

Pierre Dieumegard
professeur de SVT
Lycée Pothier
45000 Orléans
pierre.dieumegard@ac-orleans-tours.fr

Mensurasoft-PB, general-purpose software for scientific experiments

Mensurasoft-PB is a software to measure and experiment by computer. With it, you can make measures by measuring devices and interfaces, and display the graphic chart. You can send the table of the chart of measures towards the clipboard or save data or picture in a file, what allows you to analyse and to model these measures by data analysis software, such spreadsheets or statistical software, etc.

It is general-purpose software for several reasons:

- Mensurasoft-PB can work with (potentially) all the measuring tools, thanks to device drivers: using the driver of one device, Mensurasoft-PB can make the measurement with this device.
- Mensurasoft-PB uses standard text-files to save the data. These files are readable by all current software of data analysis.
- Mensurasoft-PB is portable: you do not need to make complex installation when you want to use it, nor to make deinstallation when you do not want to use it any more.
- Mensurasoft-PB works under two main current operating systems, Microsoft-Windows and Linux.
- Mensurasoft-PB is a free software. You can modify and adapt it to your personal needs.
- When the settings of your experiment are correct, you can protect them by saving them in configuration files. So, next time, you can reload the file, and your experiment will be ready, without any need to re-adjust the parameters of Mensurasoft-PB.
- Mensurasoft-PB can work in various languages. The character strings of the menus and of dialog-boxes are defined in files with .lng extension, which you can easily modify. Thanks to UTF8 Unicode code, non-Latin characters are possible.

Contents

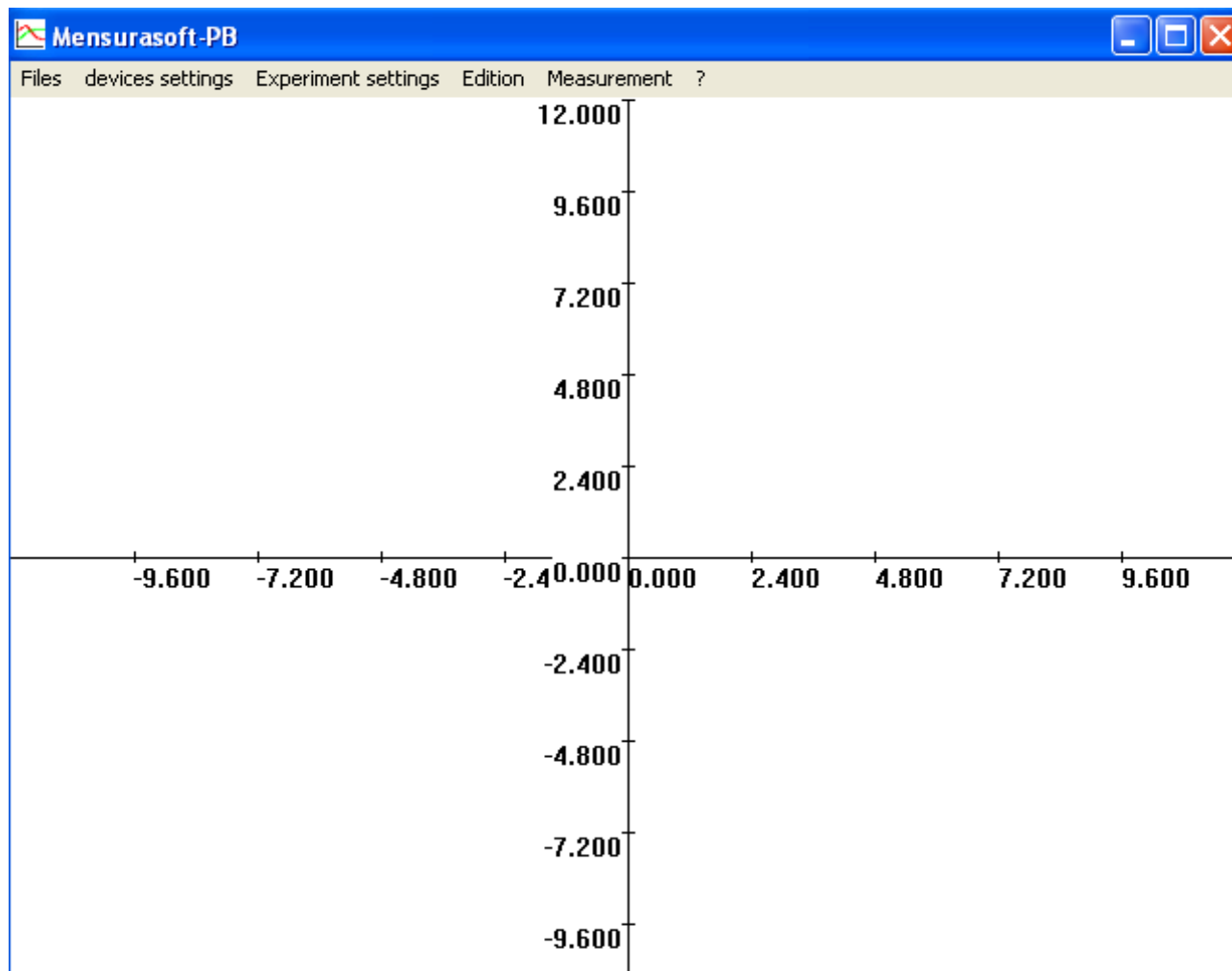
Starting display of Mensursoft-PB.....	3
Files menu.....	3
Devices settings.....	4
Experiment settings.....	4
Edition.....	5
Measurement.....	5
Help.....	5
Course of an experiment.....	6
A very simple experiment, with "system" driver.....	6
More complex experiment, with Arduino.....	10
Experimental settings and measured values.....	10
Settings of Mensursoft-PB.....	10
Results in the window of Mensursoft-PB.....	11
Using transforming functions.....	12
Syntax for transforming functions.....	12
A few files to use Mensursoft-PB more easily.....	14
Language files .lng.....	14
Configuration files .cfg.....	15
Startup file Mensursoft-PB-auto.cfg.....	16
Helpfile Mensursoft-PB-hlp.html.....	16
Devices usable by Mensursoft-PB.....	17
Principle of drivers (dynamic libraries).....	17
Versatile interfaces.....	17
Specialized devices, to plug in a serial connector or an USB-serial adapter.....	18
Useful complements for Mensursoft-PB : programs for data analysis and modelling.....	19

Starting display of Mensurasoft-PB

To start Mensurasoft-PB, just double-click on the name of the executable file: Mesu_PBxx.exe under Windows, or Mesu_PBxx under Linux.

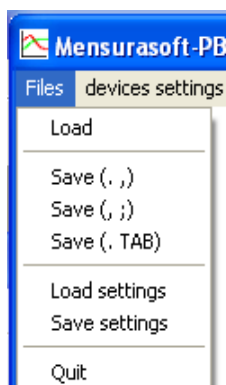
The main area of the window is used by a XY graph, now empty. Mensurasoft-PB can display) only one data set.

In this text, we assume that english language is loaded, by file mesu_pb_en.lng.



At the top of the window, a banner gives the title: Mensurasoft-PB. This banner will change later, and will contain several indications about the measures, especially numerical values, and the position of the mouse on the graph.

Below, a menu allows to select several options.



Files menu

- Load : allows to fill the chart with data from a file. This option is not very useful: Mensurasoft-PB is a software for measurement, not for modelling data.

- Save (. ,) will save the data to a text-file. Each line will be one point of data, with one or few values. First value will be the time, in seconds. Second value will be the measure of principal channel P, maybe a third value will be the measure of auxiliary channel A, and a fourth value will be the measure on supplementary channel S. In this item, values are separated by commas, and decimal separator is a point. This is the most frequent computer convention. So, data will be readable by data modelling programs.
- Save (. ;) works similarly, but values will be saved with comma as decimal separator, and semicolon as data separator. Like this, data will be readable by software adapted to French convention (spreadsheets like Excel or OpenOffice).
- Save (. TAB) will save the data with a point as decimal separator, and TAB (chr(9)) as separator between values.

These three file formats are readable by text-editors.

- Load settings will read experimental settings, previously saved in a file. Settings files are text-files with .cfg extension (like ConFiGuration).
- Save settings will save experimental settings in a .cfg file.

Devices settings

Mensursoft-PB
devices settings Experiment settings
P driver P channel transforming function P (Calibration P)
A driver A channel transforming function A
S driver S channel transforming function S
SA driver SA channel transforming function SA
Driver for logical output (SB) logical outputs (SB)

Mensursoft-PB can do measurement on one, two or three channels. Principal channel is named "P" : it is essential to be able to make measures. The two other channels, named auxiliary channel ("A") and supplementary channel ("S") are optional.

Mensursoft-PB can also control an analog output, named "SA", and logical(= digital) outputs, named "SB".

In order to use each channel, you must firstly choose the driver, which is a file with a dynamic library (.dll for Windows, .so for Linux).

Then, you must choose measurement channel, according to the abilities of the device. Several devices have only one channel, for example a pHmeter. Others have several channels, for example interfaces like Orphy or Arduino.

Transforming function allows (maybe) to modify the value sent by the driver, according to the value really observed. A pHmeter sends usually the pH-value, between 0 and 14 : so there is nothing to transform.

On the other hand, if the Arduino driver send a value in volts, while the device is connected to a temperature sensor, the transforming function must transform volts to degrees (or kelvins).

"Calibration" allows settings for some devices. For example, with colorimeters or spectrophotometers, it can allow the blank test, prior to do a measurement.

Experiment settings

Experiment settings Edition Measure
Interval between measures (s) max number of points
min. x max. x min. y max. y

Mensursoft-PB is specialized in slow measures, i.e. whose interval between two points is from one to several seconds. For "fast measures", with an interval between points is about few milliseconds or microseconds, you must use another program, oscilloscope-like.

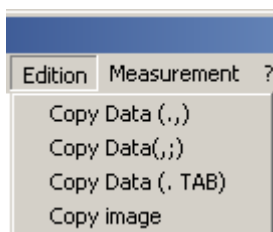
For an experiment, you can set the interval between measures by the

first option of menu. By default, this interval is one second ; you can choose several seconds, even several minutes, if you want very slow measures, like temperature measurement, during several days.

You can also set maximal number of measures, which is 100 by default. When you do not precisely know how long will be the experiment, it is better choose too large scales, and put a too big number of measures, because you could prematurely stop the experiment by menu "Measurement | stop".

By default, graphical display is from -10 to 10, in X-axis and Y-axis. During measurement, this display will be automatically set in order to display all data. If this range is too large, for example if all your data are between 0 and +1, you can use the four last options of this menu to set the minimum and maximum of X-axis and Y-axis.

Edition

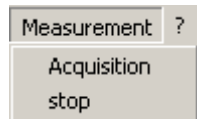


This menu is only useful when there are data in memory, when you have done an experiment (by "Measurement" menu), or loaded data from a file ("File" menu).

You can copy data to clipboard by the three first option, with the same convention as the one used for saving data with File menu. Thus, data will be easily read by spreadsheets like OpenOffice, Gnumeric or Excel.

You can also copy the image of chart, and paste it in a graphical software, or a text-processor.

Measurement

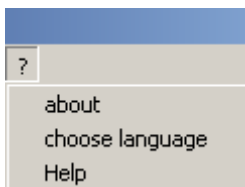


This is the main work of Mensurasoft-PB.

In order to begin acquisition, you must click on "Acquisition". In this case, points are drawn on the graphical chart, in red for principal channel P, in green for auxiliary channel A, and in blue for supplementary channel S. Do not forget : this is possible only if a driver is loaded for principal channel P, and a channel is chosen.

You can stop the experiment by option "stop".

Help



This menu, with a question mark, is used to help the user.

- about shows only a box, with the programmer's address.

- choose language allows to choose the language for menus and dialog boxes, by loading a file, with extension .lng.

- Help will open an help file.

Course of an experiment

In order to carry out an experiment with Mensursoft-PB, you must choose your hardware, and later launch acquisition.

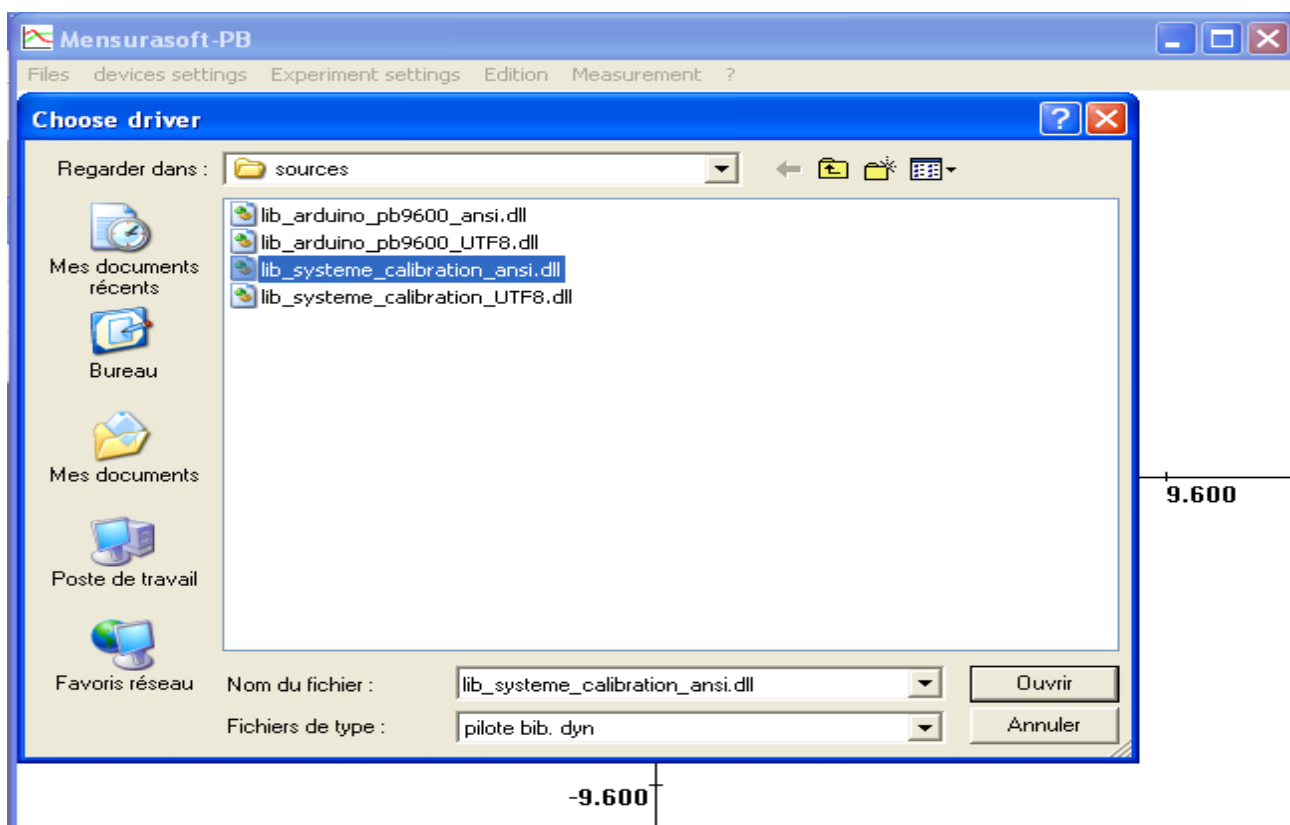
Below, illustrations are screenshots with Windows 7 ; for other systems (Windows XP, 98, 95, Linuxes...), screenshots would be different, but the principle is similar.

A very simple experiment, with "system" driver

True measuring devices are so diverse that this first example will be done with an apparatus existing in all computers : the clock. In this driver, we choose the channel which give the seconds in a minute (from 0 to 60 in a minute, and once again from 0 to 60...).

Choice of the device driver

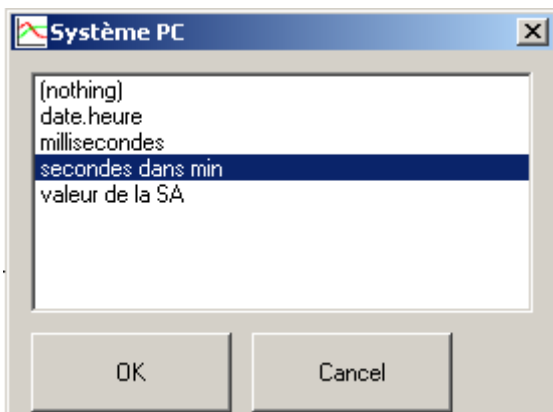
You must choose "Device settings | P driver". A dialog box for files appears, and you can choose de the driver (file .dll for Windows, or .so for Linux).



The drivers with word «systeme» allow reading of internal clock. After this choice, you must now choose the measurement channel.

Choosing measurement channel

The second option of "Devices settings" allows to open a dialog box for measurement channel choice.



The banner of this box give the title of the device driver.

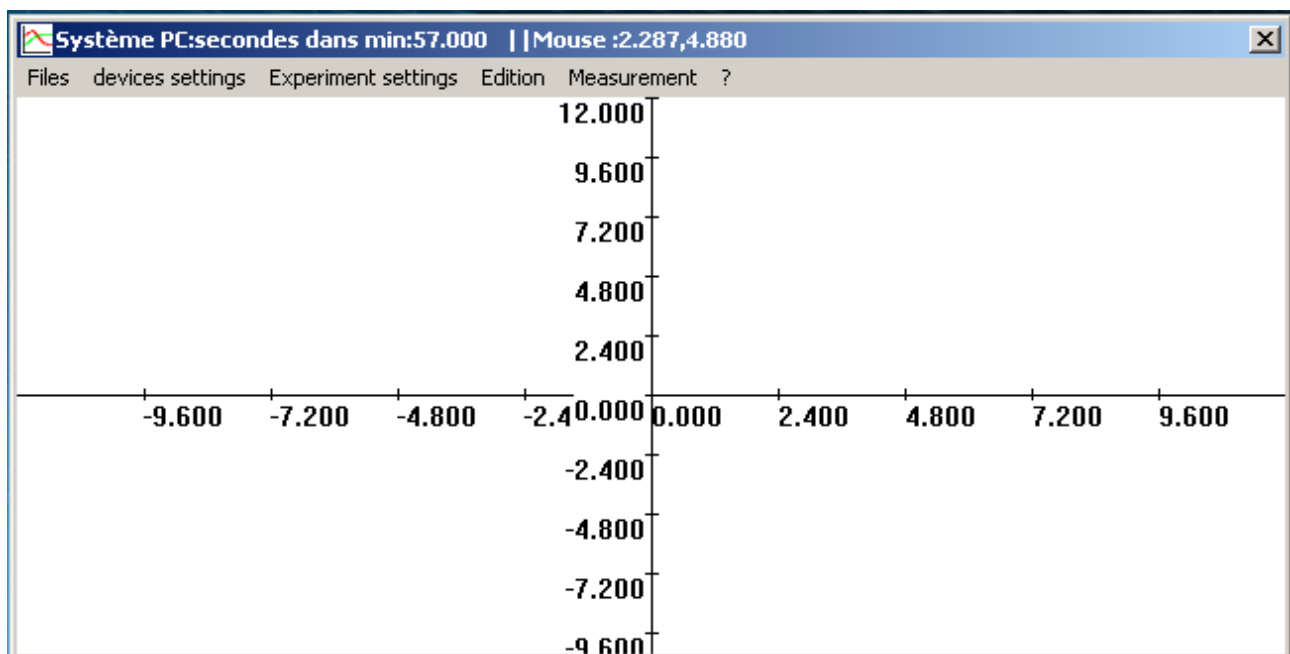
There are several channels, giving four versions of time from the computer clock. On the top, (nothing) disable the using of this driver.

Choose the fourth channel, which is seconds in a minute.

From now, measurement is possible.

Windows banner changed : it shows current values of the measure.

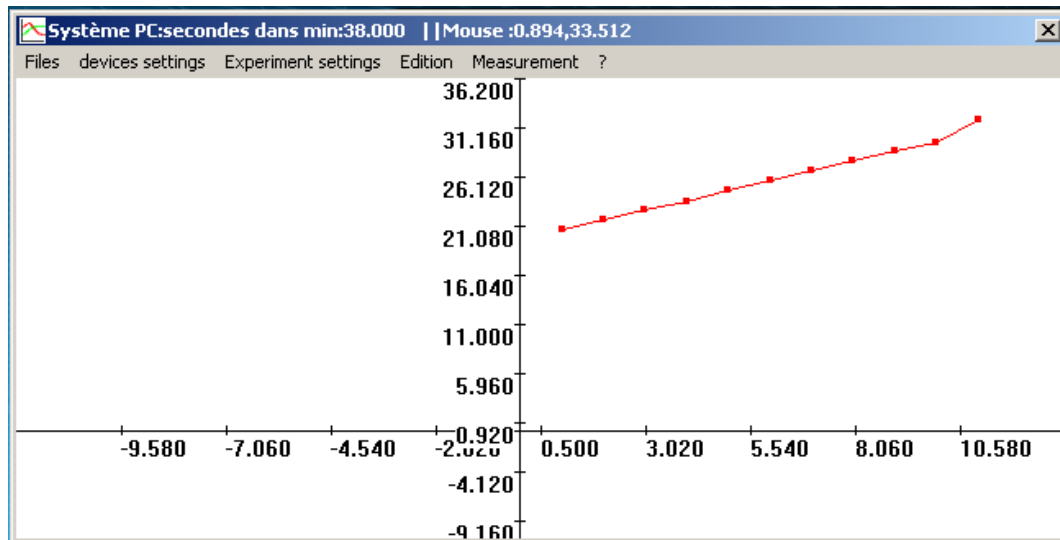
Useful information from banner



From left to right:

- title of driver for this device ("Système PC")
- title of chosen channel ("secondes dans min")
- measured value (here 57 seconds)
- mouse position (not visible here) in the chart. This will be useful for real values on the chart.

Data acquisition



In the menu, choose "Measurement | Acquisition". Red dots are drawn, showing measured values. Automatically, the chart is redrawn, so that all values are in the chart.

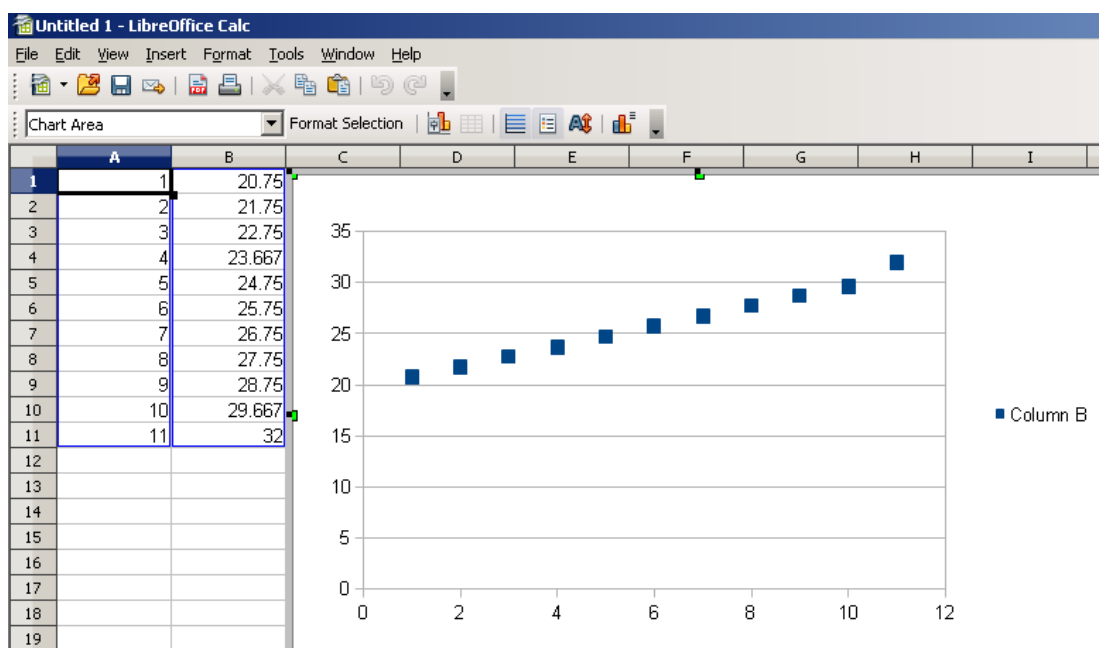
Send the experimental results to other programs

"Other programs" means here mostly software for statistical analysis and modelling, as spreadsheets (OpenOffice, Gnumeric, Excel), or Scilab, Matlab, Freemat, Octave....

Send results to clipboard

For this, use menu "Edition".

The three option "Copy data" send results to clipboard as text-strings. In accordance with your software, choose one option or another. Most of scientific software use point as decimal separator : choose first or third option. Spreadsheets with French settings (OpenOffice, Excel) use comma as decimal separator : choose the second option "Copy data (, ;)".



In OpenOffice, you can use "Paste" (Ctrl-V) to paste data from clipboard.

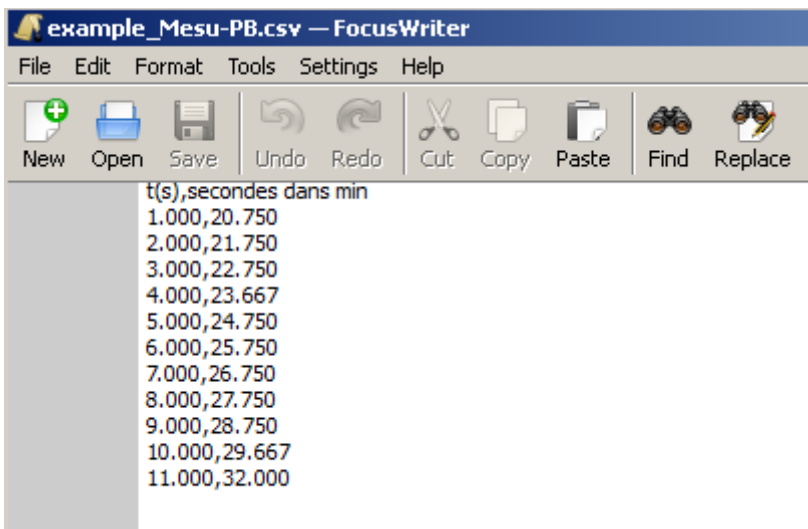
Send chart image to clipboard

This option allows you to get the chart in a graphical software, or a word-processor....

Save data in a file

Anyway, files are "delimited text-files". Again, there are three options (. .), (, ;), (. TAB) : choose the option according to the software which must read this file.

Traditional extensions for these text-files are .txt (for TeXT), but others text-files (poems, bills...) can have the same extension, .csv (for Comma Separated Values), or .tab (if TAB (chr(9)) is used as separator).



***Mensurasoft-PB
does not put
extension
automatically ! You
MUST type the
extension (.txt, .csv,
.tab or other) when
you type the
filename !***

First line of the file is filled by titles of columns : first is always time in seconds, second is name of principal channel P with text of transforming function. (After that, other fields are (maybe) for titles

of auxiliary and supplementary channels). By default , transforming function is "xp" : this means that there is no transformation..

Reload data from file by Mensurasoft-PB

There is no specific options. When you choose "Files | Load", Mensurasoft-PB shows the files list with extension .txt, .csv and .tab. It will adapt automatically to data, whatever is separator: Mensurasoft-PB will read data as numbers, and display the chart.

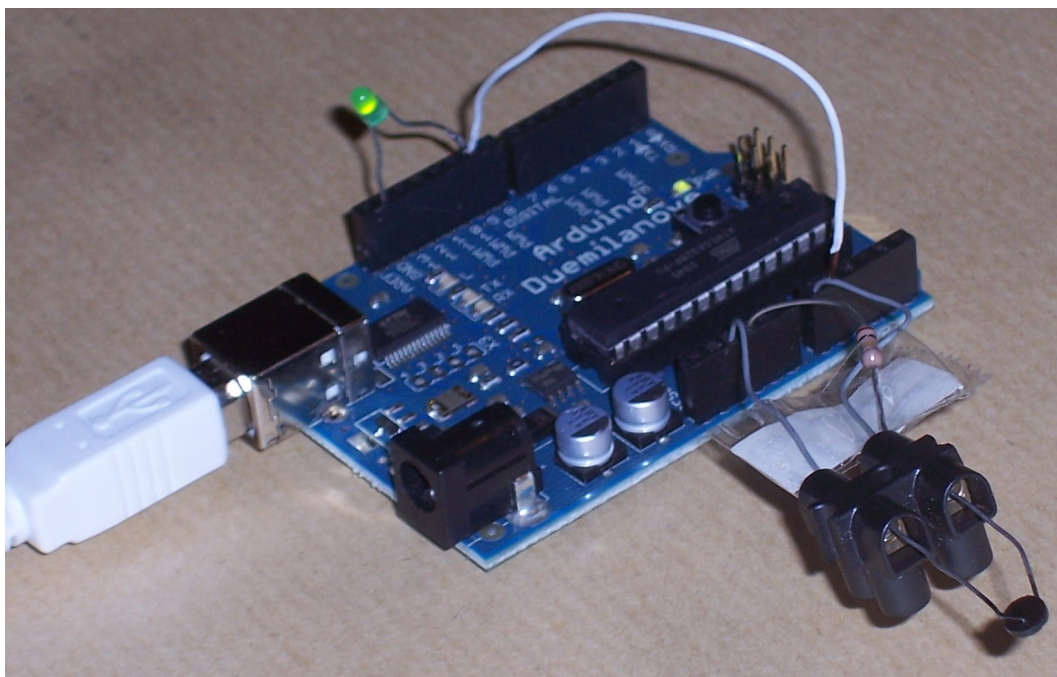
More complex experiment, with Arduino

Arduino is a little electronic cart, to link to USB-connector. It has several inputs and outputs, logical and analog.

Experimental settings and measured values

On photograph below :

- in the foreground is a sensor for temperature : its electrical resistance decreases when temperature increases. This sensor is connected to a voltage source (5V, on the left) and to a ground connector (central, connected to a resistor), and to an analog input (on the right). When temperature increases, resistance of the sensor decreases, and voltage at analog input increases.
- On the other side of this card are connectors for logical inputs/outputs, and analog outputs (PWM). Voltage of these outputs can vary inter 0V and 5V, with a choosable rhythm : their voltage is "in average" variable. You can see a Light Emitting Diode connected to a PWM (analog) output. So, emitted light changes. This output connector is also connected to analog input 1, on the right of analog input 0, where is connected temperature sensor.



Experiment will measure temperature at analog input 0, and voltage at PWM output, while voltage at this output varies during this experiment.

Settings of Mensursoft-PB

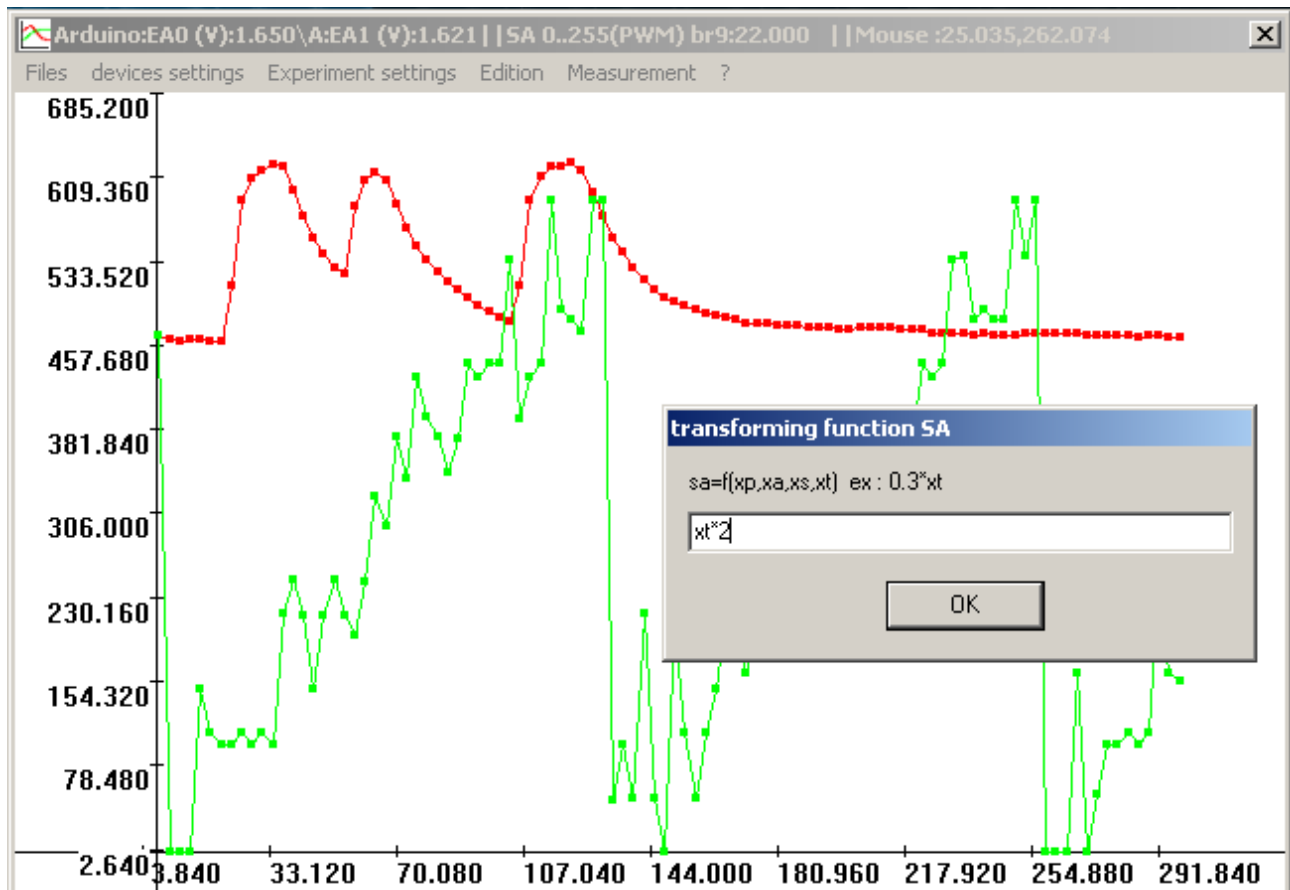
We must set :

- measurement in principal channel P, with Arduino driver (here lib_arduino_pb2.dll because Windows is the operating system ; with Linux, the driver would be lib_arduino_pb2.so). Chosen channel is 0. Transforming function is simply xp (no transformation). To have temperature in Celsius degrees, it would be necessary to put a more complex formula.
- On the auxiliary channel, driver will be also for Arduino, but channel will be 1, with transforming

function xa (no transformation)..

- there is no measurement on supplementary channel S
- analog output is also with Arduino driver. Transforming function will be $xt*2$: mean voltage will increase gradually (but only on average ! at a time, voltage is either 0V, or 5V).
- measures will be done every 3 seconds, and series will have 100 measures.

Results in the window of Mensursoft-PB



This window has a banner with driver title, title and value for principal channel, title and value for auxiliary channel, title and value for analog output, and mouse position.

After launching of measurement (menu "Measurement | acquisition", principal channel is drawn in red, and shows temperature : when we press the sensor between our fingers, its temperature increases, and red dots go up on the chart. When we release the sensor, temperature decreases, and the red lines goes down.

Auxiliary channel (in green) shows voltage at analog connector 1. This voltages increases "on average", and this green line is very irregular. Analog output can only be set from 0 to 255 : when values given by formula " $xt*2$ " are over 255, this analog output goes to 0.

This was only an example. Mensursoft-PB can perform measurement on supplementary channel S, with blue dots on the chart. The three measurement channels and the analog output can be connected to different devices, with different drivers. Transforming functions can be written with time (xt), principal channel (xp), auxiliary channel (xa) and supplementary channel (xs)..

Using transforming functions

Measurement device sends numerical value, which will be sent by driver to the main program, here Mensursoft-PB.

Sometimes, this value is an integer number, from the ADC (Analog-Digital Converter), for example between 0 and 1023 for Arduino. Sometimes this value is a real number, for example pH from a pHmeter.

You can use these values directly, but you can also use them after a transformation to a more interesting value. pH value given by a pHmeter can give information about an other physical value, for example concentration in carbon dioxide, and a transforming function can convert the pH value to concentration of CO₂. Electrodes of pHmeter are sensible to temperature, and it is necessary to modify the pH value according to the temperature, measured on an other sensor. A temperature in °C can be transformed to kelvin, by adding 273.16.

Value sent by P driver, for principal channel, is symbolized by "xp". Symbols for values from auxiliary channel A and supplementary channel S are "xa" and "xs", and time is symbolized by "xt". Transforming functions can use these symbols. During evaluation of the formula, "xp" will be replaced by the value read on principal channel, "xa" by value of auxiliary channel, "xs" by value of supplementary channel, and "xt" by the time.

On principal channel, default function is "xp" : no transformation. You can convert Celsius degrees to kelvins by "xp+273.16".

More generally, value displayed by Mensursoft-PB on principal channel will be $y_p = f_1(x_p, x_a, x_s, x_t)$, on auxiliary channel will be $y_a = f_2(x_p, x_a, x_s, x_t)$, etc.

Analog output can also use these transforming functions. To have a constant value, for example 500, you can type "500" in the input line. You can increase the value from 0 to 10 in a minute by formula "xt*10/60".

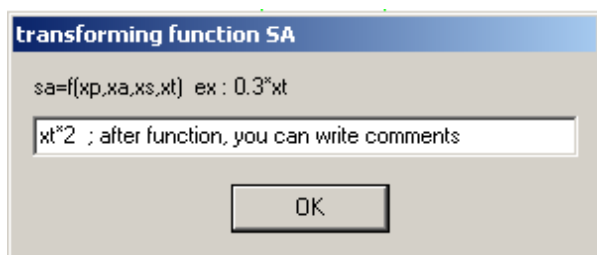
Syntax for transforming functions

Mathematical operators

You can use usual operators : + for addition, - for soustraction, * for multiplication, / for division and ^ fro exponentiation. Other operators, less usual, giving 1 when value is true and 0 when value is false, are & (logical and), | (logical or), <, >, <>, <=, >=, ==.

Mathematical functions

Unary functions are acos (arc cosinus), asin (arc sinus), atan (arc tangent), abs (valeur absolue), cos (cosinus), int (integer part), log (neperian logarithm), log10 (decimal logarithm), sin (sinus), sqr (square root), tan (tangent), random (give a random number between 0 and its argument). Binary operator pow gives the power of first parameter by second parameter. Tsec gives number of seconds from the computer starts ; tdate gives the date of now, from january 1970.



Writing comments after transforming function

In the formula, character strings which are not evaluable give a nul result.

For example, formula "xp ; pH value" give the same value as "xp", because Mensursoft-PB evaluate first xp, and after tries to evaluate "; pH value", whose result is zero.

Question : why write comments after formula ? Answer : to memorize the aim of transformation !

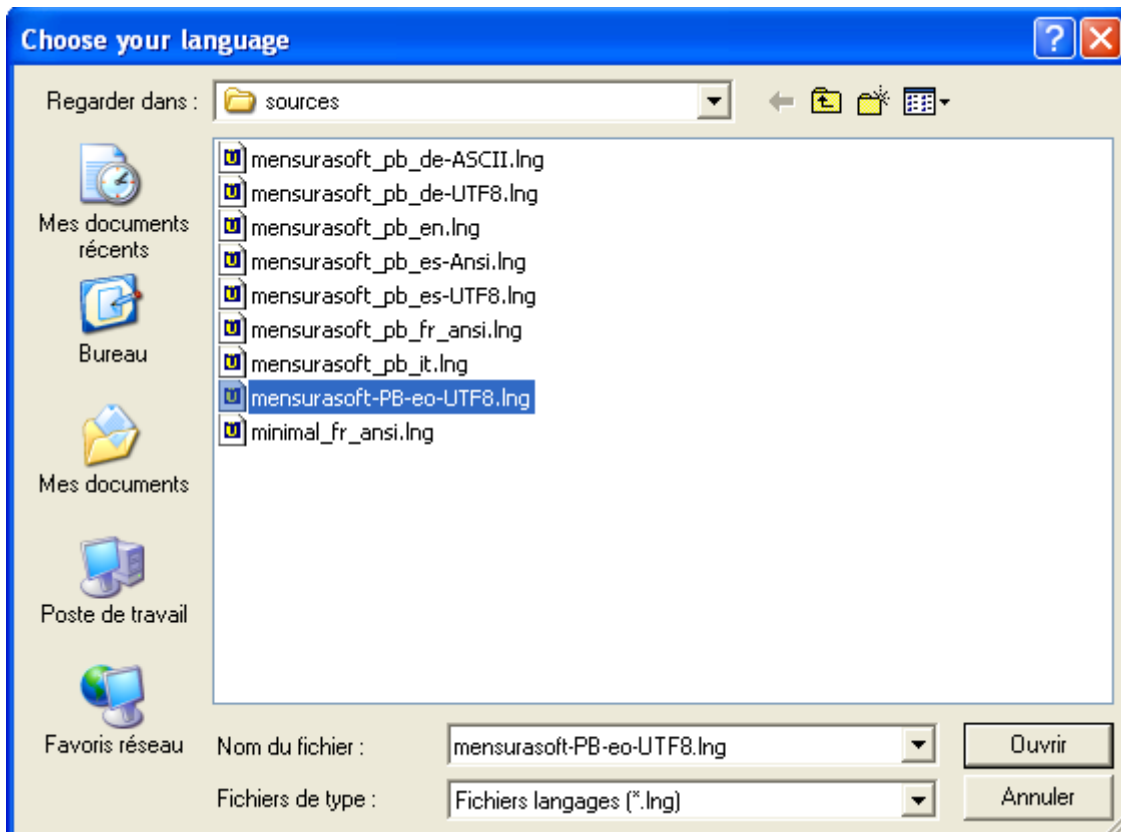
For sure, when you are experimenting, you know why you are transforming the values. But, after several months, you can forget it.

The comments are written after the formula in the first line of the data files, and in the configuration files (.cfg). This can help your mind.

A few files to use Mensursoft-PB more easily

These files are optional : scientifically, Mensursoft-PB works well without them, but these files help users to configure the software.

Language files .lng



They are text-files, with lines beginning by an identifier, followed by "=", followed by a character string, which will be displayed in menu or dialogbox.

By default, when there is no language file, Mensursoft-PB begins in french. Menu "? | langage ?" opens a dialog box, for loading language files, with extension .lng.

You can edit these files and change the text, or create new files, for new languages : only change texte after "=".

A few problems about coding of characters :

By default, Mensursoft-PB assumes that characters are coded by ASCII mode (on 8 bits), but this ASCII code cannot use non latin alphabets.

Mensursoft-PB can use files coded with Unicode-UTF8 (16 bits), these files must have a sign about this code. The sign can be a line at beginning of this file, with the string

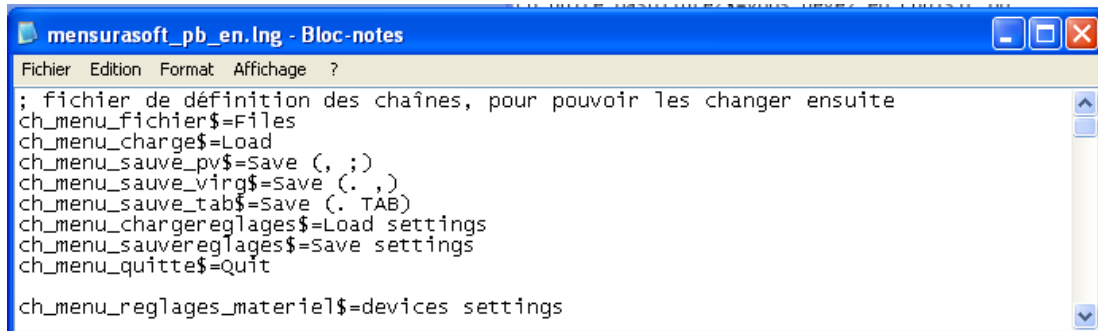
#PB_UTF8

for example the line :

#PB_UTF8 // this shows that file is Unicode-UTF8 coded.

An other possibility is to put "UTF8" or "Unicode" in the file name.

OpenOffice can edit these files, and allows you to choose the coding way.



```
mensurasoft_pb_en.lng - Bloc-notes
Fichier  Edition  Format  Affichage  ?
; fichier de définition des chaînes, pour pouvoir les changer ensuite
ch_menu_fichier$=Files
ch_menu_charger$=Load
ch_menu_sauve_pv$=Save (, ;)
ch_menu_sauve_virg$=Save (.,)
ch_menu_sauve_tab$=Save (. TAB)
ch_menu_chargerreglages$=Load settings
ch_menu_sauverreglages$=Save settings
ch_menu_quitter$=Quit

ch_menu_reglages_materiel$=devices settings
```

When the text of an item is an empty string, this item is inactive.

Theses language-file .lng allows you to change the help-file (by default Mensurasoft-PB.pdf), by a line :

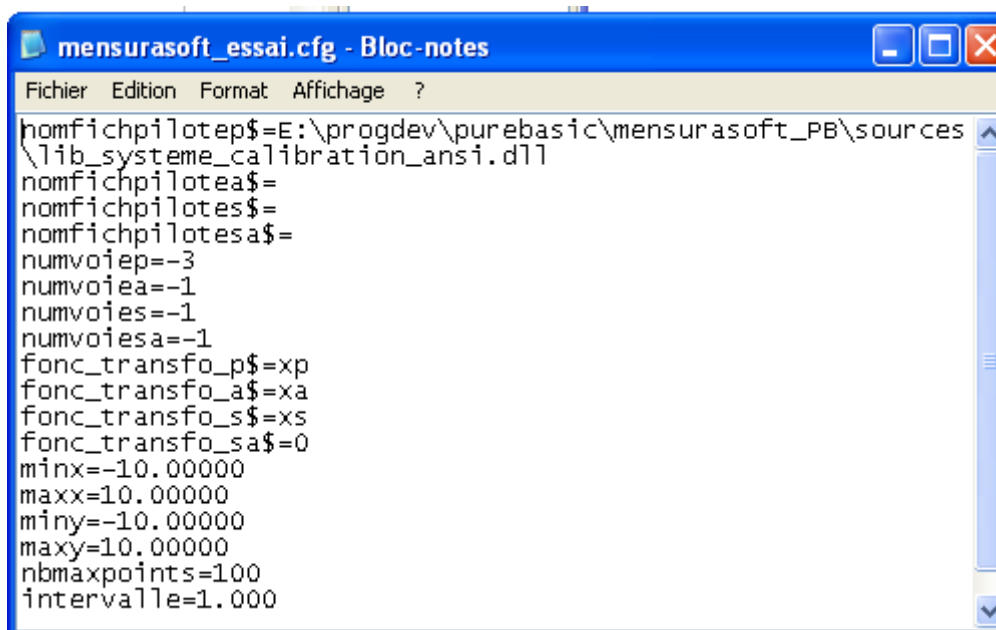
`ch_fichier_aide$=my_help_file.xxx`

Mensurasoft-PB and this help-file must be in the same directory.

Configuration files .cfg

These files can save several experimental settings. For example, when the settings for an experiment about enzymes are corrects, you can save them in a file enzymes.cfg.

A file .cfg (as ConFiGuration) has pathes for drivers, number of channel, transforming functions, minimum and maximum of axis for the chart, interval between measures and number of points.



```
mensurasoft_essai.cfg - Bloc-notes
Fichier  Edition  Format  Affichage  ?
nomfichpilote_p$=E:\progdev\purebasic\mensurasoft_PB\sources
\lib_systeme_calibration_ansi.dll
nomfichpilote_a$=
nomfichpilote_s$=
nomfichpilote_sa$=
numvoiep$=-3
numvoiea$=-1
numvoies$=-1
numvoies_a$=-1
fonc_transfo_p$=xp
fonc_transfo_a$=xa
fonc_transfo_s$=xs
fonc_transfo_sa$=0
minx=-10.00000
maxx=10.00000
miny=-10.00000
maxy=10.00000
nbmaxpoints=100
intervalle=1.000
```

As for .lng files, these .cfg files can be edited by any text-processor. You can put #PB_UTF8 in a line at beginning of the file to read this file as an Unicode-UTF8 file, but Unicode-coding is less useful than for .lng files.

Startup file Mensurasoft-PB-auto.cfg

This file is optional. It have settings for Mensurasoft-PB on startup. In this file, you can put a line for the language :

f_lng=xxxx.lng

where xxxx.lng is the path of a language file (for example mesu_pb_en.lng). So, you can start Mensurasoft-PB in english, german, spanish, esperanto...

Helpfile Mensurasoft-PB-hlp.html

By default, this file is loaded by help function. With Windows, the default browser is used ; with Linux, the default browser is firefox.

Name of this file can be changed in language files by a line as :

ch_fichier_aide\$=Mensurasoft-PB-hlp.html

Name of executable program can be changed in language files by a line as :

ch_programme_aide\$=miniwebbrowser.exe

Devices usable by Mensursoft-PB

This list is incomplete : it is (relatively) easy to make new drivers for new devices, by several programming languages. A suitable language must be compiled, to be able to make dynamic libraries.

For Linux and Windows, good languages are FreePascal, PureBasic, FreeBasic, and several C++.

Functions beginning by "std" are "stdcall" (mainly for Windows) and functions beginning by "c" are "cdecl" (mainly for Linux).

Principle of drivers (dynamic libraries)

They must have following functions :

stdtitre and ctitre : without parameter, give a short string (title of the driver)

stddetail and cdetail : without parameter, give a less short string (detail of the driver)

stddead and cead : analog input, with an integer parameter, which is number of the channel (from 0), and gives a double (real).

stdnead and cnead : name of analog input, with an integer parameter (number of the channel, from 0) ; it gives a string.

They may have following functions :

stdsad and csad : analog output, with two parameters, an integer (number of the channel) and a double (value for the output) ; it gives the value.

stdnsad and cnsad : name of the analog output, with an integer parameter (number of the channel) ; gives a string

stdcalibration and ccalibration, with a string parameter, and giving a string. These strings are not used by Mensursoft-PB. When this function exists, it is possible to use option "(calibration P)" of menu "devices settings". This option launch this function of the driver, by sending an empty string. This calibration function is useful particularly for spectrophotometers or colorimeters, to do blank calibration, or for oxymeters, to set zero and slope.

Again problems about coding of strings. Characters can be coded on one byte (Ascii-Ansi) or two bytes (Unicode-UTF8). If you see anormal characters when you try to choose a channel, it is a problem of coding. A solution is to put a string for indicate the code in the name of the file.

Put "UTF8" or "Unicode" in the filename for saying to Mensursoft-PB that coding is Unicode-UTF8 (for example "lib_mydevice_UTF8.dll" for Windows or lib_mydevice_UTF8.so for Linux). Put "Ansi", for example "lib_mydevice_Ansi.dll" or "lib_mydevice_Ansi.so" say that coding is with eight bits for a character.

Several drivers are downloadables at <http://sciencexp.free.fr>

Versatile interfaces

Unless otherwise stated, drivers exist both for Windows and Linux.

To plug in an USB-connector

Arduino

Velleman K8055 (Windows only)

Orphylab (Windows only)

Eurosmart (Windows only)

To plug in a serial connector (or an USB-serial converter)

Orphy GTS and GTS2, Orphy GTI, Orphy Portables 1 and 2...

To plug in an ISA or PCI connector

Jeulin ESAO3 et ESAO4

Candibus and Candiplus

Pierron SMF10-SMF100-Expert

MEP : PMB and PMB>

To plug in a parallel connector

MEP Ades, and «Cappar system»

Specialized devices, to plug in a serial connector or an USB-serial adapter

Multimeters MAS345, TES 2730, My77, Metex...

pHmeters Tacussel PHM210, LPH330, PHN130 ; Schott Handylab2

scales Sartorius PT600, Precia, Adam PGW, Ohaus Scout

thermometers TM906A,

luxmeters LX105

spectrophotometers Secomam, Jenway

and gameport for joysticks...

Useful complements for Mensursoft-PB : programs for data analysis and modelling

PAST : Statistical software

Freemat, Scilab, Octave : for numerical computing

OpenOffice and LibreOffice : office suites

Gnumeric : lightweight spreadsheet, but scientifically efficient

Regressi : modelling program.