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certified

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Technical description

APCI-3200

Temperature measurement board, optically isolated

Edition: 05.15 - 03/2022

Product information

This manual contains the technical installation and important instructions for correct commissioning and usage, as well as production information according to the current state before printing.
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Warning!

The following risks result from the improper implementation of the board and from use contrary to the regulations:

Personal injury

Damage to the board, the PC and peripherals

Pollution of the environment.

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

  If this leaflet is not enclosed with the documentation, please contact us and ask for it.
- Observe the instructions of this manual!

  Make sure that you do not forget or skip any step!
  We are not liable for damages resulting from the wrong use of the board.
- Pay attention to the following symbols:

NOTICE!
Designates hints and other useful information.

NOTICE!
Designates a possibly dangerous situation.
If the instructions are ignored, the board, the PC and/or peripherals may be **destroyed**.

WARNING!
Designates a possibly dangerous situation.
If the instructions are ignored, the board, the PC and/or peripherals may be **destroyed** and persons may be **endangered**.

Figures

Tables

1 DEFINITION OF APPLICATION

1.1 Intended use

The **APCI-3200** board must be inserted in a PC with PCI slots which is used as electrical equipment for measurement, control and laboratory pursuant to the standard DIN EN IEC 61010-1.

The used personal computer (PC) must fulfil the requirements of DIN EN IEC 62368-1 and DIN EN 55032 or IEC/CISPR 32 and DIN EN 55024 or IEC/CISPR 24.

The use of the board **APCI-3200** in combination with external screw terminal panels requires correct installation according to the standard DIN EN IEC 60439-1 (Low-voltage switchgear and controlgear assemblies).

1.2 Usage restrictions

The **APCI-3200** board must not be used as a safety-related part (SRP).

The board **APCI-3200** must not be used for safety-related functions, such as emergency stop functions.

The **APCI-3200** board must not be used in potentially explosive atmospheres.

The **APCI-3200** board must not be used as electrical equipment according to the Low Voltage Directive 2014/35/EU.

1.3 Limits of use

All safety information and the instructions in the manual must be followed to ensure proper intended use.

Uses of the board beyond these specifications are considered as improper use. The manufacturer is not liable for damages resulting from improper use.

The board must remain in its anti-static packaging until it is installed.

Please do not delete the identification numbers of the board or the warranty claim will be invalid.

1.4 General description of the board

Data exchange between the **APCI-3200** board and the peripherals is to occur through a shielded cable. This cable must be connected to the 50-pin D-Sub male connector of the **APCI-3200** board

The board has up to 16 output channels for processing analog signals and 4 input and 3 output channels for processing digital 24 V signals.

The use of the board **APCI-3200** in combination with external screw terminal panels or relay boards is to occur in a closed switch cabinet.

The installation is to be carried out competently.

The **PX3200** screw terminal panel allows the connection of the analog signals to a cold junction compensation through the cable **ST3200**.

The connection with our standard cable **ST3200** complies with the following specifications:

- metallised plastic hoods
- shielded cable
- cable shield folded back and firmly screwed to the connector housing.

2 USER

2.1 Qualification

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

- Installation
- Commissioning
- Use
- Maintenance.

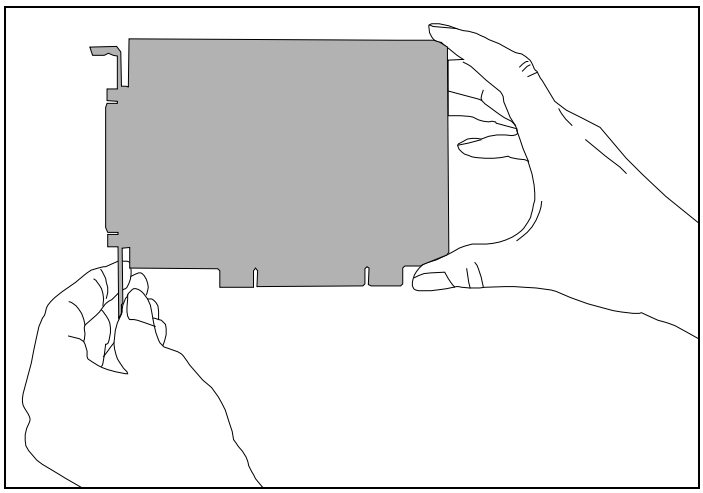
2.2 Country-specific regulations

Do observe the country-specific regulations regarding

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

3 HANDLING OF THE BOARD

Fig. 3-1: Correct handling



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

4 TECHNICAL DATA

4.1 Electromagnetic compatibility (EMC)

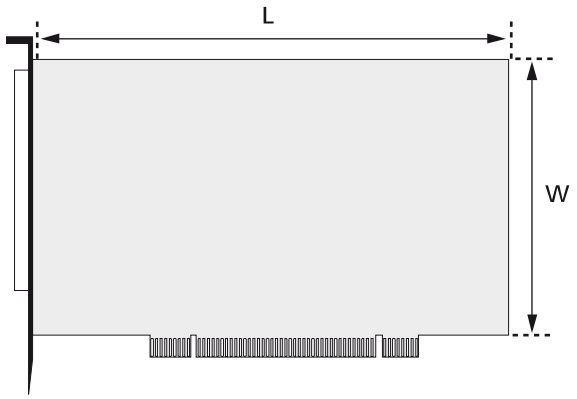
The board **APCI-3200** is suited for installation in personal computers (PCs) which comply with the European EMC directive.

The board **APCI-3200** complies with the European EMC directive. The tests were carried out by a certified EMC laboratory in accordance with the standard DIN EN IEC 61326-1. The limit values as set out by the European EMC directive for an industrial environment are complied with.

The respective EMC test report is available on request.

4.2 Physical set-up of the board

Dimensions:



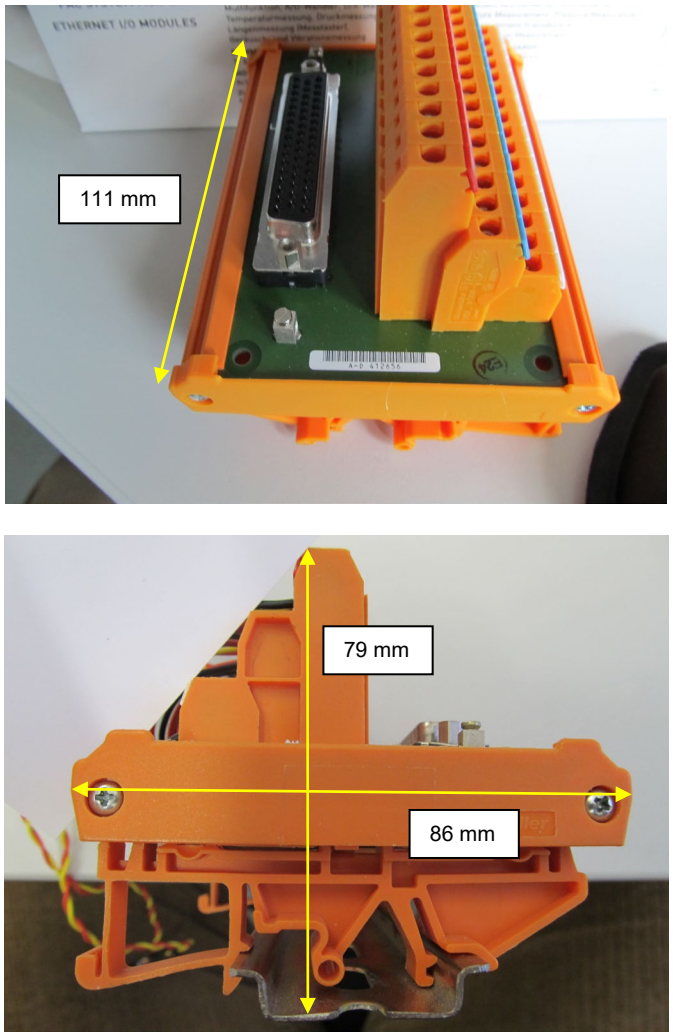
Dimensions (L x W): ..... 131 x 99 mm
Weight: ..... approx. 160 g
Installation in: ..... 32-/64-bit PCI slot 3.3 V / 5 V
Connection to the peripherals: ..... 50-pin D-Sub male connector

Accessories[1]: ..... see Fig. 7-14
Cable: **ST3200, ST010, FB3000**
Screw terminal panel: **PX3200-G**, **PX901-ZG**

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

1 Not included in standard delivery

Fig. 4-1: PX3200-G: Dimensions



4.3 Versions

The board **APCI-3200** is available in the following versions:

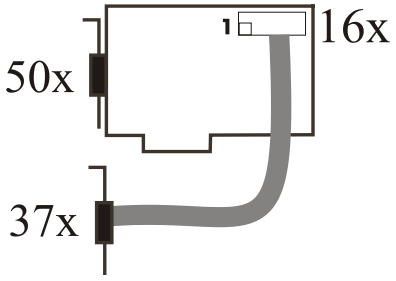
Version	Number of connected thermocouples (SE inputs)	Number of connected thermocouples (differential inputs)	Number of connected RTD (differential inputs)
APCI-3200-4	4	2	2
APCI-3200-8	8	4	4
APCI-3200-16	16	8	8

4.4 Limit values

Max. height: ..... 2000 m
Operating temperature: ..... 0 to 60 °C (with forced ventilation)
Storage temperature: ..... -25 to 70 °C
Relative humidity at indoor installation
50 % at +40 °C
80 % at +31 °C

Minimum PC requirements:
Bus speed: ..... < 33 MHz
Operating system: ..... Windows 10/7/XP, Linux

Number of required slots:
APCI-3200-x: ..... 1 + 1



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

Current sources
Number of current sources: ..... 2 to 8
+ 1 for the cold junction compensation
Output current (25 °C): ..... 200 µA ± 0.5 µA typ.
Drift: ..... ± 25 ppm/°C

Energy requirements:
- Operating voltage of the PC: ..... 3.3 V ± 5%
- Current consumption (without load): ..... 520 mA ± 10%

Analog input channels
Resolution: ..... 18-bit unipolar
Number of voltage inputs: ..... 4 to 16
Overvoltage protection: ..... ± 30 V
Input voltage range: ..... Unipolar: 0 to 1.25 V/PGA
Bipolar: ± 1.25 V/PGA
Input impedance: ..... SE: 5.6 MΩ
Diff.: 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
Bipolar: Offset binary coding

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

Voltage range: -1.25 V < V < - 100 mV and 100 mV < V < +1.25 V
Precision: 14-bit
Integral non-linearity (INL): ..... ± 0.0060 % of FSR[2] over the temperature range
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

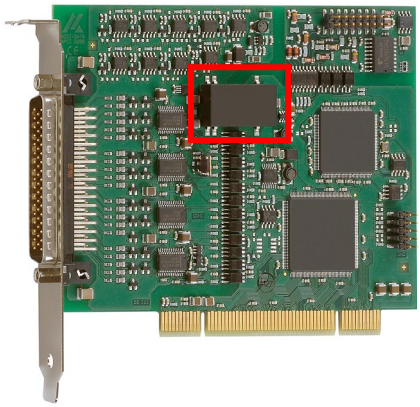
Sampling rate (Hz) 1 channel, offset, reference	Sampling period (ms)
20	50
40	25
80	12.5
160	6.25

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

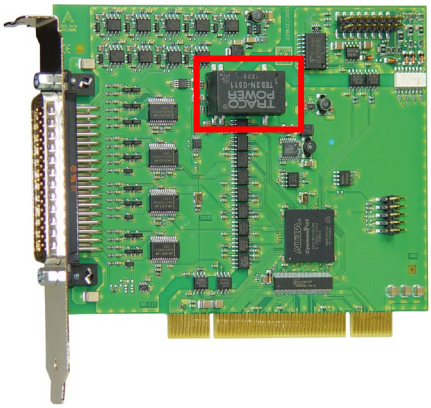
[1] FSR: Full Scale Range
[2] FSR: Full Scale Range

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

Fig. 4-2: Short-circuit and line-break diagnosis



APCI-3200: Old version



APCI-3200: New version

Table 4-2: Short-circuit and line-break diagnosis

	Short-circuit		Line break		
Type of the connected sensor Thermocouple (Single-Ended/Differential)	Diagnostic function not possible	Measured voltage at short-circuit	Diagnostic function possible	Measured voltage at line break	
				APCI-3200	
				Old version	**New version**
Thermocouple (Single-Ended/ Differential)	possible	-	possible	> 2 V	> 1 V
Resistance thermometer (Differential)	possible	< 1 mV*	possible	> 2.5 V	> 1.25 V
Potentiometer (Differential)	Diagnostic function	< 1 mV*	possible	> 2.5 V	> 1.25 V

* If no sensor is connected to the board, the voltage measured at the input is also < 1 mV. In this case an additional line-break test must confirm the short-circuit diagnosis: the measured voltage must be > 1.25 V (old **APCI-3200** version: > 2.5 V).

5 INSTALLATION OF THE BOARD

Risk of injury!
Be sure to follow the safety precautions!
Improper use of the board may lead to property damage and personal injury.

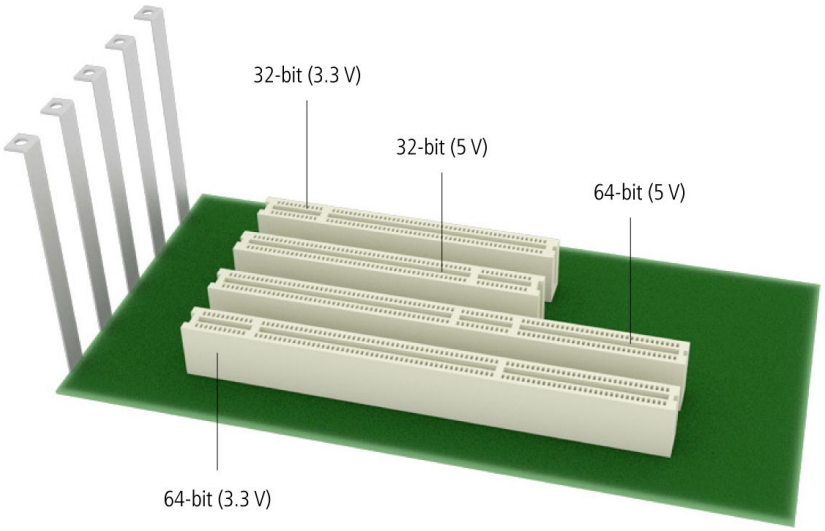
5.1 Opening the PC

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

5.2 Selecting a slot

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

Fig. 5-1: PCI slot types

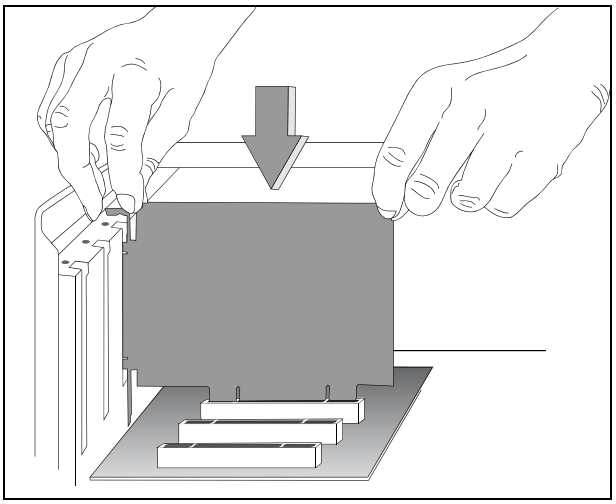


- ♦ Unscrew the back cover from the selected slot. For this, follow the operating instructions provided by the PC manufacturer!
  Keep the back cover in a safe place. You will need it if you remove the board.
- ♦ Provide for potential equalisation.
- ♦ Take the board out of its protective packaging.

5.3 Inserting the board

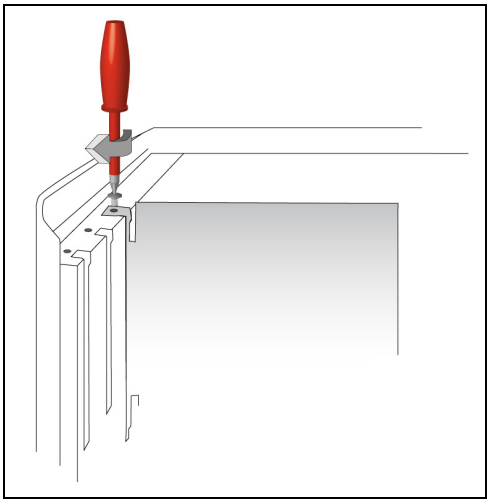
♦ Insert the board vertically from above into the chosen slot.

Fig. 5-2: Inserting the board



♦ Fasten the board to the rear of the PC housing with the screw which was fixed on the back cover.

Fig. 5-3: Fastening the board at the back cover



♦ Tighten all loose screws.

5.4 Closing the PC

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

6 DRIVER INSTALLATION

Information on how to select and download the appropriate driver can be found in the document “Quick installation PC boards” (see PDF link).

The installation of drivers of the type “ADDI-DATA Multiarchitecture Device Drivers 32-/64-Bit for x86/AMD64” as well as the installation of the corresponding samples is described in the installation instructions (see PDF link).

6.1 Questions and updates

If you have any questions, do not hesitate to call us or to send us an e-mail:

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

Manual and software download from the Internet

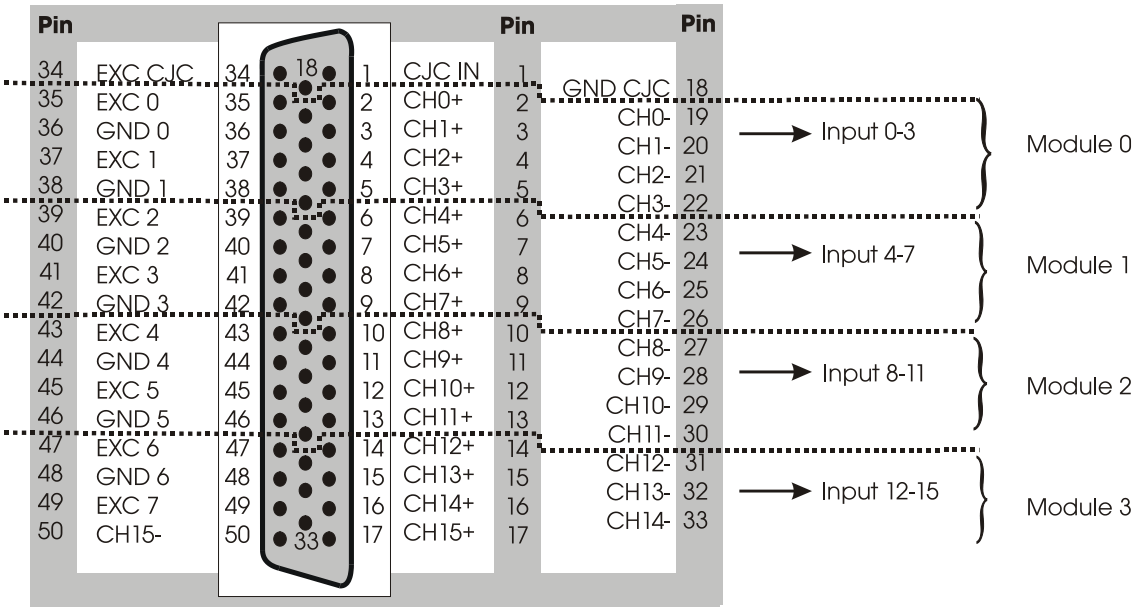
The latest versions of the technical manual and the standard software for the board **APCI-3200** can be downloaded for free at: https://drivers.addi-data.com.

NOTICE!
Before using the board and in case of malfunction during operation, check if there is an update (manual, driver) available. Current data can be found on our website or contact us directly.

7 CONNECTING THE PERIPHERALS

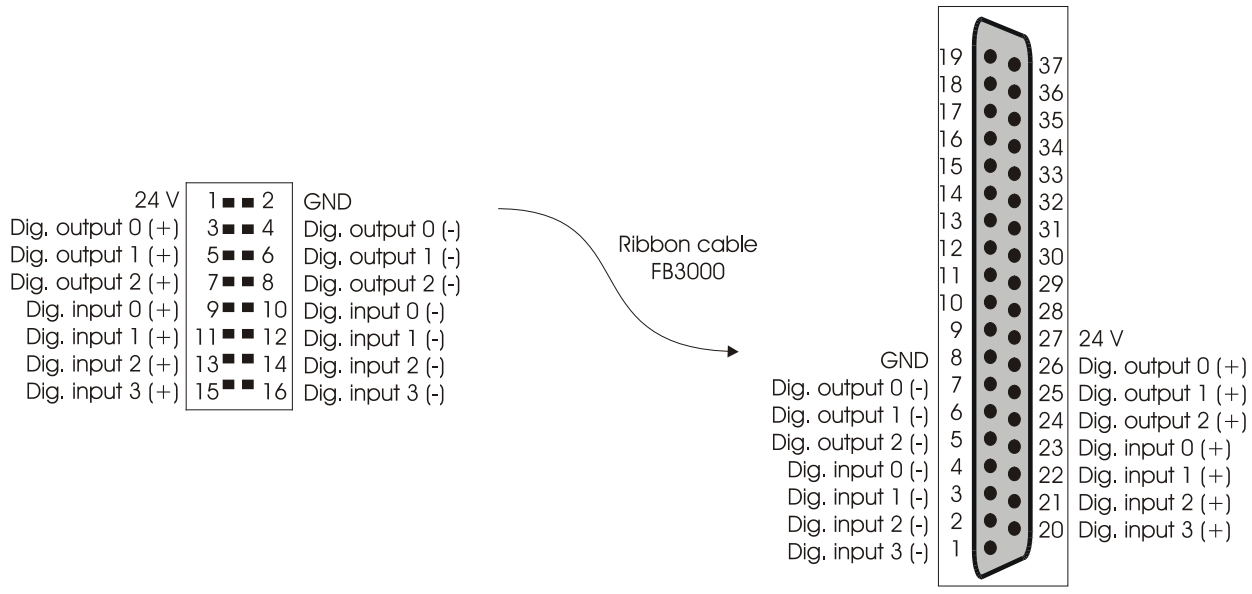
7.1 Connector pin assignment

Fig. 7-1: 50-pin D-Sub male connector



NOTICE!
On the **APCI-3200**, GND 1 to GND 6 are connected with one other.
As on the 50-pin connector of the board, all pins are connected, no GND 7 connection is available for EXC 7. Instead, GND 6 must be used for EXC 7.

Fig. 7-2: 16-pin header and 37-pin D-Sub male connector

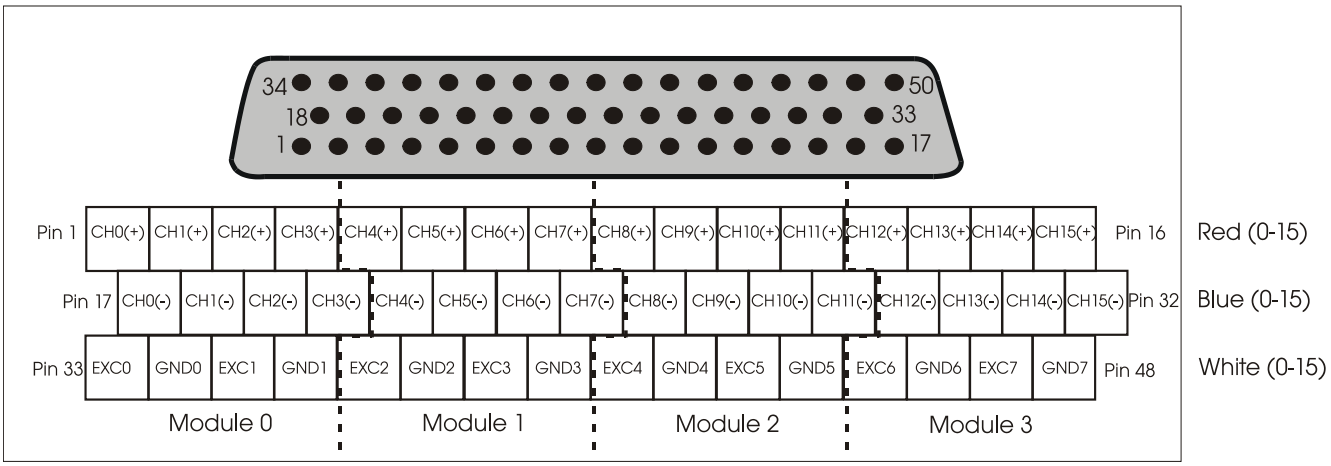


NOTICE!
Plug the **FB3000** cable into the 16-pin header of the board by inserting the red (or blue or black) cable line into pin 1 (see Fig. 7-14).

7.2 Pin assignment of the PX3200

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

Fig. 7-4: PX3200: Pin assignment



EXC: excitation; current source
Pin x : Number corresponding to the pin on the PX3200 connector

NOTICE!

On the screw terminal panel **PX3200**, pin 46 (GND 6) and pin 48 (GND 7) are connected with each other, since on the 50-pin connector of the **APCI-3200** board, all pins are connected and therefore, no line for GND 7 is available.

7.3 Connection principle

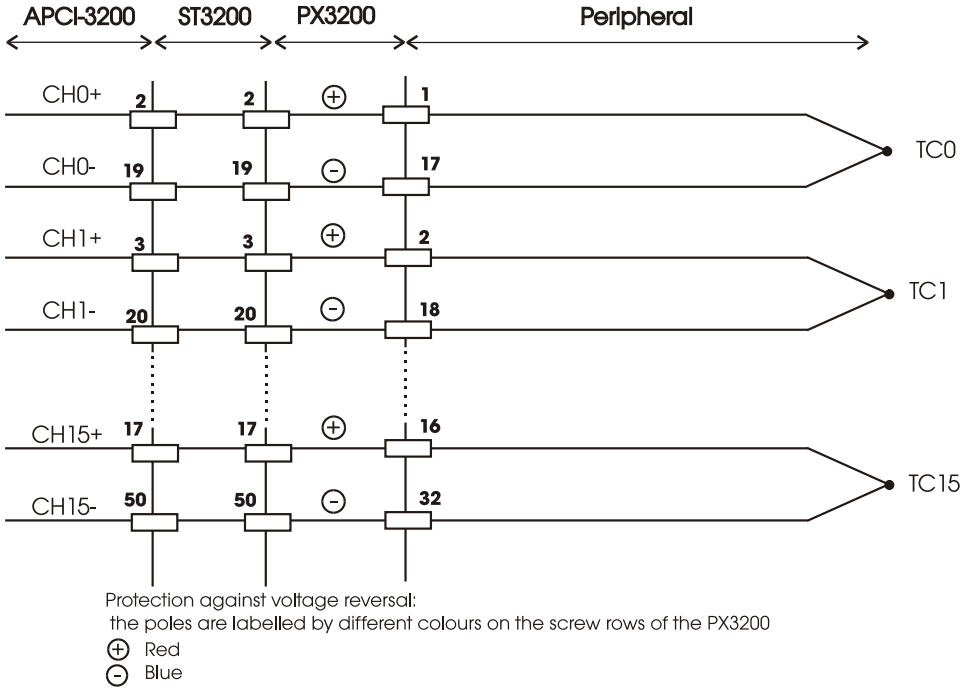
The number of connected thermocouples or RTDs depends on the version of the board and on the configuration of the board.

Table 7-1: Possible connections

Version	Max. number of connected thermocouples (SE inputs)	Max. number of connected thermocouples (differential inputs)	Max. number of connected RTDs (Diff. inputs)		
			2-wire connection	3-wire connection	4-wire connection
APCI-3200-4	4	2	2	1	2
APCI-3200-8	8	4	4	2	4
APCI-3200-16	16	8	8	4	8

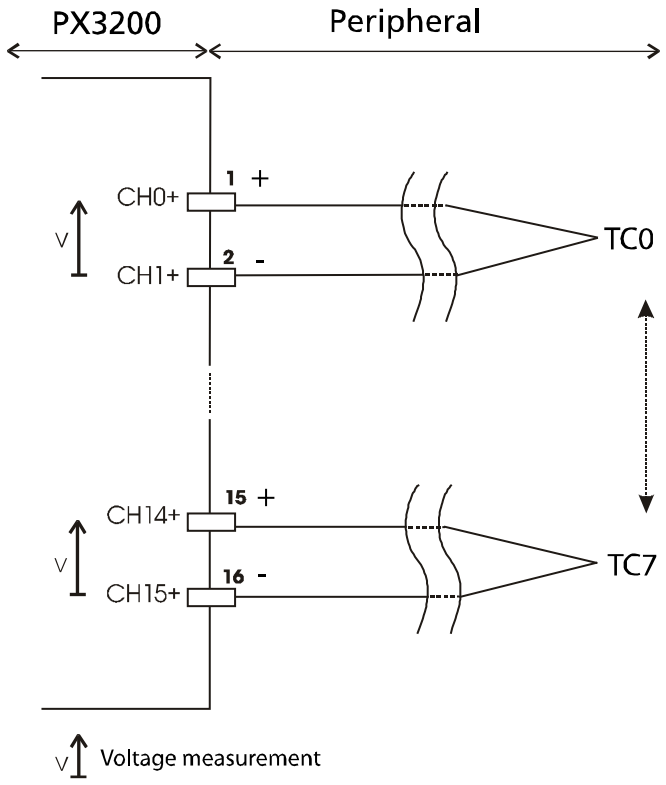
7.3.1 Connection of thermocouples through the PX3200 (single-ended)

Fig. 7-5: Connection of thermocouples through the PX3200 (single-ended)



7.3.2 Connection of thermocouples through the PX3200 (differential)

Fig. 7-6: Connection of thermocouples through the PX3200 (differential)



7.3.3 Connection of RTDs through the PX3200

Fig. 7-7: Connection of RTDs with 2-wire connection

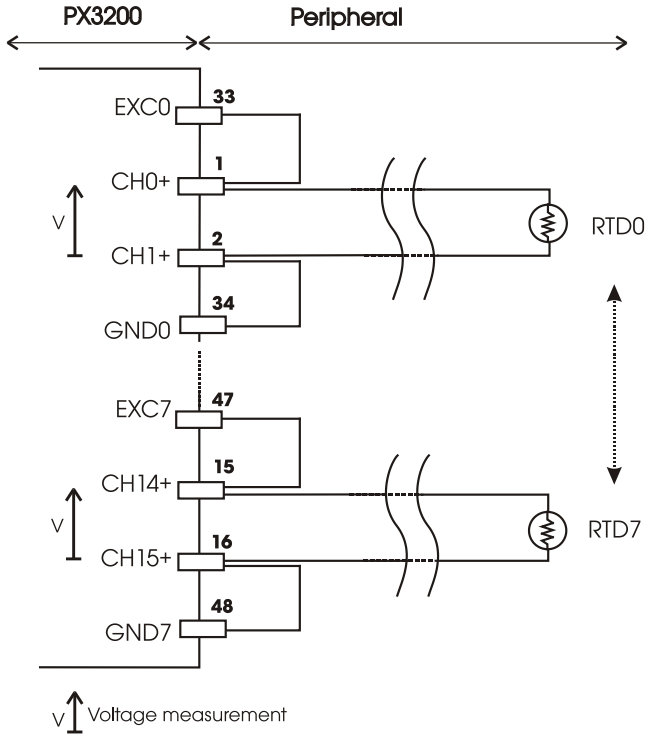


Fig. 7-8: Connection of RTDs with 3-wire connection

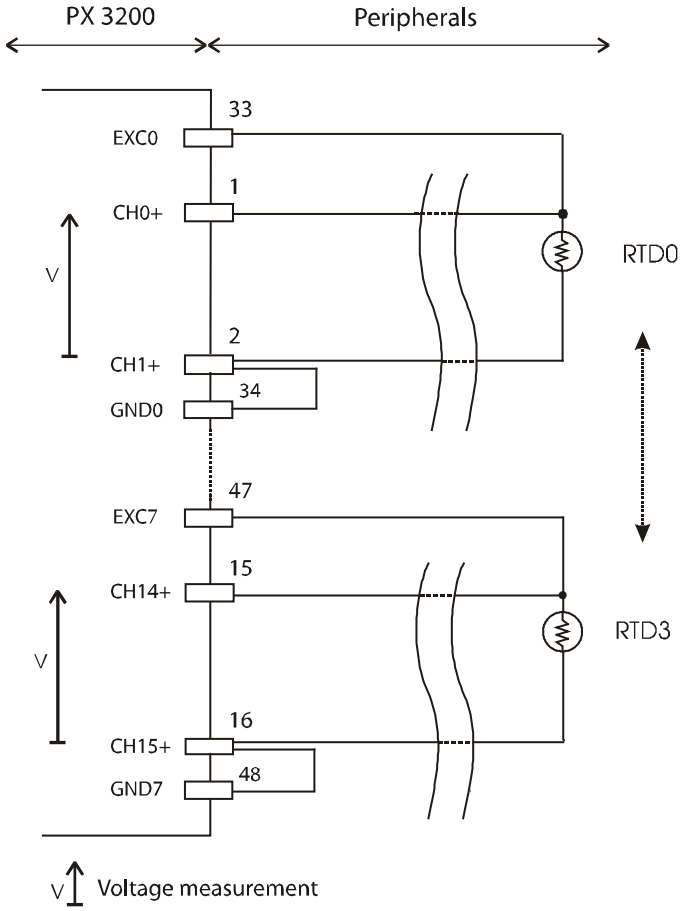
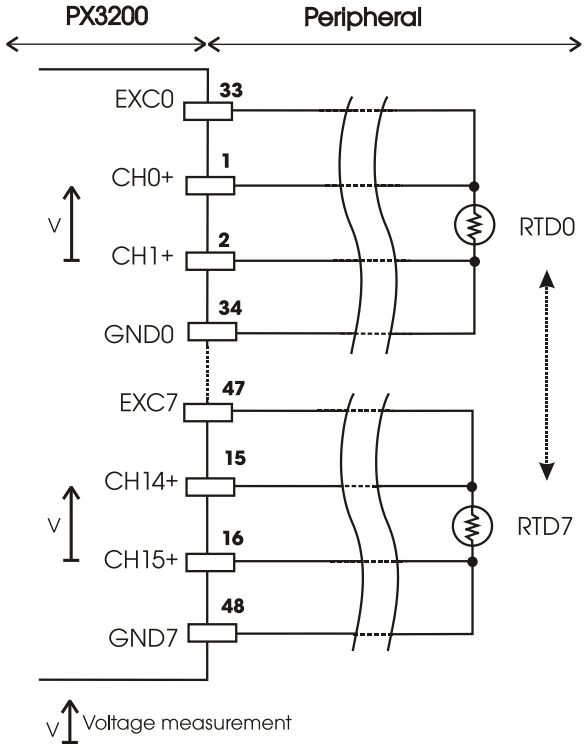
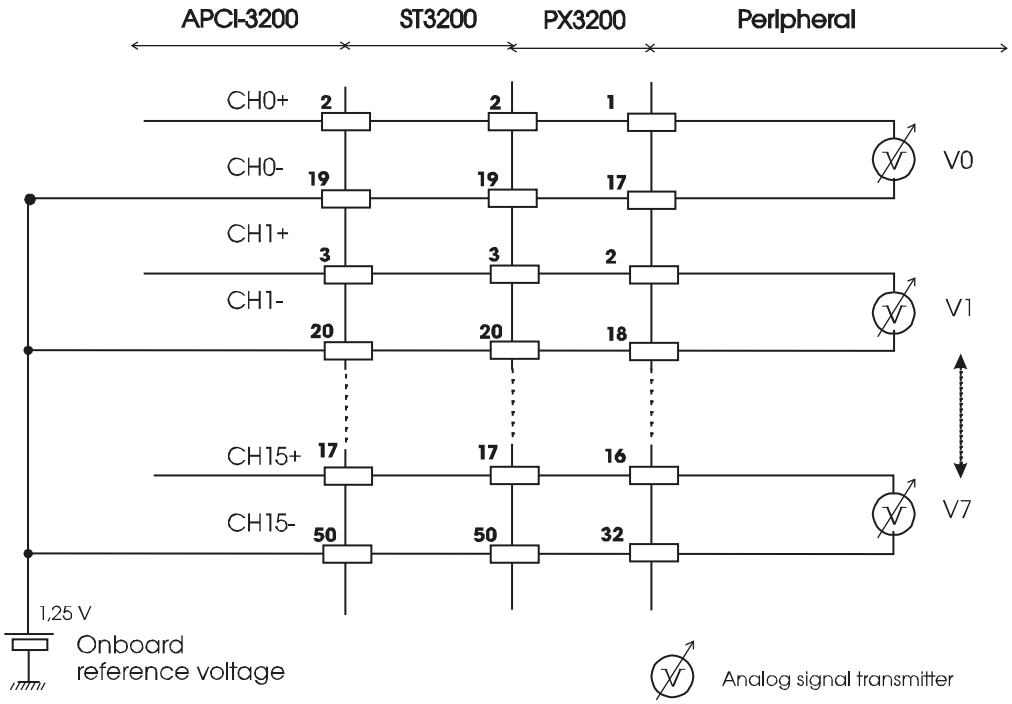


Fig. 7-9: Connection of RTDs with 4-wire connection



7.3.4 Connection of the inputs as voltage input channels

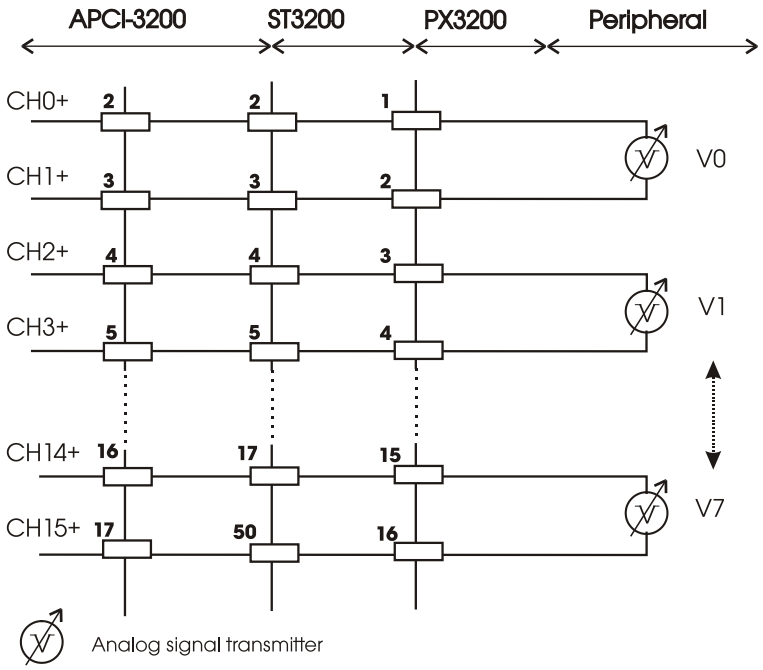
Fig. 7-10: Voltage inputs (single-ended)



NOTICE!

If you operate the input channels in **single-ended mode**, the negative inputs 0 (-) to 15 (-) are connected onboard to a reference voltage of 1.25 V. **Do not connect them to ground!** Otherwise, a short-circuit may occur and the board may be destroyed.

Fig. 7-11: Voltage inputs (differential)



7.3.5 Digital input and output channels

Fig. 7-12: Digital outputs

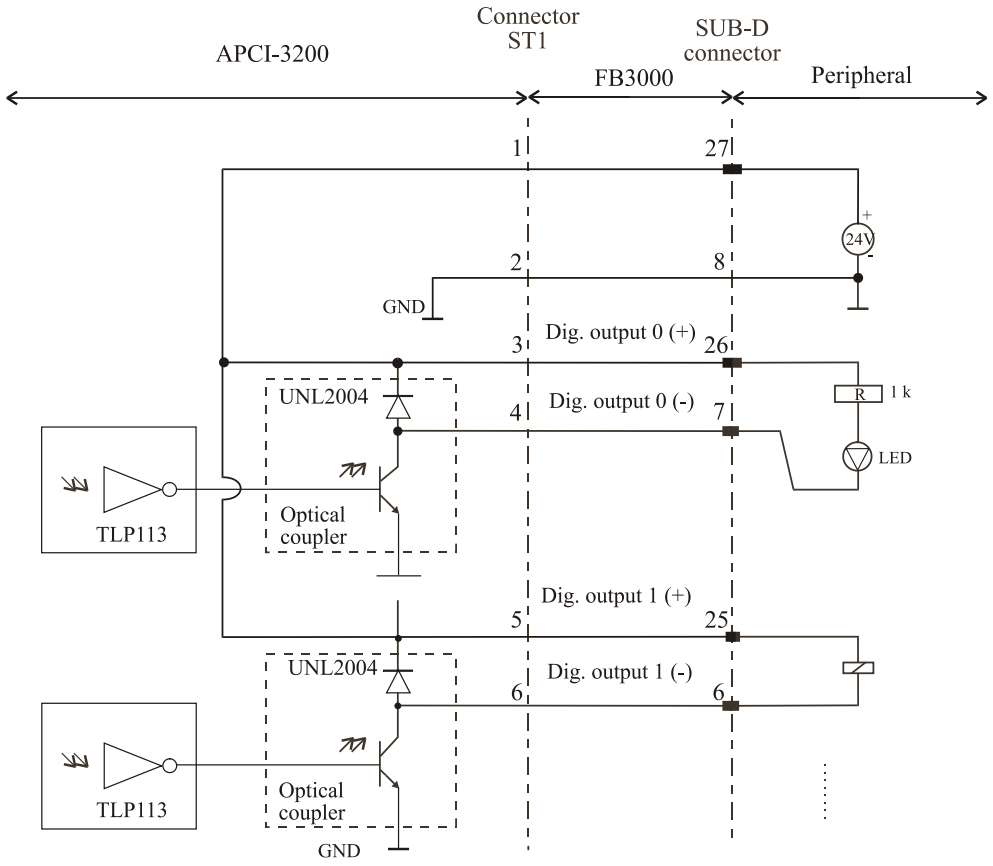
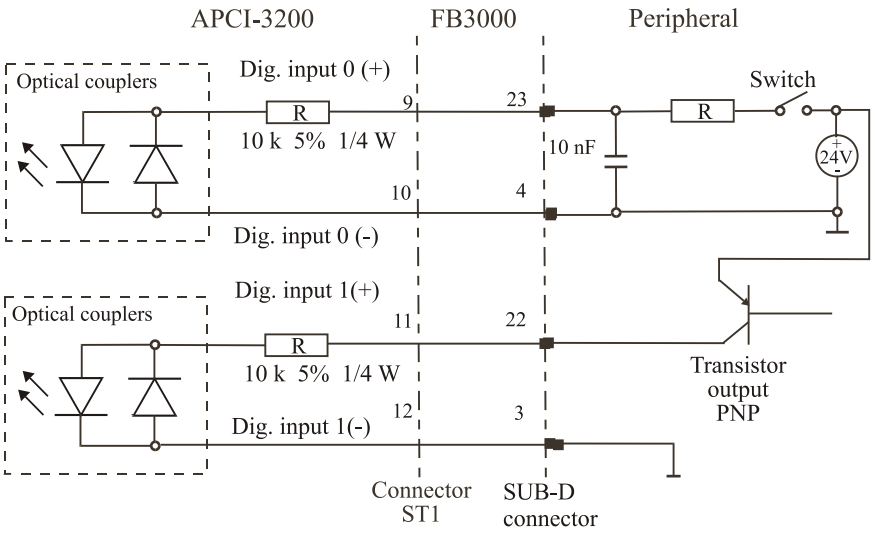
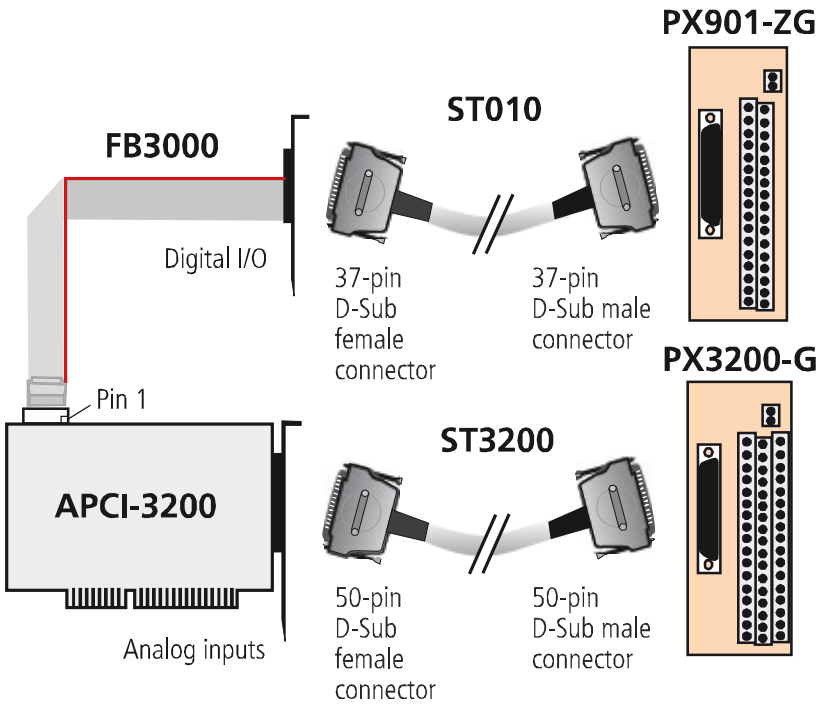


Fig. 7-13: Digital inputs



7.3.6 Connection to the screw terminal panels

Fig. 7-14: Connection to the screw terminal panels

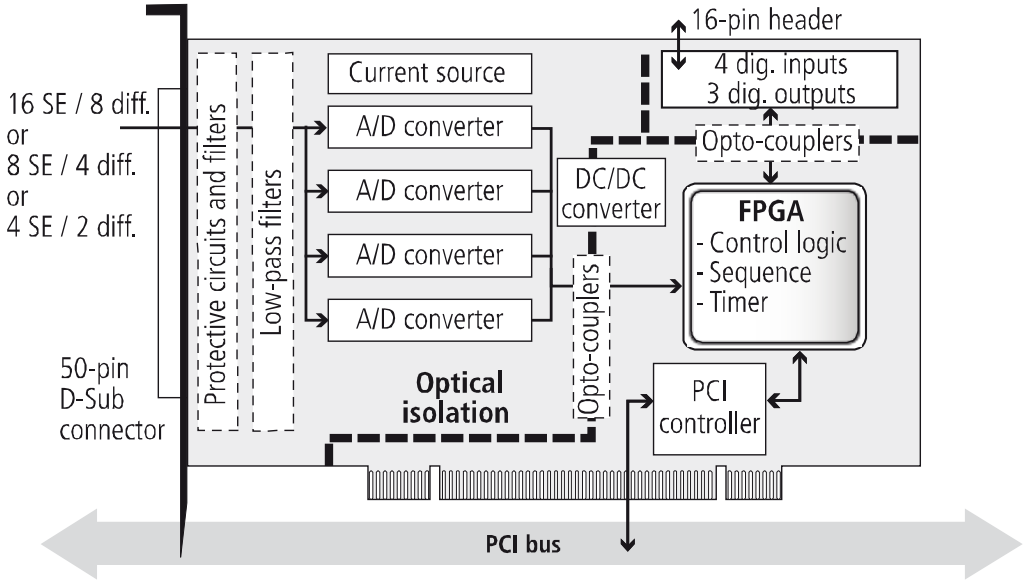


NOTICE!
Plug the **FB3000** cable into the connector by inserting the red (or blue or black) cable line into pin 1.

8 FUNCTIONS OF THE BOARD

8.1 Block diagram

Fig. 8-1: Block diagram of the APCI-3200



8.2 Analog inputs

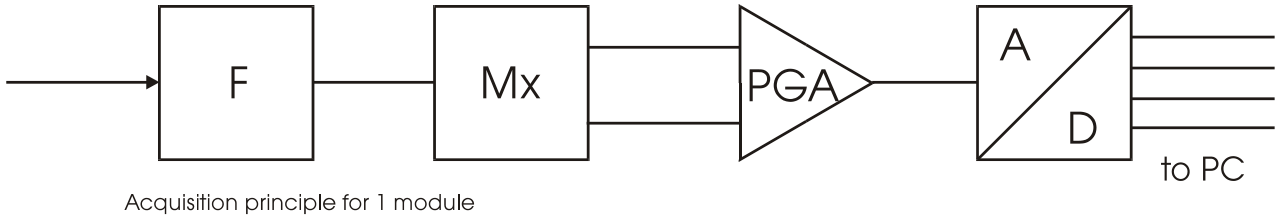
The board has max. 16 analog input channels. These are organised in 4 different modules. An 18-bit A/D converter is allocated to each module.

A converter can acquire 4 inputs:
- independently from each other or sequentially,
- once or in cycles through timer. (Scan, Single or Continuous Mode)

The APCI-3200 allows 3 different types of application:
- Acquisition of 16 SE or 8 differential analog **voltage inputs** with 18-bit resolution in a ± 1.25 V range,
- **Temperature acquisition** with thermocouples or resistance thermometer,
- **Resistance measurement.**

For the acquisition of the input signals, the following parameters are to be configured by software:
- gain
- polarity
- input mode: single-ended or differential.

Fig. 8-2: Acquisition principle of the analog inputs



Acquisition principle for 1 module

Module 0 corresponds to the inputs 0 to 3.
Module 1 corresponds to the inputs 4 to 7.
Module 2 corresponds to the inputs 8 to 11.
Module 3 corresponds to the inputs 12 to 15.

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 Acquisition modes

Sensors, thermocouples and RTDs may be connected to the board at the same time. Depending on the acquisition mode, a sensor, thermocouple or RTD can be selected per channel or per module.
Each acquisition mode is configured through software.

Read mode: Each channel is acquired individually (software start; see Fig. 8-3).
Used software functions:
- Acquisition of 1 channel: “i_PCI3200_Read1Temperature”
- Acquisition of 2 or more channels: “i_PCI3200_ReadMoreTemperature”

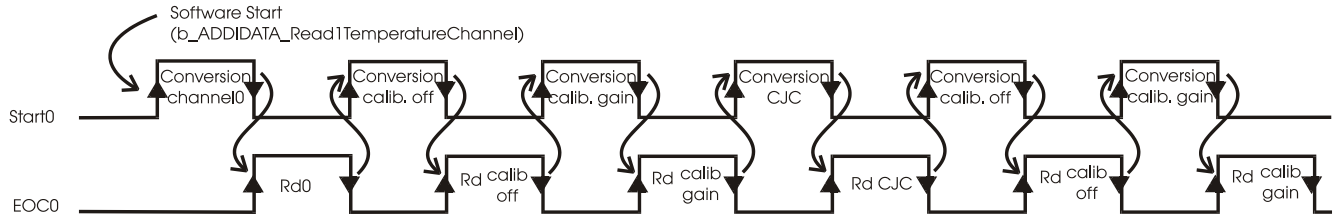
For each channel, a sensor, thermocouple or RTD can be selected.

Scan mode: Each module (4 channels) is acquired individually (one channel after the other):
- once through software trigger (single software scan; see Fig. 8-4)
- 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. 8-5).

For each module, a sensor, thermocouple or RTD can be selected.

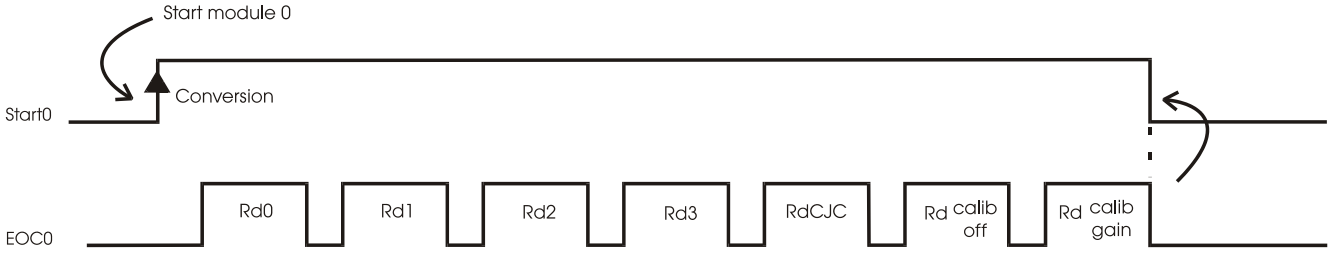
Fig. 8-3: Acquisition example - Software start

Rdx:	Read Channel x
CJC:	Cold junction compensation
calib. off:	Offset calibration
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. If the module is set as a "thermocouple input", the value of the cold junction compensation is also read before returning the measured value.

Fig. 8-4: Acquisition example - Single software scan



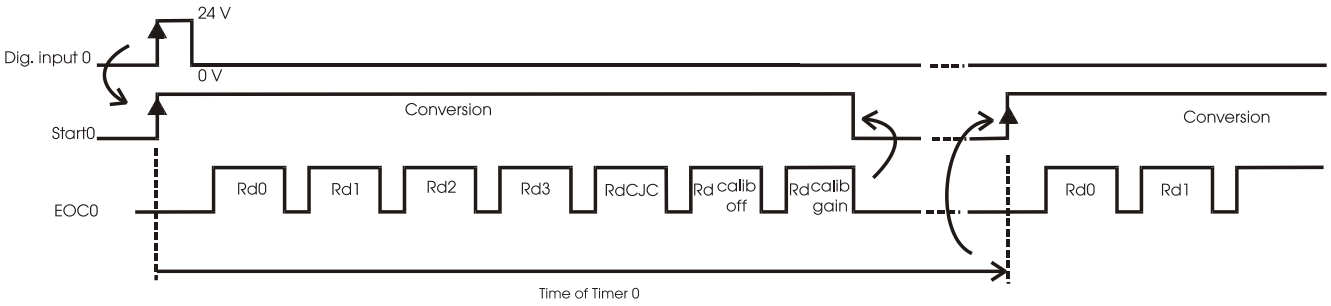
Single software scan in single-ended mode:

After a single software scan the channels 0, 1, 2, 3, the cold junction compensation, the offset value and the gain value are read. The conversion is made once (single scan) and stopped.

Single software scan in differential mode:

After a single software scan the channels 0, 1, the cold junction compensation, the offset value and the gain value are read. The conversion is made once (single scan) and stopped.

Fig. 8-5: 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 8-1: Acquisition times

Sampling rate (Hz) 1 channel, offset, reference	Sampling period (ms)
20	50
40	25
80	12.5
160	6.25

8.2.2 Interrupt

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

8.2.3 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 8-2: Timer time delays

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

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

8.2.4 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.

8.2.5 Diagnosis

A diagnostic function is integrated on the board. Depending on the sensor type used, this function can detect short-circuit and line break between the board and the peripheral (see Fig. 4-2: Short-circuit and line-break diagnosis).

8.3 Voltage acquisition

Table 8-3: Voltage accuracy

Mode	Range	Accuracy (Gain = 1)
Bipolar	-100 mV < V < +100 mV	± 38 µV
	-2.5 < V < -100 mV 100 mV < V < +2.5 V	± 152 µV
Unipolar	0 < V < 100 mV	± 19 µV
	100 mV < V < +2.5 V	± 76 µV

See also the limit values in Chapter 4.4

8.3.1 Single-ended mode

NOTICE!
If you operate the input channels in **single-ended mode**, the negative inputs 0 (-) to 15 (-) are connected onboard to a reference voltage of 1.25 V. **Do not connect them to the ground!** Otherwise, a short-circuit may occur and the board may be destroyed.

8.3.2 Differential mode

This mode is recommended if the board is to be operated in rough industrial environment with many disturbance sources.

8.4 Temperature principle

NOTICE!
For the temperature acquisition, please consider the tolerance of each sensor (thermocouple, resistance thermometer, ...) according to the measuring range.

Please read the corresponding technical features of the sensors in the data sheet of your supplier.

Linearisation

An automatic linearisation of the connected thermocouples or RTDs is defined in software in accordance with the standard tables. The intermediate values which are not included in the tables are calculated through linear interpolation:
if the measured voltage is not included in the temperature/resistance table (for the RTDs) or the temperature/voltage table (for the thermocouples), 2 close values surrounding the required value are extracted to obtain the intermediate temperature.

The temperature is given in Celsius °C and can be then converted in Fahrenheit °F or in Kelvin °K through software.

Please use the following software functions:
- b_ADDIDATA_ConvertDegreeToFahrenheit oder
- b_ADDIDATA_ConvertDegreeToKelvin

8.5 Temperature acquisition

8.5.1 Temperature acquisition through thermocouples

Cold junction compensation

A cold junction compensation is integrated on the screw terminal panel **PX3200**. Through an RTD (Pt1000), the voltage is measured at the cold junction (V_{CJC}[1]) and used as a reference voltage to measure the temperature of the thermocouples connected to the screw terminal panel.

The cold junction compensation is calculated for each channel after each acquisition and updated through software.

Precision of the cold junction compensation

[1] CJC: Cold Junction Compensation

Table 8-4: Precision of the cold junction compensation

Type	Range	Precision (Unipolar, gain = 1)
Pt1000 on board **PX3200**	0 °C +60 °C	± (0.30 °C + 0.0050 |t°C|)

NOTICE!
The absolute precision of the measured temperature is to be calculated as follows:

Temperature precision
= Precision of the CJC
+ precision of the A/D converter
+ precision of the thermocouple[1].

Type and precision of the thermocouples

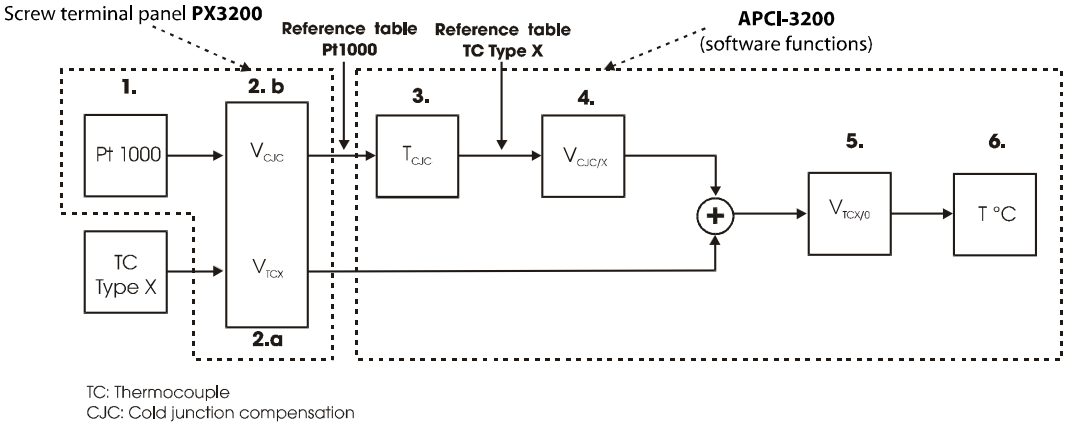
Table 8-5: Type and precision of the A/D converter (acquisition of thermocouples)

Type	Range		Precision (Bipolar, gain = 1)
Type J	-200.0 °C	-0.1 °C	± 0.6 °C
	0.0 °C	+599.9 °C	± 0.2 °C
	+600.0 °C	+1200.0 °C	± 0.6 °C
Type T	-200.0 °C	-80.0 °C	± 0.7 °C
	-79.9 °C	+400.0 °C	± 0.3 °C
Type K	-200.0 °C	-0.1 °C	± 0.8 °C
	0.0 °C	+999.9 °C	± 0.4 °C
	+1000.0 °C	+1300.0 °C	± 0.6 °C
Type E	-200.0 °C	+1000.0 °C	± 0.5 °C
Type N	-200.0 °C	-0.1 °C	± 1.0 °C
	0.0 °C	+799.9 °C	± 0.2 °C
	+800.0 °C	+1300.0 °C	± 0.5 °C
Type S	0.0 °C	+399.9 °C	± 1.6 °C
	+400 °C	1768.0 °C	± 0.7 °C
Type R	0.0 °C	+399.9 °C	± 1.6 °C
	+400.0 °C	+1768.0 °C	± 0.6 °C
Type B	+400.0 °C	799.9 °C	± 2.0 °C
	+800.0 °C	+1820.0 °C	± 1.0 °C

[1] See details on the datasheet from the sensor manufacturer

Temperature acquisition

Fig. 8-6: Temperature acquisition for the cold junction compensation



NOTICE!
The numbers in the figure above correspond to the numbers of the following list.

1. The cold junction compensation is completed through a Pt1000 which is integrated on the screw terminal panel **PX3200**.

2. Through the APCI-3200:

2.a) the voltage of the thermocouple of type X connected on the circuit board (V_{TCX})
and
2.b) the CJC voltage (V_{CJC})
are returned through software calibration (see Chapter 8.2.4)

3. The CJC voltage V_{CJC} is converted in a CJC temperature (T_{CJC}) according to **the reference table of the Pt1000**.

4. This CJC temperature (T_{CJC}) is converted in a CJC voltage ($V_{CJC/X}$) according to **the reference table of the thermocouple of type X**.

5. The voltage of the thermocouple V_{TCX} (see 2.a) and the converted voltage $V_{CJC/X}$ are added to give the thermocouple voltage ($V_{TCX/0}$) referring to 0°C.
$V_{TCX/0} = V_{TCX} + V_{CJC/X}$

6. The temperature T is calculated from the voltage referring to 0°C ($V_{TCX/0}$) in the corresponding standard table.

The temperature is given in °C and can be converted in °F or °K through software.

8.5.2 Temperature acquisition through RTD

Table 8-6: Type and precision of the A/D converter (acquisition of RTDs)

Type	Range	Precision 3-wire or 4-wire connection (Unipolar, gain = 1)
Pt100	-200.0 °C +850.0 °C	± 0.4 °C
Pt200	-200.0 °C +850.0 °C	± 0.4 °C
Pt500	-200.0 °C +850.0 °C	± 0.3 °C
Pt1000	-200.0 °C +499.9 °C +500.0 °C +850.0 °C	± 0.2 °C ± 1.0 °C
Ni100	-60.0 °C +250.0 °C	± 0.3 °C

NOTICE!
The absolute precision of the measured temperature is to be calculated as follows:

Temperature precision =
precision of the A/D converter (see table above)
+ precision of the RTD[1].

The RTD (resistance temperature detector) is a temperature-dependent resistance. The higher the resistance, the higher the temperature.

The constant measuring current flows through the RTD and causes a voltage drop. This voltage drop is measured to calculate the temperature of the RTD.

2-wire connection

See also Chapter 7.3.3, Fig. 7-7: Connection of RTDs with 2-wire connection.

If the RTD experiences a resistance, a voltage drop occurs on the connected pins (in the figure pins 1 and 2). The voltage measured at these pins corresponds to the voltage present on the RTD.

Yet this solution can cause a precision loss for rather long lines because the voltage drop of the constant current increases the measured value.

The board interprets this measured value as an increased temperature which results in a temperature error of the measured value.

[1] See details on the data sheet from the sensor manufacturer

3-wire connection

See Chapter 7.3.3, Fig. Fig. 7-8: Connection of RTDs with 3-wire connection.

In comparison to the 2-wire connection, an additional line is driven to one of the contacts of the resistance thermometer. 2 excitation lines are connected to the circuitry. As both line resistances neutralise themselves, they do not affect the voltage measurement.

The measurement accuracy at the RTD is then higher, provided the electric lines have identical properties (Length and material).

4-wire connection

See also Chapter 7.3.3, Fig. 7-9: Connection of RTDs with 4-wire connection.

The 4-wire connection theoretically represents the optimal solution. The current and ground lines are driven to the resistance independently from the voltage line. The line resistances and the temperature variation do not affect the result of the measurement. In addition, up to 8 RTDs can be connected with the highest accuracy compared to the 4 RTDs which can be connected when using the 3-wire connection.

8.6 Resistance measurement

Table 8-7: Resistance accuracy

Type	Range		Accuracy 3-wire or 4-wire connection (Unipolar, Gain = 1)
Resistance	10.0 Ω	399.9 Ω	± 0.2 Ω
	400.0 Ω	999.9 Ω	± 0.3 Ω
	1000.0 Ω	1999.9 Ω	± 0.7 Ω
	2000.0 Ω	4000.0 Ω	± 4.0 Ω

The connection and the acquisition modes of the resistors are the same as the ones of the RTDs. But the resistance does not vary with the temperature.

8.7 Possible set-up

We recommend programming the following set-up in software according to the required measurement sensor. The following parameters are to be set in the corresponding software functions.

Table 8-8: Set-up suggestion

	Temperature measurement		Resistance measurement	Voltage measurement	
	Thermocouple	RTD		Single-Ended	Differential
GAIN	1	1	1	1	1
U/B#	0 (bipolar)	1 (unipolar)	1	0	0
D/S#	0 (S.E.) 1 (diff.)	1 (diff.)	1	0	1

9 STANDARD SOFTWARE

The API software functions supported by the board are listed in an HTML document. A description of how to access the respective file can be found in the document “Quick installation PC boards” (see PDF link), in the chapter “Standard software”.

10 RETURN OR DISPOSAL

10.1 Return

If you need to return your board, you should read the following checklist before.

Checklist for returning the board:

- Specify the reason for returning your board (e.g. exchange, modification, repair), the serial number of the board, the contact person in your company including his/her telephone extension and e-mail address, as well as the mailing address for a potential new delivery. You do not have to indicate the RMA number.

Fig. 10-1: Serial number

- Note down the serial number of the board.
- Place the board in an ESD protective cover. Then pack it in a cardboard box so that it is well-protected for shipping. Send the packed board together with your details to:

  ADDI-DATA GmbH
  Airpark Business Center
  Airport Boulevard B210
  77836 Rheinmünster
  Germany
- If you have any questions, do not hesitate to contact us:

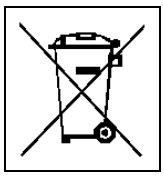
  Phone: +49 7229 1847-0
  E-mail: info@addi-data.com

10.2 Disposal of ADDI-DATA waste equipment

ADDI-DATA organises the disposal of ADDI-DATA products that were put on the German market after 13 August 2005.
If you want to return waste equipment, please e-mail your request to: info@addi-data.com.

Boards that were delivered after 13 August 2005 can be recognised by the following label:

Fig. 10-2: Disposal: Label



This symbol indicates the disposal of waste electrical and electronic equipment. It is valid in the European Union and in other European countries that have a separate collection system. Products carrying this symbol must not be treated as household waste.
For more detailed information on the recycling of these products, please contact your local citizens' office, your household waste collection service, the shop where you bought this product or the distributor you purchased this product from.

If you dispose of this product correctly, you will help to prevent damage that could be caused to the environment and to human health by inappropriate disposal.
The recycling of materials will help to conserve our natural resources.

Disposal in other countries than Germany
Please dispose of the product according to the country-specific regulations.

11 GLOSSARY

Table 11-1: Glossary

Term	Description
A/D converter	= *ADC* An electronic device that produces a digital output directly proportional to an analog signal output.
Acquisition	The process by which data is gathered by the computer for analysis or storage.
Analog	Continuous real time phenomena
Clock	A circuit that generates time and clock pulses for the synchronisation of the conversion
Cold junction compensation	A method of compensating for inaccuracies in thermocouple circuits
D/A converter	= *DAC* A device that converts digital information into a corresponding analog voltage or current.
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.
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.

Term	Description
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* 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)
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 amount of data. The PCI bus is not limited like the ISA and EISA systems.

Term	Description
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 diode, 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.
Resistance	The degree to which a substance or device opposes the passage of an electric current, causing energy dissipation. Be Ohm's law resistance (measured in ohms) is equal to the voltage divided by the current.
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.
RTD	*= Resistance temperature detector* An electrical circuit element characterized by a positive coefficient for resistivity
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.
Thermocouple	A thermoelectric device for measuring temperature, consisting of two wires of different metals connected at two points, a voltage being developed between the two junctions in proportion to the temperature difference.
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.

12 INDEX