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certified

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Preliminary version

# Technical description

# APCI-3300

## Pressure measurement board, optically isolated

Edition: 07.05 - 03/2007

## 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.
ADDI-DATA GmbH reserves the right to make changes to the technical data and the materials included herein.

## Warranty and liability

The user is not permitted to make changes to the product beyond the intended use, or to interfere with the product in any other way.
ADDI-DATA shall not be liable for obvious printing and phrasing errors. In addition, ADDI DATA, if legally permissible, shall not be liable for personal injury or damage to materials caused by improper installation and/or commissioning of the board by the user or improper use, for example, if the board is operated despite faulty safety and protection devices, or if notes in the operating instructions regarding transport, storage, installation, commissioning, operation, thresholds, etc. are not taken into consideration. Liability is further excluded if the operator changes the board or the source code files without authorisation and/or if the operator is guilty of not monitoring the permanent operational capability of working parts and this has led to damage.

## Copyright



## ADDI-DATA software product licence

Please read this licence carefully before using the standard software. The customer is only granted the right to use this software if he/she agrees with the conditions of this licence.
The software must only be used to set up the ADDI-DATA boards.
Reproduction of the software is forbidden (except for back-up and for exchange of faulty data carriers). Disassembly, decompilation, decryption and reverse engineering of the software are forbidden. This licence and the software may be transferred to a third party if this party has acquired a board by purchase, has agreed to all the conditions in this licence contract and the original owner does not keep any copies of the software.

## Trademarks

# 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.

## Figures



## Tables

# 1 DEFINITION OF APPLICATION

## 1.1 Intended use

The board **APCI-3300** must be inserted in a PC with PCI 5V/32-bit slots, which is used as electrical equipment for measurement, control and laboratory pursuant to the norm IEC 61010-1.

## 1.2 Usage restrictions

The **APCI-3300** board must not to be used as safety related part for securing emergency stop functions.

The board must not be used in potentially explosive atmospheres.

## 1.3 General description of the board

Data exchange between the **APCI-3300** board and the peripheral is to occur through a shielded cable. This cable must be connected to the 50-pin SUB-D male connector of the **APCI-3300** board.

The board has 8 or 4 input channels for processing analog pressure signals and 4 input and 3 output channels for processing digital 24 V signals.
The use of the board **APCI-3300** in combination with external screw terminal panels is to occur in a closed switch cabinet.

The **PX3200** screw terminal board allows connecting the analog pressure signals to a cold junction compensation through the **ST3200** cable.

The use of the **APCI-3300** board in combination with external screw terminal panels or relay boards is to occur in a closed switch cabinet; the installation is to be effected competently.

The connection with our standard cable **ST3200** complies with the minimum specifications as follows:
- metallized plastic hoods
- shielded cable
- cable shield folded back and firmly screwed to the connector housing.

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.

The use of the board according to its intended purpose includes observing all advises given in the *Technical description* and in the *Safety* leaflet.

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.

Make sure that the board remains in its protective packing **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

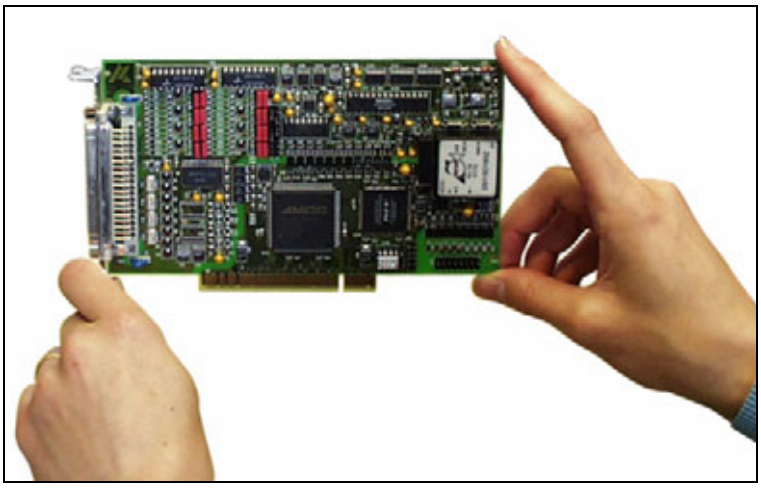
Only persons trained in electronics are entitled to perform the following works:
- installation,
- use,
- maintenance.

## 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 PC is to comply with the norm IEC61326 for measurement, control and laboratory use and with the specifications for EMC protection.

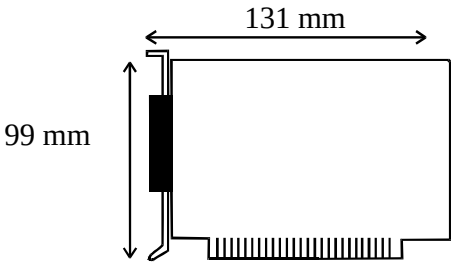
The board has been subjected to EMC tests in an accredited laboratory. The board complies with the limit values set by the norms IEC61326 as follows:

| | 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 |
| Noise emissions: | B class | |

## 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 5 V
Connection to the peripheral: 50-pin SUB-D male connector
Accessories[1]:
Cable: **ST3200**
Screw terminal panel **PX3200**

**WARNING!**
The supply lines must be installed safely against mechanical loads.

1 Not included in the standard delivery.

## 4.3 Versions

The board APCI-3300 is available in 2 versions.

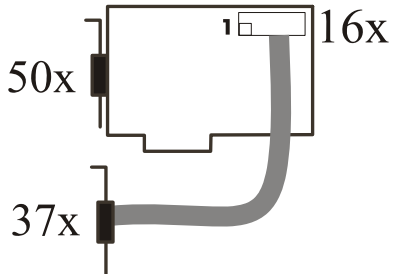
| Version | Number of connected pressure signals | Number of digital signals |
|---|---|---|
| APCI-3300-4 | 4 | 4 inputs and 3 outputs |
| APCI-3300-8 | 8 | 4 inputs and 3 outputs |

## 4.4 Limit values

Max. Altitude: ..... up to 2000 m above sea level
Operating temperature: ..... 0 to 60°C
Storage temperature: ..... -25 to 70°C
**Relative humidity at indoor installation**
50% at +40 °C
80% at +31 °C

**Minimum PC requirements:**
**PCI BIOS from Version 1.0**
Bus speed: ..... < 33 MHz
Operating system: ..... Windows NT, 98, 2000, XP, Linux
Number of slots required: ..... PCI 5 V, 32 bits/64 bits
1 slot opening for the
connection of dig. I/O

**Fig. 4-1: Number of slots required**




**PCI bus interface:**
Bus speed: ..... 33 MHz
Data access: ..... 32-bit
Decoding: ..... in the 64K I/O range of the PC
"Target Only" Operating

**Resources:**
4 I/O ranges: ..... 64 Bytes
256 Bytes
4 Bytes
4 Bytes

IRQs: ..... INTA of the PCI bus

**Optical isolation:**
Creeping distance: ..... 3.2 mm
Testing voltage: ..... 1000 VAC

**Voltage sources:**
Number of voltage sources: ..... 4 to 8
Output voltage $V_{exc}$ (25 °C): ..... typ. 5 V, 40 mA
Input noise signal
(25°C; Band width: 10 Hz to 10 kHz): ..... typ. 40 µV

**Energy requirements:**
Operating voltage of the PC: ..... 5V ± 5%
Current consumption in mA (without load): typ. See table ± 10%

| | APCI-3300-4 | APCI-3300-8 |
|---|---|---|
| + 5 V from the PC | 570 mA | 600 mA |

**Analog input pressure channels**
Resolution: ..... 18-bit, unipolar
Input type: ..... differential channels
Number of voltage inputs: ..... 4 to 8
Overvoltage protection: ..... ± 30 V
Input voltage range: ..... 0 to 2.5V/PGA
Input impedance: ..... 25 MΩ
Input capacity: ..... 530 pF
Input current: ..... 10 nA
Input amplifier (PGA): ..... 1, 2, 4, 8, 16, 32, 64, 128
Data transfer: ..... The board is located in the I/O address space of the PC. The values are written on the board through 32-bit accesses.
Digital coding: ..... Unipolar: Straight binary coding

**Voltage range: 0 mV < V < + 100 mV**
(See Table 8-4: Voltage accuracy)
Precision: ..... 16-bit
Integral non-linearity (INL): .....± 0.0015 % of FSR[1] over the temperature range
Monotony: ..... 16-bit
Offset error: ..... ± 0.0015 % of FSR (Bipolar Offset Error)

**Voltage range: 100 mV < V < + 2.5 V**
(See Table 8-4: Voltage accuracy)
Precision: ..... 14-bit

[1] FSR: Full Scale Range

Integral non-linearity (INL): ..... ± 0.0060 % of FSR over the temperature range
Monotony: ..... 14-bit
Offset error: ..... ± 0.0060 % of FSR (Bipolar Offset Error)

**Gain error:**
for gain 1, 2, 4, 8, 16, 32, 64: ..... ± 2 % of FSR
for gain 128 ..... ± 3 % of FSR

**Table 4-1: Possible acquisition times**

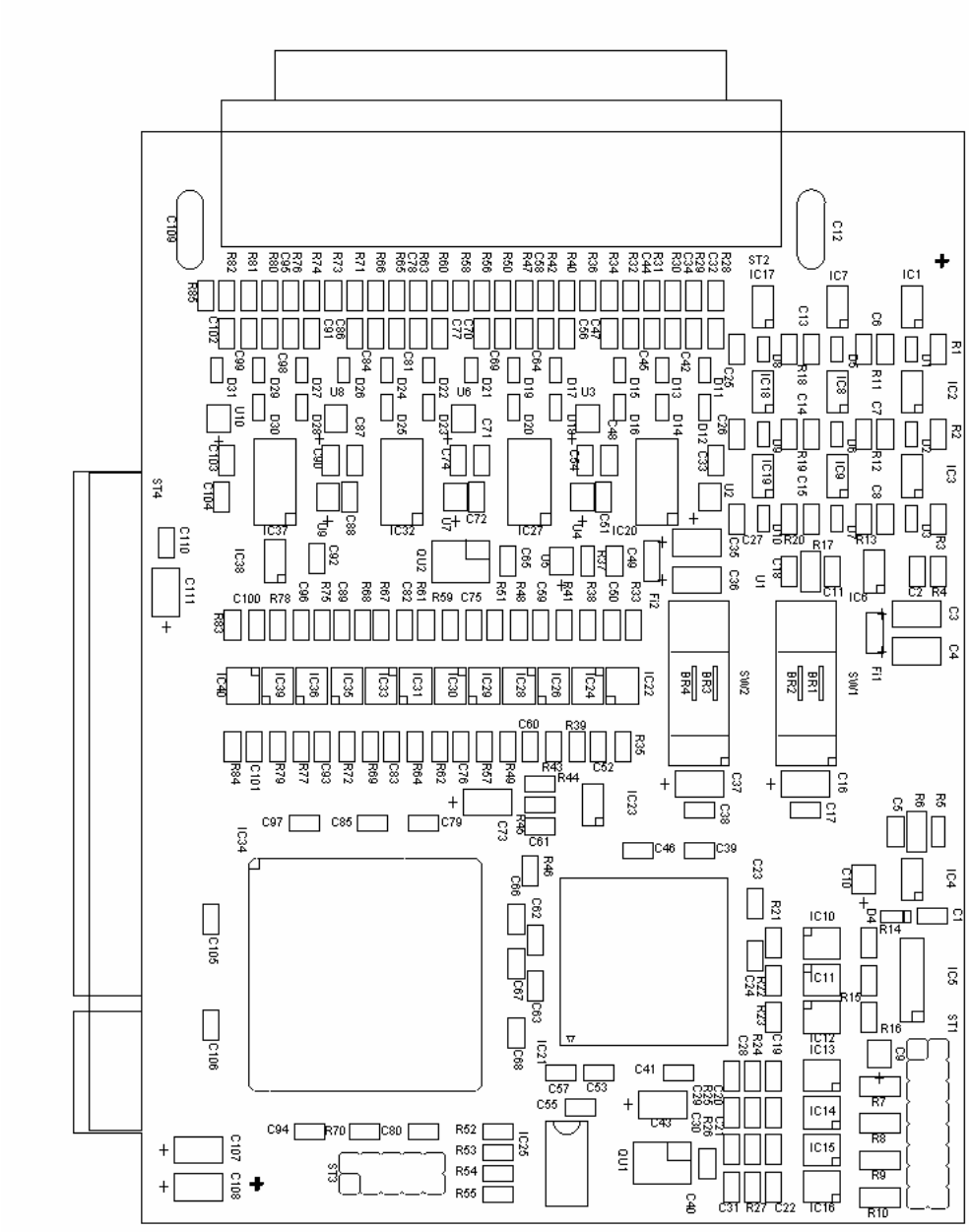
| Acquisition times (Hz) 1 channel, offset, reference | Sample period (ms) |
|---|---|
| 20 | 50 |
| 40 | 25 |
| 80 | 12.5 |
| 160 | 6.25 |

**Digital input channels:**
Number: ..... 4
Input current at 24 V: ..... 2 mA typ.
Input voltage range: ..... 0-30 V
Optical isolation: ..... 1000 VAC
Logic "0" level: ..... 0-5 V
Logic "1" level: ..... 12-30 V

**Digital output channels:**
Number: ..... 3
Max. switch current: ..... 125 mA typ.
Voltage range: ..... 8-30 V
Optical isolation: ..... 1000 VAC
Type: ..... Open Collector

## 4.5 Component scheme

**Fig. 4-2: Component scheme**



# 5 INSTALLATION OF THE BOARD

**IMPORTANT!**
Do observe the safety precautions (yellow leaflet)!

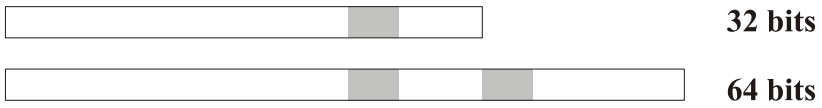
## 5.1 Opening the PC

- **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

The following PCI slot types are available for 5V systems:
PCI-5V (32-bit) and PCI-5V (64-bit)

**Fig. 5-1: Types of slots**




**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

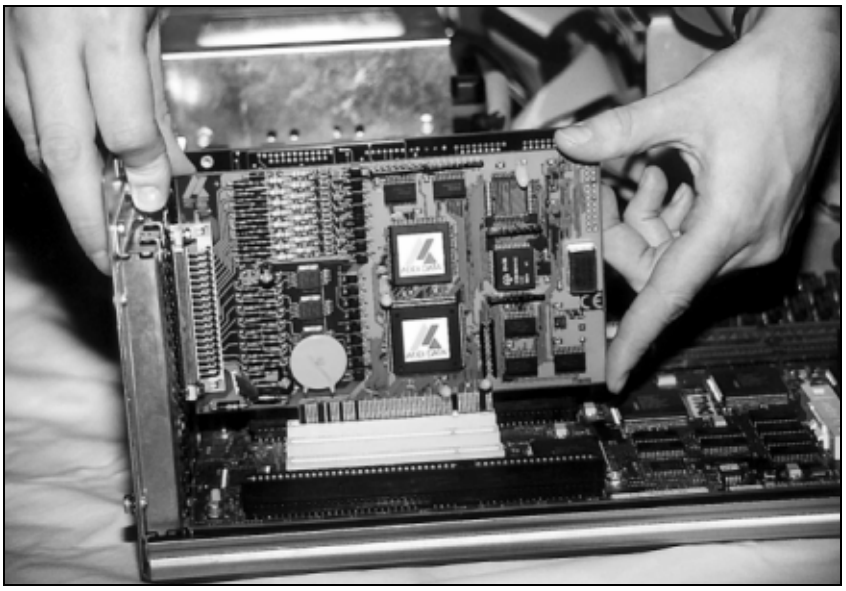
**Discharge yourself from electrostatic charges.**

**Take the board out of its protective pack.**

## 5.3 Plugging the board into the slot

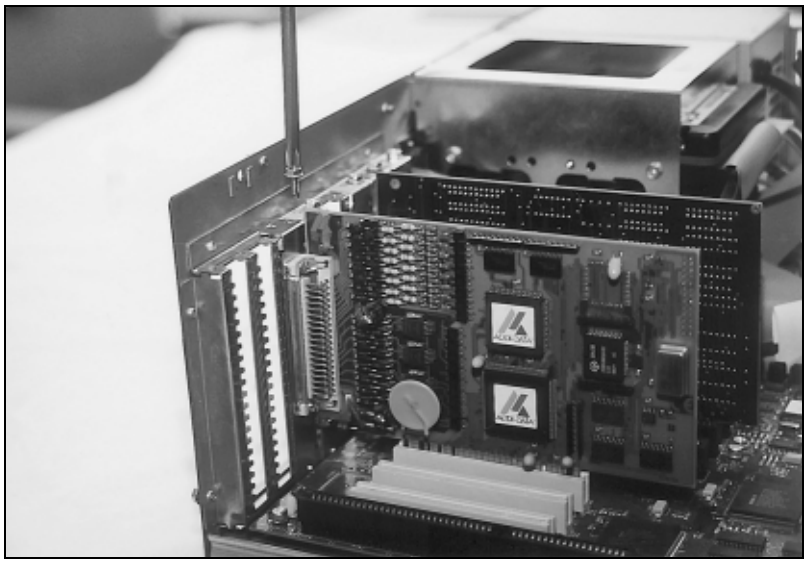
♦ Insert the board **vertically into the chosen slot.**

**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 and 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-3300** 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 and 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.

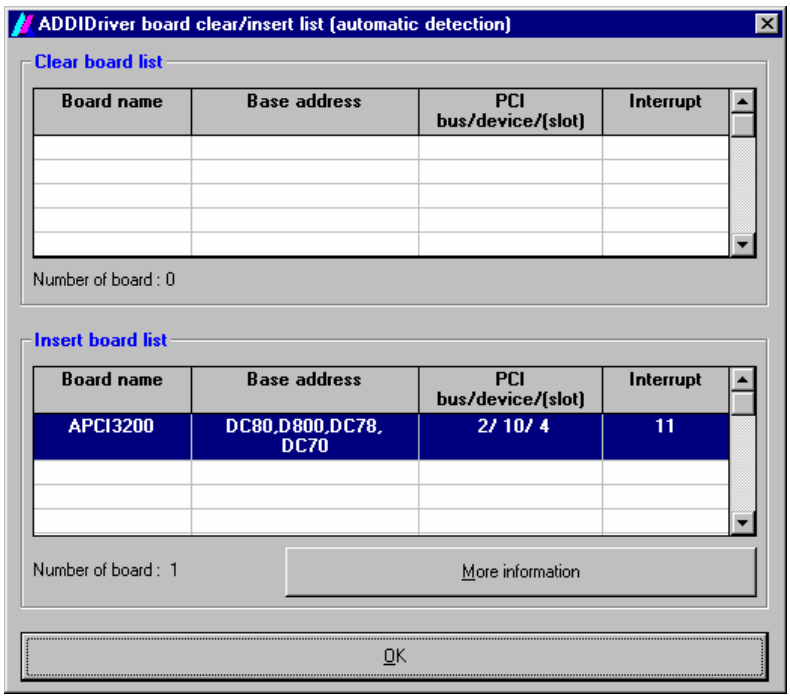
## 6.1 Board registration

When starting the set-up of ADDIREG, the APCI-3300 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 (example)**



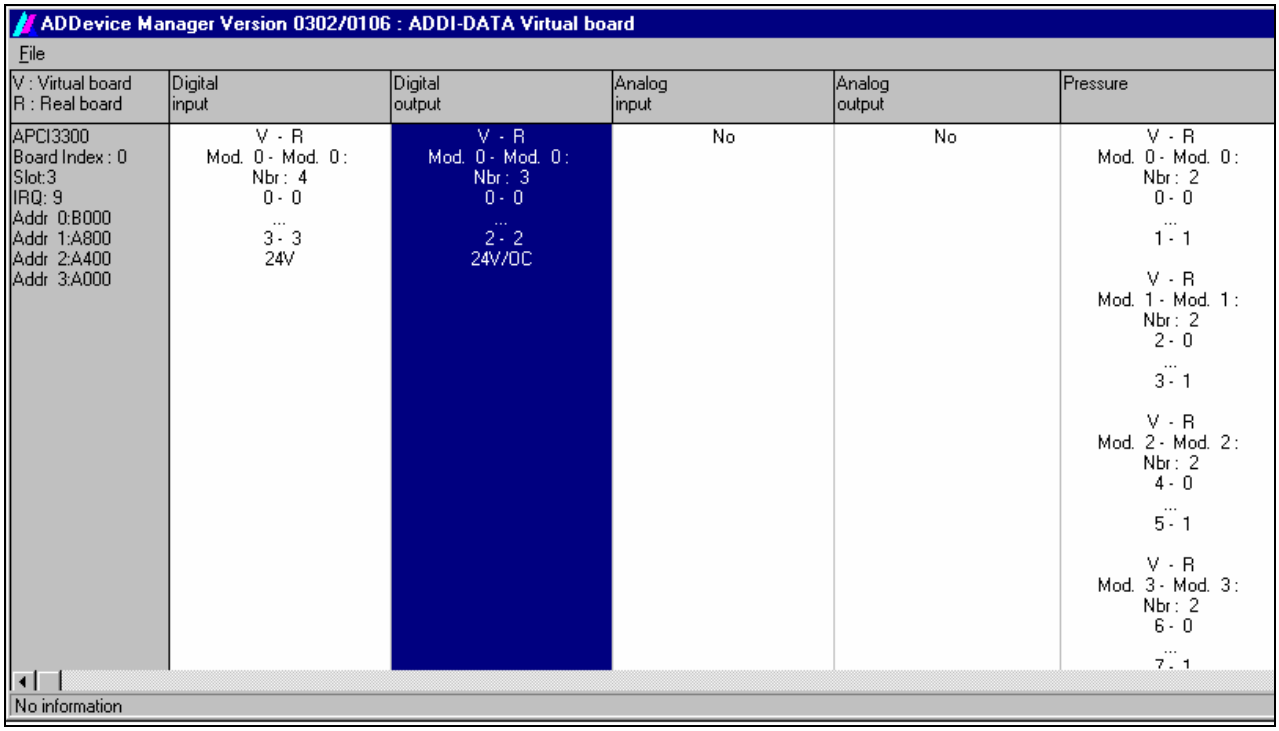

The boards which have been removed from the PC since the last ADDIREG start are listed in the upper table

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

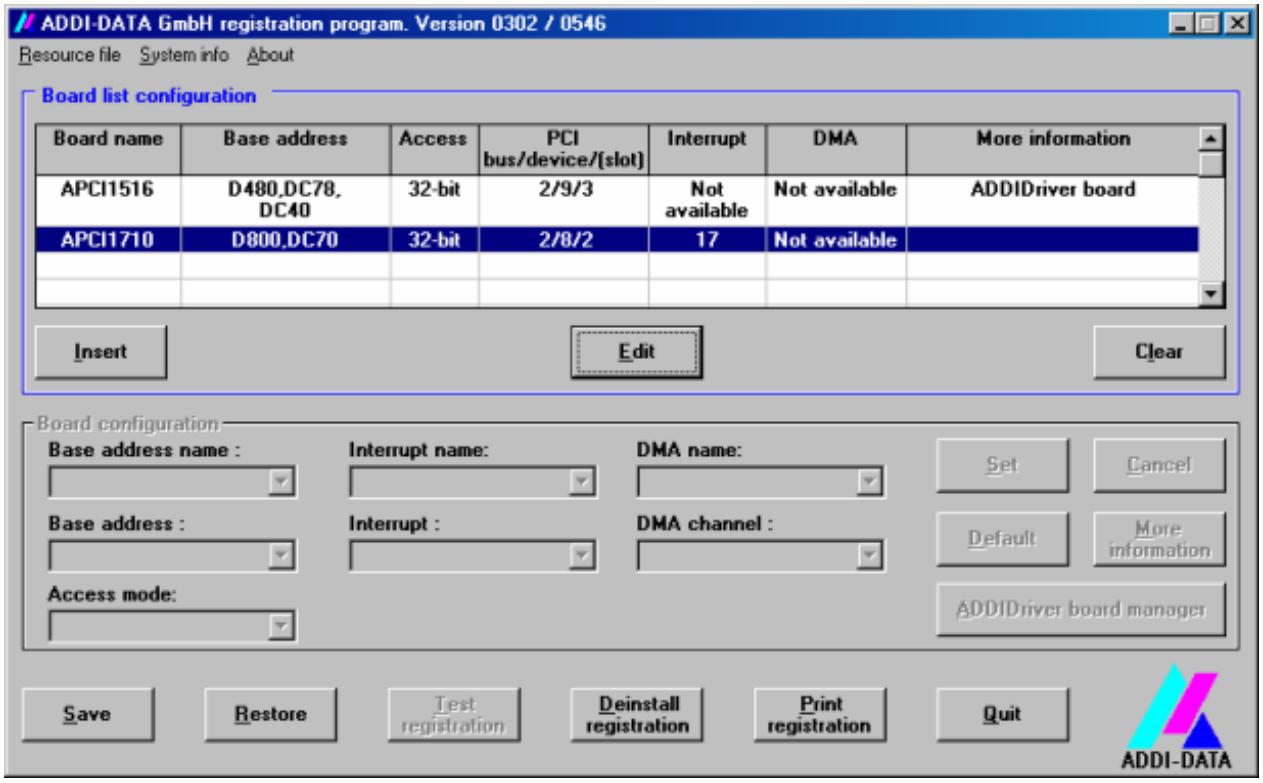
#### Description of the ADDIREG program

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

**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.

**DMA:**
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.

## Text boxes:

**Base address name:**
Description of the used base addresses for the board. Select a name though 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 though 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:**
Quits the ADDIREG program.

### Test the board registration

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.
per 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-3300.**

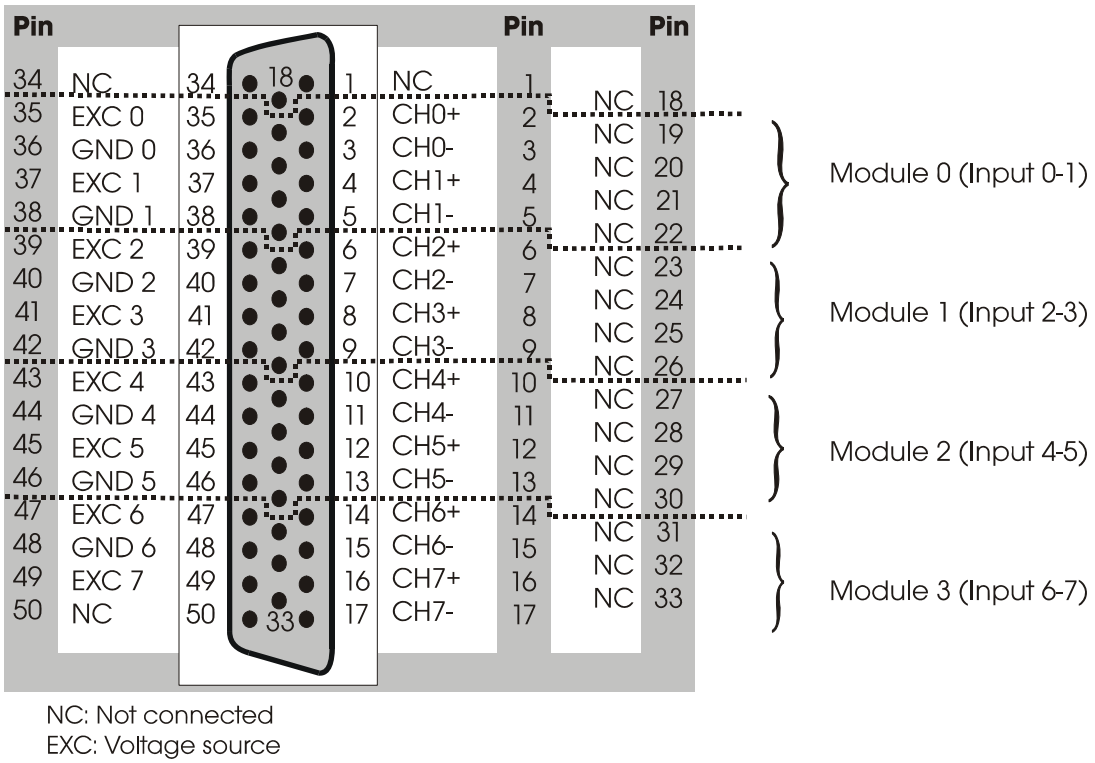
**http://www.addi-data.com**

**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 THE PERIPHERAL

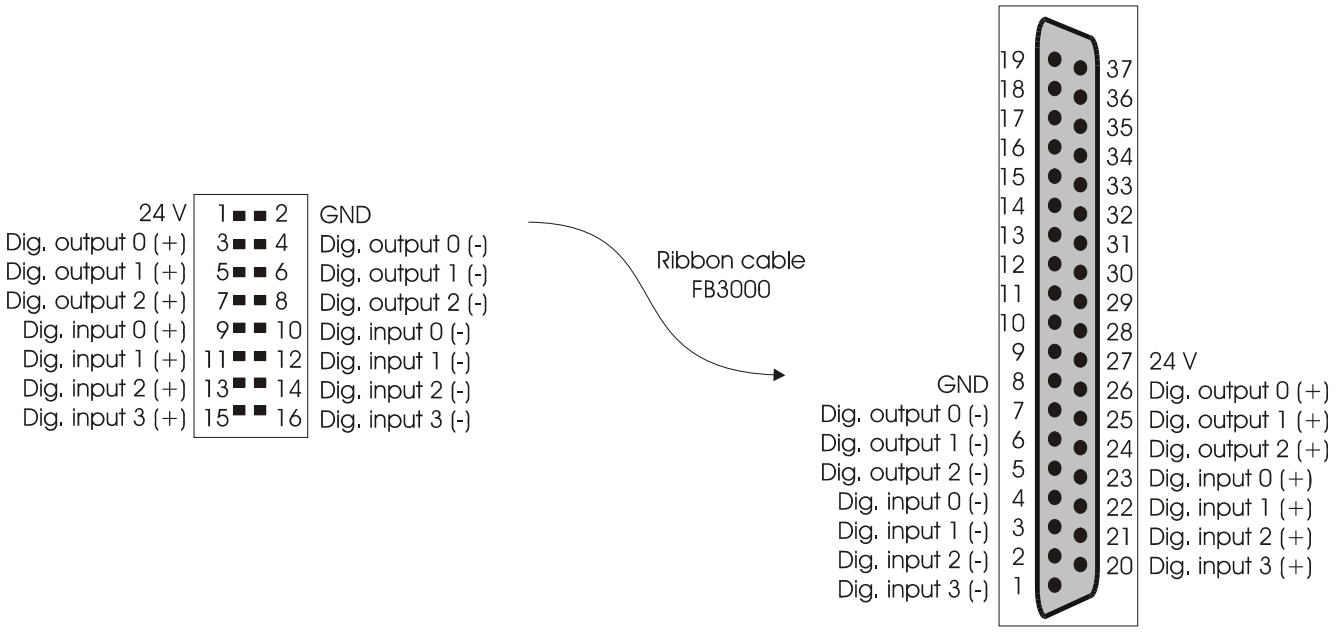
## 7.1 Connector pin assignment

**Fig. 7-1: 50-pin SUB-D male connector**




NC: Not connected
EXC: Voltage source

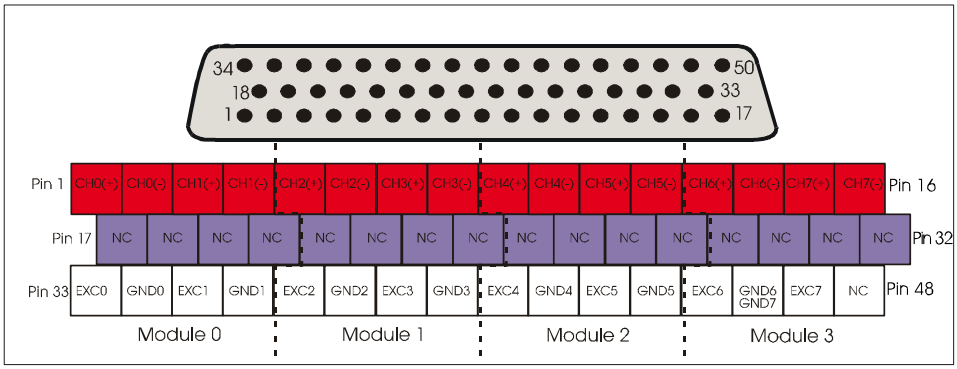
**Fig. 7-2: 16-pin connector to 37-pin SUB-D connector**




**IMPORTANT!**
Insert the FB3000 on the connector with the red cable lead on the side of the pin 1. See page 28 "Connection to the screw terminal panels".

## 7.2 Assignment of the screw terminal panel PX3200

**Fig. 7-3: 48-screw terminal panel PX3200**

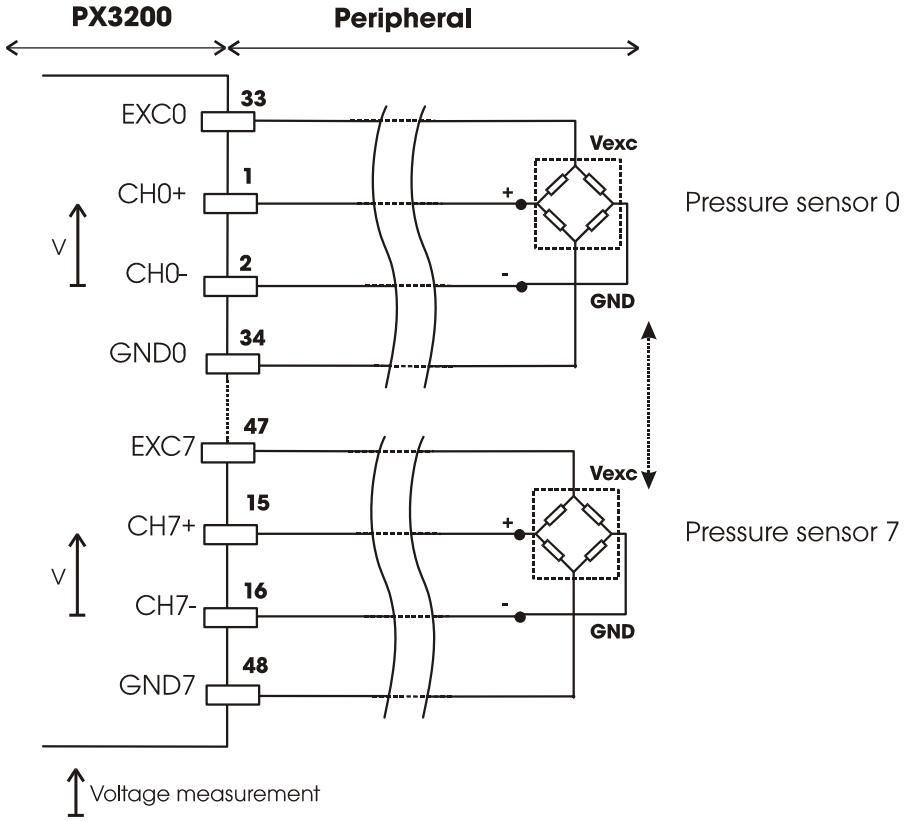



**EXC:** Excitation; voltage sources
**Pin x:** Screw terminal number
**NC:** Not connected
GND6 and GND7 are connected to the same pin of the screw terminal panel

## 7.3 Connection principle

### 7.3.1 Connection of pressure sensors through the PX3200

**Fig. 7-4: Connector of pressure sensors through the PX3200**



## 7.3.2 Connection of the digital I/O channels

**Fig. 7-5: Connection of the digital input channels**

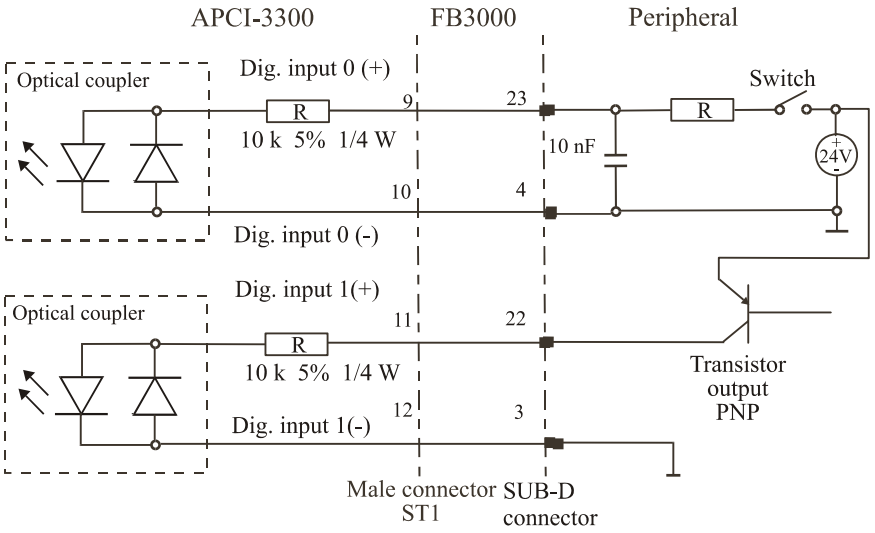
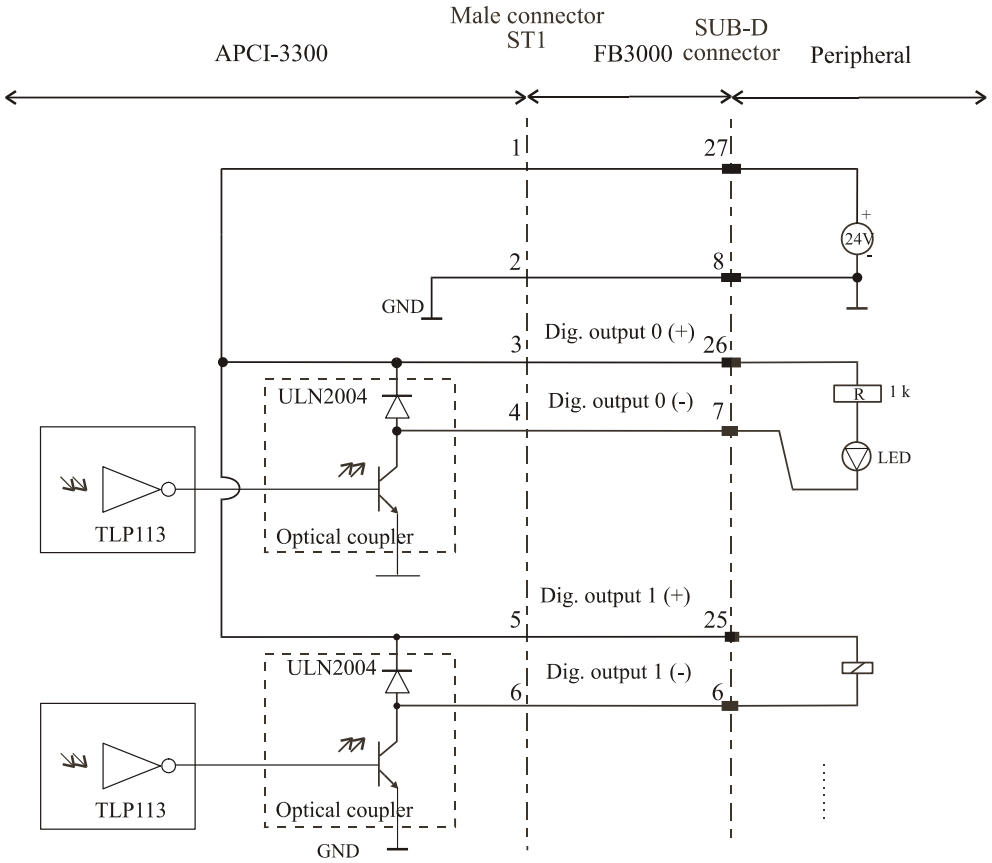
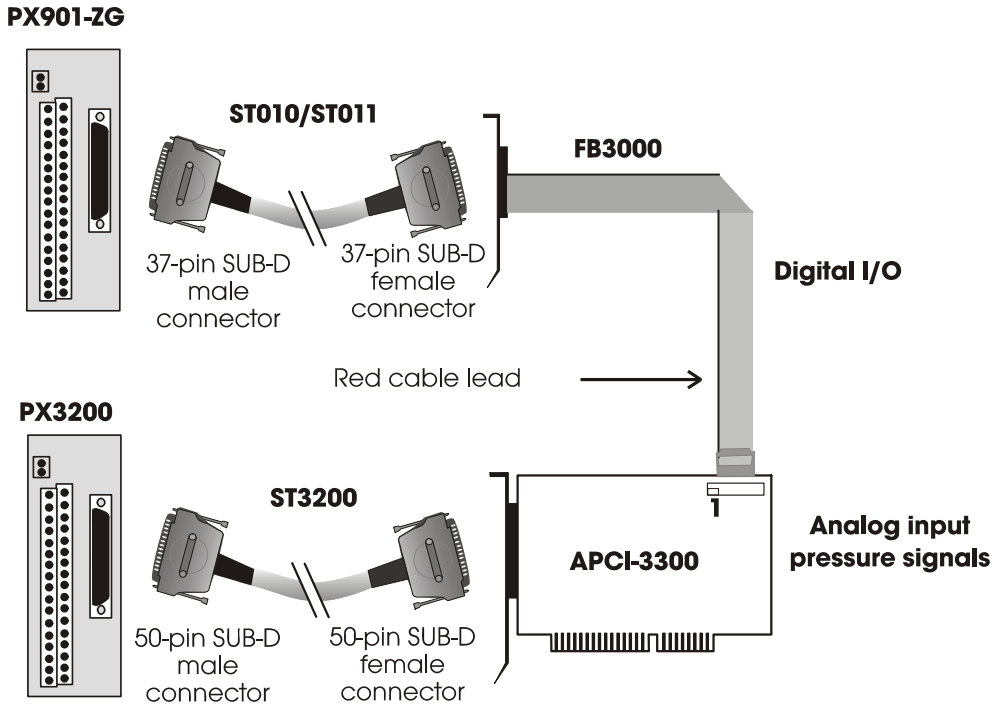



**Fig. 7-6: Connection of the digital output channels**



### 7.3.3 Connection to the screw terminal panels

**Fig. 7-7: Connection to the screw terminal panels**

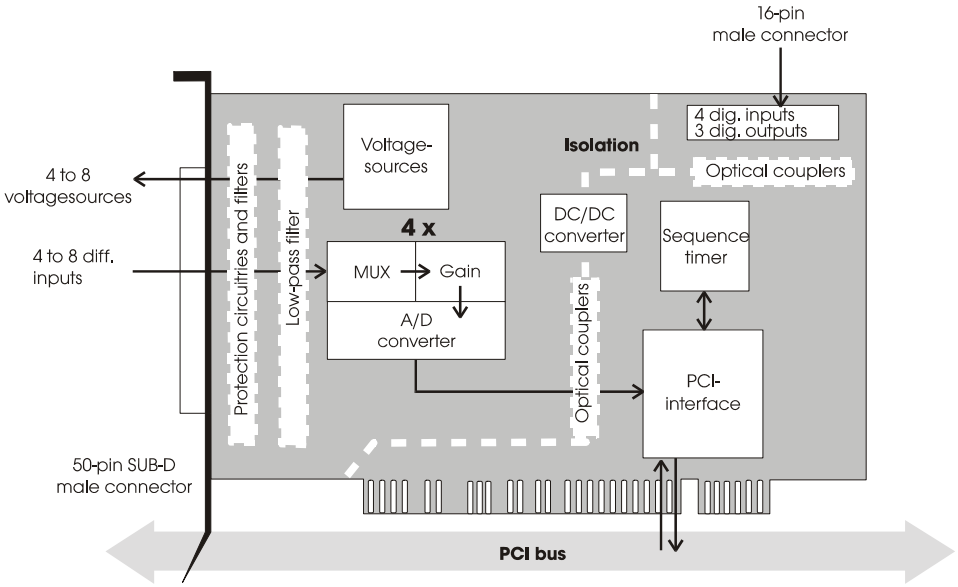



**IMPORTANT!**
Insert the **FB3000** on the connector with the red cable lead on the side of the pin 1.

# 8 FUNCTIONS OF THE BOARD

## 8.1 Block diagram

**Fig. 8-1: Block diagram of the APCI-3300**




## 8.2 Pressure measurement

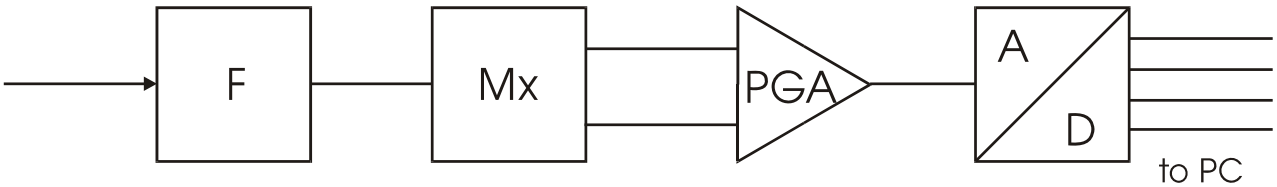
The board has max. 8 analog pressure inputs. These are organised in 4 different modules. An 18-bit A/D converter is allocated to each module.
A converter can acquire 2 inputs independently from each other or sequentially, once or in cycles through timer. (Scan, Single or Continuous Mode).

The APCI-3200 allows an acquisition with 18-bit resolution in a range of 0 to + 2.5 V.

For the acquisition of the input signals, the following parameters are to be configured by software:

- gain
- polarity

**Fig. 8-2: Acquisition principle of the analog pressure signals**




Acquisition principle for 1 module

Module 0 corresponds to the inputs 0 to 1.
Module 1 corresponds to the inputs 2 to 3.
Module 2 corresponds to the inputs 4 to 5.
Module 3 corresponds to the inputs 6 to 7.

The conversion of module x is started by single start, single scan, continuous scan with or without timer, through software trigger or external hardware trigger via a digital input channel:

- Digital input 0 for module 0.
- Digital input 1 for module 1.
- Digital input 2 for module 2.
- Digital input 3 for module 3.

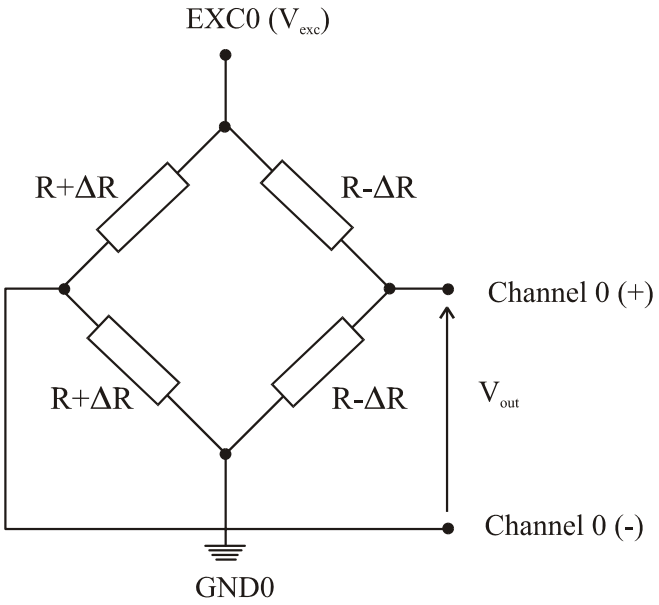
Once the conversion is completed, an interrupt is generated (EOC: end of conversion). The measured value can be read back at any time with the corresponding driver function.

## 8.2.1 Principle of the pressure measurement

The board APCI-3300 allows the connection of linear sensors and functions according to the principle of a "Wheatstone" bridge (See figure below). When pressure affects the connected sensor, the whole resistance value (R) of the bridge is modified by $\Delta R$. The higher the resistance, the higher the voltage and in consequence the pressure.

The $V_{exc}$ (EXC0 to EXC7) on the screw terminal panel are used as reference voltage i.e. as excitation voltage for the resistance bridge. The voltage measured at the 2 pins corresponds to the resistance difference $\Delta R$ between the 2 sides of the bridge.

**Fig. 8-3: Principle of the pressure sensor**




$V_{out}$: Voltage measurement

The output voltage ($V_{out}$) is defined as follows:

$$V_{out} = V_{exc} \times \frac{\Delta R}{R}$$

The connected sensors have technical properties which must be carefully considered for the pressure measurement:

- the offset voltage: measured voltage when the sensor resistance amounts 0 Ω.
- the sensor sensitivity

You will find the required values in the product specifications of the sensor manufacturer. Enter this date in the following software function (See chapter 9): b_ADDIDATA_InitPressureChannel.

Pressure is proportional to the resistance whatever the sensor type is. It results the following calculation:

$$P = \frac{V_{out} + V_{off}}{V_{exc} \times S}$$

- $V_{out}$: output voltage in mV
- $V_{off}$ : offset voltage (See product information of the sensor manufacturer)
- $V_{exc}$: reference voltage in V
- S: sensitivity of the sensor in $\frac{mV}{V \times bar}$ (See product information of the sensor manufacturer)
- P: measured pressure in Bar. The pressure value is returned with a slight inaccuracy ±ΔP.

ΔP is calculated as follows:

$$\Delta P = \mathrm{P}\left( \frac{\Delta V_{out} + \Delta V_{off}}{V_{out} + V_{off}} + \frac{\Delta S}{S} + \frac{\Delta V_{exc}}{V_{exc}} \right)$$

- ΔS: Sensitivity error (See product information of the sensor manufacturer)
- $\Delta V_{exc}$: Reference voltage error
- $\Delta V_{off}$: Offset error (See product information of the sensor manufacturer)
- $\Delta V_{out}$: Measurement precision of the board (See Table 8-4)

**Table 8-1: Conversion table of SI pressure units**

| | SI-Units | | | Technical Units | | |
|---|---|---|---|---|---|---|
| | bar | mbar | Pa | mmHg | kp/cm² | atm |
| 1 bar | 1 | $10^3$ | $10^5$ | 750,064 | 1,01972 | 0,986923 |
| 1 mbar | $10^{-3}$ | 1 | 100 | 750,064E-03 | 1,01972E-03 | 0,986923E-03 |
| 1 Pa | $10^{-5}$ | 0,01 | 1 | 7,50064E-03 | 10,1972E-06 | 9,86923E-06 |
| 1 mmHg | 1,33322E-03 | 1,33322 | 133,322 | 1 | 1,35951E-03 | 1,31579E-03 |
| 1 kp/cm² | 0,980665 | 0,980665E03 | 98,0665E-03 | 735,561 | 1 | 0,967841 |
| 1 atm | 1,01325 | 1,01325E03 | 101,325E-03 | 760 | 1,03323 | 1 |

Other pressure unit: psi (pound per square inch)
1 psi = 6.89 x $10^3$ Pa (N/m2)
1 psi = 6.89 x $10^{-2}$ bar

## 8.2.2 Temperature compensation

For a given constant pressure the output voltage changes with the temperature variations as follows:

$$\frac{dV_{out}}{dT} = \frac{dS}{dT} \times P \times V_{ref}$$

The temperature dependence of the sensor sensitivity can be calculated as follows:

$$S = S_0\left[(1 - \beta T_D) + \rho T_D^2\right]$$

- $T_D$: temperature difference between 25°C and the sensor temperature
- $S_0$: sensitivity at 25°C
- β and ρ are correlation constants (See product information of the sensor manufacturer)

Between 0°C and 70°C the change in sensitivity with temperature is quite linear and the 2nd order temperature dependent term can be ignored. Outside this temperature range, the terms from the 2nd order must be considered if accuracy of better than ± 1% is required (See sensor technical features).

Most pressure applications fall within the 0°C to 70°C operating temperature and the non-linear effects can then be ignored. Thus:

$$S = S_0(1 - \beta T_D)$$

The pressure dependence with temperature can be calculated as follows:

$$P = \frac{V_{out} + V_{off}}{V_{ref} \times S_0(1 - \beta T_D)}$$

### Example of temperature compensation

**Values**

- $V_{off}$ = - 20 mV
- $V_{ref}$ = 5 V
- $S_0$ = 21.77 $\frac{mV}{V \times bar}$
- $V_{out}$ = 40 mV
- β = - 2150 ppm/°C
- T° = 60°C

**Calculation:**

- **without temperature compensation:**

$$P = \frac{V_{out} + V_{off}}{V_{ref} \times S} = 0.184 bar$$

- **with temperature compensation:**

$$P = \frac{V_{out} + V_{off}}{V_{ref} \times S_0(1 - \beta T_D)} = 0.171 bar$$

**IMPORTANT!**
To avoid pressure modification in relation to temperature variation, the use of **temperature compensated sensors is recommended**.

If no temperature compensated sensor is used and in case the operating temperature is not 25°C or is unknown, temperature compensation is absolutely necessary.

Contact our sales department which will be pleased to help you find the required solution by inserting the board **APCI-3200 for temperature measurement**.

### 8.2.3 Acquisition functions

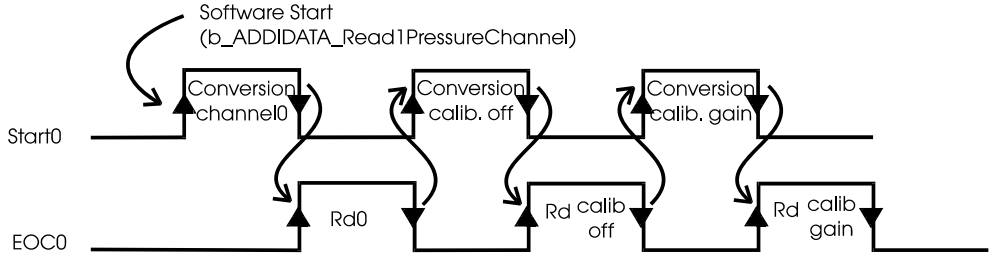
Each channel can be independently acquired (software start; See Fig. 8-4).

Each module (4 channels) can be independently acquired (one channel after the other):
- once through software trigger (single software scan; See Fig 8-5)
- once through external trigger (single hardware scan)
- cyclically through software trigger (continuous software scan)
- cyclically through software trigger with timer (continuous software scan with Timer)
- cyclically through external trigger (continuous hardware scan)
- cyclically through external trigger with timer (continuous hardware scan with Timer; See Fig. 8-6)

All functions can be configured through software.

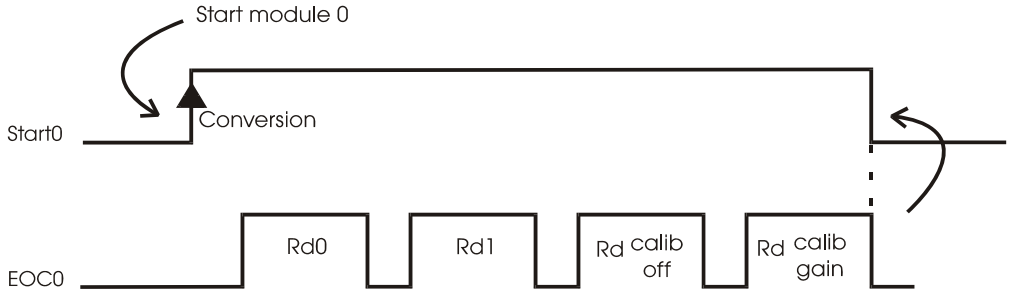
**Fig. 8-4: Acquisition example - Software start**

Rdx: Read Channel x
CJC: Cold junction compensation
calib. gain: Gain calibration
EOC0: End of Conversion for the module 0
Start0: Start of module 0



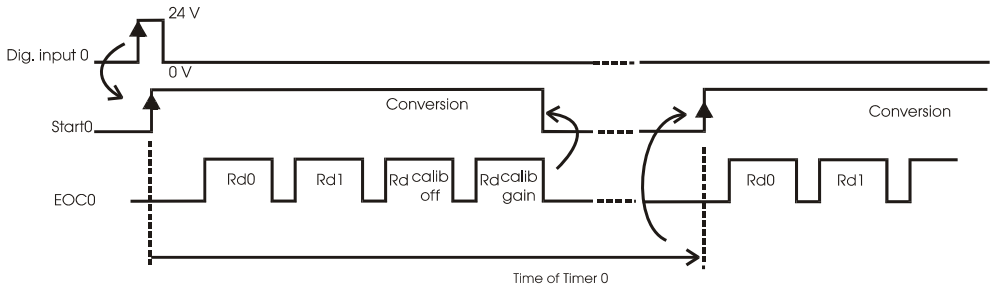

After software-start, the channel x, the offset value and the gain value are read and a 16-bit value is returned.

**Fig. 8-5: Acquisition example - Single software scan**




**Single software scan in differential mode:**
After a single software scan the channels 0, 1, the offset value and the gain value are read. The conversion is made once (single scan) and stopped.

**Fig. 8-6: Acquisition example - Continuous hardware scan with Timer (rising edge)**




The conversion is identical to the conversion in single software scan. The only difference is that the conversion is started by one of the 4 digital inputs (external trigger). A delay time between 2 scan starts can be set through one 10-bit timer. The conversion is stopped by software.

### Acquisition times

**Table 8-2: Acquisition times**

| Acquisition times (Hz) Measurement of 1 channel, offset, reference | Sample period (ms) |
|---|---|
| 20 | 50 |
| 40 | 25 |
| 80 | 12.5 |
| 160 | 6.25 |

## 8.2.4 Interrupt

For each module, an "End of Conversion" (EOC) is automatically generated after each measurement. This function can generate an interrupt.

### 8.2.5 Timer

Through the 4 x 10-bit timers, delays can be determined between 2 starts of SCAN. Each timer can be independently configured in 3 different time bases.

**Table 8-3: Timer time delays**

| Time unit | Range of the delay for this time unit | Corresponds to |
|---|---|---|
| 1ms | 0< t < 1023 ms | 0 < t < 1.023 s |
| 1s | 0< t < 1023 s | 0 < t < 17.067 min |

After the delay has run down, a new SCAN cycle is started.

### 8.2.6 Software calibration

Each channel can be independently configured through software. For each measuring process, a software calibration of the A/D converter is completed through internal comparison with the reference voltage. The offset and gain error can then be corrected in order to measure the voltage with a precision of 16 bits.

## 8.3 Voltage acquisition

**Table 8-4: Voltage accuracy**

| Mode | Range | Accuracy (Gain = 1) |
|---|---|---|
| **Unipolar** | 0 < V < 100 mV | ± 19 µV |
| | 100 mV < V < + 2.5 V | ± 76 µV |

See also the Limit values on page 5.

# 9 SOFTWARE FUNCTIONS AND SAMPLES

ADDIPACK supports the following functions for the APCI-3300.

**Table 9-1: Software functions**

| Functionality | Function name |
|---|---|
| **Common functions** | i_ADDIDATA_OpenWin32Driver |
| | i_ADDIDATA_GetCurrentDriverHandle |
| | i_ADDIDATA_GetDriverVersion |
| | i_ADDIDATA_GetLocalisation |
| | b_ADDIDATA_CloseWin32Driver |
| **Interrupt** | b_ADDIDATA_SetFunctionalityIntRoutineWin32 |
| | b_ADDIDATA_TestInterrupt |
| | b_ADDIDATA_ResetFunctionalityIntRoutine |
| **Error** | i_ADDIDATA_GetLastError |
| | i_ADDIDATA_GetLastErrorAndSource |
| | b_ADDIDATA_EnableErrorMessage |
| | b_ADDIDATA_DisableErrorMessage |
| | b_ADDIDATA_FormatErrorMessage |
| **Pressure** | b_ADDIDATA_GetNumberOfPressureChannels |
| | b_ADDIDATA_GetNumberOfPressureModules |
| | b_ADDIDATA_GetNumberOfPressureChannelsForTheModule |
| | b_ADDIDATA_GetPressureChannelInformation |
| | b_ADDIDATA_InitPressureChannel |
| | b_ADDIDATA_Read1PressureChannel |
| | b_ADDIDATA_ReadMorePressureChannels |
| | b_ADDIDATA_ConvertDigitalToRealPressureValue |
| | b_ADDIDATA_ConvertMoreDigitalToRealPressureValues |
| | b_ADDIDATA_InitPressureSCAN |
| | b_ADDIDATA_StartPressureSCAN |
| | b_ADDIDATA_GetPressureSCANStatus |
| | b_ADDIDATA_ConvertDigitalToRealPressureValueSCAN |
| | b_ADDIDATA_StopPressureSCAN |
| | b_ADDIDATA_ClosePressureSCAN |
| | b_ADDIDATA_ReleasePressureChannel |
| | b_ADDIDATA_ConvertBarToPa |
| | b_ADDIDATA_ConvertBarToPsi |

| Functionality | Function name |
|---|---|
| **Digital inputs** | b_ADDIDATA_GetNumberOfDigitalInputs |
| | b_ADDIDATA_GetDigitalInputInformation |
| | b_ADDIDATA_Read1DigitalInput |
| | b_ADDIDATA_Read2DigitalInputs |
| | b_ADDIDATA_Read4DigitalInputs |
| **Digital outputs** | b_ADDIDATA_GetNumberOfDigitalOutputs |
| | b_ADDIDATA_GetDigitalOutputInformation |
| | b_ADDIDATA_SetDigitalOutputMemoryOn |
| | b_ADDIDATA_SetDigitalOutputMemoryOff |
| | b_ADDIDATA_Set1DigitalOutputOn |
| | b_ADDIDATA_Set1DigitalOutputsOff |
| | b_ADDIDATA_Set2DigitalOutputsOn |
| | b_ADDIDATA_Set2DigitalOutputsOff |
| | b_ADDIDATA_Set4DigitalOutputOn |
| | b_ADDIDATA_Set4DigitalOutputOff |
| | b_ADDIDATA_Get1DigitalOutputStatus |
| | b_ADDIDATA_Get2DigitalOutputStatus |
| | b_ADDIDATA_Get4DigitalOutputStatus |

ADDIPACK supports the following samples for the **APCI-3300**.

**Table 9-2: Software examples for the APCI-3300**

| Functionality | Samples number | Description |
|---|---|---|
| **Pressure** | SAMPLE00 | Display information of a pressure channel |
| | SAMPLE01 | Read 1 pressure channel without interrupt. |
| | SAMPLE02 | Read 1 pressure channel with interrupt. |
| | SAMPLE03 | Read several pressure channels without interrupt. |
| | SAMPLE04 | Read several pressure channels with interrupt. |
| | SAMPLE16 | Initialise single scan with interrupt |
| | SAMPLE18 | Initialise continuous scan with interrupt |
| **Digital inputs** | SAMPLE01 | Read 1 digital input |
| | SAMPLE02 | Read 2 digital inputs |
| | SAMPLE03 | Read 4 digital inputs |
| **Digital outputs** | SAMPLE01 | Test 1 digital output with/without output memory |
| | SAMPLE02 | Test 2 digital outputs with/without output memory |
| | SAMPLE03 | Test 4 digital outputs with/without output memory |

# 10 GLOSSARY

**Table 10-1: Glossary**

| Term | Description |
|---|---|
| A/D converter | = *ADC*<br>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*<br>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*<br>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. |
| Digital signal | A signal which has distinct states. Digital computers process data as binary information having either true or false states. |
| Disturb signal | Interferences that occur during the transfer caused by reduced bandwidth, attenuation, gain, noise, delay time etc. |
| Driver | A part of the software that is used to control a specific hardware device such as a data acquisition board or a printer. |
| 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. |
| 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. |
| Low-pass filter | Transmitting all frequencies below a certain value |
| MUX | = *Multiplexer*<br>An array of semiconductor or electromechanical switches with a common output used for selecting one of a number of input signals. |
| Noise immunity | Noise immunity is the ability of a device to work during an electromagnetic interference without reduced functions. |
| Noise suppression | The suppression of undesirable electrical interferences to a signal. Sources of noise include the ac power line, motors, generators, transformers, fluorescent lights, CRT displays, computers, electrical storms, welders, radio transmitters, and others. |
| Operating voltage | The operating voltage is the voltage that occurs during the continuous operation of the device. It may not exceed the continuous limit voltage. Furthermore, any negative operation situations, such as net overvoltages over one minute at switching on the device must be taken in consideration. |
| Optical isolation | The technique of using an optoelectric transmitter and receiver to transfer data without electrical continuity, to eliminate high-potential differences and transients. |
| Opto-coupler | A device containing light-emitting and light-sensitive components used to couple isolated circuits. |
| Output voltage | The nominal voltage output reading when shaft is rotated to full range, expressed in volts DC /Vo DC) |
| 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. |
| 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. |
| 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:<br>A software generated event that starts an operation.<br>External trigger:<br>An analog or digital hardware event from an external source that starts an operation.<br>Digital trigger:<br>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. |
| Wheatstone bridge | A simple circuit for measuring an unknown resistance by connecting it so as to form a quadrilateral with three known resistances and applying a voltage between a pair of opposite corners |

# 11 INDEX