog outputs (only APCI-3100, APCI-3106 and APCI-3500)

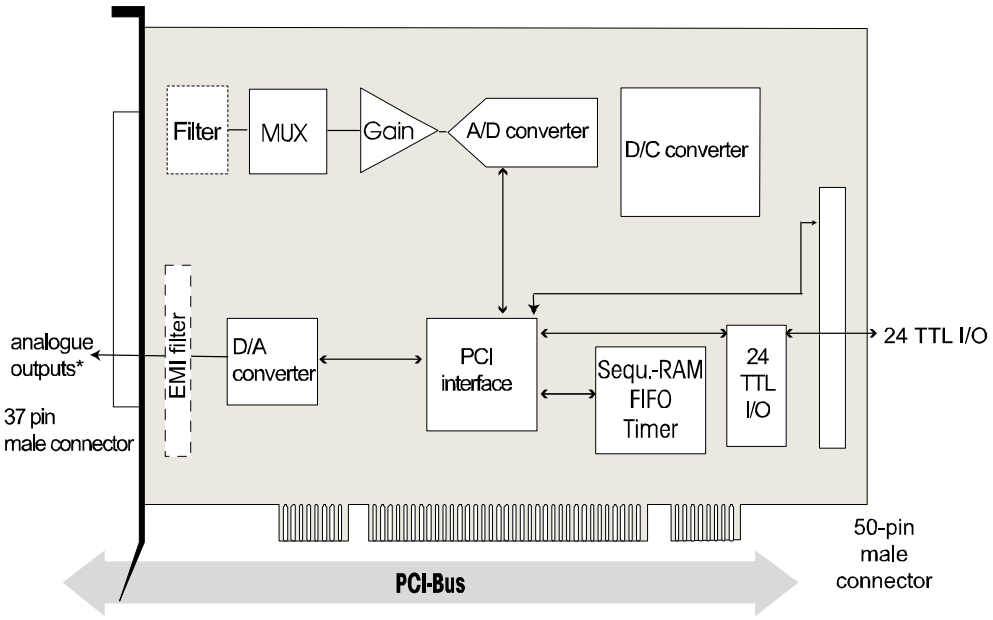
Fig. 7-6: Connection example: Analog outputs



8 FUNCTIONS OF THE BOARD

8.1 Block diagram

Fig. 8-1: Block diagram



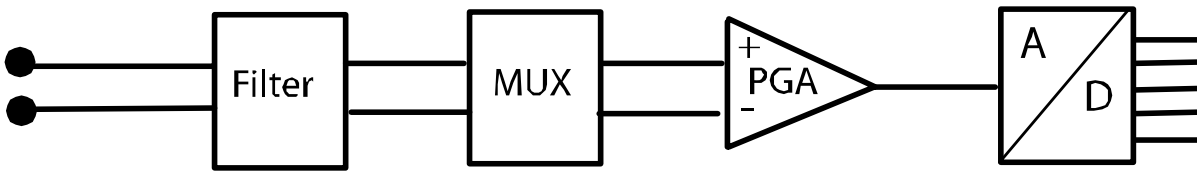
8.2 Analog input

There are 16 analog input channels on the board – the resolution of the **APCI-3000** and **APCI-3100** is 12-bit and of the **APCI-3006** and **APCI-3106** 16-bit (see Table 1-1).

8.2.1 Overview – time-multiplex system

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

Fig. 8-2: Time-multiplex system



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 (12-bit for **APCI-3000** and **APCI-3100**).

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 10 µs and 65535 µs. This is set by 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 and the A/D converter's best resolution.

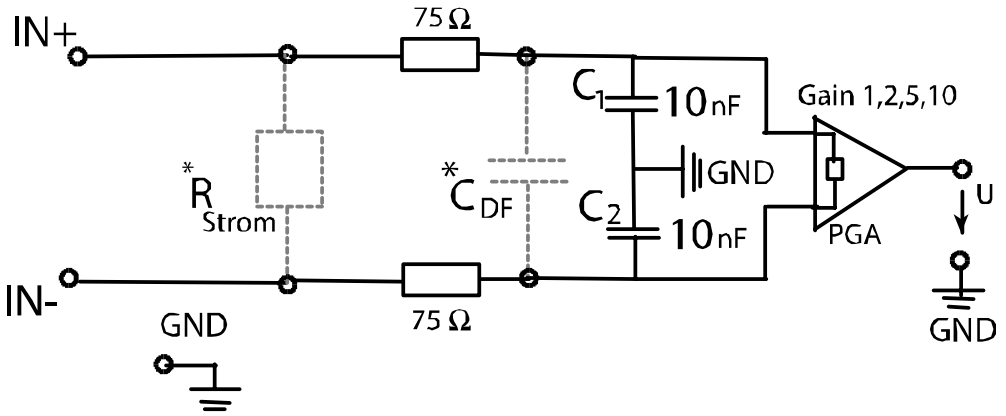
Please note: During the switching of the voltage range from unipolar to bipolar or from bipolar to unipolar there is a longer settling time of the measuring chain.

8.2.3 Analog input switch (differential inputs)

The input impedance is the input resistance of the PGA (10^{12} Ω) 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**

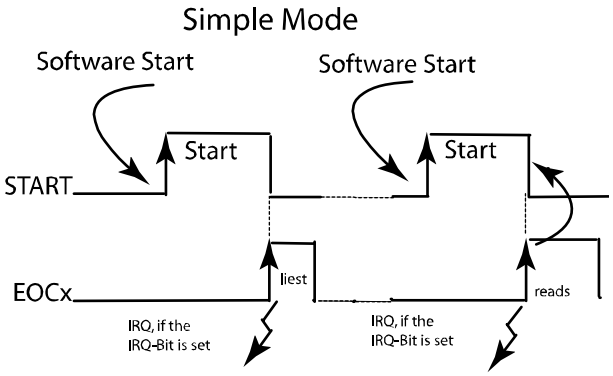
(C_{DF} not assembled)

8.2.4 Input modes of the analog inputs

16 differential channels are available on the board for the analog inputs. The acquisition can be realized in the following modes
1) Simple mode
2) Scan 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. For more detailed information please refer to the software function “Analog Inputs” in the ADDIPACK manual.



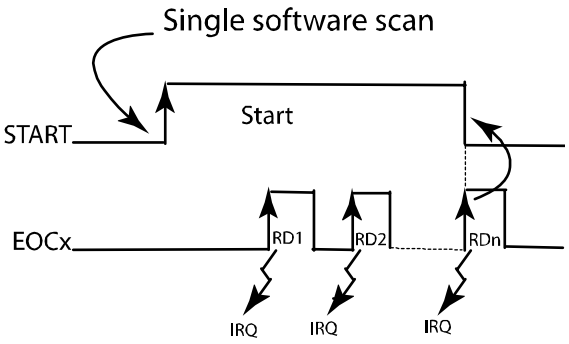
2) Scan modes

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 will describe the above mentioned scan modes more detailed:

a) Single software scan

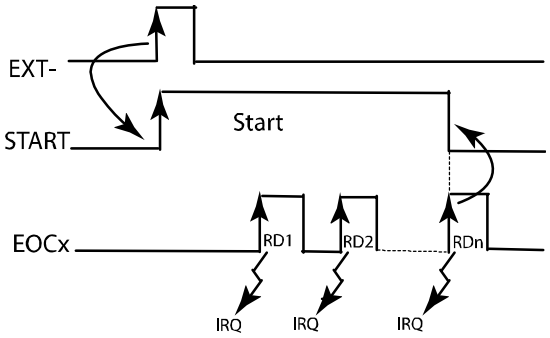
The user interrupt routine is called after the last IRQ (=ADDI-DATA driver).

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

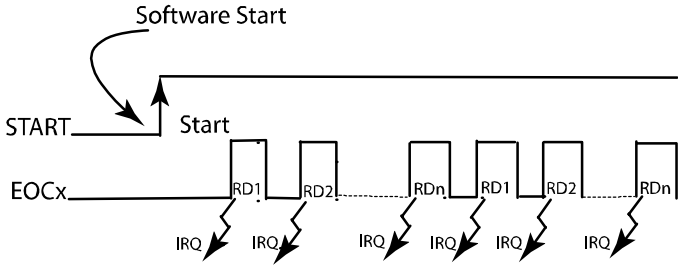


b) Single hardware triggered scan

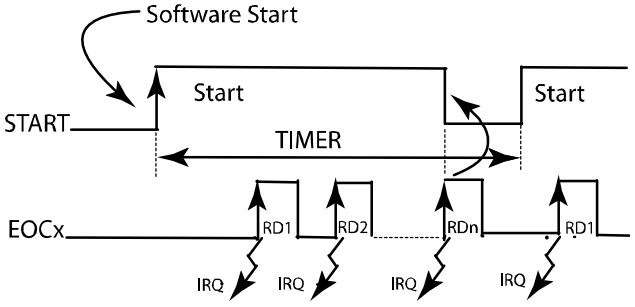
This scan can be triggered with rising or falling edge (software initializes it).



c) Continuous software scan

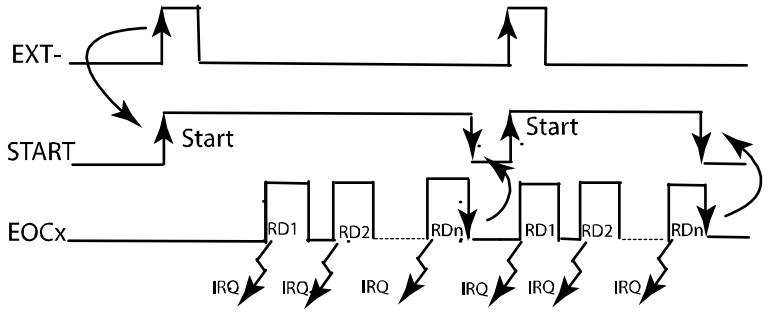


d) Continuous software scan with timer delay

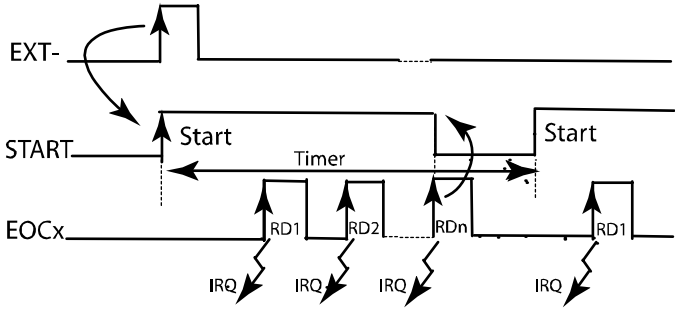


e) Continuous hardware triggered scan

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



f) Continuous hardware triggered scan with timer delay



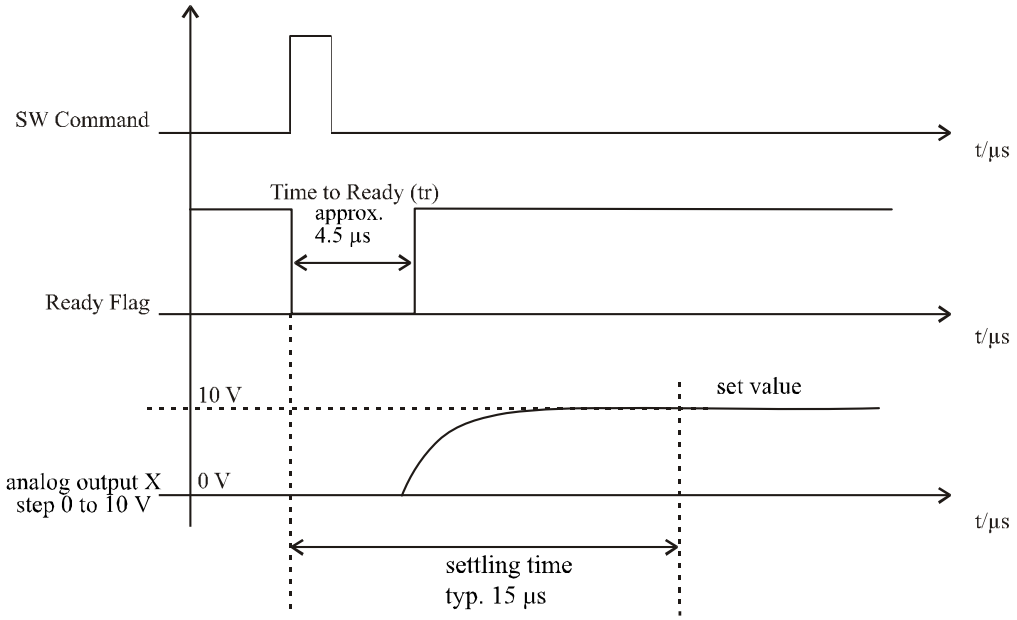
8.3 Analog outputs

There are 4 analog output channels with a resolution of 12-bit and a precision of 11-bit on the **APCI-3100, APCI-3106** and **APCI-3500.**

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"; see Fig. 8-4) 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).

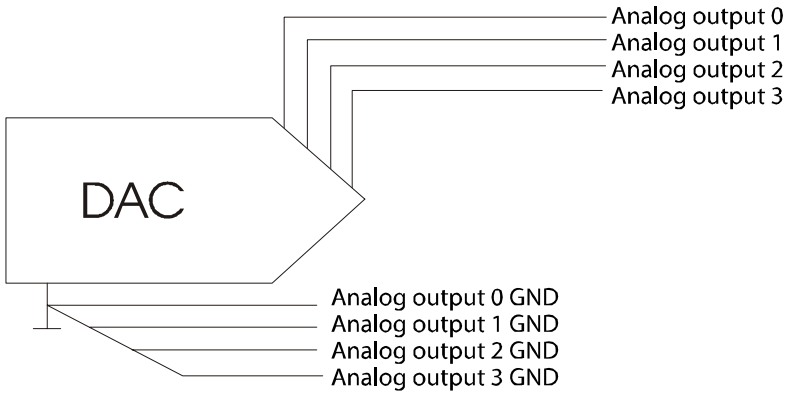
Fig. 8-4: Reaction time of the analog outputs



After the Power-ON reset of the OC the analog outputs are set to voltage value of 0 V.

Switch of the analog ground lines (voltage version)

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



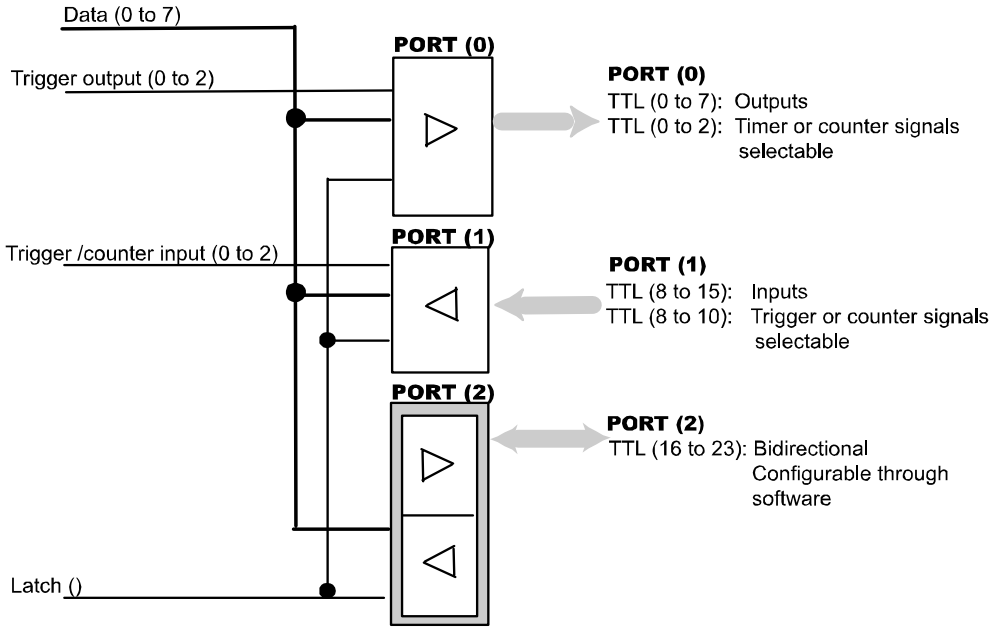
8.4 TTL inputs and outputs

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

Table 8-1: TTL I/0 (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. 8-6: Block diagram of the TTL I/O



Allocation to counters/timers/triggers:

As option a part of the TTL I/O can be used for counter, timer and trigger (see table below)

Table 8-2: TTL inputs and outputs

Channel	Description
0 (output)	Timer 0 / Counter 0
1 (output)	Timer 1 / Counter 1
2 (output)	Timer 2 / Counter 2
8 (input)	Counter 0 / Trigger for analog acquisition
9 (input)	Counter 1
10 (input)	Counter 2

8.5 Timer

The 16-bit timer is a downwards counter that can generate after the reload value (timeout) an interrupt. 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.

8.6 Counter

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

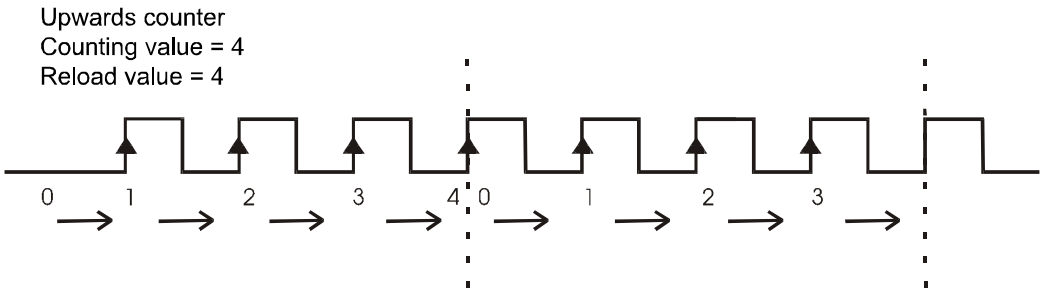
The counter inputs are called by the channels 0 to 2. If the counter function is not used, the channels are available as standard digital inputs.

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 positive or negative 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.

Upwards counter

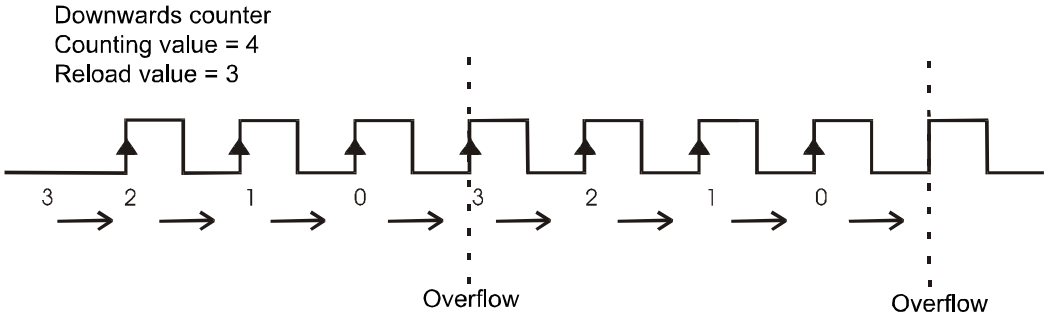
Fig. 8-7: Run down of the upwards counter



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.

Downwards counter

Fig. 8-8: Run down of the downwards counter

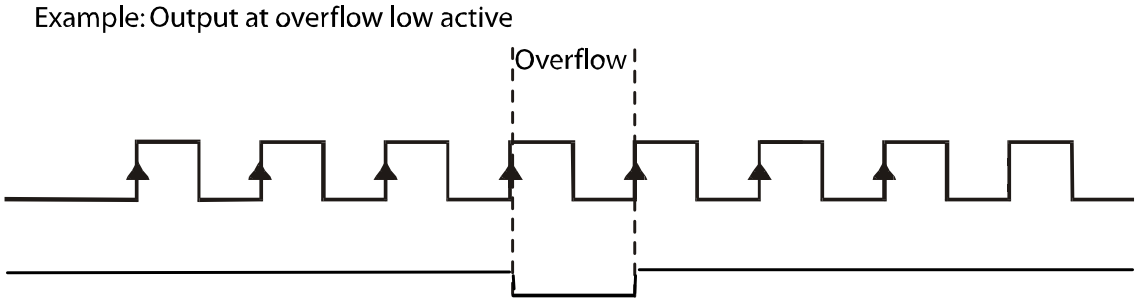


In order to get the same counting value as in the upwards mode, the reload value must be set on 3. The counter counts down to 0 and will be reset to the reload value from the next edge cycle on.

8.7 Setting a TTL output

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

Fig. 8-9: Example: Setting a TTL output



Allocation to counters/timers:

Counter/Timer 0	=	TTL0
Counter/Timer 1	=	TTL1
Counter/Timer 2	=	TTL2

9 STANDARDSOFTWARE

9.1 Software functions

ADDIPACK supports the following functions for the **APCI-3xxx.**

Table 9-1: Supported software functions

Functionality	Function name
Analog inputs	b_ADDIDATA_GetNumberOfAnalogInputs b_ADDIDATA_GetNumberOfAnalogInputModules
(APCI-3006, APCI-3106)	b_ADDIDATA_GetNumberOfAnalogInputsForTheModule
	b_ADDIDATA_GetAnalogInputModuleNumber
	b_ADDIDATA_GetAnalogInputModuleGeneralInformation *Return*: - Resolution: 16-bit - Unipolar/bipolar configurable - Available conversion timing: µs, ms - Conversion resolution: 16-bit - Min. conversion time: 10 µs
	b_ADDIDATA_GetAnalogInputModuleSingleAcquisitionInformation *Return*: - Available interrupt - Available gains: 1, 2, 5, 10 - No hardware /software trigger available - No hardware gate
	b_ADDIDATA_GetAnalogInputModuleSCANInformation Rückgabe: - Available gains: 1, 2, 5, 10 - Hardware/software trigger available - No hardware gate - SingleSCAN cycle mode available -X SCAN cycles mode available - Continuous SCAN cycles mode available - Delay available - Available delay timing: µs, ms - Delay time resolution: 16-bit
	b_ADDIDATA_InitAnalogInput Available parameters: - Gain: 1, 2, 5, 10 - Polarity: Unipolar/bipolar - Offset range: Not used - Coupling DC
	b_ADDIDATA_ReleaseAnalogInput

Functionality	Function name
	b_ADDIDATA_Read1AnalogInput Available parameters: - Interrupt: Enabled/disabled - Conversion time unit: µs/ms - Conversion time: 10 to 65535 for µs 1 to 65535 for ms
	b_ADDIDATA_ReadMoreAnalogInputs Available parameters: - Interrupt: Enabled/disabled - Conversion time unit: µs/ms - Conversion time: 10 to 65535 for µs 1 to 65535 for ms
	b_ADDIDATA_ConvertDigitalToRealAnalogValue
	b_ADDIDATA_ConvertMoreDigitalToRealAnalogValues
	b_ADDIDATA_InitAnalogInputSCANAcquisition Available parameters: - Conversion time unit: µs/ms - Conversion time: 10 to 65535 for µs 1 to 65535 for ms - Scan mode: single/X cycles/ continuous - Delay mode: Not used/Mode1/Mode2 - Delay timing: µs/ms
	b_ADDIDATA_StartAnalogInputSCAN
	b_ADDIDATA_GetAnalogInputSCANStatus
	b_ADDIDATA_ConvertDigitalToRealAnalogValueSCAN
	b_ADDIDATA_StopAnalogInputSCAN
	b_ADDIDATA_CloseAnalogInputSCAN
	b_ADDIDATA_EnableDisableAnalogInputHardwareTrigger Available parameters: - Level: High/Low - Action: SCAN One shot Single cycle x cycles
	b_ADDIDATA_GetAnalogInputHardwareTriggerStatus
	b_ADDIDATA_GetAnalogInputSoftwareTriggerInformation *Return*: - Can be used for SCAN - One shot triggermode available - Single cycle trigger mode available - X cycles trigger mode available

Functionality	Function name
	b_ADDIDATA_EnableDisableAnalogInputSoftwareTrigger Available parameters: - Action: SCAN One shot Single cycle x cycles
	b_ADDIDATA_GetAnalogInputSoftwareTriggerStatus
Analog inputs (APCI-3000, APCI-3100)	b_ADDIDATA_GetNumberOfAnalogInputs
	b_ADDIDATA_GetNumberOfAnalogInputModules
	b_ADDIDATA_GetNumberOfAnalogInputsForTheModule
	b_ADDIDATA_GetAnalogInputModuleNumber
	b_ADDIDATA_GetAnalogInputModuleGeneralInformation *Return*: - Resolution: 12-bit - Unipolar/bipolar configurable - Available conversion timing: µs, ms - Conversion resolution: 16-bit - Min. conversion time: 10 µs
	b_ADDIDATA_GetAnalogInputModuleSingleAcquisitionInformation *Return*: - Interrupt available - Available gains: 1, 2, 5, 10 - No hardware /software trigger - No hardware gate
	b_ADDIDATA_GetAnalogInputModuleSCANInformation *Return:* - Available gains: 1, 2, 5, 10 - Hardware /software trigger available - No hardware gate - Single SCAN cycle mode available - X SCAN cycle mode available - Continuous SCAN cyclus mode available - Delay available - Available delay timing: µs, ms - Resolution conversion time: 16-bit
	b_ADDIDATA_InitAnalogInput Availabe parameters: - Gain: 1, 2, 5, 10 - Polarity: Unipolar/bipolar - Offset range: Not used - Coupling DC
	b_ADDIDATA_ReleaseAnalogInput

Functionality	Function name
	b_ADDIDATA_Read1AnalogInput Available parameters: - Interrupt: Enabled/disabled - Conversion time unit: µs/ms - Convert time: 10 to 65535 for µs 1 to 65535 for ms
	b_ADDIDATA_ReadMoreAnalogInputs Available parameters: - Interrupt: Enabled/disabled - Conversion time unit: µs/ms - Convert time: 10 to 65535 for µs 1 to 65535 for ms
	b_ADDIDATA_ConvertDigitalToRealAnalogValue
	b_ADDIDATA_ConvertMoreDigitalToRealAnalogValues
	b_ADDIDATA_InitAnalogInputSCANAcquisition Available parameters: - Conversion time unit: µs/ms - Convert time: 10 to 65535 for µs 1 to 65535 for ms - Scan mode: Single/X cycles/ continuous - Delay mode: Not used/Mode1/Mode2 - Delay timing: µs/ms
	b_ADDIDATA_StartAnalogInputSCAN
	b_ADDIDATA_GetAnalogInputSCANStatus
	b_ADDIDATA_ConvertDigitalToRealAnalogValueSCAN
	b_ADDIDATA_StopAnalogInputSCAN
	b_ADDIDATA_CloseAnalogInputSCAN
	b_ADDIDATA_EnableDisableAnalogInputHardwareTrigger Available parameters: - Level: High/Low - Action: SCAN One shot Single cycle x cycles
	b_ADDIDATA_GetAnalogInputHardwareTriggerStatus
	b_ADDIDATA_GetAnalogInputSoftwareTriggerInformation *Return*: - Can be used for SCAN - One shot trigger mode available - Single cycle trigger mode available - X cycle trigger mode available

Functionality	Function name
	b_ADDIDATA_EnableDisableAnalogInputSoftwareTrigger Available parameters: - Action: SCAN One shot Single cycle x cycles
	b_ADDIDATA_GetAnalogInputSoftwareTriggerStatus
Analog outputs (APCI-3100, APCI-3106, APCI-3500)	b_ADDIDATA_GetNumberOfAnalogOutputs
	Rückgabe: - Available voltage modes: 2 - Mode 0: Bipolar (12-bit) - Mode 1: Unipolar (11-bit) - No synchronisation available
	b_ADDIDATA_Init1AnalogOutput Available parameters: - Available voltage modes : 2 - Mode 0: Bipolar (12-bit) - Mode 1: Unipolar (11-bit) - No synchronisation available
	b_ADDIDATA_InitMoreAnalogOutputs Available parameters: - Available voltage modes: 2 - Mode 0: Bipolar (12-bit) - Mode 1: Unipolar (11-bit) - No synchronisation available
	b_ADDIDATA_Write1AnalogOutput
	b_ADDIDATA_WriteMoreAnalogOutputs
	b_ADDIDATA_Release1AnalogOutput
	b_ADDIDATA_ReleaseMoreAnalogOutputs
	b_ADDIDATA_GetAnalogOutputInformation() Synchronisation available for the analog output = No Number of available voltage modes = 2 Voltage mode 0 information: Resolution = 12-bit Max. output value = 10 V Polarity selection via hardware = No Polarity selection via software = Yes Unipolar configurable = No Bipolar configurable = Yes Voltage mode 1 information:

Functionality	Function name
	Resolution = 11-bit Max. output value = 10 V Polarity selection via hardware = No Polarity selection via software = Yes Unipolar configurable = Yes Bipolar configurable = No
TTL-Outputs (APCI-3000, APCI-3006, APCI-3100, APCI-3106, APCI-3500)	b_ADDIDATA_GetNumberOfDigitalOutputs
	b_ADDIDATA_GetDigitalOutputInformation *Return*: Output type: TTL No interrupt available
	b_ADDIDATA_SetDigitalOutputMemoryOn
	b_ADDIDATA_SetDigitalOutputMemoryOff
	b_ADDIDATA_Set1DigitalOutputOn
	b_ADDIDATA_Set1DigitalOutputOff
	b_ADDIDATA_Set2DigitalOutputOn
	b_ADDIDATA_Set2DigitalOutputOff
	b_ADDIDATA_Set4DigitalOutputOn
	b_ADDIDATA_Set4DigitalOutputOff
	b_ADDIDATA_Set8DigitalOutputOn
	b_ADDIDATA_Set8DigitalOutputOff
	b_ADDIDATA_Set16DigitalOutputOn
	b_ADDIDATA_Set16DigitalOutputOff
	b_ADDIDATA_Set32DigitalOutputOn
	b_ADDIDATA_Set32DigitalOutputOff
	b_ADDIDATA_Get1DigitalOutputStatus
	b_ADDIDATA_Get2DigitalOutputStatus
	b_ADDIDATA_Get4DigitalOutputStatus
TTL-inputs (APCI-3000, APCI-3006, APCI-3100, APCI-3106, APCI-3500)	b_ADDIDATA_GetNumberOfDigitalInputs
	b_ADDIDATA_GetDigitalInputInformationEx *Return*: Input type : TTL No interrupt available
	b_ADDIDATA_Read1DigitalInput
	b_ADDIDATA_Read2DigitalInputs

Functionality	Function name
	b_ADDIDATA_Read4DigitalInputs
	b_ADDIDATA_Read8DigitalInputs
	b_ADDIDATA_Read16DigitalInputs
	b_ADDIDATA_Read32DigitalInputs
Timer (APCI-3000, APCI-3006, APCI-3100, APCI-3106, APCI-3500)	b_ADDIDATA_GetNumberOfTimers
	b_ADDIDATA_GetTimerInformationEx *Return*: Interrupt available: 16-bit Time unit available: µs, ms, s Output available: High/Low Available modes: 2 and 3
	b_ADDIDATA_InitTimer Available parameters: Interrupt: Enabled or disabled Resolution: 16-bit Time unit: µs or ms or s Modes: 2 or 3
	b_ADDIDATA_EnableDisableTimerInterrupt
	b_ADDIDATA_StartTimer
	b_ADDIDATA_StartAllTimers
	b_ADDIDATA_TriggerTimer
	b_ADDIDATA_TriggerAllTimers
	b_ADDIDATA_StopTimer
	b_ADDIDATA_StopAllTimers
	b_ADDIDATA_ReleaseTimer
	b_ADDIDATA_ReadTimerValue
	b_ADDIDATA_ReadTimerStatus
	b_ADDIDATA_EnableDisableTimerOutput Available parameters: Action: Low or High
	b_ADDIDATA_GetTimerHardwareOutputStatus
	b_ADDIDATA_ReleaseTimer
	b_ADDIDATA_TestTimerAsynchronousFIFOFull
Counter (APCI-3000,	b_ADDIDATA_GetNumberOfCounters
	b_ADDIDATA_GetCounterInformationEx

Functionality	Function name
APCI-3006, APCI-3100, APCI-3106, APCI-3500)	*Return*: Interrupt available: 16-bit Output available: High/Low Available counter mode: Up/Down Available input levels: High/Low
	b_ADDIDATA_InitCounter Available parameters: Resolution: 16-bit Input levels: High/Low
	b_ADDIDATA_SetCounterDirection Available parameters: Counter mode: Up/Down
	b_ADDIDATA_EnableDisableCounterInterrupt
	b_ADDIDATA_StartCounter
	b_ADDIDATA_StartAllCounters
	b_ADDIDATA_ClearCounter
	b_ADDIDATA_TriggerCounter
	b_ADDIDATA_TriggerAllCounters
	b_ADDIDATA_StopCounter
	b_ADDIDATA_StopAllCounters
	b_ADDIDATA_ReleaseCounter
	b_ADDIDATA_ReadCounterValue
	b_ADDIDATA_ReadCounterStatus
	Vorhandene Parameter: Vorhandene Eingangslevels: High/Low
	b_ADDIDATA_GetCounterHardwareOutputStatus
	b_ADDIDATA_TestCounterAsynchronousFIFOFull

9.2 Software samples

Table 9-2: Supported software samples

Functionality	Sample number	Description
Analog inputs	SAMPLE00	Displays 1 analog input information
	SAMPLE01	Reads 1 analog input channel without interrupt The user defines the channel he wants to use.

Functionality	Sample number	Description
	SAMPLE02	Reads 1 analog input channel with interrupt. The user defines the channel he wants to use. The user defines the interrupt mode (synchronous, asynchronous)
	SAMPLE03	Reads more analog input channels without interrupt.
	SAMPLE04	Reads more analog input channels with interrupt The user defines the interrupt mode (synchronous, asynchronous)
	SAMPLE07	Initialises the SCAN with interrupt The user defines the external trigger mode and gate mode if these are available. The user defines if he wants to use the delay and enters its value. The user defines the interrupt mode (synchronous, asynchronous)
Digital input	SAMPLE00	Gets the selected digital input channel information.
	SAMPLE01	Reads 1 digital input
	SAMPLE02	Reads 2 digital inputs
	SAMPLE03	Reads 4 digital inputs
	SAMPLE04	Reads 8 digital inputs
	SAMPLE05	Reads 16 digital inputs
	SAMPLE06	Reads 32 digital inputs
Digital outputs	SAMPLE01	Tests 1 digital output with or without Output Memory Option: Gives the status of the digital output, if possible.
	SAMPLE02	Tests 2 digital outputs with or without Ouptut Memory Option. Gives the status of the digital outputs, if possible
	SAMPLE03	Tests 4 digital outputs with or without Output Memory Option. Gives the status of the digital outputs, if possible.
	SAMPLE04	Tests 8 digital outputs with or without Output Memory Option. Gives the status of the digital outputs, if possible.
	SAMPLE05	Tests 16 digital outputs with or without Output Memory Option. Gives the status of the digital outputs, if possible.
	SAMPLE06	Tests 32 digital outputs with or without Output Memory Option. Gives the status of the digital outputs, if possible.
Timer	SAMPLE00	Shows all timer information
	SAMPLE01	Initialisation of 1 timer without interrupt. The user can trigger the timer by key press.

Functionality	Sample number	Description
		The user selects the timer he wants to use. The user defines if the HW gate, the HW trigger and the HW output are used.
	SAMPLE02	Initialisation of 1 timer with interrupt. The user can trigger the timer by key press. The user selects the timer he wants to use. The user defines if the HW gate, the HW trigger and the HW output are used. The user defines the interrupt mode (asynchronous/synchronous).
	SAMPLE03	Initialisation of all timers without interrupt. The user can trigger the timer by key press. The user selects the timer he wants to test. The user defines if the HW gate, the HW trigger and the HW output are used.
	SAMPLE04	Initialisation of all timers with interrupt. The user can trigger the timer by key press. The user selects the timer he wants to test. The user defines if the HW gate, the HW trigger and the HW output are used. The user defines the interrupt mode (asynchronous/ synchronous).
Counter	SAMPLE00	Shows all counter information
	SAMPLE01	Initialisation of 1 counter without interrupt. The user can trigger the counter by key press. The user selects the counter he wants to test. The user defines if the HW gate, the HW trigger and the HW output are used.
	SAMPLE02	Initialisation of 1 counter with interrupt. The user can trigger the counter by key press. The user selects the counter he wants to test. The user defines if the HW gate, the HW trigger and the HW output are used. The user defines the interrupt mode (asynchronous/synchronous)
	SAMPLE03	Initialisation of all counters without interrupt. The user can trigger the counter by key press. The user selects the counter he wants to test. The user defines if the HW gate, the HW trigger and the HW output are used.

Functionality	Sample number	Description
	SAMPLE04	Initialisation of all counters with interrupt. The user can trigger the counter by key press. The user selects the counter he wants to test. The user defines if the HW gate, the HW trigger and the HW output are used. The user defines the interrupt mode (asynchronous / synchronous).
Analog outputs	SAMPLE00	Shows 1 analog output information
	SAMPLE01	Writes 1 analog output value without synchronisation (ramp generation).
	SAMPLE02	Writes more analog output values without synchronisation (ramp generation).

10 APPENDIX

10.1 Glossary

Table 10-1: 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.
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.
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.
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.
Sensor	A device that responds to physical stimuli (heat, light, sound, pressure, motion, etc.) and produces a corresponding electrical output.
Settling time	The time required, after application of a step input signal, for the output voltage to settle and remain within a specified error band around the final value. The settling time of a system includes that of all of the components of the system.
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.
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.
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.
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.
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.

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