

# The plotting programs PlotXY and PlotXWin



*Short description and operating instructions (rel. July 2007)*

**About this document.** Since the program described in this document is designed to be very intuitive, it is deemed sufficient to give here only some very short information. This document contains some *Generic Information Paragraphs* (titles in **NON-ITALIC BLACK**) and modeless<sup>1</sup> window descriptions (titles in **ITALIC BLUE**).

The document describes the features of two different programs: PlotXY.exe and PlotXWin.exe. Since the latter is an enhancement of the former, the majority of descriptions relate to both programs; parts specific to PlotXWin are written in **red**.

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## GENERAL INFORMATION

### Introduction

PlotXY is a plotting program created by Massimo Ceraolo of University of Pisa to generate scientific line plots using data collected from:

- C-LIKE PL4 files created with the program Alternative Transients Program (ATP)
- generic ASCII files whose extension must be ADF (see Appendix).
- Matlab files (some constraints on the accepted file structure are reported in Appendix)
- IEEE Comtrade files

While reading Comtrade files the Program tries to understand variable types from their unit of measure.

It is also able to understand standard prefixes for unit of measure “k” and “m”. In the program arrays containing the data read the corresponding variables are converted into SI Units. If, for instance, a variable “X” is read from the Comtrade file with unit “kV”, the variable name will be “v:X”, will incorporate the  $10^3$  factor, and will be expressed in V (Volts).

Starting from 2005 in the PlotXY package two executables are distributed:

- file PlotXY.exe that is a direct evolution of previous versions of PlotXY.exe
  - file PlotXWin.exe that is able to manage several Plot Windows at a time, while PlotXY.exe manages only one.
- The choice between the two depends on users' preference, keeping into account that the bigger complexity of PlotXWin implies a larger utilisation of system resources (memory, registry space).

Installation:

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<sup>1</sup>In the GUI interface language of operating systems modeless windows are those that may stay open even when the user switches to other windows of the same program.

No installation procedure is needed (simply the file PlotXY.EXE or PlotXWin.exe is to be copied in a directory of choice)

At the first execution of PlotXY or PlotXWin, if previous versions of the program are present, the message “Error in registry” may be displayed. This is normal and will not be repeated at next executions. Note that PlotXY and PlotXWin use different registry areas so settings are independent to each other; however when one of the two programs clears the registry, it clears both registry areas, so all program settings are restored to their default values.

### Main Program features (PlotXY and PlotXWin)

- easy-to use Graphical User Interface
- full 32 bit (win32) code for very fast operation
- up to 8 plots per sheet
- allows plots from up to 8 files on the same sheet
- allows plots versus time, as well as X-Y plots
- allows linear as well as logarithmic scales
- factors and offsets and zoom support
- clever automatic axis scaling and labelling
- cursor to see values in numerical format
- printing and Windows Metafile export facilities

### Features present only in PlotXWin

- Possibility to manage up to 5 simultaneous plot windows

### User Interface highlights

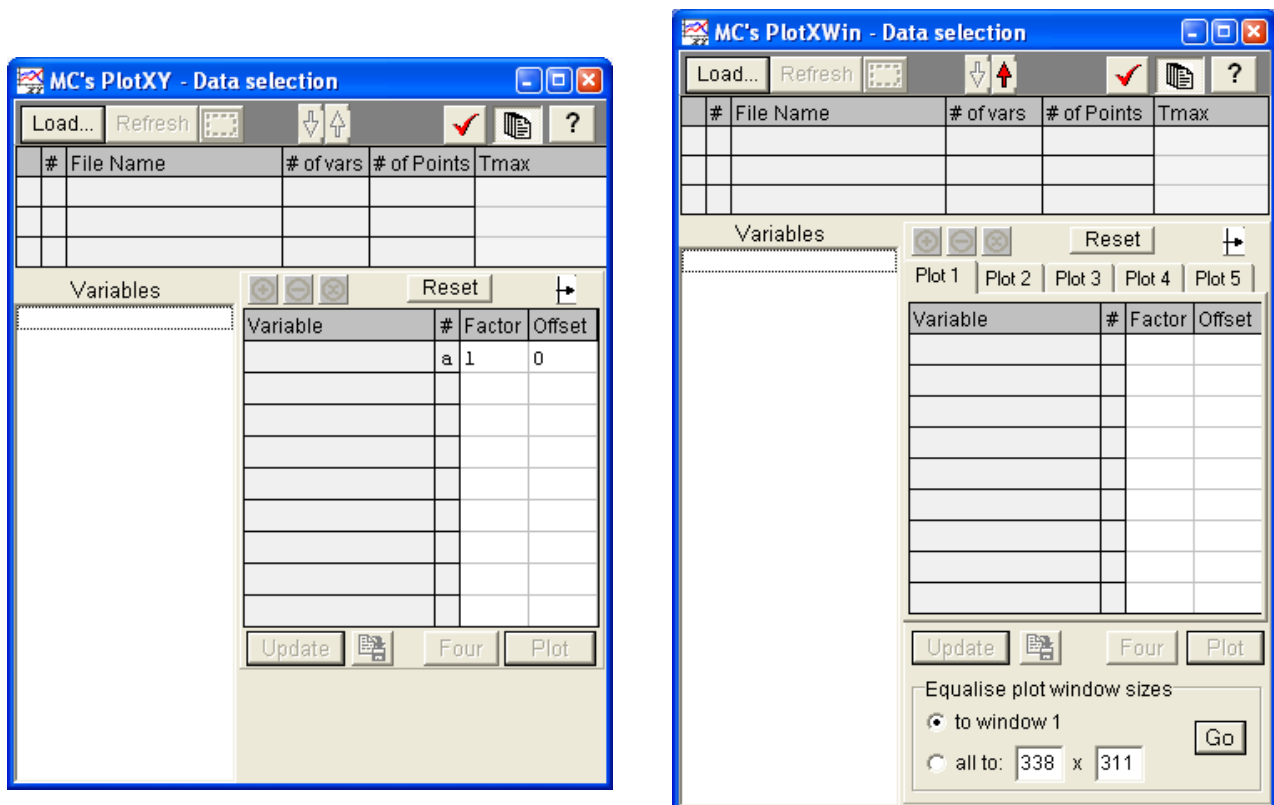
The program has no menu, since it is believed that for programs having a small number of commands, the use of buttons is to be preferred. Two types of buttons are present:

- text buttons, for which the button names are directly shown on their face
- graphic buttons, that have a graphic icon on their face, and the button name can be seen as a text hint shown when the mouse pointer is left on the button face.

## THE DATA SELECTION WINDOW








### Basic information

Once the program is activated, the *Data Selection* window is displayed (figure 1).



*Figure 1: The Data Selection Windows (left: PlotXY version, right: PlotXWin version; in both cases the multi-filemode set-up is displayed)*

In the following, the main program functions available from this window are described in a pragmatic way.



- Click on  to load a PL4 or ADF file. The variables in the file are shown.  
Variables from ADF files maintain the names read from the file.  
Variables from PL4 files are prefixed by a one- or two-character string, that is  
“v” for voltages, “c” for currents,  
“t” for TACS, “m” for Models,  
“s#” and “u#” for Synchronous and Universal Machine respectively, (# indicates a digit representing the machine number)  
“p” and “e” for branch powers and energies, respectively<sup>2</sup>  
and, for FREQUENCY SCAN runs:<sup>3</sup>  
“vr” for real parts of complex numbers, “vi” for imaginary parts of complex numbers,  
“a” for angles.
- To select variables to plot, click on them;  
Instead of “pure” variables, simple mathematical composition of two variables can be chosen.  
To make this, use the  or  or  button. The corresponding row in the *Variable-X-Factor-Offset* table is displayed in *Italic*, and, since it may happen that the full name is too long for complete display, the name is available as Windows *hint* (i.e., leave the mouse on the name and read the hint).
- If wanted, factors and offsets can be added.  
When there is time on the x-axis, if the user right-clicks on the *Variable-X-Factor-Offset* table, he can also request automatic time conversion to minutes or hour.  
If the user checks the check-box “Associate Factors and Offsets to Variable Names” in the Options window (see Program options, later on) he makes the program remember, in the current session, the numerical values of Factors and Offsets, and associate them to the respective variable names; when variables with the same names are reloaded in the current session, the the new variable is given as default the Factor and Offset of the old one; obviously the user can manually override this default.  
**NOTE.** The actual association names-Factors&Offsets are made when variables are unselected either individually by clicking on the variable name or globally by clicking the Reset button. This implies that if in PlotXWin a variable is first used with reference to a plot sheet and then is used, without deselecting it, in a second plot sheet, the factors and offsets are not associated to the values present in the first sheet.
- To deselect selected variables, click on their names in the *Variable-X-Factor-Offset* table.  
By default, the first variable in the variable list (*t* for pl4 files) is selected and is the assumed *X* variable. To use a different *X* variable simply click on the corresponding cell in the **X** column of the *Variable-X-Factor-Offset* table.
- Click on  to plot the selected variables (the "Plot" window is displayed).  
The program tries to put “round” numbers on the axes. Axis minima and maxima are selected so that they are represented using a small number of digits; therefore they define in general a larger range than what is strictly required. However, the ratio between the (Max-Min) difference of the variable values and the corresponding difference between extrema of displayed axis is always greater than (or equal) to 0.8.  
All the ‘0’ digits at the right side of numbers are dropped. The number of intermediate tics on the axes for normal plot sizes is between 4 and 7 (small plots have fewer tics); the actual number is selected with the criterion of minimising the number of the displayed digits.  
There is just one case in which the shown axis range can exclude part of the actual plot: This happens if  $\text{Max} \cdot \text{Min} < 0$  and  $|\text{Max}/\text{Min}| > 10^3$  or  $|\text{Max}/\text{Min}| < 10^{-3}$ . In this case, to improve readability, the number (Max or Min) with the least absolute value is artificially put to 0. This can be easily seen by substituting at row 1392 of the supplied file **sample3.adf** the number 0.21906 with -0.21906.  
A legend of the displayed variables is also included. The maximum space allowed for the legend is two rows, even in the (rare) cases in which it is not sufficient to display all the needed names. A trick to allow more space for the legend is to use a larger plot window.
- If the user wants to export in an output file, in numerical form, the variables present in the *Variable-X-Factor-Offset* table, they can obtain this by clicking on the  (**Save variables...**) button. Matlab and ADF output formats are always available. Since Matlab and ADF formats have some limitations in the constitution of variable names, for these output formats some name conversion is performed prior to the actual writing on file.  
In the particularly meaningful case of saving data read from a pl4 file the program, for simplicity, uses the same conversion algorithm for translating PL4 names into ADF or MAT names. These rules are the same as used in the widely diffused PL42MAT from the same author, and described in detail in Appendix. When saving data read from different file formats, similar rules apply.  
The PL4 output is available also, but only for variables read from a PL4 file containing a time run (not Frequency Scan, nor HFS). The advantage of this additional format is that the variable names are preserved exactly as they were when read from the original file.
- If a single variable is selected, click on  to see amplitudes and phases of its Fourier components

<sup>2</sup> For old ATP versions, branch powers and energies are identified as branch voltages and currents respectively. If ATP executables created after 10-Mar-99 are used, powers and energies are correctly identified, assumed that the startup variable NEWPL4 is set to 2.


<sup>3</sup> Correct interpretation of phase angles is only available when using ATP executables created after 10-Mar-99, and NEWPL4=2 in startup file.

(computed in a given time-window), and visualise the results in bar charts shown in a separate window (see the The Fourier Chart Window for details).


This function is based on a Discrete Fourier Transform (DFT) algorithm. Therefore it operates correctly only if the points are equally-spaced in the file.

8. In case of PlotXWin, a tabbed interface allows to select variables for up to 5 different plot windows. When plot button is clicked, the corresponding plots are displayed in the appropriate plot window.
9. If the user wants the program to remember which files were loaded, and which variables were selected for plotting, this information can be saved in registry by clicking on the  icon (save state). Later, they can be restored clicking on the  (load state) button. Note that, quite obviously, the program does not write the contents of files loaded on registry, but only their full names and date/time stamps. Therefore, to be able to reload a previous saved state, the original files must be present in the original locations.

## Multi-file mode

To enter multi-file mode, click on the button  (**Allow Multiple Files**) on the right-upper part of the “Data Selection” window. A table is displayed showing information about selected file(s). In the following this will be called *File-Table*.

In the following, the main program functions available in multi-file mode are described in a pragmatic way.

Press  to load one or more (max. 8) PL4 and/or ADF file(s).

To discard one of the loaded files, double click on the related file name.

Note that the load button operates a bit differently than in the single-file use. In the single file use it *Loads and eventually replaces an already loaded file*, in this case it *Loads and adds to the file list*. If one wants to replace an existing file he can use the update button, if the name is the same, or discard the existing file by double clicking on its name and then load the new one.

To display in the “Variables” sub-window of the Data selection window the directory of one of the loaded file click on a cell in the corresponding row in the *File-Table*. The corresponding file is called the *selected file*. The symbol **x** appears leftmost cell of the clicked row.

Select and deselect variables as in single-file mode. To select variables from a file different from the currently selected one, first select the new file as described in the previous point.

The possibility of selecting differences between variables instead of pure variables is currently not supported under Multi-File use.

In the X column of the *Variable-X-Factor-Offset* table a number showing from which file a variable has been selected is displayed. This even in case a variable is right-selected (=selected for the right scale).

**In case of PlotXWin plots having an X-variable different from time are allowed, given that all the plotted variables, for each plot window, belong to the same file.**

The legend on plots is always constituted by a single row per file, even if this space is not sufficient to name all the displayed variables. A trick to allow more space for the legend is to use a larger plot window.

It is possible to set a shift in the time of each file, to allow better comparisons between files having measures with different time origins. The procedure is a little tricky, but, once known, works satisfactorily. In fact, an additional column of the *File-Table*, normally not visible, is present at the right of the visible part of the table. Its name is “Tshift”. To access this column the user must use the arrow keys on the keyboard. Therefore the procedure is:


- 1) select the *File-Table* by clicking on it
- 2) press the keyboard right arrow
- 3) set or modify one or more Tshift(s).
- 4) if deemed necessary, restore previous visualisation pressing the keyboard left arrow.

## NOTES

1. Since variables from different files must share the x-axis variable, the program automatically generates the name of common x-axis variable, according to the following rules:
  - if all the x-axis variables share exactly the same name, this name is assumed as the name of the common x-axis variable
  - if this is not true and all x-axis variables have names beginning with ‘t’ or ‘f’ they are interpreted as time and frequency and are given the names “**t**” or “**f**” respectively;
  - in all other cases the common x-variable is given the name “**x**”.To remember that the reported name refers to a variable that represents the x-axis variables of **all** the involved files, in the second column of the *Variable-X-Factor-Offset* table an **a** is shown instead of the usual **x**.
2. In the Multi-File use X-Y plots are not supported.
3. Files from different directories having the same names are allowed. The full file pathname(s) can be seen leaving the mouse pointer on the filename showed in the *File-Table*.
4. To avoid a too large space to be utilised by the legend on the plot, in multi-file mode the legend contains only one row per file, even if this is not sufficient to see all the variable names correctly.
5. No output to file is possible in multi-file mode if the selected variables come from different files. This happens because, in general, different files have different time variables, and ADF and PL4 formats do not allow multiple-simulation data.

## Program options

Some program features can be customised. There are two ways to choose options:

Click on the  (**Program Options**) button, and choose the desired options. The selected options are stored in the Win32 registry. If you want to clean the registry, e.g. because you want to uninstall PlotXY, simply click on the **default** button.

The options are basically self-explanatory. Just some explanations follow:

- checking any of the two check-boxes requesting bar charts for Frequency Scan and Harmonic Frequency Scan runs implies the actual display of bar charts only for single-variable plots and when those files are correctly interpreted, i.e., the user has set NEWPL4 to 2 in his STARTUP file.
- Details on the “Associate Factors and Offsets to Variable Names” option are given above, under the “The Data Selection Window” main description, point 3
- Details on the options “Remember windows’ positions and sizes” and “Use small windows”, are reported in sect. “Additional Functions”, item 5.

Some additional options are available as command line parameters (see sect. “Command-line”).

## THE PLOT WINDOW

Once the *Plot Window* is displayed, you can see your plot<sup>4</sup> (figure 2).

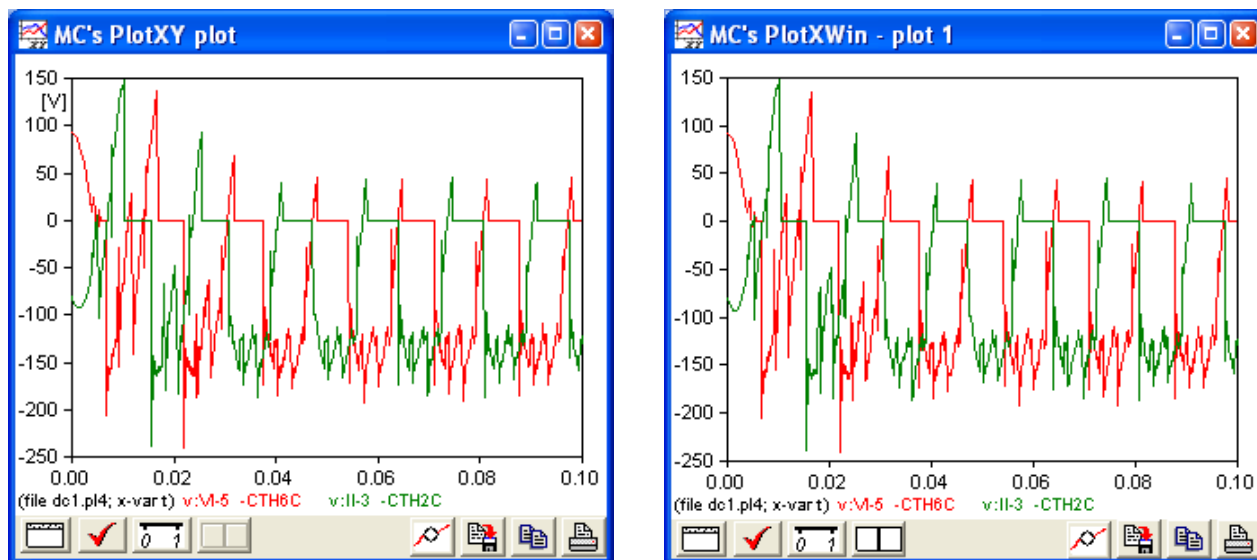



Figure 2: The Plot Windows (left: PlotXY version, right: PlotXWin version)


From this window, several functions can be accessed. These are briefly described in the following.

To **Zoom** in a particular part of the plot, use a click-and-drag mouse procedure (hold left button down, drag the mouse in the right-down direction, release the button). This operation can be repeated several times. A click on the right mouse button unzooms the plot.

Use the  (**Title**) button to toggle between plot title displayed and not displayed.


Use the  (**Customise plot**) button to make basic customisations of the way the plot is displayed.

In particular, it is possible to select linear and/or logarithmic scales, and to toggle ON or OFF a grid. The file sample3.adf is enclosed in the package so that to have an idea of the effect of a vertical logarithmic scale on a plot.

Use the  (**Manual Scale**) button to override the automatically computed *X* and/or *Y* scales user values.


The labels automatically computed by the program can be overridden (up to next pressing of the “plot” or “update” buttons).

If the *Exact Match* check box is checked, the entered values are accepted straight away; if it is not, if judged necessary, they are rounded up in a way that the resulting scale is a bit larger than the one selected by the user.

Use the  (**Show Cursor**) button to see the numerical values of the plotted points.

Once the button is pressed, a vertical black row is displayed (the *cursor*); the user can move it with the mouse to see numerical values of different points (for one-pixel/three-pixel movements the user can also use horizontal arrows, without/with CTRL).


Normally the shown numerical values refer to the points read from the input file that are the nearest to the black bar; however, if linear interpolation is preferred, a specific check-box is available.


Use the  (**Mark**) button to signal with markers the displayed curves: this can be useful for instance before B/W outputs on printer. If the Show Cursor button is active, pressing the Mark button will cause marks be

<sup>4</sup> The Plot window normally makes line plots. Only in the case of P14 files created with ATP rel. March 2001 or newer (using NEWPL4=2 in STARTUP) and single variable plots of Frequency Scan or Harmonic Frequency Scan ATP runs, bar charts can will be used if the appropriate check box in the **Program Options** dialogue box is checked.




inserted only at the *cursor* position; if it is inactive, marks will be inserted at four fixed positions, roughly at 20%, 40%, 60%, 80% of the x-axis width.

Use the  (**Write WMF file**) to write the displayed plot on a Windows metafile file. To reduce the size occupied by the WMF, visually redundant are automatically discarded. The size, in pixel and in cm, of the exported WMF is the same as that of the displayed plot.



Use the  (**Copy**) button to put a WMF copy of the plot into the Windows Clipboard. To reduce the size occupied by the WMF, visually redundant are automatically discarded. The size, in pixel and in cm, of the exported WMF is the same as that of the displayed plot.


If the copied plot is to be edited, it is suggested to make the pasting as a WMF (not a EMF). Cf. Section “known problems.”


There are cases in which the copied plot contains several redundant points, despite of the filtering technique used. In these cases the user can try to copy with the option “StrongFilter”, that is automatically executed if the Copy button is pressed while keeping down the Alt key. In this case, however, is advisable to check the quality of the copied plot, before utilising it.

Use the  (**Print**) for printing an hard copy of the plot. Some options for improving the visuali quality of the printed copy are given.

The software uses all the space available on the paper, while maintaining the aspect-ratio of the displayed plot.

If some changes in the *Variable-X-Factor-Offset* table are made, and these are to be reflected in the plot window, use the  button to see the whole time range of the selected variables, use  if you want the current *X* and *Y* axis scales to be held (in case the current *X*-variable has been changed, Update is not available).

If the file already loaded has been changed, e.g., because a new simulation has been done, press  to reload the file (the selected file when in multi-file mode) and re-plot the selected variables.

If the button  (**Retain Zooming After Refresh**) is up the re-plot is made simulating the key press of the Plot button, otherwise simulating the key press of the Update button. Already defined factors and offsets are retained.

It is not required to have in the new version of the pl4 file exactly the same variables as in the older one. In case the ATPWNT program is used, the Refresh button operates correctly even if the simulation is still in progress.


### Procedure to have plots with two vertical axes

The program allows plots with two independent vertical axes: the first is the default left-hand axis; an additional axis at the right border of the plot can be requested.

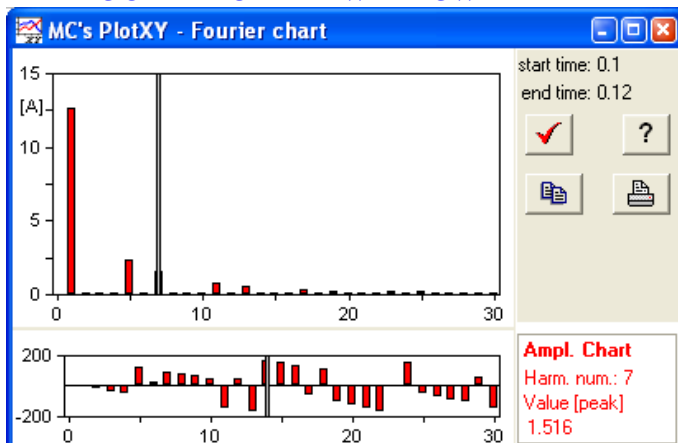
To get plots with two independent vertical axes, when selecting variables, select the variables related to the right axis clicking with the right mouse button instead of the left one. Variables selected for the right axis are indicated in the *X* column of the *Variable-X-Factor-Offset* table by a “**x**” on a yellow background.

The program makes plots with two axes only if there are both variables selected with the left mouse button and with the right one, in case all the variables are left-selected or right-selected only the left (default) axis is displayed

Variables referring to the right scale are underlined in the plot legend.

If the  button is pressed and both vertical scales are present, they are retained even if all the variables referring to the right vertical axis have been removed from the *Variable-X-Factor-Offset* table

### THE FOURIER CHART WINDOW



*Figure 3: The Fourier Chart Window  
(in the analysis of a typical input current of a three phase diode Graetz bridge)*

Once the *Fourier chart* Window is displayed, you can see your two bar charts showing amplitudes and phases of the components of the Fourier series of the selected signal. To see the corresponding numerical values, simply move the mouse pointer over one of the charts.

The bar charts can be zoomed using the same technique adopted when zooming in the Plot window.


If the mouse pointer is left over the label showing “**Ampl Chart**” or “**Phase Chart**” and the harmonic range starts from an order  $< 3$ , the Total Harmonic Distortion is also shown as a percentage of harmonic of order 1<sup>5</sup>.

By default, the program considers:


- a time-range between the  $T_f$  and  $T_f - 1/F$  (where  $T_f$  is the simulation final time and  $F$  is the default frequency as defined in the Program Options window).
- the harmonics between 0 and 30.

If we write a periodical variable  $x(t)$  as  $x(t) = A_0 + \sum_{k=1}^{\infty} A_k \sin(k\omega t + \alpha_k)$ , by default the program plots the values  $A_k$  and  $\alpha_k$   $k$  being between 0 and 30. By means of the **Options** button these defaults can be modified. Note that, since  $A_0$  is the signal average in the period considered ( $A_0 = \frac{1}{T} \int_t^{t+T} x(\tau) d\tau$ ), it can be negative.


Four buttons are present:

The  (**Options**) button allows to modify the way on which the Fourier elements are computed and/or displayed. The meaning of these options is self-explanatory and will not be detailed here.

The  (**Info**) button gives information about the current file and variable names-

The  (**Copy**) button allows the Fourier data to be copied in the Windows Clipboard. A dialogue box is displayed, allowing to choose if to copy the numerical data (e.g. to be further processed in a Spreadsheet program) or one or both of the displayed bar charts.

In case the harmonic range starts from an order  $< 3$ , the Total Harmonic Distortion (THD) is also copied<sup>5</sup>.

The  (**Print**) button allows the Fourier data to be printed.. A dialogue box is displayed, allowing to choose if to print the numerical data (Amplitude and Phase of the selected harmonics) or one or both of the displayed bar charts.

In case the harmonic range starts from an order  $< 3$ , the Total Harmonic Distortion (THD) is also printed<sup>5</sup>.

## COMMAND-LINE PARAMETERS

If one or more (up to three) valid filename(s) of PL4 and/or ADF file(s) are passed as parameters to PlotXY or PlotXWin, the program automatically loads the file(s). This can be for instance exploited for activating PlotXY from a DOS window (e.g. issuing “plotxy dc1.pl4” or “plotxy dc1.pl4 dc1bis.pl4”) or associating this program to the PL4 (and/or ADF) extension(s) in Explorer. In the latter case, double-clicking on a valid PL4/ADF filename causes PlotXY or PlotXWin to start and load the clicked file.

Command-line parameters can be used also to select some program options. The following options (all case-sensitive) can be used, putting them in the command-line before any file name(s):

- “/Ms” *request of Maximum Speed*. This option is currently unused since the currently used algorithms are a good compromise between speed and precision;
- “/st” *requests to Show plotting Times*. If this option is set, a label showing the time spent to create plots will be displayed in the main program window.

## ADDITIONAL FUNCTIONS

1. Under conditions listed below the program sets “smart” labels on the axes, e.g., [kV] for kilo-volts, etc.

Conditions for enabling this auto labeling:

- the “Autolabel known variables” option is to be checked on the *Program Options* menu of the main program window;
- the x-variable of the considered plot is the first in the variable list
- given that the variable types are identified by the first character of their names (“v” for voltages, “c” or “i” for currents, “p” for powers, “e” for energies, “t” for time, the latter only for the x-axis variable), all the variables to be plotted on the same vertical axis are of the same type

In case of mathematical composition of two variables the program uses auto-labels whenever it is able to detect reliably the correct unit to be used; in case of a product of a voltage and a current, for instance, it uses correctly [W] as label.

<sup>5</sup> THD of  $x(t)$  is computed as  $100 \cdot \sqrt{\sum_{k=2}^N X_k^2} / X_1$  ( $X_k$  being the  $k$ -th harmonic of  $x$ ). If  $X_1=0$  THD is not displayed.

2. One or more pl4 file(s) can be dragged over a PlotXY icon on the Win95/NT desktop and dropped, therefore causing PlotXY to start and load the file(s). Once the program is started, variables can be loaded using the Windows' drag-and-drop facility instead of the load button.
3. Multiple instances of the program are allowed (up to 4). It is not forbidden for different program instances to access the same file(s). In case of multiple instances the main program windows of different instances are placed in different positions on screen and have the instance number in their titles to ease readability.
4. The program contains code to visualise its modeless windows (*Data Selection*, *Plot* and *Fourier Chart* Windows) satisfactorily in all screen resolutions.  
These windows have given "base" sizes chosen so that they are a good compromise between desktop space occupation and visual clarity; these sizes are such that the *Data Selection* and the *Plot* windows put aside are globally large 800 pixels. These default sizes are subjected to two types of changes:
  - a) at program start-up they are scaled as a function of the screen resolution. In particular they are changed so that the *Data Selection* and the *Plot* windows put aside are as large as the Desktop Area Width<sup>6</sup> with a minimum of 700 pixels. There is also a maximum, equal to 750 or 950 pixels if the "Use small windows" option is selected or unselected respectively.
  - b) the user can change the window's sizes using the mouse. It must be noted that this user scaling does not modify the windows homothetically:
    - the *Data Selection* Window can be varied only in height; the only window element correspondingly modified is the "Variables" Listbox.
    - only the Plot or Chart areas of the *Plot* and *Fourier Chart* windows are modified, while the other elements (buttons, labels) are unmodified.
5. If the options "Remember windows' positions and sizes" is set, the positions and sizes of all modeless windows are stored in the registry when the program is closed and restored when is open after the execution of the scaling discussed in point a).

## KNOWN PROBLEMS

1. If a long filename is dragged and dropped on a PlotXY or PlotXWin icon on the computer desktop, the program receives the DOS, reduced name, instead of the long name. This problem is indeed a problem of the compiler used, and therefore cannot be corrected up to when a new version of the compiler is utilised.
2. When the "copy" function is used and a plot pasted into another application, once the pasted plot is open for editing one or more plot(s) can be dramatically, and erroneously, compacted. This can be avoided pasting as a WMF (Windows metafile) instead of a EMF (enhanced Windows metafile).

## USER RETURN

Comments, suggestions, and/or bug reports from the users are very much welcome, preferably at the e-mail address: m.ceraolo@ing.unipi.it

New features are added to new versions of the program, keeping in the maximum consideration those frequently-requested by the users.

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<sup>6</sup> According to the Win32 terminology the *desktop area* is the area of the screen not covered by the *taskbar*.



## APPENDIX A: FILE FORMAT SPECIFICATIONS

### FORMAT SPECIFICATION FOR ASCII FILES

In addition to pl4 files, the program is able to read generic Ascii Data Files, whose extension must be ADF. This is particularly useful for comparing ATP simulation outputs with lab results or other programs' outputs.

For the maximum flexibility of this feature, a very simple file structure is required. The file must be composed by: Header. It is constituted by two lines.

The first header line has the following format:

[*step* [*x\_variable name*]] [*comment*]

in which fields between squares [] are optional<sup>7</sup>, and the components can be separated by one or more blanks.

Description of the meaning of the components:

- *step* is a number;

When this field is specified, it is taken as a constant step for building the x-axis variable: a variable is automatically generated having values 0, *step*, 2\**step*, 3\**step*, ... . This is a useful option to reduce the ADF file size and interpretation time when a constant time-step is involved.

If no step is specified, the first variable present in the body of the file is intended to be the default x-axis.

- *x\_variable name* is a string representing the name of the automatically generated x-axis variable when *step* is specified. If this name begins with the character 't', it is interpreted as the time, expressed in seconds, by the automatic labelling algorithm of the program<sup>8</sup>. If *x\_variable name* is missing, the name "X\_(auto)" is assumed for the automatically generated x-axis variable.

- *comment* is a comment string the first characters of which are two slashes<sup>9</sup>.

The second header line will contain the names of the variables, separated by spaces and/or tab characters<sup>10</sup>.

Body. It is composed by values of the variables, in written ASCII, in the form of a matrix (a column for each variable). This way each row refers to a particular x-axis (normally time) value.

If no step is specified in the first header line, the first variable in the body of the file is intended to be the default x-axis. It is therefore required that the corresponding values be monotonically increasing; they are NOT required to be equally spaced (i.e., variable-sampling x-axis data are allowed). The numbers in a row are to be separated by spaces and/or tab characters<sup>10</sup>. The decimal separator **must be** "." no matter of the value of it set in Windows Control Panel ("International" section).

Two simple examples will clarify:

***** FILE SAMPLE1.ADF *****					***** FILE SAMPLE2.ADF *****				
time	sin(0m*t)	sin(0m*t-240°)	sin(0m*t+240°)		5.e-4 time //this is a comment	sin(0m*t)	sin(0m*t-240°)	sin(0m*t+240°)	
0.00000e+00	0.00000e+00	8.66022e-01	-8.66022e-01		0.00000e+00	8.66022e-01	-8.66022e-01		
5.00000e-04	1.56429e-01	7.77145e-01	-9.33577e-01		1.56429e-01	7.77145e-01	-9.33577e-01		
1.00000e-03	3.09008e-01	6.69133e-01	-9.78144e-01		3.09008e-01	6.69133e-01	-9.78144e-01		
1.50000e-03	4.53978e-01	5.44646e-01	-9.98628e-01		4.53978e-01	5.44646e-01	-9.98628e-01		
2.00000e-03	5.87770e-01	4.06749e-01	-9.94524e-01		5.87770e-01	4.06749e-01	-9.94524e-01		
2.50000e-03	7.07090e-01	2.58836e-01	-9.65933e-01		7.07090e-01	2.58836e-01	-9.65933e-01		
3.00000e-03	8.09000e-01	1.04551e-01	-9.13558e-01		8.09000e-01	1.04551e-01	-9.13558e-01		
3.50000e-03	8.90991e-01	-5.23084e-02	-8.38690e-01		8.90991e-01	-5.23084e-02	-8.38690e-01		

### MATLAB FILE FORMAT CONSTRAINTS

PlotXY/PlotXWin can be useful for viewing MATLAB/SIMULINK outputs in some cases, e.g.:

- when one wants to share his outputs with someone that does not have a Matlab copy of his own
- when one wants to effectively export plots into other programs by means of the Windows Clipboard. In fact PlotXY/PlotXWin have, with this respect, important advantages over MATLAB:
  - it automatically eliminates visually-redundant points. In normal use this can result in output plot size reductions by factors of 100 and over
  - if the plot is zoomed PlotXY/PlotXWin export just the useful part of the plots, while MATLAB exports also all the plotting points outside the zoom window.

Matlab files can be of type V5, created using the "save" command of Matlab rel. 5.x or 6.x, or type V4, created

<sup>7</sup> therefore *step* can be present or missing; if present can be followed by *x\_variable name*; *comment* can be missing. The row can even be empty.

<sup>8</sup> Also variables beginning with "%t" are considered as being time. This has been added for compatibility with MATLAB M-files.

<sup>9</sup> Comments can also begin with the character '%'. This has been added for compatibility with MATLAB M-files.

<sup>10</sup> The program can accept separators between names and numbers containing commas (','). To obtain this, check the "Commas are separators in ADF files" option in the **input** section of the **Program Options** dialog box.

by saving with Matlab releases up to 4.0, or with the save command of Matlab 5.x or 6.x, and the option “V4” selected.

PlotXYPlotXWin are able to read only V4 version of Matlab.

Different kind of arrays can be stored in a Matlab file: matrices of integers, floats, text strings.

However PlotXY/PlotXWin are intended for dealing with files containing output of either measures or simulations. Therefore the files managed by the program must always contain a “time” (i.e., a quantity monotonically increasing) and some “signals” associated to that time (therefore all the signals should have a number of point equal to that of time).

As a consequence of these characteristics, to be understood by the program, a mat file has to comply with some specific requirements:

- it must contain only matrices of floats sharing the same number of rows
- it has to contain a “time” variable. If there is in the file a single column variable having as name “t” it is assumed to be time. Otherwise, the first column of the first variable in the file is assumed to be time.

If some of the variables in the file has multiple columns it stores multiple signals. In this case the program adds a unique suffix to the different columns, constituted by a progressive number between parentheses.

NOTE. The best way to exploit PlotXY or PlotXWin as a SIMULINK graphical post-processor is as follows:

- use for any variable sent to workspace the same value of the “Decimation” parameter
- send data to workspace using “To workspace” blocks instead of the “Save data to workspace” feature of Scopes (this way replications of time vectors is avoided);
- send the simulation time to workspace just once by means of the “Save to workspace” feature of the Simulation|Parameters|Workspace I/O dialogue box.

## APPENDIX B: NAME CONVERSIONS

### APPENDIX: Naming conversion rules from PL4 to ADF and MAT

ADF and MATLAB names are generated by pl42mat according to the following rules:

0. Time is simply indicated as "t"
1. All the .PL4 node names and TACS, MODELS, Universal Machine and Synchronous Machine variable names are converted into lowercase, except the first characters that are converted into uppercase
2. If the names contain dashes or plus signs or embedded blanks, they are converted into underscores ('\_'); blanks at beginning or end of names are discarded
3.
  - The names for node voltages are obtained adding at the beginning of the node names as they are after step 2 the character 'v'
  - The names for branch voltages and currents are obtained combining the two node names into a unique name and then adding at the beginning of the resulting string the character 'v' or 'i' respectively; if one of the nodes is " ", it is changed into "Terra "
  - Names of TACS or MODELS variables are obtained adding at the beginning of the names as they are after step 1 the characters 't' or 'm' respectively
  - Names of Universal Machine and Synchronous Machine variables are obtained adding at the beginning of the names as they are after step 1 the characters 'u' or 's' respectively, followed by one or two digit(s) indicating the corresponding machine number (but up to 9 SMs are supported).

Examples:

(from DC5)

Node of Voltage ' GENT ': vGent  
Voltage Difference between 'TRANFF' and 'OPEN ': iTranffOpen  
Current between 'GEN ' and ' GENT ': iGenGent  
Current between 'LOAD ' and ' ': iLoad

(from DCn12)

UM variable 'UM-1 ' - 'TQGEN': u1Tqgen

(other)

Voltage Difference between 'UMPOS ' and ' ': vUmposTerra  
Voltage Difference between ' ' and 'UMNEG ': vTerraUmneg  
SM variable 'MACH 1' - 'ID ': s1Id  
SM variable 'MACH 1' - 'TQ GEN': s1Tq\_gen  
SM variable 'MACH 1' - 'ANG 1 ': s1Ang\_1  
SM variable 'MACH 2' - 'ANG 1 ': s2Ang\_1  
MODELS variable 'MODELS' - 'SOC ': mSoc  
MODELS variable 'MODELS' - 'Iw ': mIw