

User manual

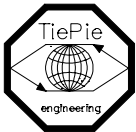
AD128

a multifunctional
PC measuring instrument

8 analog inputs, 12 bits

8 digital outputs

8 digital inputs



TiePie engineering

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User manual

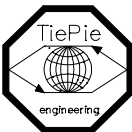
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a multifunctional
PC measuring instrument

8 analog inputs, 12 bits

8 digital inputs

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TiePie engineering

Contents

Safety	5
Declaration of conformity	7
Introduction	9
Sampling	9
- Aliasing	10
Digitizing	11
The oscilloscope	12
Hardware installation	13
Software	15
Installation of the software	15
Structure of the program	16
Starting the program	16
Controlling the program	17
- Controlling the main menu	18
- Controlling popup menus	18
Help screens	19
Program settings	19
- Saving instrument settings	20
- Loading instruments settings	20
- Setting the location of files	20
- Setting the default AD128 address	20
- Setting the printer port	20
- Text on the printer output	21
- Setting the screen colors	21
Storing measurement data on disk	21
Loading saved measurement data	21
Printing measured data	22
Choosing an instrument	23
Terminating the program	23

Oscilloscope (device: LIVE)	25
Aliasing	25
Displaying channels	26
Setting up a channel	26
- Setting the sensitivity of a channel	27
- Setting the vertical position of a channel	27
- Enlarging or reducing the vertical axis	28
- Changing the units of the vertical axis	28
Setting up the time axis	30
- Setting the timebase	30
- Magnification of the horizontal axis	30
Triggering	31
- Setting the trigger hysteresis	32
- Setting the trigger slope	32
- Adjusting the trigger level	32
- Setting the trigger time-out	33
Stopping the display	34
Storage oscilloscope (device: HOLD)	35
Differences with the oscilloscope	35
Measuring with the cross hair	35
Hardware	37
Short description	37
Connections at the 25 pin sub-D connector	38
AD128 block diagram	39
Description of the hardware	40
- I/O address use	40
- Meaning of the I/O addresses	40
- Starting a conversion and reading data	40
- Converting the measured data	41
- Controlling the hardware	43
Setting the I/O base address	43
Programming examples	45
Example 1	45
Example 2	46
Specifications	47
Hardware	47

- A/D convertor	47
- Digital inputs	47
- Digital outputs	47
- General	48
Software	48

Safety

Before you start working with the AD128, first read these safety rules.

- Avoid working **alone**.
- Check test leads for damages. Do **NOT** use them if they are damaged.
- Take care when measuring at voltages higher than 25V AC or 60 VDC.
- The AD128 is grounded by the ground lead in the power cord of the PC in which the AD128 is placed. Connect the power cord to a grounded outlet, before connections are made to the inputs and output of the AD128. A proper connection to ground is essential for safe measuring.
- Without a proper connection to ground, all conductive parts of the PC and the AD128 can render an electrical shock.
- Measuring directly on the LINE VOLTAGE can be very dangerous. The GROUND of the AD128 is connected with the GROUND of the computer.

Use a good isolation transformer or a differential probe when measuring at the LINE VOLTAGE or at GROUNDED POWER SUPPLIES!

In case this has not been considered and the GROUND of the AD128 is connected to a positive voltage, a short-circuit current will be flowing. Because of this short-circuit current both the AD128 and the computer can be damaged.

Declaration of confirmity



TiePie engineering
Battenserreed 2
9023 AR Jorwerd
Nederland

EG-verklaring van overeenstemming

Wij verklaren geheel onder eigen verantwoordelijkheid, dat het produkt

AD128

waarop deze verklaring betrekking heeft, in overeenstemming is met de geharmoniseerde Europese normen

EN 55011, EN 55022, EN 50081-1 en EN 50082-1

Volgens de bepalingen van de EMC-richtlijn 89/336/EEG, gewijzigd door de richtlijn 92/31/EEG en 93/68/EEG

Jorwerd, 2-1-1996

ir. A.P.W.M. Poelsma



TiePie engineering
Battenserreed 2
9023 AR Jorwerd
The Netherlands

EC declaration of Conformity

We declare, on our own responsibility, that the product

AD128

for which this declaration is valid, is in compliance with

EN 55011, EN 55022, EN 50081-1 and EN 50082-1

according to the conditions of the EMC standard 89/336/EEG, and the amendments 92/31/EEC and 93/68/EEC

Jorwerd, 2-1-1996

ir. A.P.W.M. Poelsma



TiePie engineering
Battenserreed 2
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The Netherlands

EG - Konformitätserklärung

Wir erklären, in Eigenverantwortlichkeit, hiermit, daß das Produkt

AD128

für das diese Erklärung gültig ist, mit

EN 55011, EN 55022, EN 50081-1 und EN 50082-1,

gemäß den Anforderungen des EMC-standards 89/336/EEC, und den Zusatzbestimmungen 92/31/EEC und 93/68/EEC übereinstimmt.

Jorwerd, 2-1-1996

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The Netherlands

Déclaration de conformité C.E.

Nous déclarons, sous notre responsabilité, que le produit

AD128

pour lequel cette déclaration est valide, est conforme aux:

EN 55011, EN 55022, EN 50081-1 et EN 50082-1

selon les conditions du standard CEM N° 89/336/EEC, et les amendements 92/31/EEC et 93/68/EEC

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TiePie engineering
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9023 AR Jorwerd
The Netherlands

Dichiarazione di Conformita' CE

Dichiariamo sotto la nostra esclusiva responsabilità che il prodotto:

AD128

per il quale vale la presente dichiarazione, è conforme alle norme

EN 55011, EN 55022, EN 50081-1 e EN 50082-1

conforme alle condizioni della normativa EMC 89/336/EEC, e successive modifiche 92/31/EEC e 93/68/EEC.

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TiePie engineering
Battenserreed 2
9023 AR Jorwerd
The Netherlands

EC-declaración de conformidad

Nosotros declaramos, bajo nuestra propia responsabilidad, que el producto

AD128

para el cual esta declaración es válida, está en relación con

EN 55011, EN 55022, EN 50081-1 y EN 50082-1

Según las condiciones del EMC estándar 89/336/EEC, y los movimientos 92/31/EEC y 93/68/EEC

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EF-Overensstemmelseserklæring

Undertegnede erklærer herved, at følgende apparat overholder beskyttelseskravene i Rådets direktiv 89/336/EØF om elektromagnetisk kompatibilitet (EMC).

Identification af apparat:

Kategori: Måleinstrument

Model/type: **AD128**

Standarder der er anvendt som grundlag for erklæring, eller henvisning til den prøvningsrapport, der er udstedt af et betrykket laboratorium:

EN 55011, EN 55022, EN 50081-1 og EN 50082-1

CE-mærket angiver kun overensstemmelse med EMC-direktiv 89/336/EØF

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The Netherlands

EC Hyväksyntäilmoitus

Velvollisuutenamme on ilmoittaa, että tuotteemme

AD128

jota tämä selvitys koskee, on hyväksytty

EN 55011, EN 55022, EN 50081-1 ja EN 50082-1

EMC standardien 89/336/EEG, ja lisästandardien 92/31/EEC ja 93/68/EEC mukaisesti

Jorwerd, 2-1-1996

ir. A.P.W.M. Poelsma

Chapter 1

Introduction



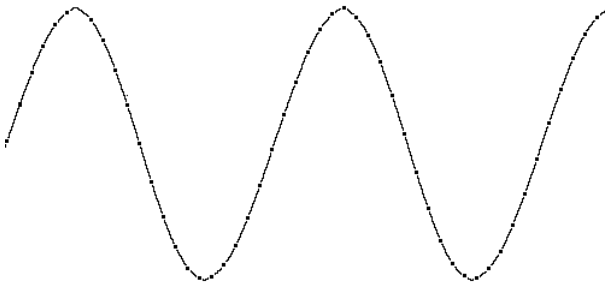
Note before using the AD128, first read the chapter about Safety

Many technicians investigate electrical signals. Though the measurement may not be electrical, the physical variable is often converted to an electrical signal, with a special transducer. Common transducers are pressure probes, accelerometers, current clamps and temperature probes. The advantages of converting the physical parameters to electrical signals are large, since several instruments for examining electrical signals are available.

The AD128 is a 8-channel, 12 bits, 100ksamples/sec measuring instrument. With the accompanying software the AD128 can be used as an oscilloscope. The instrument measures by sampling the input signal, digitizing the values, process them, save them and display them.

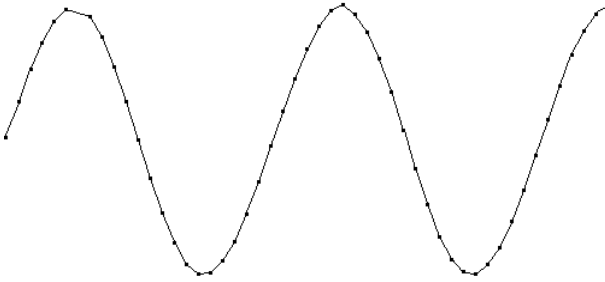
Sampling

When sampling the input signal, samples are taken at certain moments. The frequency at which the samples are taken is called the sampling frequency. By taking a (large) number of samples, the input signal can be reconstructed.



In the latter illustration a sine wave signal is sampled with 50 samples. By connecting the adjacent samples, the original signal can be reconstructed.

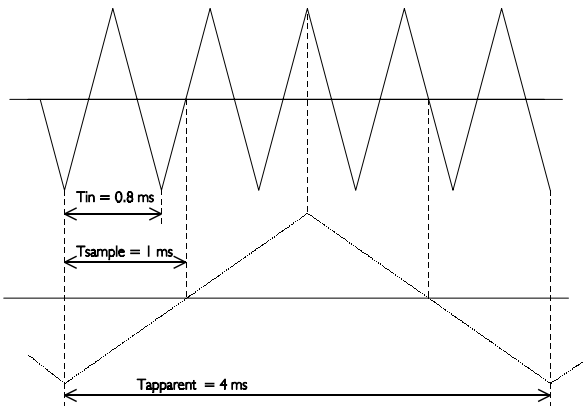
See also the next illustration.



The more samples are taken, the better the signal can be reconstructed. The sampling frequency must be higher than 2 times the highest frequency in the input signal. This is called the Nyquist frequency. Theoretically it is possible to reconstruct the input signal with more than 2 samples. In practice, 10 to 20 samples are necessary to be able to examine the signal thoroughly.

Aliasing

If the sampling frequency is lower than 2 times the frequency of the input signal, 'aliasing' will occur. The following illustration shows how aliasing occurs.

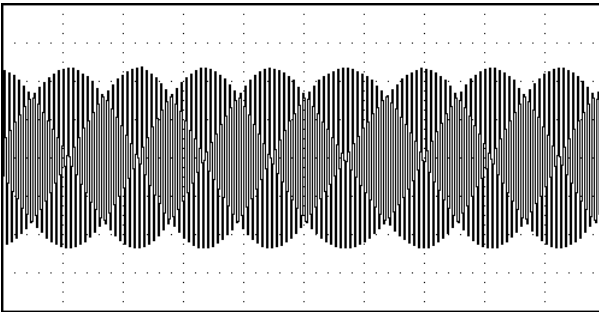


The input signal is a triangular signal with a frequency of 1.25 kHz (upper

most in the illustration). The signal is sampled at a frequency of 1 kHz. The dotted signal is the result of the reconstruction. From that triangular signal the periodical time is 4 ms, which corresponds with an apparent frequency (alias) of 250 Hz ($1.25 \text{ kHz} - 1 \text{ kHz}$).

To avoid aliasing, the sample frequency must be higher than 2 times the maximum frequency of the input signal.

Aliasing is not always visible on an oscilloscope. In the latter illustration, it gives a 'good looking' picture. It is not apparent that aliasing occurs. The next illustration gives an example of visible aliasing.



This time it is a sine wave signal with a frequency of 25.7 kHz, which is sampled at a frequency of 5 kHz. The minimal sampling frequency should have been 51.4 kHz. For proper analysis, the sampling frequency should have been 500 kHz.

Digitizing

After taking a sample of the input signal, it is digitised. This is done with an Analog to Digital Converter, ADC. The ADC converts the size of the signal to a digital number. This is called quantifying.

The first condition for accurate measurement is to have as many as possible quantifying steps. This can be realised by using an ADC with a resolution as high as possible.

The resolution of ADC's is often given in bits. The number of bits determines the number of quantifying steps according the formula:

$$\text{number of quantifying steps} = 2^{\text{number of bits}}$$

A 2 bits ADC has 4 quantifying steps. With an input range of 10 Volt, this ADC can divide the input range in 4 parts of each 2.5 Volt.

By increasing the number of bits, the resolution increases, the number of quantifying steps increases and the sub-divisions get smaller.

The oscilloscope

The oscilloscope is an instrument with which electrical voltages varying in time can be displayed. With the oscilloscope time dependent electrical signals can be examined easily.

The AD128 oscilloscope has 8 multiplexed inputs (channels), for which the sensitivity can be set.

The AD128 is equipped with two types of oscilloscopes, LIVE and HOLD. The oscilloscope LIVE measures 480 samples, 1 page. The oscilloscope HOLD measures 4800 samples, 10 pages.

The sensitivity range for the channels goes from 125 mV/div to 5 V/div. The timebase goes from 0.5 msec/div to 2 sec/div.

The display of the oscilloscope is built of 480 x 256 (wxh) pixels, which corresponds with 12x8 (wxh) divisions. Left of the display the unit of the channel is displayed. Under the display, the time axis is displayed.

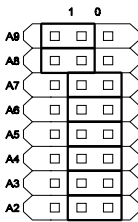
Chapter 2

Hardware installation

The AD128 is an 8 bits interface card, which can be placed in any free 8 or 16 bits ISA slot of an IBM compatible PC, XT or AT. The card does not use DMA or interrupts, so installation is very simple.

The only thing that has to be set is the I/O base address for the AD128. The card can be set to any address between \$000 and \$3FC, in steps of 4 addresses. To do that, the address lines A2..A9 of the PC are needed. The address lines A0 and A1 are used to address the 4 internal addresses of the AD128. Setting the AD128 I/O base address is done by the jumpers on the interface card.

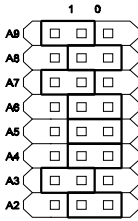
The factory default setting is address \$300, what corresponds to a jumper setting like in the following figure.



Calculation of the I/O base address:

A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
1	1	0	0	0	0	0	0	x	x
	\$3		\$0				\$0		

If the address \$300 is already in use by another device, you can set the AD128 to another I/O base address. Now follows an example for address \$288.



Calculation of the address \$288:

A9	A8		A7	A6	A5	A4		A3	A2	A1	A0
1	0		1	0	0	0		1	0	x	x
	\$2			\$8					\$8		



Note When the I/O base address of the AD128 is changed, the software has to be altered as well. See: Setting the AD128 I/O address.

Installation of the software

The software of the AD 128 is delivered on one diskette.

First you have to make a backup of the original diskette. Refer to your DOS manual for making a backup of a diskette. When you have made the backup, store the original diskette in a safe place and use the backup.

The software is delivered ready to use, without installation program. You can run the software direct from the diskette or from a hard disk.



Hint A hard disk is much faster than a diskette and has usually more free space available to store data.

To install the software on a hard disk, first make a directory for the software. Then copy all files from the diskette to the directory. The files are:

AD128.EXE	the program
AD1_HELP.ENG	the English help file
AD128_1.OVL	font file for printing output
AD128_2.OVL	info file
AD128_3.OVL	position of the popup menus

An example, where the diskette is in drive A: and the software has to be installed in a directory called AD 128 on the C: drive.

```
C :  
CD \  
MD AD128  
CD AD128  
COPY A: *. *
```

The software is now installed on the harddisk. After starting the program, the DEFAULT AD 128 ADDRESS has to be set. This is the I/O address at which the AD 128 is set to. Also, the DEFAULT DIRECTORIES can be

set. These indicate where the program has to store and look for help files, instrument setting files and measurement data files. You can set the DEFAULT AD128 ADDRESS and the DEFAULT DIRECTORIES with the menu **SETTINGS**, in the lower right corner of the screen.

Structure of the program

The program contains two integrated measuring instruments:

- 1 An oscilloscope, device: live.
- 2 A storage oscilloscope, device: hold.

Only one measuring instrument can be active at the same time.

From both measuring instruments the other measuring instrument can be activated. Standard features of the measuring instruments are options to make print outs and to leave the program to return to DOS.

Starting the program

The program can easily be started according to the below-mentioned procedure:

```
AD128 par1 par2
```

If no parameters are given, the device LIVE is selected, with the default settings.

The parameters par1 and par2 have the following meaning:

par1 Indicates the device that will be activated after starting the program. Valid values are:

- LIVE : Measuring instrument oscilloscope.
- HOLD : Measuring instrument storage oscilloscope.

par2 Indicates the filename of the instrument setting (see for writing or reading instrument settings: SETTINGS menu).

Example:

```
AD128 hold b:setting3.set
```

means the measuring instrument HOLD oscilloscope is activated with the file settings b:setting3.set. Incorrect instrument or filenames will be ignored.

The parameters par1 and par2 may be exchanged sequentially, but have to be separated by a space.



Note The AD128 software is designed to run under DOS and not under WINDOWS. Running the software under Windows will give incorrect results.

The timebase of the AD128 is generated by the computer. If the software is running under Windows, the software can (and will) be interrupted by Windows and other running tasks. This results in 'jumps' in the signal on the screen, since some information of the signal is missed during the interrupt.

To avoid these problems, run the software under DOS. Running from a DOS prompt within Windows will NOT solve the problems because Windows is still active. Quit Windows by pressing <Alt-F4>.

Windows 95 users: Shut down Windows 95 and restart the computer in MS-DOS mode.

Controlling the program

After starting the program, first an intro screen with program information is displayed. This screen indicates what kind of display adapter the program has detected.

After the intro screen has disappeared, the normal working screen appears. This screen is divided in two parts: a part for displaying the measurement data and a part for the main menu, for controlling the program. The program is controlled by the keyboard.

Controlling the main menu

Each instrument has its own main menu, in the lower part of the screen. The menu is built of three rows of 6 columns.

One of the buttons of the menu is always displayed inverted. That is the cursor, indicating the selected choice. For controlling the main menu, the following keys are available:



places the cursor one row up



places the cursor one row down



places the cursor one column to the left



places the cursor one column to the right



activates the selected choice





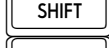

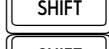

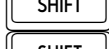

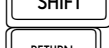

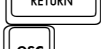



displays a list of instruments

Depending on the choice, after activating, a popup menu appears or the text in the menu changes, as well as the instrument setting.

Controlling popup menus

Various settings in the software are made by means of popup menus. For controlling the popup menus the following keys are valid:

	Move the cursor up
	Move the cursor down
	Move the cursor to the top of the menu
	Move the cursor to the bottom of the menu
 	Move the popup menu to the right
 	Move the popup menu to the left
 	Move the popup menu up
 	Move the popup menu down
	Accept the selected choice
	Leave the popup menu without changes
Space	Leave the popup menu without changes
Character	Place the cursor at the choice beginning with that character

When a popup menu has been moved by means of the <←→↑↓> keys in combination with the <**Shift**> key, the new position of the menu will be saved in the file ADI28_3.OVL.

Help screens

The program contains integrated help screens. The screens can be invoked at several places in the program, by pressing function key <**F1**>. The invoked help screen gives information about controlling the active program part or information about the active program part.

Program settings

Several parts of the program are configurable. To do that, activate the choice **SETTINGS** from the main menu. A popup menu will appear.

The contents are partly dependent on the type of graphics card in your PC. If an EGA or VGA card is available, a choice for setting the screen

colors is present. If no EGA or VGA card is detected, the choice will not be present.

Settings concerning the program itself (and not the measuring instruments of the program) are saved immediately in the file AD128.EXE.

Saving instrument settings

When the **SAVE** choice is activated all settings of both measuring instruments will be stored in a file to be indicated. The default extension of this file is "SET". At starting the program this file can also be given as parameter.

Loading instruments settings

When the **RESTORE** choice is activated a setting stored by **SAVE** can be restored.

Setting the location of files

With the choice **DEFAULT DIRECTORY** the default directories for the AD128, the print files and the data files can be set. The default directory for the AD128 is the directory containing the file AD128.EXE.

Setting the default AD128 address

With the choice **DEFAULT AD128 ADDRESS** the I/O base address at which the AD128 is set can be indicated. The address has to be entered in decimal, \$300 is 768 decimal.

Setting the printer port

With the choice **DEFAULT PRINTER PORT** the parallel printer ports 1, 2 or 3 to be connected to the printer can be selected.



Note Printer port 1 has the I/O address \$3BC, printer port 2 has the I/O address \$378 and printer port 3 has the I/O address \$278.

Text on the printer output

With **DEFAULT TEXTFILE** you can enter a filename containing three lines of text which are printed together with the measured data. Only files that are created with **COMMENT** from the main menu, can be used for printing.

Setting the screen colors

When an **EGA/VGA** color monitor is available, the colors of the background, the foreground, the signal and the cross hair can be set. While changing, the new color is displayed immediately. The color brightness can be changed using the **<←→>** keys.







Storing measurement data on disk

By activating the **WRITE DISK** choice a file name is requested. A file name without extension has to be entered. The data are stored in filename.DAT and the corresponding instrument setting in filename.GEG. In case the file name already exists, the program asks to overwrite the existing file. If there is insufficient disk space an error message appears. A file with the extension "DAT" and a file with the extension "GEG" are made during a **WRITE DISK**.

Loading saved measurement data

By activating the choice **READ DISK** a popup menu appears, giving an overview of the data files contained in the indicated default data directory. With the **<←↑↓→>** keys a file can be selected. When a selection has been made, the data and set files will be read from disk. When the data is not from the measuring instrument only the data file is read, or an error message appears.

The following file operations can be carried out with the function keys:

-  View the file information (size, date and time)
-  View the file (only text files)
-  Delete the file
-  Rename the file
-  Copy the file
-  Enter a new directory mask and/or path and/or disk

When <F4>, <F5> or <F6> is used, both the .DAT file and the .GEG file are acted on.

Printing measured data

There are two ways to print the measurement data.

The first way is pressing <Shift-PrtSc>. A quarter page size screen dump is made, containing only the information that is found on the display.

The second way is activated by the menu choice **PRINT**. A popup menu appears, displaying 2 choices.

The **DISK** choice requests for a file name to create the print file. This print file can be sent to the printer using the DOS command:

```
COPY/B filename PRN
```

where *filename* stands for the file name you entered in the input box.

With the **EPSON PRN** option the screen can be printed out on an EPSON compatible matrix printer. This printout is full page, containing extra information like date and time of the measurement and the comment lines.

Comments can be added to the printout using the **COMMENT** choice. When activated, a dialog box appears, in which three lines of text can be

entered. The comments entered are printed together with a printout. The comments are stored on disk when leaving the dialog box.

Choosing an instrument

By activating the choice **DEVICE**, menu a popup menu appears, displaying 3 choices.

When the **QUIT** choice is activated, the program will be terminated. The other options activate the indicated measuring instrument.

The measuring instruments (the devices) to be selected are:

LIVE	=	oscilloscope
HOLD	=	storage oscilloscope

This menu can also be activated by means of the <**Esc**> key (if no other menu is active).

Terminating the program

The popup menu **DEVICE** can be invoked from all program sections by means of the <**Esc**> key or the right mouse button. The **QUIT** option enables you to leave the program and takes you back to the operating system (DOS). The popup menu **DEVICE** can also be invoked with the <**Esc**> key or the right mouse button, if no other menu is active.

Chapter 4

Oscilloscope (device: LIVE)

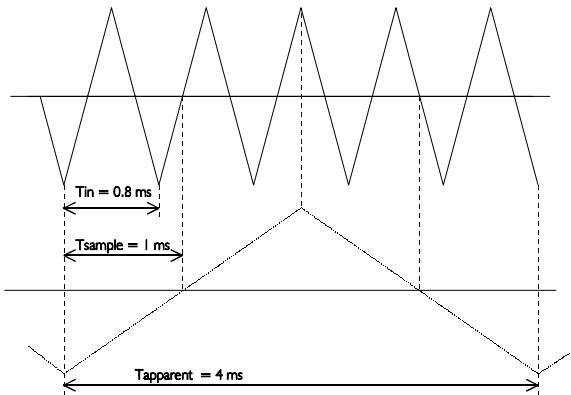
An oscilloscope is a measuring instrument which displays the changes of a voltage in the time domain.

The AD128 is equipped with an oscilloscope with 8 multiplexed inputs (channels), of which the sensitivity can be adjusted. It is a digital sampling oscilloscope. That means that the oscilloscope takes samples at fixed times. From each sample the value is determined and the size is displayed at the screen. The screen is filled with 480 samples per channel. Between two adjacent samples on the screen a line is drawn. The speed at which the samples are taken, is adjustable.

Aliasing

A disadvantage of digital sampling oscilloscopes is the fact that aliasing can occur.

Aliasing occurs when a too low and therefore wrong sampling speed is chosen. In the next illustration is shown how aliasing occurs.



The input signal is a triangular signal with a frequency of 1.25 kHz (upper most in the illustration). The signal is sampled at a frequency of 1 kHz. The dotted signal is the result of the reconstruction. From that triangular signal the periodical time is 4 ms, which corresponds with an apparent frequency (alias) of 250 Hz ($1.25 \text{ kHz} - 1 \text{ kHz}$).

To avoid aliasing, the sample frequency must be greater than 2 times the maximum frequency of the input signal.

If you have any doubts about the displayed signal, you can set the timebase of the oscilloscope one step faster or slower and check whether the signal at the display changes accordingly.

Displaying channels

The AD128 has 8 channels, of which one can be displayed at a time. Which channel has to be displayed, can be set using the choice **CHANNEL NR**.

By activating CHANNEL NR a popup menu appears with 8 options: **CHANNEL NR 1** to **CHANNEL NR 8**. Activating one of these options displays the corresponding channel.

Setting up a channel

The displayed channel of the AD128 oscilloscope is completely configurable.

With the choices **VOLTS/DIV** and **Y-as SET** from the main menu popup menus are called.

With the choices from these menus the channel can be configured.

Setting the sensitivity of a channel

By activating the choice **VOLTS/DIV** a popup menu appears, displaying 5 voltage ranges.

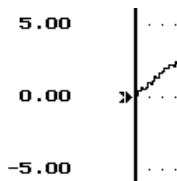
When e.g. **10** has been activated, a voltage range of 2.5 Volts/div will be set, that is, the maximum voltage to be measured is ± 10 Volt. The **AUTO** option provides for setting the voltage-axis automatically. The following ranges can be selected: 1.5, 2, 5, 10 and 20 Volt.

Setting the vertical position of a channel

The vertical position of the channel on the screen can be adjusted.

When doing this, the signal is shifted graphically, **after** sampling. This method only has an effect on the displayed signal. If the signal clipped, because it is larger than the selected input range, and is positioned with this software method, the signal remains clipped, but the clipping is now visible on the display. The signal appears to be 'cut off' at either the upper side or the lower side.

The positioning method is not done by means of a popup menu. At the lefthand side of the screen two small arrows are visible. The small arrow next to the border of the window is for the position of a channel, the outer arrow is for the trigger level, which is discussed later.



Only one arrow can be active, displayed normally. The other arrow is displayed inverted. In the above illustration the channel offset arrow is active.

The arrow indicates the offset, the 0 Volt level. The offset can be set as follows:



Note To change the offset, first remove all popup menus

SHIFT	↑	Move the offset level up
SHIFT	↓	Move the offset level down
SHIFT	home	Move the offset level to the center
SHIFT	→	Select the next offset or trigger level
SHIFT	←	Select the previous offset or trigger level
SHIFT	page up	Move the offset level to the top
SHIFT	page down	Move the offset level to the bottom
SHIFT	+	Increase the step size (2 times)
SHIFT	-	Decrease the step size (2 times)



Note the step size for changing the offset level or trigger level can be changed with <Shift-+> and <Shift-—>

Enlarging or reducing the vertical axis

The measured values can be enlarged or reduced by software. Because of that it is possible to magnify the vertical axis. It is also possible to invert the measured values. After activation of the choice **GAIN** in the menu Y-AS SET, a dialog box appears in which a multiplication factor can be entered. The factor must be between -10 .. -0,1 or 0,1 .. 10. The measured factors are multiplied by the factors and then displayed. The numbers along the vertical axis are also changed.

The GAIN can be used to invert a signal. In that case a gain factor of -1 has to be entered.

Changing the units of the vertical axis

Along the vertical axis, normally the voltage of the input signal is projected. The unit of measure is then Volt and the numbers along the axis correspond with the size of the input signal.

The AD128 oscilloscope allows you to create another definition of the vertical axis.

By means of the choice **UNIT** from the Y-AS SET menu the units of measure of the vertical axis can be changed.

After activation, a popup menu with 11 choices appears. The unit that is selected, is displayed at the top of the vertical axis. It is also placed on the paper when printed out. The possible choices are:
VOLT, AMPERE, DEGREE F, DEGREE C, WATT, PERCENT, METER, KILOGRAM, NEWTON, COLOMB and BAR.

If you are measuring e.g. with a temperature probe, you can choose **DEGREE C** for the units.

By activating the choice **UNITS/VOLT** from the menu Y-AS SET, a multiplication factor can be entered for the units of the vertical axis. A dialog box appears in which the factor is entered. The numbers along the vertical axis are multiplied by the factor and replaced by the result.

An application is the previously mentioned example with the temperature probe. Suppose the temperature probe gives a voltage change of 1 Volt at a temperature change of 5 degrees. By entering the factor 5, the temperature change is displayed directly in the number of degrees.

It is also possible to add an offset to the numbers of the vertical axis. In the dialog box called by activating **OFFSET** from the Y-AS SET menu, an offset can be entered. This offset is added to **the numbers along the vertical axis**. Nothing is done to the signal.

An application for this is again the temperature measurement. Suppose the output voltage of the temperature probe at 0°C is +10 Volt. By entering a UNITS/OFFSET of (-10 x 5), the zero level of the axis is changed in a way that the absolute temperature is directly readable. The extra factor 5 is necessary because of the factor entered with UNITS/VOLT.

Setting up the time axis

Along the horizontal axis of the screen the measuring time is projected.

Setting the timebase

By activating the choice **TIME/DIV**, a popup menu appears, displaying 12 time ranges.

When, for example, the **0.2 sec** choice has been activated, one time division will be equal to 0.2 sec. The screen contains 12 time divisions.

One time division consists of 40 samples. The screen contains $12 * 40 = 480$ sample values. By activating the **0.2 sec** choice one sample is taken every $0.2/40 = 5$ msec.

With the **0.2 sec** choice the minimum duration of the sampling process is $12 * 0.2 \text{ sec} = 2.4 \text{ sec}$. When a key is pressed within these 2.4 sec, the sampling process will be interrupted and the program will respond to the key press.

The following time-axis ranges can be selected: 0.5 msec, 1 msec, 2 msec, 5 msec, 10 msec, 20 msec, 50 msec, 0.1 sec, 0.2 sec, 0.5 sec, 1 sec and 2 sec/div.



Note On a XT computer the fastest, and sometimes the second fastest timebase setting as well, will not be available. In that case two other settings become available: 5 sec/div and 10 sec/div

Magnification of the horizontal axis

By activating the **TIME-MAG** choice, a popup menu appears, displaying 4 software time-axis magnification areas.

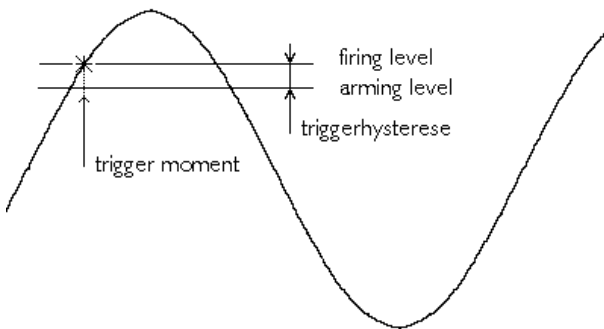
When, for example, the **2*** choice has been activated, the time-axis will be magnified 2 times. The magnified part of the screen is indicated by two interconnected arrows at the bottom of the screen. The time-axis magnification area can be moved using the **<PgUp>** and **<PgDn>** keys or by mouse. Place the mouse cursor on the interconnected arrows, press the left mouse button and drag the arrows left or right. With

the <+> and <-> keys the step size can be increased and decreased, respectively.

The following time-axis magnification areas can be selected: 1, 2, 5, and 10 times.

Triggering

To be able to examine a signal, the moment of displaying the signal has to be adjustable. Therefore an oscilloscope is equipped with a triggering system. This functions as follows:



The input signal is compared with two levels in the trigger system: the arming level and the firing level. When the input signal passes the arming level, the trigger system is armed. If the input signal passes the firing level, the trigger system becomes active and 'fires' a pulse. This pulse is used to start the display of the signal.

The arming level and the firing level are coupled to each other by the trigger hysteresis and their level is determined by the trigger level. The firing level corresponds to the trigger level. The trigger hysteresis defines at which signal size change can be triggered, the change has to be that large that both levels are passed. With a small trigger hysteresis it is possible to trigger on small signals. If a signal contains a lot of noise, a small trigger hysteresis causes triggering on the noise, instead of the original signal, which gives an unstable display. A trigger hysteresis larger than the noise level is then necessary.

In the latter illustration a signal and the two levels are displayed. In this case it is triggered on the rising slope of the signal. The signal passes the two levels from low to high. When triggering on the falling slope of a signal, the two levels are swapped. Then the signal has to pass the two levels from high to low, to generate a trigger.

Setting the trigger hysteresis

By activating the choice **HYSTERESIS**, a popup menu appears, displaying 12 trigger hysteresis options.

For example, when the **0.5 DIV** option has been activated, the trigger hysteresis will be 0.5 division of the voltage range set. This means that the signal has to come out at a minimum of 0.5 division below the trigger level set (for a positive trigger slope). When the signal has much noise the trigger hysteresis can be set high to ensure that triggering is satisfactory.

When a signal has less noise, the trigger hysteresis can be set low allowing triggering at low signal levels.

The following trigger hysteresises can be selected: 0 DIV, 0.125 DIV, 0.25 DIV, 0.5 DIV, 0.75 DIV, 1.0 DIV, 1.25 DIV, 1.5 DIV, 1.75 DIV, 2.0 DIV, 2.25 DIV and 2.5 DIV.

Setting the trigger slope

By activating the choice **SLOPE+ / SLOPE-**, the text in the menu choice changes from SLOPE+ to SLOPE- or vice versa.

In the SLOPE+ position triggering takes place on a rising slope of the signal to be measured and in the SLOPE- position on a falling slope.

Adjusting the trigger level

The adjustment of the trigger level is not done by means of a popup menu. At the lefthand side of the screen two small arrows are visible. The small arrow next to the border of the window is for the position of the channel, the outer arrow is for the trigger level.

There are two arrows, only one arrow can be active, displayed normally. The other arrow is displayed inverted. The arrow indicates the trigger level. The trigger level can be set as follows:



Note To change the trigger level, remove all popup menu's

SHIFT	↑	Move the trigger level up
SHIFT	↓	Move the trigger level down
SHIFT	home	Move the trigger level to the center
SHIFT	→	Select the next offset or trigger level
SHIFT	←	Select the previous offset or trigger level
SHIFT	page up	Move the trigger level to the top
SHIFT	page down	Move the trigger level to the bottom
SHIFT	+	Increase the step size (2 times)
SHIFT	-	Decrease the step size (2 times)



Note the step size for changing the offset level or trigger level can be changed with **<Shift-+>** and **<Shift-—>**

Setting the trigger time-out

When the input signal does not meet the trigger conditions, no new measurement data will be displayed and the last displayed signal will remain on the screen. This can be very inconvenient with unknown signals, since it is not known how the trigger system has to be set. To provide in that case for a representation of the input signal on the screen, a trigger time-out setting is available.

With the time-out setting it is determined how long the delay will be for a trigger pulse. If that time expires, the available data will be displayed. This will not result in a stable display, but it will give an impression how the trigger has to be set.

By activating the choice **TIME-OUT** from the main menu, a popup menu appears with 12 choices for the trigger time-out: 0 DIV, 10 DIV, 20 DIV, 50 DIV, 100 DIV, 150 DIV, 200 DIV, 250 DIV, 300 DIV, 350 DIV, 400 DIV and 450 DIV.

For example, when the **50 DIV** option has been activated, the signal will be controlled for 50 time divisions maximally. If the signal does not comply with the trigger level set, the trigger slope and the trigger hysteresis within 50 time divisions, it will nevertheless be measured after 50 time divisions.

Stopping the display

By activating the **LIVE/FREEZE** choice, the text in the menu changes from LIVE to FREEZE or vice versa.

In the LIVE position the oscilloscope continuously takes 480 samples and displays them on the screen.

In the FREEZE position no samples are taken and the samples last taken are displayed on the screen.

Differences with the oscilloscope

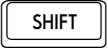

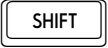

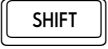

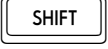

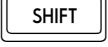

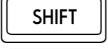

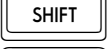

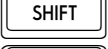

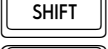

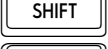



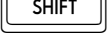

The storage oscilloscope HOLD is quite similar to the oscilloscope LIVE. There are a few differences, which will be described here. For the rest is referred to the chapter Oscilloscope (LIVE).

- The HOLD scope only works in ONE SHOT mode and does not measure 1 but 10 pages of 480 samples. With the <PgUp> and <PgDn> keys, the pages are selected. The step size can be set using the <+> or <-> keys.
- After measuring, a cross hair appears, to simplify voltage and time measurements

The main menu of the HOLD device differs slightly from the main menu of the LIVE device. At the position where in the LIVE device the LIVE / FREEZE choice is found, the HOLD device has a choice ONE SHOT.

Measuring with the cross hair

After the measured signal is displayed, a crosshair appears. With the crosshair absolute and relative time and voltage measurements can be performed. Controlling the crosshair is done with the following keys:

		Setting the absolute zero
		Setting the relative zero
		Move the crosshair to zero
		Move the crosshair up
		Move the crosshair down
		Move the crosshair to the left
		Move the crosshair to the right
		Mirror the crosshair on the relative x-axis
		Mirror the crosshair on the relative y-axis
		Decrease the step size twice
		Increase the step size twice
		Switching between crosshair controll and offset/ trigger level controll.

Absolute zero is that point at the screen where voltage and time are zero (left most, in the center of the screen). Relative zero is that point set by moving the crosshair to the intended point and subsequently pressing **<Shift-Del>**.

The time and voltage values according the crosshair position are displayed on the screen, the voltage value in the upper right corner of the screen and the time value at the right most end of the time axis. The values are displayed inverted.

Short description

The AD128 is a 12 bits A/D interface card with 8 analog inputs, 8 digital inputs and 8 digital outputs.

The conversion speed of the A/D convertor is 10 μ s. Because of the "pipe line" structure a very high effective data throughput from the A/D convertor to the computer is attainable (100,000 values per sec). The AD128 contains a SAMPLE AND HOLD function

The voltage range of the analog inputs can be set from 1.25 Volt (resolution is 610 μ Volt) to 20 Volt (resolution is 9.8 mVolt) bipolar with by means of software.

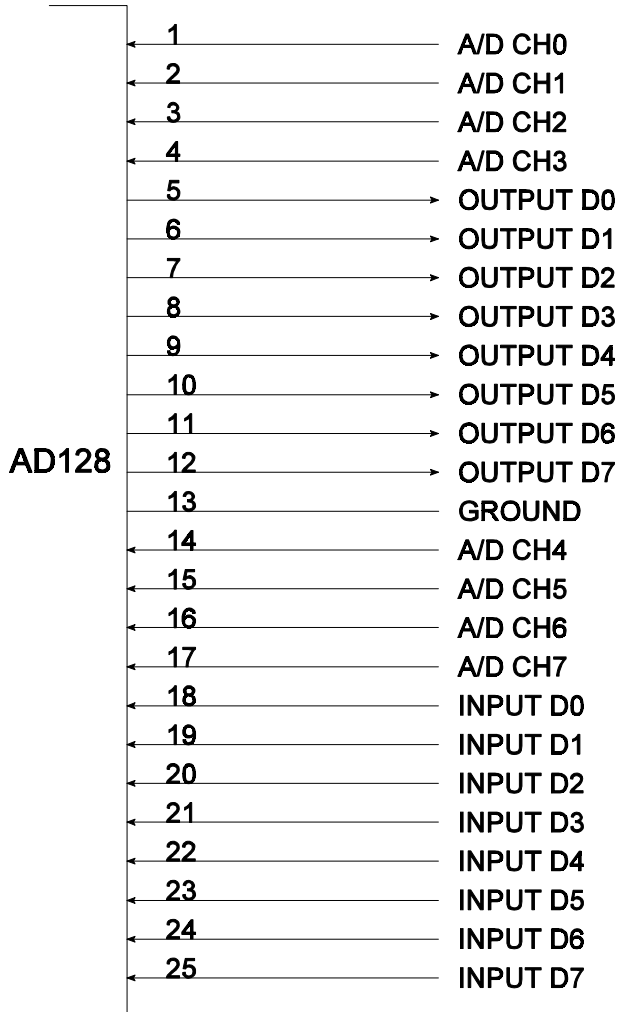
The input impedance is 800 k Ω /250pF.

The digital inputs and outputs are TTL compatible.

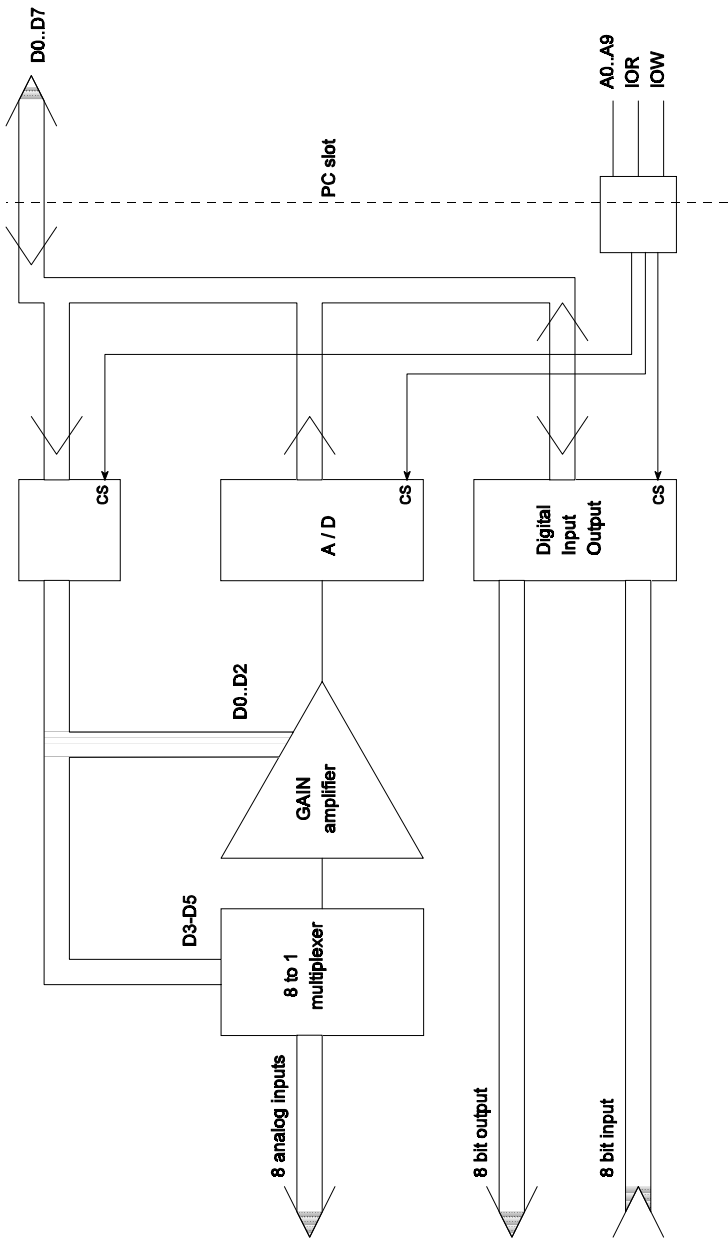
The AD128 can be placed in any free ISA slot in an IBM compatible PC, XT or AT.

Connections at the 25 pin sub-D connector

All in- and outputs of the AD128 are located at the 25 pin sub-D connector at the back of the AD128 interface card. In the following figure, the meaning of the pins is found.



AD128 block diagram



Description of the hardware

I/O address use

The AD128 takes four I/O addresses in the PC. The basic I/O address can be set with 8 jumpers. The basic I/O address is set default at \$300 (\$300 means 300 hexadecimal or 768 decimal). So communication with the AD128 is done through the basic I/O address set and the three I/O addresses following on that.

Meaning of the I/O addresses

Reading and/or writing on the basic I/O address or on the three following I/O addresses results in:

\$300 read: An A/D conversion is started. The conversion value of the **previous conversion** is available (D0..D7).

\$301 read: The conversion value of the **previous conversion** is available (D8..D11).

\$302 read: No effect.

\$303 read: Reading the 8 digital inputs.

\$300 write: No effect.

\$301 write: No effect.

\$302 write: Setting the gain factor for the A/D convertor and setting the A/D channel.

\$303 write: Writing the 8 digital outputs.

Starting a conversion and reading data

After starting a conversion (this is done by reading of the basic I/O port address) it will take 10 μ sec before the conversion is ready. During the conversion a new conversion cannot be started. During the conversion time the value of D8..D11 (of the previous conversion) can be read from the A/D convertor. The advantage of this is that there is no need to wait for the A/D convertor. But there has to be kept in mind that the value read from the A/D convertor is from the previous conversion.

Converting the measured data

The input range of the A/D convertor is bipolar. The digital code run by the A/D convertor is 12 bits binary.

- The binary value 0000 0000 0000 corresponds with the maximum negative input sensitivity.
- The binary value 1000 0000 0000 corresponds with 0 Volt
- The binary value 1111 1111 1111 corresponds with the maximum positive input voltage.

The calculation needed to convert the measured data to voltages is for some values given in the following table.

output value A/D convertor	input value channel 0..7
D11.....D0	
1111 1111 1111	factor* $\frac{2047}{2048}$
1111 1111 1110	factor* $\frac{2046}{2048}$
1000 0000 0001	factor* $\frac{1}{2048}$
1000 0000 0000	0 Volt
0111 1111 1111	- factor* $\frac{1}{2048}$
0000 0000 0001	- factor* $\frac{2047}{2048}$
0000 0000 0000	- factor* $\frac{2048}{2048}$

The value of **factor** depends on the setting of the amplifier.

The input sensitivity can be set on the basic I/O address+2 with the data bits D0..D2. The setting time of the input sensitivity is 10 μ sec. When the input sensitivity is switched over from 1.25 Volt to, for example, 20 Volt there has to be waited minimal 10 μ sec before a conversion will be started.

The input sensitivity bits are coded according the following table.

input value I/O address+2			factor value	
D2	D1	D0		
0	0	0	20	Volt
0	0	1	10	Volt
0	1	0	5	Volt
0	1	1	2.5	Volt
1	0	0	1.25	Volt

Selecting the A/D channel is done with the data bits D3..D5 on the basic I/O address+2. When the A/D channel has been set there has to be waited minimal 1 msec before the first conversion can be started.

The A/D channel bits are coded according the following table.

input value I/O address+2			the active channel number	
D5	D4	D3		
0	0	0	channel 0	on
0	0	1	channel 1	on
0	1	0	channel 2	on
0	1	1	channel 3	on
1	0	0	channel 4	on
1	0	1	channel 5	on
1	1	0	channel 6	on
1	1	1	channel 7	on

Thus the byte written on the basic I/O port address +2 consists of three bits which indicate the input sensitivity (D0 ... D2) and three bits which indicate what analog input (= A/D channel number) is active (D3 ... D5).

Setting the input sensitivity and the A/D channel number has to be done at the same time on the basic I/O port address +2.

Controlling the hardware

For reading analog signals, the following steps have to be taken:

- Select the channel number and the input sensitivity by means of an "OUT" instruction on the basic I/O address+2.
- Wait minimal 1 msec after setting the channel number.
- Start a conversion. Starting a conversion is done by means of an "IN" instruction at the basic I/O address.
- Wait minimal 10 μ sec.
- First read the bits D0..D7 by means of an "IN" instruction at the basic I/O address. A next conversion will now be started automatically.
- Read the bits D8..D11 by means of an "IN" instruction at the basic I/O address+1.

For reading the digital inputs the following step has to be taken:

- Read the digital inputs by means of an "IN" instruction at the basic I/O address+3.

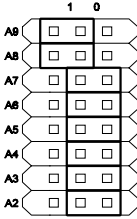
For sending out the digital outputs the following step has to be taken:

- Activate the digital outputs by means of an "OUT" instruction at the basic I/O address+3.

Setting the I/O base address

The only thing that has to be set in the hardware is the I/O base address for the AD128. The card can be set to any address between \$000 and \$3FC, in steps of 4 addresses. To do that, the address lines A2..A9 of the PC are needed. The address lines A0 and A1 are used to address the 4 internal addresses of the AD128. Setting the AD128 I/O base address is done by the jumpers on the interface card.

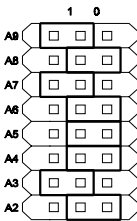
The factory default setting is address \$300, what corresponds to a jumper setting like in the following figure.



Calculation of the I/O base address:

A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
1	1	0	0	0	0	0	0	x	x
\$3		\$0				\$0			

If the address \$300 is already in use by another device, you can set the AD128 to another I/O base address. Now follows an example for address \$288.



Calculation of the address \$288:

A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
1	0	1	0	0	0	1	0	x	x
\$2		\$8				\$8			



Note When the I/O base address of the AD128 is changed, the software has to be altered as well. See: Setting the AD128 I/O address.

Chapter 7

Programming examples

Example 1

Reading data from an A/D channel (TURBO PASCAL).

```
program ReadData;
uses crt;
const AD128IoAddress = $300;
      Gain1           = 4;           {1.25 Volt input sensitivity}
      ChannelNr0     = 0;           {channel 0}
var   Data           : array[1..100] of integer;
      LoData, HiData, i : integer;
begin
  port[AD128IoAddress+2]:=Gain1+ChannelNr0;           {CH0, 1.25 V}
  delay(1);                                           {wait}
  LoData:=port[AD128IoAddress];                       {start conversion}
  for i:=1 to 100 do                                  {100 values}
  begin
    LoData:=port[AD128IoAddress]; {read D0..D7 and start conv.}
    HiData:=port[AD128IoAddress+1]; {read D8..D11}
    data[i]:=LoData + (HiData and 15) shl 8;
    (*
     * at fast computers here some delay routine
     * this loop must last at least 10 µsec
     *)
  end;
  for i:=1 to 100 do
    writeln(1.25*(data[i]-2048/2048):8);
  end.
```

Because with the instructie

```
LoData := port[AD128IoAddress]
```

the data of the previous conversion is read, this instruction has to be placed before the measurement loop, to insure the first measured value does not contain wrong data.

Example 2

Reading data from more A/D channels (TURBO PASCAL).

```
program ReadData;
const AD128IoAddress = $300;
      Gain1          = 4;           {1.25 Volt input sensitivity}
      ChannelNr0     = 0;           {Ch0 on}
      ChannelNr1     = 8;           {Ch1 on}
      ChannelNr2     = 16;         {ch2 on}
var   Data : array[1...100] of integer;
      Lo1,Hi1,
      Lo2,Hi2,
      Lo3,Hi3 : integer;
begin
  port[AD128IoAddress+2]:=Gain1+ChannelNR0;      {A/D channel 0}
  delay(1);                                       {wait min 1 msec}
  Lo1:=port[AD128IoAddress];                     {start conversion}
  delay(1);                                       {wait min. 10 usec}
  Lo1:=port[AD128IoAddress];                     {read D0..D7}
  Hi1:=port[AD128IoAddress+1] and 15;            {read D8..D11}

  port[AD128IoAddress+2]:=gain1+channel_nr1;    {A/D channel 1}
  delay(1);                                       {wait min. 1 msec}
  Lo2:=port[AD128IoAddress];                     {start conversion}
  delay(1);                                       {wait min. 10 usec}
  Lo2:=port[AD128IoAddress];                     {read D0..D7}
  Hi2:=port[AD128IoAddress+1] and 15;            {read D8..D11}

  port[AD128IoAddress+2]:=gain1+channel_nr2;    {A/D channel 2}
  delay(1);                                       {wait min. 1 msec}
  Lo3:=port[AD128IoAddress];                     {start conversion}
  delay(1);                                       {wait min. 10 usec}
  Lo3:=port[AD128IoAddress];                     {read D0..D7}
  Hi3:=port[AD128IoAddress+1] and 15;            {read D8..D11}

  writeln( Hi1 shl 8 + Lo1:8,
           Hi2 shl 8 + Lo2:8,
           Hi3 shl 8 + Lo3:8
           );
end.
```

Chapter 8

Specifications

Hardware

A/D convertor

conversion time	8 μ sec
sample and hold acquire time	2 μ sec
max data speed A/D convertor -> PC	100.000 samples/sec
input sensitivity (all channels)	
	1.25 Volt (resolution 0.61 mVolt)
	2.5 Volt (resolution 1.2 mVolt)
	5 Volt (resolution 2.4 mVolt)
	10 Volt (resolution 4.9 mVolt)
	20 Volt (resolution 10 mVolt)
maximum input voltage	200 Volt peak peak
input impedance	800 k Ω /250 pF
resolution	12 bits 0,05 %
accuracy	0,2 % \pm 1LSB
bandwidth	DC to 100 kHz
input sensitivity switching time	10 μ sec
channel switching time	1 msec

Digital inputs

input current maximum	1 μ A
logic low level maximum (TTL compatible)	0.8 Volt
logic high level minimum (TTL compatible)	2.0 Volt

Digital outputs

output current maximum	20 mA
logic low level maximum (TTL compatible)	0,3 Volt
logic high level minimum (TTL compatible)	4,0 Volt

General

recommended ambient temperature		20 °C
dimensions	height	110 mm / 4.3 "
	length	125 mm / 4.9 "
	width	20 mm / 0.8 "
weight		ca. 120 gram

Software

Timebase	<i>(not at PC-XT)</i>	0.5 ms/div
	<i>(not at PC-XT)</i>	1.0 ms/div
		2.0 ms/div
		5.0 ms/div
		0.01 s/div
		0.02 s/div
		0.05 s/div
		0.1 s/div
		0.2 s/div
		0.5 s/div
		1.0 s/div
		<i>(only at PC-XT)</i> 2.0 s/div
		<i>(only at PC-XT)</i> 5.0 s/div
Timebase accuracy		5%
Timebase enlargement		2..10 times
Y-axis enlargement		-10..10 times
Recordlength	LIVE	480 points
	HOLD	4800 points
Triggering		rising and falling slope
Trigger sensitivity		0.25..2.5 div
Trigger resolution		0.01 x full scale
Trigger time-out		0..450 div
External trigger		keyboard
Offset adjustment		software
Offset range		0..100%
Offset resolution		0.01 x full scale
Invert		software
Hardcopy		Epson compatible matrix printer

Notes

Any suggestions concerning the AD 128, the software and/or the manual can be directed to:

until April 1, 1996

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