AREPOC s.r.o.

Multifunction Data Acquisition PC Board AD25PCI

Multifunction DAQ Board

AD25PCI

AREPOC s.r.o. Company would like to thank you for purchasing the Multifunction Data Acquisition PC Board AD25PCI. We believe it will meet your expectations.

In case you need any assistance, please do not hesitate to contact us:

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Product No.:

The AD25PCI Analog and Digital I/O Board is specially designed for applications that need a programmable DC current source and precise differential analog inputs. The board in combination with PciDAQ software and AREPOC Hall probes is also ideal suited for high-resolution magnetic field measurements.

Following are the system requirements for installing the card and accompanying Windows ™ software.
- Pentium class computer with a free PCI-5V (32-bit) slot
- Windows 98/NT/2000/XP operating system

Unpacking
The data acquisition board package includes the following:
- Multifunction AD25PCI Board
- Technical Products CD-ROM with drivers and manuals
- Printed version of the AD25PCI manual
- CANNON 25-pin male connector with 10 Ohm resistor connected to the current source (pins **14**, **1**) and input Channel 0 (pins **5**, **17**).

! Electrostatic discharge can damage several components on the board. To avoid such damage in handling the board, take the following precautions:
- Ground yourself by a grounding strap or by holding a grounded object.
- Touch the antistatic package to a metal part of your computer chassis before removing the board from the package.
- Remove the board from the package and inspect the board for loose components or any other sign of damage. Notify AREPOC if the board appears damaged in any way. Do not install a damaged board into your computer.
- Never touch the exposed pins of connectors and PCI bus.

Place the board in front of you as you go through the next chapter. This will help you to identify the components on the board.

Functional Description

The conception of this high performance PCI-bus analog and digital I/O board differs from other data acquisition boards and approaches rather higher accuracy multimeters. Major component of this multifunction plug-in board consists of a single-chip microcomputer, which controls all functions of the board. The board consists of an isolated high resolution integrating AD converter with 8 differential inputs, programmable non-isolated current source and digital inputs/outputs.

Board configuration

The AD25PCI board contains 3 jumpers to configure I/O settings. Jumper **J2** is for unipolar or bipolar analog inputs selection. Jumpers **J3**, **J4** are for +15V and –15V output voltage selection.
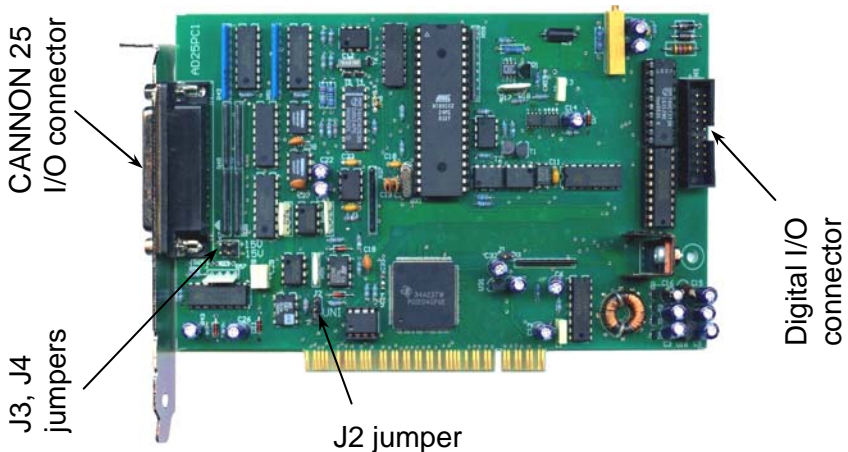
Fig. 1. *The J2, J3 and J4 jumpers and I/O connectors locations.*

Analog Inputs Settings

The AD25PCI differential analog inputs are configurable for bipolar or unipolar input ranges. Unipolar input means that the input voltage range is between *0* and V_{ref} where V_{ref} is a positive reference voltage. Bipolar input means that the input voltage range is between *-V_{ref}/2* and *+V_{ref}/2*. Following table shows the configuration of the **J2** jumper settings.

Configuration	J2 Jumper Settings		
Bipolar ±5 V (factory setting)	J2	○ ○	OPEN
Unipolar 0 to +10 V	J2	○ ○	CLOSE

Analog Inputs

The analog inputs have software-programmable gains of 1 to 128 allowing analog input ranges from ±39 mV to ±5 V in bipolar mode, respectively from +78 mV to +10 V in unipolar mode. Amplified voltages are multiplexed into an analog-to-digital converter operating on the principle of modified sigma-delta modulation of charge balancing.

The table shows actual unipolar and bipolar input ranges.

Gain	Unipolar Input Range	Bipolar Input Range
1	0 to +10 V	±5.0 V
2	0 to +5.0 V	±2.5 V
4	0 to +2.5 V	±1.25 V
8	0 to +1.25 V	±0.62 V
16	0 to +0.62 V	±0.31 V
32	0 to +0.31 V	±0.16 V
64	0 to +0.16 V	±78 mV
128	0 to +78 mV	±39 mV

Integration time of analog inputs is software-programmable from 5 to 320 ms in four steps with corresponding resolution from 20 to 26 bits. Real resolution is limited by noise of the AD converter. For low gains (1x, 2x and 4x) the noise is limited by the AD converter itself and the achievable resolution is approx. 17, 18, 19, 20 bits for integration time 5, 20, 80, 320 ms. Conversion time of each channel for data processing versus effective analog input resolution is shown in the table:

Resolution [bit]	20	22	24	26
Effective resolution [bit]	17	18	19	20
Integration time [ms]	5	20	80	320
Conversion time [ms]	13	28	88	328

For higher gains the resolution is limited by noise of the input amplifier, which is approximately 400 nV_{p-p} for integration time 320 ms and raises up to approx. 700 nV_{p-p} for 20 ms integration time. Corresponding resolution for gain 128 (range 0 - 78 mV) is 17.5 bits for integration time 320 ms.

Integration principle of conversion and isolation guarantees higher immunity against spurious voltages. In order to obtain total conversion time, 5 to 25 ms must be added (depends on a PC performance) for data processing. To reach high accuracy and stability, the board is equipped with auto-calibration function, which enables to eliminate board's offset and calibrate the range of the converter by means of a highly stable calibration source of 5 V.

Current Source

The AD25PCI board provides a programmable non-isolated unipolar DC current source. The output current can be software-configured in the range of 0 to 20 mA (0 – 100 mA optional) with 14-bits output resolution. Analog output is connected to pin **14** (OUT CURRENT) and pin **1** (PCGND) of the CANNON 25 I/O connector. It is possible to turn off the current source from application software environment. The cut-off current in the turn-off state is lower than 1 µA.

Power Connections

Pins **2** (+*15V$_{out}$*) and **15** (-*15V$_{out}$*) of the I/O connector supply voltage from a PC power supply. These +15V and -15V voltages are referenced to the floating ground (*AGND* pins **3, 4, 13** or **25**) and are available to power external accessories or circuitry. Maximum power rating is 20 mA. To enable these voltage outputs close the **J3** (+15V) and/or **J4** (–15V) jumpers.

Configuration	J3, J4 Jumper Settings		
+15 V disabled	J3	○ ○	OPEN (factory setting)
-15 V disabled	J4	○ ○	OPEN (factory setting)
+15 V enabled	J3	○ ○	CLOSE
-15 V enabled	J4	○ ○	CLOSE
+15 V enabled	J3	○ ○	CLOSE
-15 V disabled	J4	○ ○	OPEN
+15 V disabled	J3	○ ○	OPEN
-15 V enabled	J4	○ ○	CLOSE

❗ Be careful to use the +*15V$_{out}$* and -*15V$_{out}$* power outputs! Shorting or grounding these outputs (pin *2* and/or pin *15*) of the analog I/O connector can damage the board or PC motherboard! AREPOC is not liable for damages resulting from such a connection.

Digital Inputs and Outputs

The AD25PCI provides 8 digital I/O lines TTL/HCT compatible. A strobe signal is provided for latching the digital input/output signals into external circuitry. Digital I/O lines are programmable using **DigIn** and **DigOut** functions of the *Ad25plib.dll* library. Voltages **+5V DC** and **+12V DC** are referenced to *DIGGND* pins of the digital connector and are available to power external accessories.

❗ Be careful to use **+5V** and **+12V** power outputs! These voltage circuits are **NOT ISOLATED** from the PC and are connected directly to the PCI bus! Shorting or grounding pin *19* and/or pin *20* of the digital I/O connector can damage the board or PC motherboard! AREPOC is not liable for damages resulting from such a connection.

Hardware Installation

After you have correctly set and verified the **J2 - J4** jumpers, you are ready to install the board into your computer. The AD25PCI multifunction board can be installed in any available PCI-5V (32-bit) expansion slot in the computer. To achieve the best noise performance it is recommended to leave as much room as possible between the AD25PCI device and other devices installed in your PC. The following are general installation instructions. Consult your PC user manual or technical reference manual for specific instructions and warnings.

1. Turn off your computer and all peripheral devices. Unplug the power cord from the wall outlet.
2. Remove the cover from your computer.
3. Find a free PCI -5V expansion slot in your system.
4. Remove the metal plate from the slot you have chosen and put the screw aside.
5. Ground yourself and discharge any static electricity.
6. Insert the AD25PCI board into the PCI slot. It may be a tight fit, but **do not force** the board into place.
7. Secure the board to the slot with the screw you removed from the metal plate.
8. Check the installation.
9. Replace the cover of your computer.

The AD25PCI multifunction board is installed. You are now ready to install and configure your software.

Changing the Board Settings

Before changing the hardware settings of your board (**J2**, **J3** and **J4** jumper settings) you must to turn off and unplug the computer.
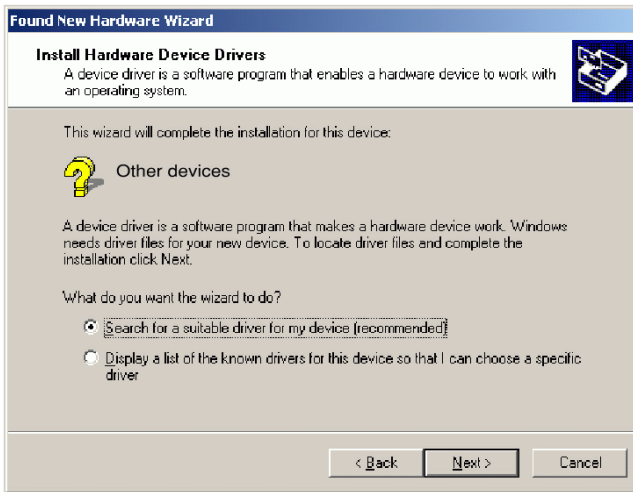
Driver Installation

The AD25PCI board is a Plug & Play component. The board requests an IRQ number via its PCI controller. The system BIOS responds with an interrupt assignment based on the card information and on known system parameters. Because configuration is controlled by the system and software, there is no jumper setting required for the base-address, DMA, and interrupt IRQ. These system parameters are determined by the driver which must be installed in your system.

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

! A user with Administrator privileges must install this driver. Please consult your system administrator or Microsoft operating system User's Manual for more information on Administrator privileges. The recommended installation steps are given below:

1. After installing your AD25PCI DAQ card, start up Windows. The Found New Hardware Wizard appears. Check **Search for a suitable driver for my device** and then click on **Next** button.

2. Check the **CD-ROM drives** option and insert the CD into the CD-ROM drive. Then click the **Next** button.

3. Wait for a moment while the operating system searches for the most suitable driver to install, and you will finally see the following window:

The Ad25pci.inf file is stored in <CD>:\INF directory.

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4. Click **Next** button and the operating system will begin to install the driver. Follow instructions that appear on your screen. If the **Digital Signature Not Found** box or **Has Not Passed Windows Logo Testing** box appears, click **Yes** or **Continue** anyway.


5. After completion click **Finish** button to finish the installation procedure. If the **Restart** dialog appears, then click **Yes** to reboot.

If your system doesn't boot or if you experience erratic operation with your PCI board, it's likely caused by an interrupt conflict (perhaps the BIOS Setup is incorrectly configured). In general, the solution, once you determine it is not a simple oversight, is to consult the BIOS documentation that comes with your system*. When done with the driver installation the device manager can be open to make sure the installation was a success. If your card has been properly installed, you should see the device name of your AD25PCI board listed on the *Device Manager* tab on the System *Property* page.

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* Sporadic, some computers with Windows'XP operating system require to have installed the DRVXWDM.SYS (or DRIVERX.SYS, DRIVERX.VXD) file in "<Windows>\System32\drivers" directory. If the AD25PCI board does not operate correctly after rebooting PC, copy the required file(s) from INF directory located on the installation CD to the "<Windows>\System32\drivers" directory.
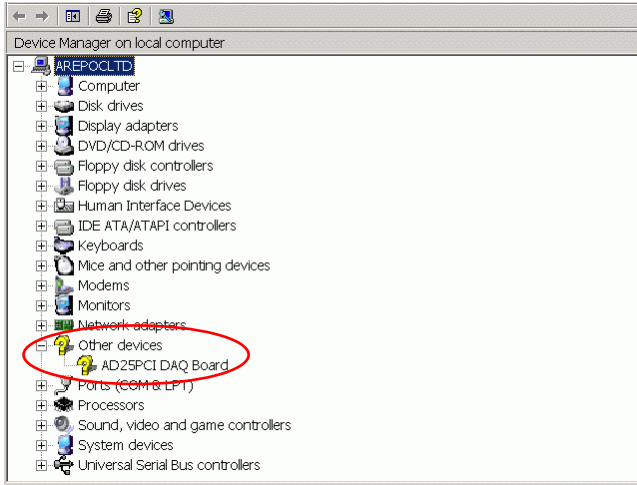
Now the first part of your installation has been completed and ready to install supporting software for the board or write your own application.

For the supporting software installation (e.g. PciDAQ software) follow instruction given by the software installation wizard.

For customers who are writing their own applications, we provide function 32-bit **ad25plib.dll** library compatible for Windows 98/NT/2000/XP operating systems. The **ad25plib.dll** and **Drvx40.dll** libraries must be copied to a folder where an application will be located. Both DLLs are stored on the *Arepoc Technical Products* CD-ROM supplied with the board in the <CD>:\INF directory.

The developing environment can be Visual Basic, Visual C++, Delphi, C++ Builder, LabVIEW, or any Windows programming language that allows calls to a DLL. The function reference description of the **ad25plib.dll** is located on the page 19 of this manual.

Analog I/O Connector

Figure 2 shows the pin assignments of the AD25PCI analog I/O connector. The connector is located on the back panel of the board and is accessible at the rear of the computer. The analog I/O connector is a CANNON 25-pin female connector.

PC GND	1			
		14	OUT CURRENT	(1 – 14) Current output
+15Vout	2			(2) +15 VDC Source
		15	-15Vout	(15) -15 VDC Source
AGND	3			
		16	Rs	(16) Reserved
AGND	4			
		17	0 IN Hi	(5 – 17) Input channel 0
0 IN Lo	5			
		18	1 IN Hi	(6 – 18) Input channel 1
1 IN Lo	6			
		19	2 IN Hi	(7 – 19) Input channel 2
2 IN Lo	7			
		20	3 IN Hi	(8 – 20) Input channel 3
3 IN Lo	8			
		21	4 IN Hi	(9 – 21) Input channel 4
4 IN Lo	9			
		22	5 IN Hi	(10 – 22) Input channel 5
5 IN Lo	10			
		23	6 IN Hi	(11 – 23) Input channel 6
6 IN Lo	11			
		24	7 IN Hi	(12 – 24) Input channel 7
7 IN Lo	12			
		25	AGND	
AGND	13			(3, 4, 13, 25) Floating ground

Fig. 2. *Pin assignments of the analog I/O connector*

The floating ground (**AGND**) must be connected either to a **Lo** pin or to the **PC GND** pin (recommended to use with Hall probes).

Digital I/O connector

Figure shows the pin assignments for the AD25PCI digital I/O connector. The connector is located on the board and is accessible after removing the cover from your computer. Before connecting or disconnecting to the digital I/O connector you must turn off and unplug the computer.

IN 0	1	2	IN 1
IN 2	3	4	IN 3
IN 4	5	6	IN 5
IN 6	7	8	IN 7
OUT 0	9	10	OUT 1
OUT 2	11	12	OUT 3
OUT 4	13	14	OUT 5
OUT 6	15	16	OUT 7
DIGGND	17	18	DIGGND
PC +5V	19	20	PC +12v

The following specifications apply to the digital I/O lines. Absolute max. voltage input rating 5.0 V with respect to DIGGND.

Digital input specifications (referenced to DIGGND):
- VIH input logic high voltage 2 V min.
- VIL input logic low voltage 0.8 V max.
- IIH input current load, logic high input voltage 20 µA max.
- IIL input current load, logic low input voltage -20 µA max.

Digital output specifications (referenced to DIGGND):
- VOH output logic high voltage 2.4 V min.
- VOL output logic low voltage 0.5 V max.
- IOH output source current, logic high 2.6 mA max.
- IOH output sink current, logic low 24 mA max.

❗ Maximum ratings are absolute ratings. Connections that exceed any of the max. ratings of input or output signals on the AD25PCI can damage the DAQ board and/or the PC AT. Arepoc is NOT liable for any damages resulting from incorrect signal connections.

Cabling and Wiring Consideration

Environmental noise can affect the accuracy of measurements made with the AD25PCI if you do not make proper considerations when running signal wires between signal sources and the AD25PCI board. The following recommendations mainly apply to analog input signal routing to the bard, although they are applicable for signal routing in general.

Use individually shielded twisted-pair wires to connect analog input signals to the AD25PCI. With this type of wire, the signals attached to the Channel 0 - 7 inputs are twisted together and then covered with a shield. This shield is then connected at only one point to the signal source ground. This kind of connection is required for signals traveling through areas with large magnetic fields or high electromagnetic interference. To protect the signal lines from magnetic fields caused by electric motors, welding equipment, breakers or transformers, run the signal lines through special metal conduits. In making your own cabling, you may decide to shield your cables. The mating connector for the AD25PCI analog I/O is a CANNON 25-position female connector.

Basically, the **Lo** input has to be connected to **AGND** when you are measuring a floating signal. To measure voltages from several RTDs which are biased from the board's current source, you have to connect the **AGND** to the **PC GND** pins (see Fig. 3).
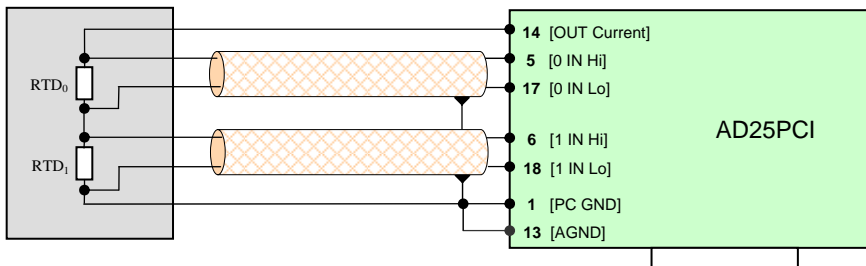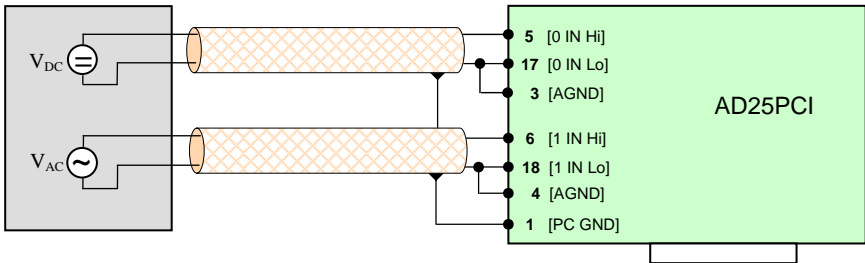

Fig. 3. Connecting to RTDs configuration

If you are measuring voltages from RTDs which are biased from an external current source, you have to connect the **AGND** to the **GND** of this current source (on one side only).
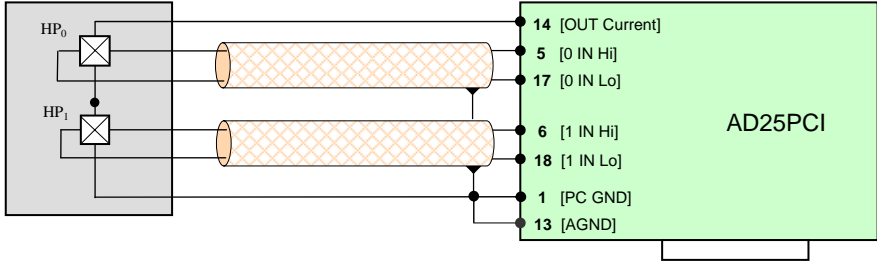
Fig. 4. Connecting to Hall probes configuration

Figure 4 shows how to connect two Hall probes to the AD25PCI board. It is possible to connect max. 8 Hall probes to the board.

Fig. 5. Connecting to floating voltage configuration

Figure 5 shows how to connect DC and/or AC floating signal sources to the AD25PCI board.

The input voltage from the **Lo** input or **Hi** input should not exceed the maximum input voltage (based on the board analog ground). If it exceeds the maximum voltage, the board may be damaged.

High resolution of the AD25PCI board results from the application of auto-calibration method. The analog I/O board AD25PCI can be used in applications where high accuracy, linearity and resolution are required. It can serve as a relatively low cost substitution of 6-decade system multimeter.

Technical Parameters:

Analog Inputs

Input resolution (programmable)	20 to 26 bits
Nonlinearity (if gain =1)	typ.: 0.0005 % of full scale
	max.: 0.0008 %
Differential nonlinearity	max.: 1 LSB
Max. error	0.005 % of reading
	0.01 % of FS
Number of analog inputs	8 differential
Input range	0 - 10 V unipolar or ± 5 V bipolar
	(jumper selectable)
Programmable gain	1 - 128 (software selectable)
Input resistance	> 100 MΩ
Input bias current	typical: 10 nA, max.: 50 nA
Input overvoltage	± 20V continues, powered
	± 10V continues, unpowered
Typical noise	< 2 ppm of FS, or < 0.5 µVp-p

Current Source

Output current range	0 - 20 mA (0 - 100 mA optional) DC
Output current resolution	14 bits
Output current ripple	< 0.0005 % of FS, or < 0.5 µA
Cut-off current	< 1 µA
Max. output voltage	7.8 V

Power Connections

Floating output voltage	+15 V, -15 V (jumper selectable)
Max. power load	20 mA

Digital Inputs and Outputs

8 digital I/O	TTL/HCT compatible
Recommended warm-up time	>15 min
Relative humidity	10% to 90% noncondensing

Warranty

The AD25PCI multifunction board is warranted against defects in materials and workmanship for a period of one year from the date of shipment, as evidenced by receipts or other documentation. Arepoc will, at its option, repair or replace equipment that proves to be defective during the warranty period. This warranty includes parts and labor. A Return Material Authorization number must be obtained from the factory and clearly marked on the outside of the package before the board will be accepted for warranty work. Arepoc believes that the information in this document is accurate. In the event that technical or typographical errors exist, we reserve the right to make changes to subsequent editions of this document without prior notice to holders of this edition. In no event shall Arepoc be liable for any damages arising out of or related to this document or the information contained in it.

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The AD25PCI comes with functions in Dynamic Link Library (DLL) **ad25plib.dll** which can be called from VC++, Delphi, Visual Basic or LabVIEW. The AD25PCI supports two modes of operation: **single conversion** or **periodical measurement**.

In single conversion mode the AD25PCI takes one sample immediately after calling function **Adconv** which returns measured value. An advantage of this mode is a simple programming. Disadvantage: triggering is derived from the PC so timing accuracy can be lower.

In periodical mode measurement sequence is programmed first using procedures **ProgCh, ProgEn, Timer,** etc. Advantage of this mode is that triggering is controlled by internal clock of the AD25PCI and, therefore, the triggering is more accurate (PC must only read-out results before start of the next conversion). Disadvantage: during periodical measurement the auto-calibration is inaccessible; therefore, this mode is suitable for short-time measurement up to few minutes only.

Description of the AD25PLIB.DLL library

Dynamic Link Library **ad25plib.dll** offers the following procedures and functions:

function **initAD:integer; stdcall; external 'ad25plib'**
Initializes the AD25PCI. After successful initialization function returns **1**, otherwise returns **0**. This function must be called first before any other function.

procedure **calibration(type, range, resol:integer); stdcall; external 'ad25plib'**
This procedure accomplishes auto-calibration of the AD25PCI. Every used range with common resolution must be calibrated before measurement! Auto-calibration removes drift of the card so it is recommended to call this routine during measurement in interval tens of seconds.

Type - 0 - calibrate only selected range (it is faster)

      1 - calibrate all ranges (call only if use more ranges during measurement)

range - 0..7 - select gain 1, 2, 4, 8, 16, 32, 64 or 128

resol - 0..3 - select integrating time 5, 20, 80 or 320 ms

function **GetRange:integer; stdcall; external 'ad25plib'**

This function return **1** if the card measures in unipolar mode, **0** in bipolar mode. Mode selects jumper J2 on the board.

function **Adconv(resol, range, chan:integer):single; stdcall; external 'ad25plib'**

Immediately takes one measurement on selected input.

Parameters:

resol, range - the same as in the procedure **calibration**

chan - 0..7 - number of the measured channel

Returned value is measured voltage in volts.

procedure **ProgEn(chan, resol:byte); stdcall; external 'ad25plib'**

Sets number of measured channels and resolution in the periodical measurement.

Parameters:

chan - number of measured channels

resol - see procedure **calibration**

procedure **ProgCh(chan, range:byte); stdcall; external 'ad25plib'**

Sets channel and range for every measured input.

Parameters - see function **Adconv**

procedure **Timer(burst:byte; time:word); stdcall; external 'ad25plib'**

Sets total measurement period in periodical measurement.

Parameters:

burst - always 1 - 2nd channel is measured immediately after the 1st, 3rd channel after 2nd, etc.

time - total measurement period in ms, max. value is 9000. For proper function **time** must be equal or bigger then the sum of conversion time of all measured channels

procedure **StartAD; stdcall; external 'ad25plib'**
Starts measurement in periodical mode.

function **GetSample(range:byte):single; stdcall; external 'ad25plib'**
Read one sample in periodical mode.
Parameters:
range - see procedure **calibration**

function **ADfinished:integer; stdcall; external 'ad25plib'**
Returns **1** if measurement in periodical mode is finished, otherwise returns **0**.

procedure **StopAD; stdcall; external 'ad25plib'**
Stops measurement in periodical mode.

procedure **DAC(value:word); stdcall; external 'ad25plib'**
Sets value of the current from the current source.
Parameters:
value - 0..4000 corresponds to current 0...20 mA i.e. 1 LSB is 0.005 mA
               (optional to current 0…100 mA i.e. 1 LSB is 0.025 mA)

procedure **DigOut(value:byte); stdcall; external 'ad25plib'**
Writes value on a digital output.

function **DigIn:byte; stdcall; external 'ad25plib'**
Reads value from a digital input.

procedure **closeAD; stdcall; external 'ad25plib'**
Unload the driver from memory.

function **GetCurrentRange:integer;stdcall; external 'ad25plib'**
Returns max. current value of the current source (20 or 100) mA.

function **GetDACresolution:integer;stdcall; external 'ad25plib'**
Returns resolution of the DAC current source converter (14 bits).

function **GetSerialN:integer;stdcall; external 'ad25plib'**
Returns serial number of the DAQ board.

Programming Example

Here is a simple common example in Delphi which can be adapted to any programming language.

Single conversion example:

```
if initAD = 0 then   //card initialization
   begin
     MessageBox(0, 'Unable to connect to AD25PCI', 'Error', MB_OK);
     Exit;
   end;
unip:= GetRange;   //read unip/bip range, unip=1-unipolar
resol:=2;   //Tint=80 ms; resolution cca 19 bits}
Calibration(0,0,resol);   //Calibration - only range ±5V
 u:= ADConv(resol,0,1);   //channel 1, range ±5V
```

### *Periodical measurement example:*

```
if initAD = 0 then            //card initialization
   begin
     MessageBox(0, 'Unable to connect to AD25PCI', 'Error', MB_OK);
     Exit;
   end;
unip:= GetRange;              //read unip/bip range, unip=1 - unipolar
resol:=2;                     //Tint=80 ms; resolution cca 19 bits}
Calibration(1,0,resol);      //Calibration - all ranges
ProgEn(3,resol);             //Measure 3 channels
ProgCh(0,0);                 //Input 0, range ±5V
ProgCh(1,2);                 //Input 1, range ±1.25V}
ProgCh(2,1);                 //Input 2, range ±2.5V}
Timer(1,1000);               //Burst mode, period 1000 ms}
StartAD;
    for i:=1 to 5 do
      begin
        repeat until Adfinished=1;   //wait for end of the conversion
        ux[0,i]:=GetSample(0);        //read input 0, range 0
        ux[1,i]:=GetSample(2);        //Input 1, range 2
        ux[2,i]:=GetSample(1);        //Input 2, range 1
      end;
StopAD;
```

Setting current example:

```
 DAC(2000);                         //current 10 mA (for AD25PCI board with
                                          the 20 mA current source)
```

Using the LabVIEW™

Procedures and functions of the **ad25plib.dll** can be called also from the LabVIEW in Windows operating system. The calling convention is **stdcall**; a simple example application can be found in the file **AD25PCI.vi** stored on the _Arepoc Technical Products CD-ROM_ supplied with the board. Before the first run it is necessary to set proper path to the **ad25plib.dll**. After loading the **AD25PCI.vi** switch to the diagram, double click on every function and set proper name and path to the library.
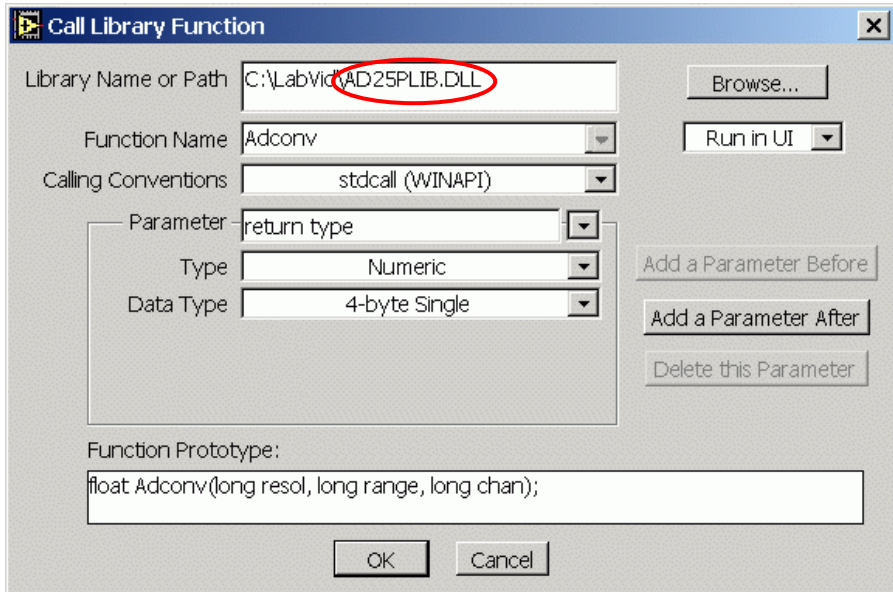
Note, that **Driverx.sys** must be installed in your ..._System32\Drivers_ directory and the **Drvx40.dll** must be installed in your application or in the LabVIEW directory.