The Signal script language

Version 2.13

March 2003

First edition (1.00)	May 1997
Second edition (1.50)	May 1998
Third edition (1.60)	July 1998
Fourth edition (1.70)	Nov 1998
Fifth edition (1.80)	May 1999
Sixth edition (2.00)	July 2000
Seventh edition (2.02)	Sept 2000
Eighth edition (2.05)	July 2001
Ninth edition (2.10)	June 2002
Tenth edition (2.11)	Jan 2003
Eleventh edition (2.13)	Mar 2003

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Curve fitting procedures are based on routines in Numerical Recipes: The Art of Scientific Computing, published by Cambridge University Press, and are used by permission.

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1 Introduction

What is a script?

For many users, the interactive nature of Signal may provide all the functionality required. This is often the case where the basic problem to be addressed is to present the data in a variety of formats for visual inspection with, perhaps, a few numbers to extract by cursor analysis and a picture to cut and paste into another application. However, some users need analysis of the form:

1. Find the first peak in the frame after a cursor.
2. Find the trough after that.
3. Compute the time difference between these two points and the slope of the line.
4. Print the results.
5. If not at the end of the file, move to the next frame and go back to step 1.

This could all be done manually, but it would be very tedious. A script can automate this process, however it requires more effort initially to write it. A script is a list of instructions (which can include loops, branches and calls to user-defined and built-in functions) that control the Signal environment. You can create scripts by example, or type them in by hand. If you are new to script writing it would be a good idea to work through the relevant chapters in the Training Manual before referring to this manual for more detailed information.

Views and view handles

The most basic concept in a script is that of a view and the view handle that identifies it. A view is a window in Signal that the script language can manipulate. The running script is hidden from most commands, however you can obtain its handle using `App()` so you can show and hide it.

There is always a *current view*. Even if you close all windows the Log view, used for text output by the `PrintLog()` command, remains. Whenever you use a built-in function that creates a new view, the function returns a *view handle*. The view handle is simply an integer number that identifies the view. It is used with the `View()` and `FrontView()` functions to specify the current view and the view that should be on top of all windows.

Whenever a script creates a new view, the view becomes the current view. However, views are created invisibly so that they can be configured before appearing. You can use `WindowVisible(1)` to display a new window.

Writing scripts by example

To help you write scripts Signal can monitor your actions and write the equivalent script. This is often a great way to get going writing scripts, but it has limitations. Scripts generated this way only repeat actions that you have already made. The good point of recording your actions is that Signal shows you the correct function to use for each activity.

For example, let us suppose that you have opened a data file. Use the Turn Recording On option of the Script menu. Click on the data file view, then select Analysis, New memory view, Waveform average, and with the default settings, process all the frames in the file. Finally you use the Stop recording command in the Script menu. Signal opens a new window holding the equivalent script:

```
var v3%;
var v4%;
v3%:=ViewFind("Example.cfs");
FrontView(v3%);
v4%:=SetAverage(-1,0.04,0,0,0);
WindowVisible(1);
ProcessFrames(1,-1,-1,0,1);
```

The `ViewFind()`, `FrontView()`, `SetAverage()`, and `ProcessFrames()` functions are described in this manual and they reflect the actions that you performed. The `v3%` and `v4%` variables hold view handles. The script needs to save these handles in unique variables. To do this it generates variable names based on the internal view number.

The `WindowVisible(1)` command is present because new windows are hidden when they are created by the script. Signal creates invisible windows so that you can size and position them before display to prevent excessive screen repainting.

The script recorder produces all the optional arguments for `ProcessFrames()`, to process all the frames from 1 to the last frame in the file, and to optimise the y axes after processing. The memory view is not cleared before processing, which in this case makes no difference as the new memory view is created with zero data.

Now do the same again, using the Turn Recording On option of the Script menu, clicking on the data file view, selecting Analysis, New memory view, Waveform average, as before, but this time change the settings to select channel 3, width 0.02 and start offset of 0.01, then process. When you use the Stop recording command you will see a similar script, but with different arguments for `SetAverage()`. In this example we did not change the options in the Process dialog.

```
var v5%;
var v8%;
v5%:=ViewFind("Example.cfs");
FrontView(v8%);
v4%:=SetAverage(-1,0.02,0.01,0,0);
WindowVisible(1);
ProcessFrames(1,-1,-1,0,1);
```

You can use the Turn Recording On option of the Script menu before any small sequence of operations. Then use the Stop recording command in the Script menu to see the script commands generated.

Using recorded actions

You can now run the recorded script, using the control buttons at the upper right of the script window. The script runs and generates a new memory view, repeating your actions. Now suppose we want to run this for several files, each one selected by the user. You must edit the script a bit more and add in some looping control. The following script suggests a solution. Notice that we have now changed the view handle variables to names that are a little easier to remember.

We simplify the `ProcessFrames()` command to replace start frame by -1 for all frames in the data file. Without the optional arguments, the y axis will not be optimised after the processing. `SetAverage(1)` also needs no extra arguments to average data in channel 1 for the whole frame.

```
var fileH%, aveH%;                'view handle variables
fileH% := FileOpen("", 0, 1);     'blank for dialog, single window
while fileH% > 0 do               'FileOpen returns -ve if no file
   aveH% := SetAverage(1);
   WindowVisible(1);              'Average channel 1
   ProcessFrames(-1);             'Process all frames in the file
   Draw();                        'Update the average display
   fileH% := FileOpen("", 0, 1);  'ask for the next file, or cancel
wend;
```

This time, Signal prompts you for the file to open. The file identifier is negative if anything goes wrong opening the file, or if you press the Cancel button. We have also included a `Draw()` statement to force Signal to draw the data after it calculates the average. There is a problem with this script if you open a file that does not contain a channel 1 that holds waveform data although this is unlikely in Signal. We will deal with this a little later.

However, you will find that the screen gets rather cluttered up with windows. We do not want the original window once we have calculated the average, so the next step is to delete it, adding the line

```
View(fileH%).FileClose();         'Shut the old window
```

The `View().` syntax allows a function to access data belonging to a view other than the current view. The `fileH%` argument, and the dot after the command, tell the script system that we want to change the current view to the data file view temporarily, for the duration of the `FileClose()` function.

We have also added a line to close down all the windows at the start, to reduce the clutter when the script starts.

```
var fileH%, aveH%;
FileClose(-1);                    'close all windows to tidy up
fileH% := FileOpen("", 0, 1);     'use a blank name to open dialog
while fileH% > 0 do               'FileOpen returns -ve if no file
  aveH% := SetAverage(1);         'set up average on selected chan
  WindowVisible(1);               'make average visible
  ProcessFrames(-1);              'do the average
  View(fileH%).FileClose();       'Shut the old window
  Draw();                         'Update the average display
  fileH% := FileOpen("", 0, 1);   'ask for the next file, or cancel
wend;
```

This seems somewhat better, but we still have the problem that there will be an error if the file does not hold a channel 1, or it is of the wrong type. The solution to this is to ask the user to choose a channel using a dialog. We will have a dialog with a single field that asks us to select a suitable channel:

```
var fileH%, aveH%, chan%;         'Add a new variable for channel
FileClose(-1);                    'close all windows to tidy up
fileH% := FileOpen("", 0, 1);     'use a blank name to open dialog
while fileH% > 0 do               'FileOpen returns -ve if no file
  DlgCreate("Channel selection"); 'Start a dialog
  DlgChan(1, "Choose channel to average", 1); 'all waveform
  if (DlgShow(chan%) > 0) and     'User pressed OK and...
    (chan% > 0) then              '...selected a channel?
    aveH% := SetAverage(chan%);   'set up average on selected chan
    WindowVisible(1);             'make average visible
    ProcessFrames(-1);            'average all the frames
    View(fileH%).FileClose();     'Shut the old window
    Draw();                       'Update the display
  endif
  fileH% := FileOpen("", 0, 1);   'ask for the next file
wend;
```

The `DlgCreate()` function has started the definition of a dialog with one field that the user can control. The `DlgChan()` function sets a prompt for the field, and declares it to be a channel list from which we must select a channel (or we can select the No channel entry). The `DlgShow()` function opens the dialog and waits for you to select a channel and press OK or Cancel. The `if` statement checks that all is well before making the histogram.

Derived views

The current view when the `ProcessFrames()` command is used is the memory view and we may want to access information about the data file, such as the maximum frame number in the original time view. The `View().` syntax allows a function to access data belonging to a view other than the current view.

```
var fileV%;
var aveV%;
fileV%:=ViewFind("Example.cfs");
FrontView(fileV%);
aveV%:=SetAverage(-1,0.04,0,0,0);
WindowVisible(1);
ProcessFrames(1, View(fileV%).FrameCount(),-1,0,1);
```

In this example we replaced -1 for last frame in file with the actual frame number returned by the `FrameCount()` function. The `fileV%` argument, and the dot after the command, tell the script system that we want to change the current view to the data file view temporarily, for the duration of the `FrameCount()` function.

In many scripts we will have a variable such as `fileV%` holding the data view handle, but you can also use the function `ViewSource()` to access it directly. The following script shows how you would ensure that when you present this message you are counting frames in the data view associated with the current memory view.

```
var fileV%, aveV%;
fileV%:=ViewFind("Example.cfs");  'view data file
if fileV%>0 then
 FrontView(fileV%);
 aveV%:=SetAverage(3);           'set up average of channel 3
 WindowVisible(1);
 ProcessFrames(-1);        'process all frames in the file
 Message("We averaged %d frames",View(ViewSource()).FrameCount());
endif
```

In this example the `Message()` command displays a string in which `%d` is replaced by the value for the frame count.

Notation conventions

Throughout this manual we use the font of this sentence to signify descriptive text. Function declarations, variables and code examples print in a monospaced font, for example `a% := View(0)`. We show optional keywords and arguments to functions in curly braces:

```
func Example(needed1, needed2 {,opt1 {,opt2}});
```

In this example, the first two arguments are always required; the last two are optional. Any of the following would be acceptable uses of the function:

```
a := Example(1,2);         'Call omitting the optional arguments
a := Example(1,2,3);       'Call omitting one argument
a := Example(1,2,3,4);     'Call using all arguments
```

A vertical bar between arguments means that there is a choice of argument type:

```
func Choice( i%|r|str$ );
```

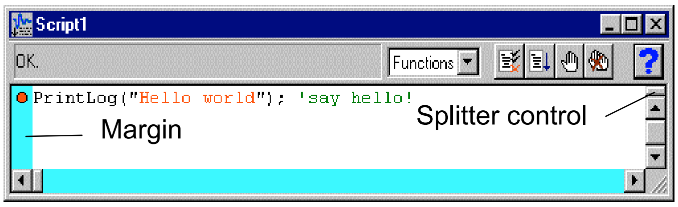
In this case, the function takes a single argument that could be an integer, a real or a string. The function will detect the type that you have passed and may perform a different action depending upon the type.

Three dots (`...`) stand for a list of further, similar items.

2 The script window and debugging

Script window

You use the script window when you write and debug a script. Once you are satisfied that your script runs correctly you would normally run a script from the script menu without displaying the source code. You can have several scripts loaded at a time and select one to run with the Script menu Run Script command.



```
PrintLog("Hello world"); 'say hello!
```

The script window is a text window with a few extra controls including a “splitter” control so that you can view two parts of the script at the same time. To use the splitter control, drag it down the window. To cancel it, drag it to the top or bottom of the window. There is no script language control of the splitter.

To the left of the text area is a margin where you can set break points (one is shown already set) and bookmarks and where the current line of the script is indicated during debugging. Above the text area is a message bar and several controls. The controls have the following functions:

Function

This control is a quick way to find any `func` or `proc` in your script. Click on this to display a list, in alphabetical order, of the names of all user-defined routines. Select one, and the window will scroll to it. To be located, the keywords `func` and `proc` must be at the start of a line and the name of the routine must be on the same line.

Compile

The script compiler checks the syntax of the script and if no errors are found it creates the compiled version, ready to run. If the script has not been changed since the last compile and no other script has been compiled, the button is disabled as there is no need to compile again. Signal can have one compiled script in memory at a time.

Run

If the script has not been compiled it is compiled first. If no errors are found, Signal runs the compiled version, starting from the beginning. Signal skips over `proc ... end;` and `func ... end;` statements, so the initial code can come before, between or after any user-defined procedures and functions. This button is disabled once the script has started to run.

Set break point

This button sets a break point on the line containing the text caret, or clears a break if one is already set. A break point stops a running script when it reaches the start of the line containing the break point. You can also set and clear break points by moving the mouse pointer over the margin on the left of the script and double clicking.

Not all statements can have break points set on them. Some statements, such as `var`, `const` and `func` and `proc` compile to entries in a symbol table; they generate no code. If you set a break point on one of them the break point will appear at the next statement that is breakable. If you set break points before you compile your script, you may find that some break points move to the next “breakable” line when you compile.

Clear all break points

This button is enabled if there are any break points set in the script. Click this button to remove all break points from the script. Break points can be set and cleared at any time, even before your script has been compiled.

Help

This button provides help on the script language. It takes you to an alphabetic list of all the built-in script functions. If you scroll to the bottom of this list you can also find links to the script language syntax and to the script language command grouped by function. Within a script, you can get help on keywords and built in commands by clicking on the keyword or command and pressing the `F1` key.

Syntax colouring

Signal version 2 supports syntax colouring for the script editor. The language keywords have the standard colour blue, quoted text strings have the standard colour red, and comments have the standard colour green. Normal text is black and the text background is white.

Editing features for scripts

There are some extra editing features that can help you when writing scripts. If you like to indent your text, you can indent and outdent selected blocks by selecting one or more characters, then use the `Tab` key to indent and the `Shift-Tab` combination to outdent. The text moves by one tab stop.

Debug overview

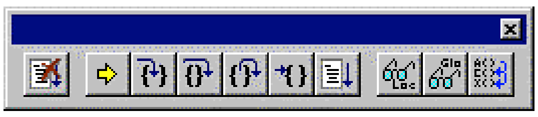
Despite all our attempts to make writing a script easy, and all your attempts to get things right, sooner or later (usually sooner), a script will refuse to do what you expect. Rather than admit to human error, programmers attribute such failures to “bugs”, hence the act of removing such effects is “debugging”. The term dates back to times when an insect in the high voltage supply to a thermionic valve really could cause hardware problems.

To make bug extermination a relatively simple task, Signal has a “debugger” built into the script system. With the debugger you can:

- Step one statement at a time
- Step into or over procedures and functions
- Step out of a procedure or function
- Step to a particular line
- View local and global variables
- Edit variable values
- See how you reached a particular function or procedure
- Set and clear break points

With these tools at your disposal, most bugs are easy to track down.

Preparing to debug



Unlike most languages, the Signal script language does not need any special preparation for debugging except that you must set a break point or include the `Debug();` command at the point in your script at which you want to enter the debugger. When your script reaches the break point or the `Debug();` command, the script stops and the debug toolbar will appear (if it was not already visible). The picture above shows the toolbar as a floating window, but you can dock it to any side of the Signal window by dragging it over to the window edge.

You can also enter the debugger by pressing the `Esc` key (you may need to hold it down for a second or two, depending on what the script is doing). If the `Toolbar()` or `Interact()` commands are active, hold down the `Esc` key and click on a button. This is a very useful way to break out of programs that are running round in a loop with no exit! You can stop the user entering debug with the `Debug(0)` command, but we suggest that this feature is added after the script has been tested! Once you have disabled debugging, there is no way out of a loop.

Stop running the script. There is no check that you really meant to do this, as we assume that if you know enough to get into the debugger, you know what you are doing! You can use the `Debug()` command to disable the debugger.

Display the current line in the script. If the script window is not visible, this will make it visible, then bring it to the top and scroll the text to the current line.

If the current statement contains a call to a user-defined `Proc` or a `Func`, step into it, otherwise just step. This does not work with the `Toolbar()` command which is not user-defined, but which can cause user-defined routines to be called. To step into a user-defined `Func` that is linked to a `Toolbar()` command, set a break point in the `Func`.

Step over this statement to the next statement. If you have more than one statement on a line you will have to click this button once for each statement, not once per line.

If you are in a procedure or function, step until you return from it. This does not work if you are in a function run from the `Toolbar()` command as there is nowhere to return to. In this case, the button behaves as if you had pressed the run button.

Run until the script reaches the start of the line containing the text caret. This is slightly quicker than setting a break point, running to it, then clearing it (which is what this does).

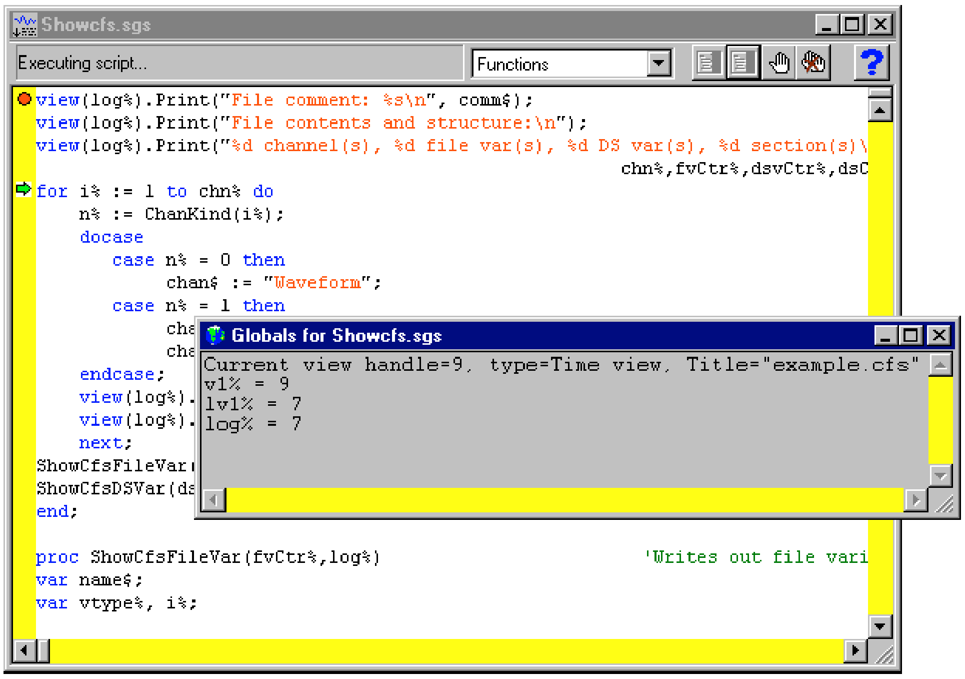
Run the script. This disables the buttons on the debug toolbar and the script runs until it reaches a break point or the end of the script.

Show the local variables for the current user-defined `func` or `proc` in a window. If there is no current routine, the window is empty. You can edit a value by double clicking on the variable. Elements of arrays are displayed for the width of the text window. If an array is longer than the space in the window, the text display for the array ends with … to show that there is more data.

Show the global variable values in a window. You can edit a global variable by double clicking on it. The very first entry in this window lists the current view by handle, type and window name.

Display the call stack (list of calls to user-defined functions with their arguments) on the way to the current line in a window. If the `Toolbar()` function has been used, the arguments for it appear, but the function name is blank.

The debug toolbar and the locals, globals and the call window close at the end of a script. The buttons in the debug toolbar are disabled if they cannot be used. If you forget what a particular button does, move the mouse pointer over the button. A "Tool tip" window will open next to the button with a short description and if the Status bar is visible, a longer description can be seen there.



```
view(log%).Print("File comment: %s\n", comm$);
view(log%).Print("File contents and structure:\n");
view(log%).Print("%d channel(s), %d file var(s), %d DS var(s), %d section(s)\
                                                     chn%,fvCtr%,dsvCtr%,dsC
for i% := 1 to chn% do
    n% := ChanKind(i%);
    docase
       case n% = 0 then
            chan$ := "Waveform";
       case n% = 1 then
            cha
            cha
    endcase;
    view(log%).
    view(log%).
    next;
ShowCfsFileVar(
ShowCfsDSVar(ds
end;

proc ShowCfsFileVar(fvCtr%,log%)                        'Writes out file vari
var name$;
var vtype%, i%;
```

```
Current view handle=9, type=Time view, Title="example.cfs"
v1% = 9
lv1% = 7
log% = 7
```

The example above shows a script that prompts the user for a data file, opens it and prints a summary of the variables in the file to the log window. The user set a break point, ran the script then clicked on the Step button three times and clicked the Globals button.

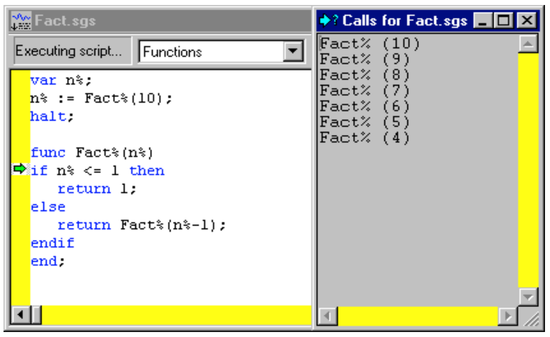
Inspecting variables

If the locals or globals windows are open, they display a list of variables. If there are more variables than can fit in the window you can scroll the list up and down to show them all. Simple variables are followed by their values. If you double click on one a new window opens in which you can edit the value of the variable.

If you double click on an array, a new window opens that lists the values of the elements of the array. You must double click on an element to edit the value. There is a limit of 32000 to the number of array elements that can be displayed and edited. This should not be a problem for most users. Function and procedure arguments show the name and cannot be edited.

Call stack

The call stack can sometimes be useful to figure out how your script arrived at a position in your code. This is particularly true if your script makes recursive use of functions. A function is recursive when it calls itself, either directly, or indirectly through other functions. This example implements factorials using recursion. We have set a break point and then displayed the call stack so you can see all the calls, and the arguments for each call. A common fault with scripts is to have mutually recursive user options. This leads to users burrowing deeper and deeper into the call stack until they run out of memory. The call stack can help to detect such problems.



```
var n%;
n% := Fact%(10);
halt;

func Fact%(n%)
if n% <= 1 then
   return 1;
else
   return Fact%(n%-1);
endif
end;
```

```
Fact% (10)
Fact% (9)
Fact% (8)
Fact% (7)
Fact% (6)
Fact% (5)
Fact% (4)
```

3 Script language syntax

Script format

A script consists of lines of text. Each line can be up to 240 characters long, however we suggest a maximum line length of 78 characters as experience shows that this makes printing and transfer of scripts to other systems simple.

The script compiler treats consecutive white space as a single space except within a literal string. White space characters are end of line, carriage return, space and tab. The compiler treats comments as white space.

The maximum size of the script is limited by the Signal script editor and this size varies with the version of the program and the operating system in use. All versions support scripts of at least 32,000 characters.

Keywords and names

All keywords, user-defined functions and variable names in the script language start with one of the letters `a` to `z` followed by the characters `a` to `z` and `0` to `9`. Keywords and names are not case sensitive, however, users are encouraged to be consistent in their use of case as it makes scripts easier to read. Variables and user-defined functions use the characters % and $ at the end of the name to indicate integer and string type.

User-defined names can extend up to a line in length. Most users will restrict themselves to a maximum of 20 or so characters.

The following keywords are reserved and cannot be used for variables or function names:

```
and           band          bor           bxor          case
const         do            docase        else          end
endcase       endif         for           func          halt
if            mod           next          not           or
proc          repeat        resize        return        step
then          to            until         var           view
wend          while         xor
```

Further, names used by Signal built-in functions cannot be redefined as user functions or global variables. They can be redefined as local variables (not recommended).

Data types

There are three basic data types in the script language: real, integer and string. The real and integer types store numbers, the string type stores characters. Integer numbers have no fractional part, and are useful for indexing arrays or for describing objects for which fractions have no meaning. Integers have a limited (but large) range of allowed values.

Real numbers span a very large range of number and can have fractional parts. They are often used to describe real-world items, for example the weight of an object.

Strings hold text and automatically grow and shrink in length to suit the number of text characters stored within them.

Real data type

This type is a double precision floating point number. Numbers are stored to an accuracy of at least 16 decimal digits and can have a magnitude in the range 10e-308 to 10e308. Variables of this type have no special character to identify them. Real constants have a decimal point or the letter `e` or `E` to differentiate from integers. White space is not allowed in a sequence of characters that define a real number. Real number constants have one of the following formats where `digit` is a decimal digit in the range 0 to 9:

```
{-}{digit(s)}digit.{digit(s)}{e|E{+|-}digit(s)}
{-}{digit(s)}.digit{digit(s)}{e|E{+|-}digit(s)}
{-}{digit(s)}digitE|e{+|-}digit(s)
```

A number must fit on a line, but apart from this, there is no limit on the number of digits. The following are legal real numbers:

```
1.2345 -3.14159 .1 1. 1e6 23e-6 -43e+03
```

`E` or `e` followed by a power of 10 introduces exponential format. The last three numbers above are: `1000000 0.000023 -43000.0`. The following are not real constants:

`1 e6`	White space is not allowed	`1E3.5`	Fractional powers are not allowed
`2.0E`	Missing exponent digits	`1e500`	The number is too large

Integer data type

The integer type is identified by a % at the end of the variable name and stores 32-bit signed integer (whole) numbers in the range -2,147,483,648 to 2,147,483,647. There is no decimal point in an integer number. An integer number has the following formats (where `digit` is a decimal digit 0 to 9, and `hexadecimal-digit` is 0 to 9 or `a` to `f` or `A` to `F` with `a` standing for decimal 10 to `f` standing for decimal 15):

```
{-}{digit(s)}digit
{-}0x|X{hexadecimal-digit(s)}hexadecimal-digit
```

You may assign real numbers to an integer, but it is an error to assign numbers beyond the integer range. Non-integral real numbers are truncated (towards zero) to the next integral number before assignment. Integer numbers are written as a list of decimal digits with no intervening spaces or decimal points. They can optionally be preceded by a minus sign. The following are examples of integers:

```
1 -1 -2147483647 0 0x6789abcd 0X100 -0xced
```

Integers use less storage space than real numbers and are slightly faster to work with. If you do not need fractional numbers or huge numeric ranges, use integers.

String data type

Strings are lists of characters. String variable names end in a $. String variables can hold strings up to 65534 characters long. Literal strings in the body of a program are enclosed in double quotation marks, for example:

```
"This is a string"
```

String literals may not extend over more than one line. Consecutive strings with only white space between them are concatenated, so the following:

```
"This string starts on one lin"
"e and ends on another"
```

is interpreted as `"This string starts on one line and ends on another"`. Strings can hold special characters, introduced by the escape character backslash:

`\"`	The double quote character (this would normally terminate the string)
`\\`	The Backslash character itself (beware DOS paths)
`\t`	The Tab character
`\n`	The New Line character (or characters, depending on the system)
`\r`	The Carriage Return character (ASCII code 13)

Conversion between data types

You can assign integer numbers to real variables and real numbers to integer variables (unless the real number is out of the integer range when a run-time error will occur). When a real number is converted to an integer, it is truncated. The `Asc()`, `Chr$()`, `Str$()` and `Val()` functions convert between strings and numbers.

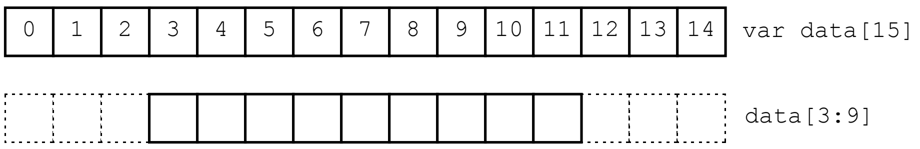
Arrays of data

The three basic types (integers, reals and strings) can be made into one and two dimensional arrays. You declare arrays with the `var` statement and as function arguments. To reference array elements, enclose the array element number in square brackets, for example: `fred[24]`. The first array element is number 0. To reference two dimensional arrays use two sets of brackets: `jim[3][23]`. The current result view is referenced as an array with no name, for example `[0]`, `[1]`, `[2]` for the first three bins.

You specify sub-arrays of an array as `array[start:size]`. The colon inside square brackets, or empty square brackets means that you are defining a sub-array. The number before the colon specifies the start index, the number after the colon specifies the number of elements. If you omit `start`, 0 is used. If you omit `size`, the array up to the end from the start index is used.

For example, consider the array of real numbers declared as `var data[15]`. This array has 15 elements numbered 0 to 14. To pass the array to a function, you could specify:

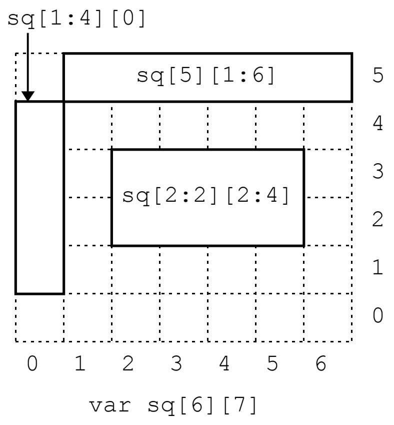
`data[3]`	This is a real variable, being the fourth element of the array.
`data[]`	This is the entire array. This is the same as `data[:]` or `data[0:15]`.
`data[3:9]`	This is a sub-array of length 9, being elements 3 to 11.
`data[:8]`	This is a sub-array, being elements 0 to 7.



With a two dimensional array, life becomes a little more complicated. You can pass a single array element, a one dimensional array, or a two dimensional array. Consider the array `sq[6][7]`. The following possibilities exist:

`sq[a][b]`	a single real number
`sq[a][b:c]`	sub-array of length c
`sq[a:b][c]`	sub-array of length b
`sq[a:b][c:d]`	sub-array dimensions `b` by `d`

This diagram shows how sub-arrays are constructed. `sq[1:4][0]` is a one dimensional array of 4 elements. This could be passed to a function that expects a one dimensional array as an argument. `sq[5][1:6]` is also a one dimensional array, this time of 6 elements. `sq[2:2][2:4]` is a two dimensional array, with dimensions `[2][4]`.



Data views as arrays

The script language can treat a channel in a data view as an array. To access an individual array element use `View(v%,c%).[index]` where `v%` is the view handle, `c%` is the channel number and `index` is the bin number, starting from 0. You can pass a channel from a data view to a function as an array using `View(v%,c%).[]` for the entire array and `View(v%,c%).[a:b]` for a sub-array starting at element `a` of length `b`. `View(0,1)[0:3]` for the first three values in channel 1 of the current view.

Marker channels act as arrays holding time values, they are read-only data because marker data times must be kept sorted. The only way to change a marker time is by using the `MarkTime()` function.

If you change a visible data view, the modified area is marked as invalid and will be redrawn at the next opportunity.

Statement types

The script language is composed of statements. Statements are separated by a semicolon. Semicolons are not required before `else`, `endif`, `case`, `endcase`, `until`, `next`, `end` and `wend` or after `end`, `endif`, `endcase`, `next` and `wend`. White space is allowed between items in statements, and statements can be spread over several lines. Statements may include comments. Statements are of one of the following types:

- A variable or constant declaration
- An assignment statement of the form:

`variable := expression;`	Set the variable to the value of the expression
`variable += expression;`	Add the expression value to the variable
`variable -= expression;`	Subtract the expression value from the variable
`variable *= expression;`	Multiply the variable by the expression value
`variable /= expression;`	Divide the variable by the expression value

  The `+=`, `-=`, `*=` and `/=` assignments are not available before version 1.50. `+=` can also be used with strings (`a$+=b$` is the same as `a$:=a$+b$`, but is more efficient).
- A flow of control statement, described below
- A procedure call or a function with the result ignored, for example `View(vh%);`

Comments in a script

A comment is introduced by a single quotation mark. All text after the quotation mark is ignored up to the end of the line.

```
View(vh%);  'This is a comment, and extends to the end of the line
```

Variable declarations

Variables are created by the `var` keyword. This is followed by a list of variable names. You must declare all variable names before you can use them. Arrays are declared as variables with the size of each dimension in square brackets. The first item in an array is at index 0. If an array is declared as being of size n, the last element is indexed n-1.

```
var myInt%,myReal,myString$;      'an integer, a real and a string
var aInt%[20],arl[100],aStr$[3]   'integer, real and string arrays
var a2d[10][4];                   '10 arrays of arrays of 4 reals
var square$[3][3];                '3 arrays of 3 arrays of strings
```

Variables can be defined in the main program, or in user-defined functions. Variables defined in the main program are global. They can be accessed from anywhere in the script after their definition. Variables defined in user-defined functions exist from the point of definition to the end of the function and are deleted when the function ends. If you have a recursive function, each time you enter the function you get a fresh set of variables.

The dimensions of global arrays must be constant expressions. The dimensions of local arrays can be set by variables or calculated expressions.

Simple variables (not arrays) can be initialised to constants when they are declared. The initialising expression may not include variables or function calls. Uninitialised numeric variables are set to 0, uninitialised strings are empty.

```
var Sam%:=3+2, jim := 2.3214, sally$ := "My name is \"Sally\"";
```

Constant declarations

Constants are created by the `const` keyword. A constant can be of any of the three basic data types, and must be initialised as part of the constant declaration. Constants cannot be arrays. The syntax and use of constants is the same as for variables, except that you cannot assign to them or pass them to a function or procedure as a reference parameter.

```
const Sam%:=3+2, jim := 2.3214, sally$ := "My name is \"Sally\"";
```

Expressions and operators

Anywhere in the script where a numeric value can be used, so can a numeric expression. Anywhere a string constant could be used, a string expression is also acceptable. Expressions are formed from functions, variables, constants, brackets and operators. In numerical expressions, the following operators are allowed, listed in order of precedence:

Numeric operators

	Operators	Names
Highest	`[], ()`	Array subscript, round brackets
	`-, not`	Unary minus, logical not
	`*, /, mod`	Multiply, divide and modulus (remainder)
	`+, -`	Add and subtract
	`<, <=, >, >=`	Less, less or equal, greater, greater or equal
	=, <>	Equal and not equal
	`and, band`	Logical and, bitwise and
Lowest	`or, xor, bor, bxor`	Logical and exclusive or and bitwise versions

The order of precedence determines the order in which operators are applied within an expression. Without rules on the order of precedence, `4+2*3` could be interpreted as 18 or 10 depending on whether the add or the multiply was done first. Our rules say that multiply has a higher precedence, so the result is 10. If in doubt, use round brackets, as in `4+(2*3)` to make your meaning clear. Extra brackets do not slow down the script.

The divide operator returns an integer result if both the divisor and the dividend are integers. If either is a real value, the result is a real. So `1/3` evaluates to `0`, while `1.0/3`, `1/3.0` and `1.0/3.0` all evaluate to `0.333333`…

The minus sign occurs twice in the list because minus is used in two distinct ways: to form the difference of two values (as in `fred:=23-jim`) and to negate a single value (`fred :=-jim`). Operators that work with two values are called *binary*, operators that work with a single value are called *unary*. There are four unary operators, `[]`, `()`, `-` and `not`, the remainder are binary.

There is no explicit `TRUE` or `FALSE` keyword in the language. The value zero is treated as false, and any non-zero value is treated as true. Logical comparisons have the value 1 for true. So `not 0` has the value `1`, and the `not` of any other value is `0`. If you use a real number for a logical test, remember that the only way to guarantee that a real number is zero is by assigning zero to it. For example, the following loop may never end:

```
var add:=1.0;
repeat
   add := add - 1.0/3.0; ' beware, 1/3 would have the value 0!
until add = 0.0;         ' beware, add may never be exactly 0
```

Even changing the final test to `add<=0.0` leads to a loop that could cycle 3 or 4 times depending on the implementation of floating point numbers.

The result of the comparison operators is integer 0 if the comparison is false and integer 1 if the comparison is true. The result of the binary arithmetic operators is integer if both operands are integers, otherwise the result is a real number. The result of the logical operators is integer 0 or 1. The result of the exclusive or operator is true if one operand is true and the other is false.

The bitwise operators `band`, `bor` and `bxor` treat their operands as integers, and produce an integer result on a bit by bit basis. They are not allowed with real number operands.

String operators

	Operators	**Names**
Highest	+	Concatenate
	<, <=, >, >=	Less, less or equal, greater, greater or equal
Lowest	=, <>	Equal and not equal

The comparison operators can be applied to strings. Strings are compared character by character, from left to right. The comparison is case sensitive. To be equal, two strings must be identical. You can also use the + operator with strings to concatenate them (join them together). The character order for comparisons (lowest to highest) is:

```
space !"#$%&'()*+,-./0123456789:;<=>?@
ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`
abcdefghijklmnopqrstuvwxyz{|}~
```

Do not confuse assignment := with the equality comparison operator, =. They are entirely different. The result of an assignment does not have a value, so you cannot write statements like `a:=b:=c;`.

Examples of expressions

The following (meaningless) code gives examples of expressions.

```
var jim,fred,sam,sue%,pip%,alf$,jane$;
jim := Sin(0.25) + Cos(0.25);
fred := 2 + 3 * 4;      'Result is 14.0 as * has higher precedence
fred := (2 + 3)* 4;     'Result is 20.0
fred += 1;              'Add 1 to fred
sue% := 49.734;         'Result is 49
sue% := -49.734;        'Result is -49
pip% := 1 + fred > 9;   'Result is 1 as 21.0 is greater than 9
jane$ := "Jane";
alf$ := "alf";
sam := jane$ > alf$;    'Result is 0.0 (a is greater than J)
sam := UCase$(jane$)>UCase$(alf$); 'Result is 1.0 (A < J)
sam := "same" > "sam";  'Result is 1.0
pip% := 23 mod 7;       'Result is 2
jim := 23 mod 6.5;      'Result is 3.5
jim := -32 mod 6;       'Result is -2.0
sue% := jim and not sam;'Result is 0 (jim = -2.0 and sam = 1.0)
pip% := 1 and 0 or 2>1; 'Result is 1
sue% := 9 band 8;       'Result is 8 (9=1001 in binary, 8=1000)
sue% := 9 bxor 8;       'Result is 1
sue% := 9 bor 8;        'Result is 9
```

Mathematical constants

We don't provide maths constants as built-in symbols, but the two most common ones, *e* and *pi* are easily generated within a script; *e* is `Exp(1.0)` and *pi* is `4.0*ATan(1.0)`.

Flow of control statements

If scripts were simply a list of commands to be executed in order, their usefulness would be severely limited. The flow of control statements let scripts loop and branch. It is considered good practice to keep flow of control statements on separate lines, but the script syntax does not require this. There are two branching statements, `if...endif` and `docase...endcase`, and three looping statements, `repeat...until`, `while...wend` and `for...next`. You can also use user-defined functions and procedures with the `Func` and `Proc` statements.

if...endif

The `if` statement can be used in two ways. When used without an `else`, a single section of code can be executed conditionally. When used with an `else`, one of two sections of code is executed. If you need more than two alternative branches, the `docase` statement is usually more compact than nesting many `if` statements.

```
if expression then                'The simple form of an if
   zero or more statements;
endif;

if expression then                'Using an else
   zero or more statements;
else
   zero or more statements;
endif;
```

If the expression is non-zero, the statements after the `then` are executed. If the expression is zero, only the statements after the `else` are executed. The following code adds 1 or 2 to a number, depending on it being odd or even:

```
if num% mod 2 then
   num%:=num%+2;          'note that the semicolons before...
else                      '...the else and endif are optional.
   num%:=num%+1;
endif;
                          'The following is equivalent
if num% mod 2 then num%:=num%+2 else num%:=num%+1 endif;
```

docase...endcase

These keywords enclose a list of `case` statements forming a multiway branch. Each `case` is scanned until one is found with a non-zero expression, or the `else` is found. If the `else` is omitted, control passes to the statement after the `endcase` if no case is non-zero. Only the first non-zero `case` is executed (or the `else` if no case is non-zero).

```
docase
 case exp1 then
   statement list;
 case exp2 then
   statement list;
 ...
 else
   statement list;
endcase;
```

The following example sets a string value depending on the value of a number:

```
var base%:=8,msg$;
docase
 case base%=2 then  msg$ := "Binary";
 case base%=8 then  msg$ := "Octal";
 case base%=10 then msg$ := "Decimal";
 case base%=16 then msg$ := "Hexadecimal";
 else msg$ := "Pardon?";
endcase;
```

repeat...until The statements between repeat and until are repeated until the expression after the until keyword evaluates to non-zero. The body of a repeat loop is always executed at least once. If you need the possibility of zero repeats, use a while loop. The syntax of the statement is:

```
repeat
   zero or more statements;
until expression;
```

For example, the following code prints the times of all data items on channel 3 (plus an extra -1 at the end):

```
var time := -1;                  'start time of search
repeat
   time := NextTime(3, time);    'find next item time
   PrintLog("%f\n", time);       'display the time to the log
until time<0;                    'until no data found
```

while...wend The statements between the keywords are repeated while an expression is not zero. If the expression is zero the first time, the statements in between are not executed. The while loop can be executed zero times, unlike the repeat loop, which is always executed at least once.

```
while expression do
   zero or more statements;
wend;
```

The following code fragment, finds the first number that is a power of two that is greater than or equal to some number:

```
var test%:=437, try%:=1;
while try%<test% do              'if try% is too small...
   try% := try% * 2;             '...double it
wend;
```

for...next For loops execute a group of statements a number of times with a variable changed by a fixed amount on each iteration. The loop can be executed zero times. The syntax is:

```
for v := exp1 to exp2 {step exp3} do
   zero or more statements;
next;
```

`v`	This is the loop variable and may be a real number, or an integer. It must be a simple variable, not an array element.
`exp1`	This expression sets the initial variable value before the looping begins.
`exp2`	This expression is evaluated once, before the loop starts, and is used to test for the end of the loop. If `step` is positive or omitted (when it is 1), the loop stops when the variable is greater than `exp2`. If `step` is negative, the loop stops when the variable is less than `exp2`.
`exp3`	This expression is evaluated once, before the loop starts, and sets the increment added to the variable when the `next` statement is reached. If there is no `step exp3` in the code, the increment is 1. The value of `exp3` can be positive or negative.

The following example prints the squares of all the integers between 10 and 1:

```
var num%;
for num% := 10 to 1 step -1 do
   PrintLog("%d squared is %d\n", num%, num% * num%);
next;
```

If you want a for loop where the end value and/or the step size are evaluated each time round the loop you should use a `while…wend` or `repeat…until` construction.

Halt

The `Halt` keyword terminates a script. A script also terminates if the path of execution reaches the end of the script. When a script halts, any open external files associated with the `Read()` or `Print()` functions are closed and any windows with invalid regions are updated. Control then returns to the user.

Functions and procedures

A user-defined function is a named block of code. It can access global variables and create its own local variables. Information is passed into user-defined functions through arguments. Information can be returned by giving the function a value, by altering the values of arguments passed by reference or by changing global variables.

User-defined functions that return a value are introduced by the `func` keyword, those that do not are introduced by the `proc` keyword. The `end` keyword marks the end of a function. The `return` keyword returns from a function. If `return` is omitted, the function returns to the caller when it reaches the `end` statement. Arguments can be passed to functions by enclosing them in brackets after the function. Functions that return a value or a string have names that specify the type of the returned value. A function is defined as:

```
func name({argument list})        or     proc name({argument list})
{var local-variable-list;}               {var local-variable-list;}
statements including return x;           statements including return;
end;                                     end;
```

There is no semicolon at the end of the argument list because the argument list is not the end of the `func` or `proc` statement; the `end` keyword terminates the statement. Functions may not be nested within each other.

Argument lists

The argument list is a list of variable names separated by commas. There are two ways to pass arguments to a function: by value and by reference:

Value	Arguments passed by value are local variables in the function. Their initial values are passed from the calling context. Changes made in the function to a variable passed by value do not affect the calling context.
Reference	Arguments passed by reference are the same variables (by a different name) as the variables passed from the calling context. Changes made to arguments passed by reference do affect the calling context. Because of this, reference arguments must be passed as variables (not expressions or constants) and the variable must match the type of the argument (except we allow you to pass a real variable where an integer variable is expected).

Simple (non-array) variables are passed by value. Simple variables can be passed by reference by placing the `&` character before the name in the argument list declaration.

Arrays and sub-arrays are always passed by reference. Array arguments have empty square brackets in the function declaration, for example `one[]` and `two[][]`. The size of the array is taken from the array passed in. You can find the size of an array with the `Len()` function. An individual array element is a treated as a simple variable.

return

The `return` keyword is used in a user-defined function to return control to the calling context. In a `proc`, the `return` must not be followed by a value. In a `func`, the return should be followed by a value of the correct type to match the function name. If no return value is specified, a `func` that returns a real or integer value returns 0, and a `func` that returns a string value returns a string of zero length.

Examples of user-defined functions

```
proc PrintInfo()            'no return value, no arguments
PrintLog(ChanTitle$(1));    'Show the channel title
PrintLog(ChanComment$(1)); 'and the comment
return;                     'return is optional in this case as...
end;                        '...end forces a return for a proc

func sumsq(a, b)            'sum the square of the arguments
return a*a + b*b;
end;

func removeExt$(name$)      'remove text after last . in a string
var n := 0, k := 1;
   repeat
   k:=InStr(name$,".",k);  'find position of next dot
   if (k > 0) then          'if found a new dot...
      n := k;               '...remember where
   endif
   until k=0;               'until all found
if n=0 then
   return name$;            'no extension
else
   return Left$(name$,n-1);
end;

proc sumdiff(&arg1, &arg2) 'returns sum and difference of args
arg1 := arg1 + arg2;        'sum of arguments
arg2 := arg1 - 2*arg2;      'original arg1-arg2
return;                     'results returned via arguments
end;

func sumArr(data[])         'sum all elements of an array
var sum:=0.0;               'initialise the total
var i%;                     'index
for i%:=0 to Len(data[])-1 do
   sum := sum + data[i%];  'of course, ArrSum() is much faster!
   next;
return sum;
end;

Func SumArr2(data[][])      'Efficient sum of 2d array elements
var n1%,n2%,i%,sum;         'sizes, index and sum, all set to 0
n1% := Len(data[0][]);      'get sizes of arrays...
n2% := Len(data[][0]);      '...so we can see which is bigger
if n1%>n2% then             'choose most efficient method
 for i%:=0 to n2%-1 do sum := sum + ArrSum(data[i%][]) next;
else
 for i%:=0 to n1%-1 do sum := sum + ArrSum(data[][i%]) next;
endif;
return sum;
end;
```

Variables declared within a function exist only within the body of the function. They cannot be used from elsewhere. You can use the same name for variables in different functions. Each variable is separate. In addition, if you call a function recursively (that is it calls itself), each time you enter the function, you have a fresh set of variables.

Scope of user-defined functions

Unlike global variables, which are only visible from the point in the script in which they are declared onwards and local variables, which are visible within a user-defined function only, user-defined functions are visible from all points in the script. You may define two functions that call each other, if you wish.

Functions as arguments

The script language allows a function or procedure to be passed as an argument. The function declaration includes the declaration of the function type to be passed. Functions and procedures can occur before or after the line in which they are used as an argument.

```
proc Sam(a,b$,c%)
...
end;

func Calc(va)
return 3*va*va-2.0*va;
end;

func PassFunc(x, func ff(realarg))
return ff(x);
end;

func PassProc(proc jim(realarg, strArg$, son%))
jim(1.0,”hello”,3);
end;

val := PassFunc(1.0, Calc);  ’pass function
PassProc( Sam );             ’pass procedure
```

The declaration of the procedure or function argument is exactly the same as for declaring a user-defined function or procedure. When passing the function or procedure as an argument, just give the name of the function or procedure, no brackets or arguments are required. The compiler checks that the argument types of a function passed as an argument match those declared in the function header. See the `ToolbarSet()` function for an example.

Although user-defined functions and built-in functions are very similar, you are not allowed to pass a built-in function as an argument to a built-in function. Further, you cannot pass a built-in function to a user-defined function if it has one or more arguments that can be of more than one type. For example, the built-in `Sin()` function can accept a real argument, or a real array argument, and so cannot be passed.

4 Commands by function

Functional command groups

This section of the manual lists commands by function. The next section lists the command alphabetically with a description of the command arguments and operation.

Windows and views

These commands are used to manipulate windows (views) to position them, display and size them, colour them and create them.

`App`	Get the application window view handle
`ChanNumbers`	Show or hide channel numbers
`Colour`	Get or set the palette entry associated with a screen item
`Dup`	Get the view handle of duplicates of the current view
`Draw`	Draw invalid regions of the view (and set x axis range)
`DrawAll`	Update all invalid regions in all views
`FileClose`	Closes a window or windows
`FileComment$`	Gets and sets the file comment for time views
`FileConvert$`	Convert a foreign file to a Signal file and open it
`FileName$`	Gets the file name associated with a window
`FileNew`	Opens an output file or a new text or data window
`FileOpen`	Opens an existing file (in a window)
`FilePrint`	Prints a range of data from the current view
`FilePrintVisible`	Prints the current view
`FilePrintScreen`	Prints all text-based and data views
`FileQuit`	Closes the Signal application
`FileExportAs`	Export from a data view in a variety of formats
`FileSave`	Save a view with same name
`FileSaveAs`	Save a view with specified new name
`FontGet`	Read back information about the font
`FontSet`	Set the font for the current window
`FrontView`	Get or set the front window on screen
`Grid`	Get or set the visibility of the axis grid
`LogHandle`	Gets the view handle of the log window
`PaletteGet`	Get the RGB colour of a palette entry
`PaletteSet`	Set the RGB colour of a palette entry
`SampleHandle`	Gets the view handle of sampling windows and controls
`View`	Change or override current view and get view handle
`ViewFind`	Get a view handle from a view title
`ViewKind`	Get the type of the current view or other view
`ViewList`	Form a list of handles to views that meet a specification
`ViewStandard`	Returns a window to a standard state
`ViewUseColour`	Get and set monochrome/colour use for view
`Window`	Sets the window size and position
`WindowDuplicate`	Duplicate a time view
`WindowGetPos`	Get window position
`WindowSize`	Changes the window size
`WindowTitle$`	Gets or changes the window title
`WindowVisible`	Sets or gets the visibility of the window (hide/show)
`XAxis`	Get or set the visibility of the x axis
`XAxisMode`	Get or set the visibility of the x axis' features (eg big ticks)
`XAxisStyle`	Get or set the x axis major and minor tick spacing
`YAxis`	Get or set the visibility of the y axis
`YAxisMode`	Get or set the visibility of the y axis' features (eg big ticks)
`YAxisStyle`	Get or set the y axis major and minor tick spacing

Data views

These commands operate on any data view, whether a file view, memory view or sampling document view.

`AppendFrame`	Add a new data frame to end of data
`DeleteFrame`	Delete a data frame if not on disk
`ExportChanFormat`	Set channel format for export
`ExportChanList`	Set list of channels for export
`ExportFrameList`	Set a list of frames for export
`ExportTextFormat`	Set format for text output of channels
`ExportTimeRange`	Set x axis range for export of data
`FileExportAs`	Export from a data view in a variety of formats
`Frame`	Get or set the current frame
`FrameAbsStart`	Get or set the current frame absolute start time
`FrameComment$`	Get or set the comment with the current frame
`FrameCount`	The number of frames in the file (or 1 in a memory view)
`FrameList`	Fills an array with frame numbers according to a frame spec
`FrameFlag`	Gets or sets a frame flag
`FrameSave`	Saves changed frame data or discards changes
`FrameState`	Gets or sets the frame state value
`FrameTag`	Gets or sets the frame tag
`FrameUserVar`	Gets or sets a frame user variable
`Maxtime`	Maximum x axis value in the current frame
`Mintime`	Minimum x axis value in the current frame
`Overdraw`	Enables or disables drawing the frame display list
`OverdrawFrames`	Sets a frame display list for the view
`OverdrawGetFrames`	Gets the frame numbers from the display list for the view
`ShowBuffer`	Get or set the frame buffer display state
`Sweeps`	Number of items processed into memory view
`TimeRatio`	Get the scaling factor from X units to seconds
`TimeUnits$`	Get the current time units
`XLow`	The start of the displayed area in x axis units
`XHigh`	The end of the displayed area in x axis units
`XRange`	Set the x axis range for next draw
`XScroller`	Show or hide the x axis scroll bar and controls
`XTitle$`	X axis title. Can be set, in a memory or sampling document view
`XUnits$`	X axis units. Can be set, in a memory or sampling document view

Vertical cursors

The following commands control the vertical cursors. Where possible, changes to cursors cause immediate screen changes; changes do not wait for the next `Draw` command. This is unlike almost all other command that save up changes until the next draw.

`Cursor`	Set or get the position of a cursor
`CursorActiveGet`	Get the active cursor parameters
`CursorActiveSet`	Set the active cursor parameters
`CursorDelete`	Delete a designated cursor
`CursorExists`	Test if a cursor exists
`CursorLabel`	Set or get the cursor label style
`CursorLabelPos`	Set or get the cursor label position
`CursorMode`	Set or get the cursor mode
`CursorNew`	Add a new cursor (at a given position)
`CursorRenumber`	Renumber the cursors in ascending position order
`CursorSet`	Set the number (and position) of vertical cursors

Horizontal cursors

Horizontal cursors belong to a channel, but can be dragged to different channels within a view by the user. Horizontal cursors have a value and are drawn at the y axis position corresponding to the value. If the value is beyond the range of the y axis, the cursor is invisible. If you delete a channel with horizontal cursors, the cursors are deleted.

`HCursor`	Set or get the position of a horizontal cursor
`HCursorChan`	Gets the channel that a horizontal cursor belongs to
`HCursorDelete`	Delete a designated horizontal cursor
`HCursorExists`	Test if a horizontal cursor exists
`HCursorLabel`	Gets or sets the horizontal cursor style
`HCursorLabelPos`	Gets or sets the horizontal cursor position
`HCursorNew`	Add a new horizontal cursor on a channel (at a given position)
`HCursorRenumber`	Renumbers the cursors from bottom to the top of the view

Channels

These commands operate on channels in a data or XY view. Channel data can also be treated as an array, so you can use all the array arithmetic commands. In a memory view, you can use the commands `BinSize` and `BinZero` to get or set x axis scale and offset, but in any other data view you can use these commands only to get x axis values.

`BinSize`	X axis interval for waveforms or resolution for markers
`BinToX`	Bin or item number at x axis position
`BinZero`	X axis position of the first bin on the channel
`ChanCount`	Count channels of a given type
`ChanDelete`	Delete a channel from an XY view only
`ChanDiff`	Differentiate data in specified channels
`ChanIntgl`	Integrate data in specified channels
`ChanItems`	Count items in a channel within an x axis range
`ChanKind`	Get the type of a channel
`ChanList`	Get a list of channels meeting a specification
`ChanMean`	Mean of waveform level within an x axis range
`ChanMeasure`	Take a variety of measurements on channel data
`ChanNegate`	Negate (invert) data in specified channels
`ChanOffset`	Offset data in specified channels by a constant value
`ChanOrder`	Modify the channel order and y axis grouping
`ChanPoints`	Number of data items in the channel in the frame
`ChanRectify`	Rectify data in specified channels
`ChanScale`	Scale data in specified channels by a constant value
`ChanSearch`	Scan a channel of data for a particular feature
`ChanSelect`	Select and report on selected state of channels
`ChanShift`	Shift data in specified channels left or right
`ChanShow`	Make a channel visible or invisible
`ChanSmooth`	Smooth (3 or 5 point) data in specified channels
`ChanSubDC`	Remove DC offset from data in specified channels
`ChanRange`	Get start and count of items in an x axis range
`ChanTitle$`	Get or set the channel title string
`ChanUnits$`	Get or set the channel units
`ChanValue`	Get channel data at a particular time or x axis position
`ChanVisible`	Get the visibility state of a channel
`ChanWeight`	Change the relative vertical space of a channel
`ChanZero`	Clear data in specified channels
`DrawMode`	Get or set display mode for a channel
`LastTime`	Find the previous item in a channel (and return values)
`MarkCode`	Get a marker code(s)
`MarkEdit`	Edit a marker code(s)
`MarkTime`	Change position of a marker

`Maxtime`	Time of last item on the channel
`Minmax`	Find minimum and maximum values (and positions)
`Mintime`	Time of first item on the channel
`NextTime`	Find the next item in a channel (and return values)
`Optimise`	Set reasonable y range for channels with axes
`XToBin`	Convert x axis value to bin number
`YLow`	Get lower limit of y axis for a channel
`YHigh`	Get upper limit of y axis for a channel
`YRange`	Set y axis range for a channel

Buffer

These commands operate on the frame buffer that is attached to each file or memory view. The buffer can be shown or hidden using the `ShowBuffer` function, these commands perform arithmetic between the buffer and a frame in the data view. These functions operate on all points in all waveform channels in the buffer. The functions that modify a frame in the data document have names such as `BuffAddTo` or `BuffMulBy`, while functions that change the frame buffer are called `BuffAdd` or `BuffMul`. Note that you can use the channel data manipulation commands to change buffer data, as well as accessing the buffer data directly.

`BuffAdd`	Add data to the frame buffer
`BuffAddTo`	Add frame buffer to a data framer
`BuffAcc`	Add data to average in frame buffer
`BuffClear`	Clear all channels in the frame buffer
`BuffCopy`	Copy data to the frame buffer
`BuffCopyTo`	Copy frame buffer to the data frame
`BuffDiv`	Divide frame buffer by data
`BuffDivBy`	Divide data frame by the frame buffer
`BuffExchange`	Exchange data in the frame buffer and data frame
`BuffMul`	Multiply frame buffer by data
`BuffMulBy`	Multiply data frame by frame buffer
`BuffSub`	Subtract data from frame buffer
`BuffSubFrom`	Subtract frame buffer from a data frame
`BuffUnAcc`	Remove data from average in frame buffer

XY views

These commands specifically manipulate XY views. XY views have from 1 to 100 channels of data. Each channel holds a list of (x, y) co-ordinate pairs that can be displayed in a variety of styles. Most functions that work on views in general will also work on an XY view.

`XYAddData`	Add data points to a channel of an XY view
`XYColour`	Set the colour of a channel
`XYCount`	Return the number of XY data points in a channel
`XYDelete`	Delete one or more data points from a channel
`XYDrawMode`	Control how a channel is drawn
`XYGetData`	Read data back from an XY channel
`XYInCircle`	Count the number of XY points within a circle
`XYInRect`	Count the number of XY points inside a rectangle
`XYJoin`	Get or set the point joining method
`XYKey`	Control the display of the XY view channel key
`XYRange`	Get rectangle containing one or more channels
`XYSetChan`	Create or modify an XY channel
`XYSize`	Get or set maximum size of an XY channel
`XYSort`	Change the sort (and draw) order of a channel

Sampling configuration commands

These commands correspond to actions on the Sampling configuration dialog. They get or change the sampling configuration settings that will be used the next time you create a new Signal data file for sampling.

These commands correspond to the General page of the configuration, or are general-purpose in intent. A few of these can also interact with sampling in progress.

`SampleBurst`	Set or get the burst mode flag
`SampleClear`	Set the Sampling configuration to a known state
`SampleKeyMark`	Add or remove the keyboard marker channel
`SampleMode`	Set or get the sweep mode for sampling
`SamplePause`	Set or get pause at sweep end flag
`SamplePoints`	Set or get the number of data points per ADC port
`SamplePorts`	Set or get which ADC ports to sample from
`SampleRate`	Set or get the ADC sample rate per channel in Hz
`SampleTrigger`	Set or get the triggered sweeps flag
`SampleWrite`	Control writing data to sampling file

These commands correspond to the Ports page of the sampling configuration.

`SamplePortFull`	Set ADC port value for full input
`SamplePortName$`	Set ADC port title
`SamplePortOptions$`	Set ADC port online processing options
`SamplePortUnits$`	Set ADC port units
`SamplePortZero`	Set ADC port value for zero

These commands correspond to the Outputs page of the sampling configuration.

`SampleDacFull`	Set or get a DAC full-scale value
`SampleDacMask`	Set or get the DAC output enable mask
`SampleDacUnits$`	Set or get a DAC units string
`SampleDacZero`	Set or get a DAC zero value
`SampleDigOMask`	Set or get the digital outputs enable mask
`SampleOutClock`	Set or get the outputs clock period
`SampleOutMode`	Set or get the outputs mode

These commands correspond to the States page of the sampling configuration.

`SampleDigIMask`	Set or get digital inputs enable mask
`SampleStates`	Set or get states enable and number of extra states
`SampleStatesIdle`	Set or get states ordering cycles before idling
`SampleStatesMode`	Set or get multiple states mode
`SampleStatesOrder`	Set or get multiple states ordering mode
`SampleStatesRepeats`	Set or get multiple states repeats count
`SampleStateDac`	Set or get DAC data for individual state
`SampleStateDig`	Set or get digital bits for individual state
`SampleStateRepeats`	Set or get repeats for individual state

These correspond to the Protocols dialog available from the States page.

`Protocols`	Get number of protocols set up
`ProtocolAdd`	Add a new protocol to list
`ProtocolClear`	Initialise a protocol
`ProtocolDel`	Delete a protocol from list
`ProtocolFlags`	Set or get protocol flags
`ProtocolName$`	Set or get protocol name
`ProtocolStepGet`	Get information on protocol step
`ProtocolStepSet`	Set protocol step values

These commands correspond to the Automation page of the sampling configuration.

`SampleArtefactGet`	Get the artefact rejection settings
`SampleArtefactSet`	Set the artefact rejection settings
`SampleAutoFile`	Set or get the automatic file save flag
`SampleAutoName$`	Set or get the template for automatic file naming
`SampleLimitFrames`	Set or clear the limit on the number of frames in the new file
`SampleLimitSize`	Set or clear the size limit of the new file
`SampleLimitTime`	Set or clear the limit on the overall sampling time

These commands correspond to the Peri-trigger page of the sampling configuration.

`SamplePeriDigBit`	Set digital bit for peri-trigger digital type
`SamplePeriBitState`	Set digital triggering to be on bit high or low
`SamplePeriHyst`	Set hysteresis value for peri-trigger + or - analog type
`SamplePeriLevel`	Set threshold level for peri-trigger analog types
`SamplePeriLowLev`	Set lower threshold level for peri-trigger =analog type
`SamplePeriType`	Set type of peri-trigger
`SamplePeriPoints`	Set peri-trigger pre-trigger points

These commands correspond to the pulse dialog or to outputs page items that specifically interact with the pulses output. The pulse functions can all be used while sampling is in progress to alter the pulses in use.

`SampleAbsLevel`	Set or get the pulses absolute levels flag (in outputs page)
`SampleFixedInt`	Set or get the fixed interval sweep mode interval
`SampleFixedVar`	Set or get the fixed interval percentage variation
`SampleOutLength`	Set or get the pulses output frame length
`SampleOutTrig`	Set or get the pulses sampling sweep trigger time
`Pulses`	Get the number of pulses for an output port
`PulseAdd`	Add a new pulse to the outputs for a port
`PulseClear`	Remove all pulses from the outputs for a port
`PulseDel`	Remove a pulse from the outputs for a port
`PulseFlags`	Set or get the options flags for a pulse
`PulseName$`	Set or get a pulse name
`PulseType`	Get a pulse type code
`PulseDataSet`	Set the amplitude and other values for a pulse
`PulseDataGet`	Get the amplitude and other values for a pulse
`PulseVarSet`	Set the variation parameters for a pulse
`PulseVarSet`	Get the variation parameters for a pulse
`PulseTimesSet`	Set the times for a pulse
`PulseTimesGet`	Get the times for a pulse
`PulseWaveSet`	Set the waveform output parameters
`PulseWaveGet`	Get the waveform output parameters
`PulseWaveformSet`	Set the waveform output data for a DAC
`PulseWaveformGet`	Get the waveform output data for a DAC

Runtime sampling commands

These commands control and interact with the data sampling process. Signal samples into one data file at a time, and these commands refer to it, regardless of the current view. The commands can also be used to retrieve the current settings.

`SampleAbort`	Exit from sampling and throw data away
`SampleAccept`	Accept or reject the current sweep
`SampleHandle`	Gets the view handle of sampling windows and controls
`SampleKey`	Adds to the keyboard marker channel, controls output sequencer
`SamplePeriHyst`	Alter hysteresis for peri-trigger + or - analog type
`SamplePeriLevel`	Alter threshold level for peri-trigger analog types
`SamplePeriLowLev`	Alter lower threshold level for peri-trigger =analog type
`SampleProtocol`	Set protocol to be used for state sequencing
`SampleReset`	Clear all data from the new file and get ready to start again
`SampleStart`	Start sampling after creating a new time view
`SampleState`	Set state for next frame to be sampled a new time view
`SampleStatesReset`	Reset states sequencing and pulse variations
`SampleStatesRun`	Set state sequencing run mode or manual
`SampleStatus`	Get the current sampling state
`SampleStop`	Stop sampling and keep the data
`SampleSweep`	Start another sampling sweep

Analysis

These functions create new memory or XY views and define an analysis process for them.

`SetAmplitude`	Set up an amplitude histogram view derived from a file view
`SetAutoAv`	Set up an auto-average multi frame view derived from a file view
`SetAverage`	Set up a waveform average view derived from a file view
`SetLeak`	Set up a leak-subtracted view produced from a file view
`SetPower`	Set up a power spectrum view derived from a file view
`SetTrend`	Set up an XY trend plot derived from a file or memory view
`SetTrendChan`	Add a channel to XY trend plot set up by `SetTrend`

These functions create new memory views without an attached analysis process.

`SetCopy`	Set up a memory view copied from a file view
`SetMemory`	Set up a memory view for user-defined data

The Process commands work with views with an attached analysis process. They carry out the analysis process defined when setting up the memory view, processing data from the source view into the memory or XY view attached to it.

`Process`	Carry out the analysis process on the current frame from file
`ProcessAll`	Process all memory views attached to a file view
`ProcessFrames`	Carry out the analysis process on multiple frames from file
`ProcessOnline`	Carry out the analysis process during sampling
`Sweeps`	Number of items processed into memory view

Signal conditioner control

These functions control serial line controlled signal conditioners.

`CondFilter`	Get or set the conditioner low-pass or high-pass filter
`CondFilterList`	Get a list of possible low-pass or high-pass filter settings
`CondGain`	Get or set the conditioner gain
`CondGainList`	Get a list of the possible gains for the conditioner
`CondGet`	Get all the settings for one channel of the conditioner
`CondOffset`	Get or set the conditioner offset for a channel

`CondOffsetLimit`	Get or set the conditioner offset range for a channel
`CondRevision$`	Get or set the conditioner offset for a channel
`CondSet`	Single call to set all channel parameters
`CondSourceList`	Get names of the signal sources available on the conditioner
`CondType`	Get the type of signal conditioner

Editing operations

These functions mimic the Edit menu commands and provide additional functionality.

`EditClear`	Delete text from a text window at the caret
`EditCopy`	Copy the current selection to the clipboard
`EditCut`	Delete the current selection to the clipboard
`EditPaste`	Paste the clipboard into the current text field
`EditSelectAll`	Select the entire text or cursor window contents
`MoveBy`	Move relative to current position
`MoveTo`	Move to a particular place
`Selection$`	This function returns the text that is currently selected

String functions

The following functions are used to manipulate strings and to convert between strings and other variable types.

`Asc`	ASCII code of first character of a string
`Chr$`	Converts a code to a one character string
`DelStr$`	Returns a string minus a substring
`InStr`	Searches for a string in another string
`LCase$`	Returns lower case version of a string
`Left$`	Returns the leftmost characters of a string
`Len`	Returns the length of a string or array
`Mid$`	Returns a substring of a string
`Print$`	Produce formatted string from variables
`ReadStr`	Extract variables from a string
`Right$`	Returns the rightmost characters of a string
`Str$`	Converts a number to a string
`UCase$`	Returns upper case version of a string
`Val`	Converts a string to number

Array arithmetic functions

These functions can be used with arrays and channel data to speed up data manipulation. In this section, the word array can be applied to an array declared with the `var` or `proc` or `func` statements, or to channel data in a file or memory view. These functions operate on one dimensional arrays only. Integer arrays can be used where indicated, but beware of overflow.

The functions all return a negative error code if there is a problem or zero if the function completed without error. The array arithmetic attempts to fix problems by setting the result element to a (possibly) useful value.

You can apply built-in mathematical functions directly on an array. For example, to form the square root of all the elements of array `fred[]` use `Sqrt(fred[])`. To access data in channel `c` of view `v` use `View(v,c).[{aExp}]` in place of `fred[{aExp}]` where `aExp` is an optional expression to specify elements as described in the script language syntax. For example, to subtract channel 2 from channel 1 in view `v1%`, use `ArrSub(View(v1%,1)[],View(v1%, 2).[])`.

`ArrAdd`	Adds an array or constant to an array
`ArrConst`	Copies an array, or sets an array to a constant value
`ArrDiff`	Replaces an array with an array of simple differences
`ArrDiv`	Divides an array by another array or a constant
`ArrDivR`	Divides array into another array or constant
`ArrDot`	Forms the dot product (sum of products) of two arrays
`ArrFFT`	Fourier transform and related operations
`ArrFilt`	Applies a FIR filter to an array
`ArrIntgl`	Integrates array; inverse of `ArrDiff()`
`ArrMul`	Multiples an array by another array or constant
`ArrSub`	Subtract constant from array, or difference of two arrays
`ArrSubR`	Subtract array from constant, or reversed difference of arrays
`ArrSum`	Sum, mean and standard deviation of an array
`Len`	Returns the length of a string or array

Mathematical functions

The following mathematical functions are built into Signal. You can apply most of the arithmetic functions to real arrays by passing an array or channel data to the function.

`Abs`	Absolute value of a number or array
`ATan`	Arc tangent of number or array
`Cos`	Cosine of a number or array
`Exp`	Exponential function of a number or array
`Frac`	Remove integral part of a number or array
`GammaP`	The incomplete gamma function
`GammaQ`	1 – GammaP()
`Ln`	Natural logarithm of a number or array
`LnGamma`	The natural logarithm of the gamma function
`Log`	Logarithm to base 10 of a number or array
`Max`	Finds maximum of array or variables
`Min`	Finds minimum of array or variables
`Pow`	Raise a number or an array to a power
`Rand`	Returns a pseudo-random number
`Round`	Round a real number to the nearest integral value
`Sin`	Sine of a number or array
`Sqrt`	Square root of a number or an array
`Tan`	Tangent of a number or array
`Trunc`	Remove fractional part of number or array

Digital filtering

These functions create and apply digital filters and manipulate the filter bank.

`ArrFilt`	Array arithmetic routine to apply FIR coefficients to an array
`FiltApply`	Apply a set of coefficients or a filter bank filter to a waveform
`FiltAtten`	Set the desired attenuation of a filter in the filter bank
`FiltCalc`	Force coefficient calculation of a filter in the filter bank
`FiltComment$`	Get or set comment for a filter in the filter bank
`FiltCreate`	Create a new filter definition in the filter bank
`FiltInfo`	Retrieve information about a filter in the filter bank
`FiltName$`	Get or set the name of a filter in the filter bank
`FiltRange`	Get the useful sampling rate range for a filter bank filter
`FIRMake`	Generate FIR filter coefficients in an array
`FIRQuick`	Generate FIR filter coefficients with desired attenuation
`FIRResponse`	Calculate frequency response of array of coefficients

Fitting functions

The following fitting functions are built into Signal.

`FitExp`	Fit multiple exponentials to arrays of x,y data points
`FitGauss`	Fit multiple gaussians to arrays of x,y data points
`FitLine`	Fit a straight line to waveform channel data
`FitLinear`	Fits y = $\mathbf{a}_0f_0(x) + \mathbf{a}_1f_1(x) + \mathbf{a}_2f_2(x)$ ... to a set of x,y data points
`FitNLUser`	Fit a non-linear user-defined function to a set of data points
`FitPoly`	Fits $\mathbf{a}_0 + \mathbf{a}_1x + \mathbf{a}_2x^2 + \mathbf{a}_3x^3$ ... to a set of x,y data points
`FitSin`	Fits $\mathbf{a}_0\text{Sin}(\mathbf{a}_1x+\mathbf{a}_2) + \mathbf{a}_3\text{Sin}(\mathbf{a}_4x+\mathbf{a}_5)$ + ... to a set of x,y data points

User interaction commands

These commands allow you to give information to, or get information from the user. They also let the user interact with the data.

`Input`	Prompt user for a number in a defined range
`Input$`	Prompt user for a string with a list of acceptable characters
`Interact`	Allow user to interact with data
`Message`	Display a message in a box, wait for OK
`Print`	Formatted text output to a file or window
`PrintLog`	Formatted text output to the Log window
`Print$`	Formatted text output to a string
`Query`	Ask a user a question, wait for response

You can build simple dialogs, with a set of fields stacked vertically or you can build free-format dialogs (but with more work to define the positions of all the dialog fields):

`DlgCreate`	Start a dialog definition
`DlgChan`	Define a dialog entry as prompt and channel selection
`DlgCheck`	Define a dialog item as a check box
`DlgInteger`	Define a dialog entry as prompt and integer number input
`DlgLabel`	Define a dialog entry as prompt only
`DlgList`	Define a dialog entry as prompt and selection from a list
`DlgReal`	Define a dialog entry as prompt and real number input
`DlgShow`	Display the dialog, get values of fields
`DlgString`	Define a dialog entry as prompt and string input
`DlgText`	Define a fixed text string for the dialog

The toolbar commands define the buttons available to the user on the toolbar, and allow the user to interact with the data, and have access to script functionality.

`Toolbar`	Let the user interact with the toolbar
`ToolbarClear`	Remove all defined buttons from the toolbar
`ToolbarEnable`	Get or set the enables state of toolbar buttons
`ToolbarSet`	Add a button (and associate a function with it)
`ToolbarText`	Display a message using the toolbar
`ToolbarVisible`	Get or set the visibility of the toolbar
`SampleBar`	Controls the sample bar buttons
`ScriptBr`	Controls the script bar buttons

File system

Signal can read information about files and directories and also change the current directory and delete or copy files.

`FileCopy`	Copies a file from one place to another
`FileDelete`	Delete one or more files
`FileList`	Get a list of files or directories
`FilePath$`	Get the current directory or directory for new data files
`FilePathSet`	Change the current directory or directory for new data files

Text files

Signal can create text files and read from them. You can also open a text file into a window.

`FileNew`	Open a new text file in a window
`FileOpen`	Open a text file in a window or for reading and writing
`FileSaveAs`	Save a view in variety of formats, including text
`Print`	Write formatted output to a file or log window
`Read`	Extract data from a text file

CFS variables

The following script commands read file and frame variables from CFS files written by other software. For those familiar with the CFS library for programming in DOS, the frames were referred to as data sections (DS).

`FileGetIntVar`	Read the value of an integer file variable
`FileGetRealVar`	Read the value of a floating point file variable
`FileGetStrVar$`	Read a string file variable
`FileVarCount`	Get the number of file variables in the file
`FileVarInfo`	Get the type and name of a numbered file variable
`FrameGetIntVar`	Read the value of an integer frame variable
`FrameGetRealVar`	Read the value of a floating point frame variable
`FrameGetStrVar$`	Read a string frame variable
`FrameVarCount`	Get the number of frame variables in the file
`FrameVarInfo`	Get the type and name of a numbered frame variable

Binary files

Signal can read and write binary files. These provide links to other software and are generally more efficient than text for passing large quantities of data between programs.

`FileClose`	Close a file opened in binary mode
`FileOpen`	Open an external file in binary mode
`BRead`	Extract 32-bit integer, 64-bit real and string data from a file
`BReadSize`	Extract 8 and 16-bit integer and 32-bit real data from a file
`BSeek`	Change the current file position for next read or write
`BWrite`	Write 32-bit integer and 64-bit real data to a file
`BWriteSize`	Write 8 and 16-bit integer, 32-bit real and string data to a file

Serial line control

These functions let the script writer read to and write from serial line ports on their computer. This feature can be used to control equipment during data capture, although they are not needed for controlling the signal conditioners for which the CondXXX family of commands are provided.

`SerialOpen`	Open a serial port and configure it (set Baud rate, parity etc.)
`SerialWrite`	Write characters to the serial port
`SerialRead`	Read characters from the serial port
`SerialCount`	Count the number of data items available to read
`SerialClose`	Release a previously opened serial port

Debugging operations

These functions can be used when debugging a script.

`Debug`	Set a permanent break point or disable the `Esc` key
`Eval`	Convert the argument to text and display

Environment

These functions don't fit well into any of the other categories!

`Date$`	Get system date in a string in a variety of formats
`Error$`	Convert a runtime error code to a message string
`Profile`	Read or write the registry entries used by Signal
`ScriptRun`	Set the next script to run automatically
`Seconds`	Get or set current relative time in seconds
`Sound`	Play a tone or a .wav file
`System`	Get system revision as number
`System$`	Get system name as a string
`Time$`	Get system time in a string in a variety of formats
`TimeDate`	Get system date and time as numbers
`Yield`	Allow the system to catch up on background processing

5 Alphabetical command reference

Alphabetical command reference

This section of the manual lists commands alphabetically. If you are not sure which command you require, look in the *Commands by function* chapter. You might also find the index useful as it cross-references commands and common keywords.

Abs()

This evaluates the absolute value of an expression as a real number. This can also form the absolute value of a real or integer array.

```
Func Abs(x|x[]);
```

`x`	A real number or a real or integer array.
Returns	If `x` is an array, this returns 0 if all was well, or a negative error code if integer overflow was detected. Otherwise it returns `x` if `x` is positive, otherwise `-x`.

App()

Signal is a MDI (multiple document interface) application, and lives in a window. This function returns the application window handle, and some special Signal view handles. Other Signal view handles are returned by functions creating them or finding them.

```
Func App({type%});
```

`type%` This specifies the window handle to return. If omitted the value 0 is used:

-2	The highest view handle currently used by Signal.
-1	100 times the program revision.
0	The application window, so users can resize the application.
1	The Signal system toolbar handle, so it can be hidden and shown.
2	The Signal status bar handle, so it can be hidden and shown.
3	The window handle of the running script (so you can hide it).
4	The Signal edit bar handle, so it can be hidden and shown.
5	The Signal script bar handle, so it can be hidden and shown.
6	The Signal sample configurations bar handle, so it can be hidden and shown.

Returns A handle for the selected window. If the requested window does not exist the return value is 0.

For example:

```
View(App(3));                'make script window the current view
WindowVisible(0);            'hide script window
View(App(0));                'application window is the current view
WindowVisible(3);            'resize the Signal window to mid screen
```

See also:`View(), Dup(), ViewFind(), Window(), WindowVisible()`

AppendFrame()

This function appends a new frame to the current data view, which should not be an online sampling view. The new frame will be cleared or can optionally be initialised with a copy of the current frame's data. The current frame in the view is not changed.

```
Func AppendFrame({copy%});
```

`copy%`	If this is present and non-zero the new frame will hold a copy of the current frame's data.
Returns	Zero or a negative error code.

See also:`DeleteFrame(), FrameCount(), FrameFlag(), FrameTag()`

ArrXXX() commands

These functions operate on one dimensional arrays of data, allowing you to use one script step to replace code that would otherwise need a loop such as `repeat...until`, `while...wend` or `for...next`. A loop with the equivalent operations on every item of data takes a lot longer to execute than a Signal array command that does the same thing. You can declare an array variable in your script, or an array can be the items in a channel of a data view which you access using the `View(v,c).[]` construction in place of `fred[]`. The source or destination in the following functions can be data in a view or an array variable declared with the `var` or `proc` or `func` statements.

An array argument can be an array or part of an array as described in detail in the *Arrays of data* section in the *Script language syntax* chapter. The following is a list of the array commands, followed by some examples of how they might appear in a script.

The array commands are:

```
Func ArrAdd(dest[], source[]|value);
Func ArrConst(dest[], source[]|value);
Proc ArrDiff(dest[]);
Func ArrDiv(dest[], source[]|value);
Func ArrDivR(dest[], source[]|value);
Func ArrDot(source1[],source2[]);
Func ArrFFT(dest[], mode%);
Func ArrFilt(dest[], coef[]);
Func ArrIntgl(dest[]);
Func ArrMul(dest[], source[]|value);
Func ArrSub(dest[], source[]|value);
Func ArrSubR(dest[], source[]|value);
Func ArrSum(source[]{, &mean{, &stDev}});
```

`dest`	A real or integer array, or a view, that holds the result.
`source`	A real or integer array, or a view.
`value`	A real or integer value

Integer overflow can be detected with integer destination arrays when the source or value is a real. `ArrAdd()`, `ArrConst()`, `ArrDiv()`, `ArrDivR()`, `ArrFilt()`, `ArrMul()`, `ArrSub()`, `ArrSubR()`, `ArrSum()` can all return a negative error code to indicate integer overflow.

The following are examples of what the function calls can look like in action. These are examples of using all or part of single dimension arrays.

```
var fred[100], tom[100], jim%[200];
var val:=0.5;

ArrAdd(fred[],jim%[]);      'Add elements 0-99 of jim% to fred
ArrSub(fred[],tom[]);       'Subtract each tom% from each fred
ArrSubR(fred[]),tom[]);     'The negative of the above result
ArrSub(jim%[],val);         'Subract val from all elements of jim%

ArrAdd(jim%[2:8],10);       'Add value 10 to elements 2-9 of jim%
```

These are examples of using all or part of two dimension arrays.

```
var chans[2][100];          'Array of 2 rows and 100 columns
var data[3][30];            'Array of three rows and thirty columns
var jim%[200]

ArrDot(chans[0][],chans[1][]);    'form the dot product of two rows
```

This would set first two elements of column one to the first two elements of `jim%`

```
ArrConst(data[0:2][1],jim%[]);    'copy jim% to one column of data
```

and this would do exactly the same

```
data[0][1]:=jim%[0];
data[1][1]:=jim%[1];
```

These are examples of using array arithmetic functions on data view channel data.

If `vm%` is a data view handle, and `ch%` is a channel number, the following will add the value of the single element `fred[10]` to all elements of channel `ch%` in data view

```
ArrAdd(View(vm%,ch%).[], fred[10]);
```

This will subtract data in channel 2 from channel 1 in data view vm%

```
ArrSub(View(vm%,1).[],View(vm%, 2).[]);
```

See also: `ArrAdd(), ArrConst(), ArrDiff(), ArrDiv(), ArrDivR(), ArrDot(), ArrFFT(), ArrFilt(), ArrIntgl(), ArrMul(), ArrSub(), ArrSubR(), ArrSum(), Len(), View(v,c).[]`

ArrAdd()

This function adds a constant, or an array, to an array. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrAdd(dest[], source[]|value);
```

`dest` The destination array.

`source` A source array to add element by element to the destination. If source and dest are of different sizes, the size of the smaller sets the number of elements copied.

`value` A value to be added to all elements of the destination array.

Returns The function returns 0 if all was well, or a negative error code for integer overflow. Overflow is detected when adding a real array to an integer array and the result is set to the nearest valid integer.

See also: `ArrXXX(),ArrConst(), ArrDiv(), ArrDivR(), ArrDot(), ArrMul(), ArrSub(), ArrSubR(), ArrSum(), Len(), BuffAdd(), BuffAddTo(), View(v,c).[]`

ArrConst()

This function sets array elements to a constant value, or copies the elements of an array to another array. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrConst(dest[]|dest%[], source[]|value);
```

`dest` The destination real or integer array.

`source` A source array to be copied to the destination. If source and dest are of different sizes, the size of the smaller determines the number of elements copied.

`value` A value to be copied to all elements of the destination array.

Returns The function returns 0, or a negative error code. If an integer overflows, the element is set to the nearest integer value to the result.

See also: `ArrXXX(),ArrAdd(), ArrDiv(), ArrDivR(), ArrDot(), ArrMul(), ArrSub(), ArrSubR(), ArrSum(), BuffCopy(), BuffCopyTo(), BuffExchange(), Len(), View(v,c).[]`

ArrDiff()

This procedure replaces an array with an array of differences. You can use this as a crude form of differentiation, however `ArrFilt()` provides a better method. See `ArrXXX()` for examples of using arrays as arguments.

```
Proc ArrDiff(dest[]);
```

`dest[]` A real or integer array that is to be replaced by an array of differences. The first element of the array is left unchanged.

The effect of the `ArrDiff()` function can be undone by `ArrIntgl()`. The following two blocks of code perform the same function:

```
var work[100],i%;
...
ArrDiff(work[]);                   'Form differences
...
for i%:=99 to 1 step -1 do         'Form differences the hard way
  work[i%] := work[i%] - work[i%-1];
  next;
```

See also:`ArrXXX(),ArrFilt(), ChanDiff(), Len(), View(v,c).[]`

ArrDiv()

This function divides a real or integer array by an array or a constant. Use `ArrDivR()` to form the reciprocal of an array. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrDiv(dest[], source[]|value)
```

`dest` An array of reals or integers.

`source` An array of reals or integers used as the denominator of the division.

`value` A value used as the denominator of the division.

Returns The function returns 0 if there were no problems, or a negative error code.

The following examples show the effect of the various combinations of arguments:

```
var dest[100], source[100], value, i%;
ArrDiv(dest[],source[]);           'Is equivalent to...
for i%:=0 to 99 do
  dest[i%] := dest[i%] / source[i%];
  next;

ArrDiv(dest[],value);              'Is equivalent to...
for i%:=0 to 99 do
  dest[i%] := dest[i%]/value;
  next;
```

See also: `ArrXXX(),ArrAdd(), ArrConst(), ArrDiff(), ArrDivR(), ArrDot(), ArrMul(), ArrSub(), ArrSubR(), ArrSum(), BuffDiv, BuffDivBy(), Len(), View(v,c).[]`

ArrDivR()

This function (Array Divide Reversed) divides a real or integer array into an array or a constant. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrDivR(dest[], source[]|value);
```

`dest`	An array of reals or integers used as the denominator of the division and for storage of the result.
`source`	An array of reals or integers used as the numerator of the division.
`value`	A value used as the numerator of the division.
Returns	The function returns 0 if there were no problems, or a negative error code if there was a problem (for example division by zero or integer overflow).

The following examples show the effect of the various combinations of arguments:

```
var dest[100], source[100], value, i%;
 ArrDivR(dest[],source[]);       'Is equivalent to...
for i%:=0 to 99 do
  dest[i%] := source[i%] / dest[i%];
  next;

ArrDivR(dest[],value);           'Is equivalent to...
for i%:=0 to 99 do
    dest[i%] := value / dest[i%];
    next;
```

See also:`ArrXXX(),ArrAdd(), ArrConst(), ArrDiv(), ArrDot(), ArrMul(), ArrSub(), ArrSubR(), ArrSum(), BuffDiv(), BuffDivBy(), Len(), View(v,c).[]`

ArrDot()

This function multiplies one array by another and returns the sum of the products (sometimes called the dot product of two arrays). The arrays are not changed. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrDot(arr1[], arr2[]);
```

`arr1`	An array of reals or integers.
`arr2`	An array of reals or integers.
Returns	The function returns the sum of the products of the corresponding elements of `arr1` and `arr2`.

See also: `ArrXXX(),ArrAdd(), ArrConst(), ArrDiff(), ArrDiv(), ArrDivR(), ArrFFT(), ArrFilt(), ArrIntgl(), ArrMul(), ArrSub(), ArrSubR(), ArrSum(), Len(), View(v,c).[]`

ArrFFT()

This command performs spectral analysis on an array of data. Variants of this command produce log amplitude, linear amplitude, power and relative phase as well as an option to window the original data. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrFFT(dest[], mode%);
```

`dest`	An array of real numbers to process. The array should be a power of two and at least eight points long. If the number of points is not a power of two, the size is reduced to the next lower power of two points.
`mode%`	The mode of the command, in the range 0 to 5. Modes are defined below.
Returns	The function returns 0 or a negative error code.

Modes 1 and 3-5 take an array of data that is a set of equally spaced samples in some unit (usually time). If this unit is `xin`, the output is equally spaced in units of 1/`xin`. In the normal case of input equally spaced in seconds, the output is equally spaced in 1/seconds, or Hz. If there are `n` input points, and the interval between the input points is `t`, the spacing between the output points is `1/(n*t)`. The transform assumes that the sampled waveform is composed of sine and cosine waves of frequencies: `0`, `1/(n*t)`, `2/(n*t)`, `3/(n*t)` up to `(n/2)/(n*t)` or `1/(2*t)`.

Display of phase in data views

The phase information sits rather uncomfortably in a data view. When it is drawn, the x axis has the correct increment per bin, but starts at the wrong frequency. If you need to draw it, the simplest solution is to copy the phase information to bin 1 from bin n/2+1 and set bins 0 and n/2 to 0 (this destroys any amplitude information):

```
ArrConst(View(0,1).[1:], View(0,1).[n/2+1:]); 'Copy phase to start
View(0,1).[0]:=0; View(0,1).[n/2]:=0; 'Clear DC and Nyquist points
View(0).Draw(0, MaxTime()/2);                     'Display the phase
```

Mode 0: Window the data

This mode is used to apply a raised cosine window to the data array. See `SetPower()` for an explanation of windows. The selected data is multiplied by a raised cosine window of maximum amplitude 1.0, minimum amplitude 0.0. This window causes a power loss in the result of a factor of 3/8.

You can supply your own window to taper the data, using the array arithmetic commands. The raised cosine is supplied as a general purpose window.

Mode 1: Forward FFT

This mode replaces the data with its forward Fast Fourier Transform. You could use this to remove frequency components, then perform the inverse transform. The output of this mode is in two parts, representing the real and imaginary result of the transform (or the cosine and sine components). The first n/2+1 points of the result hold the amplitudes of the cosine components of the result, the remaining n/2-1 points hold the amplitudes of the sine components. In the case of an 8 point transform, the output has the format:

point	frequency	contents	point	frequency	contents
0	DC(0)	amplitude	4	4/(n*t)	cosine amplitude
1	1/(n*t)	cosine amplitude	5	1/(n*t)	sine amplitude
2	2/(n*t)	cosine amplitude	6	2/(n*t)	sine amplitude
3	3/(n*t)	cosine amplitude	7	3/(n*t)	sine amplitude

There is no sine amplitude at a frequency of 4/(n*t) as this sine wave has amplitude 0 at all sampled points.

Mode 2: Inverse FFT

This mode takes data in the format produced by the forward transform and converts it back into a time series. In theory, the result of mode 1 followed by mode 2, or mode 2 followed by mode 1, would be the original data. However, each transform adds some noise due to rounding effects in the arithmetic, so the transforms do not invert exactly.

One use of modes 1 and 2 is to filter data. For example, to remove high frequency noise use mode 1, set unwanted frequency bins to 0, and use mode 2 to reconstruct the data.

Mode 3: dB and phase

This mode produces an output with the first n/2+1 points holding the log amplitude of the power spectrum in dB, and the second n/2-1 points holding the phase (in radians) of the data. In the case of our 8 point transform the output format would be:

point	frequency	contents	point	frequency	contents
0	DC	log amplitude in dB	4	4/(n*t)	log amplitude in dB
1	1/(n*t)	log amplitude	5	1/(n*t)	phase in radians
2	2/(n*t)	log amplitude	6	2/(n*t)	phase in radians
3	3/(n*t)	log amplitude	7	3/(n*t)	phase in radians

There is no phase information for DC or for the point at 4/(n*t) because the phase for both of these is zero. If you want phase in degrees, multiply by 57.3968 . The log amplitude is calculated by taking the result of a forward FFT (same as mode 1 above) and forming:

$dB = 10.0\ \mathrm{Log}(power)$ Power as defined for mode 5

Mode 4: Amplitude and phase

This mode produces the same output format as mode 3, but with amplitude in place of log amplitude. The amplitude is calculated by taking the result of a forward FFT (same as mode 1 above), and forming:

$amplitude = (\cos^2+\sin^2)^{0.5}$

Mode 5: Power and phase

This mode produces the same output format as modes 2 and 3, but with the result in terms of RMS power. The power is calculated by taking the result of a forward FFT (same as mode 1 above), and forming:

$power = \ = (\cos^2+\sin^2) * 0.5$ for all components except the DC and Nyquist
$power = \ DC^2 \text{ or } Nyquist^2$ for the DC and Nyquist components

You can compare the output of this mode with the result of `SetPower()`. If you have a waveform channel on channel 2 in view 1, with at least 1024 data points and do the following:

```
var dView%,spView%, m%;            'assume we are in a time view
var ch%:=2;                        'use data from channel 2
var xRes;                          'x resolution to apply to result

dView%:=View(0);                   'store handle for data view
spView% := SetPower(ch%,1024);     'select power spectrum channel 1
Process(0);                        'process first 1024 data points
WindowVisible(1);                  'make new memory view visible
xRes:=BinSize(1);                  'get spectrum resolution in Hz
m%:=SetMemory(1,1024,xRes,0,0,0,0,"FFT","Hz","Volt^2","","Power");
' created memory view ready to hold 1024 points for transformation
WindowVisible(1);                  'make new memory view visible
ArrConst(View(m%,1).[],View(dView%,ch%).[]);  'copy channel data
ArrFFT(View(m%,1).[], 0);          'apply raised cosine window to it
ArrFFT(View(m%,1).[], 5);                       'take power spectrum
ArrMul(View(m%,1).[0:513], 4.0/3.0);            'adjust amplitude
Draw(0,500*BinSize(1));  Optimise(1);    'show 500 bins of power
View(spView%);                           'look at SetPower() result
Draw(0,500*BinSize(1)); Optimise(1);     'show same bins of power
```

The two results are identical. The view generated by `ArrFFT()` would be 3/8 of the amplitude of the view generated by `SetPower()`. The reason for the difference is that the `SetPower()` command compensates for the effect of the window it uses internally by multiplying the result by 8/3. To produce the same numeric result, multiply by 8/3.

Note: The behaviour of the ArrFFT function in mode 5 (Power and Phase) was altered in version 1.60 of Signal. Previous versions produced a result which was 3/4 of the `SetPower()` result.

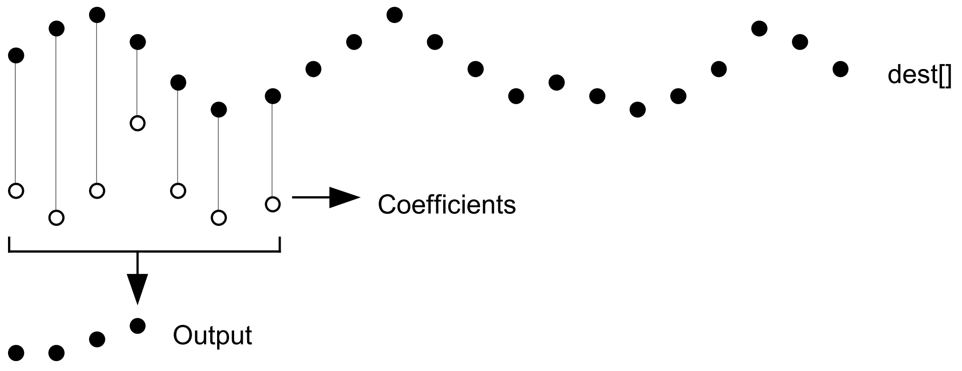
See also: `ArrXXX(),ArrAdd(), ArrConst(), ArrDiff(), ArrDiv(), ArrDivR(), ArrDot(), ArrFilt(), ArrIntgl(), ArrMul(), ArrSub(), ArrSubR(), ArrSum(), Len(), SetPower(), View(v,c).[]`

ArrFilt()

This function filters a real array by replacing each element by the product of a coefficient array and the surrounding elements of the original array. This implements a FIR (Finite Impulse Response) filter. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrFilt(dest[], coef[]);
```

`dest[]`	A real array holding the data to be filtered. It is replaced by the filtered data.
`coef[]`	A real array of filter coefficients. This array is usually an odd number of data points long so that the result is not phase shifted.
Returns	The function returns 0 if there was no error, or a negative error code.

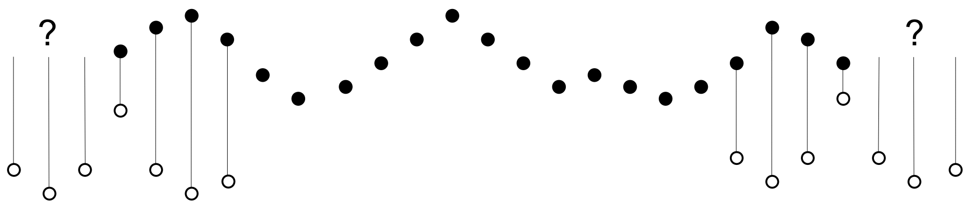


This diagram shows the general principle of the FIR filter. The hollow circles represent the filter coefficients, and the solid circles are the input and output waveforms. Each output point is generated by multiplying the waveform by the coefficients and summing the result. The coefficients are then moved one step to the right and the process repeats.

From this description, you can see that the filter coefficients (from right to left) are the *impulse response* of the filter. The impulse response is the output of a filter when the input signal is all zero except for one sample of unit amplitude.

In the example above with seven coefficients, there is no time shift caused by the filter. If the filter uses an even number of coefficients, there is a time shift in the output of half a sample period.

The filter operation is applied to every element of the array. To do this at the start and end of the array there is a problem as some of the coefficients have no corresponding data element.



The simple solution is to take these missing points as copies of the first and last points. This is usually better that taking these points as 0. You should remember that the first and last (*nc*+1)/2 points are unreliable, where *nc* is the number of coefficients.

A simple use of this command is to produce three point smoothing of data, replacing each point by the mean of itself and the two points on either side:

```
var data[1000],coef[3];     'arrays of data and the coefficients
...                         'fill data[] with values
ArrConst(coef[],0.33333);   'set all three coefficients to 0.33333
ArrFilt(data[],coef[]);     'smooth the data.
```

A more complicated example would be to implement a differentiator to calculate the slope or gradient of an array. The simplest case is to use two points:

```
coef[0]:=-1; coef[1]:=1;      'simple difference
ArrFilt(data[], coef[0:1]);   'for differences, equivalent to...
ArrDiff(data[]);              '... just using the differences
```

A simple difference produces a very crude differentiator. A slightly better one, with three coefficients is:

```
coef[0] := -0.5; coef[1] := 0.0; coef[2] := 0.5;
ArrFilt(data[], coef[]);
```

You can improve the result with more points, for example for 4 points, the coefficients are -0.3, -0.1, 0.1, 0.3 and for five points try -0.2, -0.1, 0.0, 0.1, 0.2. It is more usual to use an odd number of points as this does not cause a shift of the result by half a point.

See also: `ArrXXX(),ArrAdd(), ArrConst(), ArrDiv(), ArrDivR(), ArrDot(), ArrFFT(), ArrMul(), ArrSub(), ArrSubR(), ArrSum(), ChanSmooth(), Len(), View(v,c).[]`

ArrIntgl()

This procedure is the inverse of `ArrDiff()`, replacing each point by the sum of the points from the start of the array up to the element. See `ArrXXX()` for examples of using arrays as arguments.

```
Proc ArrIntgl(dest[]);
```

`dest`	An array or real or integer data.

Each element of the array is replaced by the sum of all the elements up to and including that element. The function is equivalent to the following:

```
for i%:=1 to Len(dest[])-1 do
    dest[i%] := dest[i%] + dest[i%-1];
```

See also: `ArrXXX(),ArrDiff(), ChanIntgl(), Len(), View(v,c).[]`

ArrMul()

This command is used to form the product of a pair of arrays, or to scale an array by a constant. A less obvious use is to negate an array by multiplying by -1. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrMul(dest[], source[]|value);
```

`dest`	An array of reals or integers.
source	An array of reals or integers to multiply the data in `dest`, element by element.
value	A value to multiply the data in `dest`.
Returns	The function returns 0 if all was well, or a negative error code.

If the `dest` array is integer, the multiplications are done as reals and truncated to integer.

See also: `ArrXXX(),ArrAdd(), ArrConst(), ArrDiv(), ArrDivR(), ArrDot(), ArrSub(), ArrSubR(), ArrSum(), BuffMul(), BuffMulBy(), Len(), View(v,c).[]`

ArrSub()

This function forms the difference of two arrays or subtracts a constant from an array. Integer overflow is detected with integer destination arrays when the source or value is a real. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrSub(dest[], source[]|value);
```

`dest` A real or integer array, or a view, that holds the result.

`source` A real or integer array, or a view.

`value` A real or integer value.

Returns If no overflow is detected, the function returns 0. Overflow is flagged by a negative error code.

The function performs the following operations:

```
var dest[100], source[100], value, i%;
ArrSub(dest[],source[]);          'Is equivalent to...
for i%:=0 to 99 do
    dest[i%] := dest[i%] - source[i%];
    next;

ArrSub(dest[],value);             'Is equivalent to...
for i%:=0 to 99 do
    dest[i%] := dest[i%] - value;
    next;
```

See also: `ArrXXX(),ArrAdd(), ArrConst(), ArrDiff(), ArrDiv(), ArrDivR(), ArrDot(), ArrMul(), ArrSubR(), ArrSum(), BuffSub(), BuffSubFrom(), Len(), View(v,c).[]`

ArrSubR()

This function forms the difference of two arrays or subtracts an array from a constant. Integer overflow is detected with integer destination arrays when the source or value is a real. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrSubR(dest[], source[]|value);
```

`dest` A real or integer array that holds the result.

`source` A real or integer array.

`value` A real or integer value.

Returns If no overflow is detected, the function returns 0. Overflow is flagged by a negative error code.

The function performs the following operations:

```
var dest[100], source[100], value, i%;
ArrSubR(dest[],source[]);         'Is equivalent to...
for i%:=0 to 99 do
    dest[i%] := source[i%] - dest[i%];
    next;

ArrSubR(dest[],value);            'Is equivalent to...
for i%:=0 to 99 do
    dest[i%] := value - dest[i%];
    next;
```

See also: `ArrXXX(),ArrSub(), ArrSum(), BuffSub(), BuffSubFrom(), Len(), View(v,c).[]`

ArrSum()

This function forms the sum of the values in an array, and optionally forms the mean and standard deviation. See `ArrXXX()` for examples of using arrays as arguments.

```
Func ArrSum(arr[]|arr%[]{, &mean{, &stDev}});
```

`arr`	A real or integer array to process.
`mean`	If present it is returned holding the mean of the values in the array. The mean is the sum of the values divided by the number of array elements.
`stDev`	If present, this is returns the standard deviation of the array elements. If the array has only one element the result is 0. It is equivalent to:

```
Func StDev(arr[])
var n%, i%, mean, sumSq:=0.0, temp;
n% := Len(arr[]);         'get array size
mean := ArrSum(arr[])/n%;'mean value
for i%:=0 to n%-1 do     'form sum of squares
    temp := arr[i%] - mean;
    sumSq := sumSq + temp * temp;
    next;
if (n%>1) then
    return Sqrt(sumSq/(n%-1));
else
    return 0.0;
endif;
end;
```

Returns The function returns the sum of the array elements

See also: `ArrXXX()`,`ArrAdd()`, `ArrConst()`, `ArrDiff()`, `ArrDiv()`, `ArrDivR()`, `ArrDot()`, `ArrFFT()`, `ArrFilt()`, `ArrIntgl()`, `ArrMul()`, `ArrSub()`, `ArrSubR()`, `Len()`, `View(v,c).[]`

Asc()

This function returns the ASCII code of the first character in the string as an integer.

```
Func Asc(text$);
```

`text$` The string to process.

See also:`Chr$()`, `%c` format in `Print()`,

ATan()

This function returns the arc tangent of an expression, or the arc tangent of an array:

```
Func ATan(s|s[] {,c});
```

`s`	If the only argument, the function uses this for the arc tangent calculation. `s` can also be a real array (in which case `c` must not be present).
`c`	If this is present, the function uses `s/c` for the calculation.

Returns If s is an array, each element of s is replaced by its arc tangent in the range -**pi**/2 to **pi**/2 radians. The function returns 0 if all was well or a negative error code.

When `s` is not an array, if `s` is the only argument, the function returns the arc tangent of `s` in the range -**pi**/2 to **pi**/2. If `c` is present, the function calculates the result of `ATan(s/c)` and uses the signs of `s` and `c` to decide the quadrant of the result. With the second argument, the result is in the range -**pi** to **pi**.

See also:`Cos()`, `Sin()`, `Tan()`

BinError()

This function is used in a memory or file view with error bins enabled to access the error information. Error bins are created for a memory view created with `SetAverage()` or `SetAutoAv()` with the last agrgument set to 1 and are subsequently stored in the cfs file if the memory view is saved.

```
Func BinError(chan%, bin% {,newSD});
```

`chan%`	The channel number in the memory view.
`bin%`	The bin number to get or set the error information.
`newSD`	You can display error information in several ways, but this function always works in terms of the standard deviation of the data.
Returns	The standard deviation at the time of the call. If there is less than 2 sweeps of data, or errors are not enabled, the result is 0.

To illustrate how errors are calculated, we will assume that we are dealing with an average set to display the mean of the data in each bin. In terms of the script language, if the array `s[]` holds the contribution of each sweep to a particular bin, the mean, standard deviation and standard error of the mean are calculated as follows:

```
var mean, sd:=0, i%, diff, sem;
for i%:= 0 to Sweeps()-1 do
    mean += s[i%];             'form sum of data
    next;
mean /= Sweeps();              'form mean data value
for i%:= 0 to Sweeps()-1 do
    diff := s[i%]-mean;        'difference from mean
    sd += diff*diff;           'sum squares of differences
    next;
sd := Sqrt(sd/(Sweeps()-1));   'the standard deviation
sem := sd/Sqrt(Sweeps());      'the standard error of the mean
```

We divide by `Sweeps()-1` to form the standard deviation because we have lost one degree of freedom due to calculating the mean from the data.

See also: `BinSize()`, `BinToX()`, `SetAutoAv()`, `SetAverage()`, `Sweeps()`, `XToBin()`

BinSize()

The value returned by this function is normally the x axis increment per point but depends upon the channel type. You can set the bin size in a memory view only.

```
Func BinSize(chan%, {nSize})
```

`chan%`	The channel number (1 to n) for which to return information.
`nSize`	If this is present it sets a new x axis resolution in a memory view.
Returns	The returned value is negative if the channel doesn't exist. Otherwise the value returned depends on the channel type:

Waveform	This is the x axis interval between points on the channel. For sampled data this is the sample interval.
Marker	The underlying x axis resolution of the channel.

See also:`BinToX()`, `XToBin()`, `SampleRate()`

BinToX()

This function converts between bin numbers and x axis units in the current view.

```
Func BinToX(chan%, bin);
```

`chan%` The channel (1 to n) for which to return information.

`bin` A bin number in the view. You can give a non-integer bin number without error. If you give a bin number outside the range of the view, the bin number is limited to the range of the view.

Returns The returned value is zero if the channel doesn't exist. Otherwise it is the equivalent x axis position.

See also:`BinSize(), XToBin(), BinZero()`

BinZero()

This function returns the x axis position for the first bin in the frame on the given channel. In a memory view you can also set this.

```
Func BinZero(chan%{,offset});
```

`chan%` The channel (1 to n) for which to return information.

`offset` If this is provided it sets a new x axis position for the first data point for channels in a memory view.

Returns The returned value is zero if the channel doesn't exist. Otherwise it is the equivalent x axis position of the start of the data.

See also:`BinToX(), XToBin(), BinZero()`

BRead()

This reads data into variables and arrays from a binary file opened by `FileOpen()`. The function reads 32-bit integers, 64-bit IEEE real numbers and zero terminated strings.

```
Func BRead(&arg1|arg1[]|&arg1%|arg1%[]|&arg1$|arg1$[] {,...});
```

`arg` Up to 20 arguments of any type. Signal reads a block of memory equal in size to the combined size of the arguments and copies it into the arguments. Strings or string arrays are read a byte at a time until a zero byte is read.

Returns It returns the number of data items for which complete data was read. This will be less than the number of items in the list if end of file was reached. If an error occurred during the read, a negative code is returned.

See also:`FileOpen(), BReadSize(), BSeek(), BWrite()`

BReadSize()

This converts data into variables and arrays from a binary file opened by `FileOpen()`. The function reads 8, 16 and 32-bit integers and converts them to 32-bit integers, and 32 and 64-bit IEEE real numbers and converts them to 64-bit reals. It also reads strings from fixed size regions in the file (zeros are ignored during the read). The read is from the current file position. The current position after the read is the byte after the last byte read.

```
Func BReadSize(size%, &arg|arg[]|&arg%|arg%[]|&arg$|arg$[]{,...});
```

`size%` The bytes to read for each argument. Legal values depend on the argument type:

Integer	1,2 or 4	Read 1, 2 or 4 bytes and sign extend to 32-bit integer.
	-1,-2	Read 1 or 2 bytes and zero extend to 32-bit integer.
Real	4	Read 4 bytes as 32-bit real, convert to 64-bit real.
	8	Read 8 bytes as 64-bit real.
String	n	Read n bytes into a string. Null characters end the string.

`arg` Up to 19 target variable(s) to be filled with data. `size%` applies to all targets.

Returns It returns the number of data items for which complete data was read. This will be less than the number of items in the list if end of file was reached. If an error occurred during the read, a negative code is returned.

See also:`FileOpen(), BRead(), BSeek(), BWrite()`

BSeek()

This function moves and reports the current position in a binary file opened by `FileOpen()`. The next binary read or write operation to the file starts from the position returned by this function.

```
Func BSeek({pos% {, rel%}});
```

`pos%` The new file position. Positions are measured in terms of the byte offset in the file from the start, the current position, or from the end. If a new position is not given, the position is not changed and the function returns the current position.

`rel%` This determines to what the new position is relative.
0 Relative to the start of the file (same as omitting the argument)
1 Relative to the current position in the file
2 Relative to the end of the file

Returns The new file position relative to the start of the file or a negative error code.

See also:`FileOpen(), BReadSize(),BRead(), BWrite()`

BuffXXX() Buffer commands

The `Buff…` family of commands can be used to carry out arithmetic on sets of data frames using the built-in frame buffer. The frame buffer is an extra frame of data attached to a data document that is provided automatically by Signal. This can be used to hold the results of arithmetic on frames, or to modify the document data. To help to avoid confusion, commands that modify buffer data all have a simple name such as `BuffSub`, or `BuffCopy`, while commands that modify the document frame data have qualified names such as `BuffSubFrom` or `BuffCopyTo`.

Nearly all of the `BuffXXX` commands require a `frame%` argument. This specifies the frame in the data document that is to be used if omitted the current frame is used. The current frame in the view is not changed.

The buffer commands do not have channel specification arguments as they operate on all channels. If you require more precise control over frame arithmetic operations, this can be achieved by creating an invisible view to act as a buffer using `SetCopy()` or `SetMemory()`, and then manipulation the frame data directly.

You can access the built-in interactive support for using the frame buffer from the analysis menu or by using the multiple frame dialog.

See also:`ShowBuffer(), BuffAdd(), BuffAddTo(), BuffAcc(), BuffClear(), BuffCopy(), BuffCopyTo(), BuffDiv(), BuffDivBy(), BuffExchange(), BuffMul(), BuffMulBy(), BuffSub(), BuffSubFrom(), BuffUnAcc(), SetCopy(), SetMemory()`

BuffAdd()

This adds the specified frame data to the frame buffer for the current view document.

```
Func BuffAdd({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrAdd`(), View(v,c).[], BuffXXX()`

BuffAddTo()

This adds the frame buffer for the current view document to the specified frame data.

```
Func BuffAddTo({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrAdd`(), View(v,c).[], BuffXXX()`

BuffAcc()

This adds the specified frame data to an average in the frame buffer for the current view document. The addition is carried out in such a way as to maintain the data as an average, which can be eg. subtracted from data frames. If you mix `BuffAcc()` and `BuffAdd()` operations, the overall effect will probably be rather messy.

```
Func BuffAcc({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrAdd`()`, `BuffUnAcc()`, `View(v,c).[]`, `BuffXXX()`

BuffClear()

This clears the data in the frame buffer for the current view document.

```
Func BuffClear();
```

Returns Zero or a negative error code.

See also:ArrConst`()`, `View(v,c).[]`, `BuffXXX()`

BuffCopy()

This copies the specified frame data to the frame buffer for the current view document.

```
Func BuffCopy({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrConst`()`, `View(v,c).[]`, `BuffXXX()`

BuffCopyTo()

This copies the frame buffer data for the current view document into the specified data frame.

```
Func BuffCopyTo({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrConst`()`, `View(v,c).[]`, `BuffXXX()`

BuffDiv()

This divides the frame buffer for the current view document by the specified frame data.

```
Func BuffDiv({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrDiv`()`, `View(v,c).[]`, `BuffXXX()`

BuffDivBy()

This divides the specified frame data by the frame buffer for the current view document.

```
Func BuffDivBy({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrDiv`()`, `View(v,c).[]`, `BuffXXX()`

BuffExchange()

This exchanges the specified frame data with the frame buffer data for the current view document.

```
Func BuffExchange({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrConst`()`, `View(v,c).[]`, `BuffXXX()`

BuffMul()

This multiplies the frame buffer for the current view document by the data in the specified frame.

```
Func BuffMul({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrMul`()`, `View(v,c).[]`, `BuffXXX()`

BuffMulBy()

This multiplies the specified frame data by the frame buffer for the current view document.

```
Func BuffMulBy({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrMul`()`, `View(v,c).[]`, `BuffXXX()`

BuffSub()

This subtracts the specified frame data from the frame buffer for the current view document.

```
Func BuffSub({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrSub`()`, `View(v,c).[]`, `BuffXXX()`

BuffSubFrom()

This subtracts the frame buffer for the current view document from the specified frame data.

```
Func BuffSubFrom({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrSub`(), View(v,c).[], BuffXXX()`

BuffUnAcc()

This subtracts the specified frame data from an average in the frame buffer for the current view document. The arithmetic is carried out in such a way as to maintain the data as an average with the specified frame now not included. If the frame was never included in the average, or if you mix `BuffUnAcc()` and `BuffSub()` operations, the overall effect will probably be rather messy.

```
Func BuffUnAcc({frame%});
```

`frame%` The frame number in the data document for the current view. If omitted, the current frame in the view is used.

Returns Zero or a negative error code.

See also:ArrSub`(), BuffAcc(), View(v,c).[], BuffXXX()`

BWrite()

This function writes binary data values and arrays into a binary file opened or created by `FileOpen()`. The function can write 32-bit integers, 64-bit IEEE real numbers and strings. The output is at the current position in the file. The current position after the write is the byte after the last byte written.

```
Func BWrite(arg1 {,arg2 {,...}});
```

`arg` Up to 20 arguments of any type, including arrays. Signal fills a block of memory equal in size to the combined size of the arguments with the data held in the arguments and copies it to the file.

An integer uses 4 bytes and a real uses 8 bytes. A string is written as the bytes in the string and plus an extra zero byte to mark the end. Use `BWriteSize()` to write a fixed number of bytes.

Returns It returns the number of arguments for which complete data was written. If an error occurred during the write, a negative code is returned.

See also:`FileOpen(), BWriteSize(), BRead(), BReadSize()`

BWriteSize()

This writes variables or arrays as binary into a file opened or created by `FileOpen()`. The function can write 8, 16 and 32-bit integers, 32 and 64-bit reals and strings. This allows you to write formats other than the 32-bit integer and 64-bit real used internally by Signal and to write variable length strings into fixed size fields in a binary file.

```
Func BWriteSize(size%, arg1 {,arg2 {,...}});
```

`size%` Bytes to write for each argument (or array element if the argument is an array). Legal values depend on the argument type:

Integer	1,2	Write least significant 1 or 2 bytes
	4	Write all 4 bytes of the integer
Real	4	Convert to 32-bit real and write 4 bytes
	8	Write 8 bytes as 64-bit real
String	n	Write n bytes. Pad with zeros if the string is too short

`arg` Up to 19 target variable(s) to be filled with data. `size%` applies to all targets.

Returns It returns the number of data items for which complete data was written or a negative error code.

See also:`FileOpen(), BWrite(), BRead(), BReadSize()`

ChanCount()

This counts channels in a data or XY view.

```
Func ChanCount({chan%});
```

`chan%` If present, this specifies the channels to count (this is ignored for XY views). If omitted, the total channel count is returned. It can be -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.

Returns The returned value is the number of channels of the specified type.

See also:`ChanList()`

ChanDelete()

This function deletes a channel from an XY view. You have the option of having the user confirm the deletion if the channel is stored in the file. You cannot delete the last XY channel as XY views must always have at least one channel. Channels are always numbered consecutively, so if you delete a channel, the channel numbers of any higher numbered channels will change. Changes will not become permanent until the XY view is saved.

```
Func ChanDelete(chan% {,query%});
```

`chan%` The channel to delete, from 1 to the number of channels in the view.

`query%` If present and non-zero, the user is asked to confirm the channel deletion if the channel is part of a saved data file.

Returns 0 if the channel was deleted or a negative error code if the user cancelled the operation or tried to delete the last XY channel or for other problems.

See also:`XYDelete(), XYSetChan()`

ChanDiff()

This differentiates the data in specifed waveform channels of the current frame in the current view. If the frame buffer is being shown, the frame buffer data is used instead. All data points in the channels used are modified.

```
Func ChanDiff(chan%|chan%[]|chan$);
```

`chan%` This sets the channel to use. This can be the channel number (1 to n), -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.

This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.

`chan$` A string to specify channel numbers, such as "1,3..8,9,11..16".

Returns 0 or a negative error code.

See also:`ShowBuffer(), ChanShow(), ChanZero(), ArrDiff()`

ChanIntgl()

This integrates the data in specifed waveform channels of the current frame in the current view. If the frame buffer is being shown, the frame buffer data is used instead. All data points in the channels used are modified.

```
Func ChanIntgl(chan%|chan%[]|chan$);
```

`chan%` This sets the channel to use. This can be the channel number (1 to n), -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.

This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.

`chan$` A string to specify channel numbers, such as "1,3..8,9,11..16".

Returns 0 or a negative error code.

See also:`ShowBuffer(), ChanShow(), ChanZero(), ArrIntgl()`

ChanItems()

This counts waveform points, or markers, in a data view over an x axis range.

```
Func ChanItems(chan%, start, finish);
```

`chan%` The channel number (1 to n) for which to return information.

`start` The start position in x axis units. If start is greater than finish, the result is 0.

`finish` The last position in x axis units. If start equals finish, only items that fall exactly at the position count towards the result.

Returns The returned value is negative if the channel doesn't exist. Otherwise it is the number of data items in the range. This will be a count of markers or waveform points depending on the channel type.

See also:`ChanRange(), ChanPoints(), View(v,c).[], XYRange()`

ChanKind()

This returns the type of a channel in the current data or XY view.

`Func ChanKind(chan%)`

`chan%` The channel number (1 to n) for which to return information.

Returns -1 for a bad channel number, -2 if not a data or XY view, or:

0	Waveform	1	Marker	2	Text Marker (future)
3	XY channel				

See also:`ViewKind()`

ChanList()

This function generates an array of channel numbers from the current data or XY view. The channels can be filtered to show only a subset of the available channels.

`Func ChanList(list%[] {, types%});`

`list%` An integer array to fill with channel numbers. Element 0 is set to the number of channels returned. The remaining elements are channel numbers. If the array is too short, enough channels are returned to fill the array. You will find that it is unnecessary to list all the channel numbers for an XY view, since they are numbered contiguously.

`types%` This argument specifies which channels to return. If omitted, all channels are returned. The values are the same as those defined for `mask%` with the `DlgChan()` function. This argument is ignored in an XY view where all channels are the same type.

Returns The number of channels that would be returned if the array was of unlimited length or 0 if the view is not a data or XY view.

See also:`ChanShow(), ChanCount(), ChanDelete(), DlgChan(), XYSetChan()`

ChanMean()

This forms the mean level of a waveform channel in an x axis range.

`Func ChanMean(chan%, start, finish[, stDev]);`

`chan%` The channel number (1 to n) for which to form the mean.

`start` The start position in x axis units. If start is greater than finish, the result is 0.

`finish` The last position in x axis units.

`stDev` If present, this is returns the standard deviation of the data values in the range. If there is only one item the result is 0.

Returns It returns the sum of the data values in the range divided by the number of items. If the channel is not a waveform channel the script will fail.

See also:`ArrSum(), ChanMeasure()`

ChanMeasure()

This performs any of the cursor regions measurements on a channel.

```
Func ChanMeasure(chan%, type%, start|start$, end|end$);
```

`chan%` The channel number (1 to n) on which to perform the measurement.

`type%` The type of measurement to take, see the documentation of the Cursor Regions window for details of these measurements. The possible values are:

```
1   Curve area        2   Mean              3   Slope
4   Area              5   Sum               6   Modulus
7   Maximum           8   Minimum           9   Amplitude
10  RMS Amplitude     11  Standard dev.     12  Absolute maximum
13  Peak              14  Trough
```

`start` The start position for the measurement in x axis units. If start is greater than finish, the result is 0.

`start$` The start position for the measurement expressed as a string. This allows constructs such as “Cursor(1)” to be used.

`end` The end position in x axis units.

`end$` The end position as a string. If the start value is a string, the end value must be a string as well.

Returns The function returns the requested measurement value.

See also: `ArrSum(), ChanMean(), ChanValue()`

ChanNegate()

This negates (inverts) the data in specifed waveform channels of the current frame in the current view. If the frame buffer is being shown, the frame buffer data is used instead. All data points in the channels used are modified.

```
Func ChanNegate(chan%|chan%[]|chan$);
```

`chan%` This sets the channel to use. This can be the channel number (1 to n), -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels, -6 for selected channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.

This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.

`chan$` A string to specify channel numbers, such as "1,3..8,9,11..16".

Returns 0 or a negative error code.

See also: `ShowBuffer(), ChanShow(), ChanZero(), ArrMul()`

ChanNumbers()

You can show and hide channel numbers in the current view and get the channel number state with this function. It is not an error to use this with data views that do not support channel number display, but the command has no effect.

```
Func ChanNumbers({show%});
```

`show%` If present, 0 hides the channel number, and 1 shows it. Other values are reserved (and currently have the same effect as 1).

Returns The channel number display state at the time of the call.

See also: `YAxis(), YAxisMode()`

ChanOffset()

This offsets the data in specifed waveform channels of the current frame in the current view by adding a constant value to it. If the frame buffer is being shown, the frame buffer data is used instead. All data points in the channels used are modified.

```
Func ChanOffset(chan%|chan%[]|chan$, val);
```

`chan%`	This sets the channel to use. This can be the channel number (1 to n), -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels. This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.
`chan$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
val	The value to add to the data, which can be negative for offsetting down.
Returns	0 or a negative error code.

See also:`ShowBuffer(), ChanScale(), ChanShift(), ChanZero(), ArrAdd()`

ChanOrder()

You can change the order of channels in a data or memory view, or group channels with a y axis so that they share a common axis with this command. This is equivalent to clicking and dragging the channel number. You can change individual channels, or sort all channels into numberical order:

```
Func ChanOrder(dest%, pos%, cSpc)
Func ChanOrder(order%);
```

`dest%`	The destination channel number.
`Pos%`	The position to drop the moved channels relative to the destination channel. Use –1 to drop before, 0 to drop on top and 1 to drop after. If you drop a channel between grouped channels, then the dropped channels become members of the group (as long as they have a y axis).
`cSpc`	A channel specifier for the channels to move.
`order%`	In this form of the command, all the channels are sorted into numerical order. Set –1 for low numbered channels at the top, 1 for High numbered channels at the top and 0 to use the default channel ordering set by the Edit menu Preferences.
Returns	When used with a list of channels the command returns the number of channels that were moved. When used to set the order of all channels, the return value is -1 if low numbered channels were placed at the top and 1 if high numbered channels were at the top.

See also:`ChanWeight(), ViewStandard()`

ChanPoints()

This function returns the total number of data items in the frame on the specified channel in a data or XY view.

```
Func ChanPoints(chan%);
```

`chan%`	The channel number (1 to n) for which to return the number of items.
Returns	The number of data points in a frame.

See also:`ChanRange(), ChanItems(), View(v,c).[], XYCount()`

ChanRange()

This function finds data items in a given x axis range.

```
Func ChanRange(chan%, &start, finish, &item);
```

`chan%` The channel number, from 1 to n.

`start` The start position in x axis units. This returns the start position of the first data point in the range, or it is left unchanged if no data is found.

`finish` The end position in x axis units.

`item` The index in the view of the data item found at the start position.

Returns The number of data items found in the range defined by `start` and `finish`.

See also:`ChanPoints(), ChanItems(), View(v,c).[]`

ChanRectify()

This rectifies the data in specifed waveform channels of the current frame in the current view. If the frame buffer is being shown, the frame buffer data is used instead. All data points in the channels used are modified.

```
Func ChanRectify(chan%|chan%[]|chan$);
```

`chan%` This sets the channel to use. This can be the channel number (1 to n), -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.

This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.

`chan$` A string to specify channel numbers, such as "1,3..8,9,11..16".

Returns 0 or a negative error code.

See also:`ShowBuffer(), ChanShow(), ChanVisible(), ChanZero()`

ChanScale()

This scales the data in specifed waveform channels of the current frame in the current view by multiplying it by a constant value. If the frame buffer is being shown, the frame buffer data is used instead. All data points in the channels used are modified.

```
Func ChanScale(chan%|chan%[]|chan$, val);
```

`chan%` This sets the channel to use. This can be the channel number (1 to n), -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.

This can also be an integer array. If it is, the first array element holds the number of channels in the list. This is followed by a list of positive channel numbers.

`chan$` A string to specify channel numbers, such as "1,3..8,9,11..16".

val The value to multiply by.

Returns 0 or a negative error code.

See also:`ShowBuffer(), ChanShow(), ChanZero(), ArrMul()`

ChanSearch()

This function searches a channel in file or memory view for the next user-defined feature in a time range. It is exactly the same as an active cursor search, but does not use or move cursors. By avoiding the need to draw and move cursors, this function should be more efficient than using the active cursors, but there is no visual feedback.

```
Func ChanSearch(chan% ,mode%, &sT, eT{, sp1{, sp2{, width}}});
```

`chan%` The number of a channel in the time view to search.

`mode%` This sets the search mode, as for the active cursors. See the cursor mode dialog documentation for details of each mode.

1 Maximum value	7 Rising threshold	13 Slope threshold
2 Minimum value	8 Falling threshold	14 Rising slope threshold
3 Maximum excursion	9 Steepest rising	15 Falling slope threshold
4 Peak find	10 Steepest falling	16 Absolute max slope
5 Trough find	11 Slope peak	17 Turning point
6 Threshold	12 Slope trough	18 Slope%

`sT` The start time for the search. This value will be returned with the result of the search.

`eT` The end time for the search. If `eT` is less than `sT`, the search is backwards.

`sp1` This is the threshold level for threshold crossings and baseline level for maximum excursion. It is in the y axis units of the search channel (y axis units per second for slopes). If omitted, the value 0.0 is used. Set it to 0 if `sp1` is not required for the mode.

`sp2` This is hysteresis for peak, trough and threshold crossings and percent for Slope%. If omitted, the value 0.0 is used. Set it to 0 if `sp2` is not required for the mode.

`width` This is the width in seconds for all slope measurements. If omitted, the value 0.0 is used. Set it to 0 if `width` is not required for the mode.

Returns 0 if the search succeeds or -1 if the search fails or a negative error code.

See also:`ChanMeasure()`, `ChanValue()`, `CursorActiveGet()`, `CursorActiveSet()`

ChanSelect()

This function is used to report on the selected/unselected state of a channel in a data view, and to change the selected state of a channel.

```
Func ChanSelect(chan%|chan%[]|chan$ {,new%});
```

`chan%` The channel number (1 to n) or -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels. Hidden channels cannot be selected.

This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.

`chan$` A string to specify channel numbers, such as "1,3..8,9,11..16".

`new%` If present it sets the state: 0 for unselected, not 0 for selected. If omitted, the state is unchanged. Attempts to change invisible channels are ignored.

Returns If you set `chan%` to a positive channel number the function returns the channel state at the time of the call, 0 for unselected, 1 for selected. Otherwise the function returns the number of selected channels at the time of the call.

See also:`ChanList()`, `ChanOrder()`, `ChanVisible()`, `ChanWeight()`

ChanShift()

This shifts the data in specifed waveform channels of the current frame in the current view a specified number of points right or left. The data is actually rotated so that points that 'fall off' one end are shifted back in at the other. If the frame buffer is being shown, the frame buffer data is used instead. All data points in the channels used are modified.

```
Func ChanShift(chan%|chan%[]|chan$, shift%);
```

`chan%` This sets the channel to use. This can be the channel number (1 to n), -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.

This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.

`chan$` A string to specify channel numbers, such as "1,3..8,9,11..16".

`shift%` The number of point to shift the data. A negative value shifts points left, a positive value shifts points right.

Returns 0 or a negative error code.

See also:`ShowBuffer(), ChanShow(), ChanZero(), ArrAdd()`

ChanShow()

Display or hide a channel, or a list of channels, in a data or XY view. Turning on a channel that is on has no effect. Turning on a channel that doesn't exist has no effect.

```
Func ChanShow(chan%|chan%[]|chan$ {,yes%});
```

`chan%` This is a channel to show or hide. A channel number (1 to n), or -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.

This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.

`chan$` A string to specify channel numbers, such as "1,3..8,9,11..16".

`yes%` If this is non-zero it turns the specified channels on and if it is zero it turns them off. If yes% is omitted no changes are made.

Returns If you set `chan%` to a positive channel number the function returns the channel state at the time of the call, 1 for visible, 0 for invisible. Otherwise it returns -1.

See also:`ChanList(), ChanVisible()`

ChanSmooth()

This smooths the data in specifed waveform channels of the current frame in the current view by replacing each point by the average of `n` adjacent points, where `n` can be 3 or 5. If the frame buffer is being shown, the frame buffer data is used instead. All data points in the channels used are modified.

```
Func ChanSmooth(chan%|chan%[]|chan$, width);
```

`chan%`	This sets the channel to use. This can be the channel number (1 to n), -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels. This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.
`chan$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
width	This sets the width to smooth over, either 3 or 5.
Returns	0 or a negative error code.

See also:`ShowBuffer(), ChanShow(), ChanZero(), ArrFilt()`

ChanSubDC()

This function subtracts any DC offset present in the data in specifed waveform channels of the current frame in the current view. The DC offset is measured over the time range specified, all data points in the channels are modified. If the frame buffer is being shown, the frame buffer data is used instead.

```
Func ChanSubDC(chan%|chan%[]|chan$, start, finish);
```

`chan%`	This sets the channel to use. This can be the channel number (1 to n), -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels. This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.
`chan$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
`start`	The start position for measurement of the DC level.
`finish`	The end position for measurement of the DC level.
Returns	0 or a negative error code.

See also:`ShowBuffer(), ChanShow(), ChanZero(), ArrSum()`

ChanTitle$()

This returns the title for a channel in a data or XY view. In a memory or XY views, or in a sampling document view, it can also set the channel title. For XY views only, it can also be used to get or set the Y axis title. In an XY view the channel titles are visible in the Key window.

```
Func ChanTitle$(chan%{,new$})
```

`chan%`	The channel number (1 to n). For an XY view only, a channel number of zero can be used to access the Y axis title.
`new$`	If present, in a sampling document or memory view, this string holds the new channel title. If the string is too long, it is truncated.
Returns	The original title for the channel. If the channel does not exist, the function does nothing and returns an empty string

See also:`ChanUnits$(), XTitle$(), XYKey(), YAxis()`

ChanUnits$()

This returns the units for a waveform channel in a data view or the Y axis units in an XY view. In a memory, XY, or sampling document view, it can also set the units.

```
Func ChanUnits$(chan%{,new$})
```

`chan%`	A channel number (1 to n). This is ignored in an XY, where it operates on the Y axis units only.
`new$`	If present, in a sampling document, XY or memory view, this string holds the new channel title. If the string is too long, it is truncated.
Returns	It returns the original units for the channel. If the channel does not exist or is not of a suitable type, the function does nothing and returns an empty string.

See also:`ChanTitle$(), XUnits$(), YAxis()`

ChanValue()

This returns the value on a given channel at a given position. It returns a value in the y axis units of the channel display mode. If the display mode has no y axis the value is the x axis position of the next item on the channel.

This returns the value corresponding to an x axis value. Use the `View(v,c).[bin]` notation or `BinToX(bin)` to access view data by bin number.

```
Func ChanValue(chan%, pos {,&data%{,mode%{,binsz}}})
```

`chan%` A channel number (1 to n).

`pos` The x axis position for which the value is needed.

`data%` This is returned as 1 if there was data at the position, 0 if there was not. For example on a waveform channel with time on the x axis, if there was no waveform point within `BinSize(chan%)` of the time set by `pos`, this would be set to 0.

`mode%` This will have no effect for a waveform channel. If present for a marker channel, this sets the display mode to use for extracting a value from a view. If an inappropriate mode is requested or if `mode%` is absent, the actual display mode is used. The modes are:

0	The current mode for the channel. Any additional arguments are ignored.
1	Dots mode for markers, returns the position of the marker at or after `pos`.
2	Lines mode for markers, result is the same as mode 1.
3	Rate mode for markers. If the `binSz` argument is present it sets the width of each bin otherwise the bin width is set to 1.0.

`binSz` If present, when `mode%` specifies rate mode for markers, this sets the width of the rate histogram bins in x axis units.

Returns It returns the value or zero if no data is found. For display modes with a y axis, if there is no data within `BinSize(chan%)` of the position, the value is zero. This is the same value returned by the Cursor Values menu for the channel

If `data%` is not provided any error stops the script. Errors include: no current window, current window not a data view, no data at `pos`, and `pos` beyond range of x axis. If `data%` is present, errors cause `data%` to be set to 0.

For example, to get data value on channel 1 at the position of the cursor number 1 in the view on data file, `mydata.cfs`.

```
vdata%:=ViewFind("mydata.cfs");   'view handle for data
FrontView(vdata%);                'focus on the data window
ampl:=ChanValue(1,Cursor(1));     'get data value at cursor
```

See also:`BinToX(), Cursor(), ChanMeasure(), DrawMode(), Interact(), View(v,c).[]`

ChanVisible()

This returns the show state of the channel as 1 if the channel is visible and 0 if it is not. If you use a silly channel number, the result is 0 (not displayed).

```
Func ChanVisible(chan%);
```

`chan%` The channel number (1 to n) to report on.

Returns 1 if the channel is displayed, 0 if it is not.

See also:`ChanShow()`

ChanWeight()

This function sets the relative vertical space to give a channel or a list of channels. The standard vertical space corresponds to a weight of 1. When Signal allocates vertical space, channels are of two types: channels with a y axis and channels without a y axis. Signal calculates how much space to give each channel type assuming all channels have a weight of 1. Then the actual space allocated is proportional to the standard space multiplied by the weight factor. This means that if you increase the weight of one channel, all other channels get less space in proportion to their original space.

```
Func ChanWeight(cSpc{, new});
```

`cSpc` The specification for the list of channels to process. See the *Script language syntax* chapter for a definition of channel specifiers.

`new` If present, a value between 0.001 and 1000.0 that sets the weight for all the channels in the list. Values outside this range are limited to the range.

Returns The command returns the channel weight of the first channel in the list.

See also:`ChanOrder(), ViewStandard()`

ChanZero()

This sets to zero the data in specifed waveform channels of the current frame in the current view. If the frame buffer is being shown, the frame buffer data is used instead. All data points in the channels used are modified.

```
Func ChanZero(chan%|chan%[]|chan$);
```

`chan%` This sets the channel to use. This can be the channel number (1 to n), -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.

This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.

`chan$` A string to specify channel numbers, such as "1,3..8,9,11..16".

Returns 0 or a negative error code.

See also:`ShowBuffer(), ChanShow(), ChanZero(), ArrConst()`

Chr$()

This function converts a code to a character and returns it as a single character string.

```
Func Chr$(code%);
```

`code%` The code to convert. Codes that have no character representation will produce unpredictable results when printed or displayed.

See also:`Asc()`, `%c` format in `Print()`

Colour()

This function gets and/or sets the colours of items. Colours are set in terms of the colour palette displayed in the Colour menu, not directly in terms of colours. XY view channels are coloured using `XYColour()`.

```
Func Colour(item% {,col%});
```

`item%` This is the item number, being the position of the item in the Colour menu, as follows:

1	Data view background	11	Rate histogram fill
2	Waveform as line	12	Text labels
3	Waveform as dots	13	Cursors & cursor labels
4	Waveform as skyline	14	Controls (not used)
5	Waveform as histogram	15	Data display grid
6	Waveform histogram fill	16	Axis markings and text labels
7	Markers as dots	17	Tagged frames background
8	Makers as lines	18	Frame list traces
9	Marker text	19	XY view background
10	Rate histogram	20	Error bar colour

`col%` If present, this sets the index of the colour in the colour palette to be applied to the item. There are 40 colours in the palette, numbered 0 to 39. The first 7 colours in the palette are set to grey scales from black to white, and the rest can be selected or mixed from basic colours.

Returns The index into the colour palette of the colour of the item at the time of the call.

See also:`PaletteGet(), PaletteSet(), XYColour()`

CondXXX() Conditioner commands

The `Cond...` family of commands can be used to control external signal conditioners through the serial ports. At the time of writing, these commands support the CED 1902 programmable signal conditioner and the Axon Instruments CyberAmp. Other conditioners may be added in the future.

These commands do not define which serial port is used by the conditioner nor the type of conditioner supported. When you install Signal you must choose the conditioner type and set the serial port.

All these commands require a `port%` argument. This is the physical waveform input port number that the conditioner channel is attached to. It is not the channel number in a view.

You can access the built-in interactive support for the conditioner from the sampling configuration channel setup dialog. This can be a useful short-cut to getting the lists of gains and signal sources available on your conditioner(s).

See individual commands and `CondSet()` for further details of conditioner operation.

See also:`CondFilter(), CondFilterList(), CondGain(), CondGainList(), CondGet(), CondOffset(), CondOffsetLimit(), CondRevision$(), CondSet(), CondSourceList(), CondType()`

CondFilter()

This sets or gets the frequency of low-pass or high-pass filter of the signal conditioner. See `CondXXX()` and `CondSet()` for further details of conditioner operation.

```
Func CondFilter(port%, high% {,freq});
```

`port%`	The waveform port number that the conditioner channel is connected to.
`high%`	This selects which filter to set or get: 0 for low-pass, 1 for high-pass.
`freq`	If present, this sets the desired cut-off frequency of the selected filter. See the `CondSet()` description for more information. Set 0 for no filtering. If omitted, the frequency is not changed. The high-pass frequency must be set lower than the frequency of the low-pass filter, if not the function returns a negative code.
Returns	The cut-off frequency of the selected filter at the time of call, or a negative error code. A return value of 0 means that there is no filtering of the type selected.

See also:`CondFilterList(), CondSet(), CondXXX()`

CondFilterList()

This function gets a list of the possible filter frequencies of the conditioner. See `CondXXX()` and `CondSet()` for further details of conditioner operation.

```
Func CondFilterList(port%, high%, freq[]);
```

`port%`	The waveform port number that the conditioner channel is connected to.
`high%`	Selects which filter to get: 0 for low-pass, 1 for high-pass.
`freq[]`	an array of reals holding the cut-off frequencies of the selected filter. A value of 0 means no filtering of the type selected.
Returns	The number of filtering frequencies of the conditioner or a negative error code.

See also:`CondFilter(), CondSet(), CondXXX()`

CondGain()

This sets and gets the gain of the signal passing through the signal conditioner. See `CondXXX()` and `CondSet()` for further details of conditioner operation.

```
Func CondGain(port% {,gain});
```

`port%`	The waveform port number that the conditioner channel is connected to.
`gain`	If present this sets the ratio of output signal to the input signal. If this argument is omitted, the current gain is returned. The conditioner will set the nearest gain it can to the requested value.
Returns	the gain at the time of call, or a negative error code.

See also:`CondSet(), CondXXX()`

CondGainList()

This function gets a list of the possible gains of the conditioner. for the selected signal source. See `CondXXX()` and `CondSet()` for further details of conditioner operation.

```
Func CondGainList(port%, gain[]);
```

`port%`	The waveform port number that the conditioner channel is connected to.
`gain[]`	An array of reals holding the conditioner gains for the selected signal source. If a conditioner (for example, 1902) has a fixed set of gains, this is the set of gain values. If the conditioner supports continuously variable gain, the first two elements of this array hold the minimum and the maximum values of the gain.
Returns	The number of gain values of the conditioner which has a fixed set of gains or 2 if the conditioner has continuously variable gain. In the case of an error, a negative error code is returned.

See also:`CondGain(), CondSet(), CondXXX()`

CondGet()

This function gets the input signal source of the signal conditioner, and the conditioner settings for gain, offset, filters and coupling. The settings are returned in arguments which must all be variables. See `CondXXX()` and `CondSet()` for further details of conditioner operation.

```
Func CondGet(port%, &in%, &gain, &offs, &low, &hi, &notch%, &ac%);
```

`port%`	The waveform port number that the conditioner channel is connected to.
`in%`	Returned as a zero-based index number of the input signal source of the conditioner.
`gain`	Returned as the ratio of output signal amplitude to the input signal amplitude (ignoring effects due to filtering).
`offs`	a value added to the input waveform to move it into a more useful range. Offset is specified in user units and is only meaningful when DC coupling is used.
`low`	Returned as the cut-off frequency of the low-pass filter. A value of 0 means that there is no low-pass filtering enabled on this channel.
`hi`	Returned as the cut-off frequency of the high-pass filter. A value of 0 means that there is no high-pass filtering enabled on this channel.
`notch%`	returned as 0 if the mains notch filter is off, and 1 if it is on.
`ac%`	Returned as 1 for AC or 0 for DC coupling.
Returns	0 if all well or a negative error code.

See also:`CondSet(), CondXXX()`

CondOffset()

This sets or gets the offset added to the input signal of the signal conditioner. See `CondXXX()` and `CondSet()` for further details of conditioner operation.

```
Func CondOffset(port% {,offs});
```

`port%`	The waveform port number that the conditioner channel is connected to.
`offs`	The value to add to the input waveform of the conditioner to move it into a more useful range. If this argument is omitted, the current offset is returned. The conditioner will set the nearest value it can to the requested value.
Returns	the offset at the time of call, or a negative error code.

See also:`CondOffsetLimit(), CondSet(), CondXXX()`

CondOffsetLimit()

This function gets the maximum and minimum values of the offset range of the conditioner for the currently selected signal source. See `CondXXX()` and `CondSet()` for further details of conditioner operation.

```
Func CondOffsetLimit(port%, offs[]);
```

`port%`	The waveform port number that the conditioner channel is connected to.
`offs[]`	This is an array of real numbers returned holding the minimum (`offs[0]`) and the maximum (`offs[1]`) values of the offset range of the conditioner for the currently selected signal source.
Returns	2 or a negative error code.

See also:`CondOffsetLimit(), CondSet(), CondXXX()`

CondRevision$()

This function returns the name and version of the signal conditioner as a string or a blank string if there is no conditioner for the port.

```
Func CondRevision$(port%);
```

`port%`	The waveform port number that the conditioner channel is connected to.
Returns	This returns a string describing the signal conditioner. The strings defined so far are: "`1902ssh`", where `ss` is the 1902 ROM software version number and `h` is the hardware revision level; and "`CYBERAMP 3n0 REV x.y.z`" where `n` is 2 or 8. If there is no conditioner attached to the port it returns an empty string.

See also:`CondType(), CondXXX()`

CondSet()

This sets the input signal source, gain, offset, filters and coupling of the conditioner. All values are requests. The actual values set will depend on the capabilities of the conditioner. In all cases, the command sets the nearest value to the that requested. If it is important to know what has actually been set you should read back the values with `CondGet()`after setting them, or use the functions for reading specific values. See `CondXXX()` for further details of conditioner operation.

```
Func CondSet(port%, in%, gain, offs {,low, high, notch%, ac%});
```

`port%`	The waveform port number that the conditioner is connected to.
`in%`	This is a zero-based index of the input signal source. A conditioner can have several different signal sources, for example, the 1902 Mk III supports `Grounded`, `Single ended`, `Normal Diff`, `Inverted Diff`, etc. Different conditioners of the same type may have different sources. `CondSourceList()` returns the whole list of the possible signal sources of your conditioner. You select a signal source by setting `in%` to its index number in the list.
`gain`	This is the desired ratio of output signal amplitude to the input signal amplitude (ignoring the effect of any filtering). The actual gain depends on the capabilities of the signal conditioner, see `CondGainList()`. The gain range may be altered by the choice of signal source. For example, the 1902 Isolated Amp input has a build-in gain of 100. The command sets the nearest gain to the requested value.
`offs`	This is the desired value in user units to add to the input waveform to move it into a more useful range. Offsets are only meaningful with DC coupling. Different conditioners have different offset ranges, and the offset range may be altered by the choice of signal source, see `CondOffsetLimit()`. The command will set the nearest offset it can to the desired value.
`low`	If present and greater than 0, it is the desired cut-off frequency of the low-pass filter. Low-pass filters are used to reduce the high frequency content of the signal, both to satisfy the sampling requirement, and in case where it is known that no useful information is to be found in the signal above a certain frequency. If omitted, or a value of 0, there is no low-pass filtering. The actual filter value set depends on the capability of the signal conditioner.
`high`	If present and greater than 0, it is a cut-off frequency of the high-pass filter. High-pass filters are used to reduce the low-frequency content of the signal. This frequency must be set lower than the frequency of the low-pass filter, if not the function returns a negative code. If omitted, or set to 0, there is no high-pass filtering. Different signal conditioners have different ranges of frequency filtering. To find out the currently set filter frequency, use `CondFilter()`. `CondFilterList()` returns the list of possible filter frequencies.
`notch%`	Some signal conditioners have a mains-frequency notch filter (usually 50Hz or 60Hz) used to reduce the effect of mains interference on low level signals. This filter will remove the fundamental 50Hz or 60Hz signal, it will not remove higher harmonics (for example 150Hz). If `notch%` is present with a value greater than 0, the notch filter is on. If omitted, or a value of 0, the notch filter is off.
`ac%`	The 1902 supports both AC and DC signal coupling. If you set AC coupling you should probably set the offset to zero too. If `ac%` is present with a value greater than 0, the signal conditioner is AC coupled. If omitted or 0, the signal conditioner is DC coupled.
Returns	0 if all well or a negative error code.

See also:`CondGet(), CondXXX()`

CondSourceList()

This function gets a list of the possible signal source names of the conditioner, or the specific signal source name with the given index number. See `CondXXX()` and `CondSet()` for further details of conditioner operation.

```
Func CondSourceList(port%, src$[]|src$ {,in%});
```

`port%`	The waveform port number that the conditioner channel is connected to.
`src$`	This is either a string variable or an array of strings that is returned holding the name(s) of signal sources. Only one name is returned per string.
`in%`	This argument lets you select an individual source or all sources. If present and greater than or equal to 0, it is the zero-based index number of the signal source to return. In this case, only one source is returned, even if `src$` is an array. If this argument is omitted and `src$` is a string, then the first source is returned in it. If `src$[]` is an array of strings, as many sources as will fit in the string array are returned.
Returns	If `in%` is greater than or equal to 0, it returns 1 or a negative error code. If `in%` is omitted, it returns the number of available signal sources or a negative error code.

See also:`CondSet(), CondXXX()`

CondType()

This function returns the type of the signal conditioner.

```
Func CondType (port%);
```

`port%`	The waveform port number that the conditioner channel is connected to.
Returns	0 for no conditioner or it is not the type set when installing, 1 for a CED 1902 and 2 for an Axon Instruments CyberAmp.

See also:`CondRevision$(), CondXXX()`

Cos()

This calculates the cosine of one or an array of angles in radians.

```
Func Cos(x|x[]);
```

`x`	The angle, expressed in radians, or a real array of angles. The best accuracy of the result is obtained when the angle is in the range -2**pi** to 2**pi**.
Returns	When the argument is an array, the function replaces the array by the cosines of all the points and returns either a negative error code or 0 if all was well. When the argument is not an array the function returns the cosine of the angle.

See also:`ATan(), Sin(), Tan()`

Cursor()

This function returns the x axis position of a vertical cursor, and can also move the cursor to a new position.

```
Func Cursor(num% {,where})
```

`num%`	The cursor number to use.
`where`	If present, the new position of the cursor. If the new position is out of range of the x axis, it is limited to the x axis.
Returns	The old cursor position or 0 if the cursor doesn't exist.

Examples:

```
Cursor(1,2.0);             'Set cursor 1 at position 2.0
where := Cursor(1);        'Get cursor position
```

See also:`ChanValue(), CursorDelete(), CursorLabel(), CursorLabelPos(), CursorNew(), CursorRenumber(), CursorSet(), HCursor()`

CursorActiveGet()

This command returns the parameters used by an active cursor in searching for a feature in the view data. Note that the use of some parameters varies according to the cursor mode set.

```
Func CursorActiveGet(num%, chan%, start|start$, end|end$ {, thresh
                                   {, hyst {, width{, def|def$}}}})
```

`num%`	The cursor number.
`chan%`	Returned holding the number of thr channel on which the cursor operates.
`start`	Returned holding the start time for the feature search.
`start$`	Returned holding the start time for the search. If the string form of this parameter is used, then search limits such as "XLow() + 0.2" can be correctly returned.
`end`	Returned holding the end time for the search.
`end$`	Returned holding the end time for the search as a string. If the string form of `start` is used, the string form of `end` must also be used, and vice versa.
`thresh`	Returned holding the threshold level used in the feature search.
`hyst`	Returned holding the hysteresis value used in the feature search.
`width`	Returned holding the slope width value used in the feature search.
`def`	Returned holding the default position if the search fails
`def$`	Returned holding the default position as a string.
Returns	Zero.

See also:`Cursor(), CursorDelete(), CursorMode(), CursorNew(), CursorActiveSet()`

CursorActiveSet()

This command sets the parameters used by an active cursor in searching for a feature in the view data. Note that the use of some parameters varies according to the cursor mode set.

```
Func CursorActiveSet(num%, chan%, start|start$, end|end$ {, thresh
                                    {, hyst {, width{, def|def$}}}})
```

`num%`	The cursor number.
`chan%`	The number of the channel on which the cursor operates.
`start`	The start time for the feature search.
`start$`	The start time for the search expressed as a string. If the string form of this parameter is used, then search limits such as "XLow() + 0.2" can be used.
`end`	The end time for the search.
`end$`	The end time for the search as a string. If the string form of `start` is used, the string form of `end` must also be used, and vice versa.
`thresh`	The threshold level used in the feature search.
`hyst`	The hysteresis value used in the feature search.
`width`	The slope width value used in the feature search.
`def`	The default position if the search fails
`def$`	The default position as a string.

Returns Zero.

See also:`Cursor(), CursorDelete(), CursorMode(), CursorNew(), CursorActiveGet()`

CursorDelete()

Deletes a cursor. It is not an error to delete an unknown cursor (which has no effect).

```
Func CursorDelete({num%})
```

`num%` The cursor number to delete, or -1 to delete all cursors. If omitted, the highest numbered cursor is deleted.

Returns the number of the cursor deleted or 0 if no cursor was deleted.

See also:`Cursor(), CursorLabel(), CursorLabelPos(), CursorNew(), CursorRenumber(), CursorSet(), HCursorDelete()`

CursorExists()

This function tests if a given vertical cursor exists at the time of the call.

```
Func CursorExists(num%)
```

`num%` The cursor number.

Returns 1 if the cursor exists, 0 if it does not.

See also:Cursor`(), CursorDelete(), HCursorExists()`

CursorLabel()

This command sets (or gets) the cursor label style for the current view. Cursors can be annotated with a position and/or the cursor number, or with a user-defined string:

```
Func CursorLabel({style%{, num%{, form$}}})
```

`style%` Label styles are: 0=None, 1=Position, 2=Number, 3=Both, 4=User-defined. Unknown styles cause no change. Style 4 is used with a format string.

`num%` Used with style 4 only. A value of 0 selects all cursors, 1 upwards selects one cursor.

`form$` A string to label the cursors. It has replaceable parameters `%p`, `%n` and `%v(chan)` for position, number and channel value (replace `chan` with the channel number whose value you require). `%w.dp` and `%w.dv(chan)` formats are allowed where `w` and `d` are numbers that set the field width and number of decimal places.

Returns The current style of cursor 1 before any change. If `style%` is omitted, the current cursor style is not changed.

See also: `Cursor(), CursorDelete(), CursorLabelPos(), CursorNew(), CursorRenumber(), CursorSet(), HCursorLabel()`

CursorLabelPos()

This lets you set and read the position of the cursor label.

```
Func CursorLabelPos(num% {,pos});
```

`num%` The cursor number. If the cursor does not exist the function does nothing and returns -1.

`pos` If present, the command sets the label position as the percentage of the distance from the top of the cursor. Out of range values are set to the appropriate limit.

Returns The cursor position before any change was made, or -1 if the cursor does not exist.

See also: `Cursor(), CursorDelete(), CursorLabel(), CursorNew(), CursorRenumber(), CursorSet(), HCursorLabelPos()`

CursorMode()

This lets you set and read the a cursor mode.

```
Func CursorMode(num% {,mode%});
```

`num%` The cursor number. If the cursor does not exist the function does nothing and returns -1.

`Mode%` If present, the command sets the new cursor mode. The possible values of `mode%` are (see the main active cursor documentation for a description of the modes):

0	Static	1	Maximum	2	Minimum
3	Maximum excursion	4	Peak	5	Trough
6	Threshold	7	+ve threshold	8	-ve threshold
9	Max slope	10	Min slope	11	Peak in slope
12	Trough in slope	13	Slope threshold	14	Slope +ve thresh.
15	Slope -ve thresh.	16	Abs max slope	17	Turning point
18	percentage slope	19	Repolarisation %	20	Expression

Returns The cursor mode before any change was made, or -1 if the cursor does not exist.

See also: `Cursor(), CursorActiveGet(), CursorActiveSet(), CursorNew(), CursorSet()`

CursorNew()

This command adds a new cursor to the view at the designated position. A new cursor is created in Static mode (not active).

```
Func CursorNew({where{, num%}})
```

`where`	Where to position the cursor. In a file or memory view it is a time in seconds. In an XY view it is in x axis units. The position is limited to the x axis range. If the position is omitted, the cursor is placed in the middle of the window.
`num%`	If this is omitted, or set to -1, the lowest numbered free cursor is used. If this is a cursor number, that cursor is created. This must be a legal cursor number or -1.
Returns	It returns the cursor number as an integer, or 0 if all cursors are in use.

See also:`Cursor(), CursorDelete(), CursorLabel(), CursorLabelPos(), CursorRenumber(), CursorSet(), HCursorNew()`

CursorRenumber()

This command renumbers the cursors from left to right in the view. There are no arguments.

```
Func CursorRenumber();
```

Returns The number of cursors found in the view.

See also:`Cursor(), CursorDelete(), CursorLabel(), CursorLabelPos(), CursorNew(), CursorSet(), HCursorRenumber()`

CursorSet()

This command deletes any existing vertical cursors, then positions a specified number of new cursors, equally spaced in the view and numbered in order from left to right. If any positions are given, they are applied. The cursor labelling style is not changed.

```
Proc CursorSet(num% {,where1 {,where2 {,where3 {,where4}}}})
```

`num%`	The number of cursors in the range 0 to the maximum allowed. 0 turns off all the cursors. It is a run-time error to ask for more than the maximum or less than 0 cursors.
`where`	Optional cursor positions in x axis units. Positions that are out of range are set to the nearest valid position.

Examples:

```
CursorSet(0);       'Delete all cursors
CursorSet(2,20,30); 'remove cursors, set 2 at 20 and 30 on x axis.
```

See also:`BinToX(), Cursor(), CursorDelete(), CursorLabel(), CursorLabelPos(), CursorNew(), CursorRenumber()`

Date$()

This function creates a string containing the date. If no arguments are supplied, a string is returned showing the day, month and year in a format specified by the operating system settings. To obtain the date as numbers, use the `TimeDate()` function. For the purpose of this description, we assume that today's date is Wednesday 1 April 1998, the system language is English and the system date separator is "`/`". **Warning**: This command does not exist in version 1.00.

```
Func Date$({dayF%, {monF%, {yearF%, {order%, {sep$}}}}});
```

`dayF%` This sets the format of the day field in the date. This can be written as a day of the week or the day number in the month, or both. If this argument is omitted, the value 2 is used. The options are:

1	Show day of week: "`Wednesday`".
2	Show the number of the day in the month with leading zeros: "`01`".
4	Show the day without leading zeros: "`1`".
8	Show abbreviated day of week: "`Wed`".
16	Show week day name first, regardless of the `order%` field.

Use 0 for no day field. Add the numbers for multiple options. For example, to return "`Wed 01`", we would enter `11` (1+2+8) as the `dayF%` argument.

If you add 4, 2 is ignored. If you add 8 or 16, 1 is added automatically. If you request both the week day name and the number of the day, the name appears before the number.

`monF%` The format of the month field. This can be returned as either a name or a number. If this argument is omitted, the value 3 is used. The options are:

0	No month field.
1	Show name of the month: "April".
2	Show number of month: "04"
3	Show an abbreviated name of month: "Apr"
4	Show number of month with no leading zeros: "4"

`yearF%` The format of the year field. This can be returned as a two or four digit year.

0	No year is shown
1	Year is shown in two digits: "98".
2	Year is shown in two digits with an apostrophe before it: "'98".
3	Year is shown in four digits: "1998".

`order%` The order that the day, month and year appear in the string. If this argument of omitted, the value 0 is used.

0	Operating system settings
1	month/day/year
2	day/month/year
3	year/month/day

`sep$` This string appears between the day, month and year fields as a separator. If this string is empty or omitted, Signal supplies a separator based on the system settings.

For example, `Date$(20, 1, 2, 1, " ")` returns `"Wednesday April 1 '98"`. As 20 is 16+4, we have the day first, even through the `order%` argument places the day in between the month and the year. `Date$()` returns `"01/Apr/98"`.

See also:`Seconds(), TimeDate(), Time$()`

Debug()

This function can be used to open the debug window so you can step through your script, set breakpoints and display and edit variables. It can also be used to control access to the debugger by the user.

```
Proc Debug({msg$|opt%});
```

`msg$`	When used with no arguments, or with a string argument, this function stops the script as though the Esc key had been pressed or a break-point reached. The debug toobar is shown if it was hidden and, if present, the `msg$` string is displayed in the debug window.
`opt%`	When used with an integer argument, the function controls the ability of the user to break into the debugger by pressing Esc. Set `opt%` to 0 to disable Esc, 1 to enable it. Each time a script starts the Esc key is enabled, so you should use this as the first instruction in your script if you want to be certain the user cannot break out.

The opt% form of the command was included for use in situations such as student use, where it is important that the user cannot break out of a script by accident. It is advisable to test your script carefully and save it to disk before disabling user breaks; once disabled you cannot stop a looping script except by forcing a fatal error.

See also:`Eval()`

DeleteFrame()

This function deletes the current frame from the current data view. Frames can only be deleted if they were appended and have not yet been saved to disk. It is not possible to delete the last frame in a memory view.

```
Func DeleteFrame();
```

Returns Zero or a negative error code.

See also:Append`Frame(), FrameCount(), FrameFlag(), FrameTag()`

DelStr$()

This function removes a substring from a string.

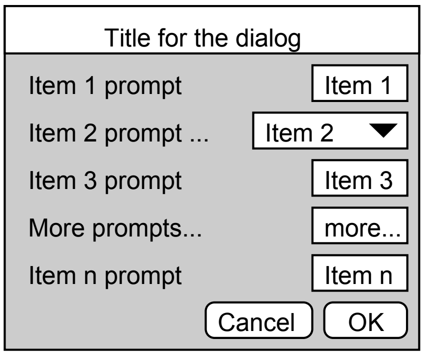
```
Func DelStr$(text$, index%, count%);
```

`text$`	The string to remove characters from. This string is not changed.
`index%`	The start point for the deletion. The first character is index 1. If this is greater than the length of the string, no characters are deleted.
`count%`	The number of characters to delete. If this would extend beyond the end of the string, the remainder of the string is removed.
Returns	`DelStr$()` returns the original string with the indicated section deleted.

See also:`InStr(), LCase$(), Len(), Mid$(), Right$(), UCase$()`

Dialogs

You can define your own dialogs to get information from the user. You can define dialogs in a simple way, where each item of information has a prompt, and the dialog is laid out automatically, or you can build a dialog by specifying the position of every item. A simple dialog has the structure shown in the diagram:



The exact appearance of the dialog depends on the system. The dialog is arranged in terms of items. Unless you specifically request otherwise, the dialog items are stacked vertically above each other.

The dialog has a title of your choosing at the top. There are OK and Cancel buttons at the bottom of the dialog. When the dialog is used, pressing the Enter key is equivalent to clicking on OK.

This form of dialog is very easy to program; there is no need to specify any position or size information, the system works it all out. Some users require more complicated dialogs, with control over the field positions. This is also possible, but more complicated to program. You are allowed up to 256 fields in a dialog.

In the more complex case, you specify the position (and usually the width) of the box used for user input. This allows you to arrange data items in the dialog in any way you choose. It requires more work as you must calculate the positions of all the items.

Dialog units

Positions within a dialog are set in *dialog units*. In the x (horizontal) direction, these are in multiples of the maximum width of the characters ‘0’ to ‘9’. In the y (vertical) direction, these are in multiples of the line spacing used for simple dialogs. Unless you intend to produce complex dialogs with user-defined positions, you need not be concerned with dialog units at all.

Dialog building

An example script `DlgMake` automates the creation of your dialog commands.

Dialog example

The example dialog shown above could be created by this code:

```
var ok%, item1%, item2%, item3, item4$, item5;
DlgCreate ("Title for the dialog");      'start new dialog
DlgInteger(1,"item 1 prompt",0,10);      'integer, range 0-10
DlgChan   (2,"item 2 prompt",1);         'Waveform channel list
DlgReal   (3,"item 3 prompt",1.0,5.0);   'real, range 1.0-5.0
DlgString (4,"More prompts...",6);       'string, any characters
DlgReal   (5,"item n prompt",-10.0,0.0); 'real, range -10-0
item4$ := "more...";
ok% := DlgShow(item1%, item2%, item3, item4$, item5); 'show dialog
```

See also: `DlgChan(), DlgCheck(), DlgCreate(), DlgInteger(), DlgLabel(), DlgList(), DlgReal(), DlgShow(), DlgString(), DlgText()`

DlgChan()

You often need to select a channel of a particular type from a view. This function defines a dialog entry that lists channels that meet a specification. For simple dialogs, the `wide`, `x` and `y` arguments are not used. Channel lists are checked or created when the `DlgShow()` function runs. If the current view is not a data or XY view, the list will be empty.

```
Proc DlgChan(item%, text$|wide, mask%|list%[]{, x{, y}});
```

`item%`	This sets the item number in the dialog.
`text$`	The text to display as a prompt.
`wide`	This is an alternative to the prompt. It sets the width of the box in which the user selects a channel. If the width is not given the number entry box has a default width of the longest channel name in the list or 12, whichever is the smaller.

`mask%` This is an integer code that determines the channels to be displayed, it is ignored for XY views. You can select channels of particular types by adding together the following codes:

1	Waveform channels
2	Marker channels

If none of the above values are used, then the list includes all channels. The following codes can be added to exclude channels from the list created above:

1024	Exclude visible channels
2048	Exclude hidden channels
4096	Exclude selected channels
8192	Exclude non-selected channels

Finally, adding the following codes allows special entries to be added to the list:

131072	Add `None` as an entry in the list (returns 0)
262144	Add `All channels` as an entry in the list (returns -1)
524288	Add `All visible channels` as an entry in the list (returns -2)
1048576	Add `Selected` as an entry in the list (returns -3)

`list%`	As an alternative to a mask, you can pass in a channel list (as constructed by `ChanList()`). This must be an array of channels, with the first element of the array holding the number of channels in the list.
`x`	If omitted or zero, the selection box is right justified in the dialog box, otherwise this sets the position of the left end of the channel selection box.
`y`	If omitted, this takes the value of `item%`. It is the position of the bottom of the channel selection box.

The variable passed to `DlgShow()` for this field should be an integer. If the variable passed in holds a channel number in the list, the field shows that channel, otherwise it shows the first channel in the list (usually `None`). The result from this field in `DlgShow()` is a channel number, or 0 if `None` is selected, -1 if `All channels` is selected, -2 if `All visible channels` is selected or -3 if `Selected` is chosen.

See also: `DlgCheck(), DlgCreate(), DlgInteger(), DlgLabel(), DlgList(), DlgReal(), DlgShow(), DlgString(), DlgText()`

DlgCheck()

This defines a dialog item that is a check box (on the left) with a text string to its right. For simple dialogs, the `x` and `y` arguments are not used.

```
Proc DlgCheck(item%, text${, x{, y}});
```

`item%`	This sets the item number in the dialog.
`text$`	The text to display to the right of the check box.
`x,y`	The position of the bottom left hand corner of the check box. If omitted, x is set to 1 and y to `item%`. When used without these fields, this function behaves exactly like the simple dialog functions, and can be mixed with them.

When `DlgShow()` is used, the box is checked if the variable passed in is non-zero and unchecked if it is zero. The variable passed should be an integer and is returned as 0 for unchecked or 1 for checked.

See also:`DlgChan(),DlgCreate(), DlgInteger(), DlgLabel(), DlgList(), DlgReal(), DlgShow(), DlgString(), DlgText()`

DlgCreate()

This function starts the definition of a dialog. It also kills off any previous dialog that might be partially defined. For simple dialogs, the optional arguments are not used.

```
Func DlgCreate(title$ {,x ,y ,wide ,high ,help%|help$});
```

`title$`	A string holding the title for the dialog.
`x,y`	Optional, taken as 0 if omitted. The position of the top left hand corner of the dialog. The positions are in percentages of the screen size. The value 0 means centre the dialog. Values out of the range 0 to 95 are limited to the range 0 to 95.
`wide`	The width of the dialog in dialog units. If this is omitted, or set to 0, Signal works out the width for itself, based on the items in the dialog.
`high`	The height of the dialog in dialog units. If omitted, or set to 0, Signal works it out for itself, based on the dialog contents.
`help`	This is a string or numeric identifier that identifies the help page to be displayed if the user requests help when the dialog is displayed. This argument is ignored if your version of Signal doesn't support help.
Returns	This function returns 0 if all was well, or a negative error code.

For simple use, only the first argument is needed. The remainder are for use with more complicated menus where precise control over menu items is required.

Use of & in prompts

In the functions that set an item with a prompt, if you precede a character in the prompt with an ampersand &, the following character is used by Windows as a short-cut key to move to the field and the character is underlined. Ampersand characters are ignored on systems that do not use this mechanism.

See also:`DlgChan(), DlgCheck(), DlgInteger(), DlgLabel(), DlgList(), DlgReal(), DlgShow(), DlgString(), DlgText()`

DlgInteger()

This function defines a dialog entry that edits an integer. The numbers you enter may not contain a decimal point. For simple dialogs, the `wide`, `x` and `y` arguments are not used.

```
Proc DlgInteger(item%, text$|wide, lo%, hi%{, x{, y}});
```

`item%`	This sets the item number in the dialog.
`text$`	The text to display as a prompt. Any text is always displayed left justified in the dialog box.
`wide`	This is an alternative to the prompt. It sets the width of the box in which the user types the integer. If the width is not given the number entry box has a default width of 11 digits.
`lo%`	The start of the range of acceptable numbers.
`hi%`	The end of the range of acceptable numbers.
`x`	If omitted or zero, the number entry box is right justified in the dialog box, otherwise this sets the position of the left end of the number entry box.
`y`	If omitted, this takes the value of `item%`. It is the position of the bottom of the number entry box.

The variable passed into `DlgShow()` can be an integer, or a real number. The field will start with the value of the variable if it is in the range, otherwise the value is limited to the nearest end of the range. A real number will be truncated.

See also:`DlgChan(), DlgCheck(), DlgCreate(), DlgLabel(), DlgList(), DlgReal(), DlgShow(), DlgString(), DlgText()`

DlgLabel()

This function sets an item that has no editable part, that is an item used as a label. For simple dialogs, the `wide`, `x` and `y` arguments are not used. You can add text to a dialog without using an item number with `DlgText()`.

```
Proc DlgLabel(item%, text${, x{, y}});
```

`item%`	This sets the item number in the dialog.
`text$`	The text to display.
`x`	If omitted, the text is left justified in the dialog box, otherwise this sets the position of the left end of the text in the dialog.
`y`	If omitted, this takes the value of `item%`. It is the position of the bottom of the text in the dialog.

When you call `DlgShow()`, you must provide a dummy variable for this field. The variable is not changed and can be of any type, but must be present.

See also:`DlgChan(), DlgCheck(), DlgCreate(), DlgInteger(),DlgList(), DlgReal(), DlgShow(), DlgString(), DlgText()`

DlgList()

This defines a dialog item for a one of n selection. Each of the possible items to select is identified by a string. For simple dialogs, the `wide`, `x` and `y` arguments are not used.

```
Proc DlgList(item%, text$|wide, list$[]|str${, n%{, x{, y}}});
```

`item%`	This sets the item number in the dialog.
`text$`	The text to display as a prompt.
`wide`	This is an alternative to the prompt. It sets the width of the box in which the user selects an item. If the width is not given the number entry box has a default width of the longest string in the list or 18, whichever is the smaller.
`list$`	An array of strings. These hold the items to be presented in the list. Each string should not be over 18 characters long, or they will be truncated.
`str$`	An alternative way to define the items to be presented in the list. The single string holds all of the items, items are separated by the vertical bar character (|). Again, items should not be more than 18 characters long.
`n%`	The number of entries in the list. If this is omitted, or if it is larger than the array, then the size of the array is used. If the `str$` form of the command is used, the number of items in the string sets the maximum number.
`x`	If omitted or zero, the selection box is right justified in the dialog, otherwise this sets the position of the left end of the selection box.
`y`	If omitted, this takes the value of `item%`. It is the position of the bottom of the list selection box.

The result obtained from this is the index into the list of the list element chosen. The first element is number 0. The variable passed to `DlgShow()` for this item should be an integer. If the value of the variable is in the range 0 to `n`-1, this sets the item to be displayed, otherwise the first item in the list is displayed.

The following example shows how to set a list:

```
var list$,ok%,which%:=0;   'string list, test for OK, result
list$ := "zero|one|two|three";            'these are the choices
 DlgCreate("List example");    'Start the dialog
DlgList(1,"Make your choice", list$);
ok% := DlgShow(which%);       'Display dialog, wait for user
```

See also:`DlgChan(), DlgCheck(), DlgCreate(), DlgInteger(), DlgLabel(), DlgReal(), DlgShow(), DlgString(), DlgText()`

DlgReal()

This function defines a dialog entry that edits a real number. For simple dialogs, the `wide`, `x` and `y` arguments are not used.

```
Proc DlgReal(item%, text$|wide, lo, hi{, x{, y}});
```

`item%`	This sets the item number in the dialog.
`text$`	The text to display as a prompt. If present, the prompt is always left justified in the dialog.
`wide`	This is an alternative to the prompt. It sets the width of the box in which the user types a real number. If the width is not given the number entry box has a default width of 12 digits.
`lo,hi`	The range of acceptable numbers.
`x`	If omitted or zero, the number entry box is right justified in the dialog box, otherwise this sets the position of the left end of the number entry box.

`y` If omitted, this takes the value of `item%`. It is the position of the bottom of the number entry box.

The variable passed into `DlgShow()` should be a real number. The field will start with the value of the variable if it is in the range, otherwise the value is limited to the nearest end of the range.

See also: `DlgChan(), DlgCheck(), DlgCreate(), DlgInteger(), DlgLabel(), DlgList(),DlgShow(), DlgString(), DlgText()`

DlgShow()

This function displays the dialog you have built and returns values from the fields identified by item numbers, or makes no changes if the user kills the dialog with the Cancel button. Once the dialog has been dismissed, all information about it is lost. You must create a new dialog before you can use this function again.

```
Func DlgShow(&item1|item1[], &item2|item2[], &item3|item3[] ...);
```

Returns The function returns 0 if the user clicked on the Cancel button, or 1 if the user clicked on OK.

For each item that you have defined, you must provide a variable of a suitable type to receive the result. It is an error to pass the wrong type of variable, except in the case of an integer field which you can return into a real or an integer variable. Items created with `DlgLabel()` must have a variable too, even though it is not changed.

These variables also set the initial values of the fields for editing. If an initial value is out of range or not allowed, the value is changed to the nearest legal value. In the case of a string, illegal characters are deleted before display.

In addition to passing a simple variable, you can pass an array. An array with `n` elements matches `n` items in the dialog. The array type must match the items.

If the user clicks on OK, all the variables are updated to their new values. If the user clicks on Cancel, the variables are not changed.

See also: `DlgChan(), DlgCheck(), DlgCreate(), DlgInteger(), DlgLabel(), DlgList(), DlgReal(), DlgString(), DlgText()`

DlgString()

This defines a dialog entry that edits a text string. You can limit the characters that you will accept in the string. For simple dialogs, the `wide`, `x` and `y` arguments are not used.

```
Proc DlgString(item%, text$|wide, max%{, legal${, x{, y}}});
```

`item%` This sets the item number in the dialog.

`text$` The text to display as a prompt.

`wide` This is an alternative to the prompt. It sets the width of the box in which the user types the string. If the width is not given the number entry box has a default width of `max%` or 20, whichever is the smaller.

`max%` The maximum number of characters allowed in the string.

`legal$` A list of acceptable characters. See `Input$()` for a full description. If this is omitted, or an empty string, all characters are allowed.

`x` If omitted or zero, the string entry box is right justified in the dialog box, otherwise this sets the position of the left end of the string entry box.

`y` If omitted, this takes the value of `item%`. It is the position of the bottom of the string entry box.

The result from this operation is a string of legal characters. The variable passed to `DlgShow()` should be a string. If the initial string set in `DlgShow()` contains illegal characters, they are deleted. If the initial string is too long, it is truncated.

See also:`DlgChan(), DlgCheck(), DlgCreate(), DlgInteger(), DlgLabel(), DlgList(), DlgReal(), DlgShow(), DlgText()`

DlgText()

This function places non-editable text in the dialog box.

```
Proc DlgText(text$, x, y);
```

`text$` A text string to place in the dialog.

`x,y` The position of the bottom left hand corner of the first character in the string, in dialog units. Set `x` to 1 for the same label position as `DlgLabel()`.

Note that this is different from `DlgLabel()` as it has no item number and so does not require a variable in the `DlgShow()` function.

See also:`DlgChan(), DlgCheck(), DlgCreate(), DlgInteger(), DlgLabel(), DlgList(), DlgReal(), DlgShow(), DlgString()`

Draw()

This allows invalid regions in the current view to update. `Draw()` on a view that is up-to-date should make no change. The view is not brought to the front.

```
Proc Draw({from {, size}});
```

`from` The left hand edge of the view in x axis units.

`size` The width of the view in x axis units.

With no arguments, `Draw()` updates invalid areas in the view. With one argument, the view is scrolled to start at `from`. With two arguments, the width is set (unless it is unchanged) and then it is drawn. If `size` is negative or omitted, the same size as last time is used.

Data views run from `Mintime()` to `Maxtime()`. There are no limits set on the range of values for an XY view axis. However, huge numbers cause ugly axis labels.

Beware! When `Draw()` makes a view scroll, it scrolls by an integral number of pixels (otherwise the image would be disjointed). Thus, the requested start may not be the same as that reported by `XLow()`. The requested value will be in the first pixel. With an x axis in seconds the following code may not move the display at all if a pixel is more than a second wide:

```
Draw(XLow()+1.0); 'This usually steps by just under 1 second
```

See also:`DrawAll(), XRange(), XLow(), XHigh(), Maxtime(), Mintime()`

DrawAll()

This routine updates all views with invalid regions. This is equivalent to iterating through all the views and performing a `Draw()` on each.

```
Proc DrawAll();
```

See also:`Draw()`

DrawMode()

This sets and reads the display mode for the channel in a data view. You can set the display mode for channels that are not displayed.

```
Func DrawMode(chan%|chan%[]|chan${, mode%{,dotSz%|binSz{,
err%}}});
```

`chan%`	This is a channel number (1 to n). Setting a draw mode for a bad channel number has no effect. We also allow channel number -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.. This can also be an integer array. If it is, the first array element holds the number of channels in the list, followed by a list of positive channel numbers.
`chan$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
`mode%`	If present and positive, this sets the display mode, and returns the previous mode. If an inappropriate mode is requested, no change is made. Some modes require additional parameters (for example a bin size, a trigger channel, or the edge to use for level event data). If additional parameters are omitted, the last known value is used. The mode values for setting draw modes in the view are:

0	The standard mode for the channel
1	Dots for markers, using the `dotSz%` argument if it is provided
2	Lines for markers
3	Rate for markers
4	Histogram for waveform
5	Line for waveform
6	Dots for waveform, using the `dotSz%` argument if it is provided
7	Skyline for waveform

If present and negative, the function returns stored bin size or dot size. The mode values for getting data are:

-1	Reserved, does nothing and returns –1
-2	Return the current dot size
-3	Return the current bin size for a histogram
-13	Return the current drawing style for errors

Values in the range –4 to –12 are reserved for future use. If `mode%` is absent no changes are made.

`dotSz%`	This sets the dot size to use on screen or the point size to use on a printer. 0 is the smallest size available. The maximum size allowed is 10. Set to –1 for no change.
`binSz`	This sets the width of the rate histogram bins.
`err%`	The drawing style for errors: 0=none, 1=1 SEM, 2=2 SEM, 3=SD.
Returns	The draw mode before the call if a single channel is set or a value determined by a negative `mode%` value. For multiple channels or an invalid call, it returns -1.

See also:`Draw(), ViewStandard(), XYDrawMode(), ChanValue()`

Dup()

This gets the view handle of a duplicate of the current view, or the number of duplicates, including the original. Duplicated views are numbered from 1 (1 is the original). If a duplicate is deleted, higher numbered duplicates are renumbered. For more information on this see `WindowDuplicate()`.

```
Func Dup({num%});
```

`num%` The number of the duplicate view to find, starting at 1. You can also pass 0 (or omit `num%`) as an argument, to return the number of duplicates.

Returns If `num%` is greater than 0, this returns the view handle of the duplicate, or 0 if the duplicate does not exist. If `num%` is 0 or omitted, this returns the number of duplicates including the original. The following illustrates the use of `Dup()`.

```
var maxDup%, i%, dvh%;      'declare variables
maxDup% := Dup(0);          'Get maximum numbered duplicate
for i% := 1 to maxDup% do  'loop round all possible duplicates
  dvh% := Dup(i%);          'get handle of this duplicate
  if (dvh% > 0) then        'does this duplicate exist?
   PrintLog(view(dvh%).WindowTitle$()+"\n");'print window title
  endif;
next;
```

See also:`App()`, `View()`, `WindowDuplicate()`

EditClear()

In a memory view, this command zeros the data in all channels. In a text view, it deletes any selected text.

```
Func EditClear();
```

Returns The function returns 0 if nothing was deleted, otherwise it returns the number of items deleted or 1 if the number is not known, or a negative error code.

See also:`EditCopy()`, `EditCut()`

EditCopy()

This command copies data from the current view to the clipboard. The effect depends on the type of the current view. Text views copy data as text. Data views copy as a bitmap, as a scaleable image, as text in the format set by `ExportTextFormat()`, `ExportChanFormat()` and `ExportChanList()` or as binary data in a private format.

```
Func EditCopy({as%});
```

`as%` This sets how to copy data when several formats are possible. If omitted, all formats are used. When only one format is possible, the argument is ignored. The format value is the sum of:

1	Copy as a bitmap
2	Copy as a scaleable image (Windows metafile)
4	Copy as text
8	Copy as binary data in the CED private format

Returns It returns the sum of the format specifiers for each format exported from a data view, or the number of characters exported from a text view. It returns 0 if nothing was placed on the clipboard.

See also:`EditSelectAll()`, `ExportTextFormat()`, `ExportChanFormat()`, `ExportChanList()`, `EditClear()`, `EditCut()`, `EditPaste()`

EditCut()

This command cuts data from the current text or script view to the clipboard.

```
Func EditCut({as%});
```

`as%` This optional argument sets how data is copied to the clipboard in cases where there are several formats possible. Currently it is ignored.

Returns Returns the number of characters placed on the clipboard.

See also:`EditClear(), EditCopy(), EditPaste()`

EditPaste()

You may only paste into a text view when the clipboard contains text. The contents of the clipboard are inserted at the current caret. If text is already selected, it is replaced by the clipboard contents. If the clipboard contains binary data in the CED private format, this data can be pasted into a data view.

```
Func EditPaste();
```

Returns The function returns the number of characters inserted.

See also:`EditCopy(), EditCut()`

EditSelectAll()

This function selects all items in the current text view that can be copied to the clipboard. This is the same as the Edit menu Select All option.

```
Func EditSelectAll();
```

Returns It returns the number of selected items that could be copied to the clipboard.

See also:`EditCopy(), EditClear(), EditCut()`

Error$()

This function converts a negative error code returned by a function into a text string.

```
Func Error$(code%);
```

`code%` A negative error code returned from a Signal function.

Returns It returns a string that describes the error.

Eval()

This evaluates the argument and converts the result into text. The text is displayed in the Script view or the Evaluate window message area, as appropriate, when the script ends. The argument can be the value returned by a function

```
Proc Eval(arg);
```

`arg` A real or integer number or a string.

If you use `Eval()` it will suppress any run-time error messages as it uses the same mechanism as the error system. A common use of `Eval()` in a script is to report an error condition during debugging, for example:

```
if val<0 then Eval("Negative value"); Halt; endif;
```

Another use of `Eval()` is in the Script menu Evaluate window to see the result returned by a function or expression, as in these examples:

```
Eval(FileDelete(myfile$)); ' display 1 or a negative error code
Eval(Error$(-1531));       ' give string for error code if known
```

See also:`Debug(), Error$(), Print(), PrintLog()`

Exp()

This function calculates the exponential function (e to the power of x) for a single value, or replaces a real array by its exponential. If a value is too large, overflow will occur, causing the script to stop for single values, and a negative error code for arrays.

```
Func Exp(x|x[]);
```

x	The argument for the exponential function or an array of real values.
Returns	With an array, the function returns 0 if all was well, or a negative error code if a problem was found (such as overflow). With an expression, it returns the exponential of the number.

ExportChanFormat()

This command sets the channel text export format for use by `FileExportAs()` and `EditCopy()`. It is equivalent to the data, time and headings settings for each channel type in the Text Output Configuration dialog. Using `ExportTextFormat()` with no arguments will reset these fields to enable the output of data, time and headings for the waveform channel type only.

```
Proc ExportChanFormat(type%, data%, xval%, heads%)
```

`type%`	The type of channel to set the format for: 0 Waveform 1 Marker
`data%`	Set this non-zero to enable data output for this channel type.
`xval%`	Set this non-zero to enable output of x axis values for this channel type. For a waveform channel this is ignored when `data%` is disabled.
`heads%`	Set this non-zero to enable output of column headings for this channel type. This is ignored if neither `data%` nor `xval%` are enabled.

See also:`EditCopy(), FileExportAs(), ExportChanList(), ExportFrameList(), ExportTextFormat(), ExportTimeRange()`

ExportChanList()

This command sets a channel list to export for use by `FileExportAs()` and `EditCopy()` from a data view.

```
Proc ExportChanList(chan%|chan%[]|chan$);
```

`chan%`	The channel to export. This can be the channel number, -1 for all channels, -2 for visible channels, -3 for selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels. This can also be an integer array. If it is, the first array element holds the number of channels in the list. This is followed by a list of positive channel numbers.
`chan$`	A string to specify channel numbers, such as "1,3..8,9,11..16".

See also:`EditCopy(), FileExportAs(), ExportChanFormat(), ExportFrameList(), ExportTextFormat(), ExportTimeRange()`

ExportFrameList()

This command sets a list of frames for use by `FileExportAs()` and `EditCopy()`.

```
Proc ExportFrameList(sFrm%{, eFrm%{,mode%}});
Proc ExportFrameList(frm$|frm%[]{,mode%});
```

`sFrm%`	First frame to export. This option processes a range of frames. `sFrm%` can also be a negative code as follows: -1 All frames in the file are included -2 The current frame -3 Frames must be tagged -6 Frames must be untagged
`eFrm%`	Last frame to export. If this is -1 the last frame is the last in the data view. This argument is ignored if `sFrm%` is a negative code.
`frm$`	A frame specification string. This option specifies a list of frames using a string such as “1..32,40,50”.
`frm%[]`	An array of frame numbers to process. This option provides a list of frame numbers. The first element holds the number of frames in the list.
`mode%`	If `mode%` is present it is used to supply an additional criterion for including each frame in the range, list or specification. If `mode%` is absent all frames are included. The modes are: 0-n Frames must have a state matching the value of `mode%` -1 All frames in the specification are processed -2 Only the current frame, if it is in the main list, is processed -3 Frames must also be tagged -6 Frames must also be untagged

The following simple example exports all frames to `fred.cfs`.

```
ExportFrameList(-1);           'export from all frames in the view
FileExportAs ("fred.cfs", 1);  'export selected data as text
```

See also:`EditCopy(), FileExportAs(), ExportChanList(), ExportChanFormat(), ExportTextFormat(), ExportTimeRange()`

ExportTextFormat()

This command sets the text export format for use by `FileExportAs()` and `EditCopy()`. It is equivalent to setting decimal places, field width, string delimiter, item separator and frame header in the Text Output Configuration dialog. The command with no arguments resets everything in the dialog to default settings: decimal places to 5, field width optional to 0, the string delimiter to double quotes, the separator to a tab character, the header disabled, and enables the output of data, time and headings for the waveform channel type only. See `ExportChanFormat()` to set these.

```
Proc ExportTextFormat({dDec%, tDec%, width%, lim$, sep$, {head%}})
```

`dDec%`	Decimal places for data values.
`tDec%`	Decimal places for time values.
`width%`	Field width for all values, or zero for minimum width.
`lim$`	The delimiter, which is the character to place at the start and end of each text string in the output. The normal character to use is a double-quote mark.
`sep$`	The separator character which is used to separate multiple data items on a line. This should be one of tab, comma or space.
`head%`	If this is present and non-zero, Signal will output the frame header information.

See also:`EditCopy(), FileExportAs(), ExportChanList(), ExportFrameList(), ExportChanFormat(), ExportTimeRange()`

ExportTimeRange()

This command sets an x axis range for use by `FileExportAs()` and `EditCopy()` in a data view. This is equivalent to setting start and end times in the export setup dialogs.

```
Proc ExportTimeRange(sRange, eRange);
```

`sRange`	The start of the range of data to export, in x axis units.
`eRange`	The end of the range of data to export, in x axis units.

See also: `EditCopy(), FileExportAs(), ExportChanFormat(), ExportChanList(), ExportFrameList(), ExportTextFormat()`

FileClose()

This is used to close the current window or external file. You can supply an argument to close all views associated with the current data view or to close all the views belonging to the application.

```
Func FileClose({all% {,query%})
```

`all%` This argument determines the scope of the file closing. Possible values are:

-1	Close all views except loaded scripts and debug windows
0	Close the current view. This is the same as omitting `all%`
1	Close all windows associated with the current view

`query%` This determines what happens if a view holds unsaved data:

-1	Don't save the data or query the user
0	Query the user about each view that needs saving. If the user chooses Cancel, the operation stops, leaving all unclosed windows behind. This is the same as omitting `query%`.

Returns The number of views that have not been closed. This can occur if a view needs saving and the user requests Cancel.

Note: A common fault in scripts is the use of the construct:

```
View(v%).FileClose(0);
```

This can cause problems because, if the current view is already `View(v%)` then, at the end of the function the script will attempt to switch back to `View(v%)` again, but it is now gone! This results in a "`View is wrong type`" error for no obvious reason. To avoid the problem use:

```
View(v%);
FileClose(0);
```

See also: `FileOpen(), FileSave(), FileSaveAs(), FileNew()`

FileComment$()

This function accesses the file comment in the file associated with the current file or memory view. File comments for XY and text based views are always blank. The comment string is up to 72 characters in length.

```
Func FileComment$({,new$});
```

`new$` If present, the command replaces the existing comment with `new$`.

Returns The comment at the time of the call.

See also: `FrameComment$()`

FileConvert$()

This function converts a data file from a “foreign” format into a Signal data file. The range of foreign formats supported depends on the number of import filters in the `Signal\import` folder.

```
Func FileConvert$(src${, dest${, flag%{ ,&err%}}});
```

`src$` This is the name of the file to convert. The file extension is used to determine the file type (unless `flag%` bit 0 is set). Known file extensions include: `abf`, `cfs`, `cnt`, `cut`, `dat`, `eeg`, `ewb`, `ibw`, `ibw`, `son` and `uff`. We expect to add more. If an empty string is used or one containing wild cards then a file selection dialog will appear.

`dest$` If this is present, it sets the destination file. If this is not a full path name, the name is relative to the current directory. If you do not supply a file extension then Signal appends `".cfs"`. If you set any other file extension, Signal cannot open the file as a Signal data file. If you do not supply this argument, the converted file will be written to the same folder as the source file using the original file name with the file extension changed to `.cfs`.

`flag%` This argument is the sum of the flag values: 1=Ignore the file extension of the source file and try all possible file converters, 2=Allow user interaction if required (otherwise sensible, non-destructive defaults are used for all decisions).

`err%` Optional integer variable that is returned as 0 if the file was converted, otherwise it is returned holding a negative error code.

Returns The full path name of the created file, or an empty string if the file was not converted.

See also:`FileOpen()`, `FilePath$()`, `FilePathSet()`, `FileList()`

FileCopy()

This function copies a source file to a destination file. File names can be specified in full or relative to the current directory. Wildcards cannot be used.

```
Func FileCopy(src$, dest${, over%});
```

`src$` The source file to copy to the destination. This file is not changed.

`dest$` The destination file. If this file exists you must set `over%` to overwrite it.

`over%` If this optional argument is 0 or omitted, the copy will not overwrite an existing destination file. Set to 1 to overwrite.

Returns The routine returns 1 if the file was copied, 0 if it was not. Reasons for failure include: no source file, no destination path, insufficient disk space, destination exists and insufficient rights.

See also:`BRead()`, `BWrite()`, `FileDelete()`, `FileOpen()`, `ProgRun()`

FileDelete()

This function deletes one or more files. File names can be specified in full, or relative to the current directory

Windows file names are of the form `x:\folder1\folder2\foldern\file.ext` or `\\machine\folder1\folder2\foldern\file.ext` across a network. If a name does not start with a \ or with `x:\` (where `x` is a drive letter), the path is relative to the current directory. Beware that \ must be written \\ in a string passed to the compiler.

```
Func FileDelete(name$[]|name${, opt%});
```

`name$` This is either a string variable or an array of strings that holds the names of the files to delete. Only one name per string and no wildcard characters are allowed. If the names do not include a path they refer to files in the current directory.

`opt%` If this is present and non-zero, the user is asked before each file in the list is deleted. You cannot delete protected or hidden or system files:

Returns The number of files deleted or a negative error code.

See also:`FilePath$()`,`FilePathSet()`, `FileList()`

FileExportAs()

This function saves the current data view or the sampling configuration as a file on disk. A data view is saved either in its native format, or as text or as a picture. It is equivalent to the two File menu commands Export As and Save configuration. This cannot be used for external text or binary files as they are already on disk.

```
Func FileExportAs(name${, type% {,yes%, {text$}}});
```

`name$` The name to use for saving. If the string is empty or if the string holds wild card characters * or ?, then the File menu Save As dialog opens, otherwise it is used directly. In Windows, the wildcards select the initial list of files. If the string is used directly, a default file extension is not provided, you must provide the extension yourself.

`type%` The type to save the file as (if omitted, type -1 is used):

- -1 Export in the native format for the data view. This is equivalent to using `type%` 0 for file and memory views or 12 for XY views.
- 0 Export part of the data view as set by `ExportFrameList()`, `ExportTimeRange()` and `ExportChanList()` to a new Signal data file. The file extension should be .cfs.
- 1 Save the contents of the current data or XY view as a text file. Signal saves the data as set by `ExportFrameList()`, `ExportTimeRange()`, and `ExportChanList()` in the text format set by `ExportChanFormat()` and `ExportTextFormat()`. The file extension should be .txt.
- 5 Save data or XY view as a picture file. The file extension should be .wmf.
- 6 Save the sampling configuration in a configuration file. The file extension should be .sgc.
- 12 For XY views only, save as an XY data file. The file extension should be .sxy.

`yes%` If this operation would overwrite an existing file you are asked if you wish to do this unless `yes%` is present and non-zero. While an existing file is open in Signal you will not be able to overwrite it.

`text$` An optional prompt displayed as part of the file dialog to prompt the user.

Returns The function returns 0 if the operation was a success, or a negative error code.

See also:`EditCopy()`, `ExportChanFormat()`, `ExportChanList()`, `ExportFrameList()`, `ExportTimeRange()`, `ExportTextFormat()`

FileGetIntVar()

This function reads a CFS file variable of integer type from the file attached to the current view, which must be a file view. The CFS supports the use of file and frame variables of integer, floating point and string types. Software other than Signal may have included these when creating a data file.

```
Func FileGetIntVar(name$ {&nVar%{, &units$, {nType%}}});
```

`name$`	The name of the variable to look for. This string is not case sensitive but every character including spaces must match exactly.
`nVar%`	If present this returns the variable number, -1 if not found, or a negative error code.
`units$`	If present this returns the units for the variable.
`nType%`	If present this returns a code for the CFS type of an integer variable: 0: INT1, 1: WRD1, 2: INT 2, 3: WRD2, 4: INT4:
Returns	The function returns the value of the variable if the operation was a success, and otherwise zero.
See also:	`FileGetRealVar(), FileGetStrVar$(), FileVarCount(), FileVarInfo(), FrameGetIntVar(), FrameGetRealVar(), FrameGetStrVar$(), FrameVarCount(), FrameVarInfo()`

FileGetRealVar()

This function reads a CFS file variable of real type from the file attached to the current view, which must be a file view.

```
Func FileGetRealVar(name$ {&nVar%{, &units$}});
```

`name$`	The name of the variable to look for. This string is not case sensitive but every character including spaces must match exactly.
`nVar%`	If present this returns the variable number, -1 if not found, or a negative error code.
`units$`	If present this returns the units for the variable.
Returns	The function returns the value of the variable if the operation was a success, and otherwise zero.
See also:	`FileGetIntVar(), FileGetStrVar$(), FileVarCount(), FileVarInfo(), FrameGetIntVar(), FrameGetRealVar(), FrameGetStrVar$(), FrameVarCount(),FrameVarInfo()`

FileGetStrVar$()

This function reads a CFS file variable of string type from the file attached to the current view, which must be a file view.

```
Func FileGetStrVar$(name$ {&nVar%{, &units$}});
```

`name$`	The name of the variable to look for. This string is not case sensitive but every character including spaces must match exactly.
`nVar%`	If present this returns the variable number, -1 if not found, or a negative error code.
`units$`	If present this returns the units for the variable.
Returns	The function returns a string contents of the variable if the operation was a success, and otherwise an empty string.
See also:	`FileGetIntVar(), FileGetRealVar(), FileVarCount(), FileVarInfo(), FrameGetIntVar(), FrameGetRealVar(), FrameGetStrVar$(), FrameVarCount(),FrameVarInfo()`

FileList()

This function gets lists of files and sub-directories (folders) in the current directory and can also return the path to the parent directory of the current directory. This function can be used to process all files of a particular type in a particular directory.

```
Func FileList(names$[]|&name$, type%{, mask$});
```

`name$`	This is either a string variable or an array of strings that is returned holding the name(s) of files or directories. Only one name is returned per string.
`type%`	This sets the type of the objects to return information on. Allowed values are:

-3	The parent directory of the current directory. The full path is returned.
-2	Sub-directories of the current directory. No path is returned.
-1	All files in the current directory
0	Signal data files
1	Text files
2	Output sequence files
3	Signal script files
5	Picture (Windows metafile) files.
6	Signal configuration files
12	XY view data file

`mask$`	This optional string limits the names returned to those that match it; * and ? in the mask are wildcards. ? matches any character and * matches any 0 or more characters. Matching is case insensitive and from left to right.
Returns	The number of names that met the specification or a negative error code. This can be used to set the size of the string array required to hold all the results.

See also:`FilePath$()`, `FilePathSet()`, `FileDelete()`, `FileName$()`

FileName$()

This returns the name of the data file associated with the current view (if any). You can recall the entire file name, or any part of it. If there is no file the result is an empty string.

```
Func FileName$({mode%})
```

`mode%` If present, determines what to return, if omitted taken as 0.

0	Or omitted, returns the full file name including the path
1	The disk drive/volume name
2	The path section, excluding the volume/drive and the name of the file
3	The file name up to and not including the last . in the name, excluding any trailing number
4	Any trailing numbers from 3
5	The end of the file name from the last dot

Returns A string holding the requested name, or a blank string if there is no file.

See also:`FileList()`, `FilePath$()`, `FilePathSet()`, `FileDelete()`

FileNew()

This is equivalent to the File menu New command. It creates a new window, also called a view, and returns the handle. You can create visible or invisible windows. Creating an invisible window lets you set the window position and properties before you draw it. The new window is the current view and if visible, the front view. Use `FileSaveAs()` to name created files.

```
Func FileNew(type%{, mode%);
```

`type%` The type of file to create:

0	A Signal data file based on the sampling configuration, ready for sampling. This opens a new file view which is also referred to as the sampling document view. It may also open other windows which will include the sampling control panels.
1	A text file in a window
2	An output sequence file in a window. Not yet implemented in version 2.00
3	A Signal script file in a window
12	An XY view with one (empty) data channel. Use `XYAddData()` to add more data and `XYSetChan()` to create new channels.

`mode%` This optional argument determines how the new window is opened. The value is the sum of these flags. If the argument is omitted, its value is 0. The flags are:

1 Make the new window(s) visible immediately. If this flag is not set the window is created, but is invisible.

2 For data files, if the sampling configuration holds information for creating additional windows, use it. If this flag is not set, data files extract enough information from the sampling configuration to set the sampling parameters for the data channels.

Returns It returns the view handle (or the handle of the lowest numbered duplicate for a data file with duplicate windows) or a negative error.

See also:`FileOpen(), FileSave(), FileSaveAs(), FileClose(), SetMemory(), SampleStart(), XYAddDAta(), XYSetChan()`

FileOpen()

This is the equivalent of the File Open... menu command. It opens an existing Signal data file or a text file in a window, or an external text or binary file. If the file is already opened, a handle for the existing view is returned. The window becomes the new current view. You can create windows as visible or invisible. It is often more convenient to create an invisible window so you can position it before making it visible.

```
Func FileOpen(name$, type% {,mode% {,text$}});
```

`name$` The name of the file to open. This can include a path. The file name is operating system dependent, see `FileDelete()`. If the name is blank or holds wild card characters (Windows only), the file dialog opens for the user to select a file.

`type%` The type of the file to open. The types currently defined (see `ViewKind()`) are:

0 Open a Signal data file. A new **file view** is created.
1 Open a text file. A new **text view** is created.
2 Open an output sequence file. A new **output sequence view** is created. Not yet supported in version 2.00.
3 Open a Signal script file. A new **script view** is created.
6 Load configuration file. No new view is created.
8 An external text file without a window. An invisible **external text view** is created in which `Read()` or `Print()` can be used.
9 An external binary file without a window. An invisible **external binary view** is created in which `BRead()`, `BWrite()`, `BSeek()` and other binary routines can be used.
12 Open an XY data file. A new **XY view** is created.

`mode%` This optional argument determines how the window or file opens. If the argument is omitted, its value is 0.

For file types 0 to 3 and 12 the value is the sum of:

1 Make the new window(s) visible immediately. If this flag is not set the window is created, but is invisible.

2 Read resource information associated with the file. This may create more than one window, depending on the file type. For data files, it restores the file to the state as it was closed. If the flag is unset, resources are ignored.

4 Return an error if the file is already open in Signal. If this flag is not set and the file is already in use, it is brought to the front and its handle is returned.

When used with file types 8 and 9 the following values of `mode%` are used. The file pointer (which sets the next output or input operation position) is set to the start of the file in modes 0 and 1 and to the end in modes 2 and 3.

0 Open an existing file for reading only
1 Open a new file (or replace an existing file) for writing (and reading)
2 Open an existing file for writing (and reading)
3 Open a file for writing (and reading). If the file doesn't exist, create it.

`text$` An optional prompt displayed as part of the file dialog, for all except type 6. If this is supplied then the file dialog will appear even if a complete file name is also supplied.

Returns If a file opens without any problem, the return value is the view handle for the file (if multiple views open, it is the handle for the first file view created). For configuration files (`type%` of 6), the return value is 0 if no error occurs. If the file could not be opened, or the user pressed Cancel in the file open dialog, the returned value is a negative error code.

If multiple windows are created for a data file, you can get a list of the associated view handles using `ViewList(list%[],64)`.

See also: `FileDelete(), FileNew(), FileSave(), FileSaveAs(), FileClose(), BRead(), BReadSize(), BSeek(), BWrite(), BWriteSize(), ViewFind(), ViewList(), ViewKind()`

FilePath$()

This function gets the “current directory”, the place on disk where file open and file save dialogs start from. It can also get the path for created data files or the directory where the Signal application is installed.

```
Func FilePath$({opt%});
```

`opt%`	If 0 or omitted, this gets the current directory. If 1, it returns the path for temporary sampled data files from the preferences dialog. If 2, it returns the path to the directory where the Signal application is installed. If 3, it returns the path for automatic file saving from the sampling configuration.
Returns	A string holding the path or an empty string if an error is detected.

See also: `FilePathSet(), FileList(), FileName$()`

FilePathSet()

This function sets the “current directory” and the directory where Signal data files created by `FileNew()` are stored until they are saved using `FileSaveAs()`. It can also be used to create the directories.

```
Func FilePathSet(path${,opt%{, make%|text$}});
```

`path$`	A string holding the new path to the directory. The path must conform to the rules for pathnames on the host system and be less than 255 characters long. If the path is empty a dialog opens for the user to select an existing directory.
`opt%`	If omitted or zero, this sets the current directory. If 1, it sets the path for temporary sampled data files in the preferences dialog. If 3, it sets the path for automatic file saving in the sampling configuration.
`make%`	If this is present and non-zero, the command will create the directory if all elements of the path exist except the last. You cannot use this option if `path$` is blank.
`text$`	Optional prompt for use with the dialog.
Returns	Zero if the path was set, or a negative error code.

See also: `FilePath$(), FileList()`

FilePrint()

This function is equivalent to the File menu Print command. It prints some, or all of the current view to the printer that is currently set for Signal. If no printer has been set, the current system printer is used. In a file or memory view, it prints a range of data with the x axis scaling set by the display. In a text or log view, it prints a range of text lines. There is currently no script mechanism to choose a printer; you must do it interactively.

```
Func FilePrint({from{, to{, flags%}}});
```

`from`	The start point of the print. This is in seconds in a file or memory view and in lines in a text view. If omitted, this is taken as the start of the view.
`to`	The end point in the same units as from. If omitted or set beyond the end of the view then the end of the view is used.
`flags%`	0=portrait, 1=landscape, 2=current setting. If omitted, the current value is used.
Returns	The function returns 0 if all went well; otherwise it returns a negative error.

The format of the printed output is based on the screen format of the current view. Beware that for file and memory views the output could be many (very many) pages long.

See also:`FilePrintScreen()`, `FilePrintVisible()`

FilePrintScreen()

This function is equivalent to the File menu Print screen command. It prints all visible data, text, script, XY and log views on the screen to the current printer on one page. The page positions are proportional to the view positions on the screen. Output sequence views will be included when they are implemented; they are not supported in Version 2.00.

```
Func FilePrintScreen({pTtl${, vTtl%{, box%{, flags%}}}});
```

`pTtl$`	This sets the page title string to print at the top of a page. If omitted or an empty string, there is no page title.
`vTtl%`	Set 1 or higher to print a title above each view, omitted or 0 for no title.
`box%`	Set 1 or higher for a box around each view. If omitted, or 0, no box is drawn.
`flags%`	0=portrait, 1=landscape, 2=current setting. If omitted, the current value is used. Prior to version 2.13, the default was landscape mode.
Returns	The function returns 0 if it all went well, or a negative error code.

See also:`FilePrint()`, `FilePrintVisible()`

FilePrintVisible()

This function prints the current view as it appears on the computer screen to the current printer. In a text view, this prints the lines in the current selection. If there is no selection, it prints the line containing the cursor. This function is equivalent to the File menu Print visible command.

```
Func FilePrintVisible({flags%})
```

`flags%`	0=portrait, 1=landscape, 2=current setting. If omitted, the current value is used.
Returns	The function returns 0 if all went well, otherwise it returns a negative error.

See also:`FilePrint()`, `FilePrintScreen()`

FileQuit()

This is equivalent to the File menu Quit/Exit command. If there is any unsaved data you are asked if you wish to save it before the application closes. If the user cancels the operation (because there were files that needed saving), the script terminates, but the Signal application is left running. Use `FileClose(-1, -1)` before `FileQuit()` to guarantee to exit.

```
Proc FileQuit();
```

See also:`FileClose()`

FileSave()

This function saves the current view as a file on disk. It is equivalent to the File menu Save command. You cannot use this command for a file view if it has just been sampled, use `FileSaveAs()` instead. If the view has not been saved previously, the File menu Save As dialog opens and the user must provide a file name. This cannot be used for external text or binary files either as they are already on disk.

```
Func FileSave();
```

Returns The function returns 0 if the operation was a success, or a negative error code.

See also:`FileOpen(), EditCopy(), FileExportAs(), FileSaveAs(), FileClose()`

FileSaveAs()

This function is equivalent to the File menu SaveAs command. It can be used to save the current view, with any changes, under a new name. Use this to save and name a Signal data file immediately after it has been sampled. Use `FileExportAs()` to export selected parts of a CFS data file to a new file, or to export from a view under a different format.

```
Func FileSaveAs(name$ {,yes%, {text$}});
```

`name$`	The name to use for saving. If the string is empty or if the string holds wild card characters * or ?, then the File menu Save As dialog opens. In Windows, the wildcards select the initial list of files. A default extension is not provided in circumstances when the dialog is not used.
`yes%`	If this operation would overwrite an existing file you are asked if you wish to do this unless `yes%` is present and non-zero. While an existing file is open in Signal you will not be able to overwrite it.
`text$`	An optional prompt displayed as part of the file dialog to prompt the user.
Returns	The function returns 0 if the operation was a success, or a negative error code.

See also:`FileSave(), EditCopy(), FileExportAs()`

FileVarCount()

This function counts CFS file variables in the data file.

```
Func FileVarCount();
```

Returns The number of file variables in the data file associated with this view.

See also:`FileGetIntVar(), FileGetRealVar(), FileGetStrVar$(), FileVarInfo(), FrameGetIntVar(), FrameGetRealVar(), FrameGetStrVar$(), FrameVarCount(), FrameVarInfo()`

FileVarInfo()

This function reads a description of a CFS file variable.

```
Func FileVarInfo(nVar%, &name$);
```

`nVar%`	This is the variable number
`name$`	The name of the variable, which can be used in the commands for reading the file variables.
Returns	The function returns the type of the variable or -1 if the variable was not found or is of unknown type. The type code is as follows:

0	An integer variable which can be read using `FileGetIntVar()`
1	A floating point variable which can be read using `FileGetRealVar()`
2	A string variable which can be read using `FileGetStrVar$()`

See also: `FileGetIntVar(), FileGetRealVar(), FileGetStrVar$(), FileVarCount(), FrameGetIntVar(), FrameGetRealVar(), FrameGetStrVar$(), FrameVarCount(), FrameVarInfo()`

FiltApply()

Applies a set of filter coefficients or a filter in the filter bank to a set of waveform channels in the current file or memory view.

Each output point is generated from the same number of input points as there are filter coefficients. Half these point are before the output point, and half are after. Where more data is needed than exists in the source file (for example at the start and end of a file and where there are gaps), extra points are made by duplicating the nearest valid point.

```
Func FiltApply(n%|coef[], chan%|chan%[]|chan$, frm%|frm%[]|frm$)
```

`n%`	Index of the filter in the filter bank to apply in the range 0-11, or
`coef[]`	An array holding a set of FIR filter coefficients to apply to the waveform.
`chan%`	A channel from the current view to filter. Use a channel number (1 to n), or -1 for all channels, -2 for all visible channels, -3 for all selected, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels. Marker channels will be ignored.
`chan$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
`chan%[]`	As an alternative to `chan%` or `chan$`, you can pass in a channel list (as constructed by `ChanList()`). This must be an array of channels in the current data view, with the first element of the array holding the number of channels in the list.
`frm%`	Frame number or a negative code as follows:

-1	All frames in the file
-2	The current frame
-3	Only tagged frames
-6	Only untagged frames

`frm$`	A frame specification string. This option specifies a list of frames using a string such as “1..32,40,50”.
`frm%[]`	An array of frame numbers. This option provides a list of frame numbers. The first element holds the number of frames in the list.

Returns The number of the last channel to be filtered or a negative error code. A negative error code is also returned if the user clicks Cancel from the progress bar that may appear during a long filtering operation.

See also: `FiltAtten()`, `FiltCalc()`, `FiltComment$()`, `FiltCreate()`, `FiltInfo()`, `FiltName$()`, `FiltRange()`

FiltAtten()

This set the desired attenuation for a filter in the filter bank. When `FiltApply()` or `FiltCalc()` is used, the number of coefficients needed to achieve this attenuation (up to a maximum of 255) will be generated. A value of zero sets the attenuation back to the default (-65 dB).

```
Func FiltAtten(index%{, dB})
```

`index%`	Index of the filter in the filter bank to use in the range 0-11.
`dB`	If present and negative, this is the desired attenuation for stop bands in the filter.

Returns The desired attenuation for a filter at the time of the call.

See also: `FiltApply()`, `FiltCalc()`, `FiltComment$()`, `FiltCreate()`, `FiltInfo()`, `FiltName$()`, `FiltRange()`

FiltCalc()

The calculation of filter coefficients can take an appreciable time. This routine forces the calculation of a filter for a particular sampling frequency if it has not already been done. If you do not force the calculation, you can still use `FiltApply()` to apply a filter. However, the coefficient calculation will then be done at the time of filter application, which may not be desirable if the filtering operation is time critical.

```
Func FiltCalc(index%, sInt{, coeff[]{, &dBGot {, nCoef%}}})
```

`index%`	Index of the filter in the filter bank to use in the range 0-11.
`sInt%`	The sample interval of the waveform you are about to filter. This is the value returned by `BinSize()` for a waveform channel.
`coeff`	An array to be filled with the coefficients used for filtering. If the array is too small, as many elements as will fit are set. The maximum size needed is 255.
`dBGot`	If present, returns the attenuation attained by the filter coefficients.
`nCoef%`	If present, sets the number of coefficients used in the calculation (use an even number for a full differentiator and an odd number for all other filter types).
Returns	The number of coefficients generated by the filter.

An example

Suppose the first filter in the bank (index 0) is a low pass filter with the pass band edge at 50 Hz. If we know that we will need to filter a channel 4 (sampled at 200 Hz) with this filter, we may want to calculate the coefficients needed in advance:

```
FiltCalc(0, BinSize(4));
```

This will calculate a filter corresponding to the specification of filter 0 for a sampling frequency of 200 Hz with an attenuation in the stop band of at least the current desired attenuation value for this filter.

Constraints on filters

The calculation of coefficients is a complex process and can produce silly results due to floating point rounding errors in some situations. To ensure that you will always get a useful result there is a limit to how small and how big a transition gap can be relative to the sampling frequency. There is a similar limit on the width of a pass or stop band:

- The transition gap and the width of a pass or stop band cannot be smaller than 0.005 of the sampling frequency.
- The transition gap cannot be larger than 0.12 of the sampling frequency.

This function always calculates a set of coefficients, but may alter the filter specification in order to do it (these changes are temporary, see later). This can happen in two cases :

1. If the sampling frequency is such that to produce the filter, the transition gap and/or pass and stop band widths are outside their limits, the widths are set to the limits before calculating the filter. In our 50 Hz low pass filter example, if we calculate it with respect to a 12 kHz sampling frequency, the minimum pass band width is 12000*0.005 = 60 Hz. So, the filter would be changed to a 60 Hz low pass filter.
2. If half the sampling frequency (the Nyquist frequency) is less than an edge of a pass or stop band, certain attributes of the filter are lost. In our 50 Hz low pass filter example, if we tried to calculate with a sampling frequency of 80 Hz, we would see that the Nyquist frequency is 40 Hz. No frequency above 40 Hz can be represented in a waveform sampled at 80 Hz, so a 50 Hz low pass filter is equivalent to an “All pass” filter. The filter specification will be altered to reflect this before calculating.

Any changes made to a filter specification to accommodate a particular calculation are made with reference to the original specification, not the specification that was last used for a calculation.

See also: `FiltApply()`, `FiltAtten()`, `FiltComment$()`, `FiltCreate()`, `FiltInfo()`, `FiltName$()`, `FiltRange()`

FiltComment$()

This function gets and sets the comment associated with a filter in the filter bank.

```
Func FiltComment$(index% {, new$})
```

`index%`	Index of the filter in the filter bank to use in the range 0-11.
`new$`	If present, sets the new comment.
Returns	The previous comment for the filter at the index.

See also: `FiltApply(), FiltAtten(), FiltCalc(), FiltCreate(), FiltInfo(), FiltName$(), FiltRange()`

FiltCreate()

This function creates a filter in the filter bank to the supplied specification and gives it a standard name and comment.

```
Func FiltCreate(index%, type%{, trW{, edge1{, edge2{, ...}}}})
```

`index%`	Index of the new filter in the filter bank in the range 0-11. This action replaces any existing filter at this index.
`type%`	The type of the filter desired (see table).
`trW`	The transition width of the filter. This is the frequency interval between the edge of a stop band and the edge of the adjacent pass band.
`edgeN`	These are a list of edges of pass bands in Hz. (see table).
Returns	0 if there was no problem or a negative error code if the filter was not created.

This table shows the relationship between different filter types and the meaning of the corresponding arguments. The numbers in brackets indicate the nth pass band when there is more than 1. An empty space in the table means that the argument is not required.

`type%`	Name	`trW`	`edge1`	`edge2`	`edge3`	`edge4`
0	All stop					
1	All pass					
2	Low pass	Yes	High			
3	High pass	Yes	Low			
4	Band pass	Yes	Low	High		
5	Band stop	Yes	High(1)	Low(2)		
6	Low pass differentiator	Yes	High			
7	Differentiator					
8	1.5 Band Low pass	Yes	High(1)	Low(2)	High(2)	
9	1.5 Band High pass	Yes	Low(1)	High(1)	Low(2)	
10	2 Band pass	Yes	Low(1)	High(1)	Low(2)	High(2)
11	2 Band stop	Yes	High(1)	Low(2)	High(2)	Low(3)

The values entered correspond to the text fields shown in the Filter edit dialog box.

See also: `FiltApply(), FiltAtten(), FiltCalc(), FiltComment$(), FiltInfo(),FiltName$(), FiltRange()`

FiltInfo()

Retrieves information about a filter in the bank.

```
Func FiltInfo(index%{, what%})
```

`index%` Index of the filter in the filter bank to use in the range 0-11.

`what%` Which bit of information about the filter to return:

-2	Maximum `what%` number allowed
-1	Desired attenuation
0	type (if you supply no value, 0 is assumed)
1	Transition width
2-5	`edge1-edge4` given in `FiltCreate()`

Returns The information requested as float.

See also:`FiltApply()`, `FiltAtten()`, `FiltCalc()`, `FiltComment$()`, `FiltCreate()`, `FiltName$()`, `FiltRange()`

FiltName$()

This function gets and/or sets the name of a filter in the filter bank.

```
Func FiltName$(index% {, new$})
```

`index%` Index of the filter in the filter bank to use in the range 0-11.

`new$` If present, sets the new name.

Returns The previous name of the filter at that index.

See also:`FiltApply()`, `FiltAtten()`, `FiltCalc()`, `FiltComment$()`, `FiltInfo()`, `FiltCreate()`, `FiltRange()`

FiltRange()

Retrieves the minimum and maximum sampling rates that this filter can be applied to without the specification being altered. See the `FiltCalc()` command, *Constraints on filters* for more information.

```
Proc FiltRange(index%, &minFr, &maxFr)
```

`index%` Index of the filter in the filter bank to use in the range 0-11.

`minFr` Returns the minimum sampling frequency you can calculate the filter with respect to so that no transition width is greater than the maximum allowed and that no attributes of the filter are lost.

`maxFr` Returns the maximum sampling frequency you can calculate the filter with respect to without the transition (or band) widths being smaller than allowed.

It is possible to create a filter which cannot be applied to any sampling frequency without being changed. This will be apparent because `minFr` will be larger than `maxFr`.

See also:`FiltApply()`, `FiltAtten()`, `FiltCalc()`, `FiltComment$()`, `FiltInfo()`, `FiltCreate()`, `FiltName$()`

FIRMake()

This function creates FIR filter coefficients and place them in an array ready for use by `ArrFilt()`. This command is very similar in operation to the DOS program `FIRMake` and has similar input requirements. Unless you need precise control over all aspects of filter generation, you may find it easier to use `FiltCalc()` or `FIRQuick()`. You will need to read the detailed information about FIR filters in the description of the Digital Filter dialog to get the best results from this command.

```
Proc FIRMake(type%, param[][], coef[]{, nGrid{, extFr[]}});
```

`type%`	The type of filter file to produce: 1=Multiband filter, 2=Differentiator, 3=Hilbert transformer, 4=Multiband pink noise (Multiband with 3 dB per octave roll-off).
`param`	This is a 2-dimensional array. The size of the first dimension must be 4 or 5. The size of the second dimension (`n`) should be the number of bands in your filter. You pass in 4 values for each band (indices 0 to 3) to describe your filter: Indices 0 and 1 are the start and end frequency of each band. All frequencies are given as fraction of a sampling frequency and so are in the range 0 to 0.5. Index 2 is the function of the band. For all filter types except a differentiator, this is the gain of the filter in the band in the range 0 to 1 (the most common values are 0 for a stop band and 1 for a pass band). For a differentiator, this is the slope of the filter in the band, normally not more than 2. The gain at any frequency *f* in the band is given by *f*function*. Index 3 is the relative weight to give the band The weight sets the relative importance of the band in multiband filters. The program divides each band into frequency points and optimises the filter such that the maximum ripple times the weight in each band is the same for all bands. The weight is independent of frequency, except in the case of the differentiator, where the weight used is weight/frequency. If there is an index 4 (the size of the first dimension was 5), this index is filled in by the function with the ripple in the band in dB.
`coef`	An array into which the FIR filter coefficients are placed. The size of this array determines the number of filter coefficients which are calculated. It is important, therefore, to make sure this array is exactly the size that you need. The maximum number of coefficients is 256.
`nGrid`	The grid density for the calculation. If omitted or set to 0, the default density of 16 is used. This sets the density of test points in internal tables used to search for points of maximum deviation from the filter specification. The larger the value, the longer it takes to compute the filter. There is seldom any point changing this value unless you suspect that the program is missing the peak points.
`extFr`	An array to hold the list of extremal frequencies (the list of frequencies within the bands which have the largest deviation from the desired filter). If there are `n%` coefficients, there are `(n%+1)/2` extremal frequencies.

The parameters passed in must be correct or a fatal error results. Errors include: overlapping band edges, band edges outside the range 0 to 0.5, too many coefficients, differentiator slope less than 0, if not a differentiator the band function must lie between 0 and 1, the band weight must be greater than 0.

For example, to create a low pass filter with a pass band from 0 to 0.3 and a stop band from 0.35 to 0.5, and no return of the ripple, you would set up `param` as follows:

```
var param[4][2]      'No return of ripple, 2 bands
para[0][0] := 0;     'Starting frequency of pass band
para[1][0] := 0.3;   'Ending frequency of pass band
para[2][0] := 1;     'Desired gain (unity)
para[3][0] := 1;     'Give this band a weighting of 1

para[0][1] := 0.35; 'Starting frequency of stop band
para[1][1] := 0.5;   'Ending frequency of stop band
para[2][1] := 0;     'Desired gain of 0 (stop band)
para[3][1] := 10;    'Give this band a weighting of 10
```

See also:`ArrFilt()`, `FiltApply()`, `FiltCalc()`, `FIRQuick()`, `FIRResponse()`

FIRQuick()

This function creates a set of filter coefficients in the same way the `FIRMake()` does, but many of the parameters are optional, allowing the most common filters to be created with a minimal specification.

```
Func FIRQuick(coef[], type%, freq {, width {, atten}})
```

`coef` An array into which the FIR filter coefficients are placed. The size of this array should be 256. This is the maximum number of coefficients that can be created and this function reserves the right to return as many as it feels necessary up to that value to create a decent filter.

`type%` This sets the type of filter to create. 0=Low pass, 1=High pass, 2=Band pass, 3=Band stop and 4=Differentiator.

`freq` This is a fraction of the sampling rate in the range 0 to 0.5 and means different things depending on the type of filter.

For Low pass, High pass and Differentiator types, this represents the cut-off frequency. This is the frequency of the higher edge of the first frequency band.

For Band pass and Band stop filters, this is the midpoint of the middle frequency band; the pass band in a Band pass filter, the stop band in a Band stop filter.

`width` For Low pass, High pass and Differentiator filters, this is the width of the transition gap between the stop band and the pass band. The default value is 0.02 and there is an upper limit of 0.1 on this argument.

For a band Pass, or Band stop filter, `width` is the width of the middle band. E.g. if you ask for a Pass band filter with the `freq` parameter to be 0.25 and the width to be 0.05, the middle pass band will be from 0.2 to 0.3. For these types of filter, you still need a positive transition width. This transition width is 0.02 and cannot be changed by the user.

`atten` The desired attenuation in the stop band in dB. The default is 50 dB. This is analogous to the desired attenuation in the `FiltAtten()` command.

Returns The number of coefficients calculated. If the array is not large enough the coefficient list is truncated (and the result is useless).

See also:`ArrFilt()`, `FiltApply()`, `FiltCalc()`, `FIRMake()`, `FIRResponse()`

FIRResponse()

This function retrieves the frequency response of a given filter as amplitude or in dB

```
Func FIRResponse(resp[], coef[]{, as%{, type%}});
```

`resp` The array to hold the frequency response. This array will be filled regardless of its size. The first element is the amplitude response at 0 Hz and the last is the amplitude response at the Nyquist frequency. The remaining elements are set to the response at a frequency proportional to the element position in the array.

`coef` The coefficient array calculated by `FIRMake()`, `FIRQuick()` or `FiltCalc()`

`as%` If this is 0 or omitted, the response is in dB (0 dB is unchanged amplitude), otherwise as linear amplitude (1.0 is unchanged).

`type%` If present, informs the command of the filter type. The types are the same as those supplied for `FIRQuick()`. 0=Low pass, 1=High pass, 2=Band pass, 3=Band stop and 4=Differentiator. If a type is given , the time to calculate the response is halved. If you are not sure what type of filter you have, or you have type not covered by the `FIRQuick()` types, then do not supply a type to this command.

See also:`ArrFilt()`, `FiltCalc()`, `FIRMake()`, `FIRQuick()`

Fitting

It frequently happens that you have a set of data values (x_1,y_1), (x_2,y_2) … (x_n,y_n) that you wish to test against a theoretical model $y = f(x, \mathbf{a}_0, \mathbf{a}_1, \mathbf{a}_2 \ldots)$ where the $\mathbf{a}_i$ are coefficients that are to be set to constant values which give the *best fit* of the model to the data values.

For example, if we were looking at the extension of a spring (y) as it is loaded by weights (x), we might wish to fit the straight line $y = \mathbf{a}_0 + \mathbf{a}_1 x$ to some measured data points so that we could measure a weight by the extension it caused. A careful experimenter might also wish to know what the probable error was in $\mathbf{a}_0$ and $\mathbf{a}_1$ so that the probable error in any weight deduced from an extension would be known. An even more cautious experimenter might want to know if the straight line formula was likely to model the measured data.

To avoid repeating definitions throughout the remainder of this chapter the following will be taken as defined. We apologise to the statisticians who may read the following and shudder.

mean

Given a set of n values y_j, the mean is $\Sigma_j\, y_j / n$ (the symbol Σ_j means form the sum over all indices $_j$ of the expression that follows).

variance

If the mean of a set of n data values y_j is y_m, then the variance σ^2 (sigma squared) of this set of values is:

$\sigma^2 = \Sigma_j\, (y_j - y_m)^2 / n$ if y_m is known independently of the data values y_j
$\sigma^2 = \Sigma_j\, (y_j - y_m)^2 / (n - 1)$ if y_m is calculated from the data values y_j

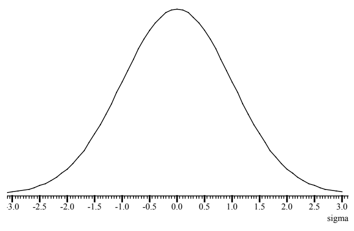
For a data set of any reasonable size, the use of n-1 or n in the denominator should make little difference.

standard deviation

The standard deviation σ (sigma) of a data set is the square root of the variance. Both the variance and the standard deviation are used as measures of the width of the distribution.

Normal distribution

If you measure a data value in any real system, there is always some error in the measurement. Once you have made a (very) large number of measurements, you can form a curve showing the probability of getting any particular value. One would hope that this error distribution would show a large peak at the "correct" value of the measurement and the width of this distribution would show the spread of likely errors.



There is a particular error distribution which often occurs, called the Normal distribution. If a set of measurements are normally distributed, with a mean y_m and standard deviation σ, then the probability of measuring any particular value y is proportional to:

$P(y) \propto \exp(-\tfrac{1}{2}(y - y_m)^2/\sigma^2)$

It is for this distribution of errors that we have the well-known result that 68% of the values lie within one standard deviation of the mean, that 95% lie within two standard deviations and that 99.7% lie within three standard deviations. Of course, **if the error distribution is not normal, these results do not apply**.

chi-squared

The fitting routines given here define *best fit* as the values of $\mathbf{a}_i$ (the coefficients) that minimise the chi-squared value (χ^2), defined as the sum over the measured data points of the square of the difference between the measured and predicted values divided by the variance of the data point:

$\chi^2 = \Sigma_j\ ((y_j - f(x_j, \mathbf{a}_i))^2 / \sigma_j^2)$

where (x_j, y_j) is a data point and σ_j^2 is the variance of the measured data at that point.

If the sigma of each data point is unknown, then the fitting routines can be used to minimise $\Sigma_j (y_j - f(x_j, \mathbf{a}_i))^2$ which produces the same result as a chi-squared fit would produce if the variance of the errors at all the data points was the same. This is commonly called least-squares fitting (meaning that the fit minimises the sum of squares of the errors between the fitted function and the data).

Chi-squared fitting is also a maximum likelihood fit if the errors in the data points are normally distributed. This means that as well as minimising the chi-squared value, the fit also selects the most probable set of coefficients that model your data. If your data measurement errors are not normally distributed you can still use this method, but the fit is not maximum likelihood.

If your errors are normally distributed and if you know the variance(s) of the data points, you can form good estimates of the variance of the fitted coefficients, and you can also test if the function you have fitted is likely to model the data.

If your errors are normally distributed but you do not know the variance of the errors at the data points, you can make an estimate of the variance of the errors (based on the assumption that the variance is the same for them all and that the model does fit the data), by fitting your model and calculating the variance from the errors between the best fit and the data. Having done this, you cannot then use this variance to test if the fit is likely to model the data.

Residuals Once your fit is completed, it is a good idea to look at the graph of the errors between your original data and the fitted data (the residuals or residual errors). If your errors are normally distributed and are independent, you would expect this graph to be more or less horizontal with no obvious trends. If this is not the case, you should consider if the correct model function has been selected, or if the fitting function has found the true minimum.

Linear fit
Non-linear fit A linear fit is one in which the theoretical model $y = f(x, \mathbf{a}_0, \mathbf{a}_1, \mathbf{a}_2\ldots)$ can be expressed as $y = \mathbf{a}_0 f_0(x) + \mathbf{a}_1 f_1(x) + \mathbf{a}_2 f_2(x)$ … for example $y = \mathbf{a}_0 + \mathbf{a}_1 x + \mathbf{a}_2 x^2$. Linear fits are relatively quick as they are done in one step. Usually, the only thing that can cause a problem is if the functions $f_i(x)$ are not linearly independent. The methods we use can usually detect this problem, and can still give a useful result.

A non-linear fit means all other cases, for example, $y = \mathbf{a}_0 \exp(-\mathbf{a}_1 x) + \mathbf{a}_2$. These types of problem are solved by making an initial guess at the coefficients (and ideally providing a range of values that the result is known to lie in) and then improving this guess. This process repeats until some criterion is met. Each repeat is called an *iteration*, so we call this an iterative process.

Covariance array Several of the fitting routines return a covariance array. If you have *n* coefficients, this array is of size *n* by *n* and is diagonally symmetric. If the errors in the original data points are normally distributed, the diagonal elements of this array are the variances in the values of the fitted coefficients. The remaining elements are the co-variances of pairs of the fitting parameters and can be used to estimate errors in derived values that depend on the product of two of the coefficients. If the errors are not normally distributed, the further away from normal the errors are, the less useful is the covariance array as a direct indication of the variances in the fitted coefficients.

For example, in the case of the linear fit $y = \mathbf{a}_0 + \mathbf{a}_1x + \mathbf{a}_2x^2$ you might collect your three coefficients in the array `coef[]`, and the covariance in the array `covar[][]`. In this case, the $\mathbf{a}_0$ value is returned in `coef[0]` and its variance in `covar[0][0]`, the $\mathbf{a}_1$ value is returned in `coef[1]` and its variance in `covar[1][1]`, and the $\mathbf{a}_2$ value is returned in `coef[2]` and its variance in `covar[2][2]`.

Because the array is diagonally symmetric, `covar[i][j]` is equal to `covar[j][i]` and the off diagonal elements are the expected variance in the product of pairs of the coefficients, so `covar[1][2]` is the variance of $\mathbf{a}_1\mathbf{a}_2$.

If you have not supplied the standard deviations of the errors in the data points, the covariance array is calculated on the assumption that all data points have a standard deviation of 1.0, and the covariance array is incorrectly scaled. In this case, if inspection of the residuals leads you to the conclusion that the function does indeed fit the data and that the errors are more or less the same for all values and not too far from normally distributed, then you can scale the covariance array to the correct values by multiplying all the elements of the array by the sum of squares of the errors between the data and the fitted values.

What does the covariance mean?

Having fitted our data, we would like some idea of how the errors in the original data feed through to uncertainties in the values of the coefficients. The best way to do this is to obtain many sets of (x,y) data and fit our coefficient to each set. Then we can inspect the values of the coefficients and obtain a mean and standard deviation for each coefficient. However, this is very time consuming.

If the errors in the data are normally distributed (or not too far from this ideal case) and known, then the covariance array gives you some useful information. The square root of the covariance for a particular coefficient is the expected standard deviation in that value (given that the remaining coefficients remain fixed at optimum values). In script language terms, the standard deviation of `coef[i]` is `sqrt(covar[i][i])`.

In this case you would expect the coefficient to be within one standard deviation of the "correct" result 68% of the time, within 2 standard deviations 95% of the time and within 3 standard deviations 99.7% of the time.

Testing the fit

If the errors in the original data are normally distributed and known (not calculated from the fit), and you know the χ^2 value for the fitted data, you can ask the question, "Given the known errors in the original data, how likely is it that you would get a value of χ^2 at least this large?" The answer is (at least in terms of the script language) that the probability is: `GammaQ((nData% - nCoef%)/2.0, chiSq/2.0);` where `nData%` is the number of data points to be fitted, `nCoef%` is the number of coefficients that were fitted and `chiSq` is the χ^2 value for the fit. `GammaQ()` is the incomplete Gamma function.

If you want to follow this result up in a statistical textbook, you should look up *chi-squared distribution for n degrees of freedom*. In our case, we have `nData%-nCoef%` degrees of freedom.

If the fit is reasonable, you should expect a probability value between 0.1 and 1 (but be a bit suspicious if you always get values close to 1.0, as you may have overestimated the errors in the data). If the wrong function has been fitted or if the fit is poor you usually get a very small probability. Intermediate values (0.0001 to 0.1) may indicate that the errors in the original data were actually larger than you thought, or they may indicate that the data just doesn't fit the model.

FitExp()

This command will fit multiple exponentials to arrays of x,y data points, with an optional weight for each point. Fitting is by an iterative method. The data is fitted to the equation:

$y = \mathbf{a}_0 \exp(-\mathbf{a}_1 x) + \mathbf{a}_2 \exp(-\mathbf{a}_3 x)\ldots$ For an even number of coefficients
$y = \mathbf{a}_0 \exp(-\mathbf{a}_1 x) + \mathbf{a}_2 \exp(-\mathbf{a}_3 x)\ldots + \mathbf{a}_n$ For an odd number of coefficients

The fitted parameters (coefficients) are the $\mathbf{a}_i$. You can fit up to 5 exponentials or 4 exponentials and an offset. However, experience shows that trying to fit more than two exponentials requires a certain amount of skill, and that the fit from even two exponentials should be viewed with caution, especially if the exponential coefficients are similar. The odd numbered $\mathbf{a}_i$ are assumed to be positive. The commands to implement this are:

Set up the problem

The first command sets the number of exponentials to fit and the data set to be fitted. You must call this function before you call any of the others.

```
func FitExp(nCoef%, y[], x[]{, s[]|s});
```

`nCoef%`	The number of coefficients to fit in the range 2 to 10. If this is even, the first form of the function above is used. If it is odd, the final coefficient is an offset.
`y[]`	An array of y data values. The length of the array must be at least `nCoef%`.
`x[]`	An array of x data values. The length of the array must be at least `nCoef%`.
`s`	An optional argument which is either an array with one value for each y data point or a single value for all data points. If the value is the standard deviation, then the error value returned when you iterate to find the best fit is the chi-squared value and the fit is a chi-squared fit. If this value is proportional to the error in the y values, then the fit is still a chi-squared fit, and the error returned is proportional to the chi-squared value. If you omit this array, the fit is a least squares error fit, and the error value returned is the sum of the squares of the errors in the y values.
Returns	The function returns 0. There is no other return value as all errors stop the script.

The number of data points is set by the smallest of the sizes of the `y[]`, `x[]` or `s[]` (if present) arrays. The number of data points must be at least the number of coefficients. If it is not, you will get a fatal error, so check this before calling the function.

Set coefficient values and ranges

This variant of the function sets the initial value of each coefficient and optionally sets the range of allowed values. You can call this function at any time after the setup call and before the iterate call (below) has returned 0 indicating that the fit is completed.

In this type of fitting it is very important that you give reasonable starting values for the coefficients. In particular, when fitting multiple exponentials, you should try to limit the range of each exponent so that they cannot overlap. If you can do this, the fit will proceed quickly. If you do not give starting values, the command will make a simplistic guess at the fitting values. As we expect that you know more about the "right" answer than the command does, we suggest that you set the values you want.

```
func FitExp(coef%, val{, lo, hi});
```

`coef%`	The coefficient to set. The first coefficient is number 0, the last one is `nCoef%`-1.
`val`	The initial value to assign to the coefficient. If you have set low and high limits, and the value is outside these limits, it is set to the nearer limit.
`lo,hi`	If present, these two values set the acceptable range of values for this coefficient. If omitted, or if both values are set to the same value, there is no

limit. The value of the coefficient is tested against these limits after each iterative step, and if it exceeds a limit, it is set to that limit.

It is well worth limiting the exponent values so that they cannot be zero which leads to degenerate cases. It is also worth limiting them so that they do not overlap as if two exponents get the same value the fit is degenerate and can wander around for ever without getting anywhere. However, setting too rigid a range may damage the fitting process as sometimes the minimisation process has to follow a convoluted n-dimensional path to reach the goal, and the path may need to wander quite a bit. Let experience be your guide.

Iterate to a solution

Once you have set up the problem and given initial values to your coefficients, you can start the iteration process that will move the coefficients from their starting values to new values that minimise the error (optionally scaled by the `s` argument).

```
func FitExp(a[], &err{, maxI%{, &iTer%{, covar[][]}}});
```

`a[]` An array of size at least `nCoef%` that is returned holding the current set of coefficient values. The first amplitude is in `a[0]`, the first exponent in `a[1]`, the second amplitude in `a[2]`, the second exponent in `a[3]` and so on.

`err` A real variable returned as the sum over the data points of $(y_{\texttt{x[i]}}\texttt{-y[i]})^2\texttt{/s[i]}^2$ if `s[]` is used or holding the sum of $(y_{\texttt{x[i]}}\texttt{-y[i]})^2$ if `s[]` is not used where $y_{\texttt{x[i]}}$ is the value predicted from the coefficients at the x value `x[i]`.

`maxI%` This is the maximum number of fitting iterations to do before returning from the function. If you omit this value, the function sets 1000. You can set any value from 1 to 10000. If you set more than 10000, the number is limited to 10000.

`iTer%` An optional integer variable that is returned holding the number of iterations done before the function returned.

`covar` An optional two dimensional array of size at least `[nCoef%][nCoef%]` that is returned holding the covariance matrix when the fit is complete. It is not changed unless the function return value is 0 or -1.

Returns This call returns 1 if the number of iterations has been completed, but the fitting process has not yet converged, 0 if the fitting process has converged, and a negative number if the fitting process is going nowhere.

Select coefficients to fit

Sometimes you will know the values of some of the coefficients, or you may wish to hold some coefficients fixed while you fit others. Normally the command fits all the coefficients, but you can use this command variant to select the coefficients to fit. You can use this command at any time after you have set the problem until the iteration variant returns 0 or -1.

```
func FitExp(fit%[]);
```

`fit%[]` An integer array of length at least `nCoef%`. Each element specifies if the corresponding coefficient is to be fitted (`fit%[i] := 1`) or held constant (`fit%[i] := 0`). If all elements are 0, then all arguments are fitted.

The effect of this command persists until either the iteration variant returns a value less than 1, or you set up a new problem, or you call this variant again.

An example The following is a template for using this set of commands (assuming you don't want to hold some parameters constant).

```
const nData%:=50;         'set number of data elements
var x[nData%], y[nData%]; 'space for our arrays
var coef[4];              'space for coefficients
var err;                  'will hold error squared
...                       'in here goes code to get the data
FitExp(4, y[], x[]);      'fit two exponentials (no sigma array)
FitExp(0, 1.0, 0.2, 4);   'set first amplitude and limit range
FitExp(1, .01, .001, .03);'set first exponent and range
FitExp(2, 2.0, 0.1, 6);   'set second amplitude and limit range
FitExp(3, .08, .03, .15); 'set second exponent and range

repeat
   DrawMyData(coefs[], x[], y[]);  'Some function to show progress
until FitExp(coefs[], err, 1) < 1;

DrawMyData(coefs[], x[], y[]);     'Show the final state
```

See also:`ShowFunc()`

FitGauss()

This command will fit multiple gaussians to arrays of x,y data points, with an optional weight for each point. Fitting is by an iterative method. The input data is fitted to the equation:

$y = \mathbf{a}_0 \exp(-½(x-\mathbf{a}_1)^2/\mathbf{a}_2^2) + \mathbf{a}_3 \exp(-½(x-\mathbf{a}_4)^2/\mathbf{a}_5^2) + \ldots$

The fitted parameters (coefficients) are the $\mathbf{a}_i$. You can fit up to 3 gaussians. The commands to implement this are:

Set up the problem The first command sets the number of gaussians to fit and the data set to be fitted. You must call this function before you call any of the others.

```
func FitGauss(nCoef%, y[], x[]{, s[]|s});
```

`nCoef%`	The number of coefficients to fit. The only legal values are 3, 6 and 9 for one, two and three gaussians.
`y[]`	An array of y data values. The length of the array must be at least `nCoef%`.
`x[]`	An array of x data values. The length of the array must be at least `nCoef%`.
`s`	An optional argument which is either an array with one value for each y data point or a single value for all data points. If the value is the standard deviation, then the error value returned when you iterate to find the best fit is the chi-squared value and the fit is a chi-squared fit. If this value is proportional to the error in the y values, then the fit is still a chi-squared fit, and the error returned is proportional to the chi-squared value. If you omit this array, the fit is a least squares error fit, and the error value returned is the sum of the squares of the errors in the y values.
Returns	The function returns 0. There is no other return value as all errors stop the script.

The number of data points is set by the smallest of the sizes of the `y[]`, `x[]` or `s[]` (if present) arrays. The number of data points must be at least the number of coefficients. If it is not, you will get a fatal error, so check this before calling the function.

Set coefficient values and ranges

This variant of the function sets the initial value of each coefficient and optionally sets the range of allowed values. You can call this function at any time after the setup call and before the iterate call (below) has returned 0 indicating that the fit is completed.

In this type of fitting it is very important that you give reasonable starting values for the coefficients. In particular, when fitting multiple gaussians, it is usual that the centre of each distribution is easy to determine. If you can set the centres and limit them so that they cannot overlap, the fit usually will proceed without any problems, even for multiple gaussians. If you do not give starting values, the command will make a simplistic guess at the fitting values. As we expect that you know more about the "right" answer than the command does, we suggest that you set the values you want.

```
func FitGauss(coef%, val{, lo, hi});
```

`coef%`	The coefficient to set. The first coefficient is number 0, the last one is `nCoef%`-1.
`val`	The initial value to assign to the coefficient. If you have set low and high limits, and the value is outside these limits, it is set to the nearer limit.
`lo,hi`	If present, these two values set the acceptable range of values for this coefficient. If omitted, or if both values are set to the same value, there is no limit. The value of the coefficient is tested against these limits after each iterative step, and if it exceeds a limit, it is set to that limit.

As long as you make a reasonable estimate of the centre points, there should be no problems fitting multiple gaussians.

Iterate to a solution

Once you have set up the problem and given initial values to your coefficients, you can start the iteration process that will move the coefficients from their starting values to new values that minimise the error (optionally scaled by the `s` argument).

```
func FitGauss(a[], &err{, maxI%{, &iTer%{, covar[][]}}});
```

`a[]`	An array of size at least `nCoef%` that is returned holding the current set of coefficient values. The first amplitude is in `a[0]`, the first centre in `a[1]`, the first sigma in `a[2]`, the second amplitude in `a[3]` and so on.
`err`	A real variable returned as the sum over the data points of $(y_{\texttt{x[i]}}\texttt{-y[i]})^2\texttt{/s[i]}^2$ if `s[]` is used or holding the sum of $(y_{\texttt{x[i]}}\texttt{-y[i]})^2$ if `s[]` is not used where $y_{\texttt{x[i]}}$ is the value predicted from the coefficients at the x value `x[i]`.
`maxI%`	This is the maximum number of fitting iterations to do before returning from the function. If you omit this value, the function sets 1000. You can set any value from 1 to 10000. If you set more than 10000, the number is limited to 10000.
`iTer%`	An optional integer variable that is returned holding the number of iterations done before the function returned.
`covar`	An optional two dimensional array of size at least `[nCoef%][nCoef%]` that is returned holding the covariance matrix when the fit is complete. It is not changed unless the function return value is 0 or -1.
Returns	This call returns 1 if the number of iterations has been completed, but the fitting process has not yet converged, 0 if the fitting process has converged, and a negative number if the fitting process is going nowhere.

Remember that even when a minimum is found, there is no guarantee that this is *the* minimum. It is the best minimum that this algorithm can find given the starting point.

Select coefficients to fit

Sometimes you will know the values of some of the coefficients, or you may wish to hold some coefficients fixed while you vary others. Normally the command will fit all the coefficients, but you can use this command variant to select the coefficient to fit. You can use this command at any time after you have set the problem until the iteration variant returns 0 or -1.

```
func FitGauss(fit%[]);
```

`fit%[]` An integer array of length at least `nCoef%`. Each element specifies if the corresponding coefficient is to be fitted (`fit%[i] := 1`) or held constant (`fit%[i] := 0`). If all elements are 0, then all arguments are fitted.

The effect of this command persists until either the iteration variant returns a value less than 1, or you set up a new problem, or you call this variant again.

An example

The following is a template for using this set of commands (assuming you don't want to hold some parameters constant).

```
const nData%:=50;          'set number of data elements
var x[nData%], y[nData%]; 'space for our arrays
var s[nData%];             'space for sigma of each point
var coef[4];               'space for coefficients
var err;                   'will hold error squared
...                        'in here goes code to get the data
FitGauss(3, y[], x[], s[]); 'fit one gaussian
FitGauss(0, 1.0, 0.2, 4);   'set amplitude and limit range
FitGauss(1, 2, 1.5, 2.5);   'set centre of the gaussian and range
FitGauss(2, 0.5, 0.3, 1.9); 'set width and limit range
repeat
   DrawMyData(coefs[], x[], y[]);  'Some function to show progress
until FitGauss(coefs[], err, 1) < 1;

DrawMyData(coefs[], x[], y[]);     'Show the final state
```

See also:`ShowFunc()`

FitLine()

This function calculates the best fit line to a set of data points using the least squares error method. This can be applied to any Waveform channel. It fits the expression: $y = \mathbf{m}\,x + \mathbf{c}$ through the data points (x_i, y_i) so as to minimise the error given by: $\mathrm{Sum}_i(y_i - \mathbf{m}\,x_i - \mathbf{c})^2$. In this expression, **m** is the gradient of the line and **c** is the y axis intercept when x is 0.

```
Func FitLine(chan%, start, finish, &grad, &inter, &corr);
```

`chan%`	A channel number (1 to n) holding waveform data.
`start`	The start position for processing. `Start` and `finish` are given in x axis units.
`finish`	The end position for processing. A data value at the `finish` position is included in the calculation.
`grad`	This is returned holding the gradient of the best fit line (**m**).
`inter`	This is returned holding the intercept of the line with the y axis (**c**).
`corr`	This is returned holding correlation coefficient indicating the "goodness of fit" of the line. Values close to 1 or -1 indicate a good fit; values close to 0 indicate a very poor fit. This parameter is often referred to as *r* in textbooks.
Returns	0 if all was OK, or -1 if there were not at least 2 data points.

The results are in user units, so in a view with a waveform measured in volts on an x axis of seconds, the units of the gradient would be volts per second and the units of the intercept would be volts.

FitLinear()

This command fits $y = \mathbf{a}_0 f_0(x) + \mathbf{a}_1 f_1(x) + \mathbf{a}_2 f_2(x) \ldots$ to a set of (x,y) data points. If you can provide error estimates for each y value, you can use the covariance output from this command to provide confidence limits on the calculated coefficients and you can use the returned chi-square value to test if the model is likely to fit the data. The command is:

```
func FitLinear(coef[], y[], x[][]{, s{, covar[][]{, r[]{, mR}}}});
```

`coef[]`	A real array which sets the number of coefficients to fit and which returned the best fit set of coefficients. The array must be between 2 and 10 elements long. The coefficient $\mathbf{a}_0$ is returned in `coef[0]`, $\mathbf{a}_1$ in `coef[1]` and so on.
`y[]`	A real array of y values.
`x[][]`	This array specifies the values of the fitting functions at each data point. If there are *nc* coefficients and *nd* data values, this array must be of size at least `[`*nc*`][`*nd*`]`. If you think of this array as a rectangular grid with the data running from left to right and the coefficients running from top to bottom, the values you must fill in are:

$f_0(x_0)$	$f_0(x_1)$	$f_0(x_2)$	$f_0(x_3)$	…	$f_0(x_{n-1})$
$f_1(x_0)$	$f_1(x_1)$	$f_1(x_2)$	$f_1(x_3)$	…	$f_1(x_{n-1})$
$f_2(x_0)$	$f_2(x_1)$	$f_2(x_2)$	$f_2(x_3)$	…	$f_2(x_{n-1})$
$f_3(x_0)$	$f_3(x_1)$	$f_3(x_2)$	$f_3(x_3)$	…	$f_3(x_{n-1})$
…	…	…	…	…	…

`s`	This is an optional argument. It is either a real array holding the standard deviations of each of the `y[]` data points, or it is a real value holding the standard deviation of all of the data points. If the argument is omitted or set to zero, a least squares error fit is performed, otherwise a chi-squared fit is done.
`covar`	An optional two dimensional array of size at least `[`*nc*`][`*nc*`]` (*nc* is the number of coefficients fitted) that is returned holding the covariance matrix.
`r[]`	An optional array of size at least `[`*nc*`]` (*nc* is the number of coefficients fitted) that is returned holding diagnostic information about the fit. The less relevant a fitting function $f_i(x)$ is to the fit, the smaller the value returned. The element of the array that corresponds to the most relevant function is returned as 1.0, smaller numbers indicate less relevance. It can also sometimes happen that some of your base fitting functions are not independent of each other, usually leading to huge coefficients that cancel each other out. In this case, several coefficients may be marked as of low relevance. The solution here is to remove one of the functions from the fit, or to set the next optional argument to exclude one of the functions, then fit again. If the remaining arguments become relevant, you have probably excluded a function that could be generated by a linear combination of the other functions. If the remaining arguments still are not relevant, you have eliminated a function that did not contribute to the fit.
`mR`	You can use this optional variable to set the minimum relevance for a function. Functions that have less relevance than this are “edited” out of the fit and their coefficient is returned as 0. If you do not provide this value, the minimum is set to 10^{-15} which will probably not exclude any values.
Returns	The function returns the chi-square value for the fit if `s[]` or `s` is given (and non-zero), or the sum of squares of the errors between the data points and the best fit line if `s` is omitted or is zero.

The smallest of the sizes of the `y[]` array (and `s[]` array, if provided) and the second dimension of `x[][]` sets the number of data points. It is a fatal error for the number of data points to be less than the number of coefficients.

An example The following example shows how you could use these commands to fit a data set to the function `y = a*sin(x/10) + b*cos(x/20)`. The x values vary from 0 to 49 in steps of 1. The function `MakeFunc()` calculates the a trial data set to which we add random noise. We do not supply an array of sigma values for each data point; instead we give all points a value of 1.0, which means that `FitLinear()` returns the sum of squares of the errors between the fitted curve and the raw data values. If you run this example, you will notice that the returned value is slightly less than the sum of squares of the added errors.

```
const noise := 0.01;       ' controls how much noise we add
const NCOEF% := 2;         ' number of coefficients
const NDATA%:=50;          ' number of data values
var data[NDATA%];          ' space for our function
var x[NCOEF%][NDATA%];     ' array of function information
var err := 0.0;            ' the sum of squares of error we add

' Generate raw data. Fit y = a*sin(x/10)+b*cos(x/20)
var coef[NCOEF%], i%, r;   ' coefficients, index, random noise
coef[0]:=1.0; coef[1]:=2;  ' set coefficients for generated data
MakeFunc(data[], coef[], x[][]);

' Now add noise to the raw data values in data[].
for i%:=0 to NDATA%-1 do
   r := (rand()-0.5)*noise;' the noise to add
   data[i%] += r;          ' add noise to the data
   err := err + r*r;       ' accumulate sum of squared noise
   next;

var covar[NCOEF%][NCOEF%]; ' covariance array
var sig2, a[NCOEF%];       ' sigma, fitted coefficients
var rel[NCOEF%];           ' array for "relevance" values
sig2 := FitLinear(a[], data[], x[][], 1, covar[][], rel[]);
Message("sig^2=%g, err=%g\ncoefs=%g\nrel=%g",sig2,err,a[],rel[]);
halt;

'y[]  is the output array (x values are 0, 1, 2...)
'a[]  is the array of coefficients
' y = a*sin(x/10)+b*cos(x/20)
proc MakeFunc(y[], a[], x[][])
var nd%,v;                 ' coefficient index, work space
for nd% := 0 to NDATA%-1 do
      v := Sin(nd% / 10.0);    ' first funcion
      x[0][nd%] := v;          ' save the value;
      y[nd%] := a[0] * v;      ' start to build the result
      v := Cos(nd%/20.0);      ' second function
      x[1][nd%] := v;          ' save it
      y[nd%] += a[1]*v;        ' full result
   next;
end;
```

FitNLUser()

This command will use a non-linear fitting algorithm to fit a user-defined function to a set of data points. The function to be fitted must be of the form $y = f(x, \mathbf{a}_0, \mathbf{a}_1, \mathbf{a}_2 \ldots)$ where the $\mathbf{a}_i$ are constants to be determined. You must be able to calculate the differential of the function f with respect to each of the coefficients. You can optionally supply an array to weight each data point. The commands to implement this are:

Set up the problem

The first command sets the user-defined function, the number of coefficients you want to fit, the number of data points and optionally, you can set the weight to give each data point. You must call this function before you call any of the others.

```
func FitNLUser(User(ind%, a[], dyda[]), nCoef%, nData%{, s[]|s});
```

`User()`	A user-defined function which is called by the fitting routine. The function is passed the current values of the coefficients and returns the error between the function and the data point identified by `ind%` and the differentials of the function with respect to each of the coefficients at that point. The return value should be the y data value at the index minus the calculated value of the function at the x value using the coefficients passed in.
`ind%`	The index into the data points at which the error and differentials are to be evaluated. If there are `n` data points, `ind%` will run from 0 to `n`-1. You can rely on the function being called with the same coefficients as `ind%` increments from 0 to `n`-1, which may be useful if you have complex functions of the coefficients to evaluate.
`a`	An array of length `nCoef%` holding the current values of the coefficients. The coefficients are refreshed for each call to the user-defined function, so it is not an error to change them, however this is usually not done.
`dyda`	An array of length `nCoef%` which your function should fill in with the values of the partial differential of the function with respect to each of the coefficients. For example, if you were fitting *y* = $\mathbf{a_0}$`*exp(-`$\mathbf{a_1}$`*x)` then set `dyda[0]` = δ*y*/δ$\mathbf{a_0}$ = `exp(-`$\mathbf{a_1}$`*x)` and `dyda[1]` = δ*y*/δ$\mathbf{a_1}$ = -$\mathbf{a_0}$ `*`$\mathbf{a_1}$`*exp(-`$\mathbf{a_1}$`*x)`.
`nCoef%`	The number of coefficients to fit in the range 1 to 10.
`nData%`	The number of data points you will be fitting. If `s[]` is provided as an array, the value of `nData%` used is the smaller of `nData%` and the length of the `s[]` array. It is a fatal error for the number of data points used to be less than `nCoef%`.
`s`	This argument is optional. It is either an array of weights to be given to each data point in the fit or a single weight to apply to all data points. If this value is the expected standard deviation of the y value of the data points, then the error value returned is the chi-squared value and the fit is a chi-squared fit. If this value is proportional to the expected error at the data point, then the fit is still a chi-squared fit, and the error returned is proportional to the chi-squared value. If you omit this argument, the fit is a least squares error fit, and the error value returned is the sum of the squares of the errors in the y values.
Returns	The `FitNLUser()` function returns 0. There is no other return value as all errors stop the script.

Unlike the other fitting routines, you will notice that the x and y data values are not passed into the command. Instead, the user-defined function is passed an index to the data values. It is assumed that the data is accessible by the user function.

Due to restrictions in the implementation of the script language, you cannot debug through the user-defined function. If you set a break point in it, or attempt to step into it you will get errors. We recommend that you check the returned values from the user-defined function by calling it from your own script code.

Set coefficient values and ranges

This variant of the function sets the initial value of each coefficient and optionally sets the range of allowed values. You can call this function at any time after the setup call and before the iterate call (below) has returned 0 indicating that the fit is completed.

In this type of fitting it is very important that you give reasonable starting values for the coefficients. If you do not give starting values, the command will set them all to zero, which is unlikely to be correct.

```
func FitNLUser(coef%, val{, lo, hi});
```

`coef%`	The coefficient to set. The first coefficient is number 0, the last one is `nCoef%`-1.
`val`	The initial value to assign to the coefficient. If you have set low and high limits, and the value is outside these limits, it is set to the nearer limit.
`lo,hi`	If present, these two values set the acceptable range of values for this coefficient. If omitted, or if both values are set to the same value, there is no limit. The value of the coefficient is tested against these limits after each iterative step, and if it exceeds a limit, it is set to that limit.

Iterate to a solution Once you have set up the problem and given initial values to your coefficients, you can start the iteration process that will move the coefficients from their starting values to new values that minimise the error (optionally scaled by the `s` argument).

```
func FitNLUser(a[], &err{, maxI%{, &iTer%{, covar[][]}}});
```

`a[]`	An array of size at least `nCoef%` that is returned holding the current set of coefficient values.
`err`	A real variable returned as the sum over the data points of $(y_{\texttt{x[i]}}\texttt{-y[i]})^2\texttt{/s[i]}^2$ if `s[]` is used or holding the sum of $(y_{\texttt{x[i]}}\texttt{-y[i]})^2$ if `s[]` is not used where $y_{\texttt{x[i]}}$ is the value predicted from the coefficients at the x value `x[i]`.
`maxI%`	This is the maximum number of fitting iterations to do before returning from the function. If you omit this value, the function sets 1000. You can set any value from 1 to 10000. If you set more than 10000, the number is limited to 10000.
`iTer%`	An optional integer variable that is returned holding the number of iterations done before the function returned.
`covar`	An optional two dimensional array of size at least `[nCoef%][nCoef%]` that is returned holding the covariance matrix when the fit is complete. It is not changed unless the function return value is 0 or -1.
Returns	This call returns 1 if the number of iterations has been completed, but the fitting process has not yet converged, 0 if the fitting process has converged, and a negative number if the fitting process is going nowhere.

Remember that even when a minimum is found, there is no guarantee that it is *the* minimum. It is the best minimum that this algorithm can find given the starting point.

Select coefficients to fit Normally the command will fit all the coefficients, but you can use this command variant to select the coefficients to fit. You can use this command at any time after you have set the problem until the iteration variant returns 0 or -1.

```
func FitNLUser(fit%[]);
```

`fit%[]`	An integer array of length at least `nCoef%`. Each element specifies if the corresponding coefficient is to be fitted (`fit%[i] := 1`) or held constant (`fit%[i] := 0`). If all elements are 0, all arguments are fitted.

The effect of this command persists until either the iteration variant returns a value less than 1, or you set up a new problem, or you call this variant again.

An example The following is an example of using this set of commands to fit the user-defined function `y = a * exp(-b*x)`. In this example we generate some test data and add to it a random error. There are two coefficients to be fitted (**`a`** and **`b`**).

```
const NDATA%:=100;          ' number of data points
const NCOEF% := 2;          ' number of coefficients
var x[NDATA%],y[NDATA%],i%;

' generate data: a:=1, b:=0.05 and add some noise
for i% := 0 to NDATA%-1 do
   x[i%] := i%;
   y[i%] := exp(-0.05*i%)+(rand()-0.5)*0.01;
   next;

' Now link in user function and set coefficient ranges
FitNLUser(UserFnc, NCOEF%, NDATA%);
FitNLUser(0, 0.5, 0.01, 2);   'Set range of amplitude
FitNLUser(1, 0.01, 0.001, 1); 'Set range of exponent

var coefs[NCOEF%], err, iter%;
i% := FitNLUser(coefs[], err, 100, iter%);
Message("fit=%d, Err=%g, iter=%d, coefs=%g", i%, err, iter%,
coefs[]);
halt;

' The user-defined function: y = a * exp(-b*x);
' dy/da = exp(-b*x)
' dy/db = -x * a * exp(-b*x)
func UserFnc(ind%, a[], dyda[])
var xi,yi,r;
xi := x[ind%];            ' local copy of x value
yi := y[ind%];            ' local copy of y value
dyda[0] := exp(-a[1]*xi); ' differential of y with respect to a
r := dyda[0] * a[0];      ' intermediate value
dyda[1] := -xi * r;       ' differential of y with respect to b
return yi-r;
end
```

FitPoly()

This command fits $y = \mathbf{a}_0 + \mathbf{a}_1 x + \mathbf{a}_2 x^2 + \mathbf{a}_3 x^3 \ldots$ to a set of (x,y) data points. If you can provide error estimates for each y value, you can use the covariance output from this command to provide confidence limits on the calculated coefficients and you can use the returned χ^2 value to test if the model is likely to fit the data. The command is:

```
func FitPoly(coef[], y[], x[]{, s[]|s{, covar[][]}});
```

`coef[]`	A real array which sets the number of coefficients to fit and which returns the best fit set of coefficients. The array must be between 2 and 10 elements long. The coefficient $\mathbf{a}_0$ is returned in `coef[0]`, $\mathbf{a}_1$ in `coef[2]` and so on.
`y[]`	A real array of y values. The smaller of the sizes of the `x[]` and `y[]` arrays (and `s[]` array, if provided), sets the number of data points. It is a fatal error for the number of data points to be less than the number of coefficients.
`x[]`	A real array of x values.
`s`	This is an optional argument. It is either a real array holding the standard deviations of each of the `y[]` data points, or it is a real value holding the standard deviation of all of the data points. If the argument is omitted or set to zero, a least squares error fit is performed, otherwise a chi-squared fit is done.
`covar`	An optional two dimensional array of size at least `[`*nc*`][`*nc*`]` (*nc* is the number of coefficients fitted) that is returned holding the covariance matrix.

Returns The function returns the chi-squared value for the fit if `s[]` or `s` is given (and non-zero), or the sum of squares of the errors between the data points and the best fit line if `s` is omitted or is zero.

An example The following example generates a set of test data, adds random noise to it, then fits a polynomial to the data.

```
const NCOEF% := 5;         ' number of coefficients
const NDATA%:=50;          ' number of data points
var y[NDATA%];             ' space for our function
var x[NDATA%];             ' x co-ordinates
const noise := 1;          ' noise to add
var err := 0.0;            ' will be sum of squares of added noise
var cf[NCOEF%], i%, r;
cf[0]:=1.0; cf[1]:=-80; cf[2]:=-2.0; cf[3]:=0.5; cf[4]:=-0.009;
MakePoly(cf[],x[],y[]);    ' generate ideal data as polynomial
for i%:=0 to NDATA%-1 do   ' now add some noise to it
   r := (rand()-0.5)*noise;
   y[i%] += r;             ' add noise to the data
   err += r*r;             ' sum of squares of added noise
   next;
var sig2, a[NCOEF%];       ' a[] will be the fitted coefficients
sig2 := FitPoly(a[], y[], x[]);
Message("sig2=%g, noise=%g\nfitted=%8.4f\nideal =%8.4f",
                                        sig2, err, a[], cf[]);
halt;

'a[]  input array of coefficients
'x[]  output x co-ordinates, y[] output data values
proc MakePoly(a[], x[], y[])
var i%,j%,xv,s;
for i% := 0 to Len(y[])-1 do
   s := 0.0;
   xv := 1;
   for j% := 0 to NCOEF%-1 do
      s += a[j%]*xv;
      xv *= i%;
      next;
   y[i%] := s;
       x[i%] := i%;
   next;
end;
```

FitSin()

This command will fit multiple sinusoids to arrays of x,y data points, with an optional weight for each point. Fitting is by an iterative method. The input data is fitted to the equation:

$y = \mathbf{a}_0 \sin(\mathbf{a}_1 x + \mathbf{a}_2) + \mathbf{a}_3 \sin(\mathbf{a}_4 x + \mathbf{a}_5) + \dots$

The fitted parameters (coefficients) are the $\mathbf{a}_i$. The angles are evaluated in radians. You can fit up to 3 sinusoids. Although the function is given in terms of sine functions, you can easily convert to cosines by subtracting $\pi/2$ from the phase angle ($\mathbf{a}_2$, $\mathbf{a}_5$, $\mathbf{a}_8$) after the fit. The commands to implement this are:

Set up the problem

The first command sets the number of sinusoids to fit and the data set to be fitted. You must call this function before you call any of the others.

```
func FitSin(nCoef%, y[], x[]{, s[]|s});
```

`nCoef%`	The number of coefficients to fit. The only legal values are 3, 6 and 9 for one, two and three sinusoids.
`y[]`	An array of y data values. The length of the array must be at least `nCoef%`.
`x[]`	An array of x data values. The length of the array must be at least `nCoef%`.
`s`	An optional argument which is either an array with one value for each y data point or a single value for all data points. If the value is the standard deviation, then the error value returned when you iterate to find the best fit is the chi-squared value and the fit is a chi-squared fit. If this value is proportional to the error in the y values, then the fit is still a chi-squared fit, and the error returned is proportional to the chi-squared value. If you omit this array, the fit is a least squares error fit, and the error value returned is the sum of the squares of the errors in the y values.
Returns	The function returns 0. There is no other return value as all errors stop the script.

The number of data points is set by the smallest of the sizes of the `y[]`, `x[]` or `s[]` (if present) arrays. The number of data points must be at least the number of coefficients. If it is not, you will get a fatal error, so check this before calling the function.

Set coefficient values and ranges

This variant of the function sets the initial value of each coefficient and optionally sets the range of allowed values. You can call this function at any time after the setup call and before the iterate call (below) has returned 0 indicating that the fit is completed.

In this type of fitting it is very important that you give reasonable starting values for the coefficients. In particular, when fitting multiple sinusoids you will usually either know, or have a good idea of the frequencies. You should limit the range of each frequency so that they cannot overlap. If you can do this, the fit will proceed quickly. If you do not give starting values, the command will make a simplistic guess at the fitting values. As we expect that you know more about the "right" answer than the command does, we suggest that you set the values you want.

```
func FitSin(coef%, val{, lo, hi});
```

`coef%`	The coefficient to set. The first coefficient is number 0, the last one is `nCoef%`-1.
`val`	The initial value to assign to the coefficient. If you have set low and high limits, and the value is outside these limits, it is set to the nearer limit.
`lo,hi`	If present, these two values set the acceptable range of values for this coefficient. If omitted, or if both values are set to the same value, there is no limit. The value of the coefficient is tested against these limits after each iterative step, and if it exceeds a limit, it is set to that limit.

Iterate to a solution

Once you have set up the problem and given initial values to your coefficients, you can start the iteration process that will move the coefficients from their starting values to new values that minimise the error (optionally scaled by the `s` argument).

```
func FitSin(a[], &err{, maxI%{, &iTer%{, covar[][]}}});
```

`a[]`	An array of size at least `nCoef%` that is returned holding the current set of coefficient values. The first amplitude is in `a[0]`, the first frequency in `a[1]`, the first phase angle in `a[2]`, the second amplitude in `a[3]` and so on.

`err` A real variable returned as the sum over the data points of $(y_{\texttt{x[i]}}-\texttt{y[i]})^2/\texttt{s[i]}^2$ if `s[]` is used or holding the sum of $(y_{\texttt{x[i]}}-\texttt{y[i]})^2$ if `s[]` is not used where $y_{\texttt{x[i]}}$ is the value predicted from the coefficients at the x value `x[i]`.

`maxI%` This is the maximum number of fitting iterations to do before returning from the function. If you omit this value, the function sets 1000. You can set any value from 1 to 10000. If you set more than 10000, the number is limited to 10000.

`iTer%` An optional integer variable that is returned holding the number of iterations done before the function returned.

`covar` An optional two dimensional array of size at least `[nCoef%][nCoef%]` that is returned holding the covariance matrix when the fit is complete. It is not changed unless the function return value is 0 or -1.

Returns This call returns 1 if the number of iterations has been completed, but the fitting process has not yet converged, 0 if the fitting process has converged, and a negative number if the fitting process is going nowhere.

Even when a minimum is found, there is no guarantee that this is *the* minimum, only that it is the best minimum that this algorithm can find given the starting point.

Select coefficients to fit

Sometimes you may wish to hold some coefficients fixed while you fit others. Normally the command will fit all the coefficients, but you can use this command variant to select the coefficients to fit. You can use this command at any time after you have set the problem until the iteration variant returns 0 or -1.

```
func FitSin(fit%[]);
```

`fit%[]` An integer array of length at least `nCoef%`. Each element specifies if the corresponding coefficient is to be fitted (`fit%[i] := 1`) or held constant (`fit%[i] := 0`). If all elements are 0, then all arguments are fitted.

The effect of this command persists until either the iteration variant returns a value less than 1, or you set up a new problem, or you call this variant again. For a sinusoidal fit it is likely that you will know the frequency to fit, so you may well hold this constant.

An example

The following is a template for using this set of commands (assuming you don't want to fit the frequency which we assume you know).

```
const nData%:=50;          'set number of data elements
var x[nData%], y[nData%]; 'space for our arrays
var s[nData%];             'space for sigma of each point
var fit%[3];               'we want to hold the frequency
var coef[4];               'space for coefficients
var err;                   'will hold error squared
...                        'in here goes code to get the data
FitSin(3, y[], x[], s[]); 'fit one sinusoid

'Note that we let the phase take any value
FitSin(0, 1.0, 0.2, 4);   'set amplitude and limit range
FitSin(1, .02, .01, .03); 'set frequency
FitSin(2, 0., 0.3, 1.9);  'set width and limit range

'Now we say that we don't want to fit the frequency
ArrConst(fit%[],1);        'set all elements to 1
fit%[1] := 0;              'but not element 1 (=frequency)
FitSin(fit%[]);            'so the frequency is fixed

repeat
   DrawMyData(coefs[], x[], y[]);  'Some function to show progress
until FitSin(coefs[], err, 1) < 1;

DrawMyData(coefs[], x[], y[]);     'Show the final state
```

FontGet()

This function gets the name of the font, and its characteristics for the current view.

```
Func FontGet(&name$, &size, &style%);
```

`name$`	This string variable is returned holding the name of the font.
`size`	The real number variable is returned holding the point size of the font.
`style%`	This integer variable is returned holding the style: 0 Normal text 1 Italic text 2 Bold text 3 Bold and italic
Returns	The function returns 0 if all was well or a negative error code. If an error occurs, the variables are not changed.

See also:`FontSet()`

FontSet()

This function sets the font for the current view. This does not cause an immediate redraw; use the `Draw()` command to force one.

```
Func FontSet(name$|code%, size, style%);
```

`name$`	This is a string holding the name of the font to use. Alternatively, you can specify a font code:
`code%`	This is an alternative (system independent) method of specifying a font. We recognise these font codes: 0 The standard system font, whatever that might be 1 A non-proportionally spaced font, usually Courier-like 2 A proportionally spaced non-serifed font, such as Helvetica or Arial 3 A proportionally spaced serifed font, such as Times Roman 4 A symbol font 5 A decorative font, such as Zapf-Dingbats or TrueType Wingdings
`size`	The point size required. Each system will set a minimum and maximum point size. Values outside this range are limited to the extreme values.
`style%`	This integer value sets the type style (if supported on your system): 0 Normal text 1 Italic text 2 Bold text 3 Bold and italic
Returns	The function returns 0 if the font change succeeded, or a negative error code.

See also:`FontGet()`

Frac()

Returns the fractional part of a real number or replaces an array of reals with its fractional parts.

```
Func Frac(x|x[]);
```

`x`	A real number or an array of reals.
Returns	For arrays, it returns 0 or a negative error code. If `x` is not an array it returns a real number equal to `x-Trunc(x)`. `Frac(4.7)` is 0.7, `Frac(-4.7)` is -0.7.

See also:`Trunc(), Round()`

Frame()

A function to get or set the current frame in a data view.

```
Func Frame({frame%});
```

`frame%` If this is present and in range the current frame changes to the new number.

Returns The frame number for the view at the time of the call.

See also: `FrameComment$(), FrameCount(), FrameFlag(), FrameTag(), FrameUserVar()`

FrameAbsStart()

Obtains the absolute start time for the current frame in a data view. The absolute start time for a frame is the time for time zero in a frame relative to the time at which sampling was started.

```
Func FrameAbsStart();
```

Returns The absolute start time, in seconds, of the current frame in the current data view.

See also: `Frame(), SampleStart()`

FrameComment$()

Gets or sets the comment with the current frame. This is a string of up to 72 characters that is stored with each frame.

```
Func FrameComment$({c$});
```

`c$` If this is present it provides a new comment to store with the frame.

Returns The frame comment at the time of the call.

See also: `FileComment$(), FrameState(), FrameTag(), FrameUserVar()`

FrameCount()

Obtains the number of frames in a document.

```
Func FrameCount();
```

Returns Number of frames (sweeps) in the file or memory view.

See also: `Frame(), Sweeps()`

FrameFlag()

This command turns a frame flag on or off or retrieves the current setting of a flag from the specified frame.

```
Func FrameFlag(frm%|frm$|frm%[], flag%{, set%});
```

`frm%` Frame number or a negative code as follows:

-1	All frames in the file
-2	The current frame
-3	Only tagged frames
-6	Only untagged frames

`frm$` A frame specification string. This option specifies a list of frames using a string such as "1..32,40,50".

`frm%[]` An array of frame numbers. This option provides a list of frame numbers. The first element holds the number of frames in the list.

`flag%` The flag number (1..32). For CFS files not created by Signal, only flags 1 to 4 and flag 16 are present, though the other flags can be used while the frame is held in memory.

`set%` If non-zero this sets flag number `flag%` on in the current frame. If zero it turns the flag off. In a file not created by Signal only flags 1,2,3,4 or 16 can be permanently changed.

Returns 1 if the flag number `flag%` is set in the last frame specified when the function was called or zero if not. Returns -1 if no frames are found to match the specification.

See also:`FrameComment$(), FrameState(), FrameTag(), FrameUserVar()`

FrameGetIntVar()

This function reads a CFS frame variable of integer type from the current frame.

```
Func FrameGetIntVar(name$ {&nVar%{, &units$, {nType%}}});
```

`name$` The name of the variable to look for. This string is not case sensitive but every character including spaces must match exactly.

`nVar%` If present this returns the variable number, -1 if not found, or a negative error code.

`units$` If present this returns the units for the variable.

`nType%` If present this returns a code for the CFS type of an integer variable:

0: INT1, 1: WRD1, 2: INT2, 3: WRD2, 4: INT4:

Returns The function returns the value of the variable if the operation was a success, and otherwise zero.

See also:`FileGetIntVar(), FileGetRealVar(), FileGetStrVar$(), FileVarCount(), FileVarInfo(), FrameGetRealVar(), FrameGetStrVar$(), FrameVarCount(),FrameVarInfo()`

FrameGetRealVar()

This function reads a CFS frame variable of real type from the current frame.

```
Func FrameGetRealVar(name$ {&nVar%{, &units$}});
```

`name$` The name of the variable to look for. This string is not case sensitive but every character including spaces must match exactly.

`nVar%` If present this returns the variable number, -1 if not found, or a negative error code.

`units$` If present this returns the units for the variable.

Returns The function returns the value of the variable if the operation was a success, and otherwise zero.

See also:`FileGetIntVar(), FileGetRealVar(), FileGetStrVar$(), FileVarCount(), FileVarInfo(), FrameGetIntVar(), FrameGetStrVar$(), FrameVarCount(), FrameVarInfo()`

FrameGetStrVar$()

This function reads a CFS frame variable of string type from the current frame.

```
Func FrameGetStrVar$(name$ {&nVar%{, &units$}});
```

`name$`	The name of the variable to look for. This string is not case sensitive but every character including spaces must match exactly.
`nVar%`	If present this returns the variable number, -1 if not found, or a negative error code.
`units$`	If present this returns the units for the variable.
Returns	The function returns the string contents of the variable if the operation was a success, and otherwise an empty string.
See also:	`FileGetIntVar(), FileGetRealVar(), FileGetStrVar$(), FileVarCount(), FileVarInfo(), FrameGetIntVar(), FrameGetRealVar(), FrameVarCount(), FrameVarInfo()`

FrameList()

This function generates an array of selected frame numbers from the current view.

```
Func FrameList(list%[], sFrm%{, eFrm%{,mode%}});
Func FrameList(list%[], frm$|frm%[]{,mode%});
```

`list%` An integer array to fill with frame numbers. The first element of the array, `list%[0]`, is set to the number of frames returned, and the remaining elements in the array are frame numbers. If the array is too short, enough frames are returned to fill the array.

`sFrm%` First frame to include. This option returns a range of frames. `sFrm%` can also be a negative code as follows:

-1	All frames in the file are included
-2	The current frame
-3	Frames must be tagged
-6	Frames must be untagged

`eFrm%` Last frame to include. If this is -1 the last frame number in the data file is used. This argument is ignored if `sFrm%` is a negative code.

`frm$` A frame specification string. This option specifies a list of frames using a string such as “1..32,40,50”.

`frm%[]` An array of frame numbers. This option provides a list of frame numbers. The first element holds the number of frames in the list.

`mode%` If `mode%` is present it is used to supply an additional criterion for including each frame in the range, list or specification. If `mode%` is absent all frames are included. The modes are:

0-n	Frames must have a state matching the value of `mode%`
-1	All frames in the range list are included
-2	Only the current frame in the view is included
-3	Frames must be tagged
-6	Frames must be untagged

Returns The number of frames that would be returned if the array was of unlimited length or 0 if the view is not a data view.

See also: `FrameState(), FrameTag(), FrameUserVar(), ExportFrameList(), ProcessFrames()`

FrameMean()

This command turns the frame mean flag on or off or gets the setting of the mean flag for the specified frame or frame type.

```
Func FrameMean(frm%|frm$|frm%[]{, on%});
```

`frm%` One frame number or a negative code as follows:

-1	All frames in the file.
-2	The current frame
-3	All tagged frames
-6	All untagged frames

`frm$` A frame specification string. This option specifies a list of frames using a string such as “1..32,40,50”.

`frm%[]` An array of frame numbers. This option provides a list of frame numbers. The first element holds the number of frames in the list.

`on%` A value of 1 marks the frame as a mean, zero marks it as a total.

Returns 1 if the last frame specified was a mean when the function was called or zero if not. Returns -1 if no frames are found to match the specification.

See also:`FrameComment$(), FrameFlag(), FrameState(), FrameUserVar(), Sweeps()`

FrameSave()

This command saves changed frame data in a file view back into the file, bypassing the usual interactive process controlled by the preferences dialog. It can also be used to discard changes to ensure that the user is not promped to save them. This command can only be used on frames already present on disk; appended frames and memory view frames will be saved as part of FileSave or FileClose.

```
Func FrameSave({no%});
```

`no%` If present and non-zero, this causes changed data to be discarded by marking the data as unchanged. If the parameter is not present or set to zero the function causes the changed data to be written back to the disk file.

Returns Zero or a negative error code.

See also:`FileExportAs(), FileSave(), FileClose(), Frame()`

FrameState()

This command sets or gets the value of the state variable for the specified frame or frames.

```
Func FrameState(frm%|frm$|frm%[]{, new%});
```

`frm%` One frame number or a negative code as follows:

-1	All frames in the file
-2	The current frame
-3	All tagged frames
-6	All untagged frames

`frm$` A frame specification string. This option specifies a list of frames using a string such as “1..32,40,50”.

`frm%[]` An array of frame numbers. This option provides a list of frame numbers. The first element holds the number of frames in the list.

`new%` If present this sets state stored with each frame specified. For values above 9 this is only effective in a file created by Signal.

Returns The state of the last frame specified when the function was called. Returns -1 if no frames are found to match the specification.

See also:`FrameComment$(), FrameFlag(), FrameTag(), FrameUserVar()`

FrameTag()

This command turns the tag on or off or gets the setting of the tag for the specified frame or frame type.

```
Func FrameTag(frm%|frm$|frm%[]{, on%});
```

`frm%` One frame number or a negative code as follows:

-1	All frames in the file.
-2	The current frame
-3	All tagged frames
-6	All untagged frames

`frm$` A frame specification string. This option specifies a list of frames using a string such as “1..32,40,50”.

`frm%[]` An array of frame numbers. This option provides a list of frame numbers. The first element holds the number of frames in the list.

`on%` A value of 1 tags the frame, zero untags it.

Returns 1 if the last frame specified was tagged when the function was called or zero if not. Returns -1 if no frames are found to match the specification.

See also:`FrameComment$(), FrameFlag(), FrameState(), FrameUserVar()`

FrameUserVar()

This command gets or sets one of the user variables stored with the current frame.

```
Func FrameUserVar(n%{,val});
```

`n%` The user variable number, between 1 and 16.

`val` If present this is the new value for user variable number `n`.

Returns The value of frame user variable number `n` before the call.

See also:`FrameComment$(), FrameFlag(), FrameState(), FrameTag()`

FrameVarCount()

This function counts CFS frame variables in the data file.

```
Func FrameVarCount();
```

Returns The number of frame variables in the data file associated with this view.

See also: `FileGetIntVar(), FileGetRealVar(), FileGetStrVar$(), FileVarCount(), FileVarInfo(), FrameGetIntVar(), FrameGetRealVar(), FrameGetStrVar$(), FrameVarInfo()`

FrameVarInfo()

This function reads a description of a CFS frame (DS) variable.

```
Func FrameVarInfo(nVar%, &name$);
```

`nVar%` This is the variable number for which information is required. The first frame variable is number zero.

`name$` This is returned holding the name of the variable, which can be used in the commands for reading the frame variable values.

Returns The function returns the type of the variable or -1 if the variable was not found or is of unknown type. The variable type codes are as follows:

0	An integer variable which can be read using `FrameGetIntVar()`.
1	A floating point variable which can be read using `FrameGetRealVar()`.
2	A string variable which can be read using `FrameGetStrVar$()`.

See also: `FileGetIntVar(), FileGetRealVar(), FileGetStrVar$(), FileVarCount(), FileVarInfo(), FrameGetIntVar(), FrameGetRealVar(), FrameGetStrVar$(), FrameVarCount()`

FrontView()

This command is used to set the view that is nearest to the top and makes it the current view. It is the view that would have the focus if all dialogs were removed. You can use this to find out the front view, or to set it. When a view becomes the front view, it is moved to the front unless it is already there. If an invisible or iconised view is made the front view, the view is made visible automatically, (equivalent to `WindowVisible(1)`). Care should be taken if using this function in an idle routine for a toolbar as calling it repeatedly will prevent the toolbar buttons from being pressed!

```
Func FrontView( {vh%} );
```

`vh%` Either 0 or omitted to return the front view handle, a view handle to be set, or -n, meaning the nth duplicate of the data view associated with the current view.

Returns 0 if there are no visible views, -1 if the view handle passed is not a valid view handle, otherwise it returns the view handle of the view that was at the front.

See also: `View(), Window(), WindowVisible()`

GammaP()

This is the incomplete gamma function $P(a, x)$ and is defined mathematically as:

$$P(a, x) = 1/\Gamma(a) \int_0^x e^{-t} t^{a-1} dt$$

$\Gamma(a)$ is the gamma function described under `LnGamma()`. From the incomplete gamma function is obtained the error function, the cumulative Poisson probability function and the Chi-squared probability function.

The error function $erf(x) = 2/\sqrt{\pi} \int_0^x e^{-t^2} dt =$ `GammaP(0.5, x*x)`

The cumulative Poisson probability function relates to a Poisson process of random events and is the probability that given an expected number of events `r` in a given time period the actual number was greater than or equal to `n`. This turns out to be `GammaP(n,r)`. Also, the probability that there are less than n events is `GammaQ(n,r)` (described below).

The Chi-squared probability function is useful where we are fitting a model to data. Given a fitting function that fits the data with `n` degrees of freedom (if you have `nData` data points and `nCoef` coefficients you usually have `nData-nCoef` degrees of freedom), and given that the errors in the data points are normally distributed, the probability of a Chi-squared value less than `chisq` is `GammaP(n/2, chisq/2)`. Similarly, the probability of a `chisq` value at least as large as `chisq` is `GammaQ(n/2, chisq/2)`. So, if you know the chi-squared value from a fitting exercise, you can ask "What is the probability of getting this value (or a greater one) given that my model fits the data?". If the probability is very small, it is likely that your model does not fit the data, or your fit has not converged to the correct solution.

```
Func GammaP(a, x);
```

`a`	This must be positive, it is a fatal error if it is not.
`x`	This must be positive, it is a fatal error if it is not.
Returns	The incomplete Gamma function.

GammaQ()

The complement of GammaP(); `GammaQ(a,x)` is `1.0-GammaP(a,x)`.

```
Func GammaQ(a, x);
```

`a`	This must be positive, it is a fatal error if it is not.
`x`	This must be positive, it is a fatal error if it is not.
Returns	The complement of the incomplete Gamma function.

Grid()

This function turns the background grid on and off for the current data or XY view. It also returns the state of the grid.

```
Func Grid({on%});
```

`on%` Optional argument that sets the grid state. If this is omitted, no change is made.

0 Turn the grid off.
1 Turn the grid on.

Returns The state of the grid at the time of the call, or a negative error code. Changes made by this function do not cause an immediate redraw.

HCursor()

This function returns the y axis position of a horizontal cursor, and optionally sets a new position. You can get and set positions of cursors attached to invisible channels or channels that have no y axis.

```
Func HCursor(num% {,where {,chan%}});
```

`num%`	The cursor to use. It is an error to attempt this operation on an unknown cursor.
`where`	If this parameter is given it sets the new y axis position of the cursor.
`chan%`	If this parameter is given, it sets the channel number (1 to n).
Returns	The function returns the y axis position of the cursor at the time of the call, or zero for a non-existent cursor number.

See also:`Cursor(), HCursorChan(), HCursorDelete(), HCursorLabel(), HCursorLabelPos(), HCursorNew(), HCursorRenumber()`

HCursorChan()

This function returns the channel number that a particular horizontal cursor is currently attached to.

```
Func HCursorChan(num%);
```

`num%`	The horizontal cursor number.
Returns	It returns the channel number that the cursor is attached to, or 0 if this cursor is not attached to any channel or if the channel number is out of the allowed range.

See also:`HCursor(), HCursorDelete(), HCursorLabel(), HCursorLabelPos(), HCursorNew(), HCursorRenumber()`

HCursorDelete()

This deletes the designated horizontal cursor. It is not an error to delete an unknown cursor, it just has no effect.

```
Func HCursorDelete({num%});
```

`num%`	The number of the cursor to delete, or -1 to delete all horizontal cursors. If this is omitted, the highest numbered cursor is deleted.
Returns	The number of the deleted cursor or 0 if no cursor was deleted.

See also:`CursorDelete(), HCursor(), HCursorChan(), HCursorLabel(), HCursorLabelPos(), HCursorNew(), HCursorRenumber()`

HCursorExists()

This function tests if a given horizontal cursor exists at the time of the call.

```
Func HCursorExists(num%)
```

`num%`	The cursor number, between 1 and 4.
Returns	1 if the cursor exists, 0 if it does not.

See also:HCursor`(), HCursorDelete(), CursorExists()`

HCursorLabel()

This command sets (or gets) the horizontal cursor label style for the current view.

```
Func HCursorLabel({style%{, num%{, form$}}})
```

`style%` The cursor style. Cursors can be annotated with a position or the cursor number or a user-defined style. The styles are: 0=Neither, 1=Position, 2=Number, 3=Both, 4=User-defined. Unknown styles cause no change.

`num%` The cursor number for style 4. 0 means all cursors, 1-4 for a single cursor.

`form$` The label string for style 4. The string has replaceable parameters `%p`, and `%n` for position and number. We also allow `%w.dp` where `w` and `d` are numbers that set the field width and decimal places. You cannot read back a label format string.

Returns The previous cursor style. If you omit `style%`, the style does not change.

See also: `CursorLabel(), HCursor(), HCursorChan(), HCursorDelete(), HCursorLabelPos(), HCursorNew(), HCursorRenumber()`

HCursorLabelPos()

This lets you set and read the position of the horizontal cursor label.

```
Func HCursorLabelPos(num% {,pos});
```

`num%` The cursor number, between 1 and 4. If the cursor does not exist the function does nothing and returns -1.

`pos` If present, the command sets the position. The position is a percentage of the distance from the left of the cursor at which to position the value. Out of range values are set to the appropriate limit.

Returns The cursor position before any change was made, or -1 if the cursor does not exist.

See also: `CursorLabelPos(), HCursor(), HCursorChan(), HCursorDelete(), HCursorLabel(), HCursorNew(), HCursorRenumber()`

HCursorNew()

This function creates a new horizontal cursor and assigns it to a channel. You can create up to 4 horizontal cursors, which can subsequently be moved to any channel.

```
Func HCursorNew(chan% {,where});
```

`chan%` A channel number (1 to n) for the new cursor. If the channel is hidden the cursor is hidden.

`where` An optional argument setting the cursor position. If this is omitted, the cursor is placed in the middle of the y axis or at zero if there is no y axis.

Returns It returns the horizontal cursor number or 0 if all cursors are in use.

See also: `CursorNew(), HCursor(), HCursorChan(), HCursorDelete(), HCursorLabel(), HCursorLabelPos(), HCursorRenumber()`

HCursorRenumber()

This command renumbers the cursors starting with channel 1, cursors in each channel are numbered from bottom to top. There are no arguments.

```
Func HCursorRenumber();
```

Returns The number of cursors found in the view.

See also: `CursorRenumber(), HCursor(), HCursorChan(), HCursorDelete(), HCursorLabel(), HCursorLabelPos(), HCursorNew()`

Help()

Signal uses the standard Windows help system.

```
Func Help(topic%|topic$ {,file$});
```

`topic%`	A numeric code for the help topic. These codes are assigned by the help system author. Code 0 changes the default help file to `file$`.
`topic$`	A string holding a help topic keyword or phrase to look-up.
`file$`	If this is omitted, or the string is empty, the standard Signal help file is used. If this holds a filename, this filename is used as the help file.
Returns	1 if the help topic was found, 0 if it was not, -1 if the help file was not found.

The Windows SDK has some help authoring tools, and third party tools are available.

Input()

This function reads a number from the user. It opens a window with a message, and displays the initial value of a variable. You can limit the range of the result.

```
Func Input(text$, val {,low {,high}});
```

`text$`	A string holding a prompt for the user. If the string contains a vertical bar character (|), the string before the bar will be used to set the title of the window.
`val`	The initial value to be displayed for editing. If limits are given, and the initial value is outside the limits, it is set to the nearer limit.
`low`	An optional low limit for the result. If `low>=high`, the limits are ignored.
`high`	An optional high limit for the result.
Returns	The value typed in. The function always returns a value. If an out of range value is entered, the function warns the user and a correct value must be given. When parsing the input, leading white space is ignored and the number interpretation stops at the first non-numeric character or the end of the string.

See also:`DlgReal(), DlgInteger(), Input$()`

Input$()

This function reads user input into a string variable. It opens a window with a message, and displays a string. You can also limit the range of acceptable characters.

```
Func Input$(text$, edit${, maxSz%{, legal$}});
```

`text$`	A string holding a prompt for the user. If the string contains a vertical bar character (|), the string before the | sets the title of the window.
`edit$`	The starting value for the text to edit.
`maxSz%`	Optional, maximum size of the response string.
`legal$`	A string holding the characters that are acceptable. The starting string is filtered before display. A hyphen indicates a range of characters. To include a hyphen in the list, place it first or last in the string. Upper and lower case characters are distinct. For alphanumeic characters use: `"a-zA-Z0-9"`.

If this string is omitted, all printing characters are allowed, equivalent to `" -~"` (space to tilde). For simple use, the sequence of printing characters is:

```
space !"#$%&'()*+,-./0123456789:;<=>?@
ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`
abcdefghijklmnopqrstuvwxyz{|}~
```

If you use extended or accented characters, the order depends on the system.

Returns The result is the edited string. A blank string is a possible result.

See also:`DlgString() ,Input()`

InStr()

This function searches for a string within another string. This function is case sensitive.

```
Func InStr(text$, find$ {,index%});
```

`text$`	The string to be searched.
`find$`	The string to look for.
`index%`	If present, the start character index for the search. The first character is index 1.
Returns	The index of the first matched character, or 0 if the string is not found.

See also:`DelStr$(), LCase$(), Left$(), Mid$(), Right$(), UCase$()`

Interact()

This function provides a quick and easy way to interact with a user. Cursors can always be dragged as we assume that they are one of the main ways of interacting with the data. You can restrict the user to a single view and limit the menu commands that can be used.

```
Func Interact(msg$, allow% {,help {, lb1$ {,lb2$ {,lb3$...}}}});
```

`msg$` The prompt to display in the tool bar during the operation. If there is not enough space to display the message and buttons, the message is truncated.

`allow%` A code that specifies the actions that the user can and cannot take while interacting with Signal. The code is the sum of possible activities:

1	User may swap to other applications
2	User may change the current window
4	User may move and resize windows
8	User may use the File menu
16	User may use the Edit menu
32	User may use the View menu
64	User may use the Analysis menu
128	User may use the Cursor menu and add cursors
256	User may use the Window menu
512	User may use the Sample menu
1024	User may not double click y axis
2048	User may not double click the x axis or scroll it
4096	User may not change channel of horizontal cursors
8192	User may not change to another frame

A value of 0 would restrict the user to inspecting data and positioning cursors in a single, unmoveable window, but able to switch frames. A value of 8192 is the same but without changing frames.

`help` This can be either a number or a string. If it is a number, it is the number of a help item (if help is supported). If it is a string, it is a help context string. This is used to set the help information that is presented when the user requests help in the manner supported on the host machine. Set 0 to accept the default help.

`lb1$` These label strings create buttons, from right to left, in the tool bar. If no labels are given, one label is displayed with the text "OK". The maximum number of buttons is 10.

Returns The number of the button that was pressed. Buttons are numbered in order, so `lb1$` is button 1, `lb2$` is button 2 and so on.

With `allow%` set to 0, all the user could do would be to press a button on the tool bar. The tool bar would be displayed (if it was not present) when `Interact()` was called. When the user presses a button to exit, the tool bar is returned to the state it was in before Interact was used.

See also:`Toolbar()`

LastTime()

This function finds the first item on a channel before a particular x axis position.

```
Func LastTime(chan%, &pos{, &val|code%[]});
```

`chan%`	The channel number (1 to n) to use for the search.
`pos`	The x axis value to search before. Items at the position are ignored. To start a backward search that guarantees to iterate through all items, start at `Maxtime(chan%)+1`. `pos` is updated to contain the x axis position of the previous item. It is left unchanged if no more items are found or there is an error.
`val`	This optional parameter returns the waveform value for waveform channels.
`code%`	This optional parameter is only used if the channel is a marker type. This is an array with at least four elements that is filled in with the marker codes.
Returns	The function returns 1 if a data item is found, 0 if there are no more items to be found or a negative error code.

See also:`Maxtime(), Mintime(),NextTime()`

LCase$()

This function converts a string into lower case.

```
Func LCase$(text$);
```

`text$`	The string to convert.
Returns	A lower cased version of the original string.

See also:`UCase$()`

Left$()

This function returns the first `n` characters of a string.

```
Func Left$(text$, n);
```

`text$`	A string of text.
`n`	The number of characters to extract.
Returns	The first n characters, or all the string if it is less than `n` characters long.

See also:`DelStr$(), Mid$(), InStr(), Len(), Right$()`

Len()

This function returns the length of a string or the size of a one dimensional array.

```
Func Len(text$);
Func Len(arr[]);
```

`text$`	The text string.
`arr[]`	A one dimensional array. It is an error to pass in a two dimensional array.
Returns	The length of the string or the array as an integer.

You can find out the size of each dimension of a two dimensional array as follows:

```
proc something(arr[][])    'function passed a 2-d array
var n%, m%;
n% := Len(arr[][0]);       'get size of first dimension
m% := Len(arr[0][]);       'get size of second dimension
return;
end;
```

Ln()

This function calculates the natural logarithm (inverse of `Exp()`) of an expression, or replaces the elements of an array with their natural logarithms.

```
Func Ln(x|x[])
```

`x`	A real number or a real array. Zero or negative numbers cause the script to halt with an error unless the argument is an array, when an error code is returned.
Returns	When used with an array, it returns 0 if all was well, or a negative error code. When used with an expression, it returns the natural logarithm of the argument.

LnGamma()

The natural logarithm of the gamma function $\Gamma(x)$ is available from the script language for real values of $x > 0.0$. The gamma function has the useful property that $\Gamma(n+1)$ is the same as $n!$ (n factorial) for integral values of n. However, the gamma function becomes inconveniently large (reaching floating point infinity as far as the script language is concerned when x is 172.62). As this is a rather restricted range, the script returns the natural logarithm of the gamma function. The mathematical definition of the gamma function is:

$$\Gamma(a) = \int_0^\infty e^{-t} t^{a-1} dt$$

```
Func LnGamma(a);
```

`a`	A positive value. The script stops with a fatal error if this is negative.
Returns	The natural logarithm of the Gamma function of `a`.

Log()

Takes the logarithm to the base 10 of the argument.

```
Func Log(x|x[]);
```

`x`	A real number or a real array. Zero or negative numbers cause the script to halt with an error unless the argument is an array, when an error code is returned.
Returns	With an array, this returns 0 if all was well or a negative error code. With an expression, this returns the logarithm of the number to the base 10.

LogHandle()

The log window, also called the log view, is a text view created by the application and is the destination for `PrintLog()`. This function returns the view handle of the log window. You need this if you are to size or hide the log window, or make it the current or front window, or use the editing commands to clear it.

```
Func LogHandle()
```

Returns	The view handle of the log window.
See also:	`EditClear()`, `EditSelectAll()`, `View()`, `FrontView()`, `Window()`, `WindowGetPos()`, `WindowSize()`, `WindowVisible()`

MarkCode()

This returns the data stored in a marker at a particular x axis position.

```
Func MarkCode(chan%, pos{, co%|co%[]});
```

`chan%`	The marker channel to read.
`pos`	The position of the marker. This must match to within ± half the time interval returned by `BinSize()` for the channel.
`co%`	Optional integer to return the first 8 bit marker code (0 to 255).
`co%[]`	Optional array in which to return the marker codes. Up to 4 of these are returned depending on the size of the array.
Returns	The first code if a marker was found, or -1 if no marker exists at `pos`.

See also:`BinSize(), MarkEdit(), MarkTime()`

MarkEdit()

This changes the data stored in a marker at a particular x axis position.

```
Func MarkEdit(chan%, pos, co%|co%[]);
```

`chan%`	The marker channel to edit.
`pos`	The position of the marker. This must match to within ± half the time interval returned by `BinSize()` for the channel.
`co%`	A value from 0 to 255 to replace the first code for the marker.
`co%[]`	Array of up to 4 values (0 to 255) to replace codes for the marker. If the array size is smaller than 4 the other codes are left untouched.
Returns	0 if a marker was edited, or -1 if no marker exists at `pos`.

See also:`BinSize(), MarkCode(), MarkTime()`

MarkTime()

This reads and changes the time for a marker.

```
Func MarkTime(chan%, pos, {new});
```

`chan%`	The channel number holding markers to move.
`pos`	The position of the marker. This must match to within ± half the time interval returned by `BinSize()` for the marker channel.
`new`	If supplied, the new position (x axis value) for the marker. Note that marker times must be in order, so this time will be truncated to prevent the marker time reaching or going past adjacent markers.
Returns	The exact marker time before any changes or 0 if no marker exists at `pos`.

See also:`BinSize(), MarkCode(), MarkEdit(), View(v,c).[]`

Max()

This function returns the maximum of several real and/or integer variables or the index of the maximum value in an array if an array argument is provided. See `Min()` for example.

```
Func Max(arr[]|arr%[]|val1 {,val2 {,val3...}})
```

`arr`	A real or integer array.
`valn`	A list of real and/or integer values to scan for a maximum.
Returns	The maximum value or index of the maximum in an array argument.

See also:`Min(), MinMax(), XYRange`

Maxtime()

This returns the maximum x axis value in the frame or a specified channel, or the latest time reached within the frame or the specified channel in a sampling document view. For the end of the visible x axis use `XHigh()`.

```
Func MaxTime({chan%})
```

`chan%` An optional channel number (1 to n). If present, and if the channel exists, the function gets the x axis value for the last item sampled in the channel or the minimum x axis value in the frame if no items are found on the channel.

Returns The value returned is the maximum x axis value for the frame or a specified channel. If the current view is of the wrong type, or if a specified channel number does not exist, the script stops with an error.

See also:`Len(), LastTime(), NextTime(), Mintime(), Seconds(), XHigh()`

Message()

This function displays a message in a box with an OK button that the user must click to remove the message. Alternatively, the user can press the Enter key.

```
Proc Message(form$ {,arg1 {,arg2...}})
```

`form$` A string that defines the output format as for `Print()`. If the string contains a vertical bar character (|) then that portion of the string before the | will be used to set the title of the dialog box.

`arg1,2` The arguments used to replace `%d %f` and `%s` type formats.

The output string will be presented as one line if it is short enough, otherwise it will be split into multiple lines. Messages longer than 70 characters are truncated.

See also:`Print(), Input(), Query(), DlgCreate()`

Mid$()

This function returns a substring of a string.

```
Func Mid$(text$, index% {,count%});
```

`text$` A text string.

`index%` The starting character in the string. The first character is index 1.

`count%` The maximum characters to return. If omitted, all the characters to the end of the string are returned.

Returns The specified string. If `index%` is larger than the original string length, the result is an empty string.

See also:`DelStr$(), InStr(), Left$(), Len(), Right$(),`

Min()

This function returns the minimum of several real and/or integer variables or the index of the minimum value in an array if an array argument is provided.

```
Func Min(arr[]|arr%[]|val1 {,val2 {,val3...}})
```

`arr`	A real or integer array.
`valn`	A list of real and/or integer values to scan for a minimum.
Returns	The minimum value or index of the minimum in an array argument.

An example finding the minimum in a sub-array holding 10 items of the original data:

```
var data[70], minPos%, minVal;
...
minPos:=Min(data[40:10]);      ' returns a position between 0 and 9
minVal:=data[40+minPos];                         ' value of minimum
```

See also:`Max(), Minmax(), XYRange`

Minmax()

`Minmax()` finds the minimum and maximum values for data view channels with a y axis, or the minimum and maximum intervals for a marker channel handled as dots or lines. The values returned for marker channels as a rate histogram are measured from the histogram with partial bins included.

```
Func Minmax(chan%, start, finish, &min, &max {,&minP{,&maxP
                                              {,mode% {,binsz}}}});
```

`chan%`	The channel number (1 to n) on which to find the maximum and minimum.
`start`	The start position in x axis units.
`finish`	The end position in x axis units.
`min`	The minimum value is returned in this variable or zero if no data found.
`max`	The maximum value is returned in this variable or zero if no data found.
`minP`	The position of the minimum is returned in this variable or zero if no data found.
`maxP`	The position of the maximum is returned in this variable or zero if no data found.
`mode%`	This will have no effect for a waveform channel. If present for a marker channel, this sets the effective drawing mode in which to find the minimum and maximum. If `mode%` is absent or inappropriate, the current display mode is used. The modes are: 0 The current mode for the channel. Any additional arguments are ignored. 1 Dots mode for markers, returns the position of the marker at or after `pos`. 2 Lines mode for markers, result is the same as mode 1. 3 Rate mode for markers. The `binSz` argument sets the width of each bin.
`binSz`	This sets the width of the rate histogram bins when specifying rate mode.
Returns	1 if data points were found, 0 if no data was found or a negative error code.

See also:`Min(), Max(), View(v,c).[], XYRange()`

Mintime()

In a data view, this returns the minimum x axis value in the frame or in a channel. For the end of the visible x axis use `XLow()`.

```
Func MinTime({chan%})
```

`chan%` An optional channel number (1 to n). If present, and if the channel exists, the function gets the x axis value for the earliest item in the channel or the minimum x axis value in the frame if no items are found on the channel.

Returns The value returned is the minimum x axis value in the frame or channel. If the current view is of the wrong type, or if the channel number is illegal the script stops with an error.

See also:`Len(), BinZero(), ChanRange(), LastTime(), NextTime(), Maxtime(), Seconds(), XLow()`

MoveBy()

This moves the text caret in a text view relative to the current position. You move the caret by lines and/or a character offset. You can extend or cancel the current selection.

```
Func MoveBy(sel%, char%{, line%});
```

`sel%` If zero, all selections are cleared. If non-zero the selection is extended to the destination of the move and the new position is the start of the selection.

`char%` This is a character offset. If `line%` is absent, the new position is obtained by adding `char%` to the current position. If this is beyond the start or end of the text it is limited to the start or end.

`line%` If present it specifies a line offset to apply. To find the new position add `line%` to the current line number and `char%` to the current character position in the line. If the new line number is beyond the start or end of the text it is limited to the start and end. If the new character position is beyond the start or end of the line it is limited to the start or end of the line.

Returns The function returns the new position in the file of the start of the selection. `MoveBy(1,0)` finds the current position without changing the selection.

See also:`MoveTo(), Selection$()`

MoveTo()

This moves the text caret in a text view. You position the caret by lines and/or a character offset. You can extend or cancel the current selection.

```
Func MoveTo(sel%, char%{, line%});
```

`sel%` If zero, all selections are cleared. If non-zero the selection is extended to the destination of the move and the new current position is the start of the selection.

`char%` This is a character offset. If `line%` is absent, this sets the new position in the file. If this is beyond the start or end of the text it is limited to the start or end. A position of 0 places the caret before the first character of the first line.

`line%` If present it specifies the new line number. If it is beyond the start or end of the text it is limited to the start and end. If the new character position is beyond the start or end of the line it is limited to the start or end of the line.

Returns The function returns the new position in the file of the start of the selection.

See also:`MoveBy(), Selection$()`

NextTime()

This function is used to find the next item on a channel after a particular x axis position.

```
Func NextTime(chan%, &pos{,&val|code%[]});
```

`chan%`	The channel number (1 to n) to use for the search.
`pos`	The x axis position to start the search after. Items at the position are ignored. To ensure that items at the `Mintime()` are found, set position to `Mintime()-1`. `pos` is updated to contain the x axis position of the next item. It is left unchanged if no more items are found or there is an error.
`val`	This optional argument is used with waveform channels. It is returned holding the waveform value.
`code%`	This optional parameter is only used if the channel is a marker type. This is an array with at least four elements that is filled in with the marker codes.
Returns	The function returns 1 if a data item is found, 0 if there are no more items to be found, or a negative error code.

See also:`LastTime(), MaxTime(), MinTime()`

Optimise()

This has the same effect as the optimise button in the YAxis dialog and can be used in a data or XY view. Optimising a channel that is not displayed is not an error. If you give a channel number that is not displayed, we assume that you know what you are doing, so it is optimised in the display mode that would be used if the channel were turned on.

```
Proc Optimise(chan%|chan%[]|chan${, start{, finish}});
```

`chan%`	The channel to optimise. Use a channel number (1 to n). We also allow -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels. This can also be an integer array. If it is, the first array element holds the number of channels in the list. This is followed by a list of positive channel numbers.
`chan$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
`start`	The start of the region to optimise. If omitted, this is the start of the window.
`finish`	The end of the region to optimise. If omitted, this is the end of the window.

See also:`YRange(), YLow(), YHigh(), MinMax(), XYRange()`

Overdraw()

This function turns overdraw mode on and off for the current view. It also returns the current overdraw mode. With overdraw mode on, a view will display not only the current frame, but also all of the other frames in the overdraw frame list.

```
Func Overdraw({on% {, cycle%}});
```

`on%`	Optional argument that sets overdraw mode. If this is omitted, no change is made. 0 Turn overdraw off. 1 Turn overdraw on.
`cycle%`	Optional argument that turns on colour cycling if present and non-zero. If omitted or zero, colour cycling is turned off.
Returns	The state of overdraw mode at the time of the call, or a negative error code. Changes made by this function do not cause an immediate redraw.

See also:`OverdrawFrames(), OverdrawGetFrames()`

OverdrawFrames()

This function is used to set or modify the list of frames to overdraw in the data view. You can specify a range of frame numbers or a list of frames. If the function is used with no arguments it clears the overdraw frame list.

```
Func OverdrawFrames({sFrm% {, eFrm%{,mode%{,add%}}}});
Func OverdrawFrames(frm$|frm%[]{,mode%{,add%}});
```

`sFrm%`	First frame to include. This option processes a range of frames. `sFrm%` can also be a negative code as follows: -1 All frames in the file are included -2 The current frame -3 Frames must be tagged -6 Frames must be untagged
`eFrm%`	Last frame to include. If this is -1 the last frame is the last in the data view. This argument is ignored if `sFrm%` is a negative code.
`frm$`	A frame specification string. This option specifies a list of frames using a string such as “1..32,40,50”.
`frm%[]`	An array of frame numbers. This option provides a list of frame numbers in an array, the first array element holds the number of frames in the list.
`mode%`	If `mode%` is present it is used to supply an additional criterion for including each frame in the range, list or specification. If `mode%` is absent all frames are included. The modes are: 0-n Frames must have a state matching the value of `mode%` -1 All frames in the range, list are included -2 Only the current frame, if in the list, is included -3 Frames must be tagged -6 Frames must be untagged
`add%`	If `add%` is present and non-zero it specifies whether the specified frames are to be added to or removed from the existing display list for the view, as follows: -1 Remove the frames from the existing display list 0 Clear the display list before adding these frames 1 Add the frames to the existing display list (the default) If `add%` is absent the new frame list will be added to the existing display list
Returns	The number of frames in the new overdraw list or a negative error code.

See also:`Overdraw(), OverdrawGetFrames()`

OverdrawGetFrames()

This function is get the list of frames overdrawn in the data view.

```
Func OverdrawGetFrames({list%[]});
```

`list%`	An optional array of frame numbers to hold the list of frame numbers. If the array is too short, enough frames are returned to fill the array. Element zero holds the number of frames returned in the array.
Returns	The number of frames that would be returned if the array was of unlimited length, or zero if the view is not a data view.

See also:`Overdraw(), OverdrawFrames()`

PaletteGet()

This reads back the percentages of red, green and blue in a colour in the palette.

```
Proc PaletteGet(col%, &red, &green, &blue);
```

`col%`	The colour index in the palette in the range 0 to 39. Items 0 and 1 are permanently fixed as white and black.
`red`	The percentage of red in the colour.
`green`	The percentage of green in the colour.
`blue`	The percentage of blue in the colour.

See also:`Colour(), PaletteSet()`

PaletteSet()

This call sets the colour of one of the palette items. There are 40 palette colours, numbered 0 to 39. Colours 0 to 6 in the palette are fixed, providing grey scales from black to white, and the rest can be specified. This command is the equivalent of mixing the colour by hand from the colour menu.

Colours are specified using the RGB (Red Green Blue) colour model. For example, bright blue is achieved by 0% red, 0% green and 100% blue. Bright yellow is 100% red, 100% green and 0% blue. Black is 0% of all three colours, white is 100% of all three colours. All screen pixels of a “solid” colour are the same hue. Systems with limited colour capabilities generate non-solid colours by mixing pixels of different hues.

```
Proc PaletteSet(col%, red, green, blue {,solid%});
```

`col%`	The colour index in the palette in the range 0 to 39. Attempting to change a fixed colour, or a non-existent colour has no effect.
`red`	The percentage of red in the colour.
`green`	The percentage of green in the colour.
`blue`	The percentage of blue in the colour.
`solid%`	If present and non-zero, the system sets the nearest solid colour to the colour requested. Systems that cannot or don't need to do this ignore the argument.

See also:`Colour(), PaletteGet()`

Pow()

This is the power function that raises `x` to the power of `y`.

```
Func Pow(x|x[], y);
```

`x`	A real number or a real array to be raised to the power of `y`.
`y`	The exponent. If the expression underflows, the result is 0. If x is negative, y must be integral.
Returns	If x is an array, it returns 0 if all was well, or a negative error code. If x is a number, it returns `x` to the power of `y` unless an error is detected, when the script halts.

Print()

This command prints to the current view, which must be a text view. The output is inserted at the position of the caret. For the commands equivalent to File menu Print options refer to FilePrint().

If the first argument is a string (not an array), it is assumed to hold format information for the remaining arguments. If the first argument is an array or not a string or if there are more arguments than format specifiers, Signal prints the arguments without a format specifier in a standard format and adds a new line character at the end. If you provide a format string and you require a new line character at the end of the output, include `\n` at the end of the format string.

```
Func Print(form$|arg0 {,arg1 {,arg2...}});
```

`form$`	A string that specifies how to treat the arguments that follow. The string contains two types of characters: ordinary text that is copied to the output unchanged and format specifiers that determine how to convert each of the following arguments to text. The format specifiers are introduced by a `%` and terminated by one of the letters `d`, `x`, `c`, `s`, `f`, `e` or `g` in upper or lower case. To place a literal `%` in the output, place `%%` in the format string.
`arg1,2`	The arguments used to replace `%c`, `%d`, `%e`, `%f`, `%g`, `%s` and `%x` type formats.
Returns	0 or a negative error code. Fields that cannot be printed are filled with asterisks.

Format specifiers

The full format specifier is:

```
%{flags}{width}{.precision}format
```

`flags` The `flags` are optional and can be placed in any order. They are single characters that modify the format specification as follows:

`-`	Specifies that the converted argument is left justified in the output field.
`+`	Valid for numbers, and specifies that positive numbers have a + sign.
`space`	If the first character of a field is not a sign, a space is added.
`0`	For numbers, causes the output to be padded to the field width on the left with 0.
`#`	For `x` format, `0x` is prefixed to non-zero arguments. For `e`, `f` and `g` formats, the output always has a decimal point. For `g` formats, trailing zeros are not removed.

`width` If this is omitted, the output field will be as wide as is required to express the argument. If this is present, the output field will be at least this wide. If this is present, it is a number that sets the minimum width of the output field. If the output is narrower than this, the field is padded on the left (on the right if the `-` flag was used) to this width with spaces (zeros if the `0` flag was used). The maximum width for numbers is 100.

`precision` This number sets the maximum number of characters to be printed for a string, the number of digits after the decimal point for `e` and `f` formats, the number of significant figures for `g` format and the minimum number of digits for `d` format (leading zeros are added if required). It is ignored for `c` format. There is no limit to the size of a string, numeric fields have a maximum `precision` value of 100.

`format` The format character determines how the argument is converted into text. Both upper or lower cased version of the format character can be given. If the formatting contains alphabetic characters (for example the `e` in an exponent, or hexadecimal digits `a-f`), if the formatting character is given in upper case the output becomes upper case too (`e+23` and `0x23ab` become `E+23` and `0X23AB`). The formats are:

`c` The argument is printed as a single character. If the argument is a numeric type, it is converted to an integer, then the low byte of the integer (this is equivalent to `integer mod 256`) is converted to the equivalent ASCII character. You can use this to insert control codes into the output. If the argument is a string, the first character of the string is output. The following example prints two tab characters, the first using the standard tab escape, the second with the ASCII code for tab (8).

```
Print("\t%c", 8);
```

`d` The argument must be a numeric type and is printed as a decimal integer with no decimal point. If a string is passed as an argument the field is filled with asterisks. The following prints "`  23,0002`":

```
Print("%4d,%.4d", 23, 2.3);
```

`e` The argument must be a numeric type, otherwise the field is filled with asterisks. The argument is printed as `{-}m.dddddde±xx{x}` where the number of `d`'s is set by the precision (which defaults to 6). A precision of 0 suppresses the decimal point unless the `#` flag is used. The exponent has at least 2 digits (in some implementations of Signal there may always be 3 digits, others use 2 digits unless 3 are required). The following prints "`2.300000e+01,2.3E+00`"

```
Print("%4e,%.1E", 23, 2.3);
```

`f` The argument must be a numeric type, otherwise the field is filled with asterisks. The argument is printed as `{-}mmm.ddd` with the number of `d`'s set by the precision (which defaults to 6) and the number of `m`'s set by the size of the number. A precision of 0 suppresses the decimal point unless the `#` flag is used. The following prints "`+23.000000,0002.3`":

```
Print("%+f,%06.1f", 23, 2.3);
```

`g` The argument must be a numeric type, otherwise the field is filled with asterisks. This uses `e` format if the exponent is less than -4 or greater than or equal to the precision, otherwise `f` format is used. Trailing zeros and a trailing decimal point are not printed unless the `#` flag is used. The following prints "`2.3e-06,2.300000`":

```
Print("%g,%#g", 0.0000023, 2.3);
```

`s` The argument must be a string, otherwise the field is filled with asterisks.

`x` The argument must be a numeric type and is printed as a hexadecimal integer with no leading `0x` unless the `#` flag is used. The following prints "`1f,0X001F`":

```
Print("%x,%#.4X", 31, 31);
```

Arrays in the argument list The `d`, `e`, `f`, `g`, `s` and `x` formats support arrays. One dimensional arrays have elements separated by commas, two dimensional arrays use commas for columns and new lines for rows. If there is a format string, the matching format specifier is applied to all elements.

See also:`FilePrint(), Message(), ToolbarText(), Print$(), PrintLog()`

Print$()

This command prints formatted output into a string. The syntax is identical to the `Print()` command, but the function returns the generated output as a string.

```
Func Print$(form$|arg0 {,arg1 {,arg2...}});
```

`form$` An optional string that specifies how to format the arguments that follow. See `Print()` for a full description.

`arg1,2` The data to form into a string.

Returns It returns the string that is the result of the formatting operation. Fields that cannot be printed are filled with asterisks.

See also: `FilePrint(), Print(), PrintLog(), ReadStr()`

PrintLog()

This commands prints to the log window. The syntax is identical to the `Print()` command, except that the output always goes to the log window and is always placed at the end of the view contents.

```
Func PrintLog(form$|arg0 {,arg1 {,arg2...}});
```

`form$` An optional string that specifies how to format the arguments that follow. See `Print()` for a full description.

`arg1,2` The data to print.

Returns 0 or a negative error code. Fields that cannot be printed filled with asterisks.

See also: `Print(), Print$(), Message()`

Process()

This function processes data into the current memory or XY view. The memory view must have been derived using `SetXXXX()` from a source data view which must not have been closed. This function takes data starting from a specified position in the current frame in the source data view and processes it.

```
Func Process(start {,clear% {,opt% {,optx%}}});
```

`start` The source view x axis position from which to start processing. Positions less than `MinTime()` are treated as `MinTime()`. Positions greater than `Maxtime()` mean no processing is done. The offset from the start of frame in `SetXXX()` will be ignored. If the start position specified plus the width of data required goes past the end of the source data then no data is processed.

`clear%` If present, and non-zero, the memory view bins are cleared before the results of the analysis are added to the view and `Sweeps()` result is reset.

`opt%` If present, and non-zero, the display of data in the memory view is optimised after processing the data.

`optx%` For XY views only, if present, and non-zero, the X axis in the XY view is optimised after processing the data.

Returns One if all is OK, zero if no data was processed or a negative error code.

A common mistake is to forget that the current view is not the source view and to use View`(0).xxx` when `View(ViewSource()).xxx` was intended.

See also: `SetXXX(), SetAverage(), SetPower(),ProcessAll(), ProcessFrames(), ProcessOnline(), Sweeps(), Optimise()`

ProcessAll()

This function is used in a data view to process all memory views derived from it.

```
Func ProcessAll(sFrm%{, eFrm%});
```

`sFrm%` The first frame to process.

`eFrm%` If this is present, a range of frames is processed, from `sFrm%` to `eFrm%` inclusive. If omitted only `sFrm%` is processed.

For each derived memory view, the settings of the `clear%` and `opt%` arguments are taken from the last call of `Process()` or `ProcessFrames()`. If a memory view had not yet been processed `clear%` is zero and `opt%` is non-zero.

Returns Zero if no errors or a negative error code.

See also:`Process(), ProcessFrames(), ProcessOnline()`

ProcessFrames()

This function is used in a derived memory view to process more than one frame from the source view. You can process a range of frame numbers or specify a list of frames.

```
Func ProcessFrames(sF% {,eF% {,mode%{,clear% {,opt% {,optx%}}}}});
Func ProcessFrames(frm$|frm%[]{,mode%{,clear% {,opt% {,optx%}}}});
```

`sF%` First frame to process. This option processes a range of frames. `sFrm%` can also be a negative code as follows:

-1	All frames in the file are included
-2	The current frame
-3	Frames must be tagged
-6	Frames must be untagged

`eF%` Last frame to process. If this is -1 the last frame in the data view is used. This argument is ignored if `sFrm%` is a negative code.

`frm$` A frame specification string. This option specifies a list of frames using a string such as “1..32,40,50”

`frm%[]` An array of frame numbers to process. This option provides a list of frame numbers in an array. The first element in the array holds the number of frames in the list

`mode%` If `mode%` is present it is used to supply an additional criterion for including each frame in the range, list or specification. If `mode%` is absent all frames are included. The modes are:

0-n	Frames must have a state matching the value of `mode%`
-1	All frames in the specification are processed
-2	Only the current frame, if in the list, will be processed
-3	Frames must also be tagged
-6	Frames must also be untagged

`clear%` If present, and non-zero, the memory view bins are cleared before the results of processing all the frames are added to the view and `Sweeps()` result is reset.

`opt%` If present, and non-zero, the display of data in the memory view is optimised after processing the data.

`optx%` For XY views only, if present, and non-zero, the X axis in the XY view is optimised after processing the data.

Returns Zero if no errors or a negative error code.

See also:`Process(), ProcessAll(), ProcessOnline()`

ProcessOnline()

This function is equivalent to the process dialog for a memory view derived from a sampling document view. It does not cause any processing, but sets up processing so that when the memory view for which the function is used is given a chance to update, the parameters set by this command are used.

```
Func ProcessOnline(mode% {,val% {,up% {,opt% {,optx%}}}});
```

`mode%` The modes are:

0 All sampled sweeps are processed regardless of whether they are written to disk. This mode will not work if you are using Fast triggers or Fast Fixed int sampling modes.
-1 All sweeps saved to disk are processed.
-3 All tagged frames written to disk are processed.
-4 Sweeps with a state of `val%` are processed. A state of 0 is used if `val%` is not provided.
-5 Processes the last `val%` sweeps including the latest. The result is cleared and `Sweeps()` count is reset to 0 before each update.
-6 All untagged frames written to disk are processed.

`val%` In `mode%` -4 or -5 this provides the value for state or number of frames respectively.

`up%` This provides the number of frames before the next process or zero for no gap.

`opt%` If present and non-zero, the memory view display is optimised after each process.

`optx%` For XY views only, if present, and non-zero, the X axis in the XY view is optimised after processing the data.

Returns 0 or a negative error code.

See also:`Process(), ProcessAll(), ProcessFrames()`

Profile()

Signal stores information within the `HKEY_CURRENT_USER\Software\CED\Signal` section of the system registry. The registry is organised as a tree of keys with lists of values attached to each key. If you think of the registry as a filing system, the keys are folders and the values are files. Keys and values are identified by case-insensitive text strings. This command can create and delete keys and store and read integer and string values, but only within the Signal section of the registry.

You can view and edit the registry with the `regedt32` program, which is part of your system. Select Run from the start menu and type `regedt32` then click OK. Please read the `regedt32` help information before making any registry changes. It is a very powerful program; careless use can severely damage your system.

Do not write vast quantities of data into the registry; it is a system resource and should be treated with respect. If you must save a lot of data, write it to a text or binary file and save the file name in the registry. If you think that you may have messed up the Signal section of the registry, use `regedt32` to locate the `Signal` section and delete it. The next time you run Signal the section will be restored; you will lose any preferences you had set.

```
Proc Profile(key${, name${, val%{, &read%}}});
Proc Profile(key${, name${, val${, &read$}}});
```

`key$` This string sets the key to work on inside the `Signal` section of the registry. If you use an empty string, the `Signal` key is used. You can use nested keys separated by a backslash, for example `"My bit\\stuff"` to use the key `stuff` inside the key `My bit`. The key name may not start with a backslash. Remember that you must use two backslashes inside quote marks; a single backslash is an escape character. It is never an error to refer to a key that does not exist; the system creates missing keys for you.

`name$`	This string identifies the data in the key to read or write. If you set an empty name, this refers to the `(default)` data item for the key set by `key$`.
`val`	This can be either a string or an integer value. If `read` is omitted, this is the value to write to the registry. If read is present, this is the default value to return if the registry item does not exist.
`read`	If present, it must have the same type as `val`. This is a variable that is set to the value held in the registry. If the value is not found in the registry, the variable is set to the value of the `val` argument.

`Profile()` can be used with 1 to 4 arguments. It has a different function in each case:

1. The key identified by `key$` is deleted. All sub-keys and data values attached to the key and sub-keys are also deleted. Nothing is done if `key$` is empty.
2. The value identified by `name$` in the key `key$` is deleted.
3. The value identified by `name$` in the key `key$` is set to `val%` or `val$`.
4. The value identified by `name$` in the key `key$` is returned in `val%` or `val$`.

The following script example collects values at the start, then saves them at the end:

```
var path$, count%;
Profile("My data", "path", "c:\\work", path$); 'get initial path
Profile("My data", "count", 0, count%); 'and initial count
...                                     'your script...
Profile("My data","path", path$);       'save final value
Profile("My data","count", count%);     'save final count
```

Registry use by Signal The `HKEY_CURRENT_USER\Software\CED\Signal` key contains the following keys that are used by Signal:

BarList This key holds the list of scripts to load into the script bar when Signal starts.

Editor This key holds the editor settings for scripts, output sequences and general text editing.

PageSetup This key holds the margins in units of 0.01 mm for printing data views, and the margins in mm and header and footer text for text-based views.

Preferences The values in this key are mainly set by the Edit menu preferences. If you change any Edit menu Preferences value in this key, Signal will use the changed information immediately. The values are all integers except the file path, which is a string:

Assume Power	0=Do not assume Power1401 hardwre, 1=do assume.
Differ Optimise	0=Y-axis optimised on data aquired so far when requested on-line, 1=Y-axis optimise differed to sweep end when requested on-line.
Enhanced Metafile	0=Windows metafile, 1=enhanced metafile for clipboard.
File shorts	0=Waveform data to be written to CFS file as 16 bit integers, 1=to be written as floating point values. Add 256 if calibrated zero is to be kept at zero volts.
File update	0=Discard changes to data,.1=query the user, values. 2=always save changes.
Font Italic	0=Use non-italic font as default for file and memory views. 1=use italic font.
Font Name	Name of font to use as default for file and memory views.
Font Pitch	0=Use default pitched font for the above, 1=use a fixed pitch font (all characters the same width), 2=use a variable pitched font. To this value you should add: 4=don't care which family of font used, 8=use a serifed, variable widthed font, 16=sans-serifed, variable widthed font, 32=constant widthed font, 64=cursive

	font, 128=decorative font.
Font Size	Size of font to use as default for file and memory views.
Font Weight	400=Normal font, 700=bold font..
Line thickness codes	Bits 0-3 = Axis code, bits 4-7 = Data code. The codes 0-15 map onto the 16 values in the drop down list. Bit 7=1 to use lines not rectangles to draw axes.
Low channels at top	0=Standard display shows low channel at bottom, 1=at top.
Metafile Scale	0-11 selects from the list of allowed scale factors.
New file path	New data file directory or blank for current folder.
No save prompt	0=Prompt to save derived views, 1=no prompt.
Time mode	0=Display seconds, 1=display ms, 2=display us.

The keys with names starting `"Bars-"` are used by system code to restore dockable toolbars. You can delete them all safely; any other change is likely to crash Signal.

Recent file list This key holds the list of recently used files that appear at the bottom of the file menu.

Recover This key holds the information to recover data from interrupted sampling sessions.

Settings This is where the evaluate bar saves the last few evaluated lines.

Tip The *Tip of the Day* dialog uses this key to remember the last tip position.

Version Signal uses this key to detect when a new version of the program is run for the first time.

Win32 In Windows NT derived systems, this key holds the desired working set sizes. The working set sizes in use are displayed in the Help menu About Signal dialog. Click the Help button in this dialog to read more about using these registry values.

Minimum working set	Minimum size in kB (units of 1024 bytes), default is 800
Maximum working set	Maximum size in kB, default is 4000 (4 MB)

See also:`ViewUseColour()`

ProgKill()

This function terminates a program started using `ProgRun()`. This is a very powerful function. It will terminate a program without giving it the opportunity to save data. Use this command with care!

```
Func ProgKill(pHdl%);
```

`pHdl%` A program handle returned by `ProgRun()`.

Returns Zero or a negative error code.

See also:`ProgRun(), ProgStatus()`

ProgRun()

This function runs a program using command line arguments as if from a DOS style command prompt.

```
Func ProgRun(cmd$ {,code% {,xLow, yLow, xHigh, yHigh}});
```

`cmd$`	The command string as would be typed at a Dos style prompt.
`code%`	If present, this sets the initial application window state: 0=Hidden, 1=Normal, 2=Iconised, 3=maximised. Some programs set their own window sizes and styles so this may not work. The next 4 arguments set the Normal window position.
`xLow`	Position of the left window edge as a percentage of the screen width.
`yLow`	Position of the top window edge as a percentage of the screen height.
`xHigh`	The right hand edge as a percentage of the screen width.
`yHigh`	The bottom edge position as a percentage of the screen height.
Returns	A program handle or a negative error code.

See also:`ProgKill()`, `ProgStatus()`

ProgStatus()

This function is used to check if a program started with `ProgRun()` is still running. If it finds that the program has terminated it will close the handle which will then become invalid if used again.

```
Func ProgStatus(pHdl%);
```

`pHdl%`	The program handle returned by `ProgRun()`.
Returns	1 if the program is still running, 0 if it has terminated or a negative error code.

See also:`ProgKill()`, `ProgRun()`

ProtocolAdd()

This function adds a new protocol to the list of protocols defined in the sampling configuration.

```
Func ProtocolAdd(name$);
```

`name$`	The name for the new protocol, which must not be blank.
Returns	The number for the new protocol or a -ve error code.

See also:`Protocols(), ProtocolDel(), ProtocolClear(), ProtocolName$()`

ProtocolClear()

This function initialises a protocol defined in the sampling configuration.

```
Func ProtocolClear(num|name$);
```

`num`	The number of the protocol to clear, from 1 to the number returned by `Protocols()`.
`name$`	The name of the protocol to be cleared.
Returns	Zero or a negative error code.

See also:`Protocols(), ProtocolDel(), ProtocolAdd(), ProtocolName$()`

ProtocolDel()

This function deletes a protocol from the list defined in the sampling configuration.

```
Func ProtocolDel(num|name$);
```

`num`	The number of the protocol to delete, from 1 to the number returned by `Protocols()`.
`name$`	The name of the protocol to be deleted.
Returns	Zero or a negative error code.

See also:`Protocols(), ProtocolAdd(), ProtocolClear(), ProtocolName$()`

ProtocolFlags()

This function gets the flags for a protocol defined in the sampling configuration and optionally sets the flags to a new value.

```
Func ProtocolFlags(num|name$ {, new});
```

`num`	The number of the protocol to use, from 1 to the number returned by `Protocols()`.
`name$`	The name of the protocol to use.
`new`	If present, the new protocol flags value. This is the sum of values for each flag option, the values are:

1	Initialise pulse variations when protocol starts.
2	Sampling switches to idling when protocol finishes.
4	Turn on writing to disk when protocol starts.

Returns The flags for this protocol before the call.

See also:`Protocols(), ProtocolClear(), ProtocolName$()`

ProtocolName$()

This function gets the name for a protocol defined in the sampling configuration and optionally sets a new name.

```
Func ProtocolName$(num|name$ {, new$});
```

`num`	The protocol number to use, from 1 to the number returned by `Protocols()`.
`name$`	The name of the protocol to use.
`new$`	If present, this sets the new protocol name.
Returns	The name of the protocol before this call.

See also:`Protocols(), ProtocolAdd(), ProtocolDel(), ProtocolClear()`

Protocols()

This function gets the number of protocols defined in the sampling configuration.

```
Func Protocols();
```

Returns The number of protocols defined in the sampling configuration.

See also:`ProtocolAdd(), ProtocolDel(), ProtocolClear(), ProtocolName$()`

ProtocolStepGet()

This function gets information about a specific step within a protocol from the list defined in the sampling configuration.

```
Func ProtocolStepGet(num|name$, step, &state, &repeat, &next);
```

`num`	The protocol number to use, from 1 to the number returned by `Protocols()`.
`name$`	The name of the protocol to use.
`step`	The step in the protocol, from 1 to 10.
`state`	This parameter is updated with the state for this step.
`repeat`	This parameter is updated with the repeat count for this step.
`next`	This parameter is updated with the next step value for this step.
Returns	Zero or a negative error code.
See also:	`Protocols(), ProtocolFlags(), SampleStates(), ProtocolClear(), ProtocolName$()`

ProtocolStepSet()

This function sets up a specific step within a protocol from the list defined in the sampling configuration.

```
Func ProtocolStepSet(num|name$, step, state, repeat, next);
```

`num`	The number of the protocol to use, from 1 to the number returned by `Protocols()`.
`name$`	The name of the protocol to use.
`step`	The step in the protocol, from 1 to 10.
`state`	This parameter sets the state for this step, from 0 to 256.
`repeat`	This parameter sets the repeat count for this step, from 1 to 1000.
`next`	This parameter sets the next step value for this step, from 0 to 10. A value of zero terminates protocol execution.
Returns	Zero or a negative error code.
See also:	`Protocols(), ProtocolFlags(), SampleStates(), ProtocolClear(), ProtocolName$()`

PulseXXX() Pulse output commands

The Pulse... family of commands can be used to control the pulse outputs generated during sampling sweeps. Pulses can be generated on up to eight 1401 DACs and on 8 bits of dedicated digital output. For the micro1401 and Micro1401 mk II, only two DACs are available.

As part of the Signal multiple states facilities, each state can have a separate set of pulse outputs. Because of this, all script functions that access the pulses information have a parameter to select the state. For single states, set this parameter to zero.

Individual pulses can be specified by their number or by name. For access by number the pulses for a given output are kept in a sorted list in order of their start time. The (always present) initial level is zero, subsequent pulses are 1 and upwards. Though access by number seems straightforward, it does have some drawbacks. Firstly, when the start time of a pulse is changed the ordering of the list can change and the pulse number will be changed. Secondly, for complex reasons, the arbitrary waveform output item is always attached to the DAC 0 outputs list, regardless of what DACs it uses, and does not appear in any other output lists. This can make things very confusing! Therefore we recommend that, for non-trivial pulse output arrangements, individual pulses are accessed by name.

See also:`PulseAdd(), PulseDataGet(), PulseDataSet(), PulseDel(), PulseFlags(), PulseName$(), Pulses(), PulseTimesGet(), PulseTimesSet(), PulseType(), PulseVarGet(), PulseVarSet(), PulseWaveformGet(), PulseWaveformSet(), PulseWaveGet(), PulseWaveSet()`

PulseAdd()

This function adds a new pulse to the output pulses for a given state and output. If this is used to add an arbitrary waveform output to pulses that already contain such an item, the pre-existing waveform output is deleted.

```
Func PulseAdd(state, out, type, name$, time, len {, flags});
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.
`type`	A code for the type of pulse. The legal codes are:

1	a simple square pulse
2	a square pulse with varying amplitude
3	a square pulse with varying duration
4	a ramp pulse
5	a cosine wave segment
6	an arbitrary waveform, the rate is initialised to 100Hz
7	a pulse train

`name$`	The name for the new pulse, this can be blank.
`time`	The start time for the pulse in seconds from the start of the outputs.
`len`	The length of the pulse, in seconds. For a pulse train, this is the length of the individual pulses in the train, not the length of the entire train.
`flags`	If present, this sets the flags for the pulse. Flag bit 0 is set for varying width pulses to push following pulses back, bit 1 is set for pulses to stay up at the end. If this parameter is omitted, the pulse flags are cleared.
Returns	The number of the new pulse or a negative error code. The initial level item is always present as pulse zero, so the smallest successful return value is 1.

See also:`Pulses(), PulseDel(), SampleStates(), SampleOutLength(), PulseName$()`

PulseClear()

This function deletes all the pulses for a given state and output.

```
Func PulseClear(state, out);
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.
Returns	Zero or a negaitive error code.

See also:`Pulses(), PulseAdd(), PulseDel(), SampleStates()`

PulseDataGet()

This function retrieves the amplitude and other values for a pulse in the outputs for a given state and output. Up to four data values can be retrieved, the meaning of most of these varies with the pulse type. A separate function, PulseWaveGet(), retrieves the settings for waveform outputs.

```
Func PulseDataGet(state, out, num|name$, &amp {, &val1 {, &val2
                        {, &val3}}});
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.
`num`	The number of the pulse in question, from 0 to the number of pulses.
`name$`	The name of the pulse to use.
`amp`	This is updated with the amplitude or level of the pulse, or the bit value for digital pulses.
`val1`	This is updated with the end amplitude for ramps, the initial phase for cosines, and the number of pulses for pulse trains.
`val2`	This is updated with the step mode for ramps, the centre value for sines and the gap for pulse trains. The step mode value is 0 for both ends, 1 for start only and 2 for end only.
`val3`	This is updated with the cycle period for sines only.
Returns	Zero or a negative error code.

See also:`Pulses(), PulseAdd(), PulseDataSet(), PulseName$()`

PulseDataSet()

This function sets the amplitude and other values for a pulse in the outputs for a given state and output. Up to four data values can be set, the meaning of most of these varies with the pulse type. A separate function, PulseWaveSet(), is used to change the settings for arbitrary waveform output.

```
Func PulseDataSet(state, out, num|name$, amp {, val1 {, val2
                        {, val3}}}});
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.
`num`	The number of the pulse in question, from 0 to the number of pulses.
`name$`	The name of the pulse to use.
`amp`	This sets the amplitude or level of the pulse, or the bit value for digital pulses.

`val1` This sets the end amplitude for ramps, the initial phase for cosines, and the number of pulses for pulse trains.

`val2` This sets the step mode for ramps, the centre value for sines and the gap between pulses for pulse trains. The step mode value is 0 for both ends, 1 for start only and 2 for end only.

`val3` This sets the cycle period for sines only.

Returns Zero or a negative error code.

See also: `Pulses(), PulseAdd(), PulseDataGet(), PulseName$()`

PulseDel()

This function deletes a pulse from the output pulses for a given state and output.

```
Func PulseDel(state, out, num|name$);
```

`state` The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.

`out` The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.

`num` The number of the pulse to delete, from 1 to the number of pulses (you cannot delete pulse zero; the initial level).

`name$` The name of the pulse to delete, you cannot delete the initial level.

Returns Zero or a negative error code.

See also: `Pulses(), PulseAdd(), SampleStates(), SampleOutMode()`

PulseFlags()

This function retrieves, and optionally sets, the options flags for a pulse in the outputs for a given state and output.

```
Func PulseFlags(state, out, num|name$ {, flags});
```

`state` The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.

`out` The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.

`num` The number of the pulse in question, from 0 to the number of pulses.

`name$` The current name of the pulse in question.

`flags` If present, this sets the new flags for the pulse. Flag bit 0 is set for varying width pulses to push following pulses back, bit 1 is set for pulses to stay up at the end.

Returns The flags for the pulse at the time of the function call.

See also: `Pulses(), PulseAdd(), SampleStates(), SampleOutMode()`

PulseName$()

This function retrieves, and optionally sets, the name of a pulse in the output pulses for a given state and output.

```
Func PulseName$(state, out, num|name$ {, new$});
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.
`num`	The number of the pulse in question, from 0 to the number of pulses.
`name$`	The current name of the pulse in question.
`new$`	The new name for the pulse. Blank pulse names are legal.
Returns	The name of the pulse at the time of the function call.

See also:`Pulses(), PulseAdd(), SampleStates(), SampleOutMode()`

Pulses()

This function returns the number of pulses for a given state and output. This number is usually straightforward to use, but can be complicated by the fact that waveforn output items always appear on the DAC 0 outputs, regardless of the DACs in use, and not on any other DAC.

```
Func Pulses(state, out);
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values from 0 upwrds select the corresponding DAC, -1 selects the digital outputs.
Returns	The number of pulses on this output. This value will be 1 or more as there is always one pulse defined for an output; the initial level.

See also:`PulseDel(), PulseAdd(), PulseWaveSet(), PulseName$()`

PulseTimesGet()

This function retrieves the times for a pulse in the outputs for a given state and output.

```
Func PulseTimesGet(state, out, num|name$, &time, &len);
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.
`num`	The number of the pulse in question, from 1 to the number of pulses. Zero is not meaningful because there are no times for the initial level.
`name$`	The name of the pulse to use.
`time`	This is updated with the start time for the pulse, in seconds from the start of the pulse outputs.
`len`	This is updated with the length of the pulse, in seconds.
Returns	Zero or a negative error code.

See also:`Pulses(), PulseAdd(), PulseTimesSet(), SampleOutMode()`

PulseTimesSet()

This function sets the times for a pulse in the outputs for a given state and output.

```
Func PulseTimesSet(state, out, num|name$, time, len);
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.
`num`	The number of the pulse in question, from 1 to the number of pulses. Zero is not usable because there are no times for the initial level.
`name$`	The name of the pulse to use.
`time`	This sets the start time for the pulse in seconds from the start of the pulse outputs.
`len`	This sets the length of the pulse in seconds. This does not affect arbitrary waveform items, use PulseWaveSet().
Returns	Zero or a negative error code.

See also:`Pulses(), PulseAdd(), PulseTimesGet(), SampleOutMode()`

PulseType()

This function returns a code for the type of a pulse in outputs for a given state and output.

```
Func PulseType(state, out, num|name$);
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.
`num`	The number of the pulse in question, from 0 to the number of pulses.
`name$`	The name of the pulse in question.
Returns	A code for the type of pulse, as follows:

0	the initial level for the output
1	a simple square pulse
2	a square pulse with varying amplitude
3	a square pulse with varying duration
4	a ramp pulse
5	a cosine wave segment
6	an arbitrary waveform
7	a pulse train

See also:`Pulses(), PulseAdd(), PulseDataGet(), PulseDataSet()`

PulseVarGet()

This function retrieves the values controlling the automatic variation of a pulse in the outputs for a given state and output.

```
Func PulseDataGet(state, out, num|name$, &step{, &repeat
                    {, &steps}});
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.
`num`	The number of the pulse in question, from 0 to the number of pulses.
`name$`	The name of the pulse in question.
`step`	This is updated with the step value for the pulse.
`repeat`	This, if present, is updated with the repeat count for each step in the variations.
`steps`	This, if present, is updated with the total steps for the variation. Note that the number of values for the variation is `steps+1` as the initial value is also used.

Returns Zero or a negative error code.

See also:`Pulses(), PulseAdd(), PulseVarSet(), PulseName$()`

PulseVarSet()

This function sets values controlling the automatic variation of a pulse in the outputs for a given state and output.

```
Func PulseVarSet(state, out, num|name$, step{, repeat
                    {, steps}});
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`out`	The output to which this applies. Values of zero upwards select the corresponding DAC output, -1 selects the digital outputs.
`num`	The number of the pulse in question, from 0 to the number of pulses.
`name$`	The name of the pulse to use.
`step`	This sets the step value for the pulse.
`repeat`	This, if present, sets the repeat count for each step in the variations.
`steps`	This, if present, sets the total steps for the variation. Note that the number of values for the variation is `steps+1` as the initial value is alsol used.

Returns Zero or a negative error code.

See also:`Pulses(), PulseAdd(), PulseVarGet(), PulseName$()`

PulseWaveformGet()

This function retrieves the waveform data values sent to a given DAC as part of the arbitrary waveform item in the pulses for a given state.

```
Func PulseWaveformGet(state, dac, dat%[]|dat[]);
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`dac`	The DAC number for which we want data. If the DAC is not used, no data will be returned.
dat%[]	An integer array that will be filled with the data for the DAC. The values are the 16-bit integer values that would be written to the DAC, a value of -32768 corresponds to an output of -5 volts, 32767 corresponds to +5 volts. If the array is too short to hold all of the waveform, it will be filled. If the array is longer than the waveform, all the points will be copied and the rest of the array left unchanged.
dat[]	A real array that will be filled with the data for the DAC. The values are calibrated using the appropriate DAC scaling factors. If the array is too short to hold all of the waveform, it will be filled. If the array is longer than the waveform, all the points will be copied and the rest of the array left unchanged.
Returns	The number of points copied or a negative error code.
See also:	`Pulses(), PulseAdd(), PulseWaveSet(), PulseWaveGet(), PulseWaveformSet()`

PulseWaveformSet()

This function sets the waveform data values sent to a given DAC as part of the arbitrary waveform item in the pulses for a given state.

```
Func PulseWaveformSet(state, dac, dat%[]|dat[]);
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`dac`	The DAC number for the data. If the DAC is not used, the function will do nothing.
dat%[]	An integer array that holds the new data for the DAC. The values are the 16-bit integer values that would be written to the DAC, a value of -32768 corresponds to an output of -5 volts, 32767 corresponds to +5 volts. If the array is too short to hold all the waveform points, only the earlier points in the waveform will be changed. If the array is longer than the waveform, the extra data in the array is unused.
dat[]	A real array that holds the new data for the DAC. The values are converted into DAC output values using the appropriate DAC scaling factors. If the array is too short to hold all of the waveform points, only the earlier points in the waveform will be changed. If the array is longer than the waveform, the extra data in the array is unused.
Returns	The number of waveform points changed or a negative error code.
See also:	`Pulses(), PulseAdd(), PulseWaveSet(), PulseWaveGet(), PulseWaveformGet()`

PulseWaveGet()

This function retrieves the values controlling the arbitrary waveform item in the pulses for a given state.

```
Func PulseWaveGet(state, &mask, &rate, &points);
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`mask`	This is updated with the DAC mask value for the output. This has one bit set for each DAC used, bit 0 for DAC 0 and so forth.
`rate`	This is updated with the output rate for the waveform data, in Hz.
`points`	This is updated with the number of points of data for each DAC.
Returns	Zero or a negative error code.

See also:`Pulses(), PulseAdd(), PulseWaveSet()`

PulseWaveSet()

This function sets the values controlling the arbitrary waveform item in the pulses for a given state.

```
Func PulseWaveSet(state, mask, rate, points);
```

`state`	The state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.
`mask`	This sets the DAC mask value for the output, which controls which DACs are used. This has one bit set for each DAC used, bit 0 for DAC 0 and so forth.
`rate`	This sets the output rate for the waveform data, in Hz.
`points`	This sets the number of points of data for each DAC in the mask.
Returns	Zero or a negative error code.

See also:`Pulses(), PulseAdd(), PulseWaveGet()`

Query()

This function is used to ask the user a Yes/No question. It opens a window with a message and two buttons. The window is removed when a button is pressed.

```
Func Query(text1$, {,Yes$ {,No$}});
```

`text1$`	This string forms the text in the window. If the string contains a vertical bar character (|), the portion of the string before the | will be used to set the title of the window. Up to 20 lines of text can be shown, each up to 60 characters long.
`Yes$`	This sets the text for the first button. If this argument is omitted, `"Yes"` is used.
`No$`	This sets the text for the second button. If this is omitted, `"No"` is used.
Returns	1 if the user selects Yes or presses Enter, 0 if the user selects the No button.

See also:`Print(), Input(), Message(), DlgCreate()`

Rand()

This function returns pseudo-random numbers, and sets the seed for the random number generator. Signal seeds the generator when it starts with a number derived from the time, so if you require a repeatable sequence, you must set the seed. The sequence will not be the same on different implementations of Signal.

```
Func Rand({seed});
```

`seed`	If present, this is a seed for the generator in the range 0 to 1. If `seed` is outside this range, the fractional part of the number is used.
Returns	A random number in the range 0 up to but not including 1. The numbers are evenly distributed. If a seed is given, a random number is still returned.

Read()

This function takes the next line read from the current view as the source of a text string and converts the text into variables. The read starts at the current position of the text cursor. The text cursor moves to the start of the next line after the read.

```
Func Read({&var1 {, &var2 {,&var3 ...}}});
```

`varn` Arguments must be variables. They can be any type. One dimensional arrays are allowed. The variable type determines how the function extracts data from the string. In a successful call, each variable will be matched with a field in the string, and the value of the variable is changed to the value found in the field.

A call to `Read()` with no arguments skips a line.

Returns The function returns the number of fields in the text string that were successfully extracted and returned in variables, or a negative error code. Attempts to read past the end of the file produce the end of file error code.

It is not considered an error to run out of data before all the variables have been updated. If this is a possibility you must check that the number of items returned matches the number you expected. If an array is passed in, it is treated as though it was the number of individual values held in the array.

The source string is expected to hold data values as real numbers, integer numbers and strings. Strings can be delimited by quote marks, for example `"This is a string"`, or they can be just text. However, if a string is not delimited by quotes, it is deemed to run to the end of the source string, so no other items can follow it.

The fields in the source string are separated by white space (tabs and spaces) and commas. Space characters are “soft” separators. You can have any number of spaces between fields. Tabs and commas are treated as “hard” separators. Two consecutive tabs or commas, or a tab and a comma (with or without intervening spaces), imply a blank field. When reading a field, the following rules are followed:

1. Space characters are skipped over
2. Characters that are legal for the variable into which data is to be read are extracted until a non-legal character or a separator or end of data is found. The characters read are converted into the variable type. If an error occurs in the translation, the function returns the error. Blank fields assigned to numbers are treated as 0. Blank fields assigned to strings produce empty strings.
3. Characters are then skipped until a separator character is found or end of data. If the separator is a space, it and any further spaces are skipped. If the next character is a hard separator it is also skipped.
4. If there are no more variables or no more data, the process stops, else back to step 1.

Example The following example shows a source line, followed by a `Read()` function, then the assignment statements that would be equivalent to the `Read()`.

```
"This is text"    ,  2 3 4,, 4.56 Text too 3 4 5
```
The source line

```
n := Read(fred$, jim[1:2], sam, dick%, tom%, sally$, a, b, c);
n := 7;
fred$ := "This is text";
jim[1] := 2; jim[2] := 3;
sam := 4;
dick% := 0;
tom% := 4;
sally$ := "Text too 3 4 5"
a, b and c are not changed
```

See also:`FileOpen(), ReadStr()`

ReadStr()

This function extracts data fields from a string and converts them into variables.

```
Func ReadStr(text$, &var1 {, &var2 {, &var3...}});
```

`text$`	The string used as a source of data.
`var`	The arguments must all be variables. The variables can be of any type, and can be one dimensional arrays. The type of each variable determines how the function tries to extract data from the string. See `Read()` for details.
Returns	The function returns the number of fields in the text string that were successfully extracted and returned in variables, or a negative error code.

It is not an error to run out of data before all the variables have been updated. If this is a possibility you must check the returned value. If an array is passed in, it is treated as though it was the number of individual values held in the array.

See also:`Read(), Print$(), Val()`

Right$()

This function returns the rightmost `n` characters of a string.

```
Func Right$(text$, n);
```

`text$`	A string of text.
`n`	The number of characters to return.
Returns	The last `n` characters of the string, or all the string if it is less than `n` characters.

See also:`DelStr$(), InStr(), Left$(), Len(), Mid$()`

Round()

Rounds a real number or an array of reals to the nearest whole number.

```
Func Round(x|x[]);
```

`x`	A real number or an array of reals.
Returns	If x is an array it returns 0. Otherwise it returns a real number with no fractional part that is the nearest to the original number.

See also:`Trunc(), Frac()`

SampleAbort()

This cancels sampling and deletes the views that were being sampled and any associated result and cursor views. If a memory view derived from the data has been saved, the saved file remains. It is equivalent to the Abort button on the floating sampling control window.

```
Func SampleAbort();
```

Returns 0 if sampling was aborted, or a negative error code.

See also:`SampleReset(), SampleStart(), SampleStop(), SampleStatus()`

SampleAbsLevel()

This function sets and gets the absolute levels flag as seen in the sampling configuration dialog Outputs page.

```
Func SampleAbsLevel({new});
```

`new`	If present, this sets the new absolute levels flag if non-zero, clears the flag if zero..
Returns	The absolute levels flag from the configuration at the time of the call.

See also: `SampleClear(), Pulses()`

SampleAccept()

This tags the current frame as accepted or rejected.

```
Func SampleAccept({yes%});
```

`yes%`	If this is zero the frame is rejected, otherwise the frame is written to disk and is equivalent to the Accept check box in the sampling control dialog.
Returns	0 if sweep was written successfully or a negative error code.

See also: `SamplePause(), SampleStatus(), SampleWrite()`

SampleArtefactGet()

This command returns the parameters used in automatic artefact rejection during sampling . Artefact rejection consists of testing all points within a given time range and rejecting or tagging frames where the points at the ADC limit exceed a set threshold.

```
Func SampleArtefactGet(mode%, start, end, per{, lev})
```

`mode%`	Returned holding the artefact rejection mode: 0 for none, 1 for Tag and 2 for Reject.
`start`	Returned holding the start time for the search for out-of-range points.
`end`	Returned holding the end time for the search for out-of-range points.
`per`	Returned holding the percentage of out-of-range points that can be tolerated, frames with more than this are deemed to contain artefacts.
`lev`	The percentage of the ADC range (from zero to full scale) above or below which will be considered an artefact.
Returns	Zero or a negative error code.

See also: `SampleArtefactSet(), SampleAccept(), FrameTag(), SamplePortFull()`

SampleArtefactSet()

This command sets the parameters used in automatic artefact rejection during sampling . Artefact rejection consists of testing all points within a given time range and rejecting or tagging frames where the points at the ADC limit exceed a set threshold.

```
Func SampleArtefactSet(mode%, start, end, per{, lev})
```

`mode%`	Sets the artefact rejection mode: 0 for none, 1 for Tag and 2 for Reject.
`start`	The start time for the search for out-of-range points.
`end`	The end time for the search for out-of-range points.
`per`	The percentage of out-of-range points that can be tolerated, frames with more than this are deemed to contain artefacts.
`lev`	The percentage of the ADC range (from zero to full scale) above or below which will be considered an artefact. The default is 100.
Returns	Zero or a negative error code.
See also:	`SampleArtefactGet(), SampleAccept(), FrameTag(), SamplePortFull()`

SampleAutoFile()

This gets or sets the flag for file auto-filing as seen in the sampling configuration dialog.

```
Func SampleAutoFile({yes%});
```

`yes%`	If present and non-zero, this turns on automatic filing of data when sampling finishes. If zero or missing it turns automatic filing off.
Returns	the automatic filing flag at the time of the function call.
See also:	`SampleAutoName$(), FileNew()`

SampleAutoName$()

This gets or sets the template for file auto-naming as in the sampling configuration dialog.

```
Func SampleAutoName$({name$});
```

`name$`	If present, this sets the new template string for file auto-naming, or turns off auto-naming if it is a blank string. See the sampling configuration documentation for details on the template string.
Returns	the auto-naming template at the time of the function call.
See also:	`SampleAutoFile(), FileNew()`

SampleBar()

This gives you access to the Sample toolbar. The format of strings passed by this command is the button label (up to 8 characters), followed by a vertical bar, followed by the full path name to a sampling configuration file, including the `.sgc` file extension, followed by a vertical bar then a comment to display when the mouse pointer is over the button. If you call the command with no arguments it returns the number of buttons in the toolbar.

```
Func SampleBar({n% {, &get$}});
Func SampleBar(set$);
```

`n%`	If set to -1, `get$` must be omitted and all buttons are cleared and the function returns 0. When set to the number of a button (the first button is 0), `get$` is as described above. In this case, the function returns -1 if the button does not exist, 0 if it exists and is the last button, and 1 if higher numbered buttons exist.
`set$`	The string passed in should have the format described above The function returns the new number of buttons or -1 if all buttons are already used.
Returns	See the descriptions above. Negative return values indicate an error.

For example, the following code clears the script bar and sets two buttons:

```
SampleBar(-1);    'clear all buttons
SampleBar("Fast|C:\\Signal2\\Fast.sgc|Fast 4 channel sampling");
SampleBar("Faster|C:\\Signal2\\FastXX.sgc|Very fast sampling");
```

See also:`App()`

SampleBurst()

This gets or sets burst mode sampling as seen in the sampling configuration dialog.

```
Func SampleBurst({bMode%});
```

`bMode%`	If present and non-zero this turns burst mode on in the sampling configuration. Burst mode is often to be preferred, as the actual sampling rate used is more likely to match the preferred rate set.
Returns	1 if burst mode is on, 0 if it is off.

See also:`SampleClear(), SampleRate(), SamplePoints(), SampleTrigger(), SamplePorts()`

SampleClear()

This procedure sets the contents shown in all the panes of the sampling configuration dialog to a standard state. You can use the sampling configuration commands to get or change values in the sampling configuration. There is a full list of the sampling configuration commands in the *Commands by function* chapter.

```
Proc SampleClear();
```

SampleDacFull()

This function gets the full-scale value used to scale values written to the DACs and optionally sets it to a new value.

```
Func SampleDacFull(port {, new});
```

port	The DAC number, from 0 to 3.
`new`	If present, sets the value in the units for this DAC corresponding to a full-scale value. This value is used throughout Signal to calibrate DAC values.
Returns	The DAC full-scale value before the call.

See also:`Pulses(), SampleDacMask(), SampleDacZero(), SampleDacUnits$(), SampleStateDac()`

SampleDacMask()

This function gets the mask value used to enable the DAC outputs and optionally sets it to a new value.

```
Func SampleDacMask({new});
```

`new`	If present, sets the mask enabling the DAC outputs. This mask has one bit for each DAC, set bits enable the corresponding DAC output.
Returns	The DAC outputs mask value before the call.
See also:	`SampleStatesMode(), SampleDigOMask(), SampleDigIMask(), SampleStateDac()`

SampleDacUnits$()

This function gets the units string for a DAC and optionally sets it to a new value.

```
Func SampleDacUnits$(port {, new$});
```

port	The DAC number, from 0 to 3.
`new`	If present, sets the units string for this DAC. This value is used throughout Signal to calibrate DAC values.
Returns	The DAC units string before the call.
See also:	`Pulses(), SampleDacMask(), SampleDacFull(), SampleDacZero(), SampleStateDac()`

SampleDacZero()

This function gets the zero value used to scale values written to the DACs and optionally sets it to a new value.

```
Func SampleDacZero(port {, new});
```

port	The DAC number, from 0 to 3.
`new`	If present, sets the value in the units for this DAC corresponding to a zero value. This value is used throughout Signal to calibrate DAC values.
Returns	The DAC zero value before the call.
See also:	`Pulses(), SampleDacMask(), SampleDacFull(), SampleDacUnits$(), SampleStateDac()`

SampleDigIMask()

This function gets the mask value used to enable the digital inputs for the External digital multiple states mode and optionally sets it to a new value.

```
Func SampleDigIMask({new});
```

`new`	If present, sets the mask enabling the digital inputs. This mask has one bit for each digital input, set bits enable the corresponding input. This value is only used in External digital states mode.
Returns	The digital inputs mask value before the call.
See also:	`SampleStatesMode(), SampleStateDig(), SampleDacMask(), SampleDigOMask()`

SampleDigOMask()

This function gets the mask value used to enable the digital outputs and optionally sets it to a new value.

```
Func SampleDigOMask({new});
```

`new` If present, sets the mask enabling the digital outputs. This mask has one bit for each digital output, set bits enable the corresponding output.

Returns The digital outputs mask value before the call.

See also: `SampleStatesMode(), SampleStateDig(), SampleDacMask(), SampleDigIMask()`

SampleFixedInt()

This function sets and gets the sweep interval for Fixed interval and Fast Fixed int sweep modes, as stored in the pulses information. Note that this sets the interval after frames with the specified state, not the interval before a frame.

```
Func SampleFixedInt(state {, period});
```

state This sets the state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.

period If present, this argument sets the fixed interval period, in seconds.

Returns The fixed interval period at the time of the call.

See also: `SampleOutMode(), SampleOutTrig(), SampleOutClock(), SampleFixedVar(), Pulses(), SampleStates()`

SampleFixedVar()

This function sets and gets the percentage variation of the sweep interval for Fixed interval sweep mode, as stored in the pulses information.

```
Func SampleFixedVar(state {, vary});
```

state This sets the state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.

vary If present, this argument sets the fixed interval variation, from 0 to 100 percent.

Returns The fixed interval variation percentage at the time of the call.

See also: `SampleOutMode(), SampleOutTrig(), SampleOutClock(), SampleFixedInt(), Pulses(), SampleStates()`

SampleHandle()

This gets the handle of a view associated with sampling. This can be used to position, show and hide the sampling control panel or the output control panel.

```
Func SampleHandle(which%);
```

`which%` Selects which view handle to return:

0	Main file view
1	Sampling control panel
2	Sequencer control panel. This is not implemented in Version 2.00.
3	Pulses configuration dialog
4	States control bar

Returns The view handle or 0 if the view does not exist.

See also: `View(), ViewList(), Window(), WindowVisible()`

SampleKey()

This procedure adds events to the keyboard marker channel, exactly as if you had typed them (with the sampling document view as the current view). If there is no sampling, the procedure does nothing. If the output sequencer is running, and you add a key that corresponds to a key linked to a sequencer step, the sequencer jumps to the step. The output sequencer is not implemented in Version 2.00.

```
Proc SampleKey(key$);
```

`key$` The first character of the string is added to the keyboard marker channel.

See also:`SampleClear(), SampleKeyMark()`

SampleKeyMark()

This function turns the keyboard marker channel on or off or gets the current setting of this from the sampling configuration.

```
Func SampleKeyMark(on%);
```

`on%` If present and non-zero this turns keyboard markers on in the sampling configuration.

Returns 1 if the keyboard channel is on in the sampling configuration, 0 if not.

See also:`SampleKey(), SampleClear()`

SampleLimitFrames()

This function corresponds to the Number of Frames field on the Automation page of the sampling configuration dialog.

```
Func SampleLimitFrames( {limit%} );
```

`limit%` The number of frames to set as a limit. A positive number sets the limit and checks the box (enabling the limit). A negative number sets the limit to the positive time, but clears the check box (so the limit is not used). A value of zero or omitting the argument leaves the time limit unchanged.

Returns The function returns the frames limit as it was at the time of the call. If the limit is disabled, the number of frames is returned negated.

See also:`SampleClear(), SampleLimitSize(),SampleLimitTime(), SampleWrite()`

SampleLimitSize()

This function corresponds to the File size field on the Automation page of the sampling configuration dialog.

```
Func SampleLimitSize( {size} );
```

`size` The size limit for the output file, in KB. A positive value sets the size and enables the limit. A negative value sets the limit to the positive value of size, but disables the limit. A zero value, or omitting the argument, means no change.

Returns The limit before the call. If the limit is disabled, the value is returned negated.

See also:`SampleClear(), SampleLimitFrames(), SampleLimitTime(), SampleWrite()`

SampleLimitTime()

This function corresponds to the Run time field on the Automation page of the sampling configuration dialog.

```
Func SampleLimitTime( {time} );
```

`time`	The time in seconds to set as a limit. A positive time sets the limit and checks the box (enabling the limit). A negative time sets the limit to the positive time, but clears the check box (so the limit is not used). A value of zero, or omitting the argument, leaves the time limit unchanged.
Returns	The function returns the time limit as it was in the sampling configuration at the time of the call. If the limit is disabled, the time is returned negated.
See also:	`SampleClear(), SampleLimitFrames(), SampleLimitSize(), SampleWrite()`

SampleMode()

This function sets and gets the sampling sweep mode as seen in the sampling configuration dialog.

```
Func SampleMode({mode%});
```

`mode%` This argument determines the action of the command:

0	Sets basic post triggered mode
1	Sets peri triggered mode
2	Sets outputs frame mode
3	Sets fixed interval mode
4	Fast triggers mode
5	Fast fixed interval mode
6	For future expansion

Returns The sweep mode from the sampling configuration at the time of the call.

See also: `SampleClear(), SamplePeriType(), SampleFixedInt(), SampleOutLength(), SampleOutTrig()`

SampleOutClock()

This function sets and gets the outputs clock as seen in the sampling configuration dialog Outputs page.

```
Func SampleOutClock({period {, synch%}});
```

`period`	If present, this argument sets the outputs clock period, in seconds. This value sets the time resolution for pulses and sequencer output, for measuring sweep absolute start times, for timing sweeps in Fixed interval mode and for measuring the time of marker data. For the standard 1401, this value should not be less than 10 ms, for a 1401*plus* 3 ms, for a micro1401 0.1 ms, for a Micro1401 mk II 25 microseconds and for a Power1401 10 microseconds.
`synch%`	If present, this sets whether to synchronise pulse outputs to the sampling sweep. A non-zero value is equivalent to checking the "`Synchronise sampling`" box in the sampling configuration dialog.
Returns	The outputs clock period from the configuration at the time of the call.
See also:	`SampleOutMode(), SampleFixedInt(), SampleOutTrig(), Pulses()`

SampleOutLength()

This function sets and gets the length of the pulses output frame; the length of time that pulses are generated, as stored in the pulses information for use in Outputs frame and Fixed interval sweep modes.

```
Func SampleOutLength(state {, length});
```

`state` This sets the state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.

`length` If present, this argument sets the length of the pulses output frame, in seconds.

Returns The pulses output frame length at the time of the call.

See also: `SampleOutMode(), SampleOutTrig(), SampleOutClock(), Pulses(), SampleStates()`

SampleOutMode()

This function sets and gets the outputs mode as seen in the sampling configuration dialog Outputs page.

```
Func SampleOutMode({mode%});
```

`mode%` This argument determines the action of the command:

0	Sets None outputs mode
1	Sets Pulses outputs mode
2	Sets Sequencer outputs mode (not available in version 2.00)
3	For future expansion

Returns The outputs mode from the configuration at the time of the call.

See also: `SampleClear(), Pulses()`

SampleOutTrig()

This function sets and gets the sweep trigger time within the pulses frame as stored in the pulses information for use in Outputs frame and Fixed interval sweep modes.

```
Func SampleOutTrig(state {, time});
```

`state` This sets the state (pulses set) to which this applies, from 0 to 256. Use 0 if multiple states are not in use.

`time` If present, this argument sets the sweep trigger time within the pulses output frame, in seconds. The value should be from 0 to the pulses output frame length.

Returns The sweep trigger time at the time of the call.

See also: `SampleOutLength(), SampleFixedInt(), SampleOutClock(), Pulses(), SampleStates()`

SamplePause()

This function ascertains or sets whether the sampling mode is paused, which is the state of the Pause at sweep end check boxes.

```
Func SamplePause({pause%});
```

`pause%` If present this is equivalent to changing the state the Pause at sweep end check boxes. A non-zero value pauses sampling and zero enables sampling.

Returns If `pause%` is present it returns the new state as 1 or 0, or a negative error code. If `pause%` is absent it returns the current state as 1 or 0.

See also: `SampleSweep(), SampleStart(), SampleStop(), SampleStatus(), SampleWrite(), SampleAbort()`

SamplePeriBitState()

This function gets or selects the state of the digital input bit required to trigger sampling. It is equivalent to the drop-down selection box in the digital peri-trigger sampling configuration.

```
Func SamplePeriBitState({set%});
```

`set%` If present a value of 1 selects Trigger on bit high in the digital peri-trigger sampling configuration. A value of 0 selects Trigger on bit low.

Returns The value for the setting at the time of the call.

See also: `SamplePeriDigBit(), SamplePeriHyst(), SamplePeriLevel(), SamplePeriLowLev(), SamplePeriType(), SamplePeriPoints()`

SamplePeriDigBit()

This function gets or sets the digital bit number in the digital peri-trigger sampling configuration.

```
Func SamplePeriDigBit({bit%});
```

`bit%` If present and in the range 8-15 this sets the new digital bit number in the digital peri-trigger sampling configuration.

Returns The value for the peri-trigger digital bit in the sampling configuration at the time of the call.

See also: `SamplePeriBitState(), SamplePeriHyst(), SamplePeriLevel(), SamplePeriLowLev(), SamplePeriType(), SamplePeriPoints()`

SamplePeriHyst()

This function gets or sets the hysteresis value for triggering from an analogue channel level in the peri-trigger sampling configuration. If used while sampling is in progress, this gets and sets the hysteresis value currently in use.

```
Func SamplePeriHyst({level});
```

`level` If present this sets the new hysteresis value in the peri-trigger sampling configuration or sampling document.

Returns The value for hysteresis in the sampling configuration at the time of the call.

See also: `SamplePeriDigBit(), SamplePeriBitState(), SamplePeriLevel(), SamplePeriLowLev(), SamplePeriType(), SamplePeriPoints()`

SamplePeriLevel()

This function gets or sets the threshold level for triggering from an analogue channel level in peri-trigger mode. In the peri-trigger sampling configuration this is the threshold level for +Analogue and -Analogue peri-trigger types and the upper threshold for =Analogue peri-trigger type. If used while sampling is in progress, this gets and sets the threshold level currently in use.

```
Func SamplePeriLevel({level});
```

`level` If present this sets the peri-trigger threshold level in the sampling configuration or sampling document.

Returns The value for peri-trigger threshold level in the sampling configuration.

See also: `SamplePeriDigBit(), SamplePeriBitState(), SamplePeriHyst(), SamplePeriLowLev(), SamplePeriType(), SamplePeriPoints()`

SamplePeriLowLev()

This function gets or sets the peri-trigger Lower threshold for =Analogue peri-trigger type in the peri-trigger sampling configuration. If used while sampling is in progress, this gets and sets the lower threshold level currently in use.

```
Func SamplePeriLowLev({level});
```

`level` If present this sets the lower threshold for =Analogue peri-trigger type in the peri-trigger sampling configuration or sampling document.

Returns The value for the lower threshold for =Analogue peri-trigger type in the peri-trigger sampling configuration.

See also: `SamplePeriDigBit(), SamplePeriBitState(), SamplePeriHyst(), SamplePeriLevel(), SamplePeriType(), SamplePeriPoints()`

SamplePeriType()

This function gets or sets the type of peri-trigger in the peri-trigger sampling configuration.

```
Func SamplePeriType({pts%});
```

`pts%` If present this sets the type of trigger in the sampling configuration as follows:

0	+Analogue
1	-Analogue
2	=Analogue
3	Digital
4	Event

Returns The trigger type in the sampling configuration at the time of the call.

See also: `SamplePeriDigBit(), SamplePeriBitState(), SamplePeriHyst(), SamplePeriLevel(), SamplePeriLowLev(), SamplePeriPoints()`

SamplePeriPoints()

This function gets or sets the number of data points in the frame before the trigger as given by Pre-trig. points in the Peri-trigger section of sampling configuration.

```
Func SamplePeriPoints({pts%});
```

`pts%` If present this sets the pre-trigger points in the peri-trigger sampling configuration. This can be any negative number or a positive number less than the points per sweep.

Returns The value for pre-trigger points in the peri-trigger sampling configuration.

See also: `SamplePeriDigBit(), SamplePeriBitState(), SamplePeriHyst(), SamplePeriLevel(), SamplePeriLowLev(), SamplePeriType()`

SamplePoints()

This function gets or sets the number of data points per ADC port per frame as given by Frame points in the sampling configuration.

```
Func SamplePoints({pts%});
```

`pts%` If present this sets the number of frame points in the sampling configuration.

Returns The value for frame points in the sampling configuration.

See also: `SampleClear(), SampleRate(), SamplePeriPoints(), SampleTrigger()`

SamplePortFull()

This function gets and sets the Full value for an input port, as shown in the sampling configuration dialog. Complete calibration of a waveform channel requires Full, Zero and Units to be set up correctly.

```
Func SamplePortFull(port% {,full});
```

`port%`	The port number (0-79).
`full`	The value of the data corresponding to the ADC full-scale level (+5 volts or +10 volts for a 10 volt system) at the input.
Returns	The value for the port Full scale value at the time of the call, or zero for illegal port numbers.

See also: `SampleClear(), SamplePorts(), SamplePortOptions$(), SamplePortUnits$(), SamplePortZero()`

SamplePortName$()

This function gets and sets the title attached to a port, as shown in the sampling configuration dialog.

```
Func SamplePortName$(port% {,new$});
```

`port%`	The port number (0-79).
`new$`	If present, the new title. If the title is too long, it is truncated.
Returns	The title at the time of the call, or an empty string for illegal channel numbers.

See also: `SampleClear(), SamplePorts(), SamplePortFull(), SamplePortOptions$(), SamplePortUnits$(), SamplePortZero()`

SamplePortOptions$()

This function gets and sets the online processing options attached to a waveform input port setup, as shown in the sampling configuration dialog.

```
Func SamplePortOptions$(port% {,new$});
```

`port%`	The port number (0-79).
`new$`	If present, the new options string, up to seven characters long. If the string is too long it will be truncated.
Returns	The options string at the time of the call, or an empty string for illegal channel numbers.

See also: `SampleClear(),SamplePortFull(), SamplePorts(), SamplePortName$(), SamplePortUnits$(), SamplePortZero()`

SamplePorts()

This function gets or sets the ADC ports, as shown in the sampling configuration.

```
Func SamplePorts({get%[]|num%{,new%[]}});
```

`num%`	If present this sets the number of ADC ports to take from the `new%` array. If `new%` is not present the new ADC ports will be `0..num%-1`.
`get%[]`	If present as a single argument this is filled with ADC ports from the sampling configuration up to the size of the array. If there are insufficient ports to fill the array the unused entries are left unchanged.
`new%[]`	If present this holds the new ADC ports for the sampling configuration. The number of new ADC ports will be restricted by the size of `num%` or by the size of this array whichever is the smaller.
Returns	The number of ADC ports at the time of the call.

See also: `SampleClear(), SamplePortFull(), SamplePortName$(), SamplePortOptions$(), SamplePortUnits$(), SamplePortZero()`

SamplePortUnits$()

This function gets and sets the units for an input port, as shown in the sampling configuration dialog. Complete calibration of a waveform channel requires Full, Zero and Units to be set up correctly.

```
Func SamplePortUnits$(port% {,new$});
```

`port%`	The port number (0-79).
`new$`	The units to use. If the string is longer than 7 characters only the first 7 are used.
Returns	The units at the time of the call, or an empty string for illegal channel numbers.

See also: `SampleClear(), SamplePorts(), SamplePortFull(), SamplePortOptions$(), SamplePortZero()`

SamplePortZero()

This function gets and sets the Zero value for an input port, as shown in the sampling configuration dialog.

```
Func SamplePortZero(port% {,zero});
```

`port%`	The port number (0-79).
`zero`	The value of the data corresponding to a zero-volt input at the ADC.
Returns	The value for the port zero value at the time of the call, or zero for illegal port numbers.

See also: `SampleClear(), SamplePorts(), SamplePortFull(), SamplePortUnits$(), SamplePortOptions$()`

SampleProtocol()

This function is used during sampling to select the protocol to use from the protocols defined in the sampling configuration.

```
Func SampleProtocol(num|name$);
```

num	The protocol number to use, from 1 to the number returned by `Protocols()`.
name$	The name of the protocol to use.
Returns	The number of the protocol in use before this call or a negative error code.

See also: `Protocols(), ProtocolName$(), SampleState()`

SampleRate()

This function gets the sample rate in Hz from the sampling configuration and optionally sets it to a new preferred value.

```
Func SampleRate({new});
```

`new`	If present, the new preferred rate in Hz. The actual sampling rate used will be as close as possible to new Rate, but it will not always match exactly.
Returns	The sampling rate before the call. This is the actual sampling rate that will be used, not the preferred rate.

See also: `SampleClear(), SamplePoints(), SampleTrigger(), SampleBurst(), BinSize()`

SampleReset()

This function can be used while sampling is in progress to abandon sampling, deleting any data that has been written to disk, and return to the state as if `FileNew()` had just been used to create a new data file.

```
Func SampleReset();
```

Returns 0 if the reset operation completed without a problem, or a negative error code.

See also: `SampleAbort(), SampleStart(), SampleStop(), SampleStatus(), SampleWrite(), SamplePause()`

SampleStart()

This function can be used after `FileNew()` has created a new file view based on the current sampling configuration. It starts sampling immediately or on a 1401 event trigger.

```
Func SampleStart({trig%});
```

`trig%` If this is 0 or omitted, sampling starts immediately, otherwise sampling waits for a trigger signal on the 1401 E1 input.

Returns 0 if all went well or a negative error code.

See also: `SampleAbort(), SampleReset(), SampleStop(), SampleStatus(), SampleWrite(), SamplePause()`

SampleState()

This function is used during sampling to directly set the current state; it is the scripting equivalent of controlling the state manually with the states control bar. The command should be used with states sequencing set to Manual, or the values set will be overridden by the sampling system.

```
Func SampleState(num);
```

num The state to use, from 0 to 256.

Returns The state in use before this call or a negative error code.

See also: `SampleStatesOrder(), SampleStatesRun(), SampleStates()`

SampleStateDac()

This function gets the dac output value for a specific state from the sampling configuration and optionally sets it to a new value.

```
Func SampleStateDac(state, port {, new});
```

`state` The state for which information is required, from 0 to 256.

port The DAC number, from 0 to 3.

`new` If present, sets the value to be output to the DAC for this state in Static outputs states mode.

Returns The DAC output value before the call.

See also: `SampleStatesMode(), SampleStates(), SampleState(), SampleDacMask(), SampleDacFull(), SampleDacZero()`

SampleStateDig()

This function gets the value to be written to the digital outputs for a specific state or the value read from the digital inputs to set a state and optionally sets it to a new value.

```
Func SampleStateDig(state {, new});
```

`state`	The state for which information is required, from 0 to 256.
`new`	If present, sets the value to be written to the digital outputs for this state in Static outputs states mode, or the value used to test the digital input data in External digital states mode..
Returns	The digital output or input value before the call.

See also:`SampleStatesMode(), SampleStates(), SampleState(), SampleDigOMask(), SampleDigIMask()`

SampleStateRepeats()

This function gets the number of repeats for a specific state from the sampling configuration and optionally sets it to a new value.

```
Func SampleStateRepeats(state {, new});
```

`state`	The state for which information is required, from 0 to 256.
`new`	If present, sets the number of times the state is repeated in Numeric and Random ordering mode if individual repeats is enabled.
Returns	The number of repeats before the call.

See also:`SampleStateRepeats(), SampleStates(), SampleState()`

SampleStates()

This function gets the number of extra states from the sampling configuration and optionally sets it to a new value.

```
Func SampleStates({new});
```

`new`	If present, the new number of extra states. Values from 1 to 256 set the states and turn on multiple states mode, a value of zero turns off multiple states.
Returns	The number of extra states before the call, or zero if multiple states were disabled.

See also:`SampleStatesMode(), SampleStatesOrder(), SampleState()`

SampleStatesIdle()

This function gets the count of states ordering cycles before idling from the sampling configuration and optionally sets it to a new value.

```
Func SampleStatesIdle({idle%});
```

`idle%`	If present, this sets the number of cycles of states using Numeric or Random state sequencing before idling, a zero value means keep cycling forever. This parameter is ignored for protocol ordering.
Returns	The states cycles before idling before the call.

See also:`SampleStates(), SampleStatesMode(), SampleStatesOrder(), SampleState(), SampleProtocol(), ProtocolFlags()`

SampleStatesMode()

This function gets the mode for multiple states from the sampling configuration and optionally sets it to a new value.

```
Func SampleStatesMode({new});
```

`new` If present, sets the new multiple states mode as follows:

0	External digital	1	Static outputs	2	Dynamic outputs

Returns The mode for multiple states before the call.

See also: `SampleStates(), SampleStatesOrder(), SampleState()`

SampleStatesOrder()

This function gets the ordering mode for multiple states from the sampling configuration and optionally sets it to a new value.

```
Func SampleStatesOrder({new%});
```

`new%` If present, this sets the new multiple states ordering mode as follows:

0	Numeric	1	Random	2	Protocol	3	Semi-random

Returns The states ordering mode before the call.

See also: `SampleStates(), SampleStatesIdle(), SampleStatesMode(), SampleState(), SampleProtocol(), ProtocolFlags()`

SampleStatesRepeats()

This function gets the number of times each state is repeated from the sampling configuration and optionally sets it to a new value, or selects individual repeats mode.

```
Func SampleStatesRepeats({new});
```

`new` If present and non-zero, disables individual repeats and sets the number of times each state is repeated in Numeric and Random ordering mode, a value of zero turns on individual repeats.

Returns The number of repeats before the call, or zero if individual repeats were enabled.

See also: `SampleStateRepeats(), SampleStatesOrder(), SampleState()`

SampleStatesReset()

This function is used during sampling to reset the states sequencing system and the pulses built-in varations; it is the scripting equivalent of pressing the Reset button on the states control bar.

```
Func SampleStatesReset();
```

Returns zero or a negative error code.

See also: `SampleStatesOrder(), SampleStatesRun(), SampleStates()`

SampleStatesRun()

This function is used during sampling to set the seqencing execution mode; the scripting equivalent of using the Manual, On write or Cycle buttons on the states control bar.

```
Func SampleStatesRun(mode);
```

mode The mode of sequencing to use, as follows:

0	Manual or direct script control of states
1	Sequencer runs, moves to next state if data written
2	Sequencer runs, moves to next state unconditionally

Returns The state sequencing mode in use before this call or a negative error code.

See also:`SampleStatesOrder(), SampleStatesReset(), SampleState()`

SampleStatus()

This function enquires about the state of any sampling.

```
Func SampleStatus();
```

Returns A code indicating the sampling state or -1 if there is no sampling:

0	A file view is ready to sample, but it has not been told to start yet
1	Sampling is waiting for an Event 1 trigger
2	Sampling of a sweep is now in progress
3	Sampling is paused at the end of a sweep
4	Sampling is stopped but not finished (changes to -1 when it has finished)

See also: `SampleAbort(), SampleReset(), SampleStart(), SampleStop(), SampleWrite(), SamplePause()`

SampleStop()

This function stops sampling in progress and is equivalent to using the Stop and Finish buttons of the sampling control panel. The default behaviour is that there is no intermediate state between stopping and finishing when sampling is stopped by using this function. The function does not return until sampling has stopped.

```
Func SampleStop({noFin%});
```

`NoFin%` If present and non zero then sampling will stop but not finish. `SampleSweep()` may then be used to continue sampling.

Returns 0 if sampling stopped correctly or a negative error code.

See also: `SampleAbort(),SamplePause(), SampleReset(), SampleStart(),SampleStatus(), SampleSweep(), SampleWrite()`

SampleSweep()

If sampling is paused at the end of a sweep, or stopped but not finished because a limit was reached, this starts sampling of the next sweep. The current sweep will be lost if it is unsaved. This function is the equivalent of the Continue button in the sampling control panel (or More when sampling is stopped).

```
Func SampleSweep();
```

Returns 0, or a negative error code.

See also: `SamplePause(), SampleReset(), SampleStart(), SampleStop(), SampleWrite()`

SampleTrigger()

This function gets or sets the external trigger option in the sampling configuration.

```
Func SampleTrigger({trig%});
```

`trig%` If this is non-zero sampling of each frame waits for a trigger input. Zero turns trigger mode off.

Returns 0 or 1, or a negative error code.

See also: `SampleClear(), SampleRate(), SampleSweep(), SamplePoints(), SampleStatus()`

SampleWrite()

This function controls the automatic writing of data to the file during sampling and is equivalent to the Write to disk at sweep end check boxes.

```
Func SampleWrite({write%});
```

`write%` If present this sets the state of automatic writing of data at the end of each sweep,

0 Disable writing to disk at the end of each sweep
1 Enable writing to disk at the end of each sweep

Returns The state of automatic writing to file at the end of each sweep: 0 for disabled, 1 for enabled

See also:`SampleClear(), SamplePause(), SampleSweep(), SampleStatus()`

ScriptBar()

This controls the Script toolbar. Call the command with no arguments to return the number of toolbar buttons. The first button is numbered 0.

```
Func ScriptBar({nBut%{, &get$}});
Func ScriptBar(set$);
```

`nBut%` Set –1 and omit `get$` to clear all buttons and return 0. Otherwise it is a button number and returns -1 if the button does not exist, 0 if it is the last button, and 1 if higher numbered buttons exist. `get$` returns the information as for `set$`.

`set$` This holds up to 8 characters of button label, a vertical bar, the path to the script file including `.sgs`, a vertical bar and a pop-up comment. The function returns the new number of buttons or -1 if all buttons are already used.

Returns See the descriptions above. Negative return values indicate an error.

For example, the following code clears the script bar and sets a button:

```
ScriptBar(-1);    'clear all buttons
ScriptBar("ToolMake|C:\\Scripts\\ToolMake.sgs|Build a toolbar");
```

See also:`App()`

ScriptRun()

This sets the name of a script to run when the current script terminates. You can pass information to the new script using disk files or by using the `Profile()` command. You can call this function as often as you like; only the last use has any effect.

```
Proc ScriptRun(name${, flags%});
```

`name$` The script file to run. You can supply a path relative to the current folder or a full path to the script file. If you supply a relative path, it must still be valid at the end of the current script. Set `name$` to `""` to cancel running a script.

`flags%` Optional flags that control the new script. If omitted, 0 is used. The only flag defined now is 1 = run new script even if the current script ends in an error.

If the file you name does not exist when Signal tries to run it, nothing happens. If the nominated script is not already loaded, Signal will load it, run it and unload it.

See also:`App(), Profile()`

Seconds()

This sets or gets the timer in seconds and is used for relative time measurements. If you want the position reached in the current sweep, use the `Maxtime()` function.

```
Func Seconds({set});
```

`set` If present, this sets the time in seconds.

Returns The time in seconds. If you have not used the set call, the time is the time since the Signal system was started. If the `set` argument is present in the call, the value returned is the value before the new time was set.

See also:`MaxTime()`

Selection$()

This function returns the text in the current view that is currently selected, that is the text that would be copied to the clipboard if the Edit menu Copy command was used.

```
Func Selection$();
```

Returns The current text selection. If there is no text selected, or if the view is inappropriate for this action, an empty string is returned.

SerialClose()

This function closes a serial port opened by `SerialOpen()`. Closing a port releases memory and system resources. Ports are automatically closed when a script ends, however it is good practice to close a port when your script has finished with it.

```
Func SerialClose(port%);
```

`port%` The serial port to close as defined for `SerialOpen()`.

Returns 0 or a negative error code

See also:`SerialOpen()`, `SerialWrite()`, `SerialRead()`, `SerialCount()`

SerialCount()

This counts the characters or items buffered in a serial port opened by `SerialOpen()`. Use this to detect input so your script can do other tasks while waiting for serial data. There is an internal buffer (belonging to Signal) of 1024 characters per port that is filled when you use `SerialCount`. The size of this buffer limits the number of characters that this function can tell you about. To avoid character loss when you are not using a serial line handshake, do not buffer up more than a few hundred characters with `SerialCount`.

```
Func SerialCount(port% {,term$});
```

`port%` The serial port to use as defined for `SerialOpen()`.

`term$` An optional string holding the character(s) that terminate an input item.

Returns If `term$` is absent or empty, this returns the number of characters that could be read. If `term$` is set, this returns the number of complete items that end with `term$` that could be read.

See also:`SerialOpen()`, `SerialWrite()`, `SerialRead()`, `SerialClose()`

SerialOpen()

This function opens a serial port and configures it for use by the other serial line functions. It is not an error to call `SerialOpen` more than once on the same port. The serial routines use the host operating system serial line support. Consult your system documentation for information on serial line connections and baud rates limit.

```
Func SerialOpen(port%{, baud%{, bits%{, par%{, stop%{, hsk%}}}}});
```

`port%`	The serial port to use in the range 1 to 9. The number of ports depends on the computer. Two ports (1 and 2) are common on both PC and Macintosh systems.
`baud%`	This sets the serial line Baud rate (number of bits per second). The maximum character transfer rate is of order one-tenth this figure. All standard rates from 50 to 115200 Baud are supported. If you do not supply a Baud rate, 9600 is used.
`bits%`	The number of data bits used to encode a character. Windows supports 4 to 8 bits, the Macintosh supports 7 or 8. If `bits%` is omitted, 8 is set. Apart from very specialised use, standard values are 7 or 8 data bits. If you set 7 data bits, character codes from 0 to 127 can be read. If you set 8 data bits, codes from 0 to 255 are possible.
`par%`	Set this to 0 for no parity check, 1 for odd parity or 2 for even parity. If you do not specify this argument, no parity is set.
`stop%`	This sets the number of stop bits as 1 or 2. If omitted, 1 stop bit is set. If you specify 5 data bits, a request for 2 stop bits results in 1.5 stop bits being used.
`hsk%`	This sets the handshake mode, sometimes called “flow control”. 0 sets no handshake, 1 sets a hardware handshake, 2 sets XON/XOFF protocol.
Returns	0 or a negative error code.

See also:`SerialWrite()`,`SerialRead()`,`SerialCount()`,`SerialClose()`

SerialRead()

This function reads characters, a string, an array of strings, or binary data from a nominated serial port that was previously opened with `SerialOpen()`. Binary data can include character code 0, string data never includes character 0.

```
Func SerialRead(port%, &in$|in$[]|&in%|in%[]{,term${, max%}});
```

`port%`	The serial port to read from as defined for `SerialOpen()`.
`in$`	A single string or an array of strings to fill with characters. There is no point providing an array of strings unless you have set a terminator as without a terminator all input goes to the first string in the array.
`in%`	A single integer (`term$` and `max%` are ignored) or an array of integers (`term$` and `max%` can be used) to read binary data. Each integer can hold one character, coded as 0 up to 255. The function returns the number of characters returned.
`term$`	If this is an empty string or omitted, all characters read are input to the string, integer array or to the first string in the string array and the number of characters read can be limited by `max%`. The function returns the number of characters read. If this is not empty, the contents are used to separate data items in the input stream. Only complete items are returned and the terminator is not included. For example, set the terminator to `"\n"` if lines end in line feed, or to `"\r\n"` if input lines end with carriage return then line feed. If `in$` is a string, one item at most is returned. If `in$[]` is an array, one item is returned per array element. The function returns the number of items read unless `in` is an integer when the function returns the number of characters returned.
`max%`	If present, it sets the maximum number of characters to read into each string or into the integer array. If a terminator is set, but not found after this many characters, the function breaks the input at this point as if a terminator had been found. There is a maximum limit set by the size of the buffers used by Signal to process data and by the size of the system buffers used outside Signal. This is typically 1024 characters.
Returns	The function returns the number of characters or items read or a negative error code. If there is nothing to read, it waits 1 second for characters to arrive before timing out and returning 0. Use `SerialCount()` to test for items to read to avoid hanging up Signal.

See also:`SerialOpen()`, `SerialWrite()`, `SerialCount()`, `SerialClose()`

SerialWrite()

This writes one or more strings or binary data to a serial port opened by `SerialOpen()`.

```
Func SerialWrite(port%, out$|out$[]|out%|out%[]{, term$});
```

`port%`	The serial port to write to as defined for `SerialOpen()`.
`out$`	A single string to write to the output or an array of strings to write.
`out%`	A single integer or an array of integers to write as binary. The maximum value writeable depends on the number of data bits set for the port; 7-bit data wriites as `out% band 127`, 8-bit data writes as `out% band 255`.
`out%[]`	An array of characters to write, stored one per integer.
`term$`	If present, it is written to the output port after the contents of `out%`, `out%[]` or `out$` or after each string in `out$[]`.
Returns	The number of strings or binary characters written or a negative error code. If the output system becomes full, the function waits for one second before timing out. If a time-out occurs, the function returns the number of strings sent before the time-out.

See also:`SerialOpen()`, `SerialRead()`, `SerialCount()`, `SerialClose()`

SetXXX() commands

This family of commands creates memory view windows. Memory views which require processing are derived from and attached to the current data view, which should be a file view. This does not apply to `SetCopy()` and `SetMemory()` which create memory views that do not use a `Process` command. The `SetTrend()` function is special in that it creates an XY view which will receive data points from processing a source view which can be either a file or a memory view. The `SetXXX()` functions do not update the display, for which you should use `Draw()` or `DrawAll()`.

All these functions return a positive view handle if they succeed or a negative error code. Possible errors are: Bad channel number, illegal number of bins and out of memory.

The new derived memory view will be empty until a processing command is executed for it. The processing of a memory view takes data from the source data view and replaces or adds to the data in the memory view.

When these functions create a new view, it is made the current view. The view is created invisibly and must be made visible with `WindowVisible(1)` before it will appear.

See also: `Process(), ProcessAll(), ProcessFrames(), SetAutoAv(), SetAverage(), SetLeak(), SetPower(), SetTrend(), SetCopy(), SetMemory()`

SetAmplitude()

This function creates a memory view to hold an amplitude histogram in each channel when it is processed. `Sweeps()` reports the number of sweeps of waveform data accumulated by processing into the memory view. The current view when `SetAmplitude()` is called will be the source view for the data to be processed. In this version of Signal the source view can not be a memory view.

```
Func SetAmplitude(ch%, bins% {, minAmp{, maxAmp{, sTime|sTime$
                                              {, eTime|eTime$}}});
```

`ch%`	A waveform channel to analyse from the current view. Use a channel number (1 to n), or -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.
`bins%`	The number of bins in the resulting histogram.
`minAmp`	The smallest amplitude to be represented in the histogram.
`maxAmp`	The largest amplitude to be representred in the histogram.
`sTime`	The start time of the data to be included in the analysis.
`sTime$`	A sting giving the start time of the data to be included in the analysis eg “Cursor(1)”.
`eTime`	The end time of the data to be included in the analysis.
`eTime$`	A sting giving the end time of the data to be included in the analysis eg “Cursor(2)”.
Returns	The function returns a handle for the new view, or a negative error code.

See also: `SetXXX(), Process(), ProcessAll(), ProcessFrames(), Sweeps(), View()`

SetAutoAv()

This function creates a memory view to hold a sum or average in each channel when it is processed. The memory view will hold multiple frames, with set numbers of source frames being averaged into each destination frame. This allows you to set up averaging with, for example, every ten source frames processed into a new average. The amount moved-on between averages can be separately controlled for extra flexibility. The current view when `SetAutoAv()` is called will be the source view for the data to be processed. In this version of Signal the source view can not be a memory view. `SetAutoAv()` is very similar to `SetAverage()`.

```
Func SetAutoAv(ch%|list%[]|ch$, perAv%, betAv%{, width, offs
                    {, sum%{ ,xzero%{, cntExc%{, doErrs%}}}}});
```

`ch%`	A waveform channel to analyse from the current view. Use a channel number (1 to n), or -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.
`ch$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
`list%[]`	As an alternative to `ch%` or `ch$`, you can pass in a channel list (as constructed by `ChanList()`). This must be an array of waveform channels with the first element of the array holding the number of channels in the list.
`perAv%`	The number of source frames to use per average.
`betAv%`	The number of source frames between the first frame for one average and the first frame for the next. If `perAv%` is the same as `betAv%`, then each `perAv%` frames processed make a new average frame. If `betAv%` is less than `perAv%`, then some source frames are used for more than one average, if it is greater than `perAv%` then some source frames will be unused.
`width`	The width of the average in x axis units. If omitted the whole frame will be used. The maximum is limited by available memory.
`offs`	This sets the offset in x axis units from start of frame to the start of the data to average. If omitted or zero, the data will be taken from the start of the frame.
`sum%`	If present and non-zero, each channel in the memory view will hold the sum of the data accumulated. If omitted or zero, the memory view channels will hold the mean of the data accumulated.
`xzero%`	If present and non-zero, this forces the x axis of the memory view to start at zero. If omitted or zero, the start of the x axis will be the same as the start of the data that is averaged.
`cntExc%`	If present and non-zero, excluded frames will count as if they had been added so Signal will not continue to search for enough frames to form each average and remain in step with the sampling protocol.
`doErrs%`	If present and set to 1 then error bar information will be generated.

Returns The function returns a handle for the new view, or a negative error code.

See also: `SetXXX(), SetAverage(), Process(), ProcessAll(), ProcessFrames(), Sweeps(), View(), MinTime()`

SetAverage()

This function creates a memory view to hold a sum or average in each channel when it is processed. `Sweeps()` reports the number of sweeps of waveform data accumulated by processing into the memory view. The current view when `SetAverage()` is called will be the source view for the data to be processed. In this version of Signal the source view can not be a memory view.

```
Func SetAverage(ch%|list%[]|ch${, width, offs{, sum%{, xzero%{,
doErrs%}}}});
```

`ch%`	A waveform channel to analyse from the current view. Use a channel number (1 to n), or -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.
`ch$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
`list%[]`	As an alternative to `ch%` or `ch$`, you can pass in a channel list (as constructed by `ChanList()`). This must be an array of waveform channels in the current data view, with the first element of the array holding the number of channels in the list.
`width`	The width of the average in x axis units. If omitted the whole frame will be used. The maximum is limited by available memory.
`offs`	This sets the offset in x axis units from start of frame to the start of the data to average. If omitted or zero, the data will be taken from the start of the frame.
`sum%`	If present and non-zero, each channel in the memory view will hold the sum of the data accumulated. If omitted or zero, the memory view channels will hold the mean of the data accumulated.
`xzero%`	If present and non-zero, this forces the x axis of the memory view to start at zero. If omitted or zero, the start of the x axis will be the same as the start of the data to average, as defined by offset `offs` from `MinTime()` in the current frame.
`doErrs%`	If present and set to 1 then error bar information will be generated.

Returns The function returns a handle for the new view, or a negative error code.

See also:`SetXXX(), SetAutoAv(), Process(), ProcessAll(), ProcessFrames(), Sweeps(), View(), MinTime()`

SetCopy()

This function creates a new memory view with channels selected from and identical to those in the current view. The new view can be empty or contain data copied from the current frame. It is attached to no source view and has no implied `Process()`.

```
Func SetCopy(chan%|list%[]|chan$, title$, bcopy%);
```

`chan%`	A channel from the current view to include in the new view. Use a channel number (1 to n), or -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.
`chan$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
`list%[]`	As an alternative to `chan%` or `chan$`, you can pass in a channel list (as constructed by `ChanList()`). This must be an array of channels in the current data view, with the first element of the array holding the number of channels in the list.
`title$`	The new window title.

`bcopy%`	If this is not 0 the data values are copied into the new memory view. If this is 0 the waveform data values in the new view are zero and marker channels are empty.
Returns	Handle for the new view, or a negative error code.

See also:`SetXXX(), SetMemory(), View()`

SetLeak()

This function creates a memory view to hold leak subtracted data when it is processed. The current view when `SetLeak()` is called, which must be a file view, will be the source view for the data to be processed.

```
Func SetLeak(mode%, chan%, stim%, base|base$, pulse|pulse$, width,
                                   form%, sub%{, zero%{, cntExc%}});
```

`mode%`	A value to set the leak subtraction mode: 0 for Basic, 1 for P/N or 2 for States.
`chan%`	A single waveform channel from the current view, this is the channel that will be leak-subtracted, all other source channels are copied unchanged. Use a channel number (1 to n).
`stim%`	A single waveform channel from the current view, this is the channel that will be used to measure the stimulus pulse size. Normally this will be a channel on which the stimulus was recorded.
`base`	A time at which the baseline level can be measured; a time outside the stimulus pulse.
`base$`	The baseline level time expressed as a string, allowing constructs such as “Cursor(1) - 10”.
`pulse`	A time at which the pulse level can be measured; a time inside the stimulus pulse.
`pulse$`	The pulse time expressed as a string.
`width`	The width of the two level measurements, the measurement used is the average of all waveform points within the specified width.
`form%`	The first frame used to measure the leak in Basic mode, the number of frames to use for the leak in P/N mode and the state code for leak frames in States mode.
`sub%`	The last frame used to measure the leak in Basic mode, the number of frames to subtract the current leak from in P/N mode. This parameter is unused in States mode.
`zero%`	If present and non-zero, the baseline level will be maintained constant by the leak subtraction process, otherwise this adjustment is not done.
`cntExc%`	If present and non-zero, excluded frames will count as if they had been used so Signal will not continue to search for enough frames to form each leak and so remain in step with the sampling protocol.
Returns	The function returns a handle for the new view, or a negative error code.

See also:`SetXXX(), FrameState(), SetPower(), Process(), ProcessAll(), ProcessFrames(), View()`

SetMemory()

This function creates a memory view of user-defined type, attached to no source view and with no implied `Process()`.

```
Func SetMemory(chans%, pts%, binsz, offset, marks%, tmks%,
                             mkBns%, title$, xU${, yU${, xT${, yT$}}});
```

`chans%`	The number of waveform channels in the view.
`pts%`	The number of data points in each waveform channel.
`binsz`	The x axis increment per point in the waveform channels, this is equivalent to the sample interval for sampled data. This value should be positive and non-zero.
`offset`	The x axis value at the first point of the waveform channels.
`marks%`	The number of marker channels in the view, not including text markers.
`tmks%`	The number of text marker channels in the view. Not implemented yet.
`mkBns%`	The number of marker items in each marker channel.
`title$`	The new window title.
`xU$`	The x axis units.
`yU$`	Optional, y axis units, blank if omitted.
`xT$`	Optional, x axis title (otherwise blank).
`yT$`	Optional, y axis title (otherwise blank).
Returns	The function returns a handle for the new view, or a negative error code.

See also:`SetXXX(), SetCopy(), View()`

SetPower()

This function creates a memory view to hold a power spectrum in each channel when it is processed. `Sweeps()` reports the number of sweeps accumulated by processing into the memory view. The current view when `SetPower()` is called will be the source view for the data to be processed. In this version of Signal the source view cannot be a memory view.

```
Func SetPower(chan%|list%[]|chan$, fftsz%{, offset});
```

`chan%`	A waveform channel to analyse from the current view. Use a channel number (1 to n), or -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels.
`chan$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
`list%[]`	As an alternative to `chan%` or `chan$`, you can pass in a channel list (as constructed by `ChanList()`). This must be an array of waveform channels in the current data view, with the first element of the array holding the number of channels in the list.
`fftsz%`	The size of the transform used in the FFT. This must be a power of 2 in the range 16 to 4096. The memory view has half this number of bins. The width of each bin is the sampling rate of the channel divided by `fftsz%`. Each block of `fftsz%` data points processed increments the value for `Sweeps()`.
`offset`	This sets the offset in x axis units from start of frame to the start of the data to analyse. If omitted or zero, the data will be taken from the start of the frame.
Returns	The function returns a handle for the new view, or a negative error code.

See also:`SetXXX(), SetAverage(), ArrFFT(), Process(), Sweeps(), View()`

SetTrend()

This function creates an XY view to hold XY points calculated by processing. The current view when `SetTrend()` is called, which can be a file or memory view, will be the source view for the data to be processed. The `SetTrend` function creates an XY view with a single channel, more channels can be added using `SetTrendChan()`.

```
Func SetTrend(name$, xtyp%, xc%, xp|xp$, xb|xb$, xw, ytyp%, yc%,
                                    yp|yp$, yb|yb$, yw {, pts%});
```

`name$`	The name of the channel. The channel name is shown in the XY key area.
`xtyp%`	The type of measurement to take for the X part of each point. The possible values are:

```
0    Value at a point
1    Value difference between points
2    Time at a point
3    Time difference between points
4    Frame number
5    Absolute time of frame
6    Frame state value
7    Fit coefficient
8    User entered value
9    Curve area between points
10   Mean between points
11   Slope between points
12   Area between points
13   Sum between points
14   Modulus between points
15   Maximum value between points
16   Minimum value between points
17   Amplitude value between points
18   RMS Amplitude value between points
19   Standard dev. value between points
20   Absolute maximum value between points
21   Peak found between points
22   Trough found between points
```

`xc%`	A single waveform channel from the current view, this is the channel that will be used to take the X measurement. Use a channel number (1 to n). For type 7 this is the coefficient index.
`xp`	The time for single-point X measurements and difference measurements. For measurements between points, this is the end time.
`xp$`	The time for single-point X measurements and difference measurements expressed as a string. This allows constructs such as "Cursor(1) - 10". To be used.
`xb`	The reference time for difference measurements, for measurements between points, this is the start time.
`xb$`	The reference time for difference measurements expressed as a string.
`xw`	The width used for some measurements, particularly value at point and value difference.
`ytyp%`	The type of measurement to take for the Y part of each point. The possible values are the same as for `xtyp%`.
`yc%`	A single waveform channel from the current view, this is the channel that will be used to take the Y measurement. Use a channel number (1 to n). For type 7 this is the coefficient index.
`yp`	The time for single-point Y measurements and difference measurements. For measurements between points, this is the end time.
`yp$`	The time for single-point Y measurements and difference measurements expressed as a string. This allows constructs such as "Cursor(1) - 10". To be used.

`yb`	The reference time for difference measurements, for measurements between points, this is the start time.
`xb$`	The reference time for difference measurements expressed as a string.
`yw`	The width used for some measurements, particularly value at point and value difference.
`pts%`	The number of points for this channel before they are recycled. If this is omitted or set to zero, all points are simply added.

Returns The function returns a handle for the new view, or a negative error code.

See also:`SetXXX(), FrameState(), FrameAbsStart(), ChanMeasure(), SetTrendChan(), Process(), ProcessAll(), ProcessFrames()`

SetTrendChan()

This function adds another channel to an XY view created using `SetTrend()`. The current view when `SetTrendChan()` is called must be the XY view to be modified. The `SetTrendChan` function can be used to create XY views with up to 32 channels.

```
Func SetTrendChan(name$, xtyp%, xc%, xp|xp$, xb|xb$, xw, ytyp%,
                                    yc%, yp|yp$, yb|yb$, yw {, pts%});
```

All of the parameters to `SetTrendChan()` are exactly the same as for `SetTrend()`.

Returns The function returns zero or a negative error code.

See also:`SetXXX(), FrameState(), FrameAbsStart(), ChanMeasure(), SetTrend(), Process(), ProcessAll(), ProcessFrames()`

ShowBuffer()

This function gets or sets the show frame buffer flag from the current view.

```
Func ShowBuffer({yes%});
```

`yes%` If this is non-zero the frame buffer is shown otherwise the current frame data is shown. If this is omitted, no change is made.

Returns The buffer show flag at the time of the call.

See also:BuffXXX`(), Frame()`

ShowFunc()

This function draws a function over a data channel.

```
Func ShowFunc(func%, chan% {, start, coefs[]});
```

`func%` The type of the function to show:

0	Don't show a function
1	Single exponential
2	Double exponential
3	Single gaussian
4	Double gaussian

`chan%` The channel on which to show the function.

`start` The time to start drawing from.

`coefs` The coefficients to use in drawing the function.

Returns The function returns zero or a negative error code.

See also:`FitExp(), FitGauss()`

Sin()

This function calculates the sine of an angle in radians, or converts an array of angles into an array of sines.

```
Func Sin(x|x[]);
```

`x` The angle, expressed in radians, or a real array of angles. The best accuracy of the result is obtained when the angle is in the range -2**pi** to 2**pi**.

Returns When the argument is an array, the function replaces the array data with the sines of the data points and returns either a negative error code or 0 if all was well.

When the argument is not an array the function returns the sine of the angle.

See also:`ATan(), Cos(), Tan()`

Sound()

This has two variants. The first plays a tone of set pitch and duration in Windows NT and a short "beep" in Windows 95. The second plays a `.WAV` file or system sound if your system has multimedia support. The `.WAV` output was added at version 2.05.

```
Func Sound(freq%, dur{, midi%});                    Tone output
Func Sound(name${, flags%);             Multimedia sound output
```

`freq%` If `midi%` is 0 or omitted this holds the sound frequency in Hz. If `midi%` is non-zero this is a MIDI value in the range 1-127. A MIDI value of 60 is middle C, 61 is C# and so on. Add or subtract 12 to change the note by one octave.

`dur` The sound duration, in seconds. The script stops during output.

`midi%` If this is present and non-zero, the frequency is interpreted as a MIDI value, otherwise it is a frequency in Hz.

`name$` Either the name of `.wav` file or the name of a system sound. You can either supply the full path to the file or just a file name and the system will search for the file in the current directory, the Windows directory, the Windows system directory, directories listed in the `PATH` environmental variable and the list of directories mapped in a network. If no file extension is given, `.wav` is assumed. The file must be short enough to fit in available physical memory, so this function is suitable for files of a few seconds duration only.

A blank name halts sound output. If `name$` is any of the following (case is important), a standard system sound plays:

`"S*"`	Asterisk	`"SS"`	System start	`"SE"`	System exit
`"S?"`	Query	`"SW"`	System welcome	`"SD"`	System default
`"SH"`	Hand	`"S!"`	System exclamation		

`flags%` This optional argument controls how the data is played. It is the sum of the following values (given in hexadecimal and decimal):

0x0001	1	Play asynchronously (start output and return). Without this flag, Signal does nothing (including sampling) until replay ends.
0x0002	2	Silence when sound not found. Normally `Sound()` plays the system default sound if the nominated sound cannot be found.
0x0008	8	Loop sound until stopped by another Sound command. You must also supply the asynchronous flag if you use loop mode.
0x0010	16	Don't stop a playing sound. Normally, unless the "No wait" flag is set, each command cancels any playing sound.
0x2000	8192	No wait if sound is already playing. `Sound("",0x2010)` can be used to detect if a previous asynchronous sound has finished.

If you don't supply this argument, the flag value is set to 0x2000.

Returns The tone output returns 0 or a negative error code. The multimedia output returns non-zero if the function succeeded and zero if it failed.

Sqrt()

Forms the square root of a real number or an array of real numbers. Negative numbers cause the script to halt with an error when x is not an array. With an array, negative numbers are set to 0 and an error is returned.

```
Func Sqrt(x|x[]);
```

`x`	A real number or a real array to replace with an array of square roots.
Returns	With an array, this returns 0 if all was well, or a negative error code. With an expression, it returns the square root of the expression.

Str$()

This converts a number to a string.

```
Func Str$(x {,width% {,decs%}});
```

`x`	A number to be converted.
`width%`	Optional minimum field width. The number is right justified in this width.
`decs%`	Optional number of decimal places.
Returns	A string holding a representation of the number.

See also:`Print$(), Print(), Val()`

Sweeps()

This function returns the number of sweeps accumulated into the frame data. If the memory view is saved and reloaded as a file view, the sweeps value is preserved. What each item or sweep is depends on the type of the analysis.

```
Func Sweeps();
```

Returns	The number of sweeps accumulated to produce the frame data.

See also:`SetAverage(), SetPower(), View()`

System$()

This function returns the name and version of the operating system as a string.

```
Func System$()
```

Returns	This returns a string describing the operating system. The strings defined so far are: `" Windows 95 x.yy "`, `"Windows 98 x.yy"` and `"Windows NT x.yy"`. x is the major revision number and yy is the minor revision number.

See also:`System()`

System()

This function returns the version of the operating system as a number.

```
Func System()
```

Returns	This returns the revision level of the operating system times 100. Windows 98 returns 410. Windows 95 returns 400, Windows NT will return 350, 351 or 400. NT 2000 returns 500.

See also:`System$()`

Tan()

This calculates the tangent of an angle in radians or converts an array of angles into tangents. Tangents of odd multiples of **pi**/2 are infinite, so cause computational overflow. There are 2**pi** radians in 360°. The value of **pi** is 3.14159265359 (`4.0*ATan(1))`.

```
Func Tan(x|x[]);
```

`x`	The angle, expressed in radians, or a real array of angles. The best accuracy of the result is obtained when the angle is in the range -2**pi** to 2**pi**.
Returns	For an array, it returns a negative error code (for overflow) or 0. When the argument is not an array the function returns the tangent of the angle.

See also:`ATan(), Cos(), Sin()`

Time$()

This function returns the current system time of day as a string. If no arguments are supplied, the returned string shows hours, minutes and seconds in a format determined by the operating system settings. To obtain the time as numbers, use the `TimeDate()` function. To obtain relative time (and fractions of a second), use `Seconds()`. **Warning**: this command does not exist in version 1.00.

```
Func Time$({tBase%, {show%, {amPm%, {sep$}}}});
```

`tBase%` Specifies the time base to show the time in. You can choose between 24 hour clock or 12 hour clock mode. If this argument is omitted, a value of 0 is used.

0	Operating system settings
1	24 hour format
2	12 hour format

`show%` Specifies which time fields to show. Add the values of the required options together and enter that number as the argument. If this argument is omitted or a value of 0 is used, 7 (1+2+4) is used for 24 hour format and 15 (1+2+4+8) for 12 hour format.

1	Show hours
2	Show minutes
4	Show seconds
8	Remove leading zeros from hours

`amPm%` This sets the position of the "`AM`" or "`PM`" string in 12 hour format. This parameter has no effect in 24 hour format. If this argument is omitted, a value of zero is used. The actual string which gets printed ("`AM`" or "`PM`") is specified by the operating system.

0	Operating system settings
1	Show to the right of the time
2	Show to the left of the time
3	Hide the "`AM`" or "`PM`" string

`sep$` This string appears between adjacent time fields. If `sep$` = "`:`" then the time will appear as `12:04:45`. If an empty string is entered or `sep$` is omitted, the operating system settings are used.

See also:`Date$()`, `Seconds()`, `TimeDate()`

TimeDate()

This procedure returns the time and date in seconds, minutes, hours, days, months, and years. It can also return the day of the week. You can either enter a separate variable for each field to be returned, or alternatively, an integer array of the desired size. This procedure returns numerical values. If you wish to have a formatted string containing either the date or the time you should use `Date$()` and `Time$()`. If you want to measure relative times, or times to a fraction of a second, see the `Seconds()` command. To get the current sampling time, see `MaxTime()`. **Warning**: this command is not in version 1.00.

```
Proc TimeDate(&s%, {&m%, {&h%, {&d%, {&mon%, {&y%, {&wDay%}}}}}});
Proc TimeDate(now%[])
```

`s%`	If this is the only argument is passed, the number of seconds since midnight is returned in this variable. If the `min%` argument is present, the number of seconds since the beginning of the present minute is returned.
`m%`	If this is the last argument, then the number of minutes since midnight is returned in this variable. If `hour%` is present, then the number of full minutes since the beginning of the present hour is returned
`h%`	If present, the number of hours since Midnight is returned in this variable.
`d%`	If present, the day of the month is returned as an integer in the range 1 to 31.
`mon%`	If present, the month number is returned as an integer in the range 1 to 12.
`y%`	If present. the year number is returned here. It will be an integer such as 1998 (the year 2000 is returned as 2000, not 0).
`wDay%`	If present, the day of the week will be returned here. This will be an integer in the range 0 (Monday) to 6 (Sunday).
`now%[]`	If an array is passed as the first and only arguments, array elements are filled with time and date data. Elements beyond the seventh are not changed. The array can be less than seven elements long. Element 0 is set to the seconds, 1 to the minutes, 2 to the hours, and so on.

See also:`Date$()`, `MaxTime()`, `Seconds()`, `Time$()`

TimeRatio()

This function returns the ratio between the current view X axis units and seconds, for example in milliseconds mode it returns 1000. Use of this value allows script output to use the preferred time units, as the script functions always see time values in seconds, regardless of the time units preferred.

```
Func TimeRatio();
```

Returns The current time ratio.

See also: `TimeUnits$()`

TimeUnits$()

This function returns the current view time units, for example in milliseconds mode it returns "ms". Use of this allows script output to show the preferred time units.

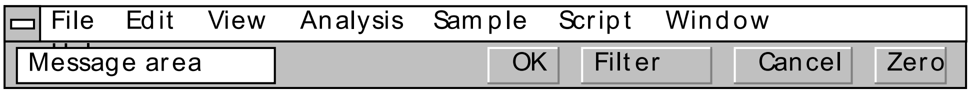
```
Func TimeUnits$();
```

Returns The current time units.

See also:`TimeRatio()`

The toolbar

The toolbar is at the top of the screen, below the menu. The bar has a message area and can hold buttons that are used in the `Interact()` and `Toolbar()` commands.



It is possible to link user-defined functions and procedures to the toolbar buttons. This is done through a set of functions that define buttons and optionally link the buttons to the toolbar. You can define up to 17 buttons in your toolbar, but you will probably be limited by the available space to a maximum of around 10. Buttons are numbered from 1 to 17. There is an invisible button, numbered 0, that is used to set a function that is called when the toolbar is waiting for a button to be pressed.

When you start a script, the toolbar is invisible and contains no buttons. When a script stops running, the toolbar becomes invisible (if it was visible).

Toolbar building There is an example script `Toolmake.s2s` which automates the writing of toolbar commands to generate your desired toolbar.

See also:`Interact(), Toolbar(), ToolbarClear(), ToolbarEnable(), ToolbarSet(), ToolbarText(), ToolbarVisible()`

Toolbar()

This function displays the toolbar and waits for the user to click on a button. If button 0 has been defined with an associated function, that function is called repeatedly while no button is pressed. If no buttons are defined or enabled, or if all buttons become undefined or disabled, the toolbar is in an illegal state and an error is returned. If the toolbar was not visible, it becomes visible when this command is given.

If the user presses the “escape” key (Esc) with the toolbar active, the script will stop unless an “escape button” has been set by `ToolbarSet()` in which case the action associated with that button is performed.

```
Func Toolbar(text$, allow% {,help%|help$});
```

`text$` A message to display in the message area of the toolbar. The area available for messages competes with the area for buttons. If there are too many buttons, the message may not be visible.

`allow%` A code that defines what the user can do (apart from pressing toolbar buttons). The code is the sum of possible activities:

1	User may swap to other applications
2	User may change the current window
4	User may move and resize windows
8	User may use the File menu
16	User may use the Edit menu
32	User may use the View menu
64	User may use the Analysis menu
128	User may use the Cursor menu and add cursors
256	User may use the Window menu
512	User may use the Sample menu
1024	User may not double click y axis
2048	User may not double click the x axis or scroll it
4096	User may not change channel of horizontal cursors
8192	User may not change to another frame

A value of 0 would restrict the user to the current view in a fixed window and, in a data view, the user would be able to scroll data and switch frames. A value of 9216 is the same as 0 but without being able to change y axes or frame.

`help` This is either a numeric code or a string that defines the help to be presented if the user asks for it while using the toolbar. A code of 0 means use standard help.

Returns The function returns the number of the button that was pressed to leave the toolbar, or a negative code returned by an associated function.

The buttons are displayed in order of their item number. Undefined items leave a gap between the buttons. This effect can be used to group related buttons together.

See also: `Interact(), ToolbarClear(), ToolbarEnable(), ToolbarSet(), ToolbarText(), ToolbarVisible()`

ToolbarClear()

This function is used to remove all, or some of the buttons from the toolbar. If you delete all the buttons the `Toolbar()` function will insert a button labelled OK so you can get out of the `Toolbar()` function. Use `ToolbarText("")` to clear the toolbar message.

```
Proc ToolbarClear({item%});
```

`item%` If present, this is the number of the button in the toolbar to clear. Buttons are numbered starting at 0. If omitted, all buttons in the toolbar are cleared.

See also: `Interact(), Toolbar(), ToolbarEnable(), ToolbarSet(), ToolbarText(), ToolbarVisible()`

ToolbarEnable()

This function enables and disables toolbar buttons, and reports on the state of a button. Enabling an undefined button has no effect. If you disable all the buttons and then use the `Toolbar()` function or if you disable all the buttons in a function linked to the toolbar, and there is no idle function set, a single OK button is displayed.

```
Func ToolbarEnable(item% {,state%});
```

`item%` The number of the button or -1 for all buttons. You must enable and disable button 0 with `ToolbarSet()` and `ToolbarClear()`.

`state%` If present this sets the button state. A value of 0 disables a button, a value of 1 enables a button.

Returns The function returns the state of the button prior to the call as 0 for disabled and 1 for enabled. If all buttons were selected the function returns 0. If an undefined button, or button 0 is selected, the function returns -1.

See also: `Interact(), Toolbar(), ToolbarClear(), ToolbarSet(), ToolbarText(), ToolbarVisible()`

ToolbarSet()

This function adds a button to the toolbar and optionally associates a function with it. When a button is added, it is added in the enabled state.

```
Proc ToolbarSet(item%, label$ {,func ff%()});
```

`item%` The button number to add or replace. Buttons are numbered from 1-17. You can use an item number of 0 to set or clear a function that is called repeatedly while the toolbar waits for a button press. If you leave out a button this creates a gap between the adjacent buttons.

You can set an "escape" key as described in `Toolbar()`, by negating `item%`. For example `ToolbarSet(-2,"Quit");` sets button 2 as the escape key.

`label$` The label for the button. Labels compete for space with each other, so it is a good idea to keep the labels fairly short. The label is ignored for button 0.

You can link a key to a button by placing `&` before a character in the label, or by adding a vertical bar and a key code in hexadecimal (e.g. 0x30), octal (e.g. 060) or decimal (e.g. 48) to the end of the label. Characters set by `&` are case insensitive. For example `"a&Maze"` generates the label aMaze and responds to `m` or `M`; the label `"F1:Go|0x70"` generates the label F1:Go and responds to the F1 key. Useful key codes include (nk = numeric keypad):

0x08 Backspace	0x09 Tab	0x0d Enter	0x1b Escape
0x20 Spacebar	0x21 Page up	0x22 Page down	0x23 End
0x24 Home	0x25 Left arrow	0x26 Up arrow	0x27 Right arrow
0x28 Down arrow	0x2e Del	0x30-0x39 0-9	0x41-0x5a A-Z
0x60-0x69 nk 0-9	0x6a nk *	0x6b nk +	0x6c nk separator
0x6d nk -	0x62 nk .	0x6f nk /	0x70-0x87 F1-F24

Use of other keys codes or use of `&` before characters other than a-z, A-Z or 0-9 may cause unpredictable and undesirable effects.

Beware: When the toolbar is active, it owns all keys linked to it. If `A` is linked, you cannot type `a` or `A` into a text window with the toolbar active.

`ff%()` This is the name of a function. This function should have no arguments and the name with no brackets is given, for example `ToolbarSet(1,"Go",DoIt%);` where `func DoIt%()` is defined somewhere in the script. When the `Toolbar()` function is used and the user clicks on the button, the linked function is run (or if the `item%` 0 function is set, the function runs while no button is pressed). The function return value controls the action of `Toolbar()` after a button is pressed.

If it returns 0, the `Toolbar()` function returns to the caller, passing back the button number. If it returns a negative number, the `Toolbar()` call returns the negative number. If it returns a number greater than 0, the `Toolbar()` function does not return, but waits for the next button. An item 0 function must return a value greater than 0, otherwise `Toolbar()` will return immediately.

If this argument is omitted, there is no function linked to the button. When the user clicks on the button, the `Toolbar()` function returns the button number.

See also: `Interact(), Toolbar(), ToolbarClear(), ToolbarEnable(), ToolbarText(), ToolbarVisible()`

ToolbarText()

This function replaces any message in the toolbar, and makes the toolbar visible if it is invisible. This function can be used to give a progress report on the state of a script that takes a while to run.

`Proc ToolbarText(msg$);`

`msg$` A string to be displayed in the message area of the toolbar.

See also: `Interact(), Toolbar(), ToolbarClear(), ToolbarEnable(), ToolbarSet(), ToolbarVisible()`

ToolbarVisible()

This function reports on the visibility of the toolbar, and can also show and hide it. You cannot hide the toolbar if the `Toolbar()` function is in use.

`Func ToolbarVisible({show%});`

`show%` If present and non-zero, the toolbar is made visible. If zero and the `Toolbar()` function is not active, the toolbar is made invisible.

Returns The state of the toolbar at the time of the call. The state is returned as 2 if the toolbar is active, 1 if it is visible but inactive and 0 if it is invisible.

See also: `Interact(), Toolbar(), ToolbarClear(), ToolbarEnable(), ToolbarSet(), ToolbarText()`

Trunc()

Removes the fractional part of a real number or truncates an array. To truncate a real number and return an integer value, just assign the real to the integer. To copy a real array to an integer array, use `ArrConst()`.

`Func Trunc(x|x[]);`

`x` A real number or a real array.

Returns With an array this returns 0 or a negative error code (most unlikely). With an expression as argument it returns the expression with the fractional part removed. `Trunc(4.7)` is `4.0`, `Trunc(-4.7)` is `-4.0`.

See also: `Frac(), Round(), ArrConst()`

UCase$()

This function converts a string into upper case. The upper-case operation may be system dependent. Some systems may provide localised uppercasing, others may only provide the minimum translation of the ASCII characters a-z to A-Z.

`Func UCase$(text$);`

`text$` The string to convert.

Returns An upper cased version of the original string.

See also: `LCase$()`

Val()

This converts a string to a number. The converter allows the same number format as the script compiler and leading white space is ignored.

```
Func Val(text${, &nCh%});
```

`text$`	The string to convert to a number. The expected format is: `{white space}{-}{digits}{.digits}{e|E{+|-}digits}`
`nCh%`	If present, it is set to the number of characters used to construct the number.
Returns	It returns the extracted number, or zero if no number was present.

See also:`Str$(), ReadStr()`

View()

The `View()` function sets the current view and returns the last view handle, or a negative error. A view handle is a positive integer > 0. Changing the current view does not change the focus or bring the view to the front, use `FrontView()` to do that.

```
Func View( {vh%} );
```

`vh%` An integer argument being:

- >0 A valid view handle that is to be made the current view. An invalid view handle will stop the script with a fatal error.
- 0 (or omitted) no change of the current view is required
- <0 If the argument is `-n`, this selects the `n`th duplicate of the current data view. This is equivalent to `Dup(n)`. Use `ViewSource()` to get the data view from which a memory view is derived.

Returns 0 if there are no views at all, -1 if the duplicate requested does not exist, otherwise it returns the view handle of the view that was current.

See also:`FrontView(), ViewFind(), ViewKind(), ViewSource(), Window(), WindowTitle$(), View().x(), View(v,c).[]`

View(v,c).[ ]

The `View(vh%,c).[]` construction accesses view data for channel `c`. The `[]` refers to the whole array unless it encloses an expression to define a range of array elements. For waveform channels, the array holds the waveform values as expected. Marker channels appear as an array holding the marker times, but this array is read-only and a script error will be caused by attempting to assign to it. Use the `MarkTime()` function to change the times of markers.

```
View( vh%, c% ).[{aExp}]
```

`vh%`	A view handle of an existing view, 0 for the current view, or -n for the nth duplicate view associated with the current view.
`c%`	A channel number from the view.
`aExp`	An optional array indexing expression. If omitted, the whole array is accessed.

Here are three examples, to work on data from bin `b%` in channel `c%` of view `v%`:

```
val:=View(v%,c%).[b%]            'get one data value
sum:=ArrSum(View(v%,c%).[b%:100])'sum 100 data values
ArrDiff(View(v%,c%).[])          'replace data by differences
```

See also:`View(), View().x(), ViewSource(), ArrXXX(), MarkTime()`

View().x()

The `View().x()` construction overrides the current view for the evaluation of the function that follows the dot. It is an error if the selected view does not exist, and the script stops. Don't use this contruct for functions which close the view.

```
View( vh% ).x()
```

`vh%`	A view handle of an existing view, 0 for the current view (a waste of time), or -n for the nth duplicate view associated with the current view.
`x()`	A function or procedure.

For example, `View(vh%).Draw()` draws the view indicated by `vh%`. The equivalent code to `View(vh%).x()` is:

```
var temp%;
temp% := View(vh%);
x();
View(temp%);
```

See also:`View(), View(v,c).[], ViewSource()`

ViewFind()

This function searches for a window with a given title and returns its view handle.

```
Func ViewFind(title$);
```

`title$`	A string holding the view title to search for. Note that, in Window 95 or 98, system settings in Windows Explorer can cause the file extension to be removed from the view title, so you may have to search both with and without the ".cfs".
Returns	The view handle of a view with a title that matches the string, or 0 if no view matches the title.

See also:`FileOpen(), Window(), WindowTitle$(), View()`

ViewKind()

This function returns the type of a view or of the current view. Types 5-7 are reserved.

```
Func ViewKind({vh%});
```

`vh%`	The handle of the view for which the type is required. If omitted the function returns information about the current view.
Returns	The type of the view, view types are:

0	File view	A data view showing one frame at a time from a CFS data file. Access to any frame in the file is possible for analysis etc.
1	Text view	A view holding a text file for editing.
2	Output sequence	Not available in Version 2.x.
3	Script view	A view holding a script file.
4	Memory view	A data view created by a `SetXXX()` command, similar to a file view but wholly held in memory.
8	External text file	An invisible view for use with routines `Read()` and `Print()`.
9	External binary file	An invisible view for use by `BRead()`, `BWrite()` etc.
10	Application window	The Signal program window.
11	Other types	Other views with handles, such as the Status bar, and Toolbar, which can be made visible or invisible.
12	XY view	An XY view showing sets of XY data points.
-1	Unknown type	These include the cursor windows.
-2	Invalid handle	The return value if the `vh%` parameter value is invalid.

See also: `App(), ChanKind(), FileOpen(), View(), ViewList()`

ViewList()

This function fills an integer array with a list of view handles. It never returns the view handle of the running script, use the `App()` command to get this.

```
Func ViewList({list%[] {,types%}});
```

`list%` An integer array that is returned holding view handles. The first element of the array, `list%[0]`, is set to the number of handles returned, and the remaining elements in the array are view handles. If the array is too small to hold the full number, the number that will fit are returned.

`types%` The types of view to include. This is a code that can be used to filter the view handles. The filter is formed by adding the types from the list below. If this is omitted or if no types are specified for inclusion, all view handles are returned.

1	File views	8	Script views	512	External binary	4096	XY views
2	Text views	16	Memory views	1024	Application view		
4	Sequencer	256	External text	2048	Other view types		

You can also exclude views otherwise included by adding:

8192	Exclude views not directly related to the current view
16384	Exclude visible windows
32768	Exclude hidden windows
65536	Exclude duplicates

Returns The total number of windows that satisfy the `types%`. This can be used to find a suitable array size.

See also:`App(), SampleHandle(), ViewKind()`

ViewSource()

This function returns the handle of the source view for a memory view.

```
Func ViewSource();
```

Returns The handle of the data view from which this memory view was derived, and from which it obtains its data. Note that memory views created using `SetCopy()` or `SetMemory()` do not have a data view attached and return 0.

See also:`View(), SetXXX(), SetAverage(), SetCopy(), SetMemory(), SetPower()`

ViewStandard()

This returns the current data or XY view to a standard state by making all channels and axes visible in their standard drawing mode, axis range and colour. In an XY view the key is hidden and the axes are optimised. For other window types it is undefined. If you use this without a current window, nothing happens.

```
Proc ViewStandard();
```

See also:`ChanOrder(),ChanWeight(),DrawMode(), XYDrawMode()`

ViewUseColour()

This function can be used to force the display to use black and white only, or to use the colours set in the colour dialog or by the `Colour()` command.

```
Func ViewUseColour( {use%} );
```

`use%` If present, a value of 0 forces Signal to display all windows in black and white. Any other value allows the use of colour. If omitted, no change is made.

Returns The current state as 1 if colour is in use, 0 if black and white is used.

See also:`Colour()`

Window()

This sets the window position (and size) of the current view. Positions are given as percentages of the available area, measured from the top left hand corner. When this is used to position the Signal application window the available area is the whole screen, otherwise the available area is Signal application area.

```
Proc Window(xLow, yLow{,xHigh{,yHigh}})
```

`xLow`	Position of the left hand edge of the window, as a percentage of the area.
`yLow`	Position of the top edge of the window, as a percentage of the area.
`xHigh`	If present, the right hand edge. If omitted the previous width is maintained. If the window is made too small, the minimum allowed size is used.
`yHigh`	If present, the bottom edge position. If omitted the previous height is maintained. If the window is made too small, the minimum allowed size is used.

In this example the Signal window will be sized to the maximum possible screen area, before positioning the data window within the Signal area.

```
var vdata%;
view(App()).Window(0,0,100,100);  'set largest application size
vdata%:=ViewFind("mydata.cfs");   'view handle for data
FrontView(vdata%);                'focus on the data window
Window(15,15,85,85);    'data window in middle with 15% around
```

See also:`App(), FrontView(), View(), ViewFind() WindowDuplicate(), WindowGetPos(), WindowSize(), WindowTitle$(), WindowVisible()`

WindowDuplicate()

This duplicates the current data view, creating a new window that has all the settings of the current view. It does not duplicate channels; these are shared with the existing window. The new window becomes the current view and is created invisibly.

```
Func WindowDuplicate()
```

Returns This command returns the view handle of the new window or a negative error code or 0 if no free duplicates (there is a limit of 9 duplicates per data view).

See also:`Dup(), Window(), WindowGetPos(), WindowSize(), WindowTitle$(), WindowVisible(), View()`

WindowGetPos()

This gets the position of the current view. Positions are given as percentages of the available area, measured from the top left hand corner. Positions for the Signal application window are measured with respect to the whole screen, otherwise the positions are measured with respect to the Signal application area.

```
Proc WindowGetPos(&xLow, &yLow ,&xHigh ,&yHigh)
```

`xLow`	A real variable that is set to the position of the left hand edge of the window.
`yLow`	A real variable that is set to the position of the top edge of the window.
`xHigh`	A real variable that is set to the position of the right hand edge of the window.
`yHigh`	A real variable that is set to the position of the bottom edge of the window.

See also:`App(), Window(), WindowDuplicate(),WindowSize(), WindowTitle$(), WindowVisible()`

WindowSize()

This procedure is used to resize the current window without changing the position of the top left-hand corner. Setting a window dimension less than zero leaves the dimension unchanged. Setting a dimension smaller than the minimum allowed sets the minimum value. Setting a size greater than the maximum allowed sets the maximum size. There are no errors from this function. When this is used to size Signal application window the available area is the whole screen, otherwise the available area is Signal application area.

```
Proc WindowSize(width, height);
```

`width`	The width of the window as a percentage of the available area.
`height`	The height of the window as a percentage of the available area.

See also: `App(), Window(), WindowDuplicate(), WindowGetPos(), WindowTitle$(), WindowVisible()`

WindowTitle$()

This function gets and sets the title of the current window. There may be windows that are resistant to having their title changed. For these, the routine has no effect. Most windows can return a title. If you change a title, dependent window titles change, for example, cursor windows belonging to data views track the title of the data view.

```
Func WindowTitle$({new$});
```

`new$`	If present, this sets the new window title. Window titles must follow any system rules for length or content. Illegal titles (for example titles containing control characters) are mangled or ignored at the discretion of the system.
Returns	The window title as it was prior to this call.

See also: `Window(), WindowDuplicate(), WindowGetPos(), WindowSize(), WindowVisible()`

WindowVisible()

This function is used to get and set the visible state of the current view. This function can also be used on the application window, however the effect will vary with the system and on some, there may be no effect at all.

```
Func WindowVisible({code%});
```

`code%` If present, this sets the window state. The possible states are:

0 Hidden, the window becomes invisible. A hidden window can be sent data, sized and so on, the result is just not visible.

1 Normal, the window assumes its last normal size and position and is made visible if it was invisible or iconised.

2 Iconised. An iconised window can be sent data, sized and so on, the result is not visible.

3 Maximised. The window is made as large as possible.

Returns The window state prior to this call.

See also: `FrontView(), Window(), WindowDuplicate(), WindowGetPos(), WindowSize(), WindowTitle$()`

XAxis()

This function can be used to turn on and off the x axis of the current view, or to find the state of the x axis:

```
Func XAxis({on%});
```

`on%` Optional, set the axis state. If omitted, no change is made. Possible values are:

0	Hide the axis
1	Show the axis with units in seconds
2	Show with units of hh:mm:ss relative to start of file (not implemented yet)
3	Show with time of day (not implemented yet)

Returns The axis state at the time of the call (0 to 3, as above) or a negative error code. It is an error to use this function on a view that has no concept of an x axis.

Changes made by this function do not cause a redraw immediately. The affected view is drawn at the next opportunity.

See also:`XHigh(), XLow(), XRange(), XTitle$(), XUnits$()`

XAxisMode()

This function controls what is drawn in an x axis.

```
Func XAxisMode({mode%});
```

`mode%` Optional argument that controls how the axis is displayed. If omitted, no change is made. Possible values are the sum of the following. Values not included in the sum will be restored to their default states:

1	Hide all the title information.
2	Hide all the unit information.
4	Hide small ticks on the x axis. Small ticks are hidden if big ticks are hidden.
8	Hide numbers on the x axis. Number are hidden if big ticks are hidden.
16	Hide the big ticks and the horizontal line that joins them.
32	Scale bar axis. If selected add 4 to remove the end caps.

Returns The x axis mode value at the time of the call or a negative error code.

See also:`XAxis(),XHigh(),XLow(),XRange(),YAxisMode()`

XAxisStyle()

This function controls the major and minor tick spacing for all views that have an x axis. If you set values that would cause illegible or unintelligible axes, they are stored but not used unless the axis range or scaling changes to make the values useful.

```
Func XAxisStyle({style%{, nTick%{, major}}});
```

`style%` A value of –1 returns the number of minor divisions set or 0 for automatic. A value of –2 returns the major tick spacing or 0 for automatic spacing.

`nTick%` The number of minor tick subdivisions or 0 for automatic spacing. Omit `nTick%` or set it to –1 for no change.

`major` If present, values greater than 0 set the major tick spacing. Values less than or equal to 0 select automatic major tick spacing.

Returns See the description of `style%` for return values.

See also:`XAxis(),XAxisMode(),XHigh(),XLow(),XRange(),YAxisStyle()`

XHigh()

This returns the value of the right end of the x axis of the current data or XY view. To find the frame limit use `Maxtime()`.

```
Func XHigh()
```

Returns The x axis upper limit in x axis units. It is a fatal error to use this function in an inappropriate view.

See also:`Draw()`, `XRange()`, `BinToX()`, `XToBin()`, `XLow()`, `Maxtime()`

XLow()

This returns the value that corresponds to the left end of the x axis of the current data or XY view. To find the frame limit use `Mintime()`.

```
Func XLow()
```

Returns The x axis lower limit in x axis units. It is a fatal error to use this function in an inappropriate view.

See also:`Draw()`, `XRange()`, `BinToX()`, `XToBin()`, `XHigh()`, `Mintime()`

XRange()

This function sets the start and end of the x axis in a data or XY view in x axis units. Unlike `Draw()`, it does not update the view immediately, updates must wait for the next `Draw()`, `DrawAll()` or some interactive activity.

```
Proc XRange(low {,high});
```

`low`	The left hand edge of the view in x axis units.
`high`	The right hand edge of the view. If omitted, the view stays the same width.

Values are limited to the axis range. Without `high`, it preserves the width, adjusting `low` if required. If the resulting width is less than the minimum allowed, no change is made.

See also:`Draw()`, `XLow()`, `XHigh()`

XScroller()

This function gets and optionally sets the visibility of the x axis scroller.

```
Func XScroller({show%});
```

`show%`	If present, 0 hides the scroll bar and buttons, non-zero shows it.
Returns	0 if the scroll bar was hidden, 1 if it was visible.

XTitle$()

This function gets the title of the x axis. In a memory or XY view, or in a sampling document view, you can also set the title. The window will update with a new title at the next opportunity, but, in Version 2.00, the x axis title is not written to CFS data files.

```
Func XTitle$({new$});
```

`new$`	If present this sets the new x axis title in a sampling document or memory view.
Returns	The x axis title at the time of the call.

See also:`ChanTitle$()`, `XUnits$()`

XToBin()

This converts between x axis units and bin numbers in a data view.

```
Func XToBin(chan%, x);
```

`chan%` A channel number (1 to n)

`x` An x axis value. If it exceeds the x axis range it is limited to the nearer end.

Returns In a data view it returns the bin position that corresponds to x. In general, this will not be an integral number of bins, however, when used to access a bin, it will be truncated to an integer, and will refer to the bin that contains the x value.

See also: `BinToX(), BinSize(), BinZero()`

XUnits$()

This function gets the units of the x axis in the current view. In a memory, XY, or sampling document view, you can also set the units. The window will update with the new units at the next opportunity and they will become part of the new file if it is saved.

```
Func XUnits$({new$});
```

`new$` If present this sets the new x axis units in a new file or memory view.

Returns The x axis units at the time of the call.

See also: `ChanUnits$(), XTitle$()`

XYAddData()

This adds one or more data points to a channel in an XY view. If the axes are set to automatic expanding mode by `XYDrawMode()`, they will change when you add a new data point that is out of the current axis range. If the channel is set to a fixed size (see `XYSize()`), adding new points causes older points to be deleted once the channel is full.

```
Func XYAddData(chan%, x|x[]|x%[], y|y[]|y%[]);
```

`chan%` A channel number in the current XY view.

`x` The x co-ordinate(s) of the added data point(s). Both x and y must be either single variables or arrays. If they are arrays, the number of data points added is equal to the size of the smaller array.

`y` The y co-ordinate(s) of the added data point(s).

Returns The number of data points which have been added successfully.

See also: `XYColour(), XYCount(), XYDelete(), XYDrawMode(), XYGetData(), XYInCircle(), XYInRect(), XYJoin(), XYKey(), XYRange(), XYSetChan(), XYSize(), XYSort()`

XYColour()

This gets or sets the colour of a channel in the current XY view. The default channel colour is the same as for an ADC channel in a time window.

```
Func XYColour(chan% {,col%});
```

`chan%` A channel number in the current XY view.

`col%` The index of the colour in the colour palette. There are 40 colours in the palette, their indexes are numbered from 0 to 39. If omitted, there is no change of colour for the channel.

Returns The index of the colour in the colour palette or a negative error code.

See also: `Colour(), XYAddData(), XYCount(), XYDelete(), XYDrawMode(), XYGetData(), XYInCircle(), XYInRect(), XYJoin(), XYKey(), XYRange(), XYSetChan(), XYSize(), XYSort()`

XYCount()

This gets the number of data points in a channel in the current XY view. To find the maximum number of data points, see the `XYSize()` command.

```
Func XYCount(chan%)
```

`chan%` A channel number in the current XY view.

Returns The number of data points in the channel or a negative error code.

See also: `XYAddData(), XYColour(), XYCount(), XYDelete(), XYDrawMode(), XYGetData(), XYInCircle(), XYInRect(), XYJoin(), XYKey(), XYRange(), XYSetChan(), XYSize(), XYSort()`

XYDelete()

This command deletes a range of data points or all data points from one channel of the current XY view. Use `ChanDelete()` to delete the entire channel.

```
Func XYDelete(chan% {,first% {,last%}});
```

`chan%` A channel number in the current XY view.

`first%` The zero-based index of the first data point to delete. If omitted, all data points are deleted.

`last%` The zero-based index of the last data point to delete. If omitted, data points from `first%` to the last point in the channel are deleted. If `last%` is less than `first%` no data points are deleted.

Returns The function returns the number of deleted data points.

The index number of a data point depends on the current sorting method of the channel set by `XYSort()`. For different sorting methods, a data point may have different index numbers. The data points in a channel have continuous index numbers. When a point has been deleted the remaining points re-index themselves automatically.

See also: `ChanDelete(), XYAddData(), XYColour(), XYCount(), XYDrawMode(), XYGetData(), XYInCircle(), XYInRect(), XYJoin(), XYKey(), XYRange(), XYSetChan(), XYSize()`

XYDrawMode()

This gets and sets the drawing and automatic axis expansion modes of a channel in the current XY view. It is an error to use this command with any other view type.

```
Func XYDrawMode(chan%, which% {,new%});
```

`chan%` A channel number in the current XY view. This is ignored when `which%` = 5, as all the channels in a XY view share the same axes.

`which%` Which drawing parameter to get or set in the range 1 to 5. When setting parameters, the new value is held in the `new%` argument. The values are:

1 Get or set the data point draw mode. The drawing modes are:

0	dots (default)	1	boxes	2	plus signs +
3	crosses x	4	circles (NT only)	5	triangles
6	diamonds	7	horizontal line	8	vertical line

2 Get or set the size of the data points. The sizes allowed are 0 to 100 (0 is invisible). The default size is 5.

3 Get or set the line style. If the line thickness is greater than 1 all lines are drawn as style 0. Styles are:

0	solid (default)	1	dotted	2	dashed

4 Get or set the line thickness. Thickness values range from 0 (invisible) to 10. The default is 1.

5 Get or set automatic axis range mode. This applies to the entire view, so the `chan%` argument is ignored. Values are:

0 The axes do not change automatically when new data points are added.

1 When new data points are added that lie outside the current x or y axis range, the data and axes screen area update at the next opportunity to display all the data.

`new%` New channel draw or axis expanding mode. If omitted, no change is made.

Returns The value of relevant channel draw mode or axis expanding mode at time of call if succeeds or a negative error code if fails.

See also: `XYAddData(), XYColour(), XYCount(), XYDelete(), XYGetData(), XYInCircle(), XYInRect(), XYJoin(), XYKey(), XYRange(), XYSetChan(), XYSize(), XYSort()`

XYGetData()

This gets data points between two indices from a channel in the current XY view. It is an error to use this command with any other view type.

```
Func XYGetData(chan%, &x|x[], &y|y[] {,first% {,last%}});
```

`chan%` A channel number in the current XY view.

`x|x[]` The returned x co-ordinate(s) of data point(s). When arrays are used, either both `x` and `y` must be arrays or neither can be. The smaller of the two arrays sets the maximum number of data points that can be returned.

`y|y[]` The returned y co-ordinate(s) of data point(s)

`first%` The zero-based index of the first data point to return. If omitted, the first data point is index 0.

`last%` The zero-based index of the last data point returned. `last%` is only meaningful when `x` and `y` are array names. If omitted or if `last%` is greater than or equal to the number of data points, the final data point is the last one in the channel. If `last%` is less than `first%`, no data points are returned.

Returns The number of data points copied. This can be less than the number of data points between the requested indices. For example, if the size of x or y array is not big enough to hold all the data points from `first%` to `last%`, the number of data points returned is equal to the size of array. If x and y are simple variables, 1 is returned if the data point with index number `first%` exists.

The index number of a data point depends on the current sorting method (see `XYSort()`).

See also: `XYAddData(), XYColour(), XYCount(), XYDelete(), XYDrawMode(), XYInCircle(), XYInRect(), XYJoin(), XYRange(), XYKey(), XYSetChan(), XYSize(), XYSort()`

XYInCircle()

This gets the number of data points inside a circle defined by `xc`, `yc`, and `r` in the current XY view. A general point `(x,y)` is considered to be inside the circle if:

(x-xc)^2 + (y-yc)^2 <= r^2

Points lying on the circumference are considered inside, but due to floating point rounding effects they may be indeterminate.

```
Func XYInCircle(chan%, xc, yc, r);
```

`chan%`	A channel number in the current XY view.
`xc,yc`	These are the x and y co-ordinates of the centre of the circle.
`r`	This is the radius of the circle. `r` must be >= 0.
Returns	the number of data points inside the circle or a negative error code.

See also:`XYAddData(), XYColour(), XYCount(), XYDrawMode(), XYGetData(), XYInRect(), XYJoin(), XYRange(), XYKey(), XYSetChan(), XYSize(), XYSort()`

XYInRect()

This function returns the number of data points in a channel of the current XY view that lie inside a rectangle. Data points on the boundaries of the rectangle are considered to be inside, but due to floating point rounding they may be indeterminate.

```
Func XYInRect(chan%, xl, yl, xh, yh);
```

`chan%`	A channel number in the current XY view.
`xl,xh`	The `x` co-ordinates of the left and right hand edges of the rectangle. `xh` must be greater than or equal to `xl`.
`yl,yh`	The `y` co-ordinates of the bottom and top edges of the rectangle. `yh` must be greater than or equal to `yl`.
Returns	The number of data points inside the rectangle or a negative error code.

See also:`XYInCircle(), XYDelete(), XYDrawMode(), XYGetData(), XYJoin(), XYRange(), XYSetChan(), XYSize(), XYSort()`

XYJoin()

This function gets or sets the data point joining method of a channel in the current XY view. Data points can be separated, joined by lines, or joined by lines with the last point connected to the first point (making a closed loop).

```
Func XYJoin(chan% {,join%});
```

`chan%` A channel number in the current XY view.

`join%` If present, this is the new joining method of the channel. If this is omitted, no change is made. The data point joining methods are:

0 Not joined by lines (this is the default joining method)
1 Joined by lines. The line styles are set by `XYDrawMode()`.
2 Joined by lines and the last data point is connected to the first data point to form a closed loop.

Returns the joining method at time of call if succeeds or a negative error code if fails.

See also:`XYAddData(), XYColour(), XYDrawMode(), XYRange(), XYKey(), XYSetChan(), XYSize(), XYSort()`

XYKey()

This gets and sets the display mode and positions of the channel key for the current view, which must be an XY view. The key displays channel titles (set by `ChanTitle$()`) and drawing symbols for all visible channels. It can be positioned anywhere within the data area. The key can be framed or unframed, transparent or opaque and visible or invisible.

```
Func XYKey(which%, {new});
```

`which%` This determines which property of the key we are interested in. Properties are :

1 Visibility of the key. 0 if the key is hidden (default), 1 if it is visible.

2 Background state. 0 for opaque (default), 1 for transparent.

3 Draw border. 0 for no border, 1 to draw a border (default)

4 Key left hand edge x position. It is measured from the left-hand edge of the x axis and is a percentage of the drawn x axis width in the range 0 to 100. The default value is 0.

5 Key top edge `y` position. It is measured from the top of the XY view as a percentage of the drawn `y` axis height in the range 0 to 100. The default is 0.

`new` If present it changes the selected property. If it is omitted, no change is made.

Returns The value selected by `which%` at the time of call, or a negative error code.

See also: `ChanTitle$(), XYAddData(), XYColour(), XYDrawMode(), XYJoin(), XYRange(), XYSetChan(), XYSize(), XYSort()`

XYRange()

This function gets the range of data values of a channel or channels in the current XY view. This is equivalent to the smallest rectangle that encloses the points.

```
Func XYRange(chan%, &xLow, &yLow, &xHigh, &yHigh);
```

`chan%` A channel number in the current XY view or -1 for all channels or -2 for all visible channels.

`xLow` A variable returned with the smallest x value found in the channel(s).

`yLow` A variable returned with the smallest y value found in the channel(s).

`xHigh` A variable returned with the biggest x value found in the channel(s).

`yHigh` A variable returned with the biggest y value found in the channel(s).

Returns 0 if there are no data points, or the channel does not exist, 1 if values found.

See also: `XYAddData(), XYColour(), XYCount(), XYDelete(), XYDrawMode(), XYGetData(), XYInCircle(), XYInRect(), XYKey(), XYSetChan(), XYSize(), XYSort()`

XYSetChan()

This function creates a new channel or modifies an existing channel in the current XY view. It is an error to use this function if the current view is not an XY view. This function can be used as a short-cut method for modifying all properties of an existing channel without calling the `XYSize()`, `XYSort()`, `XYJoin()` and `XYColour()` commands individually.

```
Func XYSetChan(chan% {,size% {,sort% {,join% {,col%}}}});
```

`chan%` A channel number in the current XY view. If `chan%` is 0, a new channel is created. Each XY view can have maximum of 256 channels, numbered from 1 upwards. The first channel is created automatically by Signal when you open a new XY view with `FileNew()`. If `chan%` is not 0, it must be the channel number of an existing channel which will be modified.

`size%` This sets the number of data points in the channel and how and if the number of data points can extend. The only limits on the number of data points is the available memory and the time taken to draw the view.

A value of zero (the default) sets no limit on the number of points and the size of the channel expands as required to hold data added to it.

If a negative size is given, for example `-n`, this limits the number of points in the channel to `n`. If more than `n` points are added, the oldest points added are deleted to make space for the newer points. If you set a negative size for an existing channel that is smaller than the points in the channel, points are deleted.

If a positive value is set, for example n, this allocates storage space for n data points, but the storage will grow as required to accommodate further points. Using a positive number rather than 0 can save time if you know in advance the likely number of data points as it costs time to grow the data storage.

`sort%` This sets the sorting method of data points. The sorting method is only important if the points are joined. If they are not joined, it is much more efficient to leave them unsorted as sorting a large list of points takes time. The sort methods are:

0 Unsorted (default). Data is drawn and sorted in the order that it was added. The most recently added point has the highest sort index.

1 Sorted by `x` value. The index runs from points with the most negative x value to points with the most positive x value.

2 Sorted by `y` value. The index runs from points with the most negative y value to points with the most positive y value.

If this is omitted, the default value 0 is used for a new channel. For an existing channel, there is no change in sorting method.

`join%` If present, this is the new joining method of the channel. If this is omitted, no change is made to an existing channel, a new channel is given mode 0. The data point joining methods are:

0 Not joined by lines (this is the default joining method)

1 Joined by lines. The line styles are set by `XYDrawMode()`.

2 Joined by lines and the last data point is connected to the first data point to form a closed loop.

`col%` If present, this sets the index of the colour in the colour palette to use for this channel. There are 40 colours in the palette, their index numbered 0 to 39. If omitted, the colour of an existing channel is not changed. The default colour for a new channel is the colour that an user has chosen for an ADC channel in a time window.

Returns The number of channels (including any created channel) or a negative error code. When you create a new channel, the value returned is the number of the new channel.

See also: `XYAddData(), XYColour(), XYCount(), XYDelete(), XYDrawMode(), XYGetData(), XYInCircle(), XYInRect(), XYJoin(), XYKey(), XYRange(), XYSize(), XYSort()`

XYSize()

This function gets and sets the limits on the number of data points of a channel in the current XY view. Channels can be set to have a fixed size, or to expand as more data is added. The only limit on the number of data points is the available memory and the time taken to draw data.

```
Func XYSize(chan% {,size});
```

`chan%` A channel number in the current XY view.

`size%` This sets the number of data points in the channel and how and if the number of data points can extend. A value of zero sets no limit on the number of points and the size of the channel expands as required to hold data added to it.

If a negative size is given, for example `-n`, this limits the number of points in the channel to `n`. If more than `n` points are added, the oldest points added are deleted to make space for the newer points. If you set a negative size for an existing channel that is smaller than the points in the channel, points are deleted.

If a positive value is set, for example n, this allocates storage space for n data points, but the storage will grow as required to accommodate further points. Using a positive number rather than 0 can save time if you know in advance the likely number of data points as it costs time to grow the data storage.

If this is omitted, there is no change to the size.

Returns If the number of points for the channel is fixed at n points, the function returns -`n`. Otherwise, the function returns the maximum number of points that could be stored in the channel without allocating additional storage space.

See also:`XYAddData(), XYColour(), XYCount(), XYDelete(), XYDrawMode(), XYGetData(), XYInCircle(), XYInRect(), XYJoin(), XYKey(), XYRange(), XYSetChan(), XYSort()`

XYSort()

In the current XY view, gets or sets the sorting method of the channel.

```
Func XYSort(chan% {,sort%});
```

`chan%` The channel number.

`sort%` This sets the sorting method of data points. The sorting method is only important if the points are joined. If they are not joined, it is much more efficient to leave them unsorted as sorting a large list of points takes time. The sort methods are:

0 Unsorted (default). Data is drawn and sorted in the order that it was added. The most recently added point has the highest sort index.

1 Sorted by `x` value. The index runs from points with the most negative x value to points with the most positive x value.

2 Sorted by `y` value. The index runs from points with the most negative y value to points with the most positive y value.

If this is omitted, there is no change in sorting method.

Returns The function returns the sorting method at time of call or a negative error code.

See also:`XYAddData(), XYColour(), XYCount(), XYDelete(), XYDrawMode(), XYGetData(), XYInCircle(), XYInRect(), XYJoin(), XYKey(), XYRange(), XYSetChan(), XYSize()`

YAxis()

This function is used to turn the y axes on and off in the current view and to find the state of the y axes in a view.

```
Func YAxis({on%});
```

`on%`	Optional argument that sets the state of the axes. If omitted, no change is made. Possible values are: 0 Hide all y axes in the view. 1 Show all y axes in the view.
Returns	The state of the y axes at the time of the call (0 or 1) or a negative error code.

See also:`ChanTitle$(), ChanUnits$(), YHigh(), YLow(), YRange(), Optimise()`

YAxisMode()

This function controls what is drawn in a y axis and where the y axis is placed with respect to the data.

```
Func YAxisMode({mode%});
```

`mode%` Optional argument that controls how the axis is displayed. If omitted, no change is made. Possible values are the sum of the following values. Values not included in the sum will be restored to their default states:

1	Hide all the title information.
2	Hide all the unit information.
4	Hide y axis small ticks. They are also hidden when big ticks are hidden.
8	Hide y axis numbers. They are also hidden when big ticks are hidden.
16	Hide the big ticks and the vertical line that joins them.
32	Scale bar axis. If selected add 4 to remove the end caps.
4096	Place the y axis on the right of the data

Returns The state of the y axis mode at the time of the call or a negative error code.

See also:`ChanNumbers(),YAxis(),YAxisStyle(),YHigh(),YLow(),YRange()`

YAxisStyle()

This function controls the y axis major and minor tick spacing. If you set values that would cause illegible or unintelligible axes, they are stored but not used unless the axis range or scaling changes to make the values useful.

```
Func YAxisStyle(cSpc, opt%{, major});
```

`cSpc`	A channel specifier or -1 for all, -2 for visible and -3 for selected channels. When multiple channels are specified, returned values are for the first channel.
`opt%`	Values greater than 0 set the number of subdivisions between major ticks. 0 sets automatic small tick calculation. Use –1 for no change. Values less than -1 return information, but do not change the axis style
`major`	If present and `opt%` is greater than -2, values greater than 0 sets the major tick spacing. Values less than or equal to 0 select automatic major tick spacing.
Returns	If `opt%` is –2 this returns the current number of forced subdivisions or 0 if they are not forced. If `opt%` is –3 this returns the current major tick spacing if forced or 0 if not forced. Otherwise the return value is 0 or a negative error code.

See also:`YAxis(),YAxisMode(),YHigh(),YLow(),YRange(),XAxisStyle()`

Yield()

This function suspends script operation for a user defined time and allows the system to idle. During the idle time, invalid screen areas update, you can interact with the program and the system has the opportunity to do housekeeping. If your script runs for long periods without using `Interact()` or `Toolbar()`, adding an occasional `Yield()` can make it feel more responsive and stop the operating system marking Signal as "not responding".

```
Func Yield({wait{, allow%}});
```

`wait`	An optional time period, in seconds, to wait. If omitted or set to 0, the program will give the system one idle cycle and continue to run. If set negative, there is no idle cycle but the `allow%` argument is applied.
`allow%`	This defines what the user can do during the wait period. See `Interact()` for the allowed values. The `allow%` value is cancelled after the command unless `wait` is 0 or negative.
Returns	The function returns 1. We may add more return codes in future versions.

See also:`Interact()`,`Seconds()`,`TimeDate()`,`Toolbar()`

YHigh()

This function returns the current upper limit of the y axis in a data or XY view.

```
Func YHigh(chan%);
```

`chan%`	A channel number (1 to n). The channel number is ignored for an XY view.
Returns	The value at the appropriate end of the axis.

See also:`ChanTitle$(), ChanUnits$(), YLow(), YRange(), Optimise()`

YLow()

This function returns the current lower limit of the y axis in a data or XY view.

```
Func YLow(chan%);
```

`chan%`	A channel number (1 to n). The channel number is ignored for an XY view.
Returns	The value at the appropriate end of the axis.

See also:`ChanTitle$(), ChanUnits$(), YHigh(), YRange(), Optimise()`

YRange()

This sets the y axis range for a channel or XY view. Attempting to set the range for a display mode that doesn't have a y axis is not an error, but has no effect. If the y range changes, the display is invalidated, but waits for the next `Draw()`.

```
Proc YRange(chan%|chan%[]|chan$, low, high)
```

`chan%`	A channel number (1 to n) or you can also use -1 for all channels, -2 for all visible channels, -3 for all selected channels, -4 for waveform channels or -5 for marker channels, -6 for selected waveform channels or visible if none selected, -7 for visible waveform channels or -8 for selected waveform channels. The channel number is ignored in an XY view as there is only one axis for all channels. This can also be an integer array. If it is, the first array element holds the number of channels in the list. This is followed by a list of positive channel numbers.
`chan$`	A string to specify channel numbers, such as "1,3..8,9,11..16".
`low`	The value for the bottom of the y axis.
`high`	The value for the top of the y axis. If `low` and `high` are the same, or stupidly close, the range is not changed.

See also:`YHigh()`, `YLow()`, `ChanScale()`, `ChanOffset()`, `Optimise()`

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