



# PSION Programming Reference

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This is a first attempt at putting [Psion's](#) Programmer's Reference onto the Web. If, like me, you bought your 3a after they stopped shipping the manual, or you just keep forgetting it, you should find this useful. It is a first attempt, so please bear with me. 😊

By the way, rather than edit the **oplman** text files by hand I've used a PERL program to do the majority of the work. This is convenient for me, but it may mean a few blips here and there. Please email me with any cock-ups you see, and I'll fix them, and make the whole thing available via FTP.

*[Dave Stafford](#)*

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v1.0 Aug 93 English Part no. 6103-0045-01

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This HTML version of the manual was automagically created (with a tiny bit of tweaking 😊) from the oplman text files using PERL. If you want the source for this, or if you have any suggestions, please email me [Dave Stafford](#)

# Creating and running programs

There are 3 stages to producing a program using OPL, the Series 3a programming language:

- Type in the program, using the Program editor (the Program icon on the System screen).
- Translate the program. This makes a new version of your program in a format which the Series 3a can "run".
- Run the program. If it does not work as you had intended, re-edit it, then translate and run it again.

This chapter guides you through these stages with a simple example. If you wish to follow the example, note that each instruction for you to do something is numbered.

Note: the example programs in the first few chapters do not include full error handling. This keeps the programs short and easy to understand. But it means that when you run one of these programs and, for example, fail to type in the kind of value which the program asks for, the program may fail harmlessly stopping before it completed. As you develop your own programs, you should usually add some error handling code to them. A later chapter gives a full explanation of error handling.

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## Creating a new module

As well as the word program, you'll often see the word module used. The terms program and module are used almost interchangeably to describe each OPL file you say "OPL module" like you might say "Word Processor document".

Create a new module and give it a name:

1. Move to the Program icon on the System screen, and select 'New file' from the 'File' menu.
2. Type "test" as the name to use for this OPL module and press Enter. You will move into the Program editor.

Module names can be up to 8 characters long, like other filenames on the Series 3a. The names can include numbers, but must start with a letter.

It's always best to choose a name that describes what the module does. Then, when you've written several modules, you can still recognise which is which.

## Inside the Program editor

When you first move into the Program editor you will see that "PROC :" has already been entered on the first line, and "ENDP" on the third.

"PROC" and "ENDP" are the keywords that are used to mark the start and end of a procedure. Larger modules are broken up into procedures, each of which has one specific function to perform. A simple OPL module, like the one you are going to create, consists of only one procedure.

A procedure consists of a number of statements instructions which the Series 3a acts upon. You type these statements, in order, between "PROC :" and "ENDP". When you come to run the program, the Series 3a goes through the statements one by one. When the last statement in the procedure has been acted upon and "ENDP" is reached, the procedure ends.

You can type and edit in the Program editor in much the same way as in the Word Processor, except that text you type does not word-wrap; you should press Enter at the end of each statement. Note also that the Program editor does not offer

text layout features such as styles and emphases.

 You can use upper or lower case letters when entering OPL keywords.

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## An example procedure to type in

The next few pages work with this example procedure:

```
PROC test:  
  PRINT "This is my OPL program"  
  PAUSE 80  
  CLS  
  PRINT "Press a key to finish"  
  GET  
ENDP
```

This procedure does nothing of any real use it is just an example of how some common OPL keywords (PRINT, PAUSE, CLS and GET) are used. (The procedure first displays "This is my OPL program" on the screen. After a few seconds this is replaced by "Press a key to finish". Then, when you press a key, the program finishes.)

---

## Type in and edit the procedure

Before you type the statements that constitute the procedure, you must type a name for it, after the word "PROC". The flashing cursor is automatically in the correct place (before the colon) for you to do this. You can choose any name you like (with the same restrictions as when entering the filename earlier). For simple procedures which are the only procedure in a module, you might use the same filename you gave the module.

1. Type "test" . The top line should now read "PROC test:" .
2. Press " DOWN ". The cursor is already indented, as if the Tab key had been pressed.

You can now type the statements in this procedure:

3. Type "PRINT "This is my OPL program"" . (Note the space after "PRINT".) Press Enter at the end of the line.

Each new line is automatically indented, so you don't need to press the Tab key each time. These indents are not obligatory, though as you'll see, they can make a procedure easier to read. However, other spacing such as the space between "PAUSE" and "80" is essential for the procedure to work properly.

4. Type the other statements in the procedure. Press Enter at the end of each line. You are now ready to translate the module and then run it.

When you are entering the statements in a procedure you can, if you want, combine adjacent lines by separating them with a space and colon. For example, the two lines:

```
PAUSE 80 CLS
```

could be combined as this one line:

```
PAUSE 80 :CLS
```

You can, of course, use the other Series 3a applications at any time while you are editing an OPL module. Use Control-Word (hold down the Control key and press the Word button) to return to the Program editor to continue editing your program.

## What the keywords do when the program runs

"PRINT" takes text you enter between quote marks, and displays it on the screen. The text to be displayed, in the first

statement, is "This is my OPL program".

"PAUSE" pauses the program, for a specified number of twentieths of a second. "PAUSE 80" waits for 4 seconds. ("PAUSE 20" would wait for 1 second, and so on.)

"CLS" clears the screen.

"GET" waits for you to press a key on the keyboard.

---

## Translating a module

The translation process makes a separate version of your program in a format which the Series 3a can run.

You'd usually try to translate a module as soon as you finish typing it in, to check for any typing mistakes you've made, and then to see if the program runs as you intended.

1. Select the 'Translate' option from the 'Prog' menu.

☞ The 'Prog' menu also has a 'S3 translate' option, for translating the current program in a form which can run on a Psion Series 3 (as opposed to a Series 3a).

### What happens when you translate a module?

First: the procedures in the module are checked for errors.

If the Series 3a cannot understand a procedure, because of a typing error, a message is shown, such as 'Syntax error'. The cursor is positioned at the point where the error was detected, so that you can correct it. For example, you might have typed "PRONT "This is..."", or "PAUSE80" without the space.

When you think you've corrected the mistake, select 'Translate' from the 'Prog' menu again. If there is still a mistake, you are again taken back to where it was detected.

☞ If you've already used up almost all of the memory, the Series 3a may be unable to translate the program, and will report a 'No system memory' message. You'll need to free some memory, as described in the 'Troubleshooting' chapter of the User Guide, before trying again.

When 'Translate' can find no more errors, the translation will succeed, producing a separate version of your module in a format which the Series 3a can run.

There may still be errors in your program at this point because there are some errors which cannot be detected until you try to run the program.

### Running after translating

When your module translates successfully, the 'Run program' dialog is displayed, asking whether to run the translated module. You'd usually run it straight away in order to test it.

☞ Running a module does require some free memory, so again a 'No system memory' message is possible.

1. Press 'Y' to run the module; the screen is cleared, and the module runs.

When the module has finished running, you return to the Program editor, with the cursor where it was before.

If an error occurs while the module is running, you will return to editing the module, with the cursor at the point where the error occurred.

---

## File management

## New OPL modules

You can create new OPL modules in the same way as new Word Processor documents. Use the 'New file' option in the Program editor, or move to the Program icon in the System screen and use its 'New File' option.

Your module names are listed below the Program icon. The word 'Program' is shown below the icon if there are no modules at all.

The names under the RunOpl icon are those modules which have been translated successfully.

To re-edit an existing OPL program, use the 'Open file' option in the Program editor, or move to the Program icon in the System screen and select the filename from the list.

## Copying modules

Use the 'Copy file' option in the System screen to copy modules (or translated modules). See the User Guide for full details. You can also use the 'Save as' option in the Program editor itself, to make new copies of an OPL module.

## Deleting modules

You can delete an OPL module (or a translated version) as you would any other file go to the System screen, move the highlight onto the file and use the 'Delete file' option.

☞ If you delete all of your translated modules, the RunOpl icon will remain on the System screen, with the word 'RunOpl' beneath it.

## 'File or device in use'

If you see a 'File or device in use' error message when deleting or copying an OPL module, the file is open it is currently being edited in the Program editor. Exit the file, eg with the Delete key in the System screen, then try again.

If it's the translated file you're trying to delete or copy, 'File or device in use' means that the translated file is currently running. Stop the running program by pressing Control-Calc (to go to the running program) then Psion-Esc (to stop it), and then you can try again.

---

## More about running modules

### Running from the Program editor

You can run a module at any time from within the Program editor, by selecting 'Run' from the 'Prog' menu. This runs the translated version of your program; if you've made changes to the module and haven't translated it again, you must translate the module again, or the changes have no effect.

'Run' displays a dialog, letting you select the name of any translated module which you want to run.

### Running modules from the System screen

The names of any successfully translated programs automatically appear under a new icon in the System screen. The icon is just the word "OPL" in a speech bubble, and is called the 'RunOpl' icon. It appears at the right-hand end of the list of icons (past the Program icon), and is usually off the right-hand edge of the screen. Just move the highlight onto the name of the translated program you want to run, and press Enter.

Like the Program editor, RunOpl is assigned a keypress - you can press Control-Calc (hold down Control and press the Calc button) as the short-cut to move to the RunOpl icon, whatever you're doing. (If there is a running program, this instead moves directly to it.)

When an OPL module has been successfully translated and run, you will usually run it from the System screen. While you're still editing and testing, however, it's quicker to run it from inside the Program editor. This also positions the cursor for you, if errors occur.

## Stopping a program while it's running

To stop a running program, press Psion-Esc. (If you've gone away from the running program it will still be running, and you must first return to it perhaps by pressing Control-Calc and/or selecting it from under the RunOpl icon in the System screen before pressing Psion-Esc.)

To pause a running program, press Control-S. It will be paused as soon as it next tries to display something on the screen. Press any other key to let the program resume running.

## Displaying a status window

A temporary status window is always available while an OPL program is running. Press Psion-Menu to see it. As you'll see, there are keywords for displaying a status window yourself.

## Looking at a running program

If you translate and run a module from the Program editor, the Control-Word keypress will still return to the Program editor, even if the translated program has not finished running. A 'Busy' message is shown you can move the cursor around the program as normal, but you can't edit it.

To return to the running version, select it from beneath the RunOpl icon in the System screen. It will be in bold, at the top of the list, to show that it is currently running. Alternatively, press Control-Calc.

## Running more than one module

If a module is running, and you select a second one from the System screen, the first one is not replaced both modules run together, and will be in bold on the file list. Control-Shift-Calc swaps between them.

---

## Menu options while editing

While you're typing in the procedure, all the options on the 'Edit' menu such as 'Copy text' and 'Insert text' are available and can be used as in the Word Processor. Refer to the chapter on the Word Processor in the User Guide for more information.

The menus available are the same as in the Word Processor, except that the 'Word' menu has been replaced by the 'Prog' menu. The 'Prog' menu has options for translating and running the current program. It also has a 'Show error' option, to re-display an error which prevented successful translation, and an 'Indentation' option, for setting the tab width and to turn auto-indentation on and off in the Program editor.

Unlike the Word Processor, the Program editor only ever uses one template for creating new files, called 'default'. When you use the 'New file' option, the 'Use template' line is therefore unavailable; the new file is created using the 'default' template automatically. If you wish to change the 'default' template, you can use the 'Save as template' option to replace it with the current file. Do not try to swap templates between the Word Processor and the Program editor.

'Set preferences' allows you to choose between bold/normal and mono/proportional text. It also has options for showing tabs, spaces, paragraph ends, soft hyphens and forced line breaks.

There is no 'Password' option.

## The ◆ (diamond) key

The ◆ key allows you to switch between a 'Normal' and an 'Outline' view of your OPL module. The 'Outline' view lists

only the names of each procedure, for quick navigation around the module.

---

## **SUMMARY**

Move to the Program icon in the System screen and select the 'New file' option.

Type in your procedure.

Select 'Translate' from the 'Prog' menu.

When a module translates correctly you are given the option to run it. You can run it again at any time, either with 'Run' in the 'Prog' menu, or directly from the RunOpl icon in the System screen.

---

# Error handling

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## Syntax errors

Syntax errors are those which are reported when translating a procedure. (Other errors can occur while you're running a program.) The OPL translator will return you to the line where the first syntax error is detected.

All programming languages are very particular about the way commands and functions are used, especially in the way program statements are laid out. Below are a number of errors which are easy to make in OPL. The incorrect statements are in bold and the correct versions are on the right.

## Punctuation errors

Omitting the colon between statements on a multi-statement line:

Incorrect	Correct
<b>a\$="text" PRINT a\$</b>	a\$="text" :PRINT a\$

Omitting the space before the colon between statements :

Incorrect	Correct
<b>a\$=b\$:PRINT a\$</b>	a\$=b\$ :PRINT a\$

Omitting the colon after a called procedure name:

Incorrect	Correct
<b>PROC proc1:</b> GLOBAL a,b,c . <b>ENDP</b>	<b>PROC proc1:</b> GLOBAL a,b,c . <b>ENDP</b>

proc2	proc2:
-------	--------

Using only 1 colon after a label in GOTO/ONERR/VECTOR (instead of 0 or 2):

Incorrect	Correct
<b>GOTO below:</b> . <b>below::</b>	GOTO below . below::

## Structure errors

The DO...UNTIL, WHILE...ENDWH and IF...ENDIF structures can produce a 'Structure fault' error if used incorrectly:

- Attempting to nest any combination of these structures more than eight levels deep.
- Mixing up the three structures eg by using DO...WHILE instead of DO...UNTIL.
- Using BREAK or CONTINUE in the wrong place.
- Using ELSE IF with a space, instead of ELSEIF.

VECTOR...ENDV can also produce a 'Structure fault' error if used incorrectly.

---

# Errors in running procedures

OPL may display an error message and stop a running program if certain 'error' conditions occur. This may happen because:

- There is a mistake, or bug, in your program, which could not be detected during translation for example, a calculation has involved a division by zero.
- A problem has occurred which prevents a command or function from working for example, an APPEND command may fail because an SSD is full.

Unless you include statements which can handle such errors when they occur, OPL will use its own error handling mechanism. The program will stop and an error message be displayed. The first line gives the names of the procedure in which the error occurred, and the module this procedure is in. The second line is the 'error message' one of the messages listed at the end of this chapter. If appropriate, you will also see a list of variable names or procedure names causing the error.

If you were editing the module with the Program editor and you ran it from there, you would also be taken back to editing the OPL module, with the cursor at the line where the error occurred.

## Error handling functions and commands

To prevent your program being stopped by OPL when an error occurs, include statements in your program which anticipate possible errors and take appropriate action. The following error handling facilities are available in OPL:

- TRAP temporarily suppresses OPL's error processing.
- ERR and ERR\$ find out what kind of error has occurred.
- ONERR establishes an error handler which can suppress OPL's error processing over whole modules.
- RAISE can be used to simulate error conditions.

These facilities put you in control and must be used carefully.

## Strategy

You should design the error handling of a program in the same way as the program itself. OPL works best when programs are built up from procedures, and you should design your error handling on the same basis. Each procedure should normally contain its own local error handling:

(picture)

The error handling statements can then be appropriate to the procedure. For example, a procedure which performs a calculation would have one type of error handling, but another procedure which offers a set of choices would have another.

---

## TRAP

TRAP can be used with any of these commands: APPEND, BACK, CACHE, CLOSE, COMPRESS, COPY, CREATE, DELETE, ERASE, EDIT, FIRST, gCLOSE, gCOPY, gFONT, gPATT, gSAVEBIT, gUNLOADFONT, gUSE, INPUT, LAST, LCLOSE, LOADM, LOPEN, MKDIR, NEXT, OPEN, OPENR, POSITION, RENAME, RMDIR, UNLOADM, UPDATE and USE.

The TRAP command immediately precedes any of these commands, separated from it by a space for example:

TRAP INPUT a%

If an error occurs in the execution of the command, the program does not stop, and the next line of the program executes as if there had been no error. Normally you would use ERR on the line after the TRAP to find out what the error was.

## Example

When INPUT is used without TRAP and a text string is entered when a number is required, the display just scrolls up and a "?" is shown, prompting for another entry. With TRAP in front of INPUT, you can handle bad entries yourself:

```
PROC trapinp:
LOCAL profit%
DO
PRINT
PRINT "Enter profit",
TRAP INPUT profit%
UNTIL ERR=0
PRINT "Valid number"
GET
ENDP
```

This example uses the ERR function, described next.

---

## ERR and ERR\$

When an error occurs in a program, check what number the error was, with the ERR function:

e%=ERR

If ERR returns zero, there was no error. The value returned by ERR is the number of the last error which occurred it changes when a new error occurs. TRAP sets ERR to zero if no error occurred. Check the number it returns against the error messages listed at the end of this Chapter.

The ERR\$ function gives you the message for error number e%:

e\$=ERR\$(e%)

You can also use ERR and ERR\$ in conjunction:

e\$=ERR\$(ERR)

This returns the error message for the most recent error.

## Example

The lines below anticipate that error number -101 (File already open) may occur. If it does, an appropriate message is displayed.

```
TRAP OPEN "main",A,a$
e%=ERR
IF e% REM Checks for an error
IF e%=-101
PRINT "file is already open!"
ELSE
PRINT ERR$(e%)
ENDIF
ENDIF
```

The inner IF...ENDIF structure displays either the message in quotes if the error was number -101, or the standard error message for any other error.

## TRAP INPUT/EDIT and the Esc key

If in response to a "TRAP INPUT" or "TRAP EDIT" statement, the Esc key is pressed while no text is on the input/edit line, the 'Escape key pressed' error (number -114) will be raised. (This error will only be raised if the INPUT or EDIT has been trapped. Otherwise, the Esc key still leaves you editing.)

You can use this feature to enable someone to press the Esc key to escape from editing or inputting a value. For example:

```
PROC trapInp:
  LOCAL a%,b%,c%
  PRINT "Enter values."
  PRINT "Press Esc to exit"
  PRINT "a% =", :TRAP INPUT a% :PRINT
  IF ERR=-114 :GOTO end :ENDIF
  PRINT "b% =", :TRAP INPUT b% :PRINT
  IF ERR=-114 :GOTO end :ENDIF
  PRINT "a%*b% =", a%*b%
  PAUSE -40
  RETURN
end::
  PRINT :PRINT "OK, finishing..."
  PAUSE -40
  RETURN
ENDP
```

---

## ONERR ... ONERR OFF

ONERR sets up an error handler. This means that, whenever an error occurs in the procedure containing ONERR, the program will jump to a specified label instead of stopping in the normal way. This error handler is active until an ONERR OFF statement.

You specify the label after the word ONERR.

The label itself can then occur anywhere in the same procedure even above the ONERR statement. After the label should come the statements handling whatever error may have caused the program to jump there. For example, you could just have the statement "PRINT ERR\$(ERR)" to display the message for whatever error occurred.

All statements after the ONERR command, including those in procedures called by the procedure containing the ONERR, are protected by the ONERR, until the ONERR OFF instruction is given.

### Example

(picture)

If an error occurs in the lines between "ONERR errHand" and "ONERR OFF", the program jumps to the label "errHand:." where a message is displayed.

Always cancel ONERR with ONERR OFF immediately after the label.

### When to use ONERR OFF

You could protect the whole of your program with a single ONERR. However, it's often easier to manage a set of procedures which each have their own ONERR...ONERR OFF handlers, each covering their own procedure. Secondly, an endless loop may occur if all errors feed back to the same single label.

For example, the diagram below shows how an error handler is left active by mistake. Two completely different errors cause a jump to the same label, and cause an inappropriate explanatory message to be displayed. In this example an endless loop is created because "next:" is called repeatedly: (picture)

### Multiple ONERRs

You can have more than one ONERR in a procedure, but only the most recent ONERR is active. Any errors cause a jump to the label for the most recent ONERR.

ONERR OFF disables all ONERRs in the current procedure. But if there are other ONERRs in procedures above this procedure (calling procedures) these ONERRs are not disabled.

## TRAP and ONERR

TRAP has priority over ONERR. In other words, an error from a command used with TRAP will not cause a jump to the error handler specified with ONERR.

---

## RAISE

The RAISE command generates an error, in the same way that OPL raises errors whenever it meets certain conditions which it recognises as unacceptable (for example, when invalid arguments are passed to a function). Once an error has been raised, either by OPL or by the RAISE command, the error-handling mechanism currently in use takes effect the program will stop and report a message, or if you've used ONERR the program will jump to the ONERR label.

There are two reasons for using RAISE:

- You may want to mimic OPL's error conditions in your own procedures. For example, if you create a new procedure which performs a calculation and returns a value, you may want to RAISE an 'Overflow' or 'Divide by zero' error if unsuitable numbers are passed as parameters.

In this case, you would RAISE one of the standard error numbers. You could handle this yourself with ONERR, or let OPL handle it in the normal way.

- OPL raises only a limited range of errors for general use, and you may want to raise new kinds of error codes specific to your program or particular circumstances.

In this case, you would RAISE a new error number. With ONERR on, RAISE would go to the ONERR label, where you would have code to interpret your new error numbers. You could then display appropriate messages.

You can use any positive number (from 0 to 127) as a new error code. Do not use any of the numbers in the list that follows.

You may also find RAISE useful for testing your error handling.

Example:

```
PROC main:
  REM calling procedure
  PRINT myfunc:(0.0)      REM will raise error -2
ENDP

PROC myfunc: (x)
  LOCAL s
  REM returns 1/sqr(x)
  s=SQR(x)
  IF s=0
    RAISE -2
    REM 'Invalid arguments'
    REM avoids 'divide by zero'
  ENDIF
  RETURN (1/s)
ENDP
```

This uses RAISE to raise the 'Invalid arguments' error not the 'divide by zero' error, since the former is the more appropriate message.

---

# Error messages

These are the numbers of the errors which OPL can raise, and the message associated with them:

Number Message:

-1 General failure  
-2 Invalid arguments  
-3 O/S error  
-4 Service not supported  
-5 Underflow (number too small)  
-6 Overflow (number too large)  
-7 Out of range  
-8 Divide by zero  
-9 In use (eg serial port being used by another program)  
-10 No system memory  
-13 Process table full/Too many processes  
-14 Resource already open  
-15 Resource not open  
-16 Invalid image/device file  
-17 No receiver  
-18 Device table full  
-19 File system not found (eg if you unplug cable to PC)  
-20 Failed to start  
-21 Font not loaded  
-22 Too wide (dialogs)  
-23 Too many items (dialogs)  
-24 Batteries too low for digital audio  
-25 Batteries too low to write to Flash

File and device errors

-32 File already exists  
-33 File does not exist  
-34 Write failed  
-35 Read failed  
-36 End of file (when you try to read past end of file)  
-37 Disk full  
-38 Invalid name  
-39 Access denied (eg to a protected file on PC)  
-40 File or device in use  
-41 Device does not exist  
-42 Directory does not exist  
-43 Record too large  
-44 Read only file  
-45 Invalid I/O request  
-46 I/O operation pending  
-47 Invalid volume (corrupt disk)  
-48 I/O cancelled  
  
-50 Disconnected  
-51 Connected  
-52 Too many retries  
-53 Line failure  
-54 Inactivity timeout  
-55 Incorrect parity  
-56 Serial frame (usually because Baud setting is wrong)  
-57 Serial overrun (usually because Handshaking is wrong)  
-58 Cannot connect to remote modem  
-59 Remote modem busy  
-60 No answer from remote modem  
-61 Number is black listed (you may try a number only a certain number of times; wait a while and try again)  
-62 Not ready  
-63 Unknown media (corrupt SSD)  
-64 Root directory full (on any device, the root directory has a maximum amount of memory allocated to it)  
-65 Write protected  
-66 Media is corrupt  
-67 User abandoned

-68 Erase pack failure  
-69 Wrong file type

#### Translator errors

-70 Missing "  
-71 String too long  
-72 Unexpected name  
-73 Name too long  
-74 Logical device must be A-D  
-75 Bad field name  
-76 Bad number  
-77 Syntax error  
-78 Illegal character  
-79 Function argument error  
-80 Type mismatch  
-81 Missing label  
-82 Duplicate name  
-83 Declaration error  
-84 Bad array size  
-85 Structure fault  
-86 Missing endp  
-87 Syntax Error  
-88 Mismatched ( or )  
-89 Bad field list  
-90 Too complex  
-91 Missing ,  
-92 Variables too large  
-93 Bad assignment  
-94 Bad array index  
-95 Inconsistent procedure arguments

#### OPL specific errors

-96 Illegal Opcode (corrupt module translate again)  
-97 Wrong number of arguments (to a function or  
parameters to a procedure)  
-98 Undefined externals (a variable has been  
encountered which hasn't been declared)  
-99 Procedure not found  
-100 Field not found  
-101 File already open  
-102 File not open  
-103 Record too big (data file contains record too big for OPL)  
-104 Module already loaded (when trying to LOADM)  
-105 Maximum modules loaded (when trying to LOADM)  
-106 Module does not exist (when trying to LOADM)  
-107 Incompatible translator version (OPL file needs  
retranslation)  
-108 Module not loaded (when trying to UNLOADM)  
-109 Bad file type (data file header wrong or corrupt)  
-110 Type violation (passing wrong type to parameter)  
-111 Subscript or dimension error (out of range in array)  
-112 String too long  
-113 Device already open (when trying to LOPEN)  
-114 Escape key pressed  
-115 Incompatible runtime version  
-116 ODB file(s) not closed  
-117 Maximum drawables open (maximum 8 windows and/or  
bitmaps allowed)  
-118 Drawable not open  
-119 Invalid Window (window operation attempted on a bitmap)  
-120 Screen access denied (when run from Calculator)

---

# Advanced Topics

Many of the subjects covered in this chapter may provide benefits for all levels of programmers.

The subjects become progressively more technical, however. This manual cannot cover every OPL keyword in detail, as some give access to the innermost workings of the Series 3a. Some of these keywords are touched on in this chapter.

---

## Programs, modules, procedures

### Programs using more than one module

Program is the more general word for the "finished product" a set of procedures which can be run. A program may consist of one module containing one or more procedures: (picture)

It may also consist of a number of modules containing various procedures: (picture)

A procedure in one module can call procedures in another module, provided this module has been loaded with the LOADM command. LOADM needs the filename of the module to load.

For example, if an OPL module "MAIN" has these two procedures:

```
PROC main:
  LOADM "library"
  pthis: REM run pthis: in this module
  pother: REM run pother: in "library"
  PRINT "Finished"
  PAUSE 40
  UNLOADM "library"
ENDP
```

```
PROC pthis:
  PRINT "Running pthis:"
  PRINT "in this module"
  PAUSE 40
ENDP
```

and a module called "LIBRARY" has this one:

```
PROC pother:
  PRINT "Running pother:"
  PRINT "in module called LIBRARY"
  PAUSE 40
ENDP
```

then running "MAIN" would display "Running pthis:" and "in this module"; then display "Running pother:" and "in module called LIBRARY"; and then display "Finished".

### You would usually only need to load other modules when developing large OPL programs.

You can use LOADM up to three times, to load up to three modules. If you want to load a fourth module, you must first unload one of those currently loaded, by using UNLOADM with the filename. To keep your program tidy, you should UNLOADM a module as soon as you have finished using it.

☛ If there is an error in the running program, you will only be positioned in the Program editor to the place where the error occurred if you were editing the module concerned (and you ran the program from there).

In spite of its name, LOADM does not "load" the whole of another module into memory. Instead, it just loads a block of data stored in the module which lists the names of the procedures which it contains. If such a procedure is then called, the procedure will be searched for, copied from file into memory and the procedure will then be run.

The modules are searched through in the order that they were loaded the module loaded last is searched through last. **You may make considerable improvements in speed if you have few modules loaded at a time (so avoiding a long search for each procedure) and if you load the modules with the most commonly called procedures first.**

## Cacheing procedures for speed

Without procedure cacheing, procedures are loaded from file whenever they are called, and discarded when they return. This is true even when procedures are all in one module. (With more than one module, LOADM simply loads a map listing procedure names and their positions in the module file so that they can be loaded fairly efficiently. It does not load procedures into memory.)

If a well-designed program calls procedures regularly, you can speed it up by cacheing procedures keeping the code for a procedure loaded in memory after it returns, so that if it is called again there is no need to fetch it from file again. The CACHE command takes two arguments the initial size of the cache and the maximum size (both in bytes). These can be up to 32,767 bytes. The minimum in both cases is 2000 bytes.

For a small program, you might use "CACHE 2000,2000" at the start of the program. Up to 2000 bytes of procedure code will be cached. If the cache fills up, and a procedure is called which is not in the cache, space will be made for it in the cache by removing other procedures from it.

For a much larger program, you might use "CACHE 10000,10000". You may wish to change the settings and find the smallest setting which produces the maximum speed improvement.

Once a cache has been created, "CACHE OFF" prevents further cacheing, although the cache is still searched when calling subsequent procedures. "CACHE ON" may then be used to re-enable cacheing.

## Calling procedures by strings

Procedures can be called using a string expression for the procedure name. Use an "@" symbol, optionally followed by a character to show what type of value is returned for example, "%" for an integer. Follow this with the string expression in brackets. You can use upper or lower case characters.

Here are examples showing the four types of value which can be returned:

```
i% = @(name$):(parameters) for integer
l& = @&(name$):(parameters) for long integer
s$ = @$ (name$):(parameters) for string
f = @(name$):(parameters) for floating-point
```

So, for example, "test\$(1.0,2)" and "@\$("test"): (1.0,2)" are equivalent.

Note that the string expression does not itself include a symbol for the type ("% ", "&" or "\$").

You may find this useful if, in a more complex program, you want to "work out" the name of a procedure to call at a particular point. The chapter on 'Friendlier interaction' includes an example program which uses this method.

---

## Where files are kept

The internal memory and SSDs use a DOS-compatible directory structure, the same as that used on disks on business PCs. However, the Series 3a hides the complexities of this. You have only to supply a filename, and to say whereabouts a file is internal, on an SSD, or on another computer to which the Series 3a is linked.

In fact, in order to completely specify a file, the Series 3a uses a filing system, drive (or device), directory and filename:

- The filing system usually specifies the computer, and is usually "LOC::" ('local' the Series 3a) or "REM::" ('remote' an attached computer). This is always three letters and two colons.

- The drive is the area on that computer where the file is kept. On the Series 3a this can be "M:" (internal disk), "A:" (left SSD drive) or "B:" (right SSD drive).
- Every drive has one root directory, usually written as a backslash ("\"). This can "contain" files and/or other directories, each of which can contain more files and/or more directories. When you have "directories in directories" like this, they're often called subdirectories. Their names show where they are. For example, the root directory ("") could contain a directory called "\JO", which might in turn contain a directory called "\JO\BACKUP", which might contain some files.
- Filenames are composed of one to eight letters and/or numbers, optionally followed by a file extension comprised of a dot and from one to three letters/numbers. File extensions are by convention used to group different types of files. The Series 3a uses file extensions in this way, but hides this from you.

To completely specify a file, you add the four parts together. The directory part must end with a backslash. So an OPL module named "TEST", in a directory called "\JO" in the Series 3a internal memory can be specified as "LOC::M:\JO\TEST.OPL". If this file were in the "\JO\BACKUP" directory, it would be completely specified as "LOC::M:\JO\BACKUP\TEST.OPL". If it were in the root directory, you would specify it as "LOC::M:\TEST.OPL".

A full file specification may be up to 128 characters long.

In OPL, unless you say otherwise, files are kept on the Series 3a "(LOC::)", in the internal memory ("M:"). The directories and file extensions used are:

Type of file	Directory	File extension
OPL modules	\OPL	.OPL
translated modules	\OPO	.OPO
data files	\OPD	.ODB
bitmaps	\OPD	.PIC

## Using file specifications in OPL

OPL commands which specify a filename, such as OPEN, CREATE, gLOADBIT and so on, can also use any or all of the other parts that make up a full file specification. (Normally, the only other part you might use is the drive name, if the file were on an SSD.) So for example, "OPEN "REM::C:\ADDR.TXT"... tries to open a data file called "ADDR.TXT" on the root directory of a hard disk "C:" on an attached PC.

You can use the PARSE\$ function if you need to build up complex filenames. See the alphabetic listing for more details of PARSE\$.

Unless you have a good reason, though, it's best not to change directories or file extensions for files on the Series 3a. You can lose information this way, unless you're careful.

## Control of directories

Use the MKDIR command to make a new directory. For example, "MKDIR "M:\MINE\TEMP"" creates a "M:\MINE\TEMP" directory, also creating "M:\MINE" if it is not already there. An error is raised if the chosen directory exists already use "TRAP MKDIR" to avoid this.

SETPATH sets the current directory for file access for example, "SETPATH "A:\DOCS"". LOADM continues to use the directory of the running program, but all other file access will be to the new directory instead of \OPD.

Use RMDIR to remove a directory for example, "RMDIR "M:\MINE"" removes the "MINE" directory on "M:\". An error is raised if the directory does not exist use "TRAP RMDIR" to avoid this.

You can only remove empty directories.

## File specifications on REM::

You should not assume that remote file systems use DOS-like file specifications for example, an Apple Macintosh specification is "disk:folder:folder:filename". You can only assume that there will be four parts disk/device, path, filename and (possibly null) extension. PARSE\$, however, will always build up or break down REM:: file specifications correctly.

---

## Safe pointer arithmetic

Whenever you wish to add or subtract something from an integer which is an address of something (or a pointer to something) you should use UADD and USUB. If you do not, you will risk an 'Integer overflow' error.

An address can be any value from 0 to 65535. An integer variable can hold the full range of addresses, but treats those values from 32768 to 65535 as if they were -32768 to -1. If your addition or subtraction would convert an address in the 0-32767 range to one in the 32768-65535 range, or vice versa, this would cause an 'Integer overflow'.

UADD and USUB treat integers as if they were unsigned, ie as if they really held a value from 0 to 65535.

For example, to add 1 to the address of a text string (in order to skip over its leading byte count and point to the first character in the string), use "i%=UADD(ADDR(a\$),1)", not "i%=ADDR(a\$)+1".

USUB works in a similar way, subtracting the second integer value from the first integer, in unsigned fashion for example, "USUB(ADDR(c%),3)".

☞ "USUB(x%,y%)" has the same effect as "UADD(x%,-y%)".

---

## OPL applications (OPAs)

You can make an OPL program appear as an icon in the system screen, and behave like the other icons there, by converting it into an OPL application, or OPA. There are five different types of OPA, called type 0 to type 4:

- "TYPE 0" (like Calc): The OPA uses no files.
- "TYPE 1": Only one file is used. A type 1 OPA will look the same as a type 0. The only difference is that the type 1 is using a file, of the same name as the OPA.
- "TYPE 2" (like World): You can have more than one file, but only one can be in use (bold) at any time.

When you pick a new file to use, its name becomes bold, and the one that was previously bold reverts to normal. What has actually happened is that the running OPA has switched files it has not closed down, and no new copy of the OPA is run.

- "TYPE 3" (like Data, Word, Agenda and Sheet): You can have more than one file, and any number may be open (bold) at a given time.

When you select a new file, one of the running OPAs normally switches to this file, as with type 2 OPAs. You can, however, with Shift-Enter, start a new OPA running just for this file, without a different file exiting.

- "TYPE 4" (like RunOpl): Many files can be used, and any number may be in use at a given time. When you select a new file, a new version of the OPA is always run, to use the new file.

Types 3 and 4 allow more than one file to be in use (ie have their names in bold). When this happens a separate version of the OPA runs for each bold file. With types 0, 1 and 2, only one version of the OPA can be running at any time.

Initially, the OPA's name appears beneath the icon. If you move onto this name and press Enter, file-based OPAs (types 1 to 4) will use a file of this name. Types 2, 3 and 4 allow you to create lists of files below the icon (with the 'New file' option). You use the file lists in the same way as the lists under the other icons in the System screen.

You can stop a running OPA by moving the cursor onto its bold name and pressing Delete. After a 'Confirm' dialog, the System screen tells the OPA to stop running.

## Defining an OPA

To make an OPA, your OPL file should begin with the APP keyword, followed by a name for the OPA. The name should begin with a letter, and comprise of 1 to 8 letters and/or numbers. (Note that it does not have quote marks.) The APP line may be followed by any or all of the keywords PATH, EXT, ICON and TYPE. A Series 3a OPA should also add \$1000 to the type if it has its own 48x48 pixel, black/grey icon (see the discussion of ICON below for details). Finally, use ENDA, and then the first procedure may begin as in a normal OPL file. Here is an example of how an OPA might start:

```
APP Expenses
  TYPE $1003
  PATH "\EXP"
  EXT "EXP"
  ICON "\OPD\EXPENSES.PIC"
ENDA
```

Here is another example:

```
APP Picture
  TYPE 1
ENDA
```

TYPE takes an integer argument from 0 to 4. The various types of OPA are outlined earlier. If you don't specify the type, 0 is used.

PATH gives the directory to use for this OPA's files. If you do not use this, the normal "\OPD" directory will be used. The maximum length, including a final "\", is 19 characters. Don't include any drive name in this path.

EXT gives the file extension of files used by this OPA. If you do not specify this, ".ODB" is used. Note that the files used by an OPA do not have to be data files, as the I/O commands give access to files of all kinds. EXT does not define the file type, just the file extension to use. However, for simplicity's sake, examples in this section use data files.

(PATH and EXT provide information for the System screen they do not affect the program itself. The System screen displays under the OPA icon all files with the specified extension in the path you have requested.)

ICON gives the name of the bitmap file to use as the icon for this OPA. If no file extension is given, .PIC is used. If you do not use ICON, the OPA is shown on the System screen with a standard OPA icon.

As mentioned above, you should add \$1000 to the argument to TYPE for a Series 3a icon. This specifies that the icon has size 48x48 pixels (instead of 24x24 as it was on the Series 3). If the first bitmap has size 24x24, it is ignored and the following two bitmaps must be the 48x48 black and grey icons respectively. If the first bitmap is 48x48, it is assumed to be the black icon and the grey icon must follow. If \$1000 is not set, a scaled up 24x24 icon will be used. The translator does not check the size of the icons. If you want to design your own icon using an OPL program, see gSAVEBIT for details on saving both black and grey planes to a bitmap file.

The arguments to any of the keywords between APP and ENDA must be constants and not expressions. So, for example, you must use "TYPE \$1003" instead of "TYPE \$1000 OR 3".

## Running the OPA

Once you've translated the OPL file, return to the System screen and use Install on the App menu to install the OPA in the System screen. (You only need to do this once.) Once installed, file-based OPAs are shown with the list of available files, if any are found. Otherwise, the name used after the APP keyword appears below the icon.

(Note: the translated OPA is saved in a "\APP" directory. If you previously translated the module without the APP..ENDA at the start, the old translated version will still be listed under the RunOpl icon, and should be deleted.)

The first thing a file-based OPA should do is to get the name of the file to use, and check whether it is meant to create it or open it. "CMD\$(2)" returns the full name of the file to use; "CMD\$(3)" returns "C" for "Create" or "O" for "Open".

All file-based OPAs (types 1 to 4) should handle both these cases; if a "Create" fails because the file exists already, or an "Open" fails because it does not, OPL raises the error, and the OPA should take suitable action - perhaps even just exiting.

## How the SERIES 3a talks to an OPA

When the Series 3a wants an OPA to exit or to switch files, it sends it a System message, in the form of an event. This would happen if you press Delete to stop a running OPA, or select a new file for a type 2 or 3 OPA.

TESTEVENT and GETEVENT check for certain events, including both keypresses and System messages. All types of OPA must use these keywords to check for both keypresses and System messages; keyboard commands such as GET, KEY and KEYA cause other events to be discarded.

GETEVENT waits for an event whereas TESTEVENT simply checks whether an event has occurred without getting it.

If TESTEVENT returns non-zero, an event has occurred, and can be read with GETEVENT. This takes one argument, the name of an integer array for example, "GETEVENT a%()". The array should be at least 6 integers long. (This is to allow for future upgrades you only need use the first two integers.)

If the event is a keypress:

a%(1)= keycode (as for GET)

a%(2) AND \$00ff= modifier (as for KMOD)

a%(2)/256= auto-repeat count (ignored by GET; you can ignore it too)

For non-key events "(a%(1) AND \$400)" will be non-zero. If the event is a System message to change files or quit, "a%(1)=\$404". You should then use GETCMD\$ to find the action required.

GETCMD\$ returns a string, whose first character is "C", "O" or "X". If it is "C" or "O", the rest of the string is a filename.

You can only call GETCMD\$ once for each event. You should do so as soon as possible after reading the event. Assign the value returned by GETCMD\$ to a string variable so that you can extract its components.

If you have "c\$=GETCMD\$", the first character, which you can extract with "LEFT\$(c\$,1)", has the following meaning:

"C" close down the current file, and create the specified new file.

"O" close down the current file, and open the specified existing file.

"X" close down the current file (if any) and quit the OPA.

Again with "c\$=GETCMD\$", "MID\$(c\$,2,128)" is the easiest way to extract the filename.

Note: events are ignored while you are using keywords which pause the execution of the program GET, GET\$, EDIT, INPUT, PAUSE, MENU and DIALOG. If you need to use these keywords, use "LOCK ON / LOCK OFF" (described later) around them to prevent the System screen from sending messages.

## Example OPAs

Here is a type 0 OPA, which just prints the keys you press. The keyboard procedure "getk%:" returns the key pressed, as with GET, but jumps to a procedure "endit:" if a System message to close down is received. (Type 0 OPAs do not receive "change file" messages.)

"getk%:" does not return events with values 256 (\$100) or above, as they are not simple keypresses. This includes the non-typing keys like Menu (\$100-\$1FF), hot-keys (\$200-\$3FF), and non-key events (\$400 and above).

```
APP myapp0 TYPE $1000 ICON "\opd\me" ENDA
```

```
PROC start:
```

```
GLOBAL a%(6),k%
```

```
STATUSWIN ON :FONT 11,16
```

```

PRINT "Q to Quit"
PRINT " or press Delete in"
PRINT " the System screen"
DO
  k%=getk%:
  PRINT CHR$(k%);
UNTIL (k% AND $ffdf)=%Q  REM Quick way to do uppercase
ENDP

```

```

PROC getk%:
DO
  GETEVENT a%()
  IF a%(1)=$404
    IF LEFT$(GETCMD$,1)="X"
      endit:
    ENDIF
  ENDIF
UNTIL a%(1)<256
RETURN a%(1)
ENDP

```

```

PROC endit:
STOP
ENDP

```

Here is a similar type 3 OPA. It does the same as the previous example, but System messages to change files cause the procedure "fset:" to be called. The relevant files are opened or created; the name of the file in use is shown in the status window.

APP myapp3 TYPE \$1003 ICON "\opd\me" ENDA

```

PROC start:
GLOBAL a%(6),k%,w$(128)
STATUSWIN ON :FONT 11,16 :w$=CMD$(2)
fset:(CMD$(3))
PRINT "Q to Quit"
PRINT " or press Delete in"
PRINT "the System screen"
PRINT " or create/swap files in"
PRINT "the System screen"
DO
  k%=getk%:
  PRINT CHR$(k%);
UNTIL (k% AND $ffdf)=%Q
ENDP

```

```

PROC getk%:
LOCAL t$(1)
DO
  GETEVENT a%()
  IF a%(1)=$404
    w$=GETCMD$
    t$=LEFT$(w$,1)
    w$=MID$(w$,2,128)
    IF t$="X"
      endit:
    ELSEIF t$="C" OR t$="O"
      TRAP CLOSE
      IF ERR
        CLS :PRINT ERR$(ERR)
        GET :CONTINUE
      ENDIF
    fset:(t$)
  ENDIF
ENDIF
UNTIL a%(1)<256
RETURN a%(1)
ENDP

```

```

PROC fset:(t$)

```

```

LOCAL p%(6)
IF t$="C"
    TRAP DELETE w$ REM SYS.SCREEN DOES ANY "OVERWRITE?"
    TRAP CREATE w$,A,A$
ELSEIF t$="O"
    TRAP OPEN w$,A,A$
ENDIF
IF ERR
    CLS :PRINT ERR$(ERR)
    GET :STOP
ENDIF
SETNAME w$
ENDP

PROC endit:
    STOP
ENDP

```

You should, as in both these examples, be precise in checking for the System message; if in future the GETCMD\$ function were to use values other than "C", "O" or "X", these procedures would ignore them.

If you need to check the modifier keys for the returned keypress, use "a%(2) AND \$00ff" instead of KMOD.

SETNAME extracts the main part of the filename from any file specification (even one that is not DOS-like), in the same way as PARSE\$. Using SETNAME ensures that the correct name will be used in the file list in the System screen. If an OPA lets you change files with its own 'Open file' option, it should always use SETNAME to inform the System screen of the new file in use.

To be strict, whenever creating a file, an OPA should first use PARSE\$ to find the disk and directory requested. It should then use "TRAP MKDIR" to ensure that the directory exists.

## When an OPA cannot respond

The LOCK command marks an OPA as locked or unlocked. When an OPA is locked with "LOCK ON", the System will not send it events to change files or quit. If, for example, you move onto the file list in the System screen and press Delete to try to stop that running OPA, a message will appear, indicating that the OPA cannot close down at that moment.

You should use "LOCK ON" if your OPA uses a keyword, such as EDIT, which pauses the execution of the program. You might also use it when the OPA is about to go busy for a considerable length of time, or at any other point where a clean exit is not possible. Do not forget to use "LOCK OFF" as soon as possible afterwards.

An OPA is initially unlocked.

## Designing an icon

As discussed earlier, an OPA icon is black and grey and has size 48 by 48 pixels. The icon is stored as two 48x48 bitmaps, black followed by grey, in a bitmap file. Here is a simple example program which creates a suitable bitmap:

```

PROC myicon:
    gCREATE (0,0,48,48,1,1)
    gBORDER $200
    gAT 6,28
    gPRINT "me!"
    gSAVEBIT "me"
ENDP

```

Here the window is created with a grey plane (the sixth argument to gCREATE) gSAVEBIT automatically saves a window with both black and grey plane to a file in the required format.

In the OPA itself use the ICON keyword, as explained previously, to give the name of the bitmap file to use here, "ICON "\opd\me"".

## OPAs and the status window

If you use "STATUSWIN ON,2" to display the status window, it shows the OPA's own icon and the name used with the APP keyword. "STATUSWIN ON,1" displays the smaller status window.

Important: The permanent status window is behind all other OPL windows. In order to see it, you must use FONT (or both SCREEN and gSETWIN) to reduce the size of the text and graphics windows. You should ensure that your program does not create windows over the top of it.

You can also display a list of modes/views for use with the **◆** key with DIAMINIT and position the **◆** indicator with "DIAMPOS".

The name can be changed with the SETNAME command. In general, an OPA should use SETNAME whenever it changes files, or creates a new file.

## Other TYPE options

You can add any of these numbers to the value you use with TYPE:

- \$8000 (-32768) stops the System screen's 'New file' option from working, as for the RunOpl icon (translated OPL modules).
- \$4000 (16384) stops the System screen from closing the OPA, as for the Time icon. You should not use this without a very good reason.
- \$100 (8192) causes the System screen to terminate the OPA (when Delete is pressed there) without sending a message to the OPA to quit ("X"), as for the RunOpl icon again. This should be used only for OPAs which have no data that could be lost by sudden termination.

For example, use "TYPE \$8001" for a type 1 OPA having the first of the features above. (Note that "TYPE \$8000+1" would fail to translate as the translator cannot evaluate expressions for any keywords between APP and ENDA).

---

## Tricks

### The calculator memories

The calculator memories M0 to M9 are available as floating-point variables in OPL. You might use them to allow OPL access to results from the calculator, particularly if you use OPL procedures from within the calculator.

It's best not to use them as a substitute for declaring your own variables. Your OPL program might go wrong if another running OPL program uses them, or if you use them yourself in the calculator.

### Running a program twice

Although you may never need to, you can run more than one copy of the same translated OPL module at the same time. There are two ways:

- Use 'Copy file' in the System screen to make a new copy of the module, with a different filename. Then run both files.
- Run the file as normal. Then move the highlight to under the RunOpl icon, press Tab to show the file selector, and pick the name of the translated module again.

### Foreground and background

- "CALL (\$6c8d)" tells the Series 3a to send a "machine switch on" event to the current program, whenever the Series 3a switches on, even if this program is in the background. If required, use it just once at the start of your program.

- "CALL(\$198d,0,0)" brings the current program to the foreground.
- "CALL(\$198d,100,0)" sends it to the background again.

Each of these should be followed by "gUPDATE" to ensure they take effect immediately.

This example program comes to the foreground and beeps whenever you turn the Series 3a on. Be careful to enter the CALL and GETEVENT statements exactly as shown.

```

PROC beepon:
local a%(6)
print "Hello"
call($6c8d) :gupdate
while 1
  do
    getevent a%()
    if a%(1)=$404 :stop :endif :REM closedown
    until a%(1)=$403 :REM machine ON
    call($198d,0,0) :gupdate
    beep 5,300 :pause 10 :beep 5,500
    call($198d,100,0) :gupdate
  endwh
ENDP

```

Note: when a program runs in the background it can stop the "automatic turn off" feature from working. However, as soon as the program waits for a keypress or an event, with GET/GET\$ or GETEVENT, auto-turn off can occur.

Auto-turn off can also occur if the program does a PAUSE (of 2 or more 20ths of a second), but only if the program has used "CALL(\$138b)" ("unmark as active")

## Cacheing procedures

Without procedure cacheing, procedures are loaded from file whenever they are called and discarded when they return. LOADM simply loads a map listing procedure names and their positions in the module file so that they can be loaded fairly efficiently. The cache handling commands provide a method for keeping the code for a procedure loaded after it returns; it remains loaded until a procedure called later requires the space in the cache. The strategy is then to remove the least recently used procedures, making it more likely that all the procedures called together in a loop, for example, remain in the cache together, thus speeding up procedure calling significantly.

Cache handling keywords allow you to:

- create a cache of a specified initial and maximum size using "CACHE init%,max%". You can specify these up to 32,767 bytes.
  - ☞ If you use hex, you can even exceed this figure, if you need to eg "CACHE \$9000,\$9000". However, you cannot exceed the 64k total memory limit which each Series 3a process has.
- prevent loading and removal of procedures from the cache so that a given set of procedures can be guaranteed to remain in the cache using "CACHE OFF". Procedures already in the cache are still used when cacheing is off. The loading and removal of procedures can subsequently be resumed using "CACHE ON".
- tidy the cache by removing procedures that are no longer in use (ie. procedures that have returned) using "CACHETIDY".
- for advanced use during program development, further keywords are provided for inspecting the contents of the cache at any time (see CACHEHDR and CACHEREC).

## Cache size

Cacheing procedures is not a cure all. Care should be taken that the cache size is sufficient to load all procedures required for a fast loop otherwise, for example, a large procedure may cause all the small ones in a loop to be removed and equally, a small one may require the large one to be removed, so that the cache provides no benefit at all. In fact, the overhead needed for cache management can then make your program less efficient than having no cache at all. If the maximum cache size you can have is limited, careful use of "CACHE OFF" should prevent such problems at the expense of not fitting all the procedures in the loop in the cache. "CACHE OFF" is implemented very efficiently and calling it frequently in a loop should not cause much concern.

To guarantee that there is enough memory for a given cache size, create the cache passing that value as the initial size using "TRAP CACHE init%,max%". TRAP ensures that if the cache creation succeeds, ERR returns zero and otherwise the negative 'Out of memory' error is raised. After creation, the cache will grow as required up to the maximum size "max%" or until there is not enough free memory to grow it. On failure to grow the cache, any procedures which will not fit into the existing cache, even when unused procedures are removed, are simply loaded without using the cache and are discarded when they return.

If you want to ensure a certain minimum cache size, say 10000 bytes, but do not care how large it grows, you could use "TRAP CACHE 10000,\$ffff" so that the cache just grows up to the limits of memory. For a relatively small program, you might want to load the whole program into cache by making the cache size the same size as the module. This will in fact be a little larger than required, unnecessarily including a procedure name table and module file header which are not loaded into the cache. The minimum cache size is 2000 bytes, which is used if any lower value is specified. If the maximum size specified is less than the initial size, the maximum is set to the initial size. The maximum cache size cannot be changed once the cache has been created and an error is returned if you attempt to do so.

☞ The initial cache size should ideally be large enough to hold all procedures that are to be cached simultaneously. There is no advantage in growing the cache from its initial size when you know that a certain minimum size is needed.

## Procedures in unloaded modules

When a module is unloaded, all procedures in it that are no longer in use are removed from the cache. Any procedure that is still in use, is hidden in the cache by changing its first character to lower case; when it finally returns, a hidden procedure is removed in the normal manner to make room for loading a new procedure when the cache is full. Note that it is considered bad practice to unload a module containing procedures that are still running eg. for a procedure to unload its own module.

## Cache timings

Calling an empty procedure that simply returns is approximately 10 times faster with a cache. This figure was obtained by calling such a procedure 10000 times in a loop, both with cacheing off and on, and subtracting the time taken running an empty loop in each case.

Clearly that case is one of the best for showing off the advantages of cacheing and there is no general formula for calculating the speed gain. The procedures that benefit most will be those that need most module file access relative to their size in order to load them into memory. The programmer cannot reasonably write code taking this into account, so no further details are provided here.

The case described above does not require any procedures to be removed from the cache to make room for new procedures when the cache is full, and removal of procedures requires a fair amount of processing by the cache manager. If many procedures in a time-critical section of your program are loaded into the cache and not used often before removal, the speed gain may be less than expected a larger cache may be called for to prevent too many removals.

It should be noted however, that even with the worst case of procedures being loaded into the cache for use just once before removal, having a cache is often superior to having no cache. This is because the cache manager reads module file data (required for loading the procedures into memory) in one block rather than a few bytes at a time and it is the avoidance of excessive file access which provides the primary speed gains for cacheing.

## Compatibility mode modules

Procedures in modules translated for the Series 3 cannot be loaded into the cache. On encountering such a procedure, the cache manager simply loads it without using the cache and discards it when it returns. The reason for this is that a few extra bytes of data are stored in the Series 3a modules which are needed by the cache manager.

## Potential problems in existing programs

It is possible that previously undiscovered bugs in existing OPL programs are brought to light simply by adding code to use the cache.

Without cacheing, the variables in a procedure are followed immediately by the code for the procedure. Writing beyond the variables (for example reading too many bytes into the final variable using such keywords as `gPEEKLINE` or `KEYA`) would have written over the code itself but would have gone unnoticed unless you happened to loop back to the corrupted code. With a cached procedure, the code no longer follows your variables, so the corruption occurs elsewhere in memory, resulting quite probably in the program crashing.

## Controlling procedure cacheing

"TRAP CACHE initSize%,maxSize%" creates a cache of a specified initial number of bytes, which may grow up to the specified maximum. If the maximum is less than the initial size, the initial size becomes the maximum. If growing the cache fails, normal loading without the cache is used. The 'In use' error (-9) is raised if a cache has been created previously or the 'Out of memory' error (-10) on failure to create a cache of the specified initial size use the TRAP command if required. Procedure code and other information needed for setting up variables are loaded into the cache when the procedure is called. If there is no space in the cache and enough space can be regained, the least recently used procedures are removed. Otherwise the procedure is loaded in the normal way without cacheing.

Once a cache has been created, "CACHE OFF" prevents further cacheing although the cache is still searched when calling subsequent procedures. "CACHE ON" may then be used to reenale cacheing. Note that "CACHE ON" or "CACHE OFF" are ignored if used before "CACHE initSize%,maxSize%".

## Tidying the cache

CACHETIDY removes any procedures from the cache that have returned to their callers. This might be called after performing a large, self-contained action in the program which required many procedures. Using CACHETIDY will then result in speedier searching for procedures called subsequently and, more importantly, will prevent the procedures being unloaded one at a time when the need arises it is very efficient to remove a set of procedures that are contiguous in the cache as is likely to be the case in this situation.

Note that a procedure which has returned is automatically removed from the cache if you unload the module it is in, so CACHETIDY needn't be used for such a procedure.

## Getting cache index header information

The CACHEHDR command is provided for advanced use and is intended for use during program development only.

"CACHEHDR ADDR(hdr%())" reads the current cache index header into the array "hdr%()" which must have at least 11 integer elements. Note that any information returned is liable to change whenever a procedure is called, so you cannot save these values over a procedure call.

If no cache has yet been created, "hdr%(10)=0" and the other data read is meaningless. Otherwise, the data read is as follows:

hdr%(1)	current address of the cache itself
hdr%(2)	number of procedures currently cached
hdr%(3)	maximum size of the cache in bytes
hdr%(4)	current size of the cache in bytes
hdr%(5)	number of free bytes in the cache
hdr%(6)	total number of bytes in cached procedures which are freeable (ie. not running)
hdr%(7)	offset from the start of the cache index to the first

```

                                free index record
hdr%(8)      offset from start of cache index to most recently used
                                procedure's record; zero if none
hdr%(9)      offset from start of cache index to least recently used
                                procedure's record; zero if none
hdr%(10)     address of the cache index, or zero if no cache created yet
hdr%(11)     non-zero if cacheing is on, and zero if it is off

```

The cache manager maintains an index for the cache consisting of an index header containing overall information for the whole cache as well as one index record for each procedure cached. All offsets mentioned above give the number of bytes from the start of the index to the procedure record specified. The index records for cached procedures form a doubly linked list, with one list beginning with the most recently used procedure (MRU), with offset given by "hdr%(8)", and the other with the least recently used procedure (LRU) with offset given by "hdr%(9)". A further singly linked list gives the offsets to free index records. The linkage mechanism is described in the discussion of CACHEREC below.

## Getting a cache index record

The CACHEREC command is provided for advanced use and is intended for use during program development only.

"CACHEREC ADDR(rec%()),offset%" reads the cache index record (see the description of CACHEHDR above) at "offset%" into array "rec%()" which must have at least 18 integer elements. "offset%=0" specifies the most recently used (MRU) procedure's record if any and "offset%<0" the least recently used procedure (LRU) procedure's record if any.

The data returned by CACHEREC is meaningless if no cache exists (in which case "rec%(17)=0") or if there are no procedures cached yet (when "hdr%(8)=0" as returned by CACHEHDR).

Each record gives the offset to both the more recently used and to the less recently used procedure's record in the linked lists, except for the MRU and the LRU procedures' records themselves which each terminate one of the lists with a zero offset. The first free index record (see CACHEHDR above) starts the free record list, in which each record gives the offset of the next free record or zero offset to terminate the list. To "walk" the cache index, you would always start by calling CACHEREC specifying either the MRU or LRU record offset, and use the values returned to read the less or more recently used procedure's record respectively. Note that any information returned is liable to change whenever a procedure is called, so you cannot save these values over a procedure call.

For the free cell list, only "rec%(1)" is significant, giving the offset of the next free index record. For the records in the lists starting with either the LRU or MRU record, the data returned in "rec%()" is:

```

rec%(1) offset to less recently used procedure's record or zero if on LRU
rec%(2) offset to more recently used procedure's record or zero if on MRU
rec%(3) usage count zero if not running
rec%(4) offset in cache itself to descriptor for building the procedure frame
rec%(5) offset in cache itself to translated code for the procedure
rec%(6) offset in cache itself to the end of the translated code for the procedure
rec%(7) number of bytes used by the procedure in the cache itself
rec%(8-15) leading byte counted procedure name, followed by some private data
rec%(16) address of the procedure's leading byte counted module name
rec%(17) address of the cache index, or zero if no cache created yet
rec%(18) non-zero if cacheing is on, and zero if it is off

```

For example, to print the names of procedures and their sizes from MRU to LRU:

```

CACHEHDR ADDR(hdr%())
IF hdr%(10)=0
    PRINT "No cache created yet"
    RETURN
ENDIF
IF hdr%(8)=0                                rem MRU zero?
    PRINT "None cached currently"
    RETURN
ENDIF
rec%(1)=0                                    rem MRU first
DO
    CACHEREC ADDR(rec%()),rec%(1) rem less recently used
                                                rem proc
    PRINT PEEK$(ADDR(rec%(8))),rec%(7) rem name and size
UNTIL rec%(1)=0

```

# Sprite handling

## How sprites work

OPL includes a set of keywords for handling a sprite a user-defined black/grey/white graphics object of variable size, displayed on the screen at a specified position.

The sprite can also be animated you can specify up to 13 bitmap-sets which are automatically presented in a cycle, with the duration for each bitmap-set specified by you. Each bitmap-set may be displayed at a specifiable offset from the sprite's notional position.

The 13 bitmap-sets are each composed of up to six bitmaps. The set pixels in each bitmap specify one of the following six actions: black pixels to be drawn; black pixels to be cleared; black pixels to be inverted; grey pixels to be drawn; grey pixels to be cleared; or grey pixels to be inverted. The bitmaps in a set must have the same size.

All the bitmaps in a set are drawn to the screen together and displayed for the specified duration, followed by the next set, and so on.

If you do not specify that a pixel is to be drawn, cleared or inverted, the background pixel is left unchanged.

Black pixels are drawn "on top of" grey pixels, so if you clear/invert just the grey pixels in the sprite they will be hidden under any pixels set black. So to clear/invert pixels on a background which has both grey and black pixels set, you need to clear/invert both black and grey pixels in the sprite.

☞ The pixels of one colour (black or grey) which are set in one bitmap of the bitmap-set should not overlap with those of the same colour which are set in another bitmap in the same bitmap-set. This is because the order in which the bitmaps are applied is undefined. So, for example, do not specify that pixel (0,0) should have the black pixel both drawn and cleared.

## Why use sprites?

A sprite is useful for displaying something in foreground without having to worry about restoring the background display. Also a sprite can have any shape, leaving the background display all around it intact, and it can even be hollow only the pixels specified by you are drawn, cleared or inverted. Typically only one bitmap-set containing two black bitmaps would be used one for setting and one for clearing pixels.

You would not often use the sprite features in their full generality. In fact, more than one bitmap-set is needed only for animation and it is also seldom necessary to use all the available bitmaps in a single bitmap-set.

## Creating a sprite

`sprId%=CREATESPRITE` creates a sprite and returns the sprite ID.

## Appending a bitmap-set to a sprite

`APPENDSPRITE tenths%,bitmap$()`

`APPENDSPRITE tenths%,bitmap$( ),dx%,dy%`

append a single bitmap-set to a sprite. These may be called up to 13 times for each sprite. "APPENDSPRITE" may be called only before the sprite is drawn, otherwise it raises an error. **tenths%** gives the duration in tenths of seconds for the bitmap-set to be displayed before going on to the next bitmap-set in the sequence. It is ignored if there is only one bitmap-set.

`bitmap$()` contains the names of the six bitmap files in the set:

```
bitmap$(1) for setting black pixels
bitmap$(2) for clearing black pixels
bitmap$(3) for inverting black pixels
bitmap$(4) for setting grey pixels
bitmap$(5) for clearing grey pixels
```

```
bitmap$(6) for inverting grey pixels
```

Use "" to specify no bitmap. If "" is used for all the bitmaps in the set, the sprite is left blank for the specified duration.

The array must have at least 6 elements.

All the bitmaps in a single bitmap-set must be the same size, otherwise an 'Invalid arguments' error is raised on attempting to draw the sprite. Bitmaps in different bitmap-sets may differ in size. dx% and dy% are the (x,y) offsets from the sprite position (see CREATESPITE) to the top-left of the bitmap-set with positive for right and down. The default value of each is zero.

Sprites may use considerable amounts of memory. A sprite should generally be created, initialised and closed in the same procedure to prevent memory fragmentation. Care should also be taken in error handling to close a sprite that is no longer in use.

Creating or changing a sprite consisting of many bitmaps requires a lot of file access and should therefore be avoided if very fast sprite creation is required. Once the sprite has been drawn, no further file access is performed (even when it is animated) so the number of bitmaps is no longer important.

## Drawing a sprite

DRAWSprite x%,y% draws a sprite in the current window with top-left at pixel position (x%,y%). The sprite must previously have been initialised using APPENDSPRITE or the 'Resource not open' error (-15) is raised. If any bitmap-set contains bitmaps with different sizes, DRAWSprite raises an 'Invalid arguments' error (-2).

## Changing a bitmap-set in a sprite

```
CHANGESprite index%,tenths%,var bitmap$()  
CHANGESprite index%,tenths%,var bitmap$( ),dx%,dy%
```

change the bitmap-set specified by "index%" (1 for the first bitmap-set) in the sprite using the supplied bitmap files, offsets and duration which are all used in the same way as for APPENDSPRITE.

CHANGESprite can be called only after DRAWSprite.

Note that if all or many bitmap-sets in the sprite need changing or if each bitmap-set consists of many bitmaps, the time required to read the bitmaps from file may be considerable, especially if fast animation is in progress. In such circumstances, you should think about closing the sprite and creating a new one, which will often be more efficient.

## Positioning a sprite

POSSprite x%,y% sets the position of the sprite to (x%,y%).

## Closing a sprite

CLOSESprite sprId% closes the sprite with ID sprId%.

## Sprite example

The following code illustrates all the sprite handling keywords using a sprite consisting of just two bitmap-sets each containing a single bitmap.

```
PROC sprite:  
  LOCAL bit$(6,6),sprId%  
  
  crBits:                REM create bitmap files  
  gAT gWIDTH/2,0  
  gFILL gWIDTH/2,gHEIGHT,0 REM fill half of screen  
  sprId%=CREATESprite  
  bit$(1)="" :bit$(2)=""  
  bit$(3)="cross"      REM black cross, pixels inverted
```

```

bit$(4)="" :bit$(5)="" :bit$(6)=""
APPENDSPRITE 5,bit$(),0,0 REM cross for half a second
bit$(1)="" :bit$(2)="" :bit$(3)=""
bit$(4)="" :bit$(5)="" :bit$(6)=""
APPENDSPRITE 5,bit$(),0,0 REM blank for half a second
DRAWSPRITE gWIDTH/2-5,gHEIGHT/2-5
                                REM animate the sprite
BUSY "flash cross, c",3  REM no offset
                                REM ('c' for central)

GET
bit$(3)="box"                REM black box, pixels inverted
CHANGESPRITE 2,5,bit$(),0,0  REM in 2nd bitmap-set
BUSY "cross/box, c/c",3  REM central/central
GET
CHANGESPRITE 2,5,bit$(),40,0
                                REM offset by 40 pixels right
BUSY "cross/box, c/40",3  REM central/40
GET
bit$(3)=""                    REM Remove the cross in set 1
CHANGESPRITE 1,3,bit$(),0,0  REM display for 3/10 seconds
BUSY "flash box, 40",3  REM box at offset 40 still
GET
bit$(3)="cross"
CHANGESPRITE 1,5,bit$(),0,0
                                REM cross centralised - set 1

bit$(3)="box"
CHANGESPRITE 2,5,bit$(),0,0
                                REM box centralised - set 2

BUSY "Escape quits"
DO
    POSSPRITE RND*(gWIDTH-11),RND*(gHEIGHT-11)
                                REM move sprite randomly
    PAUSE -20                    REM once a second
UNTIL KEY = 27
CLOSESPRITE sprId%
ENDP

PROC crBits:
    REM create bitmap files if they don't exist
    IF NOT EXIST("cross.pic") OR NOT EXIST("box.pic")
        gCREATE(0,0,11,11,1,1)
        gAT 5,0 :gLineBy 0,11
        gAT 0,5 :gLineBy 11,0
        gSAVEBIT "cross"
        gCLS
        gAT 0,0
        gBOX gWIDTH,gHEIGHT
        gSAVEBIT "box"
        gCLOSE gIDENTITY
    ENDIF
ENDP

```

---

## Scanning the keyboard directly

It is sometimes useful to know which keys are being pressed at a given moment and also when a key is released. For example, in a game, a certain key might start some action and releasing the key might stop it.

`CALL($288e,ADDR(scan%()))` returns with the array `scan%()`, which must have at least 10 elements, containing a bit set for keys currently being pressed.

Every key on the keyboard is represented by a unique bit. This includes the modifier keys (Shift, Control etc) and the application buttons (System, Data, Word etc).

A set bit simply signifies a pressed key a key pressed on its own gives one bit set; that same key with a modifier gives the same bit set with another bit for the modifier; the modifier on its own gives the same modifier bit on its own.

The following table lists each key (according to the text printed on the physical key itself), the scan%() array element for that key and the hexadecimal bit mask to be "AND"ed with that array element to check whether the key is being pressed.

key	scan%()	mask
System	5	\$200
Data	4	\$200
Word	6	\$200
Agenda	2	\$200
Time	1	\$200
World	3	\$200
Calc	2	\$100
Sheet	1	\$100
Esc	8	\$100
1	8	\$02
2	8	\$04
3	6	\$40
4	5	\$04
5	5	\$08
6	8	\$08
7	4	\$40
8	3	\$08
9	3	\$10
0	2	\$10
+	2	\$08
Delete	3	\$01
Tab	1	\$04
Q	7	\$02
W	7	\$20
E	6	\$20
R	5	\$02
T	5	\$10
Y	1	\$08
U	4	\$20
I	3	\$04
O	3	\$20
P	2	\$20
-	2	\$04
Enter	1	\$01
Control	3	\$80
A	7	\$04
S	7	\$10
D	6	\$10
F	6	\$02
G	5	\$20
H	8	\$40
J	4	\$10
K	3	\$02
L	3	\$40
*	2	\$40
/	2	\$02
Left shift	2	\$80
Z	7	\$08
X	7	\$40
C	6	\$08
V	6	\$04
B	5	\$40
N	1	\$40
M	4	\$08
,	4	\$02
.	8	\$10
Up	8	\$20
Right shift	4	\$80
Psion	1	\$80
Menu	6	\$80
◆	5	\$80
Space	5	\$01
Help	4	\$04
Left	1	\$10
Down	1	\$20
Right	1	\$02

For example, pressing Tab sets bit 2 of scan%(1), pressing Control sets bit 7 of scan%(3) and pressing both together sets both these bits. So Tab is being pressed if scan%(1) AND \$04 is non-zero, and Control is being pressed if scan%(3) AND \$80 is non-zero.

A possible strategy for scanning the keys might be to wait for any key of interest using "GETEVENT" or "GET" (allowing switch off and less intensive use of the battery); start the required action which is to be continued only while the key is being pressed; scan the keyboard as discussed above until the key is released and then stop the action; wait for the next key and repeat.

☞ Note that the key returned by "GETEVENT" or "GET" is not precisely synchronised with those scanned, so once you have waited for a relevant key you should scan for all the keys pressed, ignoring the keycode returned by "GETEVENT" or "GET".

---

## I/O functions and commands

OPL includes powerful facilities to handle input and output ('I/O'). These functions and commands can be used to access all types of files on the Series 3a, as well as various other parts of the low-level software.

This section describes how to open, close, read and write to files, and how to set the position in a file. The data file handling commands and functions have been designed for use specifically with data files. The I/O functions and commands are designed for general file access. You don't need to use them to handle data files.

These are powerful functions and commands and they must be used with care. Before using them you must read this chapter closely and have a good grounding in OPL in general.

### Error handling

You should have a good understanding of error handling before using the I/O functions.

The functions in this section never raise an OPL error message. Instead they return a value if this is less than zero an error has occurred. It is the responsibility of the programmer to check all return values, and handle errors appropriately. Any error number returned will be one of those in the list given in the error handling chapter. You can use ERR\$ to display the error as usual.

### Handles

Many of these functions use a handle, which must be an integer variable. IOOPEN assigns this handle variable a value, which subsequent I/O functions use to access that particular file. Each file you IOOPEN needs a different handle variable.

### `var' variables

In this section, `var' denotes an argument which should normally be a LOCAL or GLOBAL variable. (Single elements of arrays may also be used, but not field variables or procedure parameters.) Where you see `var' the address of the variable is passed, not the value in it. (This happens automatically; don't use ADDR yourself.)

In many cases the function you are calling passes information back by setting these `var' variables.

`var' is just to show you where you must use a suitable variable you don't actually type it.

For example:

```
ret%=IOOPEN(var handle%,name$,mode%)
```

indicates that "IOOPEN(h%,"abc",0)" is OK while "IOOPEN(100,"abc",0) is incorrect.

It is possible, though, that you already have the address of the variable to use. It might be that this address is held in a field variable, or is even a constant value, but the most common situation is when the address was passed as a parameter to the current procedure.

If you add a '#' prefix to a 'var' argument, this tells OPL that the expression following is the address to be used, not a variable whose address is to be taken.

Here is an example program:

```
PROC doopen: (phandle%, name$, mode%)
  REM IOOPEN, handling errors
  LOCAL error%
  error% = IOOPEN(#phandle%, name$, mode%)
  IF error% : RAISE error% : ENDIF
ENDP
```

The current value held in phandle% is passed to IOOPEN. You might call doopen: like this:

```
local filhand%,...
...
doopen:(addr(filhand%), "log.txt", $23)
...
```

The "doopen:" procedure calls IOOPEN with the address of "filhand%", and IOOPEN will write the handle into "filhand%".

☞ If you ever need to add or subtract numbers from the address of a variable, use the UADD and USUB functions, or you run the risk of 'Integer overflow' errors.

## Opening a file with IOOPEN

```
ret%=IOOPEN(var handle%,name$,mode%)
```

or

```
ret%=IOOPEN(var handle%,address%,mode%)
```

for unique file creation

Creates or opens a file (or device) called name\$ and sets handle% to the handle to be used by the other I/O functions.

mode% specifies how the file is to be opened. It is formed by ORing together values which fall into the three following categories:

### *Mode Category 1 Open mode*

One and only one of the following values must be chosen from this category.

\$0000

Open an existing file (or device). The initial current position is set to the start of the file.

\$0001

Create a file which must not already exist.

\$0002

Replace a file (truncate it to zero length) or create it if it does not exist.

\$0003

Open an existing file for appending. The initial current position is set to the end of the file. For text format files (see \$0020 below) this is the only way to position to end of file.

\$0004

Creates a file with a unique name. For this case, you must use the address of a string instead of "name\$". This string

specifies only the path of the file to be created (any file name in the string is ignored). The string at "address%" is then set by IOOPEN to the unique file name generated (this will include the full path). The string must be large enough to take 130 characters (the maximum length file specification). For example: " s\$="M:\home\"

IOOPEN(handle%,ADDR(s\$),mode%) "This mode is typically used for temporary files which will later be deleted or renamed."

### ***Mode Category 2 File format***

One and only one of the following values must be chosen from this category. When creating a file, this value specifies the format of the new file. When opening an existing file, make sure you use the format with which it was created.

\$0000

The file is treated as a byte stream of binary data with no restriction on the value of any byte and no structure imposed upon the data. Up to 16K can be read from or written to the file in a single operation.

\$0020

The file is treated as a sequence of variable length records. The records are assumed to contain text terminated by any combination of the CR and LF ("0D", "0A") characters. The maximum record length is 256 bytes and Control-Z ("1A") marks the end of the file.

### ***Mode Category 3 Access flags***

Any combination of the following values may be chosen from this category.

\$0100

Update flag. Allows the file to be written to as well as read. If not set, the file is opened for reading only. You must use this flag when creating or replacing a file.

\$0200

Choose this value if you want the file to be open for random access (not sequential access), using the IOSEEK function.

\$0400

Specifies that the file is being opened for sharing for example, with other running programs. Use if you want to read, not write to the file. If the file is opened for writing ("0100" above), this flag is ignored, since sharing is then not feasible. If not specified, the file is locked and may only be used by this running program.

## **Closing a file with IOCLOSE**

Files should be closed when no longer being accessed. This releases memory and other resources back to the system.

ret%=IOCLOSE(handle%)

Closes a file (or device) with the handle "handle%" as set by IOOPEN.

## **Reading a file with**

IOREAD

ret%=IOREAD(handle%,address%,maxLen%)

Reads up to "maxLen%" bytes from a file with the handle "handle%" as set by IOOPEN. "address%" is the address of a buffer into which the data is read. This buffer must be large enough to hold a maximum of "maxLen%" bytes. The buffer could be an array or even a single integer as required. No more than 16K bytes can be read at a time.

The value returned to "ret%" is the actual number of bytes read or, if negative, is an error value.

## ***Text files***

If "maxLen%" exceeds the current record length, data only up to the end of the record is read into the buffer; no error is returned and the file position is set to the next record.

If a record is longer than "maxLen%", the error value `Record too large' (-43) is returned. In this case the data read is valid but is truncated to length "maxLen%", and the file position is set to the next record.

A string array "buffer\$(255)" could be used, but make sure that you pass the address "UADD(ADDR(buffer\$),1)" to IOREAD. This leaves the leading byte free. You can then POKEB the leading byte with the count (returned to "ret%") so that the string conforms to normal string format. See the example program.

### **Binary files**

If you request more bytes than are left in the file, the number of bytes actually read (even zero) will be less than the number requested. So if "ret% To read up to 16K bytes (8192 integers), you could declare an integer array "buffer% (8192)".

## **Writing to a file**

```
ret%=IOWRITE(handle%,address%,length%)
```

Writes "length%" bytes stored in a buffer at "address%" to a file with the handle "handle%".

When a file is opened as a binary file, the data written by IOWRITE overwrites data at the current position.

When a file is opened as a text file, IOWRITE writes a single record; the closing CR/LF is automatically added.

## **Positioning within a file**

```
ret%=IOSEEK(handle%,mode%,var offset&)
```

Seeks to a position in a file that has been opened for random access (see IOOPEN above).

"mode%" specifies how the argument "offset&" is to be used. "offset&" may be positive to move forwards or negative to move backwards. The values you can use for "mode%" are:

- 1       Set position in a binary file to the absolute value specified in "offset&", with 0 for the first byte in the file.
- 2       Set position in a binary file to "offset&" bytes from the end of the file.
- 3       Set position in a binary file to "offset&" bytes relative to the current position.
- 6       Rewind a text file to the first record. "offset&" is not used, but you must still pass it as a argument, for compatibility with the other cases.

IOSEEK sets the variable "offset&" to the absolute position set.

## **Example - displaying a plain text file**

This program opens a plain text file, such as one created with the `Save as' option in the Word Processor or Database, and types it to the screen. Press Esc to quit and any other key to pause the typing to the screen.

```
PROC ioType:
  LOCAL ret%, fName$(128), txt$(255), address%
  LOCAL handle%, mode%, k%
  PRINT "Filename?", :INPUT fName$ : CLS
  mode%= $0400 OR $0020
  REM open=$0000, text=$0020, share=$0400
  ret%=IOOPEN(handle%, fName$, mode%)
  IF ret%<0
    showErr:(ret%)
  RETURN
ENDIF
address%=ADDR(txt$)
```

```

WHILE 1
  k%=KEY
  IF k%      REM if keypress
    IF k%=27 REM Esc pressed
      RETURN
    REM otherwise wait for a key
    ELSEIF GET=27
      RETURN REM Esc pressed
    ENDIF
  ENDIF
  ret%=IOREAD(handle%,address%+1,255)
  IF ret%<0
    IF ret%<>-36 REM NOT EOF
      showErr:(ret%)
    ENDIF
    BREAK
  ELSE
    POKEB address%,ret%
    REM leading byte count
    PRINT txt$
  ENDIF
ENDWH
ret%=IOCLOSE(handle%)
IF ret%
  showErr:(ret%)
ENDIF
PAUSE -100 :KEY
ENDP

PROC showErr:(val%)
  PRINT "Error",val%,err$(val%)
  GET
ENDP

```

## I/O device handling

The following I/O functions provide access to devices. A full description is not within the scope of this manual, since these functions require extensive knowledge of the Series 3a operating system and related programming techniques. The syntax and argument descriptions are provided here for completeness.

ret%=IOW(handle%,func%,var arg1,var arg2) - The device driver opened with handle% (as returned by IOOPEN) performs the synchronous I/O function func% with the two further arguments. The size and structure of these two arguments is specified by the particular device driver's documentation.

ret%=IOA(handle%,func%,var status%,var arg1,var arg2) - The device driver opened with handle% (as returned by IOOPEN) performs the asynchronous I/O function func% with two further arguments. The size and structure of these two arguments is specified by the particular device driver's documentation.

Asynchronous means that the IOA returns immediately, and the OPL program can carry on with other statements. status% will usually be set to -46, which means that the function is still pending.

When, at some later time, the function completes, status% is automatically changed. (For this reason, "status%" should usually be global if the program is still running, "status%" must be available when the request completes, or the program will probably crash.) If "status%" >=0, the function completed without error. If <0, the function completed with error. The error number is specific to the device driver.

At the same time, a signal is sent to the running OPL program.

In most cases, you cannot perform another I/O read/write function to this device until you first read the signal of this function's completion. If this is the only I/O device with a function pending, wait for the signal with "IOWAITSTAT status%". (If you have other functions pending on other devices, you must use IOWAIT and IOSIGNAL. These commands are described below.)

Alternatively, you can cancel the pending function with "IOW(handle%,4)". The program will still receive a signal,

which should be read with IOWAITSTAT or IOWAIT.

If an OPL program is ready to exit, it does not have to wait for any signals from pending IOA calls.

**IOWAIT** Wait for an asynchronous request (such as one requested by IOC or IOA) to complete. IOWAIT returns when any asynchronous I/O function completes. Check "status%" to see whether it was the function which you called with IOA. You must keep a count of the number of times IOWAIT returns due to other functions completing. When "status%" finally shows that IOWAIT has returned because of this function completing, you must then call IOSIGNAL once for each other function which completed, to replace these other signals.

If you have no other functions pending on different I/O handles, use IOWAITSTAT instead.

**IOSIGNAL** Replace a signal of an I/O function's completion. See IOWAIT.

**IOWAITSTAT** var status% Wait for a particular asynchronous function, called with IOA, to complete. This saves using IOWAIT, checking each time to see if it was the desired function completing, and finally calling IOSIGNAL for each unexpected function completion.

**"IOYIELD"** ensure that any asynchronous function is given a chance to run. Some devices are unable to perform an asynchronous request if an OPL program becomes computationally intensive, using no I/O (screen, keyboard etc) at all. In such cases, the OPL program should use IOYIELD before checking its "status%" variable. IOYIELD is the equivalent of IOSIGNAL followed by IOWAIT the IOWAIT returns immediately with the signal from IOSIGNAL, but the IOWAIT causes any asynchronous handlers to run.

**IOC(handle%,func%,var stat%,var a1,var a2)**

**IOC(handle%,func%,var stat%,var a1)**

**IOC(handle%,func%,var stat%)** - Make an I/O request with guaranteed completion. This has the same form as IOA but it returns zero always (ie the return value can be ignored). It is effectively the same as:

```
ret%=IOA(h%,f%,stat%,...)  
IF ret%<0  
  IF ret%=-46 :RAISE -1 :ENDIF  
  stat%=ret% :IOSIGNAL  
ENDIF
```

IOC allows you to assume that the request started successfully any error is always given in the status word "stat%". If there was an error, "stat%" contains the error code and the IOSIGNAL causes the next IOWAIT to return immediately as if the error occurred after completion. There is seldom a requirement to know whether an error occurred on starting a function, and IOC should therefore be used in preference to IOA nearly always.

**IOCANCEL(handle%)** - Cancels any outstanding asynchronous I/O request (IOC or IOA) on the specified channel, causing them to complete with the completion status word containing -48 ("I/O cancelled"). The return value is always zero and may be ignored. Device drivers that support truly asynchronous services provide a cancel service. The detailed effect of the cancel depends on the device driver. However, the following general principles apply:

- The cancel precipitates the completion of the request (it does not stop the request from completing).
- The cancel may or may not be effective (ie. the request may complete naturally before the cancel is processed).
- After a cancel, you must still process the completion of the asynchronous request (typically by immediately calling IOWAITSTAT to "use up" the signal).

The IOCANCEL function is harmless if no request is outstanding (eg if the function completed just before cancellation requested).

**err%=KEYA(var status%,key%(1))** - This is an asynchronous keyboard read function. You must declare an integer array with two elements here, key%(1) and key%(2) to receive the keypress information. If a key is pressed, the information is returned in this way:

- key%(1) is assigned the character code of the key.
- The least significant byte of key%(2) takes the key modifier, in the same way as KMOD 2 for Shift down, 4 for Control down and so on. KMOD cannot be used with KEYA.
- The most significant byte of key%(2) takes the count of keys pressed (0 or 1).

KEYA needs an IOWAIT in the same way as IOA.

KEYA has been included in OPL because the handle of the keyboard driver is unknown to the programmer. Otherwise it is equivalent to IOA(keyhand%,1,status%,key%()).

"err%=KEYC(var status%)" Cancels a KEYA.

## Some useful IOW functions

IOW has this specification:

```
ret%=IOW(handle%,func%,var arg1,var arg2)
```

Here are some uses:

```
LOCAL a%(6)
  a%(1)=x1% :a%(2)=y1%
  a%(3)=x2% :a%(4)=y2%
  IOW(-2,8,a%(),a%()) REM 2nd a% is ignored
```

reads the cursor position in the rectangle x1%,y1% (top left), x2%,y2% (bottom right), writing the x and y positions to a%(5) and a%(6) respectively. This returns 0,0, not 1,1, as the top left.

Set "x1%,y1%,x2%,y2%" to the screen top left and bottom right (set by SCREEN), to read the cursor position in the current screen.

```
LOCAL i%,a%(6)
  i%=2
  a%(1)=x1% :a%(2)=y1%
  a%(3)=x2% :a%(4)=y2%
  IOW(-2,7,i%,a%())
```

clears a rectangle at x1%,y1% (top left), x2%,y2% (bottom right). If y2% is one greater than y1%, this will clear part or all of a line.

## Example of IOW screen functions

The final two procedures in this module call the two IOW screen functions described beforehand. The rest of the module lets you select the function and values to use. It uses the technique used in the 'Friendlier interaction' chapter of handling menus and hot-keys by calling procedures with string expressions.

```
PROC iotest:
GLOBAL x1%,x2%,y1%,y2%
LOCAL i%,h$(2),a$(5)
  x1%=2 :y1%=2
  x2%=25 :y2%=5 REM our test screensize
  SCREEN x2%-x1%,y2%-y1%,x1%,y1%
  AT 1,1
  PRINT "Text window IO test"
  PRINT "Psion-Esc quits"
  h$="cr" REM our hot-keys
  DO
    i%=GET
    IF i%=$122 REM Menu key
      mINIT
```

```

mCARD "Set", "Rect", %r
mCARD "Sense", "Cursor", %c
i%=MENU
IF i% AND INTF(LOC(h$,CHR$(i%)))
    a$="proc"+chr$(i%)
    @(a$):
ENDIF
ELSEIF i% AND $200 REM hot-key
i%=(i%-$200)
i%=LOC(h$,CHR$(i%)) REM One of ours?
IF i%
    a$="proc"+MID$(h$,i%,1)
    @(a$):
ENDIF REM ignore other weird keypresses
ELSE REM some other key, so return it
PRINT CHR$(i%);
ENDIF
UNTIL 0

```

**ENDP**

**PROC procc:**

```

LOCAL a&
a&=iocurs&:
PRINT "x";1+(a& AND &ffff);
PRINT "y";1+(a&/&10000);

```

**ENDP**

**PROC procr:**

```

LOCAL xx1%,yy1%,xx2%,yy2%
LOCAL xx1&,yy1&,xx2&,yy2&
dINIT "Clear rectangle"
dLONG xx1&,"Top left x",1,xx2%-xx1&
dLONG yy1&,"Top left y",1,yy2%-yy1&
dLONG xx2&,"Bottom left x",2,xx2%-xx1&
dLONG yy2&,"Bottom left y",2,yy2%-yy1&
IF DIALOG
    xx1%=xx1&-1 :xx2%=xx2&-1
    yy1%=yy1&-1 :yy2%=yy2&-1
    iorect:(xx1%,yy1%,xx2%,yy2%)
ENDIF

```

**ENDP**

**PROC iocurs&:**

```

LOCAL a%(4),a&
REM don't change the order of these!
a%(1)=x1% :a%(2)=y1%
a%(3)=x2% :a%(4)=y2%
IOW(-2,8,a%(),a%()) REM 2nd a% is ignored
RETURN a&

```

**ENDP**

**PROC iorect:(xx1%,yy1%,xx2%,yy2%)**

```

LOCAL i%,a%(6)
i%=2 :REM "clear rect" option
a%(1)=xx1% :a%(2)=yy1%
a%(3)=xx2% :a%(4)=yy2%
IOW(-2,7,i%,a%())

```

**ENDP**

## Alarm example IOC to ALM:

The "ALM:" device provides access to alarms. When writing to it with IOW, IOC or IOA, you can use these two functions:

- function=1 only the date (and no time) is shown on the screen when the alarm rings eg "Thu 5 Sep"
- function=2 the day and time are shown eg "Thu 11:54"

In either case, you must pass these two arguments:

- An array of 2 long integers the first is the time for the alarm to go off, and the second is the time for which it is due. Both are given in seconds since midnight on 1/1/1970.
- A message, as a zero-terminated string of up to 64 characters.

This procedure asks for the information for an alarm, and sets it (as type 2 day and time to be shown when the alarm rings). If you press the Time button, and this is the next alarm to ring, it is shown as a 'RunOpl' alarm.

**PROC alm:**

```
LOCAL h%, a$(2), a$(64), b$(65), d%, t%, t2%, a%, r%, s%
r%=IOOPEN(h%, "ALM:", 0)
IF r%<0 :RAISE r% :ENDIF
d%=DAYS(DAY, MONTH, YEAR) REM today
t%=DATETOSECS(1970, 1, 1, HOUR, MINUTE, 0)
DINIT "Set alarm"
DTIME t%, "Time", 0, 0, DATETOSECS(1970, 1, 1, 23, 59, 59)
DDATE d%, "Date", d%, DAYS(31, 12, 2049)
DTIME t2%, "Alarm advance time", 2, 0, 86399
DEDIT a$, "Message"
IF DIALOG
  a$(2)=86400*(d%-25567)+t%
  a$(1)=a$(2)-t2%
  b$=a$+CHR$(0) REM zero-terminate the string
  IOC(h%, 2, s%, a$( ), #UADD(ADDR(b$), 1))
ENDIF
IOCLOSE(h%)
```

**ENDP**

At the moment the alarm rings, either "s%" must still be available to take the status word set by this ALM: function, or the program must have exited. Otherwise the status word will be written to a random area of memory. So in this example, no error-checking is done after the IOC - the program just ends. So you would have to use this as a whole program itself you must not call this procedure as written here from another procedure.

## Dialling example IOW to SND:

The "SND:" device provides sound services on the Series 3a. One function, number 10, provides access to DTMF dialling. It requires these two arguments:

- The number to dial, as a zero-terminated string of up to 24 characters.
- An array of 2 integers. The first is the tone length (\*256) plus the delay length, and the second is the pause length. All of these are specified in 1/32 s of a second.

**PROC dtmf:**

```
LOCAL h%, a$(24), b$(25), z%, r%, a%(2)
r%=IOOPEN(h%, "SND:", 0)
IF r%<0 :RAISE r% :ENDIF
dINIT
dEDIT a$, "Dial"
IF DIALOG
  a%(1)=8+(256*8)
  a%(2)=48
  b$=a$+CHR$(0)
  r%=IOW(h%, 10, #UADD(ADDR(b$), 1), a%( ))
  IF r%<0 :RAISE r% :ENDIF
ENDIF
r%=IOCLOSE(h%)
IF r%<0 :RAISE r% :ENDIF
```

**ENDP**

---

# Recording and playing sounds

This section explains how to write a program which records sounds to a sound file using the in-built Series 3a microphone, and which plays these or pre-recorded sound files back.

## Sound file structure

Series 3a sound files are files with a .WVE extension that contain a 32-byte header and a byte stream of digital sound which is sampled and played back at 8000 bytes per second (12-bit sound is converted to 8-bit using A-Law encoding).

The file header has the following format:

offset in file	bytes	contents
0	16	zero-terminated 'ALawSoundFile**'
16	2	version of this format
18	4	number of 8-bit samples
22	2	trailing silence in ticks
24	2	repeats
26	6	spare bytes reserved for future use

The number of samples is the number of bytes following the header and should always be size of file less 32 for the header.

The silence in ticks is the number of system ticks of silence appended to each repeat on playback (in practice, you get at least 2 ticks between repeats). A system tick is 1/32 seconds or 250 samples.

The repeats are the number of times to repeat the sound on playback (0 and 1 are treated as the same).

You can truncate the sound file, change the number of repeats and the trailing silence by changing the file length and header using the I/O binary file handling functions (IOOPEN, IOW, IOSEEK, IOWRITE etc) described elsewhere in this chapter.

For example, you can truncate the file to length newLen& using: ret%=IOW(handle%,11,newLen&,#0)

## How to record and play sounds

The following set of procedures perform asynchronous recording and playing of sounds.

```
PROC recorda: (pstat%, inname$, size%)
  LOCAL name$(128)
  name$=inname$+chr$(0)
  CALL ($2186, UADD(ADDR(name$), 1), size%, 0, 0, pstat%)
ENDP

PROC recordc:
  CALL ($2386)
ENDP

PROC recordw%: (inname$, size%)
  LOCAL name$(128), p%, ret%
  p%=PEEKW($1c)+6 REM address of saved flags after CALL
  name$=inname$+chr$(0)
  ret%=CALL ($2286, UADD(ADDR(name$), 1), size%)
  IF PEEKW(p%) AND 1 REM carry set for error
    RETURN ret% OR $FF00 REM return error
  ENDIF
ENDP

PROC playa: (pstat%, inname$, ticks%, vol%)
  LOCAL name$(128)
  name$=inname$+chr$(0)
  CALL ($1E86, UADD(ADDR(name$), 1), ticks%, vol%, 0, pstat%)
ENDP
```

```

PROC playc:
    CALL($2086)
ENDP

```

```

PROC playw%:(iname$, ticks%, vol%)
    LOCAL name$(128), p%, ret%
    p%=PEEKW($1c)+6 REM address of saved flags after CALL
    name$=iname$+chr$(0)
    ret%=CALL($1F86, UADD(ADDR(name$), 1), ticks%, vol%)
    IF PEEKW(p%) AND 1 REM carry set for error
        RETURN ret% OR $FF00 REM return error
    ENDIF
ENDP

```

"recorda:(pstat%,iname\$,size%)" and "recordw%:(iname\$,size%)" respectively perform asynchronous and synchronous recording to file "iname\$". Any existing file is replaced. You can only record to the Internal disk or to a RAM SSD you cannot record to a Flash SSD. (You can playback from a Flash SSD, however.)

"size%" specifies the maximum number of bytes to be recorded in units of 2048 bytes. To record for one second "size%=4". This figure excludes the 32-byte header. Before recording, a file of length "32+size%\*2048" bytes is created and there must actually be room on the disk for a file of that length.

"pstat%" is the address of the status word to take the completion code for asynchronous recording.

"recordc:" cancels recording and truncates the file to the actual length recorded before cancellation.

"playa:(pstat%,iname\$,ticks%,vol%) " and "playw%:(iname\$,ticks%,vol%)" respectively perform asynchronous and synchronous playing of "iname\$".

"iname\$" should either be the filename of the sound file to play or a `\*' followed by just the name component of the sound file. If it is preceded by a `\*', the extension .WVE is assumed and the service automatically searches ROM:: and the \WVE directories of M: (Internal disk), A: and B: (in that order). The ROM:: .WVE files have names SYSSAL01, SYSSAL02 and SYSSAL03.

"ticks%" is the duration that the sound file will play back in system ticks. If it is shorter than the given sound then playback is truncated to that time. If "ticks%" is negative, in addition to truncating the playback of longer files, it pads out as necessary to that duration with silence. If duration is zero, it plays the file without truncation or padding. (Alarms use a parameter of -480 to truncate or pad out to 15 seconds.)

"volume%" is a number between 0 and 5 inclusive, with 0 being the loudest. On the Series 3a there are only 4 actual levels: 0/1, 2, 3, and 4/5. "pstat%" is the address of the status word to take the completion code for asynchronous playback. Playback will append periods of silence and repeat the sound as specified in the file header.

"playc:" cancels playing back a sound.

## Alarms

The system dialogs that are used to set alarms detect the presence of any .WVE files in the \WVE directory of any local directory (in practice, A:, B: and Internal) and make these available (by file name) as the sound of the alarm.

When an alarm with a .WVE file rings, .WVE file playback (including any repeats) is clipped to 15 seconds. If the .WVE file plays for less than 15 seconds (including any repeats), the 15 seconds is padded out with silence.

## Example of recording

The following asynchronously records "time%" seconds of sound to file "file\$" or cancels the recording when any key is pressed. The section I/O device handling and asynchronous requests also in this chapter discusses the principles involved. The "recorda:" and "recordc:" procedures, from above, are used.

```

PROC record:(file$, time%)
    LOCAL sstat%, kstat%, key%(4), size%, ret%, signals%
    size%=time%*4

```

```

recorda: (ADDR(sstat%),file$,size%) REM async record
IOC(-2,1,kstat%,key%())           REM async key read
WHILE 1
  IOWAIT REM wait for recording to complete, or a key
  IF sstat%<>-46           REM if sound no longer pending
    IOCANCEL(-2)         REM cancel key read
    IOWAITSTAT kstat%    REM wait for cancellation
    IF sstat%<0
      gIPRINT "Error recording:"+err$(sstat%)
    ENDIF
    BREAK
  ELSEIF kstat%<>-46     REM else if key pressed
    recordc:            REM cancel record
    IOWAITSTAT sstat%   REM wait for cancellation
    gIPRINT "Cancelled"
    BREAK
  ELSE
    REM some async request made outside this PROC
    signals%=signals%+1 REM save it for later
  ENDIF
ENDWH
WHILE signals%
  IOSIGNAL              REM put back foreign signals
  signals%=signals%-1
ENDWH
ENDP

```

---

## OPL database information

ODBINFO var info%() is provided for advanced use only and allows you to use OS and CALL to call DbfManager interrupt functions not accessible with other OPL keywords.

The description given here will be meaningful only to those who have access to full SDK documentation of the DbfManager services, which explains any new terms. Since that documentation is essential for use of "ODBINFO", no attempt is made here to explain these terms.

ODBINFO returns "info%()", which must have four elements containing pointers to four blocks of data; the first corresponds to the file with logical name "A", the second to "B" and so on.

Take extreme care not to corrupt these blocks of memory, as they are the actual data structures used by the OPL runtime interpreter.

A data block which has no open file using it has zero in the first two bytes. Otherwise, the block of data for each file has the following structure, giving the offset to each component from the start of the block and with offset 0 for the 1st byte of the block:

Offset	Bytes	Description
0	2	DBF system's file control block (handle) or zero if file not open
2	2	offset in the record buffer to the current record
4	2	pointer to the field name buffer
6	2	number of fields
8	2	pointer to start of record buffer
10	2	length of a NULL record
12	1	non-zero if all fields are text
13	1	non-zero for read-only file
14	1	non-zero if record has been copied down
15	1	number of text fields
16	2	pointer to device name

---

## Example

To copy the Descriptive Record of logical file "B" to logical file "C":

### PROC dbfDesc:

```
LOCAL ax%,bx%,cx%,dx%,si%,di%
LOCAL info%(4),len%,psrc%,pdest%
ODBINFO info%()
bx%=PEEKW(info%(2)) REM handle of logical file B
ax%=$1700 REM DbfDescRecordRead
IF OS($d8,ADDR(ax%)) and 1
RETURN ax% OR $ff00 REM return the error
ENDIF
REM the descriptive record has length ax%
REM and is at address peekW(uadd(info%(2),8))
IF ax%=0
RETURN 0 REM no DescRecord
ENDIF
len%=ax%+2 REM length of the descriptive
REM record read + 2-byte header
psrc%=PEEKW(uadd(info%(2),8))
pdest%=PEEKW(uadd(info%(3),8))
CALL($a1,0,len%,0,psrc%,pdest%)
REM copy to C's buffer
cx%=len%
bx%=PEEKW(info%(3)) REM handle of logical file C
ax%=$1800 REM DbfDescRecordWrite
IF OS($d8,ADDR(ax%)) and 1
RETURN ax% OR $ff00
ENDIF
RETURN 0 REM success
```

ENDP

---

## DYL handling

This section contains a complete reference description of OPL's support for accessing previously created dynamic libraries (DYLs). These libraries have an object-oriented programming (OOP) user-interface and several have been built into the Series 3a ROM for use by the ROM applications. DYLs cannot be created using OPL.

Since a vast amount of documentation would need to be provided to describe the essential concepts of OOP and the services available in existing DYLs, no attempt is made to supply it here. This section simply introduces the syntax for all the OOP keywords supported in OPL with a brief description of each. Also, OOP terminology is used here without explanation, to cater for those who have previous experience of DYL handling in the 'C' programming language.

### `var' arguments

The use of `var' and "#" for arguments was discussed earlier in this chapter in the section 'I/O functions and commands'. The DYL handling keywords use `var' and "#" in the same way, for example: "ret%=SEND(pobj%,method%,var p1,var p2,var p3)".

This is because many DYL methods need the address of a variable or of a structure to be passed to them.

When you use a LOCAL or GLOBAL variable as the `var' argument, the address of the variable is used. (You cannot use procedure parameters or field variables, for this reason.) If you use a "#" before a `var' argument, though, the argument/value is used directly, instead of its address being used.

If, for example, you need to call a method with "p1" the address of a long variable "a&", "p2" the integer constant 3, and "p3" the address of a zero terminated string "X", you could call it as follows:

```
s$="X"+CHR$(0) REM zero terminate p%=UADD(ADDR(s$),1) REM skip leading count byte
ret%=SEND(pobj%,method%,a&,#3,#p%)
```

The address of "a&" is passed because there is no "#". "3" and the value in "p%" are passed directly (no address is taken) because they are preceded by "#".

### Loading a DYL

"ret%=LOADLIB(var cathand%,name\$,link%)" loads and optionally links a DYL that is not in the ROM. If successful, writes the category handle to "cathand%" and returns zero. You would normally only set "link%" to zero if the DYL uses another DYL which you have yet to load in which case LINKLIB would subsequently be used. The DYL is shared in memory if already loaded by another process.

## Unloading a DYL

"ret%=UNLOADLIB(cathand%)" unloads a DYL from memory. Returns zero if successful.

## Linking a DYL

"LINKLIB cathand%" links any libraries that have been loaded using LOADLIB. LINKLIB is not likely to be used much in OPL pass "link%" with a non-zero value to LOADLIB instead.

## Finding a category handle given its name

"ret%=FINDLIB(var cathand%,name\$)" finds DYL category "name\$" (including ".DYL" extension) in the ROM. On success returns zero and writes the category handle to "cathand%". To get the handle of a RAM-based DYL, use LOADLIB which guarantees that the DYL remains loaded in RAM. FINDLIB will get the handle of a RAM-based DYL but does not keep it in RAM.

## Converting a category number to a handle

"cathand%=GETLIBH(catnum%)" converts a category number "catnum%" to a handle. If "catnum%" is zero, this gets the handle for OPL.DYL.

## Creating an object by category number

"pobj%=NEWOBJ(catnum%,clnum%)" creates a new object by category number "catnum%" belonging to the class "clnum%", returning the object handle on success or zero if out of memory. This keyword simply converts the category number supplied to a category handle using GETLIBH and then calls NEWOBJH.

## Creating an object by category handle

"pobj%=NEWOBJH(cathand%,clnum%)" creates a new object by category handle "cathand%" belonging to the class "clnum%", returning the object handle on success or zero if out of memory.

## Sending a message to an object

"ret%=SEND(pobj%,method%)" "ret%=SEND(pobj%,method%,var p1)" "ret%=SEND(pobj%,method%,var p1,var p2)" "ret%=SEND(pobj%,method%,var p1,var p2,var p3)" send a message to the object "pobj%" to call the method number "method%", passing between zero and three arguments depending on the requirements of the method, and returning the value returned by the selected method.

## Protected message sending

"ret%=ENTERSEND(pobj%,method%)" "ret%=ENTERSEND(pobj%,method%,var p1)" "ret%=ENTERSEND(pobj%,method%,var p1,var p2)" "ret%=ENTERSEND(pobj%,method%,var p1,var p2,var p3)" send a message to an object with protection.

Methods which return errors by leaving must be called with protection.

ENTERSEND is the same as SEND except that, if the method leaves, the error code is returned to the caller; otherwise the value returned is as returned by the method.

Use ENTERSEND0 (described next) for methods which leave but do not return a value explicitly on success.

## Protected message sending (returns zero on success)

```
"ret%=ENTERSEND0(pobj%,method%)" "ret%=ENTERSEND0(pobj%,method%,var p1)"
```

```
"ret%=ENTERSEND0(pobj%,method%,var p1,var p2)" "ret%=ENTERSEND0(pobj%,method%,var p1,var p2,var p3)"
```

send a message to an object with protection and guarantee that the known value zero is returned on success. Otherwise ENTERSEND0 is the same as ENTERSEND.

Methods which return errors by leaving but return nothing (or NULL) on success must use ENTERSEND0. Besides providing protection, ENTERSEND0 also returns zero if the method did not leave, or the negative error code if it did.

If ENTERSEND were incorrectly used instead and the method completed successfully (ie. without leaving), the return value would be random and could therefore be in the range of the error codes implying that the method failed.

---

## Dynamic memory allocation

### Overview of memory usage

For each running OPL program (or process) the operating system automatically allocates memory which can grow up to a maximum of 32 bytes less than 64K. The actual memory used, up to this limit, depends on the requirements of the process and is automatically grown or shrunk as necessary. This memory is called the process data segment and contains all the data used by the process as well as some fixed length data at low memory in the segment needed by the operating system to manage the process and for other system data.

Although the data segment for an OPL process contains several components, the only component of significant interest to the OPL programmer is the process heap. This section describes several keywords for accessing the heap.

The heap is essentially a block of memory at the highest addresses in a process data segment, so that the operating system can grow and shrink the heap simply by growing and shrinking the data segment and without having to move other blocks of memory at higher addresses in the data segment. The heaps of different processes are totally independent you need concern yourself only with the heap used in your own data segment.

### The heap allocator

The heap allocator keywords are used to allocate, resize and free variable length memory cells from the process heap. Cells typically range in size from tens of bytes to a few kilobytes. Allocated cells are referenced directly by their address; they do not move to compact free space left by freed cells.

Heap allocator keywords are:

- ALLOC allocates a cell of specified size, returning its address.
- FREEALLOC frees a previously allocated cell, which is returned to the heap.
- REALLOC changes the size of a cell, returning its new address.
- ADJUSTALLOC opens or closes a gap in the middle of a cell (useful for insertion or deletion of cell content), changing the size of the cell as appropriate.
- LENALLOC returns the size of a cell.

### The heap structure

Initially, the heap consists of a single free cell. After a number of calls to allocate and free cells, the heap typically consists of ranges of adjacent allocated cells separated by single free cells (which are linked). If a cell being freed is next to another free cell the two cells are automatically joined to make a single cell to prevent the free cell linked list from growing unnecessarily.

Writing beyond the end of a cell will corrupt the heap's integrity. Such errors are difficult to debug because there is no immediate effect the corruption is a "time bomb". It will eventually be detected resulting in the process exiting prematurely by a subsequent allocator call such as "FREEALLOC".

## **Growing and shrinking the heap**

The heap is not fixed in size. The operating system can grow the heap to satisfy allocation requests or shrink it to release memory back to the system.

Allocation of cells is based on "walking" the free space list to find the first free cell that is big enough to satisfy the request. If no free cell is big enough, the operating system will attempt to grow the data segment to add more free space at the end of the heap.

If there is no memory in the system to accommodate growth or if the data segment has reached its maximum size of (approximately) 64K, the allocate request fails. There are few circumstances when an allocate request can be assumed to succeed and calls to ALLOC, REALLOC and ADJUSTALLOC should have error recovery code to handle a failure to allocate.

## **Lost cells**

There are cases in which programs allocate a sequence of cells which must either exist as a whole or not at all. If during the allocate sequence one of the later allocations fails, the previously allocated cells must be freed. If this is not done, the heap will contain unreferenced cells that consume memory to no purpose.

When designing multi-cell sequences of this kind, you should be mindful of the recovery code that must be written to free partially built multi-cell structures. The fewer the cells in such a structure, the simpler the recovery code is.

## **Internal fragmentation**

The free space in the heap is normally fragmented to some extent; the largest cell that can be allocated is substantially smaller than the total free space. Excessive fragmentation, where the free space is distributed over a large number of cells and where, by implication, many of the free cells are small should be avoided because it results in inefficient use of memory and reduces the speed with which cells are allocated and freed.

Practical design hints for limiting internal fragmentation are:

- Avoid using the heap for small, highly transient data structures for which ordinary variables are adequate. High frequency cycling through allocate and free pairs, "churns" the heap and leads to a long free space list.
- When you have a large number of variable length data structures particularly when they are frequently resized, "granularise" them (ie. round the allocation up to a multiple of some reasonable value) so that you decrease the chance of leaving small, unusable free space cells.

## **The OPL runtime interpreter and the heap**

The OPL runtime interpreter, which actually runs your program, uses the same data segment and heap as your program and makes extensive use of the heap. It is very important that you should understand the interpreter's use of the heap at least to a limited extent to avoid substantial internal fragmentation as described above.

Whenever an OPL procedure is called, a cell is allocated to store data required by the interpreter to manage the procedure. The same cell contains all the variables that you have declared in the procedure. When caching is not being used, the same cell also contains the translated code for the procedure which is interpreted. When the procedure returns

(or implicitly returns due to an error) the cell is freed again back to the heap. This use of the heap is very tidy adjacent cells are allocated and freed with little opportunity for leaving gaps in the heap.

Unfortunately various other keywords also cause cells to be allocated and these can cause fragmentation. For example, LOADM, CREATE, OPEN etc. all allocate cells; UNLOADM, CLOSE etc. free those cells. If a procedure is called which uses CREATE to create a data file, the procedure cell is allocated, followed by the CREATE cell and the procedure cell is then freed when the procedure returns. The heap structure therefore contains a gap where the procedure cell was, which remains until all cells at higher addresses are freed.

Although a small number of gaps are not too serious and should eventually disappear in most cases anyway, the new heap allocating keywords provide ample opportunity to fragment the heap. Provided that you create and free cells in a careful and structured way, where any task needing the allocator frees them tidily on completion, there should not be a problem.

## **Warning peeking/poking the cell**

Using the allocator is by no means simple in OPL since the data in an allocated cell usually has to be read or written in OPL using the PEEK and POKE set of keywords which are intrinsically subject to programming error. OPL does not provide good support for handling pointers (variables containing addresses), which are basic to heap usage, nor for complicated data structures, so that it is all too easy to make simple programming errors that have disastrous effects.

For these reasons, you are recommended to use the heap accessing keywords only when strictly necessary (which should not be very often) and to take extreme care when you do use them. On the other hand, for programmers with previous experience of dynamic memory allocation, the heap allocation keywords will often prove most useful.

## **Reasons for using the heap allocator**

A few common instances where the allocator might be used are:

- when the amount of data to be stored is variable or cannot be determined at the time of writing the program. Without using the allocator, you would have to declare a large array to hold the data always even when it turns out that only a few bytes are needed in a particular case. Using the allocator allows you to grow the cell containing your data as and when required.
- the amount of data may be specified in a file or by the user of the program. Once again, you would need to declare a possibly unnecessarily large array to cope with all allowed cases.
- a system of library procedures might use a common cell, usually called a control block, to store common data. You could have one procedure creating the cell and initialising data in it, other procedures in the system could be passed the address of the cell, using and possibly updating the data in it, and finally a further procedure could free the cell.

This concept will be familiar to you if you have used handles for the I/O keywords, where the handle references a cell used internally by the I/O system.

If you did not use the allocator in this case, you would probably need to declare a global array in the procedure calling the library procedures, with the disadvantages that the name and size of the array would need to be fixed for all time even when a better alternative mechanism has been devised for the library code with different data requirements.

- ADJUSTALLOC allows you to insert or remove data at the start or in the middle of data that has previously been set up. With an array, you would need to copy each element to the next or previous element to make or close a gap.

---

## **Using the heap allocator**

### **Allocating a cell**

Use "pcell%=ALLOC(size%)" to allocate cell on heap of specified size returning the pointer to the cell or zero if there is not enough memory. The new cell is uninitialised you cannot assume that it is zeroed.

## Freeing an allocated cell

Use "FREEALLOC pcell%" to free a previously allocated cell at "pcell%" as returned, for example, by ALLOC. Does nothing if "pcell%" is zero.

## Changing a cell's size

Use "pcelln%=REALLOC(pcell%,size%)" to change the size of a previously allocated cell at address "pcell%" to "size%", returning the new cell address or zero if there is not enough memory. If out of memory, the old cell at "pcell%" is left as it was.

If successful, "pcelln%" will not be the same as "pcell%" on return only if the size increases and there is no free cell following the cell being grown which is large enough to accomodate the extra amount.

## Inserting or deleting data in cell

Use "pcelln%=ADJUSTALLOC(pcell%,offset%,amount%)" to open or close a gap at "offset%" within the allocated cell "pcell%" returning the new cell address or zero if there is not enough memory. "offset%" is 0 for the first byte in the cell. Opens a gap if amount% is positive and closes it if negative. The data in the cell is automatically copied to the new position.

If successful, "pcelln%" will not be the same as "pcell%" on return only if "amount%" is positive and there is no free cell following the cell being adjusted which is large enough to accomodate the extra amount.

## Finding out the cell length

Use "len%=LENALLOC(pcell%)" to get the length of the previously allocated cell at "pcell%".

---

## Example using the allocator

This example illustrates the careful error checking which is essential when using the allocator. RAISE is used to jump to the error recovery code.

If you cannot understand this example it would be wise to avoid using the allocator altogether.

```
local pcell% rem pointer to cell
LOCAL pcelln%      rem new pointer to cell
LOCAL p%          rem general pointer
LOCAL n%          rem general integer
ONERR e1
pcell%=ALLOC(2+2*8) rem holds an integer and
                  rem 2 8-byte floats initially

IF pcell%=0
  RAISE -10      rem out of memory; go to e1::
ENDIF
POKEW pcell%,2  rem store integer 2 at start of cell
                  rem ie. no. of floats
POKEF UADD(pcell%,2),2.72  rem store float 2.72
POKEF UADD(pcell%,10),3.14 rem store float 3.14
...
pcelln%=REALLOC(pcell%,2+3*8) rem space for 3rd float
IF pcelln%=0
  RAISE -10      rem out of memory
ENDIF
pcell%=pcelln%  rem use new cell address
n%=PEEKW(pcell%) rem no. of floats in cell
POKEF UADD(pcell%,2+n%*8),1.0 rem 1.0 after 3.14
```

```
POKEW pcell%,n%+1          rem one more float in cell
...
pcelln%=ADJUSTALLOC(pcell%,2,8) rem open gap before 2.72
IF pcelln%=0
  RAISE -10                rem out of memory
ENDIF
pcell%=pcelln%             rem use new cell address
POKEF UADD(pcell%,2),1.0 rem store 1.0 before 2.72
POKEW pcell%,4            rem 4 floats in cell now
...
p%=UADD(pcell%,LENALLOC(pcell%)) rem byte after cell end
p%=USUB(p%,8)             rem address of final float
POKEF p%,90000.1         rem overwrite with 90000.1
RAISE 0                   rem clear ERR value
e1::
FREEALLOC pcell%         rem free any cell created
IF err<>0
  ...                     rem display error message etc
ENDIF
RETURN ERR
```

---

# Overview

Keywords can be subdivided into functions, which return a value, and commands, which do not. In practice you use functions and commands together, often using functions as if they were commands, ignoring the values they return.

This chapter lists all the keywords, grouped according to their purpose. Use this chapter if you know what you'd like to do, but not which function or command will do it.

The chapter which follows this one lists the keywords alphabetically, with explanations and full specifications.

---

## Program control

### Loops, branches, jumps

Repeat a set of instructions	DO...UNTIL WHILE...ENDW
Do either one set of instructions or another set, or another, or another..	IF...ENDIF
Go... ...to a specified label ...to one of a list of labels ...to the end/start of a repeating set of instructions ...back to the calling procedure	GOTO VECTOR/ENDV BREAK, CONTINUE RETURN
End the program	STOP

### Error handling

Raise an error	RAISE
Put an explanatory comment in your program	REM
Declare an error-handler	ONERR
Let the program continue after an error	TRAP
After an error, find out what the error was	ERR, ERR\$

---

## Screen and keyboard control

Display a string to be edited and get a value from the keyboard	EDIT
Get a value from the keyboard	INPUT
Display text, numbers etc.	PRINT
Set screen update method	gUPDATE
Pause...	
...for a number of seconds	PAUSE
...until a key is pressed	GET, GET\$
Position or hide the cursor	AT, CURSOR
Clear the text window	CLS
Sound the buzzer	BEEP
Set the size/position of the text window	SCREEN
Get information on the text window	SCREENINFO
Set text window font and style	FONT, STYLE
Find out which key was pressed, if any	KEY, KEY\$, GET, GET\$
Find out what combination of modifiers was pressed	KMOD
Disable/enable stopping from a running program	ESCAPE Off/On
Turn the Series 3a off	OFF

---

## Files

### General file management

Copy a file	COPY
Delete or rename a file	DELETE, RENAME
Check to see if a certain file exists	EXIST

Find out what files there are DIR\$

## OPL procedures and modules

Set up a procedure cache CACHE

Load an OPL module file so you can use the procedures in it LOADM

Remove a module from memory UNLOADM

## Data files

Create a new data file CREATE

OPEN or CLOSE a data file OPEN, OPENR, CLOSE

Use a different data file that has been opened USE

Copy a data file, optionally appending to another data file, and removing deleted records COMPRESS

Once a data file has been OPENed, you can:

Make a new record APPEND

Change a record UPDATE

Search for those records which contain a certain string FIND, FINDFIELD

Erase a record ERASE

Move to a different record {FIRST, LAST, NEXT,  
{BACK, POSITION

Count the records COUNT

Find whether you're at the end of the file yet EOF

Find the current record number POS

Find the number of bytes used by the current record RECSIZE

## Managing directories

Create directory	MKDIR
Set current directory	SETPATH
Remove directory	RMDIR

---

## Memory

Declare variables	
GLOBAL, LOCAL	
Find how much free memory there is on a device	
SPACE	

---

## Printing

Specify a device or file to print to	LOPEN
Close the print device or file opened with LOPEN	LCLOSE
Print to a device or file	LPRINT

---

## Numbers

### Trigonometry

Trig functions	{COS, SIN, TAN, {ACOS, ASIN, ATAN
Convert between degrees and radians	RAD, DEG

### Other functions

Raise e to a power	EXP
Logarithms	LN, LOG
Pi as a constant	PI
Square root	SQR
Use random numbers	RND, RANDOMIZE
Unsigned integer/pointer arithmetic	UADD, USUB

### **Lists of numbers**

Find the greatest or smallest value in the list	MAX, MIN
Average the list	MEAN
Add up the list	SUM
Find the standard deviation or variance	STD, VAR

### **Changing the format of numbers**

Knock the minus sign off a number	ABS, IABS
Take whole number, removing any fractional part	INT, INTF
Convert...	
...an integer into floating-point	FLT
...an integer into a hexadecimal string	HEX\$
...a number into a string	{FIX\$, GEN\$
	{SCI\$, NUM\$
...a string into a number	EVAL, VAL

## **Strings**

Copy characters from a string	LEFT\$, MID\$, RIGHT\$
Repeat a string	REPT\$
Make a string upper or lower case	LOWER\$, UPPER\$

Find out...	
...how long a string is	LEN
...the character code of the first char of a string	ASC
...	
...where a certain string is within a string	LOC
Convert...	
... a string of digits to a number	VAL
...a number to a string	{FIX\$, GEN\$ {SCI\$, NUM\$
Get the character with a certain character code	CHR\$

---

## Date and time

Find out the current date and time...	
...as a string	DATIM\$
...just the current time	{SECOND, {MINUTE, HOUR
...just the current date	DAY, MONTH, YEAR
Find out...	
...the number of days between two dates	DAYS
...what day of the week, or what week number, a certain date falls in	DOW, WEEK
Express...	
...1-12 as the name of a month	MONTH\$
...1-7 as a day of the week	DAYNAME\$
Convert between time formats	{DATETOSECS {SECSTODATE

---

## Graphics

### Drawing commands

Set current position	gAT, gMOVE
Draw a line	gLINEBY, gLINETO
Draw a sequence of lines	gPOLY
Draw a rectangle	{gBOX, gBORDER {gXBORDER

Fill a rectangle	gFILL
Invert a rectangle	gINVERT
Scroll a rectangle	gSCROLL
Get current position	gX, gY
Display a running clock	gCLOCK
Draw a 3-D button (key)	gBUTTON
Draw a lozenge	gDRAWOBJECT

### **Displaying graphics text**

Display a list of expressions	gPRINT
Display text in a cleared box	gPRINTB
Display text neatly clipped	gPRINTCLIP
Find width required by text	gTWIDTH
Display text underlined/highlighted	gXPRINT

### **Setting styles**

Set font to use	gFONT
Set to user-defined fonts	{gLOADFONT {gUNLOADFONT
Set graphics to set / clear / invert points	gGMODE
Set text to set / clear / invert / replace points	gTMODE
Set text to bold / underline / inverse / double / mono / italic	gSTYLE

### **Windows and bitmaps**

Create a new window	gCREATE
---------------------	---------

Set position and/or size of a window	gSETWIN
Set order to show windows	gORDER
Get order of a window	gRANK
Set window visible / invisible	gVISIBLE
Get screen position of a window	{gORIGINX {gORIGINY
Create a bitmap	gCREATEBIT
Load a bitmap from file	gLOADBIT
Clear a window / bitmap	gCLS
Save window / bitmap to bitmap file	gSAVEBIT
Close down a window / bitmap	gCLOSE
Set which window / bitmap to use	gUSE
Set grey on/off in a window	{gGREY {DEFAULTWIN
Fill an area with repetitions of another window/bitmap	{gPATT
Copy an area from one window/bitmap to another	gCOPY
Read data back from a window / bitmap	gPEEKLINE
Get ID number of a window / bitmap	gIDENTITY
Get size of a window / bitmap	gWIDTH, gHEIGHT
Get status information about a window/bitmap and about the cursor	gINFO

## **Sprites**

Create a sprite	CREATESPRITE
Define bitmap-sets for a sprite	{APPENDSPRITE {CHANGESPRITE
Draw a sprite	DRAWSPRITE
Set a sprite's position	POSSPRITE

Set which sprite to use	USESPRITE
Close a sprite	CLOSESPRITE

---

## Menus

Start a new set of menus	mINIT
Define a menu	mCARD
Display menus	MENU

---

## Dialogs

Start a new dialog	dINIT
Position a dialog	dPOSITION
Define text for a dialog	dTEXT
Define an edit box for a dialog	dEDIT
Define a secret edit box for a dialog	dXINPUT
Define a filename edit box for a dialog	dFILE
Define a choice list for a dialog	dCHOICE
Define a numeric edit box for a dialog	dFLOAT, dLONG
Define a date/time edit box for a dialog	dDATE, dTIME
Define exit keys for a dialog	dBUTTONS
Display a dialog	DIALOG
Display a simple "alert" dialog	ALERT

---

## Status Window

Display/hide status window	STATUSWIN
Get status window information	STATWININFO
Set a program's name	SETNAME
Initialise a ◆ list	DIAMINIT
Position ◆ on a ◆ list	DIAMPOS

---

## Screen messages

Display information messages	GIPRINT
Display `busy' messages	BUSY

---

## Advanced use

Run machine code	USR, USR\$
Find out where a certain variable is in memory	ADDR
Store a value in a specific place in memory	POKE commands
Find out the value stored at a certain place in memory	PEEK commands
Open any type of file	IOOPEN
Read from a file opened with IOOPEN	IOREAD
Write to a file opened with IOOPEN	IOWRITE
Close a file opened with IOOPEN	IOCLOSE
Position within a file opened with IOOPEN	IOSEEK

Keywords which provide low-level access to the Series 3a

Call an operating system service	CALL, OS
Perform an asynchronous I/O function	IOA, IOC

Cancel an asynchronous I/O function	IOCANCEL
Wait for completion of a function performed by IOA or IOC	{IOWAIT {IOWAITSTAT
Signal completion of an I/O function	IOSIGNAL
Ensure an asynchronous handler runs	IOYIELD
Perform a synchronous I/O function	IOW
Perform an asynchronous keyboard read	KEYA
Cancel a KEYA	KEYC
Get command line information	CMD\$, GETCMD\$
Parse a full file specification	PARSE\$
Check for system events	{GETEVENT {TESTEVENT
Mark an OPA as locked or unlocked	LOCK
Get system-level info on data files	ODBINFO
Load/link a DYL	LOADLIB, LINKLIB
Unload a DYL	UNLOADLIB
Find category handles	FINDLIB, GETLIBH
Create new objects	NEWOBJ, NEWOBJH
Send a message to an object	{SEND, ENTERSEND {ENTERSEND0
Allocate a heap cell	ALLOC
Free an allocated cell	FREEALLOC
Change size of allocated cell	REALLOC
Insert or delete section of cell	ADJUSTALLOC
Find length of allocated cell	LENALLOC
Remove returned procedures from a cache	CACHETIDY
Read cache index header	CACHEHDR



# Alphabetic listing

This chapter explains how keywords (functions and commands) are specified and used, then lists them all alphabetically. Use this chapter if you know which keyword you need to use, but need to check how to use it. Each one is listed with the specification of its usage, then a description of what it does.

Note: the example programs in this chapter do not include full error handling code. This means that the programs have been kept short and easy to understand, but may fail if, for example, you enter the wrong type of value for a variable.

If you want to develop programs from these examples, it is recommended that you add some error handling code to them. An earlier chapter covers Error handling.

## Typing commands, functions and arguments

Commands, functions and arguments may be typed in any combination of UPPER and lower case.

- To put more than one statement on a line, separate them by a space followed by a colon eg:

```
CLS :PRINT hello :GET
```

Any commands may be strung together like this, and as many of them as you like provided the total line length does not exceed 255 characters. The colon is optional before a REM statement.

- Where one space is allowed, any number of spaces is allowed, eg:  
CLS : PRINT Press Esc
- Functions may be used as arguments to other functions or commands eg. PRINT LEFT\$(A\$, 3) and a=COS (ABS (x)) are OK.

## How commands are specified

Commands are specified as COMMAND argument(s) where argument(s) follow the command after a space and are separated from each other by commas. The arguments may include:

- Floating-point expression (eg SIN(30)+2), variable (eg price or z) or literal value (eg 78.9)
- Integer expression (eg 3\*567), variable (eg price%, or price& if in range) or literal value (eg -5676)
- Long integer expression (eg 3\*56799), variable (eg profit&) or literal value (eg -5676869)
- String expression (eg b\$+MID\$(a\$)), variable (eg price\$) or literal value (eg word)
- Logical file name (A, B, C or D)
- Field name

For example, AT X%,Y% might be used like this: AT 15,2

## How functions are specified

Functions are specified as variable=FUNCTION(argument(s)) where variable may be f% or f& for a function returning an integer or long integer result, f for a function returning a floating-point result, or f\$ for a function returning a string

result. The argument(s):

- follow the command immediately
- are enclosed in brackets ( )
- are separated from each other in the brackets by a comma
- may include variables, literal values or expressions of the appropriate kind integer, long integer, floating-point or string, as described above.

Eg `f$=LEFT$(g$,x%)` might be used like this: `PRINT LEFT$(fname$,2)`

If you use the wrong type of number as an argument it will, where possible, be converted. For example, you can use an integer for a floating-point argument, or a long integer for an integer argument. If the conversion is not possible for example, if you use a floating-point number for an integer argument and its value is outside the range of integers an error will be produced and the program stopped.

Some functions, such as GET, have no arguments.

---

## ABS

**Usage:** `a=ABS (x)`

Returns the absolute value of a floating-point number that is, without any +/- sign for example `ABS(-10.099)` is 10.099

If x is an integer, you won't get an error, but the result will be converted to floating-point for example `ABS(-6)` is 6.0. Use IABS to return the absolute value as a long integer.

---

## ACOS

**Usage:** `a=ACOS (x)`

Returns the arc cosine, or inverse cosine ( $\text{COS}^{-1}$ ) of x.

x must be in the range -1 to +1. The number returned will be an angle in radians. To convert the angle to degrees, use the DEG function.

---

## ADDR

**Usage:** `a%=ADDR(variable)`

Returns the address at which variable is stored in memory.

The values of different types of variables are stored in bytes starting at `ADDR(variable)`. See PEEK for details.

See also UADD, USUB.

---

## ADJUSTALLOC

**Usage:** `pcelln%=ADJUSTALLOC (pcell%,off%,am%)`

Opens or closes a gap at `off%` within the allocated cell `pcell%`, returning the new cell address or zero if out of memory. `off%` is 0 for the first byte in the cell. Opens a gap if the amount `am%` is positive, and closes it if negative.

---

## ALERT

### Usage any of:

```
r%=ALERT (m1$, m2$, b1$, b2$, b3$)
r%=ALERT (m1$, m2$, b1$, b2$)
r%=ALERT (m1$, m2$, b1$)
r%=ALERT (m1$, m2$)
r%=ALERT (m1$)
```

Presents an alert a simple dialog with the messages and keys specified, and waits for a response. m1\$ is the message to be displayed on the first line, and m2\$ on the second line. If m2\$ is not supplied or if it is a null string, the second message line is left blank.

Up to three keys may be used. b1\$, b2\$ and b3\$ are the strings (usually words) to use over the keys. b1\$ appears over an Esc key, b2\$ over Enter, and b3\$ over Space. This means you can have Esc, or Esc and Enter, or Esc, Enter and Space keys. If no key strings are supplied, the word CONTINUE is used above an Esc key.

The key number 1 for Esc, 2 for Enter or 3 for Space is returned.

---

## ALLOC

**Usage:** pcell%=ALLOC (size%)

Allocates a cell on the heap of the specified size, returning the pointer to the cell or zero if there is not enough memory.

---

## APP

**Usage:**

```
APP name
...
ENDA
```

Begins definition of an OPA. name gives the name of the OPA.

See the Advanced Topics chapter for more details of OPAs.

---

## APPEND

**Usage:** APPEND

Adds a new record to the end of the current data file. The record which was current is unaffected. The new record, the last in the file, becomes the current record.

The record added is made from the current values of the field variables A.field1\$, A.field2\$, and so on, of the current data file. If a field has not been assigned a value, zero will be assigned to it if it is a numeric field, or a null string if it is a string field.

Example:

```
PROC add:
OPEN address,A,f1$,f2$,f3$
PRINT ADD NEW RECORD
PRINT Enter name:,
INPUT A.f1$
PRINT Enter street:,
INPUT A.f2$
PRINT Enter town:,
INPUT A.f3$
APPEND
CLOSE
ENDP
```

To overwrite the current record with new field values, use UPDATE.

---

## APPENDSPRITE

### Usage:

```
APPENDSPRITE time%,bit$(),dx%,dy%  
APPENDSPRITE time%,bit$()
```

Appends a single bitmap-set to the current sprite.

time% gives the duration in tenths of seconds for the bitmap-set to be displayed before going on to the next bitmap-set in the sequence.

bit\$() contains the names of bitmap files in the set, or to specify no bitmap. The array must have at least 6 elements:

```
bit$(1) for setting black pixels  
bit$(2) for clearing black pixels  
bit$(3) for inverting black pixels  
bit$(4) for setting grey pixels  
bit$(5) for clearing grey pixels  
bit$(6) for inverting grey pixels
```

All the bitmaps in a single bitmap-set must be the same size or 'Argument' error (-2) is raised on attempting to draw the sprite. Bitmaps in different bitmap-sets may differ in size.

dx% and dy%, if supplied, are the (x,y) offsets from the sprite position to the top-left of this bitmap-set, with positive for right and down. The default value of each is zero.

---

## ASC

**Usage:** a%=ASC(a\$)

Returns the character code of the first character of a\$.

See the character set in the back of the User Guide for the character codes. Alternatively, use A%=%char to find the code for char eg %X for 'X'.

If a\$ is a null string () ASC returns the value 0.

Example A%=ASC(hello) returns 104, the code for h.

---

## ASIN

**Usage:** a=ASIN(x)

Returns the arc sine, or inverse sine (SIN<sup>-1</sup>) of x.

x must be in the range -1 to +1. The number returned will be an angle in radians. To convert the angle to degrees, use the DEG function.

---

## AT

**Usage:** AT x%,y%

Positions the cursor at x% characters across the text window and y% rows down. AT 1,1 always moves to the top left corner of the window. Initially, the window is the full size of the screen, but you can change its size and position with the SCREEN command.

A common use of AT is to display strings at particular positions in the text window. For example: AT 5,2 :PRINT message.

- PRINT statements without an AT display at the left edge of the window on the line below the last PRINT statement (unless you use `,' or `;') and strings displayed at the top of the window eventually scroll off as more strings are displayed at the bottom of the window.
- Displayed strings always overwrite anything that is on the screen they do not cause things below them on the screen to scroll down.

Example:

```

PROC records:
LOCAL k%
OPEN clients,A,name$,tel$
DO
  CLS
  AT 1,7
  PRINT Press a key to
  PRINT step to next record
  PRINT or Q to quit
  AT 2,3 :PRINT A.name$
  AT 2,4 :PRINT A.tel$
NEXT
IF EOF
  AT 1,6 :PRINT EndOfFile
  FIRST
ENDIF
k%=GET
UNTIL k%=%Q OR k%=%q
CLOSE
ENDP

```

## ATAN

**Usage:** a=ATAN(x)

Returns the arc tangent, or inverse tangent ( $TAN^{-1}$ ) of x.

The number returned will be an angle in radians. To convert the angle to degrees, use the DEG function.

## BACK

**Usage:** BACK

Makes the previous record in the current data file the current record.

If the current record is the first record in the file, then the current record does not change.

## BEEP

**Usage:** BEEP time%,pitch%

Sounds the buzzer. The beep lasts for time%/32 seconds so for a beep a second long make time%=32, etc. The maximum is 3840 (2 minutes).

The pitch (frequency) of the beep is  $512/(pitch\%+1)$  KHz.

BEEP 5,300 gives a comfortably pitched beep.

If you make time% negative, BEEP first checks whether the sound system is in use (perhaps by another OPL program), and returns if it is. Otherwise, BEEP waits until the sound system is free.

Example a scale from middle C:

**PROC scale:**

```

LOCAL freq,n%
REM n% relative to middle A
n%=3 REM start at middle C
WHILE n%<16
  freq=440*2**(n%/12.0)
  REM middle A = freq 440Hz
  BEEP 8,512000/freq-1.0
  n%=n%+1
  IF n%=4 OR n%=6 OR n%=9 OR
      n%=11 OR n%=13
    n%=n%+1
  ENDIF
ENDWH
ENDP

```

(Note that the IF statement should all be on the same line).

Alternatively, sound the buzzer with this statement: `PRINT CHR$(7)`. This beeps at a fixed pitch for a fixed length of time.

## BREAK

**Usage:** BREAK

Makes a program performing a DO...UNTIL or WHILE...ENDWH loop exit the loop and immediately execute the line following the UNTIL or ENDWH statement.

Example: (picture)

```

DO
  ...
  ....
  IF a=b
    BREAK
  ENDIF
  ..
  ...
  .....
UNTIL a=b
x%=3
..

```

## BUSY

**Usage - one of:**

```

BUSY str$,c%,delay%
BUSY str$,c%
BUSY str$
BUSY OFF

```

`BUSY str$` displays `str$` in the bottom left of the screen, until `BUSY OFF` is called. Use this to indicate 'Busy' messages, usually when an OPL program is going to be unresponsive to keypresses for a while.

If `c%` is given, it controls the corner in which the message appears:

```

c%      corner
0       top left
1       bottom left (default)
2       top right
3       bottom right

```

`delay%` specifies a delay time (in half seconds) before the message should be shown. Use this to prevent 'busy' messages from continually appearing very briefly on the screen.

Only one message can be shown at a time. The string to display can be up to 19 characters long.

---

## CACHE

### Usage - one of:

```
CACHE init%,max%  
CACHE ON  
CACHE OFF
```

CACHE creates a procedure cache of a specified initial number of bytes `init%` which may grow up to the maximum size `max%`. You should usually TRAP this.

Once a cache has been created, CACHE OFF prevents further cacheing, although the cache is still searched when calling subsequent procedures. CACHE ON may then be used to re-enable cacheing.

---

## CACHEHDR

**Usage:** `CACHEHDR addr(hdr%)`

Read the current cache index header into array `hdr%`, which must have at least 11 integer elements.

See the 'Advanced topics' chapter for more details.

---

## CACHEREC

**Usage:** `CACHEREC addr(rec%),off%`

Read the cache index record at offset `off%` into array `rec%`, which must have at least 18 integer elements.

See the 'Advanced topics' chapter for more details.

---

## CACHETIDY

**Usage:** `CACHETIDY`

Remove from the cache any procedures that have returned to their callers.

---

## CALL

**Usage:** `e%=CALL(s%,bx%,cx%,dx%,si%,di%)`

This function enables you to make operating system calls. To use it requires extensive knowledge of the Operating System and related programming techniques. The syntax of this command is included here for completeness.

The INT number itself is the least significant byte of `s%`. The AH value (the subfunction number) is the most significant byte of `s%`. The values of the other arguments are passed to the corresponding 8086 registers. The value of the AX register is returned.

---

## CHANGESPRITE

### Usage:

```
CHANGESPRITE ix%,time%,bit$(),dx%,dy%  
CHANGESPRITE ix%,time%,bit$()
```

Changes the bitmap-set specified by `ix%` (1 for the first bitmap-set) in the current sprite, using the supplied bitmap files,

offsets and duration in the same way as for APPENDSPRITE.

---

## CHRS

**Usage:** a\$=CHR\$ (x%)

Returns the character with character code x%.

You can use it to display characters not easily available from the keyboard for example, the instruction PRINT CHR\$(174) displays ®.

The full character set is in the User Guide.

---

## CLOSE

**Usage:** CLOSE

Closes the current file (that is, the one which has been OPENED and most recently USED).

If you've used ERASE to remove some records, CLOSE recovers the memory used by the deleted records, provided it is held either in the internal memory or on a Ram SSD.

---

## CLOSESPRITE

**Usage:** CLOSESPRITE id%

Closes the sprite with ID id%.

---

## CLS

**Usage:** CLS

Clears the contents of the text window.

The cursor then goes to the beginning of the top line. If you have used CURSOR OFF the cursor is still positioned there, but is not displayed.

---

## CMD\$

**Usage:** c\$=CMD\$ (x%)

Returns the command-line arguments passed when starting a program. Null strings may be returned. x% should be from 1 to 5. cmd\$(2) to cmd\$(5) are only for OPAs (OPL applications).

cmd\$(1) returns the full path name used to start the running program.

cmd\$(2) returns the full path name of the file to be used by an OPA application.

cmd\$(3) returns C for Create file or O for Open file. If the OPA is being run with a new filename, this will return C. This happens the very first time the OPA is used, and whenever a new filename is used to run it. Otherwise, the OPA is being run with the name of an existing file, and cmd\$(3) will return O.

cmd\$(4) returns the alias information, if any. In practice this has no relevance for OPAs.

cmd\$(5) returns the application name, as declared with the APP keyword.

See the Advanced Topics chapter for more details of OPAs.

See also GETCMD\$.

---

## COMPRESS

**Usage:** COMPRESS src\$,dest\$

Copies data file src\$ to another data file dest\$. If dest\$ already exists, the records in src\$ are appended to the end of dest\$.

Deleted records are not copied. This makes COMPRESS particularly useful when copying from a Flash SSD. (The space used by deleted records on a Ram SSD or in internal memory is automatically freed when you close the file.)

If you want src\$ to overwrite instead of append to dest\$, use: TRAP DELETE dest\$ before the COMPRESS statement.

You can use wildcards if you wish to copy more than one file at a time. But if the first name contains any wildcards, the second name must not include a filename, just the device and directory to which the files are to be copied under their original names.

Example: to copy all the data files on A: (in \OPD, the default directory) to B:\BCK\:

```
COMPRESS A:*.ODB,B:\BCK\
```

(Remember the final backslash on the directory name.)

See COPY for copying any type of file.

---

## CONTINUE

**Usage:** CONTINUE

Makes a program immediately go to the UNTIL... line of a DO...UNTIL loop or the WHILE... line of a WHILE...ENDWH loop ie to the test condition.

Example: (picture)

```
DO
  ...
  .....
  ....
  IF a<3.5
    CONTINUE
  ENDIF
  ..
  ....
  ...
UNTIL a=b
..
```

See also BREAK.

---

## COPY

**Usage:** COPY src\$,dest\$

Copies the file src\$, which may be of any type, to the file dest\$. Any existing file with the name dest\$ is deleted. You can copy across devices.

Use the appropriate file extensions to indicate the type of file, and wildcards if you wish to copy more than one file at a

time:

- If src\$ contains wildcards, dest\$ must not specify a filename, just the device and directory to which the files are to be copied under their original names.
- You must specify either an extension or .\* on the first filename. The file type extensions are listed in the User Guide.

Example: To copy all the OPL files from internal memory (in \OPL) to B:\ME\:

```
COPY M:\OPL\*.OPL,B:\ME\
```

(Remember the final backslash on the directory name.)

See COMPRESS for more control over copying data files. If you use COPY to copy a data file, deleted records are copied and you cannot append to another data file.

There are more details of full file specifications in the Advanced Topics chapter.

---

## COS

**Usage:** c=COS (x)

Returns the cosine of x, where x is an angle in radians.

To convert from degrees to radians, use the RAD function.

---

## COUNT

**Usage:** c%=COUNT

Returns the number of records in the current data file.

This number will be 0 if the file is empty.

---

## CREATE

**Usage:** CREATE file\$,log,f1,f2,...

Creates a data file called file\$.

- The filename may be a full file specification of up to 128 characters. Field names may be up to 8 letters/numbers.
- The file may have up to 32 fields, as specified by f1, f2... (if viewed in the Database application, field f1 starts on the top line of the window, f2 is below it, etc.)
- log specifies the logical file name A, B, C or D. This is used as an abbreviation for the file name when you use other data file commands such as USE.

Immediately after the CREATE statement, the file is open and can be accessed.

Example:

```
CREATE CLIENTS,B,NM$,PHON$
```

would create a data file in the internal memory with the name CLIENTS and the logical name B.

---

## CREATESPRITE

**Usage:** id%=CREATESPRITE

Creates a sprite, returning the sprite ID.

---

## CURSOR

**Usage - one of:**

```
CURSOR ON
CURSOR OFF
CURSOR id%,asc%,w%,h%
CURSOR id%,asc%,w%,h%,type%
CURSOR id%
```

CURSOR ON switches the text cursor on at the current cursor position. Initially, no cursor is displayed.

You can switch on a graphics cursor in a window by following CURSOR with the ID of the window. This replaces any text cursor. At the same time, you can also specify the cursor's shape, and its position relative to the baseline of text.

asc% is the ascent the number of pixels (-128 to 127) by which the top of the cursor should be above the baseline of the current font. h% and w% (both from 0 to 255) are the cursor's height and width.

If you do not specify them, the following default values are used: asc%=font ascent h%=font height w%=2

If type% is given, it can have these effects: 1 obloid 2 not flashing 4 grey

You can add these values together to combine effects eg if type% is 6 a grey non-flashing cursor is drawn.

An error is raised if id% specifies a bitmap rather than a window.

CURSOR OFF switches off any cursor.

---

## DATETOSECS

**Usage:** s&=DATETOSECS (yr%,mo%,dy%,hr%,mn%,sc%)

Returns the number of seconds since 00:00 on 1 January 1970 at the date/time specified.

Raises an error for dates before 1 January 1970.

The value returned is an unsigned long integer. (Values up to +2,147,483,647, which is 03:14:07 on 19/1/2038, are returned as expected. Those from +2,147,483,648 upwards are returned as negative numbers, starting from -2,147,483,648 and increasing towards zero.)

See also SECSTODATE, HOUR, MINUTE, SECOND.

---

## DATIM\$

**Usage:** d\$=DATIM\$

Returns the current date and time from the system clock as a string for example: Fri 16 Oct 1992 16:25:30 The string returned always has this format 3 mixed-case characters for the day, then a space, then 2 digits for the day of the month, and so on.

---

## DAY

**Usage:** d%=DAY

Returns the current day of the month (1 to 31) from the system clock.

---

## DAYNAMES

**Usage:** d\$=DAYNAME\$(x%)

Converts x%, a number from 1 to 7, to the day of the week, expressed as a three letter string.

Eg d\$=DAYNAME\$(1) returns MON.

Example:

```
PROC Birthday:
LOCAL d&,m&,y&,dWk%
DO
  dINIT
  dTEXT ,Date of birth,2
dTEXT ,eg 23 12 1963,$202
  dLONG d&,Day,1,31
  dLONG m&,Month,1,12
  dLONG y&,Year,1900,2155
  IF DIALOG=0 :BREAK :ENDIF
  dWk%=DOW(d&,m&,y&)
  CLS :PRINT DAYNAME$(dWk%),
  PRINT d&,m&,y&
  dINIT
  dTEXT ,Again?,$202
  dBUTTONS No,%N,Yes,%Y
UNTIL DIALOG<>%y
ENDP
```

See also DOW.

---

## DAYS

**Usage:** d&=DAYS(day%,month%,year%)

Returns the number of days since 01/01/1900.

Use this to find out the number of days between two dates.

Example:

```
PROC deadline:
LOCAL a%,b%,c%,deadlin&
LOCAL today&,togo%
PRINT What day? (1-31)
INPUT a%
PRINT What month? (1-12)
INPUT b%
PRINT What year? (19??)
INPUT c%
deadlin&=DAYS(a%,b%,1900+c%)
today&=DAYS(DAY,MONTH,YEAR)
togo%=deadlin&-today&
PRINT togo%,days to go
GET
ENDP
```

See also dDATE, SECSTODATE.

---

## dBUTTONS

## Usage - one of:

```
dBUTTONS p1$, k1%, p2$, k2%, p3$, k3%
dBUTTONS p1$, k1%, p2$, k2%
dBUTTONS p1$, k1%
```

Defines exit keys to go at the bottom of a dialog.

From one to three exit keys may be defined. Each pair of p\$ and k% specifies an exit key; p\$ is the text to be displayed above it, while k% is the keycode of the key. DIALOG returns the keycode of the key pressed (in lower case for letters).

For alphabetic keys, use the % sign %A means `the code of A', and so on. An appendix lists the codes for keys (such as Tab) which are not part of the character set. If you use the code for one of these keys, its name (eg `Tab', or `Enter') will be shown in the key.

If you use a negative value for a k% argument, that key is a `Cancel' key. The corresponding positive value is used for the key to display and the value for DIALOG to return, but if you do press this key to exit, the var variables used in the commands like dEDIT, dTIME etc. will not be set.

The Esc key will always cancel a dialog box, with DIALOG returning 0. If you want to show the Esc key as one of the exit keys, use -27 as the k% argument (its keycode is 27) so that the var variables will not be set if Esc is pressed.

There can be only one dBUTTONS item per dialog, and it takes up three lines on the screen. dBUTTONS must be the last dialog command you use before DIALOG itself.

Some keypresses, such as those using the Control key, cannot be specified.

This example presents a simple query, returning `True' for Yes, or `False' for No.

```
PROC query:
  dINIT
  dTEXT ,FORGET CHANGES,2
  dTEXT ,Sure?, $202
  dBUTTONS No, %N, Yes, %Y
  RETURN DIALOG=%y
ENDP
```

---

## dCHOICE

**Usage:** dCHOICE var choice%, p\$, list\$

Defines a choice list to go in a dialog.

p\$ will be displayed on the left side of the line. list\$ should contain the possible choices, separated by commas for example, Yes,No. One of these will be displayed on the right side of the line, and LEFT RIGHT can be used to move between the choices.

choice% must be a LOCAL or a GLOBAL variable. It specifies which choice should initially be shown 1 for the first choice, 2 for the second, and so on. When you finish using the dialog, choice% is given a value indicating which choice was selected again, 1 for the first choice, and so on.

---

## dDATE

**Usage:** dDATE var lg&, p\$, min&, max&

Defines an edit box for a date, to go in a dialog.

p\$ will be displayed on the left side of the line.

lg&, which must be a LOCAL or a GLOBAL variable, specifies the date to be shown initially. Although it will appear on the screen like a normal date, for example 15/03/92, lg& must be specified as days since 1/1/1900.

min& and max& give the minimum and maximum values which are to be allowed. Again, these are in days since 1/1/1900. An error is raised if min& is higher than max&.

When you finish using the dialog, the date you entered is returned in lg&, in days since 1/1/1900.

The system setting determines whether years, months or days are displayed first.

See also DAYS, SECSTODATE.

---

## dEDIT

### Usage:

```
dEDIT var str$,p$,len%  
dEDIT var str$,p$
```

Defines a string edit box, to go in a dialog.

p\$ will be displayed on the left side of the line.

str\$ is the string variable to edit. Its initial contents will appear in the dialog. The length used when str\$ was defined is the maximum length you can type in.

len%, if supplied, gives the width of the edit box (allowing for widest possible character in the font). The string will scroll inside the edit box, if necessary. If len% is not supplied, the edit box is made wide enough for the maximum width str\$ could possibly be.

See also dTEXT.

---

## DEFAULTWIN

**Usage:** DEFAULTWIN mode%

Change the default window (ID=1) to enable or disable the use of grey. Initially grey cannot be used in that window.

mode%=1 enables the use of grey. mode%=0 disables the use of grey.

A side-effect of DEFAULTWIN is to clear the default window.

Using grey does use more memory than using black only.

You are advised to call DEFAULTWIN once and for all near the start of your program if you need to use grey. If it fails with 'Out of memory' error, the program can then exit cleanly without losing vital information.

See also gGREY and gCREATE.

---

## DEG

**Usage:** d=DEG (x)

Converts from radians to degrees.

Returns x, an angle in radians, as a number of degrees. The formula used is:  $180*x/\text{PI}$

All the trigonometric functions (SIN,COS etc.) work in radians, not degrees. You can use DEG to convert an angle returned by a trigonometric function back to degrees:

Example:

```
PROC xarctan:
```

```
LOCAL arg,angle
PRINT Enter argument:;
INPUT arg
PRINT ARCTAN of,arg,is
angle=ATAN(arg)
PRINT angle,radians
PRINT DEG(angle),degrees
GET
ENDP
```

To convert from degrees to radians, use RAD.

---

## DELETE

**Usage:** DELETE filename\$

Deletes any type of file.

You can use wildcards for example, to delete all the OPL files in B:\OPL DELETE B:\OPL\\*.OPL

The file type extensions are listed in the User Guide.

See also RMDIR.

---

## dFILE

**Usage:** dFILE var str\$,p\$,f%

Defines a filename edit box, to go in a dialog. A `Disk' selector is automatically added on the line below.

p\$ will be displayed on the left side of the line.

f% controls the type of file editor, and the kind of input allowed. You can add together any of the following values:

value	meaning
1	use an edit box
2	allow directory names
4	directory names only
8	disallow existing files
16	query existing files
32	allow null string input
64	don't display extension
128	obey/allow wildcards

The first of the list is the most crucial. If you add 1 into f%, you will see an file edit box, as when creating a new file. If you do not add 1, you will see the `matching file' selector, used when choosing an existing file.

If performing a `copy to' operation, you might use 1+2+16, to specify a file edit box, in which you can type the name of a directory to copy to, and which will produce a query if you type the name of an existing file.

If asking for the name of a directory to remove, you might use 4, to allow an existing directory name only.

`Query existing' is ignored if `disallow existing' is set. These two, as well as `allow null string input', only work with file edit boxes, not `matching file' selectors.

str\$ is the string variable to edit. Its initial contents always control the initial drive and directory used. For a file edit box, any filename part of str\$ is shown. For a `matching file' selector, you can use wildcards in the filename part (such as \*.tmp) to control which filenames are matched. To do this, you must add 128 to f%. 128 also allows wildcard specifications to be entered (returned in str\$), for both `matching' and `new file' selectors.

If str\$ does not contain any drive or directory information, the path as set by SETPATH is used. If SETPATH has not been used, the \OPD directory on the default drive (usually M:, `Internal') is used.

With a matching file selector (as opposed to an edit box) the value 8 restricts the selection to files which match the filename/extension in str\$. Matching file selectors can also use 64, in which case files with the same extension as that in str\$ are shown without this extension. (Many Series 3a file selectors are like this.)

You can always press Tab to produce the full file selector with a dFILE item.

str\$ must be declared to be at least 128 bytes long, or an error will be raised.

---

## dFLOAT

**Usage:** dFLOAT var fp,p\$,min,max

Defines an edit box for a floating-point number, to go in a dialog.

p\$ will be displayed on the left side of the line.

min and max give the minimum and maximum values which are to be allowed. An error is raised if min is higher than max.

fp must be a LOCAL or a GLOBAL variable. It specifies the value to be shown initially. When you finish using the dialog, the value you entered is returned in fp.

---

## DIALOG

**Usage:** n%=DIALOG

Presents the dialog prepared by dINIT and commands such as dTEXT and dCHOICE. If you complete the dialog by pressing Enter, your settings are stored in the variables specified in dTEXT, dCHOICE etc., although you can prevent this with dBUTTONS.

If you used dBUTTONS when preparing the dialog, the keycode which ended the dialog is returned. Otherwise, DIALOG returns the line number of the item which was current when Enter was pressed. The top item (or the title line, if present), has line number 1.

If you cancel the dialog by pressing Esc, the variables are not changed, and 0 is returned.

---

## DIAMINIT

**Usage:** DIAMINIT pos%,str1\$,str2\$...

Initialises the ◆ list (discarding any existing list). str1\$, str2\$ etc. contain the text to be displayed in the status window for each item in the list.

pos% is the initial item on to which the ◆ indicator should be positioned, with pos%=1 specifying the first item. (Any value greater than the number of strings specifies the final item.) If pos%>=1 you must supply at least this many strings.

If pos% is not supplied or if pos%=0, or if DIAMINIT is used on its own with no arguments, no bar is defined.

If pos%=-1 the list is replaced by the icon instead in the large status window.

---

## DIAMPOS

**Usage:** DIAMPOS pos%

Positions the ◆ indicator on the ◆ list.

Positioning outside the range of the items wraps around in the appropriate way. pos%=0 causes the ◆ symbol to

disappear.

---

## dINIT

**Usage:** dINIT title\$ or dINIT

Prepares for definition of a dialog, cancelling any existing one. Use dTEXT, dCHOICE etc. to define each item in the dialog, then DIALOG to display the dialog.

If title\$ is supplied it will be displayed at the top of the dialog, centred and with a line across the dialog below it.

---

## DIR\$

**Usage:**

```
d$=DIR$(filespec$) then
d$=DIR$()
```

Lists filenames, including subdirectory names, matching a file specification. You can include wildcards in the file specification. If filespec\$ is just a directory name, include the final backslash on the end for example, M:\TEMP\. Use the function like this:

- DIR\$(filespec\$) returns the name of the first file matching the file specification.
- DIR\$() then returns the name of the second file in the directory.
- DIR\$() again returns the third, and so on.
- When there are no more matching files in the directory, DIR\$() returns a null string.

Example, listing all the .DBF files in M:\DAT:

```
PROC dir:
LOCAL d$(128)
d$=DIR$(M:\DAT\*.DBF)
WHILE d$<>
PRINT d$
d$=DIR$()
ENDWH
GET
ENDP
```

---

## dLONG

**Usage:** dLONG var lg&,p\$,min&,max&

Defines an edit box for a long integer, to go in a dialog.

p\$ will be displayed on the left side of the line.

min& and max& give the minimum and maximum values which are to be allowed. An error is raised if min& is higher than max&.

lg& must be a LOCAL or a GLOBAL variable. It specifies the value to be shown initially. When you finish using the dialog, the value you entered is returned in lg&.

---

## DO...UNTIL

## Usage:

```
DO
  statement
  statement
  .
  .
  .
UNTIL condition
```

DO forces the set of statements which follow it to execute repeatedly until the condition specified by UNTIL is met.

This is the easiest way to repeat an operation a certain number of times.

- Every DO must have its matching UNTIL to end the loop.
- If you set a condition which is never met, the program will go round and round, locked in the loop forever. You can escape by pressing Psion-Esc, provided you haven't set ESCAPE OFF. If you have set ESCAPE OFF, you will have to return to the System screen, move to the program name under the RunOpl icon, and press Delete.

---

## DOW

**Usage:** d%=DOW(day%,month%,year%)

Returns the day of the week from 1 (Monday) to 7 (Sunday) given the date.

day% must be between 1 and 31, month% from 1 to 12 and year% from 1900 to 2155.

For example, D%=DOW(4,7,1992) returns 6, meaning Saturday.

---

## dPOSITION

**Usage:** dPOSITION x%,y%

Positions a dialog. Use dPOSITION at any time between dINIT and DIALOG.

dPOSITION uses two integer values. The first specifies the horizontal position, and the second, the vertical. dPOSITION -1,-1 positions to the top left of the screen; dPOSITION 1,1 to the bottom right; dPOSITION 0,0 to the centre, the usual position for dialogs.

dPOSITION 1,0, for example, positions to the right-hand edge of the screen, and centres the dialog half way up the screen.

---

## DRAWSPRITE

**Usage:** DRAWSPRITE x%,y%

Draws the current sprite in the current window with top-left at pixel position x%,y%.

---

## dTEXT

**Usage:** dTEXT p\$,body\$,t% or dTEXT p\$,body\$

Defines a line of text to be displayed in a dialog.

p\$ will be displayed on the left side of the line, and body\$ on the right side. If you only want to display a single string, use a null string () for p\$, and pass the desired string in body\$. It will then have the whole width of the dialog to itself.

An error is raised if body\$ is a null string.

body\$ is normally displayed left aligned (although usually in the right column). You can override this by specifying t%:

t%	effect
0	left align body\$
1	right align body\$
2	centre body\$

In addition, you can add any or all of the following three values to t%, for these effects:

t%	effect
\$100	use bold text for body\$
\$200	draw a line below this item
\$400	(allow this item to be selected)

Only one line can be drawn across a dialog. It will be below the last item which asks for it, whether the title from dINIT or a dTEXT item.

See also dEDIT.

---

## dTIME

**Usage:** dTIME var lg&,p\$,t%,min&,max&

Defines an edit box for a time, to go in a dialog.

p\$ will be displayed on the left side of the line.

lg&, which must be a LOCAL or a GLOBAL variable, specifies the time to be shown initially. Although it will appear on the screen like a normal time, for example 18:27, lg& must be specified as seconds after 00:00. A value of 60 means one minute past midnight; 3600 means one o'clock, and so on.

min& and max& give the minimum and maximum values which are to be allowed. Again, these are in seconds after 00:00. An error is raised if min& is higher than max&.

When you finish using the dialog, the time you entered is returned in lg&, in seconds after 00:00.

t% specifies the type of display required, as follows:

t% time display 0 absolute time no seconds 1 absolute time with seconds 2 duration no seconds 3 duration with seconds

For example, 03:45 represents an absolute time while 3 hours 45 minutes represents a duration.

Absolute times are displayed in 24-hour or am/pm format according to the current system setting.

---

## dXINPUT

**Usage:** dXINPUT var str\$,p\$

Defines a secret string edit box, such as for a password, to go in a dialog.

p\$ will be displayed on the left side of the line.

str\$ is the string variable to take the string you type. Important: str\$ must be at least eight characters long.

Initially the dialog does not show any characters for the string; the initial contents of str\$ are ignored. A special symbol will be displayed for each character you type, to preserve the secrecy of the string.

---

## EDIT

**Usage:** EDIT a\$

Displays a string variable which you can edit directly on the screen. All the usual editing keys are available the arrow keys move along the line, Esc clears the line, and so on.

When you have finished editing, press Enter to confirm the changes. If you press Enter before you have made any changes, then the string will be unaltered.

If you use EDIT in conjunction with a PRINT statement, use a comma at the end of the PRINT statement, so that the string to be edited appears on the same line as the displayed string:

```
... PRINT Edit address:, EDIT A.address$ UPDATE ....
```

TRAP EDIT If the Esc key is pressed while no text is on the input line, the 'Escape key pressed' error (number -114) will be returned by ERR provided that the EDIT has been trapped. You can use this feature to enable someone to press the Esc key to escape from inputting a string.

See also INPUT, dEDIT.

ELSE(IF)/ENDA/ENDIF/ENDV/ ENDWH

See IF/APP/VECTOR/WHILE

ENTERSEND

Usage:

```
ret%=ENTERSEND(pobj%,m%,var p1,...)
```

This is the same as SEND except that, if the method leaves, the error code is returned to the caller. Otherwise the value returned is as returned by the method.

---

## ENTERSEND0

**Usage:** ret%=ENTERSEND0 (pobj%,m%,var p1,...)

This is the same as ENTERSEND except that, if the method does not leave, zero is returned.

---

## EOF

**Usage:** e%=EOF

Finds out whether you're at the end of a file yet.

Returns -1 (true) if the end of the file has been reached, or 0 (false) if it hasn't.

When reading records from a file, you should test whether there are still records left to read, otherwise you may get an error.

Example:

```
PROC eofstest:
OPEN myfile,A,a$,b%
DO
PRINT A.a$
PRINT A.b%
NEXT
PAUSE -40
```

```
UNTIL EOF
PRINT The last record
GET
RETURN
ENDP
```

---

## ERASE

**Usage:** ERASE

Erases the current record in the current file.

The next record is then current. If the erased record was the last record in a file, then following this command the current record will be null and EOF will return true.

---

## ERR

**Usage:** e%=ERR

Returns the number of the last error which occurred, or 0 if there has been no error.

Example:

```
..
PRINT Enter age in years
age::
TRAP INPUT age%
IF ERR=-1
    PRINT Number please:
    GOTO age
ENDIF
...
```

See also ERR\$.

See the Error handling chapter for full details, including the list of error numbers and messages.

---

## ERR\$

**Usage:** e\$=ERR\$(x%)

Returns the error message for the specified error code x%.

ERR\$(ERR) gives the message for the last error which occurred. Example:

```
TRAP OPEN B:\FILE,A,field1$
IF ERR
    PRINT ERR$(ERR)
    RETURN
ENDIF
```

See also ERR.

See the Error handling chapter for full details, including the list of error numbers and messages.

---

## ESCAPE OFF

**Usage:** ESCAPE OFF...ESCAPE ON

ESCAPE OFF stops Psion-Esc being used to break out of the program when it is running. ESCAPE ON enables this feature again.

ESCAPE OFF takes effect only in the procedure in which it occurs, and in any sub-procedures that are called. Psion-Esc is always enabled when a program begins running.

If your program enters a loop which has no logical exit, and ESCAPE OFF has been used, you will have to return to the System screen, move to the program name under the RunOpl icon, and press the Delete key.

---

## EVAL

**Usage:** d=EVAL (s\$)

Evaluates the mathematical string expression s\$ and returns the floating-point result. s\$ may include any mathematical function or operator (eg. sin(x)/(2\*\*3)). Note that floating-point arithmetic is always performed.

For example:

```
DO
AT 10,5 :PRINT Calc:,
TRAP INPUT n$
IF n$= :CONTINUE :ENDIF
IF ERR=-114 :BREAK :ENDIF
CLS :AT 10,4
PRINT n$;=;EVAL(n$)
UNTIL 0
```

See also VAL.

---

## EXIST

**Usage:** e%=EXIST(filename\$)

Checks to see that a file exists.

Returns -1 ('True') if the file exists and 0 ('False') if it doesn't.

Use this function when creating a file to check that a file of the same name does not already exist, or when opening a file to check that it has already been created:

```
IF NOT EXIST(CLIENTS)
  CREATE CLIENTS,A,names$
ELSE
  OPEN CLIENTS,A,names$
ENDIF
...
```

---

## EXP

**Usage:** e=EXP(x)

Returns ex that is, the value of the arithmetic constant e (2.71828...) raised to the power of x.

---

## EXT

**Usage:** EXT name\$

Gives the file extension of files used by an OPA.

This can only be used between APP and ENDA.

See the Advanced Topics chapter for more details of OPAs.

---

## [FIND](#)

**Usage:** f%=FIND(a\$)

Searches the current data file for fields matching a\$. The search starts from the current record, so use NEXT to progress to subsequent records. FIND makes the next record containing a\$ the current record and returns the number of the record found. Capitals and lower-case letters match.

You can use wildcards:

? matches any single character  
\* matches any group of characters.

To find a record with a field containing Dr and either BROWN or BRAUN, use: F%=FIND(\*DR\*BR??N\*)

FIND(BROWN) will find only those records with a field consisting solely of the string BROWN.

You can only search string fields.

See also FINDFIELD.

---

## [FINDFIELD](#)

**Usage:** f%=FINDFIELD(a\$, start%, no%, flags%)

FINDFIELD, like FIND, finds a string, makes the record with this string the current record, and returns the number of this record.

You may experience some problems in using FINDFIELD with some versions of OPL. To ensure that problems are avoided use the line:

```
POKEB(peekw($1c)+7),0
```

immediately before each call to FINDFIELD.

a\$ is the string to look for, as for FIND. start% is the number of the field to start looking in (1 for the first field), and no% is the number of fields to search in (starting from the field specified by the start%). If you want to search in all fields, use start%=1 and for no% use the number of fields you used in the OPEN/CREATE command.

flags% adds together two values:

- 0 for a case independent match, where capitals and lower-case letters match, or 1 for a case dependent match. This value should be multiplied by 16 (Hex \$00 or \$10).
  - 0 to search backwards from the current record, 1 to search forwards from the current record, 2 to search backwards from the end of the file, or 3 to search forwards from the start of the file.
- 

## [FINDLIB](#)

**Usage:** ret%=FINDLIB(var cat%, name\$)

Find DYL category name\$ (including .DYL extension) in the ROM. On success returns zero and writes the category handle to cat%.

FIRST

Usage:

FIRST

Positions to the first record in the current data file.

---

## [FIX\\$](#)

**Usage:** `f$=FIX$(x, y%, z%)`

Returns a string representation of the number `x`, to `y%` decimal places. The string will be up to `z%` characters long.

Example: `FIX$(123.456,2,7)` returns 123.46.

- If `z%` is negative then the string is right-justified for example `FIX$(1,2,-6)` returns 1.00 where there are two spaces to the left of the 1.
- If `z%` is positive then no spaces are added for example `FIX$(1,2,6)` returns 1.00.
- If the number `x` will not fit in the width specified by `z%`, then the string will just be asterisks, for example `FIX$(256.99,2,4)` returns \*\*\*\*.

See also `GEN$`, `NUM$`, `SCI$`.

---

## [FLT](#)

**Usage:** `f=FLT(x&)`

Converts an integer expression (either integer or long integer) into a floating-point number. Example:

```
PROC gamma : (v)
  LOCAL c
  c=3E8
  RETURN 1/SQR(1-(v*v)/(c*c))
ENDP
```

You could call this procedure like this: `gamma:(FLT(a%))` if you wanted to pass it the value of an integer variable without having first to assign the integer value to a floating-point variable.

See also `INT` and `INTF`.

---

## [FONT](#)

**Usage:** `FONT id%, style%`

Sets the text window font and style.

See 'The text and graphics windows' at the end of the 'Graphics' chapter for more details.

---

## [FREEALLOC](#)

**Usage:** `FREEALLOC pcell%`

Frees a previously allocated cell at `pcell%`.

---

## [gAT](#)

**Usage:** `gAT x%, y%`

Sets the current position using absolute co-ordinates. `gAT 0,0` moves to the top left of the current drawable.

See also gMOVE.

---

## gBORDER

### Usage:

```
gBORDER flags%,width%,height%
gBORDER flags%
```

Draws a one-pixel wide border around the edge of the current drawable. If width% and height% are supplied, a border shape of this size is drawn with the top left corner at the current position. If they are not supplied, the border is drawn around the whole of the current drawable.

flags% controls three attributes of the border a shadow to the right and beneath, a one-pixel gap all around, and the type of corners used:

flags%	effect
1	single pixel shadow
2	gap for single pixel shadow
3	double pixel shadow
4	gap for double pixel shadow
\$100	one-pixel gap all round
\$200	more rounded corners

You can combine the values to control the three different effects. (1, 2, 3 and 4 are mutually exclusive you cannot use more than one of them.) For example, for rounded corners and a gap for a double pixel shadow, use flags%=\$204.

Set flags%=0 for no shadow, no gap, and sharper corners.

For example, to de-emphasise a previously emphasised border, use gBORDER with the shadow turned off:

```
gBORDER 3 REM show border
```

```
GET
```

```
gBORDER 4 REM border off
```

```
...
```

See also gXBORDER.

---

## gBOX

**Usage:** gBOX width%,height%

Draws a box from the current position, width% to the right and height% down. The current position is unaffected.

---

## gBUTTON

**Usage:** gBUTTON text\$,type%,w%,h%,st%

Draws a 3-D black and grey button (a key, not an application button) at the current position in a rectangle of the supplied width w% and height h%, which fully encloses the button in all its states. text\$ specifies up to 64 characters to be drawn in the button in the current font and style. You must ensure that the text will fit in the button.

type%=0 it draws a Series 3 style button; type%=1 draws a Series 3a button.

The meaning of state% varies according to type%:

- For type%=0, state%=0 for a raised button and state%=1 for a depressed (flat) button.
- For type%=1, state%=0 for a raised button, state%=1 for a semi-depressed (flat) button and state%=2 for a fully-depressed (sunken) button. An error is raised if the current window has no grey plane.

## gCLOCK

### Usage - one of:

```
gCLOCK ON/OFF
gCLOCK ON,mode%
gCLOCK ON,mode%,offset%
gCLOCK ON,mode%,offset%,format$
gCLOCK ON,mode%,offset%,format$,font%
gCLOCK ON,mode%,offset%,format$,font%,style%
```

Displays or removes a clock showing the system time. The current position in the current window is used. Only one clock may be displayed in each window.

mode% controls the type of clock. Modes 1 to 5 are provided for Series 3 compatibility, and produce Series 3 clocks: small (digital), medium (system setting), medium (analog), medium (digital), and large (analog) respectively. Other values are:

```
6 black and grey medium, system setting
7 black and grey medium, analog
8 second type medium, digital
9 black and grey extra large
10 formatted digital (described below)
```

You can OR the value with any of these:

\$10 shows the date in all except the extra large and formatted clocks

\$20 shows seconds in small digital, large analog, black and grey medium analog and extra large clocks

\$40 shows am/pm in small digital and black medium clocks only. \$80 specifies that a clock is to be drawn in the grey plane (only for clocks that do not contain both black and grey: ie. all except the black and grey, medium, analog clock and the extra large clock).

format\$, font% and style% are used only for formatted digital clocks as described below.

☞ Do not use gSCROLL to scroll the region containing a clock. When the time is updated, the old position would be used. The whole window may, however, be moved using gSETWIN.

☞ It is possible to draw clocks that include grey in windows that have no grey plane.

Digital clocks display in 24-hour or 12-hour mode according to the system-wide setting in Time. The `am/pm' flag (\$40) can be used with digital clocks in 12-hour mode, and with medium analog clocks.

offset% specifies an offset in minutes from the system time to the time displayed. This allows you to display a clock showing a time other than the system time.

If these arguments are not supplied, mode% is taken as 1, and offset% as 0.

**For the formatted digital clock** (mode%=10), you may optionally specify font% and style% with values as for gFONT and gSTYLE. The default font for gCLOCK is the system font (value \$9a). The default style is normal (0).

**For the formatted digital clock**, a format string (up to 255 characters long) specifies how the clock is to be displayed. The format string contains a number of format specifiers in the form of a % followed by a letter. (Upper or lower case may be used.) For example, %H means hours and %T means minutes; gCLOCK ON,10,0,h:%H, m:%T, at 11:05 pm,

displays a running clock as h:23, m:05.

To make each item as abbreviated as possible, you can use a \* after the %. For example, %\*T at 11:05 pm abbreviates `05' to `5'. In the following list of specifiers, those which produce numbers will do so without any leading zero, if you use %\* instead of %. Other abbreviations are marked, appropriately, by Abbrev:

%% = a % character

%, %/ = time and date separators, as set in the Time application

%A = `am' or `pm' text (Abbrev: 1st letter)

%D,%W,%M = day/week/month number as two digits, 01-31, 01-53 and 01-12

%E,%N = day/month name (Abbrev: shorter form, eg 1st 3 characters in English)

%H,%I = hour in 24-hour or 12-hour format, 00-23 and 01-12

%S,%T = seconds/minutes, 00-59

%X = suffix string for day number, eg st in `1st', nd in `2nd'

%Y = year as a four digit number (Abbrev: discards the century)

%1,%2,%3 = day,month,year as ordered in the Time application. Eg Europe is Day/month/year, so %1=%D, %2=%M, %3=%Y. So to display a date in correct format use %1/%2/%3. (Abbrev: see %G/%P/%U.)

%4,%5 = day,month as ordered in the Time application.

%F,%O = toggles days/months (displayed by %1, %2 and %3) between numeric and name formats. On 9th March 1993, with European date type, %1%F%1%F%1 gives 09Tuesday09

%G,%P, %U = toggles %1, %2 and %3 between long form and abbreviation. On 9th March 1993, with European date type, %F%1%G%1%G%1 gives TuesdayTueTuesday

%L = toggles the suffix on the day number for %1/%2/%3 (in numeric form only). On 9th March 1993, with European date type, %G%1%L%1%L%1 gives 99th9

%6,%7 = hour and am/pm text according to the format selected in the Time application. With am-pm format, %6=%I and %7=%A. With 24-hour format, %6=%H and %7 gives no `am/pm' characters.

So the format string %1%/%2%/%3 automatically generates a clock with day, month and year in the order as selected in the Time application. %4%/%5 gives a clock with just day and month in selected order. Similarly, %6%:%T%:%S%7 gives a clock with hour, minute and second automatically conforming to the system configuration.

 Note that for those specifiers that toggle between two different options (eg. %F), the state of toggle is remembered only within one format string and not from one string to the next ie the toggle state is restored to the default setting when displaying a new clock.

As a final example, assuming that the settings in the Time application are for `Day/month/year' date format, `am-pm' time format and `:' time separator and that the time is 11:30:05 pm on 9th March 1993, %G%L%P%O%\*E, %1 %2 %3 %6%:%T%:%S%

generates Tue, 9th Mar 1993 11:30:05pm. With the same setup except for `Month/day/year' date format in `24-hour' mode, the same string generates Tue, Mar 9th 1993 23:30:05.

---

[gCLOSE](#)

Usage: gCLOSE id%

Closes the specified drawable that was previously opened by gCREATE, gCREATEBIT or gLOADBIT.

If the drawable closed was the current drawable, the default window (ID=1) becomes current.

An error is raised if you try to close the default window.

---

## gCLS

**Usage:** gCLS

Clears the whole of the current drawable and sets the current position to 0,0, its top left corner.

---

## gCOPY

**Usage:** gCOPY id%, x%, y%, w%, h%, mode%

Copies a rectangle of the specified size (width w%, height h%) from the point x%,y% in drawable id%, to the current position in the current drawable.

As this command can copy both set and clear pixels, the same modes are available as when displaying text. Set mode% = 0 for set, 1 for clear, 2 for invert or 3 for replace. 0, 1 and 2 act only on set pixels in the pattern; 3 copies the entire rectangle, with set and clear pixels.

The current position is not affected in either window.

gCOPY is affected by the setting of gGREY (in the current window) as follows: with gGREY 0 it copies black to black; with gGREY 1 it copies grey to grey, or black to grey if source is black only; with gGREY 2 it copies grey to grey and black to black, or black to both if source is black only.

---

## gCREATE

**Usage:**

```
id%=gCREATE (x%, y%, w%, h%, v%)  
id%=gCREATE (x%, y%, w%, h%, v%, grey%)
```

Creates a window with specified position and size (width w%, height h%), and makes it both current and foreground. Sets the current position to 0,0, its top left corner. If v% is 1, the window will immediately be visible; if 0, it will be invisible.

If grey% is not given or is 0, the window will not have a grey plane. If grey% is 1, it will have one.

Returns id% (2 to 8) which identifies this window for other keywords.

See also gCLOSE, gGREY, DEFAULTWIN.

---

## gCREATEBIT

**Usage:** id%=gCREATEBIT (w%, h%)

Creates a bitmap with the specified width and height, and makes it the current drawable. Sets the current position to 0,0, its top left corner.

Returns id% (2 to 8) which identifies this bitmap for other keywords.

See also gCLOSE.

---

## [gDRAWOBJECT](#)

**Usage:** gDRAWOBJECT type%, flags%, w%, h%

Draws the scaleable graphics object specified by type%, scaled to fit in the rectangle with top left at the current graphics cursor position and with the specified width w% and height h%.

The Series 3a has only one object type (set type%=0) a 'lozenge'. This is a 3-D rounded box lit from the top left, with a shadow at bottom right and a grey body. (For an example, see the text 'City' in the top left of the World application.)

For type%=0, flags% specifies the corner roundness: 0 for normal roundness 1 for more rounded 2 for a single pixel removed from each corner.

An error is raised if the current window has no grey plane.

---

## [GEN\\$](#)

**Usage:** g\$=gen\$(x, y%)

Returns a string representation of the number x. The string will be up to y% characters long.

Example GEN\$(123.456,7) returns 123.456 and GEN\$(243,5) returns 243

- If y% is negative then the string is right-justified for example GEN\$(1,-6) returns 1 where there are five spaces to the left of the 1.
- If y% is positive then no spaces are added for example GEN\$(1,6) returns 1.
- If the number x will not fit in the width specified by y%, then the string will just be asterisks, for example GEN\$(256.99,4) returns \*\*\*\*.

See also FIX\$, NUM\$, SCIS.

---

## [GET](#)

**Usage:** g%=GET

Waits for a key to be pressed and returns the character code for that key.

For example, if the 'A' key is pressed with Caps Lock off, the integer returned is 97 (a), or 65 (A) if 'A' was pressed with the Shift key down.

The character codes of special keys, such as 'Pg Dn', are given in an appendix at the back of this manual.

You can use KMOD to check whether modifier keys (Shift, Control, Psion and Caps Lock) were used.

See the User Guide for the full character set.

See also KEY.

---

## [GET\\$](#)

**Usage:** g\$=GET\$

Waits until a key is pressed and then returns which key was pressed, as a string.

For example, if the 'A' key is pressed in lower case mode, the string returned is a.

You can use KMOD to check whether any modifier keys (Shift, Control, Psion and Caps Lock) were used.

See also KEY\$.

---

## GETCMD\$

**Usage:** w\$=GETCMD\$

Returns new command-line arguments to an OPA, after a change files or quit event has occurred. The first character of the returned string is C, O or X. If it is C or O, the rest of the string is a filename.

The first character has the following meaning:

C close down the current file, and create the specified new file.

O close down the current file, and open the specified existing file.

X close down the current file (if any) and quit the OPA.

You can only call GETCMD\$ once for each system message.

See the Advanced Topics chapter for more details of OPAs.

See also CMD\$.

---

## GETEVENT

**Usage:** \*\*\* GETEVENT var a%()

Waits for an event to occur. Returns with a%() specifying the event. The data returned in a%() depends on the type of event that occurred. If the event is a key-press, (a%(1) AND \$400) is guaranteed to be zero. For other events (a%(1) AND \$400) is guaranteed to be non-zero.

If a key has been pressed:

a%(1)= keycode (as for GET)

a%(2) AND \$00ff= modifier (as for KMOD)

a%(2)/256= auto-repeat count (ignored by GET)

If a program has moved to foreground: a%(1)= \$401

If a program has moved to background: a%(1)= \$402

If the machine has switched on:a%(1)= \$403

If the Series 3a wants an OPA to change files or exit:a%(1)= \$404

If the date changes:a%(1)= \$405

Note: events are ignored while you are using keywords which wait for keypresses GET, GET\$, EDIT, INPUT, MENU and DIALOG. If you need to use these keywords in OPAs, use LOCK ON / LOCK OFF around them.

If you do use GETEVENT you should allow for other events to be specified in the future.

For a key-press event, the modifier is returned in a%(2) and is not returned by KMOD.

Note: If a non-key event such as 'foreground' occurs while a keyboard keyword such as GET, INPUT, MENU or DIALOG is being used, the event is discarded. So GETEVENT must be used if non-key events are to be monitored.

(OPAs can still handle the \$404 event correctly see the LOCK command for more details.)

The array (or string of integers) must be at least 6 integers long.

See also TESTEVENT, GETCMD\$.

---

## GETLIBH

**Usage:** cat%=GETLIBH(num%)

Convert a category number num% to a handle. If num% is zero, gets the handle for OPL.DYL.

---

## gFILL

**Usage:** gFILL width%,height%,gMode%

Fills a rectangle of the specified size from the current position, according to the graphics mode specified.

The current position is unaffected.

---

## gFONT

**Usage:** gFONT fontId%

Sets the font for current drawable to fontId%. The font may be one of the predefined fonts in the ROM or a user-defined font. See the 'Graphics' chapter for more details of fonts.

User-defined fonts must first be loaded by gLOADFONT, which returns the fontId% needed for gFONT.

See also gLOADFONT, FONT.

---

## gGMODE

**Usage:** gGMODE mode%

Sets the effect of all subsequent drawing commands gLINEBY, gBOX etc. on the current drawable.

mode%	Pixels will be:
0	set
1	cleared
2	inverted

When you first use drawing commands on a drawable, they set pixels in the drawable. Use gGMODE to change this. For example, if you have drawn a black background, you can draw a white box outline inside it with either gGMODE 1 or gGMODE 2, followed by gBOX.

---

## gGREY

**Usage:** gGREY mode%

Controls whether all subsequent graphics drawing and graphics text in the current window draw to the grey plane, the black plane or to both.

mode%=0 for black plane only (default)

mode%=1 for grey plane only

mode%=2 for both planes

It is helpful to think of the black plane being in front of the grey plane, so a pixel set in both planes will appear black. See the 'Graphics' chapter for details.

To enable the use of grey in the default window (ID=1) use DEFAULTWIN 1 at the start of your program. If grey is required in other windows you must create the windows with a grey plane using gCREATE.

gGREY cannot be used with bitmaps which have only one plane.

See also DEFAULTWIN and gCREATE.

---

## gHEIGHT

**Usage:** height% = gHEIGHT

Returns the height of the current drawable.

---

## gIDENTITY

**Usage:** id%=gIDENTITY

Returns the ID of the current drawable.

The default window has ID=1.

---

## gINFO

**Usage:** gINFO var i%()

Gets general information about the current drawable and about the graphics cursor (whichever window it is in). The information is returned in the array i%() which must be at least 32 integers long.

The information is about the drawable in its current state, so eg the font information is for the current font in the current style.

The following information is returned:

i%(1)	lowest character code
i%(2)	highest character code
i%(3)	height of font
i%(4)	descent of font
i%(5)	ascent of font
i%(6)	width of '0' character
i%(7)	maximum character width
i%(8)	flags for font (see below)
i%(9-17)	name of font
i%(18)	current graphics mode (gGMODE)
i%(19)	current text mode (gTMODE)
i%(20)	current style (gSTYLE)
i%(21)	cursor state (ON=1,OFF=0)
i%(22)	ID of window containing cursor (-1 for text cursor)
i%(23)	cursor width
i%(24)	cursor height
i%(25)	cursor ascent
i%(26)	cursor x position in window
i%(27)	cursor y position in window
i%(28)	1 if drawable is a bitmap
i%(29)	cursor effects
i%(30)	gGREY setting
i%(31)	reserved (window server ID of drawable)
i%(32)	reserved

i%(8) specifies a combination of the following font characteristics:

Value:	Meaning:
1	font uses standard ASCII characters (32-126)
2	font uses Code Page 850 characters (128-255)
4	font is bold
8	font is italic
16	font is serifed
32	font is monospaced
\$8000	font is stored expanded for quick drawing

(See HEX\$ for an explanation of hexadecimal numbers.)

Use PEEK\$(ADDR(i%(9))) to read the name of the font as a string.

If the cursor is on (i%(21)=1), it is visible in the window identified by i%(22).

i%(29) has bit 0 set (i%(29) AND 1) if the cursor is obloid, bit 1 set (i%(29) AND 2) if not flashing, and bit 2 set (i%(29) AND 4) if grey.

If the cursor is off (i%(21)=0), or is a text cursor (i%(22)=-1), i%(23) to i%(27) and i%(29) should be ignored.

---

## gINVERT

**Usage:** gINVERT width%,height%

Inverts the rectangle width% to the right and height% down from the cursor position, except for the four corner pixels.

---

## GIPRINT

**Usage:** GIPRINT str\$,c% or GIPRINT str\$

GIPRINT displays an information message for about two seconds, in the bottom right corner of the screen. For example, GIPRINT Not Found displays Not Found. The string you specify can be up to 64 characters. If a string is too long for the screen, it will be clipped.

If c% is given, it controls the corner in which the message appears:

c%	corner
0	top left
1	bottom left
2	top right
3	bottom right (default)

Only one message can be shown at a time. You can make the message go away for example, if a key has been pressed with GIPRINT .

---

## gLINEBY

**Usage:** gLINEBY dx%,dy%

Draws a line from the current position to a point dx% to the right and dy% down. Negative dx% and dy% mean left and up respectively.

For horizontal lines, the line includes the pixel with the lower x coordinate and excludes the pixel with the higher x coordinate. Similarly for vertical lines, the line includes the pixel with the lower y coordinate and excludes the pixel with the higher y coordinate. For oblique lines (where the x and y coordinates change), the line is drawn minus one or both end points.

The current position moves to the end of the line drawn.

`gLINEBY 0,0` sets the pixel at the current position.

See also `gLINETO`, `gPOLY`.

---

## [gLINETO](#)

**Usage:** `gLINETO x%,y%`

Draws a line from the current position to the point `x%,y%`. The current position moves to `x%,y%`.

For horizontal lines, the line includes the pixel with the lower x coordinate and excludes the pixel with the higher x coordinate. Similarly for vertical lines, the line includes the pixel with the lower y coordinate and excludes the pixel with the higher y coordinate. For oblique lines (where the x and y coordinates change), the line is drawn minus one or both end points.

To plot a single point, use `gLINETO` to the current position (or `gLINEBY 0,0`).

See also `gLINEBY`, `gPOLY`.

---

## [gLOADBIT](#)

**Usage - one of:**

```
id%=gLOADBIT (name$,write%,i%)
id%=gLOADBIT (name$,write%)
id%=gLOADBIT (name$)
```

Loads a bitmap from the named bitmap file and makes it the current drawable. Sets the current position to 0,0, its top left corner. If `name$` has no file extension `.PIC` is used. The bitmap is kept as a local copy in memory.

Returns `id%` (2 to 8) which identifies this bitmap for other keywords.

`write%=0` sets read-only access. Attempts to write to the bitmap in memory will be ignored, but the bitmap can be used by other programs without using more memory. `write%=1` allows you to write to and re-save the bitmap. This is the default case.

For bitmap files which contain more than one bitmap, `i%` specifies which one to load. For the first bitmap, use `i%=0`. This is also the default value. Bitmap files saved with `gSAVEBIT` have only one bitmap, and this argument is not needed for them.

See also `gCLOSE`.

---

## [gLOADFONT](#)

**Usage:** `fontId%=gLOADFONT (name$)`

Loads the user-defined font `name$`. It returns a font ID; use this with `gFONT` to make the current drawable use this font. If `name$` does not contain a file extension, `.FON` is used.

`gFONT` itself is very efficient, so you should normally load all required fonts at the start of a program.

Note that the built-in Series 3/Series 3a fonts are automatically available, and do not need loading.

See also `gUNLOADFONT`.

---

## [GLOBAL](#)

**Usage:** GLOBAL variables

Declares variables to be used in the current procedure (as does the LOCAL command) and (unlike LOCAL) in any procedures called by the current procedure, or procedures called by them.

The variables may be of 4 types, depending on the symbol they end with:

- Variable names not ending with \$ % & or () are floating-point variables, for example price, x
- Those ending with a % are integer variables, for example x%, sales92%
- Those ending with an & are long integer variables, for example x&, sales92&.
- Those ending with a \$ are string variables. String variable names must be followed by the maximum length of the string in brackets for example names\$(12), a\$(3)

Array variables have a number immediately following them in brackets which specifies the number of elements in the array. Array variables may be of any type, for example: x(6),y%(5),f\$(5,12),z&(3)

When declaring string arrays, you must give two numbers in the brackets. The first declares the number of elements, the second declares their maximum length. For example surname\$(5,8) declares five elements, each up to 8 characters long.

Variable names may be any combination of up to 8 numbers and alphabetic letters. They must start with a letter. The length includes the % & or \$ sign, but not the () in string and array variables.

More than one GLOBAL or LOCAL statement may be used, but they must be on separate lines, immediately after the procedure name.

See also LOCAL.

---

## **gMOVE**

**Usage:** gMOVE dx%, dy%

Moves the current position dx% to the right and dy% downwards, in the current drawable.

A negative dx% causes movement to the left; a negative dy% causes upward movement.

See also gAT.

---

## **gORDER**

**Usage:** gORDER id%, position%

Sets the window specified by id% to the selected foreground/background position, and redraws the screen. Position 1 is the foreground window, position 2 is next, and so on. Any position greater than the number of windows is interpreted as the end of the list.

On creation, a window is at position 1 in the list.

Raises an error if id% is a bitmap.

See also gRANK.

---

## [gORIGINX](#)

**Usage:** `x%=gORIGINX`

Returns the gap between the left side of the screen and the left side of the current window.

Raises an error if the current drawable is a bitmap.

---

## [gORIGINY](#)

**Usage:** `y%=gORIGINY`

Returns the gap between the top of the screen and the top of the current window.

Raises an error if the current drawable is a bitmap.

---

## [GOTO](#)

**Usage:**

```
GOTO label or GOTO label::  
..  
..  
label::
```

Goes to the line following the `label::` and continues from there. The label

- Must be in the current procedure
  - Must start with a letter and end with a double colon, although the double colon is not necessary in the GOTO statement
  - May be up to 8 characters long excluding the colons.
- 

## [gPATT](#)

**Usage:** `gPATT id%,width%,height%,mode%`

Fills a rectangle of the specified size from the current position with repetitions of the drawable `id%`.

As with `gCOPY`, this command can copy both set and clear pixels, so the same modes are available as when displaying text. Set `mode% = 0` for set, 1 for clear, 2 for invert or 3 for replace. 0, 1 and 2 act only on set pixels in the pattern; 3 copies the entire rectangle, with set and clear pixels.

If you set `id%=-1` a pre-defined grey pattern is used.

The current position is unaffected.

`gPATT` is affected by the setting of `gGREY` (in the current window) in the same way as `gCOPY`: with `gGREY 0` it copies black to black; with `gGREY 1` it copies grey to grey, or black to grey if source is black only; with `gGREY 2` it copies grey to grey and black to black, or black to both if source is black only.

---

## [gPEEKLINE](#)

**Usage:** `gPEEKLINE id%,x%,y%,d%(),ln%`

Reads a horizontal line from the black plane of the drawable `id%`, length `ln%`, starting at `x%,y%`. The leftmost 16 pixels are read into `d%(1)`, with the first pixel read into the least significant bit.

The array `d%`() must be long enough to hold the data. You can work out the number of integers required with  $((\text{ln}\%+15)/16)$  (using whole-number division).

If you set `id%` to 0, this just reads from the whole screen, not from any particular window.

If you add \$8000 to `id%`, the grey plane (not the black plane) will be peeked.

---

## gPOLY

**Usage:** `gPOLY a%()`

Draws a sequence of lines, as if by `gLINEBY` and `gMOVE` commands.

The array is set up as follows:

```
a%(1)  starting x position
a%(2)  starting y position
a%(3)  number of pairs of offsets
a%(4)  dx1%
a%(5)  dy1%
a%(6)  dx2%
a%(7)  dy2% etc.
```

Each pair of numbers `dx1%,dy1%`, for example specifies a line or a movement. To draw a line, `dy%` is the amount to move down, while `dx%` is the amount to move to the right multiplied by two.

To specify a movement (ie without drawing a line) work out the `dx%,dy%` as for a line, then add 1 to `dx%`.

(For drawing/movement up or left, use negative numbers.)

`gPOLY` is quicker than combinations of `gAT`, `gLINEBY` and `gMOVE`.

Example, to draw three horizontal lines 50 pixels long at positions 20,10, 20,30 and 20,50:

```
a%(1)=20 :a%(2)=10 REM 20,10
a%(3)=5 REM 5 operations
REM draw right 50
a%(4)=50*2 :a%(5)=0
REM move down 20
a%(6)=0*2+1 :a%(7)=20
REM draw left 50
a%(8)=-50*2 :a%(9)=0
REM move down 20
a%(10)=0*2+1 :a%(11)=20
REM draw right 50
a%(12)=50*2 :a%(13)=0
gPOLY a%()
```

---

## gPRINT

**Usage:** `gPRINT list of expressions`

Displays a list of expressions at the current position in the current drawable. All variable types are formatted as for `PRINT`.

Unlike `PRINT`, `gPRINT` does not end by moving to a new line. A comma between expressions is still displayed as a space, but a semi-colon has no effect. `gPRINT` without a list of expressions does nothing.

See also `gPRINTB`, `gPRINTCLIP`, `gTWIDTH`, `gXPRINT`, `gTMODE`.

---

## gPRINTB

### Usage any of:

```
gPRINTB t$,w%,al%,tp%,bt%,m%
gPRINTB t$,w%,al%,tp%,bt%
gPRINTB t$,w%,al%,tp%
gPRINTB t$,w%,al%
gPRINTB t$,w%
```

Displays text t\$ in a cleared box of width w% pixels. The current position is used for the left side of the box and for the baseline of the text.

al% controls the alignment of the text in the box 1 for right aligned, 2 for left aligned, or 3 for centred.

tp% and bt% are the clearances between the text and the top/bottom of the box. Together with the current font size, they control the height of the box. An error is raised if tp% plus the font ascent is greater than 255.

m% controls the margins. For left alignment, m% is an offset from the left of the box to the start of the text. For right alignment, m% is an offset from the right of the box to the end of the text. For centering, m% is an offset from the left or right of the box to the region in which to centre, with positive m% meaning left and negative meaning right.

If values are not supplied for some arguments, these defaults are used:

```
al% left
tp% 0
bt% 0
m% 0
```

See also gPRINT, gPRINTCLIP, gTWIDTH, gXPRINT.

---

## [gPRINTCLIP](#)

**Usage:** w%=gPRINTCLIP(text\$,width%)

Displays text\$ at the current position, displaying only as many characters as will fit inside width% pixels. Returns the number of characters displayed.

See also gPRINT, gPRINTB, gTWIDTH, gXPRINT, gTMODE.

---

## [gRANK](#)

**Usage:** rank%=gRANK

Returns the foreground/background position, from 1 to 8, of the current window.

Raises an error if the current drawable is a bitmap.

See also gORDER.

---

## [gSAVEBIT](#)

**Usage:**

```
gSAVEBIT name$,width%,height%
gSAVEBIT name$
```

Saves the current drawable as the named bitmap file. If width% and height% are given, then only the rectangle of that size from the current position is copied. If name\$ has no file extension .PIC is used.

Saving a window to file when it includes grey will save both planes to the file black bitmap first followed by grey.

---

## [gSCROLL](#)

**Usage:** gSCROLL dx%,dy%,x%,y%,wd%,ht% or gSCROLL dx%,dy%

Scrolls pixels in the current drawable by offset dx%,dy%. Positive dx% means to the right, and positive dy% means down. The drawable itself does not change its position.

If you specify a rectangle in the current drawable, at x%,y% and of size wd%,ht%, only this rectangle is scrolled.

The areas dx% wide and dy% deep which are left behind by the scroll are cleared.

The current position is not affected.

---

## [gSETWIN](#)

**Usage:**

```
gSETWIN x%,y%,width%,height%  
gSETWIN x%,y%
```

Changes position and, optionally, the size of the current window.

An error is raised if the current drawable is a bitmap.

The current position is unaffected.

If you use this command on the default window, you must also use the SCREEN command to ensure that the area for PRINT commands to use is wholly contained within the default window.

---

## [gSTYLE](#)

**Usage:** gSTYLE style%

Sets the style of text displayed in subsequent gPRINT, gPRINTB and gPRINTCLIP commands on the current drawable.

style%	Text style:
0	normal
1	bold
2	underlined
4	inverse
8	double height
16	mono
32	italic

You can combine these styles by adding their values for example, to set bold, underlined and double height, use gSTYLE 11, as  $11=1+2+8$ .

This command does not affect non-graphics commands, like PRINT.

---

## [gTMODE](#)

**Usage:** gTMODE mode%

Sets the way characters are displayed by subsequent gPRINT and gPRINTCLIP commands on the current drawable.

mode%	Pixels will be:
0	set
1	cleared
2	inverted
3	replaced

When you first use graphics text commands on a drawable, each dot in a letter causes a pixel to be set in the drawable.

This is mode%=0.

When mode% is 1 or 2, graphics text commands work in a similar way, but the pixels are cleared or inverted. When mode% is 3, entire character boxes are drawn on the screen pixels are set in the letter and cleared in the background box.

This command does not affect other text display commands.

---

## **gTWIDTH**

**Usage:** width%=gTWIDTH(text\$)

Returns the width of text\$ in the current font and style.

See also gPRINT, gPRINTB, gPRINTCLIP, gXPRINT.

---

## **gUNLOADFONT**

**Usage:** gUNLOADFONT fontId%

Unloads a user-defined font that was previously loaded using gLOADFONT. Raises an error if the font has not been loaded.

The built-in Series 3/Series 3a fonts are not held in memory and cannot be unloaded.

See also gLOADFONT.

---

## **gUPDATE**

**Usage one of:**

gUPDATE ON  
gUPDATE OFF  
gUPDATE

The Series 3a screen is usually updated whenever you display anything on it. gUPDATE OFF switches off this feature. The screen will then be updated as few times as possible (though note that some keywords will always cause an update.) You can still force an update by using the gUPDATE command on its own.

This can result in a considerable speed improvement in some cases. You might, for example, use gUPDATE OFF, then a sequence of graphics commands, followed by gUPDATE. You should certainly use gUPDATE OFF if you are about to write exclusively to bitmaps.

gUPDATE ON returns to normal screen updating.

gUPDATE affects anything that displays on the screen. If you are using a lot of PRINT commands, gUPDATE OFF may make a noticeable difference in speed.

Note that with gUPDATE OFF, the location of errors which occur while the procedure is running may be incorrectly reported. For this reason, gUPDATE OFF is best used in the final stages of program development, and even then you may have to remove it to locate some errors.

---

## **gUSE**

**Usage:** gUSE id%

Makes the drawable id% current. Graphics drawing commands will now go to this drawable. gUSE does not bring a drawable to the foreground (see gORDER).

---

## [gVISIBLE ON/OFF](#)

**Usage:** gVISIBLE ON/OFF

Makes the current window visible or invisible.

Raises an error if the current drawable is a bitmap.

---

## [gWIDTH](#)

**Usage:** width%=gWIDTH

Returns the width of the current drawable.

---

## [gX](#)

**Usage:** x%=gX

Returns the x current position (in from the left) in the current drawable.

---

## [gXBORDER](#)

**Usage:**

```
gXBORDER type%, flags%, w%, h%
gXBORDER type%, flags%
```

Draws a border in the current drawable of a specified type, fitting inside a rectangle of the specified size or with the size of the current drawable if no size is specified.

type%=0 for drawing the Series 3 type border; flags% are then as for gBORDER.

type%=1 for drawing the Series 3a 3-D grey and black border. A shadow or a gap for a shadow is always assumed. flags%=1,2,3,4 are as for gBORDER. When the shadow is enabled (1 or 3) only the grey and black parts of the border are drawn; you should pre-clear the background for the white parts. When the shadow is disabled (2 or 4) the outer and inner border lines are drawn, but the areas covered by grey/black when the shadow is enabled are now cleared. (This allows a shadow to be turned off simply by calling gXBORDER again.)

The following values of flags% apply to all border types:

```
0 for normal corners
OR with $100 leaves 1 pixel gap around the border.
OR with $200 for more rounded corners
OR with $400 for losing a single pixel.
```

If both \$400 and \$200 are mistakenly supplied, \$200 has priority.

An error is raised if the current window has no grey plane.

See also gBORDER.

---

## [gXPRINT](#)

**Usage:** gXPRINT string\$, flags%

Displays string\$ at the current position, with precise highlighting or underlining. The current font and style are still used, even if the style itself is inverse or underlined. Text mode 3 (replace) is used both set and cleared pixels in the text are drawn.

flags% has the following effect:

flags%	effect
0	normal, as with gPRINT
1	inverse
2	inverse, except corner pixels
3	thin inverse
4	thin inverse, except corner pixels
5	underlined
6	thin underlined

Where lines of text are separated by a single pixel, the thin options maintain the separation between lines.

gXPRINT does not support the display of a list of expressions of various types.

---

## gY

**Usage:** y%=gY

Returns the y current position (down from the top) in the current drawable.

---

## HEX\$

**Usage:** h\$=HEX\$(x&)

Returns a string containing the hexadecimal (base 16) representation of integer or long integer x&.

For example HEX\$(255) returns the string FF.

Notes To enter integer hexadecimal constants (16 bit) put a \$ in front of them. For example \$FF is 255 in decimal. (Don't confuse this use of \$ with string variable names.)

To enter long integer hexadecimal constants (32 bit) put a & in front of them. For example &FFFFFF is 1048575 in decimal.

Counting in hexadecimal is like this: 0 1 2 3 4 5 6 7 8 9 A B C D E F 10... A stands for decimal 10, B for decimal 11, C for decimal 12 ... up to F for decimal 15. After F comes 10, which is equivalent to decimal 16. To understand numbers greater than hexadecimal 10, again compare hexadecimals with decimals. In these examples, 10<sup>2</sup> means 10x10, 10<sup>3</sup> means 10x10x10 and so on.

253 in decimal is:  
 $(2 \times 10^2) + (5 \times 10^1) + (3 \times 10^0)$   
 $= (2 \times 100) + (5 \times 10) + (3 \times 1)$   
 $= 200 + 50 + 3$

By analogy, &253 in hexadecimal is:  
 $(\&2 \times 16^2) + (\&5 \times 16^1) + (\&3 \times 16^0)$   
 $= (2 \times 256) + (5 \times 16) + (3 \times 1)$   
 $= 512 + 80 + 3 = 595$  in decimal.

Similarly, &A6B in hexadecimal is:  
 $(\&A \times 16^2) + (\&6 \times 16^1) + (\&B \times 16^0)$   
 $= (10 \times 256) + (6 \times 16) + (11 \times 1)$   
 $= 2560 + 96 + 11 = 2667$  in decimal.

You may also find this table useful for converting between hex and decimal:

hex	decimal
&1	1 =16 <sup>0</sup>
&10	16 =16 <sup>1</sup>

&100	256	=16 <sup>2</sup>
&1000	4096	=16 <sup>3</sup>

For example, &20F9 is  $(2 \times \&1000) + (0 \times \&100) + (15 \times \&10) + 9$   
which in decimal is:  $(2 \times 4096) + (0 \times 256) + (15 \times 16) + 9 = 8441$ .

All hexadecimal constants are integers (\$) or long integers (&). So arithmetic operations involving hexadecimal numbers behave in the usual way. For example, &3/&2 returns 1, &3/2.0 returns 1.5, 3/\$2 returns 1.

---

## HOUR

**Usage:** h%=HOUR

Returns the number of the current hour from the system clock as an integer between 0 and 23.

---

## IABS

**Usage:** i&=IABS(x&)

Returns the absolute value, ie without any sign, of the integer or long integer expression x&.

For example IABS(-10) is 10.

See also ABS, which returns the absolute value as a floating-point value.

---

## ICON

**Usage:** ICON name\$

Gives the name of the bitmap file to use as the icon for an OPA.

This can only be used between APP and ENDA.

See the Advanced Topics chapter for more details of OPAs.

---

## IF...ENDIF

**Usage:**

```
IF condition1
  ..
  ...
  .
ELSEIF condition2
  ...
  ....
ELSE
  ..
ENDIF
```

Does either

- the statements following the IF condition

or

- the statements following one of the ELSEIF conditions  
(there may be as many ELSEIF statements as you like none at all if you want)

or

- the statements following ELSE (or, if there is no ELSE, nothing at all). There may be either one ELSE statement or none.

After the ENDIF statement, the lines following ENDIF carry on as normal.

IF, ELSEIF, ELSE and ENDIF must be in that order.

Every IF must be matched with a closing ENDIF.

You can also have an IF...ENDIF structure within another, for example:

```
IF condition1
  ..
  ...
  .
ELSE
  ...
  IF condition2
  ....
  ENDIF
  ..
ENDIF
```

condition is an expression returning a logical value for example a

---

## INPUT

### Usage:

```
INPUT variable
INPUT log.field
```

Waits for a value to be entered at the keyboard, and then assigns the value entered to a variable or data file field.

You can edit the value as you type it in. All the usual editing keys are available the arrow keys move along the line, Esc clears the line and so on.

If inappropriate input is entered, for example a string when the input was to be assigned to an integer variable, a ? is displayed and you can try again. However, if you used TRAP INPUT, control passes on to the next line of the procedure, with the appropriate error condition being set and the value of the variable remaining unchanged.

INPUT is usually used in conjunction with a PRINT statement:

```
PROC exch:
LOCAL pds,rate
DO
  PRINT Pounds Sterling?,
  INPUT pds
  PRINT Rate (DM)?,
  INPUT rate
  PRINT =,pds*rate,DM
  GET
UNTIL 0
ENDP
```

Note the commas at the end of the PRINT statements, used so that the cursor waiting for input appears on the same line as the messages.

### TRAP INPUT

If a bad value is entered (for example abc for a%) in response to a TRAP INPUT, the ? is not displayed, but the ERR function can be called to return the value of the error which has occurred. If the Esc key is pressed while no text is on the input line, the 'Escape key pressed' error (number -114) will be returned by ERR (provided that the INPUT has been trapped). You can use this feature to enable someone to press the Esc key to escape from inputting a value.

See also EDIT. This works like INPUT, except that it displays a string to be edited and then assigned to a variable or

field. It can only be used with strings.

---

## INT

**Usage:** `i&=INT(x)`

Returns the integer (in other words the whole number) part of the floating-point expression `x`. The number is returned as a long integer.

Positive numbers are rounded down, and negative numbers are rounded up for example `INT(-5.9)` returns `-5` and `INT(2.9)` returns `2`. If you want to round a number to the nearest integer, add `0.5` to it (or subtract `0.5` if it is negative) before you use `INT`.

In the Calculator, you need to use `INT` to pass a number to a procedure which requires a long integer parameter. This is because the Calculator passes all numbers as floating-point by default.

See also `INTF`.

---

## INTF

**Usage:** `i=INTF(x)`

Used in the same way as the `INT` function, but the value returned is a floating-point number. For example, `INTF(1234567890123.4)` returns `1234567890123.0`

You may also need this when an integer calculation may exceed integer range.

See also `INT`.

## I/O functions

These functions are covered in detail in the Advanced Topics chapter.

`r%=IOA(h%,f%,var status%,var a1,var a2)`

The device driver opened with handle `h%` performs the asynchronous I/O function `f%` with two further arguments, `a1` and `a2`. The argument `status%` is set by the device driver. An `IOWAIT` must be performed for each `IOA`.

`r%=IOC(h%,f%,var status%,var a1,var a2)`

Make an I/O request with guaranteed completion. This has the same form as `IOA` etc but it returns zero always.

`r%=IOCANCEL(h%)`

Cancels any outstanding asynchronous I/O request (`IOC` or `IOA`).

`r%=IOCLOSE(h%)`

Closes a file with the handle `h%`.

`r%=IOOPEN(var h%,name$,mode%)`

Creates or opens a file called `name$`. Defines `h%` for use by other I/O functions. `mode%` specifies how to open the file. For unique file creation, use `IOOPEN(var h%,addr%,mode%)`

`r%=IOREAD(h%,addr%,maxLen%)`

Reads from the file with the handle `h%`. `address%` is the address of a buffer large enough to hold a maximum of `maxLen%` bytes. The value returned to `r%` is the actual number of bytes read or, if negative, is an error value.

r%=IOSEEK(h%,mode%,var off&)

Seeks to a position in a file that has been opened for random access. mode% specifies how the offset argument off& is to be used.

IOSIGNAL

Signals an I/O function's completion.

r%=IOW(h%,func%,var a1,var a2)

The device driver opened with handle h% performs the synchronous I/O function func% with the two further arguments.

---

## IOWAIT

**Waits for an asynchronous I/O function to signal completion.**

IOWAITSTAT var stat%

Waits for an asynchronous function, called with IOA, to complete.

r%=IOWRITE(h%,addr%,length%)

Writes length% bytes in a buffer at address% to the file with the handle h%.

---

## IOYIELD

**Ensures that any asynchronous handler set up with IOA**

---

## KEY

**Usage:** k%=KEY

Returns the character code of the last key pressed, if there has been one since the last call to the keyboard. These functions count as calling to the keyboard: INPUT, EDIT, GET, GET\$, KEY and KEY\$.

If no key has been pressed, zero is returned.

See Appendix D for a list of special key codes. You can use KMOD to check whether modifier keys (Shift, Control, Psion and Caps Lock) were used.

This command does not wait for a key to be pressed, unlike GET.

---

## KEY\$

**Usage:** k\$=KEY\$

Returns the last key pressed as a string, if there has been a keypress since the last use of the keyboard by INPUT, EDIT, GET, GET\$, KEY or KEY\$.

If no key has been pressed, a null string () is returned.

See Appendix D for a list of special key codes. You can use KMOD to check whether modifier keys (Shift, Control, Psion and Caps Lock) were used.

This command does not wait for a key to be pressed, unlike GET\$.

---

## KEYA

**Usage:** `err%=KEYA(var stat%,var key%(1))`

This is an asynchronous keyboard read function.

See the Advanced Topics chapter for details.

Cancel with KEYC.

---

## KEYC

**Usage:** `err%=KEYC(var stat%)`

Cancels the previously called KEYA function with status stat%.

See the Advanced Topics chapter for details.

---

## KMOD

**Usage:** `k%=KMOD`

Returns a code representing the state of the modifier keys (whether they were pressed or not) at the time of the last keyboard access, such as a KEY function. The modifiers have these codes:

		binary
2	Shift down	10
4	Control down	100
8	Psion down	1000
16	Caps Lock on	10000

If there was no modifier, the function returns 0. If a combination of modifiers was pressed, the sum of their codes is returned for example 20 is returned if Control (4) was held down and Caps Lock (16) was on.

Always use immediately after a KEY/KEY\$/GET/GET\$ statement.

The value returned by KMOD has one binary bit set for each modifier, as shown above. By using the logical operator AND on the value returned by KMOD you can check which of the bits are set, in order to see which modifier keys were held down. For more details on AND, see Appendix B.

Example:

```
PROC modifier:
LOCAL k%,mod%
PRINT Press a key :k%=GET
CLS :mod%=KMOD
PRINT Key code,k%,with
IF mod%=0
  PRINT no modifier
ENDIF
IF mod% AND 2
  PRINT Shift down
ENDIF
IF mod% AND 4
  PRINT Control down
ENDIF
IF mod% AND 8
  PRINT Psion down
ENDIF
IF mod% AND 16
  PRINT Caps Lock on
ENDIF
ENDP
```

---

## LAST

**Usage:** LAST

Positions to the last record in a data file.

---

## LCLOSE

**Usage:** LCLOSE

Closes the device opened with LOPEN. (The device is also closed automatically when a program ends.)

---

## LEFT\$

**Usage:** b\$=LEFT\$(a\$, x%)

Returns the leftmost x% characters from the string a\$.

For example if n\$ has the value Charles, then b\$=LEFT\$(n\$,3) assigns Cha to b\$.

---

## LEN

**Usage:** a%=LEN(a\$)

Returns the number of characters in a\$.

Eg if a\$ has the value 34 Kopechnie Drive then LEN(a\$) returns 18.

You might use this function to check that a data file string field is not empty before displaying:

```
IF LEN(A.client$)
  PRINT A.client$
ENDIF
```

---

## LENALLOC

**Usage:** len%=LENALLOC(pcell%)

Returns the length of the previously allocated cell at pcell%.

---

## LINKLIB

**Usage:** LINKLIB cat%

Link any libraries that have been loaded using LOADLIB.

---

## LN

**Usage:** a=LN(x)

Returns the natural (base e) logarithm of x.

Use LOG to return the base 10 log of a number.

---

## LOADLIB

**Usage:** `ret%=LOADLIB(var cat%,name$,link%)`

Load and optionally link a DYLIB that is not in the ROM. If successful, this writes the category handle to `cat%` and returns zero. The DYLIB is shared in memory if already loaded by another process.

---

## LOADM

**Usage:** `LOADM module$`

Loads a translated OPL module so that procedures in that module can be called. Until a module is loaded with `LOADM`, calls to procedures in that module will give an error.

`module$` is a string containing the name of the module. Specify the full file name only where necessary.

Example `LOADM MODUL2`

Up to 4 modules can be in memory at any one time; if you try to `LOADM` a fifth module, you get an error. Use `UNLOADM` to remove a module from memory so that you can load a different one.

By default, `LOADM` always uses the directory of the initial running program, or the one specified by a OPA application. It is not affected by the `SETPATH` command.

---

## LOC

**Usage:** `a%=LOC(a$,b$)`

Returns an integer showing the position in `a$` where `b$` occurs, or zero if `b$` doesn't occur in `a$`. The search matches upper and lower case.

Example: `LOC(STANDING,AND)` would return the value 3 because the substring `AND` starts at the third character of the string `STANDING`.

---

## LOCAL

**Usage:** `LOCAL variables`

Used to declare variables which can be referenced only in the current procedure. Other procedures may use the same variable names to create new variables. Use `GLOBAL` to declare variables common to all called procedures.

The variables may be of 4 types, depending on the symbol they end with:

- Variable names not ending with `$ % &` or `()` are floating-point variables, for example `price`, `x`
- Those ending with a `%` are integer variables, for example `x%`, `sales92%`
- Those ending with an `&` are long integer variables, for example `x&`, `sales92&`.
- Those ending with a `$` are string variables. String variable names must be followed by the maximum length of the string in brackets, for example `names$(12)`, `a$(3)`

Array variables have a number immediately following them in brackets which specifies the number of elements in the array. Array variables may be of any type, for example: `x(6)`, `y%(5)`, `f$(5,12)`, `z&(3)`

When declaring string arrays, you must give two numbers in the brackets. The first declares the number of elements, the

second declares their maximum length. For example `surname$(5,8)` declares five elements, each up to 8 characters long.

Variable names may be any combination of up to 8 numbers and alphabetic letters. They must start with a letter. The length includes the % & or \$ sign, but not the () in string and array variables.

More than one GLOBAL or LOCAL statement may be used, but they must be on separate lines, immediately after the procedure name.

See also GLOBAL and Chapter 2.

---

## LOCK

### Usage:

```
LOCK ON
LOCK OFF
```

Mark an OPA (OPL application) as locked or unlocked. When an OPA is locked with LOCK ON, the System screen will not send it events to change files or quit. If, for example, you move onto the file list in the System screen and press Delete to try to stop that running OPA, a message will appear, indicating that the OPA cannot close down at that moment.

You should use LOCK ON if your OPA uses a command, such as EDIT or DIALOG, which accesses the keyboard. You might also use it when the OPA is about to go busy for a considerable length of time, or at any other point where a clean exit is not possible. Do not forget to use LOCK OFF as soon as possible afterwards.

'Foreground', 'background' and 'Machine on' events may still occur while the OPA is accessing the keyboard, and will be discarded.

An OPA is initially unlocked.

---

## LOG

**Usage:** `a=LOG(x)`

Returns the base 10 logarithm of x.

Use LN to find the base e (natural) log.

---

## LOPEN

**Usage:** `LOPEN device$`

Opens the device to which LPRINTs are to be sent.

No LPRINTs can be sent until a device has been opened with LOPEN.

You can open any of these devices:

- The parallel port, with `LOPEN PAR:A`
- The serial port, with `LOPEN TTY:A`
- A file on the Series 3a or an attached computer. LOPEN the file name, eg on a PC:

```
LOPEN REM::C:\BAK\MEMO.TXT
```

or on an Apple Macintosh:

```
LOPEN REM::HD40:ME:MEMO5
```

Any existing file of the name given will be overwritten when you print to it.

Only one device may be open at any one time. Use LCLOSE to close the device. (It also closes automatically when a program finishes running.)

See Appendix C.

---

## LOWERS

**Usage:** `b$=LOWERS(a$)`

Converts any upper case characters in the string a\$ to lower case and returns the completely lower case string.

Eg if a\$=CLARKE, LOWERS(a\$) returns the string clarke

Use UPPER\$ to convert a string to upper case.

---

## LPRINT

**Usage:** `LPRINT list of expressions`

Prints a list of items, in the same way as PRINT, except that the data is sent to the device most recently opened with LOPEN.

The expressions may be quoted strings, variables, or the evaluated results of expressions. The punctuation of the LPRINT statement (commas, semi-colons and new lines) determines the layout of the printed text, in the same way as PRINT statements.

If no device has been opened with LOPEN you will get an error.

See PRINT for displaying to the screen.

See LOPEN for opening a device for LPRINT.

See Appendix C for an overview of printing from OPL.

---

## MAX

**Usage:**

`m=MAX(list)`

`m=MAX(array(), element)`

Returns the greatest of a list of numeric items.

The list can be either:

- A list of variables, values and expressions, separated by commas

or

- The elements of a floating-point array.

When operating on an array, the first argument must be the array name followed by (). The second argument, separated from the first by a comma, is the number of array elements you wish to operate on for example `m=MAX(arr(),3)` would return the value of the largest of elements `arr(1)`, `arr(2)` and `arr(3)`.

---

## mCARD

## Usage:

```
mCARD title$,n1$,k1%  
mCARD title$,n1$,k1%,n2$,k2% etc.
```

Defines a menu. When you have defined all of the menus, use MENU to display them.

title\$ is the name of the menu. From one to eight items on the menu may be defined, each specified by two arguments. The first is the item name, and the second the keycode for a hot-key. This specifies a key which, when pressed together with the Psion key, will select the option. If the keycode is for an upper case key, the hot-key will use both the Shift and Psion keys.

The options can be divided into logical groups by displaying a grey line under the final option in a group. To do this, pass the negative value corresponding to the hot-key keycode for the final option in the group. For example, -%A specifies hot-key Shift-Psion-A and displays a grey line under the associated option in the menu.

---

## MEAN

### Usage:

```
m=MEAN(list)  
m=MEAN(array(),element)
```

Returns the arithmetic mean (average) of a list of numeric items.

The list can be either:

- A list of variables, values and expressions, separated by commas

or

- The elements of a floating-point array.

When operating on an array, the first argument must be the array name followed by (). The second argument, separated from the first by a comma, is the number of array elements you wish to operate on for example `m=MEAN(arr(),3)` would return the average of elements `arr(1)`, `arr(2)` and `arr(3)`.

This example displays 15.0:

```
a(1)=10  
a(2)=15  
a(3)=20  
PRINT MEAN(a(),3)
```

---

## MENU

### Usage:

```
val%=MENU  
val%=MENU (var init%)
```

Displays the menus defined by mINIT and mCARD, and waits for you to select an item. Returns the hot-key keycode of the item selected, as defined in mCARD, in lower case.

If you cancel the menu by pressing Esc, MENU returns 0.

If the name of a variable is passed it sets the initial menu and item to be highlighted. `init%` should be `256*(menu%)+item%`; for both `menu%` and `item%`, 0 specifies the first, 1 the second and so on. If `init%` is 517 (`=256*2+5`), for example, this specifies the 6th item on the third menu.

If `init%` was passed, MENU writes back to `init%` the value for the item which was last highlighted on the menu. You can then use this value when calling the menu again. You only need to use this technique if you have more than one menu in

your program.

---

## MIDS

**Usage:** `m$=MID$(a$, x%, y%)`

Returns a string comprising y% characters of a\$, starting at the character at position x%.

Eg if name\$=McConnell then MID\$(name\$,3,3) would return the string Con.

---

## MIN

**Usage:**

```
m=MIN(list)
m=MIN(array(), element)
```

Returns the smallest of a list of numeric items.

The list can be either:

- A list of variables, values and expressions, separated by commas

or

- The elements of a floating-point array.

When operating on an array, the first argument must be the array name followed by (). The second argument, separated from the first by a comma, is the number of array elements you wish to operate on for example `m=MIN(arr(),3)` would return the minimum of elements `arr(1)`, `arr(2)` and `arr(3)`.

---

## mINIT

**Usage:** `mINIT`

Prepares for definition of menus, cancelling any existing menus. Use `mCARD` to define each menu, then `MENU` to display them.

---

## MINUTE

**Usage:** `m%=MINUTE`

Returns the current minute number from the system clock (0 to 59).

Eg at 8.54am MINUTE returns 54.

---

## MKDIR

**Usage:** `MKDIR name$`

Creates a new directory. For example, `MKDIR M:\MINE\TEMP` creates a `M:\MINE\TEMP` directory, also creating `M:\MINE` if it is not already there.

---

## MONTH

**Usage:** m%=MONTH

Returns the current month from the system clock as an integer between 1 and 12.

Eg on 12th March 1992 m%=MONTH returns 3 to m%.

---

## MONTH\$

**Usage:** m\$=MONTH\$(x%)

Converts x%, a number from 1 to 12, to the month name, expressed as a three-letter mixed case string.

Eg MONTH\$(1) returns the string Jan.

---

## NEWOBJ

**Usage:** pobj%=NEWOBJ(num%, clnum%)

Create a new object by category number num% belonging to the class clnum%, returning the object handle on success or zero if out of memory.

---

## NEWOBJH

**Usage:** pobj%=NEWOBJH(cat%, clnum%)

Create a new object by category handle cat% belonging to the class clnum%, returning the object handle on success or zero if out of memory.

---

## NEXT

**Usage:** NEXT

Positions to the next record in the current data file.

If NEXT is used after the end of a file has been reached, no error is reported but the current record is a null and the EOF function returns true.

---

## NUM\$

**Usage:** n\$=NUM\$(x, y%)

Returns a string representation of the integer part of the floating-point number x, rounded to the nearest whole number. The string will be up to y% characters wide.

- If y% is negative then the string is right-justified for example NUM\$(1.9,-3) returns 2 where there are two spaces to the left of the 2.
- If y% is positive no spaces are added: eg NUM\$(-3.7,3) returns -4.
- If the string returned to n\$ will not fit in the width y%, then the string will just be asterisks; for example NUM\$(256.99,2) returns \*\*.

See also FIX\$, GEN\$, SCI\$.

---

## ODBINFO

**Usage:** ODBINFO var info%()

Provided for advanced use only, this keyword allows you to use OS and CALL to access data file interrupt functions not accessible with OPL keywords. See the 'Advanced topics' chapter for more details.

---

## OFF

**Usage:**

```
OFF
OFF x%
```

Switches the Series 3a off.

When you switch back on, the statement following the OFF command is executed, for example: OFF :PRINT Hello again

If you specify an integer, x%, between 8 and 16383, the machine switches off for that number of seconds and then automatically turns back on and continues with the next line of the program (16383 is about 4 1/2 hours). However, during this time the machine may be switched on by an alarm, and of course you can turn it on with ON/Esc.

Warning: be careful how you use this command. If, due to a programming mistake, a program uses OFF in a loop, you may find it impossible to switch the Series 3a back on, and may have to reset the computer.

---

## ONERR

**Usage:**

```
ONERR label
ONERR label::
..
..
ONERR OFF
```

ONERR label:: establishes an error handler in a procedure. When an error is raised, the program jumps to the label:: instead of the program stopping and an error message being displayed.

The label may be up to 8 characters long starting with a letter. It ends with a double colon (::), although you don't need to use this in the ONERR statement.

ONERR OFF disables the ONERR command, so that any errors occurring after the ONERR OFF statement no longer jump to the label.

It is advisable to use the command ONERR OFF immediately after the label:: which starts the error handling code.

See the Error handling chapter for full details.

---

## OPEN

**Usage:** OPEN file\$,log,f1,f2...

Opens an existing data file file\$, giving it the logical file name log, and giving the fields the names f1, f2..

You need only specify those fields which you intend to update or append, though you cannot miss out a field.

The opened file is then referred to within the program by its logical name (A, B, C or D).

Up to 4 files can be open at once.

Example:

OPEN clients,A,name\$,addr\$

See also CREATE, USE and OPENR.

---

## OPENR

**This command works exactly like OPEN except that the opened** or UPDATE the records it contains.

This means that you can run two separate programs at the same time, both sharing the same file.

---

## OS

### Usage:

```
a%=OS(i%, addr1%)
a%=OS(i%, addr1%, addr2%)
```

Calls the Operating System interrupt i%, reading the values of all returned 8086 registers and flags. The CALL function, although simpler to use, does not allow the AL register to be passed and no flags are returned, making it suitable only for certain interrupts.

The input registers are passed at the address addr1%. The output registers are returned at the address addr2% if supplied, otherwise they are returned at addr1%. Both addresses can be of an array, or of six consecutive integers.

Register values are stored sequentially as 6 integers and represent the register values in this order: AX, BX, CX, DX, SI and DI. The interrupt's function number, if required, is passed in AH.

The output array must be large enough to store the 6 integers returned in all cases, irrespective of the interrupt being called.

The value returned by OS is the flags register. The Carry flag, which is relevant in most cases, is in bit 0 of the returned value, so (a% and 1) will be 'True' if Carry is set. Similarly, the Zero flag is in bit 6, the Sign flag in bit 7 and the Overflow flag in bit 10.

For example, to find cos(pi/4):

```
PROC add:
    local a%,b%,c%,d%,si%,di%
    local result,cosArg,flags%
    cosArg=pi/4
    si%=addr(cosArg)
    di%=addr(result)
    ax%=$0100 REM AH=1
                                REM for cosine
    flags%=os(140,addr(ax%))
ENDP
```

The OS function requires extensive knowledge of the Operating System and related programming techniques.

See also CALL.

---

## PARSE\$

**Usage:** p\$=PARSE\$(f\$,rel\$,var off%())

Returns a full file specification from the filename f\$, filling in any missing information from rel\$.

The offsets to the filename components in the returned string is returned in off%() which must be declared with at least 6 integers:

off%(1) filing system offset (1 always)  
off%(2) device offset  
off%(3) path offset  
off%(4) filename offset  
off%(5) file extension offset  
off%(6) flags for wildcards in returned string

The flag values in offset%(6) are:

0 : no wildcards  
1 : wildcard in filename  
2 : wildcard in file extension  
3 : wildcard in both

If rel\$ is not itself a complete file specification, the current filing system, device and/or path are used as necessary to fill in the missing parts.

f\$ and rel\$ should be separate strings.

Example:

```
p$=PARSE(NEW,LOC::M:\ODB\*.ODB,x%())
```

sets p\$ to LOC::M:\ODB\NEW.ODB and x%() to (1,6,8,13,16,0).

---

## PATH

**Usage:** PATH name\$

Gives the directory to use for an OPA's files.

This can only be used between APP and ENDA.

See the Advanced Topics chapter for more details of OPAs.

---

## PAUSE

**Usage:** PAUSE x%

Pauses the program for a certain time, depending on the value of x%:

x% result

0 waits for a key to be pressed.

+ve pauses for x% twentieths of a second.

-ve pauses for x% twentieths of a second or until a key is pressed.

So PAUSE 100 would make the program pause for  $100/20 = 5$  seconds, and PAUSE -100 would make the program pause for 5 seconds or until a key is pressed.

If x% is 0, a GET, GET\$, KEY or KEY\$ will return the key press which terminated the pause. If you are not interested in this keypress, but in the one which follows it, clear the buffer after the PAUSE with a single KEY function: PAUSE 0 :KEY

You should be especially careful about this if x% is negative, since then you cannot tell whether the pause was terminated by a keypress or by the time running out.

---

## PEEK functions

**The PEEK functions find the values stored in specific bytes.** Usage :

p%=PEEKB(x%) returns the integer value of the byte at address x% p%=PEEKW(x%) returns the integer at address x%  
p&=PEEKL(x%) returns the long integer value at address x% p=PEEKF(x%) returns the floating-point value at address  
x% p\$=PEEK\$(x%) returns the string at address x%

Usually you would find out the byte address with the ADDR function. For example, if var% has the value 7,  
PEEKW(ADDR(var%)) returns 7.

The different types are stored in different ways across bytes:

- Integers are stored in two bytes. The first byte is the least significant byte, for example: (picture)

ADDR returns the address of the first (least significant) byte.

- Long integers are stored in four bytes, the least significant first and the most significant last, for example: (picture)

ADDR returns the address of the first (least significant) byte.

- Strings are stored with one character per byte, with a leading byte containing the string length, eg: (picture)

Each letter is stored as its character code for example, A as 65.

For example, if var\$=ABC, PEEK\$(ADDR(var\$)) will return the string ABC. ADDR returns the address of the length byte.

- Floating-point numbers are stored under IEEE format, across eight bytes. PEEKF automatically reads all eight bytes and returns the number as a floating-point. For example if var=1.3 then PEEKF(ADDR(var)) returns 1.3.

You can use ADDR to find the address of the first element in an array, for example ADDR(x%()). You can also specify individual elements of the array, for example ADDR(x%(2)).

See also the POKE commands and ADDR.

---

## PI

**Usage:** p=PI

Returns the value of Pi (3.14... ).

---

## POKE commands

**The POKE commands store values in specific bytes.** Usage :

POKEB x%,y% stores the integer value y% (less than 256) in the single byte at address x% POKEW x%,y% stores the integer y% across two consecutive bytes, with the least significant byte in the lower address, that is x% POKEL x%,y& stores the long-integer y& in bytes starting at address x% POKEF x%,y stores the floating-point value y in bytes starting at address x% POKE\$ x%,y\$ stores the string y\$ in bytes starting at address x%

Use ADDR to find out the address of your declared variables.

**Warning:** Casual use of these commands can result in the loss of data in the Series 3a.

See PEEK for more details of how the different types are stored across bytes.

---

## POS

**Usage:** p%=POS

Returns the number of the current record in the current data file, from 1 (the first record) upwards.

A file can have up to 65534 records. However integers can only be in the range -32768 to +32767. Record numbers above 32767 are therefore returned like this:

record	value	returned by POS
32767		32767
32768		-32768
32769		-32767
32770		-32766
.		.
.		.
65534		-2

To display record numbers, you can use this check:

```
IF POS<0
  PRINT 65536+POS
ELSE PRINT POS
ENDIF
```

---

## POSITION

**Usage:** POSITION x%

Makes record number x% the current record in the current data file.

If x% is greater than the number of records in the file then the EOF function will return true.

---

## POSSPRITE

**Usage:** POSSPRITE x%,y%

Set the position of the current sprite to pixel x%,y%.

---

## PRINT

**Usage:** PRINT list of expressions

Displays a list of expressions on the screen. The list can be punctuated in one of these ways:

- If items to be displayed are separated by commas, there is a space between them when displayed.
- If they are separated by semi-colons, there are no spaces.
- Each PRINT statement starts a new line, unless the preceding PRINT ended with a semi-colon or comma.
- There can be as many items as you like in this list. A single PRINT on its own just moves to the next line.

Examples:

On 1st January 1993, PRINT TODAY is, PRINT DAY;.;MONTH would display TODAY is 1.1

PRINT 1 1 PRINT Hello Hello PRINT Number,1 Number 1 See also LPRINT, gUPDATE, gPRINT, gPRINTB, gPRINTCLIP, gXPRINT.

---

## RAD

**Usage:** r=RAD(x)

Converts x from degrees to radians.

All the trigonometric functions assume angles are specified in radians, but it may be easier for you to enter angles in degrees and then convert with RAD.

Example:

```
PROC xcosine:
LOCAL angle
PRINT Angle (degrees)?;
INPUT angle
PRINT COS of, angle, is,
angle=RAD(angle)
PRINT COS(angle)
GET
ENDP
```

(The formula used is  $\text{PI} \times x / 180$ )

To convert from radians to degrees use DEG.

---

## RAISE

**Usage:** RAISE x%

Raises an error.

The error raised is error number x%. This may be one of the errors listed in the Error handling chapter, or a new error number defined by you.

The error is handled by the error processing mechanism currently in use either OPL's own, which stops the program and displays an error message, or the ONERR handler if you have ONERR on.

For a full explanation, see the Error handling chapter.

---

## RANDOMIZE

**Usage:** RANDOMIZE x&

Gives a 'seed' (start-value) for RND.

Successive calls of the RND function produce a sequence of random numbers. If you use RANDOMIZE to set the seed back to what it was at the beginning of the sequence, the same sequence will be repeated.

For example, you might want to use the same 'random' values to test new versions of a procedure. To do this, precede the RND statement with the statement RANDOMIZE value. Then to repeat the sequence, use RANDOMIZE value again.

Example:

**PROC SEQ:**

```

LOCAL g$(1)
WHILE 1
  PRINT S: set seed to 1
  PRINT Q: quit
  PRINT other key: continue
  g$=UPPER$(GET$)
  IF g$=Q
    BREAK
  ELSEIF g$=S
    PRINT Setting seed to 1
    RANDOMIZE 1
    PRINT First random no:
  ELSE
    PRINT Next random no:
  ENDIF
  PRINT RND
ENDWH
ENDP

```

---

**REALLOC****Usage:** pcelln%=REALLOC(pcell%,size%)

Change the size of a previously allocated cell at pcell% to size%, returning the new cell address or zero if there is not enough memory.

---

**RECSIZE****Usage:** r%=RECSIZE

Returns the number of bytes occupied by the current record.

Use this function to check that a record may have data added to it without overstepping the 1022-character limit.

Example:

```

PROC rectest:
LOCAL n$(20)
OPEN name,A,name$
PRINT Enter name:,
INPUT n$
IF RECSIZE<=(1022-LEN(n$))
  A.name$=n$
  APPEND
ELSE
  PRINT Won't fit in record
ENDIF
ENDP

```

---

**REM****Usage:** REM text

Precedes a remark you include to explain how a program works. All text after the REM up to the end of the line is ignored.

When you use REM at the end of a line you need only precede it with a space, not a space and a colon.

Examples:

```

INPUT a
b=a*.175 REM b=TAX

```

```
INPUT a
b=a*.175 :REM b=TAX
```

---

## RENAME

**Usage:** RENAME file1\$,file2\$

Renames file1\$ as file2\$. You can rename any type of file.

You cannot use wildcards.

You can rename across directories RENAME \dat\x.dbf\x.dbf is OK. If you do this, you can choose whether or not to change the name of the file.

Example:

```
PRINT Old name: :INPUT a$
PRINT New name: :INPUT b$
RENAME a$,b$
```

---

## REPTS

**Usage:** r\$=REPT\$(a\$,x%)

Returns a string comprising x% repetitions of a\$.

For example, if a\$=ex, r\$=REPT\$(a\$,5) returns exexexexex.

---

## RETURN

**Usage:** RETURN or RETURN variable

Terminates the execution of a procedure and returns control to the point where that procedure was called (ENDP does this automatically).

RETURN variable does this as well, but also passes the value of variable back to the calling procedure. The variable may be of any type. You can return the value of any single array element for example RETURN x%(3). You can only return one variable.

RETURN on its own, and the default return through ENDP, causes the procedure to return the value 0 or a null string.

Example: (picture)

```
PROC price:
  LOCAL x
  PRINT Enter price:,
  INPUT x
  x=tax:(x)
  PRINT x
  GET
ENDP

PROC tax:(price)
  RETURN price+17.5%
ENDP
```

---

## RIGHTS

**Usage:** r\$=RIGHT\$(a\$,x%)

Returns the rightmost x% characters of a\$.

Example:

```
PRINT Enter name/ref,
```

```
INPUT c$
```

```
ref$=RIGHT$(c$,4)
```

```
name$=LEFT$(c$,LEN(c$)-4)
```

---

## RMDIR

**Usage:** RMDIR str\$

Removes the directory given by str\$. You can only remove empty directories.

---

## RND

**Usage:** r=RND

Returns a random floating-point number in the range 0 (inclusive) to 1 (exclusive).

To produce random numbers between 1 and n eg between 1 and 6 for a dice use the following statement:

```
f%=1+INT(RND*n)
```

RND produces a different number every time it is called within a program. A fixed sequence can be generated by using RANDOMIZE. You might begin by using RANDOMIZE with an argument generated from MINUTE and SECOND (or similar), to seed the sequence differently each time.

Example:

```
PROC rndvals:
LOCAL i%
PRINT Random test values:
DO
  PRINT RND
  i%=i%+1
  GET
UNTIL i%=10
ENDP
```

---

## SCIS

**Usage:** s\$=SCI\$(x, y%, z%)

Returns a string representation of x in scientific format, to y% decimal places and up to z% characters wide. Examples:

```
SCI$(123456,2,8)=1.23E+05 SCI$(1,2,8)=1.00E+00 SCI$(1234567,1,-8)= 1.2E+06
```

If the number does not fit in the width specified then the returned string contains asterisks.

If z% is negative then the string is right-justified.

See also FIX\$, GEN\$, NUM\$.

---

## SCREEN

**Usage:**

```
SCREEN width%,height%
SCREEN width%,height%,x%,y%
```

Changes the size of the window in which text is displayed. *x%,y%* specify the character position of the top left corner; if they are not given, the text window is centred in the screen.

An OPL program can initially display text to the whole screen.

---

**SCREENINFO**

**Usage:** SCREENINFO var info%()

Gets information on the text screen (as used by PRINT etc.)

This keyword allows you to mix text and graphics. It is required because while the default window is the same size as the physical screen, the text screen is slightly smaller and is centred in the default window. The few pixels gaps around the text screen, referred to as the left and top margins, depend on the font in use.

On return, the array info%(), which must have at least 10 elements, contains this information:

```
info%(1) left margin in pixels
info%(2) top margin in pixels
info%(3) text screen width in character units
info%(4) text screen height in character units
info%(5) reserved (window server id for default window)
info%(6) font id (FONT and gFONT)
info%(7) pixel width of text window character cell
info%(8) pixel height of text window line
info%(9), info%(10) reserved
```

Initially SCREENINFO returns the values for the initial text screen. Subsequently any keyword which changes the size of the text screen font, such as FONT, will change some of these values and SCREENINFO should therefore be called again.

See also FONT.

---

**SECOND**

**Usage:** s%=SECOND

Returns the current time in seconds from the system clock (0 to 59).

Eg at 6:00:33 SECOND returns 33.

---

**SECSTODATE**

**Usage:** SECSTODATE s&, var yr%, var mo%, var dy%, var hr%, var mn%, var sc%, var yrday%

Sets the variables passed by reference to the date corresponding to s&, the number of seconds since 00:00 on 1 January 1970. yrday% is set to the day in the year (1-366).

s& is an unsigned long integer. To use values greater than +2,147,483,647, subtract 4,294,967,296 from the value.

See also DATETOSECS, HOUR, MINUTE, SECOND, dDATE, DAYS.

---

**SEND**

**Usage:** ret%=SEND (pobj%, m%, var p1, ...)

Send a message to the object pobj% to call the method number m%, passing between zero and three arguments (p1...) depending on the requirements of the method, and returning the value returned by the selected method.

---

## SETNAME

**Usage:** SETNAME name\$

Sets the name of the running OPA to name\$ and redraws any status window, using that name below the icon.

---

## SETPATH

**Usage:** SETPATH name\$

Sets the current directory for file access for example, SETPATH a:\docs. LOADM continues to use the directory of the initial program, or the one specified by a OPA application, but all other file access will be to the new directory.

---

## SIN

**Usage:** s=SIN(angle)

Returns the sine of angle, an angle expressed in radians.

To convert from degrees to radians, use the RAD function.

---

## SPACE

**Usage:** s&=SPACE

Returns the number of free bytes on the device on which the current (open) data file is held.

Example:

```
PROC stock:
OPEN A:stock,A,a$,b%
WHILE 1
  PRINT Item name;;
  INPUT A.a$
  PRINT Number;;
  INPUT A.b%
  IF RECSIZE>SPACE
    PRINT Disk full
    CLOSE
    BREAK
  ELSE
    APPEND
  ENDIF
ENDWH
ENDP
```

---

## SQR

**Usage:** s=SQR(x)

Returns the square root of x.

---

## STATUSWIN

## Usage one of:

```
STATUSWIN ON,type%  
STATUSWIN ON  
STATUSWIN OFF
```

Displays or removes a 'permanent' status window.

If type%=1 the small status window is shown. If type%=2 the large status window is shown. STATUSWIN ON on its own displays an appropriate status window; on the Series 3a this will always be the large status window.

The permanent status window is behind all other OPL windows. In order to see it, you must use FONT (or both SCREEN and gSETWIN) to reduce the size of the text and graphics windows. You should ensure that your program does not create windows over the top of it.

---

## STATWININFO

**Usage:** t%=STATWININFO(type%,var xy%())

Sets xy%(1),xy%(2), xy%(3) and xy%(4) to the top left x, top left y, width and height respectively of the specified type of status window. type%=1 is the small status window; type%=2 is the large status window; type%=3 is the Series 3 compatibility mode status window; type%=-1 is whichever status window is current.

STATWININFO returns t%, the type of the current status window (with values as for type%, or zero if there is no current status window).

---

## STD

### Usage:

```
s=STD(list)  
s=STD(array(),element)
```

Returns the standard deviation of a list of numeric items.

The list can be either:

- A list of variables, values and expressions, separated by commas

or

- The elements of a floating-point array.

When operating on an array, the first argument must be the array name followed by (). The second argument, separated from the first by a comma, is the number of array elements you wish to operate on for example m=STD(arr(),3) would return the standard deviation of elements arr(1), arr(2) and arr(3).

This function gives the sample standard deviation, using the formula:

$\text{SQR}((x_i - \bar{x})^2 / (n - 1))$  where  $\bar{x}$  means  $x_i / n$ . To convert to population standard deviation, multiply the result by  $\text{SQR}((n - 1) / n)$ .

---

## STOP

**Usage:** STOP

Ends the running program.

---

## STYLE

**Usage:** `STYLE style%`

Sets the text window character style. `style%` can be 2 for underlined, or 4 for inverse.

See 'The text and graphics windows' at the end of the 'Graphics' chapter for more details.

---

## SUM

**Usage:**

```
s=SUM(list)
s=SUM(array(),element)
```

Returns the sum of a list of numeric items.

The list can be either:

- A list of variables, values and expressions, separated by commas

or

- The elements of a floating-point array.

When operating on an array, the first argument must be the array name followed by (). The second argument, separated from the first by a comma, is the number of array elements you wish to operate on for example `m=SUM(arr(),3)` would return the sum of elements `arr(1)`, `arr(2)` and `arr(3)`.

---

## TAN

**Usage:** `t=TAN(angle)`

Returns the tangent of angle, an angle expressed in radians.

To convert from radians to degrees, use the DEG function.

---

## TESTEVENT

**Usage:** `t%=TESTEVENT`

Returns 'True' if an event has occurred, otherwise returns 'False'. The event is not read by TESTEVENT it may be read with GETEVENT.

---

## TRAP

**Usage:** `TRAP command`

TRAP is an error handling command. It may precede any of these commands:

Data file commands

APPEND, UPDATE BACK, NEXT, LAST, FIRST, POSITION USE, CREATE, OPEN, OPENR, CLOSE, DELETE

File commands

COPY, COMPRESS, ERASE, RENAME LOPEN, LCLOSE LOADM, UNLOADM

Directory commands

MKDIR, RMDIR

Data entry commands

EDIT, INPUT

Graphics commands

gSAVEBIT, gCLOSE, gUSE gUNLOADFONT, gFONT, gPATT, gCOPY

For example, TRAP FIRST.

Any error resulting from the execution of the command will be trapped. Program execution will continue at the statement after the TRAP statement, but ERR will be set to the error code.

TRAP overrides any ONERR.

See the Error handling chapter for further details.

---

## TYPE

**Usage:** TYPE num%

Sets the type of an OPA, from 0 to 4, with num%. On the Series 3a you should set num% from \$1000 to \$1004 to set type 0 to 4 respectively; the \$1000 allows a 48x48 black/grey icon to be used.

This can only be used between APP and ENDA.

See the Advanced Topics chapter for more details of OPAs.

---

## UADD

**Usage:** i%=UADD(val1%, val2%)

Add val1% and val2%, as if both were unsigned integers with values from 0 to 65535. Prevents integer overflow for pointer arithmetic eg UADD(ADDR(text\$),1) should be used instead of ADDR(text\$)+1.

One argument would normally be a pointer and the other an offset expression.

See also USUB.

---

## UNLOADLIB

**Usage:** ret%=UNLOADLIB(var cat%)

Unload a DYL from memory. If successful, returns zero.

---

## UNLOADM

**Usage:** UNLOADM module\$

Removes from memory the module module\$ loaded with LOADM.

module\$ is a string containing the name of the translated module.

The procedures in an unloaded module cannot then be called by another procedure.

---

## UNTIL

**See DO.** \*\*\* UPDATE

Usage:

UPDATE

Deletes the current record in the current data file and saves the current field values as a new record at the end of the file.

This record, now the last in the file, remains the current record.

Example:

A.count=129

A.name\$=Brown

UPDATE

Use APPEND to save the current field values as a new record.

---

## UPPER\$

**Usage:** u\$=UPPER\$(a\$)

Converts any lower case characters in a\$ to upper case, and returns the completely upper case string.

Example:

```
...
CLS :PRINT Y to continue
PRINT or N to stop.
g$=UPPER$(GET$)
IF g$=Y
  nextproc:
ELSEIF g$=N
  RETURN
ENDIF
...
```

Use LOWER\$ to convert to lower case.

---

## USE

**Usage:** USE logical name

Selects the data file with the logical name A, B, C or D. The file must previously have been opened with OPEN, OPENR or CREATE and not yet be closed.

All the record handling commands (such as POSITION or UPDATE) then operate on this file.

---

## USR

**Usage:** u%=USR(pc%, ax%, bx%, cx%, dx%)

Executes your machine code, returning an integer. The USR code (ie the assembler code you have written) must return with a far RET, otherwise the program will crash.

The values of of ax%,bx%... are passed to the AX, BX... 8086 registers. The microprocessor then executes the machine

code starting at pc%. At the end of the routine, the value in the AX register is passed back to u%.

WARNING: Casual use of this function can result in the loss of data in the Series 3a.

This example shows a simple operation, ending with a far RET:

```
PROC trivial:  
LOCAL t%(2),u%,ax%  
t%(1)=$c032 REM xor al,al  
t%(2)=$cb REM retf  
ax%=$1ab  
u%=usr(addr(t%(1)),ax%,0,0,0)  
REM returns (ax% AND $FF00)  
PRINT u% REM 256 ($100)  
GET  
ENDP
```

See also USR\$, ADDR, PEEK, POKE.

---

## USR\$

**Usage:** u\$=USR\$(pc%,ax%,bx%,cx%,dx%)

Executes your machine code, returning a string. The USR\$ code you have written must return with a far RET, otherwise the program will crash.

The values of of ax%,bx%... are passed to the ax, bx... 8086 registers. The microprocessor then executes the machine code starting at pc%. At the end of the routine, the value in the ax register must point to a length-byte preceded string. This string is then copied to u\$.

WARNING: Casual use of this function can result in the loss of data in the Series 3a.

See USR for an example. See also ADDR, PEEK, POKE.

---

## USUB

**Usage:** i%=USUB(val1%, val2%)

Subtract val2% from val1%, as if both were unsigned integers with values from 0 to 65535. Prevents integer overflow for pointer arithmetic.

See also UADD.

---

## VAL

**Usage:** v=VAL(numeric string)

Returns the floating-point number corresponding to a numeric string.

The string must be a valid number eg not 5.6.7 or 196f. Expressions, such as 45.6\*3.1, are not allowed. Scientific notation such as 1.3E10, is OK.

Eg VAL(470.0) returns 470

See also EVAL.

---

## VAR

**Usage:**

```
v=VAR(list)
v=VAR(array(), element)
```

Returns the variance of a list of numeric items.

The list can be either:

- A list of variables, values and expressions, separated by commas

or

- The elements of a floating-point array.

When operating on an array, the first argument must be the array name followed by (). The second argument, separated from the first by a comma, is the number of array elements you wish to operate on for example `m=VAR(arr(),3)` would return the variance of elements `arr(1)`, `arr(2)` and `arr(3)`.

This function gives the sample variance, using the formula:

$(x_i - \bar{x})^2 / (n - 1)$  where  $\bar{x}$  means  $\sum x_i / n$ . To convert to population variance, multiply the result by  $(n - 1) / n$

---

## VECTOR

### Usage:

```
VECTOR I%
label1, label2, ...
labelN
ENDV
```

VECTOR I% jumps to label number i% in the list if i% is 1 this will be the first label, and so on. The list is terminated by the ENDV statement. The list may spread over several lines, with a comma separating labels in any one line but no comma at the end of each line.

If i% is not in the range 1 to N, where N is the number of labels, the program continues with the statement after the ENDV statement.

See also GOTO.

---

## WEEK

**Usage:** `w%=WEEK(day%, month%, year%)`

Returns the week number in which the specified day falls, as an integer between 1 and 53.

day% must be between 1 and 31, month% between 1 and 12, year% between 1900 and 2155.

Each week is taken to begin on the 'Start of week' day, as specified in the Time application. When a year begins on a different day, it counts as week 1 if there are four or more days before the next week starts..

---

## WHILE...ENDWH

### Usage:

```
WHILE expression
..
...
..
....
ENDWH
```

Repeatedly performs the set of instructions between the WHILE and the ENDWH statement, so long as expression returns logical true non-zero.

If expression is not true, the program jumps to the line after the ENDWH statement.

Every WHILE must be closed with a matching ENDWH.

See also DO...UNTIL and Chapter 3.

---

## YEAR

**Usage:** `y%=YEAR`

Returns the current year as an integer between 1900 and 2155 from the system clock.

For example, on 5th May 1992 YEAR returns 1992.

---

# Variables and constants

Programs can process data in a variety of ways. They may, for example, perform calculations with numbers, or save and recall strings of text (such as names and phone numbers in a data file).

In all cases, your program must be able to handle values different types of numbers, strings, and so on.

In OPL, there are two ways of handling values: variables and constants. Constants are fixed values, such as 1, 2, 3. Variables are used to store values which may change for example, a variable called "X" may start with the value 3 but later take the value 7.

---

## Declaring variables

Most procedures begin by declaring (creating) variables:

```
LOCAL x, y, z
```

LOCAL is the word telling the Series 3a to create variables, with the names which follow here "x", "y" and "z" separated by commas.

The statement "LOCAL x,y,z" defines three variables called "x", "y" and "z". The Series 3a will recognise these names whenever you use them in this procedure. (If you used them in another procedure, they wouldn't be recognised; the variables are 'local' to the procedure in which they are declared.)

These variables are initially given the value 0.

Any variables you wish to use must be declared at the start of a procedure.

---

## Choosing the variable

Before declaring variables, decide what information they are going to contain. There are different types of variables for different sorts of values. If you try to give the wrong type of value to a variable, an error message will be displayed.

You specify the type of each variable when you declare it, by adding a symbol at the end of its name.

### Numbers

- For small whole numbers for example 6 use an integer variable. Integer variables have a "%" symbol on the end, for example "number%".

Integer variables can handle numbers only in the range -32768 to +32767. If you try to give an integer variable a whole number bigger than this, an error message will be displayed.

- For larger whole numbers for example 10000000 use a long integer variable. Long integer variables have an "&" symbol on the end, for example "number&".

Long integer variables can handle whole numbers in the range -2147483648 to +2147483647. If a variable may have to handle numbers outside normal integer range, make it a long integer variable.

- For non-whole numbers for example 2.5 use a floating-point variable. Floating-point variables have no symbol on the end "price", for example.

**If you know that at some stage in your program your variable will have to handle non-whole numbers, like 1.2, use a floating-point, not an integer variable.** Otherwise you may get unpredictable results. (There's more about this

later in this chapter.)

- For very large numbers outside long integer range you should also use floating-point variables. These can handle numbers as big as `"9.999999999999e99` and as small as `"1e-99`. (Intermediate results in calculations may even be up to about `"10307`.)

## Text

For text "Are you sure?", "54th", etc. use a string variable. (Pieces of text are called strings in OPL.) String variables have a "\$" symbol on the end for example, "name\$".

To declare a string variable, you must follow the "\$" symbol with the maximum length of string you want the variable to handle, in brackets. So if you want to store names up to 15 characters long in the variable "NAME\$", declare it like this: `"LOCAL NAME$(15)"`. Strings cannot be longer than 255 characters.

## Array variables

You may want a group of variables, for example to store lists of values. Instead of having to declare separate variables "a", "b", "c", "d" and "e", you can declare array variables "a(1)" to "a(5)" in one go like this:

`"LOCAL a%(5)"` (array of integer variables) `"LOCAL a(5)"` (array of floating-point variables) `"LOCAL a$(5,8)"` (array of string variables) or `"LOCAL a&(5)"` (array of long integers)

The number in brackets is the number of elements in the array. So `"LOCAL a%(5)"` creates five integer variables: `"a%(1)"`, `"a%(2)"`, `"a%(3)"`, `"a%(4)"` and `"a%(5)"`.

With strings, the second number in the brackets specifies the maximum length of the strings. All the elements in the string array have the same capacity for example, `"LOCAL ID$(5,10)"` allocates memory space for five strings, each up to ten characters in length.

OPL does not support two-dimensional arrays.

## Initial values

All numeric variables have zero as their initial value. String variables have a string with no characters in it. Every element in an array variable is also initialised in the appropriate way.

## Choosing descriptive names

To make it easier to write your programs, and understand them when you read through them at a later date, give your main variables names which describe the values they hold. For example, in a procedure which calculates fuel efficiency, you might use variables named "speed" and "distance".

All variable names:

- May be up to 8 characters long
- Must start with a letter, but after that may use any combination of numbers and letters
- May be entered in any combination of upper and lower case. "sPeeD" and "SpEEd" would be considered the same name.

Additionally, you must not use any of the names of keywords, as listed in the 'Alphabetic listing' chapter if you use these you will see a 'Declaration error' message when you translate your module.

The "\$" & "&" and "%" symbols are included in the 8 characters allowed in variable names so `"V2345678%"` is too long to be a valid variable name, but `"V234567%"` is acceptable.

---

# Examples

- "LOCAL clients\$(12),z&(3)" declares one string variable, "clients\$", of capacity twelve characters, and one long integer array variable containing three elements, "z&(1)", "z&(2)" and "z&(3)"
- "LOCAL AGE%,B5\$(10),i" declares one integer variable, "AGE%", one string variable, "B5\$", of capacity ten characters, and one floating-point variable, "i"
- "LOCAL profit93" declares one floating-point variable, "profit93"
- "LOCAL x,MAN6\$(4,7)" declares one floating-point variable, "x", and one string array variable, "man6\$", containing four elements, "man6\$(1)", "man6\$(2)", "man6\$(3)" and "man6\$(4)", each of capacity 7 characters

## For preference

- Integer variables use less memory than long integer variables, and both use less than floating-point.
  - Integer variables are processed faster than floating-point.
- 

# Giving values to variables

## Assigning values

You can assign a value to a variable directly, like this:

```
x=5  
y=10
```

This procedure adds two numbers together:

```
PROC add:  
  LOCAL x%, y%, z%  
  x%=569  
  y%=203  
  z%=x%+y%  
  PRINT z%  
  GET  
ENDP
```

"add:" is the procedure name.

The "LOCAL" statement defines three variables "x%", "y%" and "z%", all initially with the value 0. "PRINT" displays the value of "z%" on the screen. You can display the value of any variable like this.

"PROC" and "ENDP" define the beginning and end of the procedure as you saw in Chapter 1.

Assigning values to string variables String variables can be assigned text values like this:

```
a$="some text"
```

The text to use must be enclosed in double quote characters.

Assigning values to an array variable If you declare a%(4), assign values to each of the elements in the array like this: "a%(1)=56, a%(2)=345" and so on. Similarly for the other variable types: "a(1)=.0346, a&(3)=355440, a\$(10)="name"".

## Arithmetic operations

You can use these operators:

+	plus
-	minus or make negative
/	divide
*	multiply
**	raise to a power
%	percentage

Operators have the same precedence as in the Calculator. For example, "3+51.3/8" is treated as "3+(51.3/8)", not "(3+51.3)/8". For more information on operators and precedence, see Appendix B.

## Values from functions

There are two kinds of keyword commands and functions:

- A command is just a straightforward instruction to OPL to do some particular thing. PRINT and PAUSE, for example, are commands.
- A function is just like a command but it also returns a value which you can then use.

GET is in fact a function; it waits for you to press a key on the keyboard, and then returns a value which identifies the key which was pressed. (In previous example programs, the value returned by GET was ignored, as GET was being used to provide a pause while you read the screen. This is a common use of the GET function.)

The number returned by GET will always be a small whole number, so you might store it away in an integer variable, like this:

```
a%=GET
```

There is more about the GET function later in this chapter.

## Expressions

You can assign a value to a variable with an expression that is, a combination of numbers, variables, and functions. For example:

"z=x+y/2" gives the "z" the value of "x" plus the value of " y/2 ".

"z=x\*y+34.78" gives "z" the value of "x" times "y", plus "34.78".

"z=x+COS(y)" gives "z" the value of "x" plus the cosine of "y". COS is another OPL function. Unlike the GET function, COS requires a value or variable to work with. As you can see, you put this in brackets, after the function name. Values you give to functions in this way are called arguments to the function. There is more information about arguments in the next chapter.

All of the above are operations using the variables "x" and "y" assigning the result to "z" and not actually affecting the value of "x" or "y".

The ways you can change the values of variables fall into these groups:

- Arithmetic operations, such as multiplication or addition for example "z=sales+costs" or "z=y%\*(4-x%)"
- Using one of the OPL functions, for example "z=SIN(PI/6)"

or

- Using certain keywords like INPUT or EDIT which wait for you to type in values from the keyboard.

Self reference In expressions, variables can refer to themselves. For example:

"z%=z%+1" (make the value of "z%" one greater than its current value)

"x%=y+x%/4" (make the value of "x%" a quarter of its current value, plus the value of "y")

## Constants

In an OPL program, numbers (and strings in quote marks) are sometimes called constants. In practice, you will use constants without thinking about them. For example:

```
x=0.32
x%=569
x&=32768
x$="string"
x(1)=4.87
```

OPL can also represent hexadecimal constants. This is explained under the HEX\$ entry in the 'Alphabetic listing' chapter.

Exponential notation may be useful for very large or very small numbers. Use "E" (capital or lower case) to mean "times ten to the power of" for example, 3.14E7 is  $3.14 \times 10^7$  (31400000), while 1E-9 is  $1 \times 10^{-9}$  (0.000000001).

## Problems with integers

When calculating an expression, OPL uses the simplest arithmetic possible for the numbers involved. If all of the numbers are integers, integer arithmetic is used; if one is outside integer range but within long integer range, then long integer arithmetic is used; if any of the numbers are not whole numbers, or are outside long integer range, floating-point arithmetic is used.

This has the benefit of maximising speed, but you must beware of calculations going out of the range of the type of arithmetic used. For example, in "X=200\*300" both "200" and "300" are integers, so integer arithmetic is used for speed (even though "X" is a floating-point variable). However, the result, 60000, cannot be calculated because it is outside integer range (-32767 to 32768), so an 'Integer Overflow' error is produced.

You can get around this by using the INT function, which turns an integer into a long integer, without changing its value. If you rewrite the previous example as "X=INT(200)\*300", OPL has to use long integer arithmetic, and can therefore give the correct result (60000). (If you understand hexadecimal numbers, you can instead write one of the numbers as a hexadecimal long integer eg "200" would become "&C8".)

Integer arithmetic uses whole numbers only. For example, if "y%" is 7 and "x%" is 4, "y%/x%" gives 1. However, you can use the INTF function to convert an integer or long integer into a floating-point number, forcing floating-point arithmetic to be used for example, "INTF(y%)/x%" gives 1.75. This rule applies to each part of an expression -e.g. "1.0+2/4" works out as "1.0+0" (=1.0), while "1+2.0/4" works out as "1+0.5" (=1.5).

If one of the integers in an all-integer calculation is a constant, you can instead write it as a floating-point number. 7/4 gives 1, but 7/4.0 gives 1.75.

## Operations on strings

If "a\$" is ""down"" and "b\$" is ""wind"", then the statement "c\$=a\$+b\$" means "c\$" becomes ""downwind"".

Alternatively, you could give "c\$" the same value with the statement "c\$="down"+"wind"". "

When adding strings together, the result must not be longer than the maximum length you declared eg if you declared "LOCAL a\$(5)" then "a\$="first"+"second"" would cause an error to be displayed.

Most operators do not work on strings. To cut up strings, use string functions like MID\$, LEFT\$ and RIGHT\$, explained in a later chapter. You need them to extract even a single character you cannot, for example, refer to the 4th character in "a\$(7)" as "a\$(4)".

---

## Displaying variables

PRINT is one of the most useful OPL commands. Use it to display any combination of text messages and the values of variables.

### Where the cursor goes after a PRINT

In general, each PRINT statement ends by moving to a new line. For example:

```
A%=127 :PRINT "A% is"  
PRINT a%
```

would display as

```
A% is  
127
```

You can stop a PRINT statement from moving to a new line by ending it with a semicolon. For example:

```
A%=127 :PRINT "A% is";  
PRINT a%
```

would display as

```
A% is127
```

If you end a PRINT statement with a comma, it stays on the same line but displays an extra space. For example:

```
A%=127 :PRINT "A% is",  
PRINT a%
```

would display as

```
A% is 127
```

## Displaying a list of things

You can use commas or semicolons to separate things to be displayed on one line, instead of using one PRINT statement for each. They have the same effect as before: " A%=127 :PRINT "A% is",a%" would display as " A% is 127" while " user\$="Fred" " PRINT "Hello",user\$;"!" would display as " Hello Fred!"

## Displaying the quote character

Each string you use with PRINT must start and end with a quote character. Inside the string to display, you can represent the quote character itself by entering it twice. So "PRINT "Press "" key"" displays as "Press " key", while "PRINT """" displays a single quote character.

---

## Values from the keyboard

If you want a program to be reusable, it often needs to be able to accept different sets of information each time you use it. You can do this with the INPUT command, which takes numbers and text typed in at the keyboard and stores them in variables.

For example, this simple procedure converts from Pounds Sterling to Deutschmarks. It asks you to type in two numbers

the number of Pounds Sterling, and the current exchange rate. You can edit as you type the numbers the Delete key, for example, deletes characters, and Esc clears everything you've typed. Press Enter when you've finished each number. The values are assigned to the variables "pounds" and "rate", and the result of the conversion is then displayed:

```
PROC exch:  
  LOCAL pounds, rate  
  AT 1, 4  
  PRINT "How many Pounds Sterling?",  
  INPUT pounds :REM value from keyboard  
  PRINT "Exchange rate (DM to ø1)?",  
  INPUT rate :REM value from keyboard  
  PRINT "=", pounds*rate, "Deutschmarks"  
  GET  
ENDP
```

Here PRINT is used to show messages (often called prompts) before the two INPUT commands, to say what information needs to be typed in. In both cases the PRINT command ends in a comma, which displays a single space, and keeps the cursor position on the same line. Without the commas, the numbers you type to the INPUT commands would appear on the line below.

The value entered to an INPUT command must be of the appropriate kind for the variable which INPUT is setting. If you enter the wrong type (for example, if you enter the string "three" for the floating-point variable "rate"), INPUT will show a "?" prompt, and wait for you to enter another value.

When using INPUT with a numeric variable (integer, long integer or floating-point), you can enter any number within the range of that type of variable. Note that if you enter a non-whole number as the value for an integer variable, it will take only the whole number part (so eg if you enter 12.75 for an integer variable, it will be set to 12).

### **Comments**

The REM command lets you add comments to a program to help explain how it works. Begin the comment with the word REM (short for 'remark'). Everything after the REM command is ignored.

If you put a REM command on the end of a line, the colon you would normally put before it is optional. For example, you could use either of these:

```
CLS :REM Clears the screen
```

or

```
CLS REM Clears the screen
```

### **AT command**

This positions the cursor or your message at the co-ordinates you specify. Use the command like this:

```
AT column%,row%
```

where "column%" and "row%" give the character position to use.

"AT 1,1" positions the cursor to the top left corner.

### **Single keypresses**

In addition to using INPUT to ask for values, your program can ask for single keypresses. Use one of these functions:

- GET waits for a keypress and returns the key pressed.
- KEY returns a key if any was pressed, but doesn't wait for one.

Every separate letter, number or symbol has a number which represents it, called a character code. The full list of character codes the character set is included as an appendix to the User Guide. GET and KEY return the character code of the key pressed for example, if "A" were pressed, these functions would return the value 65. KEY returns 0 if no key

was pressed.

KEY\$ and GET\$ work in the same way as KEY and GET, except that they return the key pressed as a string, not as a character code:

- GET\$ waits for a keypress and returns the key pressed, as a string.
- KEY\$ returns a key if any was pressed, but doesn't wait for one. KEY\$ returns a null string ("") if no key was pressed.

Unlike INPUT, these functions do not display the key pressed on the screen, and do not wait for you to press Enter.

## Example using GET\$

```
PROC kchar:
  LOCAL k$(1)
  PRINT "Press a key, A-Z:"
  k$=GET$
  PRINT "You pressed",k$
  PAUSE 60
ENDP
```

Single keypresses are often useful for making decisions. A program might, for example, offer a set of choices which you choose from by typing the word's first letter, like this: "Add (A) Erase (E) or Copy (C) ?" Or it might ask for confirmation of a decision, by displaying a "YES or NO?" message and waiting until "Y" or "N" is pressed.

## Modifier keys

If you need to check for the Shift, Control, Psion keys and/or Caps Lock being used, see the description of the KMOD function, in the 'Alphabetic listing' chapter.

## SUMMARY

Declare variables with one or more LOCAL statements in the line after "PROC:"

- Integer variables for example "year%"
- Floating-point variables for example "price"
- String variables for example "name\$(12)" where the maximum length is given in the brackets
- Long integer variables for example "profit&"

Variables will be floating-point unless you add a symbol to the end of the variable name.

- Array variables for example "prices%(4)" or "clients\$(5,12)" where the first number inside the brackets specifies the number of elements, and the second number in the brackets, in the case of string arrays, specifies the maximum length.

Assign values to variables:

- Expressions for example "x=5.5/y" , "profit=x-y"
- INPUT command for example "INPUT a\$"
- 'Add' strings for example "a\$="MR"+names\$"

REM allows you to add comments to a program.

AT positions the cursor.

GET and KEY return the key pressed as a character code.

GET\$ and KEY\$ return the key pressed as a single-character string.

GET and GET\$ wait until a key is pressed, KEY and KEY\$ do not.

---

# Loops and branches

The programs in the earlier chapters consist of a number of instructions which are executed one by one, from start to finish.

However, there are a number of other ways a program can proceed:

Repeating a set of instructions (called loops)

Doing one set of instructions or another (called IF statements)

Jumping from one line of your program to another

---

## Repeating instructions (loops)

The DO...UNTIL and WHILE...ENDWH commands are structures they don't actually do anything to your data, but control the order in which other commands are executed:

- DO...UNTIL repeats a set of instructions until a certain condition is true.
- WHILE...ENDWH repeats a set of instructions so long as a certain condition is true.

There is a test condition at the end of the DO...UNTIL loop, and at the beginning of the WHILE...ENDWH loop.

### DO...UNTIL

```
PROC test:
  LOCAL a%
  a%=10
  DO
    PRINT "A="; a%
    a%=a%-1
  UNTIL a%=0
  PRINT "Finished"
  GET
ENDP
```

The instruction "DO" says to OPL:

"Execute all the following instructions until an UNTIL is reached. If the condition following UNTIL is not met, repeat the same set of instructions until it is."

The first time through the loop, "a%"=10. 1 is subtracted from "a%", so that "a%" is 9 when the UNTIL statement is reached. Since "a%" isn't zero yet, the program returns to DO and the loop is repeated.

"a%" goes down to 8, and again it fails the UNTIL condition. The loop therefore repeats 10 times until "a%" does equal zero.

When "a%" equals zero, the program continues with the instructions after UNTIL.

The statements in a DO...UNTIL loop are always executed at least once.

### WHILE...ENDWH

```
PROC test2:
  LOCAL a%
```

```

a%=10
WHILE a%>0
    PRINT "A=";a%
    a%=a%-1
ENDWH
PRINT "Finished"
GET
ENDP

```

The instructions between the WHILE and ENDWH statements are executed only if the condition following the WHILE is true in this case if "a%" is greater than 0.

Initially, "a%"=10 and so "A=10" is displayed on the screen. "a%" is then reduced to 9. "a%" is still greater than zero, so "A=9" is displayed. This continues until "A=1" is displayed. "a%" is then reduced to zero, and so "Finished" is displayed.

Unlike DO...UNTIL, it's possible for the instructions between WHILE and ENDWH not to be executed at all.

## Example using WHILE...ENDWH

```

PROC newkey:
    WHILE KEY :ENDWH
        PRINT "Press a new key."
ENDP

```

This procedure ignores any keys which may already have been typed, then waits for a new keypress.

KEY returns the value of a key that was pressed, or "0" if no key has been pressed. "WHILE KEY :ENDWH" reads any keys previously pressed, one by one, until they have all been read and "KEY" returns zero.

## Choosing between instructions

In a program, you might have several possible cases ("x%" may be 1, or it may be 2, or 3...) and want to do something different for each one (if it's 1, do this, but if it's 2, do that...). You can do this with the IF...ENDIF structure:

```

IF condition1
    do these statements
ELSEIF condition2
    do these statements
ELSEIF condition3
    do these statements
.
.
ELSE
    do these statements
ENDIF

```

These lines would do either

- the statements following the IF line (if condition1 is met)

or

- the statements following one of the ELSEIF lines (if one of condition2, condition3... is met)

or

- the statements following the ELSE line (if none of condition1, condition2, condition3... have been met).

and then continue with the statements after the ENDIF.

You can cater for as many cases as you like with ELSEIF statements. You don't have to have any ELSEIFs. There may be either one ELSE statement or none; you do not specify conditions for the ELSE statement.

Every IF in your program must be matched by an ENDIF otherwise you'll see an error message when you try to translate the module. The structure must start with an IF and end with an ENDIF.

## "Nesting" loops the 'Too complex' message

You can have up to 8 DO...UNTIL, WHILE...ENDWH and/or IF...ENDIF structures nested within each other. If you nest them any deeper, a 'Too complex' error message will be displayed.

## Example using IF

```
PROC zcode:
  LOCAL g%
  PRINT "Are you going to press Z?"
  g%=GET
  IF g%=%Z OR g%=%z
    PRINT "Yes!"
  ELSE
    PRINT "No."
  ENDIF
  PAUSE 60
ENDP
```

## % operator

The program checks character codes with the % operator. "%a" returns the code of "a", "%Z" the code of "Z" and so on. Using "%A" is entirely equivalent to using 65, the actual code for "A", but it saves you having to look it up, and it makes your program easier to follow.

Be careful not to confuse character codes like these with integer variables.

## OR operator

OR lets you check for either of two conditions. OR is an example of a logical operator. There is more about logical operators later in this chapter.

## Example using DO...UNTIL and IF

```
PROC testny:
  DO
    g$=UPPER$(GET$)
  UNTIL g$="N" OR g$="Y" REM wait for a Y or N
  IF g$="N" REM was it an N?
    ... REM `N' pressed
  ELSE REM must have been a Y
    ... REM `Y' pressed
  ENDIF
ENDP
```

This procedure checks for a 'Y' or 'N' keypress. You'd put your own code in the IF statement, where "..." has been used.

---

## Arguments to functions

Some functions, as with commands like PRINT and PAUSE, require you to give a value or values. These values are called arguments. The UPPER\$ function needs you to specify a string argument, and returns the same string but with all letters in upper case. For example, "UPPER("12.+aBcDeF")" returns ""12.+ABCDEF"".

### Functions as arguments to other functions

Since GET\$ returns a string, you can use this as the argument for UPPER\$. "UPPER\$(GET\$)" waits for you to press a key, because of the "GET\$"; the "UPPER\$" takes the string returned and, if it's a letter, returns it in upper case. This

means that you can check for ""Y"" without having to check for ""y"" as well.

---

## 'True' and 'False'

The test condition used with DO...UNTIL, WHILE...ENDWH and IF...ENDIF can be any expression, and may include any valid combination of operators and functions. Examples:

Condition	Meaning
"x=21" this is a test	does the value of "x" equal 21? (Note as condition, it does not assign "x" the value 21)
"a%<>b% "	is the value of "a%" not equal to the value of "b%"?
"x%=(y%+z%) "	is the value of "x%" equal to the value of "y%+z%"? (does not assign the value "y%+z%" to "x%").

The expressions actually return a logical value that is, a value meaning either 'True' or 'False'. Any non-zero value is considered 'True' (to return a 'True' value, OPL uses -1), while zero means 'False'. So if "a%" is 6 and "b%" is 7, the expression "a%>b%" will return a zero value, since "a%" is not greater than "b%".

These are the conditional operators:

"<"	less than	"<="	less than or equal to
">"	greater than	"="	greater than or equal to
"="	equal to	"<>"	not equal to

## Logical operators

The operators AND, OR and NOT allow you to combine or change test conditions. This table shows their effects. ("c1" and "c2" represent conditions.)

Example	Result	Integer returned
"c1 AND c2"	True if both "c1" and "c2" are true False if either "c1" or "c2" are false	-1 0
"c1 OR c2"	True if either "c1" or "c2" is true False if both "c1" and "c2" are false	-1 0
"NOT c1"	True if "c1" is false False if "c1" is true	-1 0

However, AND, OR and NOT become bitwise operators something very different from logical operators when used exclusively with integer or long integer values. If you use "IF A% AND B%", the AND acts as a bitwise operator, and you may not get the expected result. You would have to rewrite this as "IF A%<>0 AND B%<>0". (Operators, including bitwise operators, are discussed further in an Appendix.)

---

## Jumping to a different line

### Jumping out of a loop: BREAK

The BREAK command jumps out of a DO...UNTIL or WHILE...ENDWH structure. The line after the UNTIL or ENDWH statement is executed, and the lines following are then executed as normal. For example: (picture)

### Jumping to the test condition: CONTINUE

The CONTINUE command jumps from the middle of a loop to its test condition. The test condition is either the UNTIL line of a DO...UNTIL loop or the WHILE line of a WHILE...ENDWH loop. For example: (picture)

### Jumping to a 'label': GOTO

The GOTO command jumps to a specified label. The label can be anywhere in the same procedure (after any LOCAL or

GLOBAL variable declarations). In this example, when the program reaches the GOTO statement, it jumps to the label "exit::", and continues with the statement after it. (picture)

The two PRINT statements are missed out.

Labels themselves must end in a double colon. This is optional in the "GOTO" statement both "GOTO exit::" and "GOTO exit" are OK.

The jump to the label always happens it is not conditional.

Don't use GOTOs instead of DO...UNTIL or WHILE...ENDWH, as they make procedures difficult to understand.

## Vectoring to a label: VECTOR/ENDV

VECTOR jumps to one of a list of labels, according to the value in an integer variable. The list is terminated by the ENDV statement. For example:

```
VECTOR P%
  FUNCA, FUNCX
  FUNCR
ENDV
PRINT "P% was not 1/2/3" :GET :STOP
FUNCA::
PRINT "P% was 1" :GET :STOP
FUNCX::
PRINT "P% was 2" :GET :STOP
FUNCR::
PRINT "P% was 3" :GET :STOP
```

Here, if "P%" is 1, VECTOR jumps to the label "FUNCA:". If it is 2, it jumps to "FUNCX::", and if 3, "FUNCR:". If "P%" is any other value, the program continues with the statement after the "ENDV" statement.

The list of labels may spread over several lines, as in this example, with a comma separating labels in any one line but no comma at the end of each line. Again, you can write each label in the list with a double colon, if you like.

VECTOR...ENDV can sometimes save you from having to write very long "IF...ENDIF" structures, with "ELSEIF" used many times.

### *Stopping a running program*

This example introduces the STOP command. This stops a running program completely, just as if the end of the program had been reached. In a module with a single procedure, STOP has the same effect as using GOTO to jump to a label above the final ENDP.

## UNTIL 0, WHILE 1

Zero and non-zero are logical values meaning 'False' and 'True' respectively. "UNTIL 0" and "WHILE 1" therefore mean 'do forever', since the condition 0 is never 'True' and the condition 1 is always 'True'. Use loops with these conditions when you need to check the real condition somewhere in the middle of the loop. When the real condition is met, you can BREAK out of the loop.

For example:

```
PROC test:
  WHILE 1
    ... REM some other lines here
    IF KEY :BREAK :ENDIF
    ... REM some other lines here
  ENDWH
ENDP
```

This example uses the KEY command. KEY returns 0 if no key has been pressed. When a key is pressed, KEY returns a non-zero value which counts as 'True', and the BREAK is executed.

## SUMMARY

```
DO
  statements
UNTIL condition
```

```
WHILE condition
  statements
ENDWH
```

```
IF condition
  statements
(ELSEIF condition
  statements)
(ELSE
  statements)
ENDIF
```

```
VECTOR int%
  label1, label2
  label3...
ENDV
```

**GOTO label** jumps to **label::**

**BREAK** goes to the first line after the end of the loop the line following the UNTIL or ENDWH line.

**CONTINUE** goes to the test condition of the loop the UNTIL or the WHILE line.

**STOP** stops a running program completely.

---

# Calling procedures

---

## Using more than one procedure

If you wanted a single procedure to perform a complex task, the procedure would become long and complicated. It is more convenient to have a module containing a number of procedures, each of which you can write and edit separately.

Many OPL modules are in fact a set of procedures linked up each procedure doing just one job (such as a certain calculation) and then passing its results on to other procedures so they can do other operations: (picture)

OPL is designed to encourage programs written in this way, since:

- You can store all the procedures which make up a program in the same module file

and

- One procedure can call, that is run, another.

## Modules containing more than one procedure

You can have as many procedures as you like in a module. Each must begin with PROC and end with ENDP.

**When you run a translated module it is always the first procedure, at the top of the module, which is actually run.** When this finishes, the module stops; any other procedures in the file are only run if and when they are called.

Although you can use any name you want, it's common to give the first procedure a name like "start".

Procedures which run on their own should be written and translated as separate modules, otherwise you won't be able to run them.

## Calling procedures

To run another procedure, simply give the name of the procedure (with the colon). For example, this module contains two procedures:

```
PROC one:
  PRINT "Start"
  PAUSE 40
  two:    REM calls procedure two:
  PRINT "Finished"
  PAUSE 40
ENDP

PROC two:
  PRINT "Doing..."
  PAUSE 40
ENDP
```

Running this module would run procedure "one:", with this effect: "Start" is displayed; after a PAUSE it calls "two:", which displays "Doing..."; after another PAUSE "two:" returns to the "one:" procedure; "one:" displays "Finished"; and after a final PAUSE, "one:" finishes.

## Uses of calling procedures

Calling procedures can be used to:

- Structure your programs more clearly so they're easier to adapt after you've written them
- Use the same procedure in different programs say, to perform a certain common calculation.

For example, when your program asks you "Do this or do that?", make two procedure calls either "this:" or "that:" procedure depending on what you reply, for example:

```

PROC input:
  LOCAL a$(1)
  PRINT "Add [A] or Subtract [S]?:",
  a$=UPPER$(GET$)
  IF a$="A"
    add:      REM first procedure
  ELSEIF a$="S"
    subtract: REM second procedure
  ENDIF
ENDP

```

To make full use of procedure calls, you must be able to communicate values between one procedure and another. There are two ways of doing this: global variables and parameters.

---

## Parameters

Values can be passed from one procedure to another by using parameters. They look, and act, very much like arguments to functions.

In the example below, the procedure "price:" calls the procedure "tax:". At the same time as it calls it, it passes a value (in this case, the value which INPUT gave to the variable "x") to the parameter "p" named in the first line of "tax:". The parameter "p" is rather like a new local variable inside "tax:", and it has the value passed when "tax:" is called. (The "tax:" procedure is not changing the variable "x".)

The "tax:" procedure displays the value of "x" plus 17.5% tax.

```

PROC price:
  (picture)
  LOCAL x
  PRINT "ENTER PRICE",
  INPUT x
  tax:(x) REM Passes the value of x to p
  GET
ENDP

PROC tax: (p)
  PRINT "PRICE INCLUDING TAX =",p*1.175
ENDP

```

- In the called procedure, follow the procedure name by the names to use for the parameters, in brackets and separated by commas for example "proc2:(cost,profit)".

The parameter type is specified as with variables for example "p" for a floating-point parameter, "p%" for an integer, "p&" for a long integer, "p\$" for a string. You can't have array parameters.

- In the calling procedure, the values for the parameters are given in brackets, in the right order and separated by commas, after the colon of the called procedure for example "proc2:(60,30)".

The values passed as parameters may be the values of variables, strings in quotes, or constants. So a call might be "calc:(a\$,x%,15.8)" and the first line of the called procedure "PROC calc:(name\$,age%,salary)"

In the called procedure, you cannot assign values to parameters for example, if "p" is a parameter, you cannot use a

statement like "p=10".

You will see a 'Type mismatch' error displayed if you try to pass the wrong type of value to a parameter for example, 45 to (a\$).

## Multiple parameters

In the following example, the second procedure "tax2:" has two parameters:

- The value of the price variable "x" is passed to the parameter "p1".
- The value of the tax rate variable "r" is passed to the parameter "p2".

"tax2:" displays the price plus tax at the rate specified.

```
PROC price2:
  (picture)
  LOCAL x,r
  PRINT "ENTER PRICE",
  INPUT x
  PRINT "ENTER TAX RATE",
  INPUT r
  tax2:(x,r)
  GET
ENDP

PROC tax2:(p1,p2)
  PRINT p1+p2 %
ENDP
```

This uses the "%" symbol as an operator "p1+p2 %" means "p1" plus "p2" percent of "p1". Note the space before the "%"; without it, "p2%" would be taken as representing an integer variable.

Appendix B has more about the "%" operator.

## Returning values

In the following example, the RETURN command is used to return the value of "x" plus tax at "r" percent to be displayed in "price3:". This is very similar to the way functions return a value.

The "tax3:" procedure calculates, but doesn't display the result. This means it can be called by other procedures which need to perform this calculation but do not necessarily need to display it.

```
PROC price3:
  (picture)
  LOCAL x,r
  PRINT "ENTER PRICE",
  INPUT x
  PRINT "ENTER TAX RATE",
  INPUT r
  PRINT "PRICE INCLUDING TAX =",tax3:(x,r)
  GET
ENDP

PROC tax3:(p1,p2)
  RETURN p1+p2 %
ENDP
```

Only one value may be returned by the RETURN command.

The name of a procedure which returns a value must end with the correct identifier "\$" for string, "%" for integer, or "&" for long integer. To return a floating-point number, it should end with none of these symbols. For example, "PROC

abcd\$:" can return a string, while "PROC counter%:" can return an integer. In this example, "ref\$:" returns a string:

```
PROC refname:
LOCAL a$(30),b$(2)
PRINT "Enter reference and name:",
INPUT a$
b$=ref$:(a$)
PRINT "Ref is:",b$
GET
ENDP

PROC ref$(name$)
RETURN LEFT$(name$,2)
REM LEFT$ takes first 2 letters of name$
ENDP
```

If you don't use the RETURN command, a string procedure returns the null string (""""). Other (numeric) types of procedure return zero.

---

## GLOBAL variables

You can only return one value with the RETURN command. If you need to pass back more than one value, use GLOBAL variables.

Instead of declaring "LOCAL x%,name\$(5)" declare "GLOBAL x%,name\$(5)". The difference is that:

- Local variables are valid only in the procedure in which they are declared.
- Global variables can also be used in any procedures (including those in loaded modules) called by the procedure in which they are declared.

So this module would run OK:

```
PROC one:
GLOBAL a%
PRINT a%
two:
GET
ENDP

PROC two:
a%=2 REM Sees a% declared in one:
PRINT a%
ENDP
```

When you run this, the value 0 is displayed first, and then the value 2.

You would see an 'Undefined externals' error displayed if you used LOCAL instead of GLOBAL to declare "a%", since the procedure "two:" wouldn't recognise the variable "a%". In general, though, it is good practice to use the LOCAL command unless you really need to use GLOBAL.

A local declaration overrides a global declaration in that procedure. So if "GLOBAL a%" was declared in a procedure, which called another procedure in which "LOCAL a%" was declared, any modifications to the value of "a%" in this procedure would not effect the value of the global variable "a%".

## Passing back values

You can effectively pass as many values as you like back from one procedure to another by using global variables. Any modifications to the value of a variable in a called procedure are automatically registered in the calling procedure.

For example:

```
PROC start:
  GLOBAL varone, vartwo
  varone=2.5
  vartwo=2
  op:
  PRINT varone, vartwo
  GET
ENDP

PROC op:
  varone=varone*2
  vartwo=vartwo*4
ENDP
```

This would display "5 8"

## **`Undefined externals' error**

If, perhaps because of a typing error, you use a name which is not one of your variables, no error occurs when you translate the module. This is because it could be the name of a global variable, declared in a different procedure, which might be available when the procedure in question was called. If no such global variable is available, an `Undefined externals' error is shown. This also displays the variable name which caused the error, together with the module and procedure names, in this format: `Error in MODULE\PROCEDURE,VARIABLE'.

## **SUMMARY**

Call a procedure by stating its name, including the colon.

Pass parameters to a procedure by following the procedure call with the values for the parameters, eg "calc2:(4.5,32)". In the called procedure, follow the procedure name with the parameter names, eg "PROC calc2:(mod,div%)".

To make variables declared in one procedure accessible to called procedures, declare the variables with GLOBAL instead of LOCAL.

---

# Data file handling

You can use OPL to create data files (databases) like those used by the Database. You can store any kind of information in a data file, and retrieve it for display, editing or calculations.

## This chapter covers:

- Creating data files
  - Adding and editing records
  - Searching records
  - Using a data file both in OPL and in the Database
- 

## Files, records and fields

Data files (or databases) (picture)

are made up of records

(picture)

For example, in a data file of names and addresses, each record might have a name field, a telephone number field, and separate fields for each line of the address.

In OPL you can:

- Create a new file with `CREATE`, or open an existing file with `OPEN`, and copy, delete and rename files with `COPY`, `DELETE` and `RENAME`.
  - Add a new record with `APPEND`, change an existing one with `UPDATE`, and remove a record with `ERASE`.
  - Fill in a field by assigning a value to a field variable.
- 

## Creating a data file

Use the `CREATE` command like this:

```
CREATE filename$,logical name,field1,field2,...
```

For example:

```
CREATE "clients",B,nm$,tel$,ad1$,ad2$,ad3$
```

creates a data file called "clients".

The file name is a string, so remember to put quote marks around it. You can also assign the name string to a string variable (for example `fil$="clients"`) and then use the variable name as the argument `"CREATE fil$,A,field1,field2"`.

## Logical names

You can have up to 4 data files open at a time. Each of these must have a logical name: "A", "B", "C" or "D". The logical

name lets you refer to this file without having to keep using the full file name.

A different logical name must be used for each data file opened one called "A", one called "B", one called "C" and one called "D". A file does not have to be opened with the same logical name as the last time it was opened. When a file is closed, its logical name is freed for use by another file.

## Fields

"field1, field2",... are the field names up to 32 in any record. These are like variables, so use "%" "&" or "\$" to make the appropriate types of fields for your data. You cannot use arrays. Do not specify the maximum length of strings that the string fields can handle. The length is automatically set at 255 characters.

Field names may be up to 8 characters long, including any qualifier like "&".

When referring to fields, add the logical file name to the front of the field name, to specify which opened file the fields belong to. Separate the two by a dot. For example, "A.name\$" is the "name\$" field of the file with logical name "A", and "C.age%" is the "age%" field of the file with logical name "C".

The values of all the fields are 0 or null to start with. You can see this if you run this example program:

```
PROC creatfil:
  CREATE "example",A,int%,long&,float,str$
  PRINT "integer=";a.int%
  PRINT "long=";a.long&
  PRINT "float=";a.float
  PRINT "string=";a.str$
  CLOSE
  GET
ENDP
```

---

## Opening a file

When you first CREATE a data file it is automatically open, but it closes again when the program ends. If a file already exists, trying to CREATE it again will give an error- so if you ran the procedure "creatfil:" a second time you would get an error. To open an existing file, use the OPEN command.

OPEN works in the same way as the CREATE command. For example:

```
OPEN "clients",B,a$,b$,c$,d$,e$
```

- You must use the same filename as when you first created it.
- You must include in the OPEN command each of the fields you intend to alter or read. You can omit fields from the end of the list; you cannot miss one out from the middle of the list, for example "field1\$,,name\$" They must remain the same type of field, but you can change their names. So a file created with fields "name\$,age%" could later be opened with the fields "a\$,x\$".
- Give the file a logical name. Up to 4 files may be open at any one time, with logical names "A", "B", "C" and "D". You can't have two files open simultaneously with the same logical name, so when opening the files, remember which logical names you have already used.

You might make a new module, and type these two procedures into it:

```
PROC openfile:
  IF NOT EXIST("example")
    CREATE "example",A,int%,lng&,fp,str$
  ELSE
    OPEN "example",A,int%,lng&,fp,str$
  ENDIF
  PRINT "Current values:"
```

```

show:
PRINT "Assigning values"
A.int%=1
A.lng&=&2**20 REM the 1st & avoids integer overflow
A.fp=SIN(PI/6)
PRINT "Give a value for the string:"
INPUT A.str$
PRINT "New values:"
show:
ENDP

PROC show:
PRINT "integer=";A.int%
PRINT "long=";A.lng&
PRINT "float=";A.fp
PRINT "string=";A.str$
GET
ENDP

```

## Notes

Opening/creating the file The IF...ENDIF checks to see if the file already exists, using the EXIST function. If it does, the file is opened; if it doesn't, the file is created.

Giving values to the fields The fields can be assigned values just like variables. The field name must be used with the logical file name like this: "A.f%=1" or "INPUT A.f\$".

If you try to give the wrong type of value to a field (for example ""Davis"" to "f%") an error message will be displayed.

You can access the fields from other procedures, just like global variables. Here the called procedure "show:" displays the values of the fields.

Field names You must know the type of each field, and you must give each a separate name you cannot refer to the fields in any indexed way, eg as an array.

Opening a file for sharing The OPENR command works in exactly the same way as OPEN, except that the file cannot be written to (with UPDATE or APPEND), only read. However, more than one running program can then look at the file at the same time.

## Saving records

The last example procedure did not actually save the field values as a record to a file. To do this you need to use the APPEND command. This program, for example, allows you to add records to the "example" data file:

```

PROC count:
LOCAL reply%
OPEN "example",A,f%,f&,f,f$
DO
  CLS
  AT 20,1 :PRINT "Record count=";COUNT
  AT 9,5 :PRINT "(A)dd a record"
  AT 9,7 :PRINT "(Q)uit"
  reply%=GET
  IF reply%=%q OR reply%=%Q
    BREAK
  ELSEIF reply%=%A OR reply%=%a
    add:
  ELSE
    BEEP 16,250
  ENDIF
UNTIL 0
ENDP

PROC add:

```

```

CLS
PRINT "Enter integer field:";
INPUT A.f%
PRINT "Enter long integer field:";
INPUT A.f&
PRINT "Enter numeric field:";
INPUT A.f
PRINT "Enter string field:";
INPUT A.f$
APPEND
ENDP

```

## **BEEP**

The BEEP command makes a beep of varying pitch and length:

BEEP duration%,pitch%

The duration is measured in 1/32 s of a second, so "duration%=32" would give a beep a second long. Try "pitch%=50" for a high beep, or "500" for a low beep.

## **The number of records**

The COUNT function returns the number of records in the file. If you use it just after creating a database, it will return 0. As you add records the count increases.

## **How the values are saved**

Use the APPEND command to save a new record. This has no arguments. The values assigned to "A.f%", "A.f&", "A.f" and "A.f\$" are added as a new record to the end of the "example" data file. If you only give values to some of the fields, not all, you won't see any error message. If the fields happen to have values, these will be used; otherwise null strings ("" ) will be given to string fields, and zero to numeric fields.

New field values are always added to the end of the current data file as the last record in the file (if the file is a new one, it will also be the first record).

At any time while a data file is open, the field names currently in use can be used like any other variable for example, in a PRINT statement, or a string or numeric expression.

## **APPEND and UPDATE**

APPEND adds the current field values to the end of the file as a new record, whereas UPDATE deletes the current record and adds the current field values to the end of the file as a new record.

## **Moving from record to record**

When you open or create a file, the first record in the file is current. To read, edit, or erase another record, you must make that record current that is, move to it. Only one record is current at a time. To change the current record, use one of these commands:

POSITION `moves to' a particular record, setting the field variables to the values in that record. For example, the instruction "POSITION 3" makes record 3 the current record. The first record is record 1.

You can find the current record number by using the POS function, which returns the number of the current record.

FIRST moves to the first record in a file.

NEXT moves to the following record in a file. If the end of the file is passed, NEXT does not report an error, but the current record is a new, empty record. This case can be tested for with the EOF function.

BACK moves to the previous record in the file. If the current record is the first record in the file then that first record

stays current.

LAST moves to the last record in the file.

## Deleting a record

ERASE deletes the current record in the current file.

The next record is then current. If the erased record was the last record in a file, then following this command the current record will be empty and EOF will return true.

---

## Finding a record

FIND makes current the next record which has a field matching your search string. Capitals and lower-case letters match. For example:

```
r%=FIND("Brown")
```

would select the first record containing a string field with the value "Brown", "brown" or "BROWN", etc. The number of that record is returned, in this case to the variable "r%". If the number returned is zero, no matching field was found. Any other number means that a match was found.

The search includes the current record. So after finding a matching record, you need to use NEXT before you can continue searching through the following records.

"FIND("Brown")" would not find a field "Mr Brown". To find this, use wildcards, as explained below.

**You can only search string fields, not number fields.** For example, if you assigned the value 71 to the field "a%", you could not find this with FIND. But if you assigned the value "71" to "a\$", you could find this.

## Wildcards

"r%=FIND("\*Brown\*)" would make current the next record containing a string field in which "Brown" occurred for example, the fields "MR BROWN", "Brown A.R." and "Browns Plumbing" would be matched. The wildcards you can use are:

? matches any one character

\* matches any number of characters.

Once you've found a matching record, you might display it on the screen, erase it or edit it. For example, to display all the records containing "BROWN":

```
FIRST
WHILE FIND ("*BROWN*")
  PRINT a.name$, a.phone$
NEXT
GET
ENDWH
```

## More controlled finding

FINDFIELD, like FIND, finds a string, makes the record with this string the current record, and returns the number of this record. However you can also use it to do case-dependent searching, to search backwards through the file, to search from the first record (forwards) or from the last record (backwards), and to search in one or more fields only.

You may experience some problems in using FINDFIELD with some versions of OPL. To ensure that problems are avoided use the line:

POKEB(peekw(\$1c)+7),0

immediately before each call to FINDFIELD.

The first argument to FINDFIELD is the string to look for, as for FIND. The second is the number of the field to start looking in (1 for the first field), and the third is the number of fields to search in (starting from the field specified by the second argument). If you want to search in all fields, use 1 as the second argument and for the third argument use the number of fields you used in the OPEN/CREATE command.

The fourth argument adds together two values:

- 0 for a case independent match, where capitals and lower-case letters match, or 1 for a case dependent match. **This value should be multiplied by 16.**
- 0 to search backwards from the current record, 1 to search forwards from the current record, 2 to search backwards from the end of the file, or 3 to search forwards from the start of the file.

For a case independent search (0) forwards from the current record (1\*16), use 0+(1\*16), ie 16. If you wanted to search only in the second and third fields, the full statement might look like this: "FINDFIELD("brown",2,2,16)".

☞ If you understand hexadecimal arithmetic, as described under HEX\$ in the 'Alphabetic listing' chapter, note that you can combine the two values more easily using hexadecimal numbers. Use a "\$" symbol, then the digit for the start/direction (0/1/2/3), then the digit for case dependency (0/1). In the previous example the digits are 1 and 0, producing the hexadecimal number "\$10" (=16).

If you find a matching record and then want to search again from this record, you must first use NEXT or BACK (according to the direction you are searching in), otherwise the same match will be "found" in the current record again."

---

## Changing/closing the current file

Immediately after a file has been created or opened, it is automatically current. This means that the APPEND or UPDATE commands save records to this file, and the record-position commands (explained below) move around this file. You can still use the fields of other open files, for example "A.field1=B.field2"

USE makes current one of the other opened files. For example "USE B" selects the file with the logical name B (as specified in the OPEN or CREATE command which opened it).

If you attempt to USE a file which has not yet been opened or created, an error is reported.

In this procedure, the EOF function checks whether you are at the end of the current data file that is, whether you've gone past the last record. You can use EOF in the test condition of a loop UNTIL EOF or WHILE NOT EOF in order to carry out a set of actions on all the records in a file.

## Example copies selected records from one file to another

```
PROC copyrec:
  OPEN "example",A,f%,f&,f,f$
  TRAP DELETE "temp"
  REM If file doesn't exist, ignore error
  CREATE "temp",B,f%,f&,f,f$
  PRINT "Copying EXAMPLE to TEMP"
  USE A REM the EXAMPLE file
  DO
    IF a.f%>30 and a.f<3.1415
      b.f%=a.f%
      b.f&=a.f&
      b.f=a.f
      b.f$="Selective copy"
  USE B REM the TEMP file
```

```

APPEND
USE A
ENDIF
NEXT
UNTIL EOF REM until End Of File
CLOSE REM closes A; B becomes current
CLOSE REM closes B
ENDP

```

This example uses the DELETE command to delete any "temp" file which may exist, before making it afresh. Normally, if there was no "temp" file and you tried to delete it, an error would be generated. However, this example uses TRAP with the DELETE command. TRAP followed by a command means "if an error occurs in the command, carry on regardless".

There are more details of TRAP in the chapter on 'Error Handling'.

## Closing a data file

You should always 'close' a data file (with the CLOSE command) when you have finished using it. Data files close automatically when programs end. You can only have 4 files open at a time if you have 4 files open and you want to access another one, close one of them. CLOSE closes the current file.

## Keeping data files compressed

When you change or delete records in a data file, the space taken by the old information is not automatically recovered. By default, the space is recovered when you close the file, provided it is on 'Internal drive' or on a RAM SSD (ie it is not on a Flash SSD).

Closing a very large file which contains changed or deleted records can be slow when compression is enabled, as the whole file beyond each old record needs copying down, each time.

You can prevent data file compression if you wish, with these two lines:

```

p%=PEEKW($1c)+$1e
POKEW p%,PEEKW(p%) or 1

```

(Use any suitable integer variable for "p%".) Files used by the current program will now not compress when they close.

Use these two lines to re-enable auto-compression:

```

p%=PEEKW($1c)+$1e
POKEW p%,PEEKW(p%) and $fffe

```

**Warning:** be careful to enter these lines exactly as shown. These examples work by setting a system configuration flag.

If you have closed a file without compression, you can recover the space by using the COMPRESS command to create a new, compressed version of the file. "COMPRESS "dat" "new"", for example, creates a file called "new" which is a compressed version of "dat", with the space which was taken up by old information now recovered. (You have to use COMPRESS to compress data files which are kept on a Flash SSD.)

## Data files and the Database

The files you use with the Database (listed under the Data icon in the System screen) often called databases or database files are also just data files.

Data files created by the Database can be viewed in OPL, and vice versa.

In OPL: to open a data file made by the Database, begin its name with "\DAT\", and end it with ".DBF". For example, to open the file called "data" which the Database normally uses:

OPEN "\dat\data.dbf",A,a\$,b\$,c\$,d\$...

Restrictions:

- You can use up to 32 field variables, all strings. It is possible for records to contain more than 32 fields, but these fields cannot be accessed by OPL. It's safe to change such a record and use UPDATE, though, as the extra fields will remain unchanged.
- The maximum record length in OPL is 1022 characters. You will see a 'Record too large' error (-43) if your program tries to open a file which contains a record longer than this.
- The Database breaks up long records (over 255 characters) when storing them. They would appear as separate records to OPL.

In the Database: to examine an OPL data file, press the Data button, select 'Open' from the 'File' menu, and type the name with "\OPD\" on the front and ".ODB" at the end for example:

\opd\example.odb

Restrictions:

- All of the fields must be string fields.
- You can have up to a maximum of 32 fields, as specified in the CREATE command. If you view an OPL data file with the Database, and add more lines to records than the number of fields specified in the original CREATE command, you will get an error if you subsequently try to access these additional fields in OPL.

In both cases, you are using a more complete file specification. There is more about file specifications in the Advanced Topics chapter.

---

# Graphics

OPL graphics allows you, for example, to:

- Draw lines and boxes.
- Fill areas with patterns.
- Display text in a variety of styles, at any position on the screen.
- Scroll areas of the screen.
- Manipulate windows and bit patterns.
- Read data back from the screen.

You can draw using black, grey and white.

Graphics keywords begin a "G". In this manual a lower case "g" is used for example, "gBOX" but you can type them using upper or lower case letters.

**IMPORTANT:** Some graphics keywords are mentioned only briefly in this chapter. For more details about them, see the 'Alphabetic listing' chapter.

---

## Simple graphics

The Series 3a screen is made up of a regular pattern of 480 points across by 160 down. These points are sometimes referred to as pixels.

Each pixel is identified by two numbers, giving its position across and down from the top left corner of the screen. 0,0 denotes the pixel in the top left corner; 2,1 is the pixel 2 points across and one down, and so on. 479,159 is the pixel in the bottom right corner.

Note that these co-ordinates are very different to the cursor positions set by the AT command.

OPL maintains a current position on the screen. Graphics commands which draw on the screen generally take effect at this position. Initially, the current position is the top left corner, 0,0.

You can draw using black, grey and white although grey is not accessible by default. See the section 'Drawing in grey' below for further details.

---

## Screen positions

### Drawing lines

Here is a simple procedure to draw a horizontal line in the middle of the screen:

```
PROC lines:  
  gMOVE 180,80  
  gLINEBY 120,0  
  GET  
ENDP
```

gMOVE moves the current position by the specified amount. In this case, it moves the current position 180 pixels right

and 80 down, from 0,0 to 180,80. It does not display anything on the screen.

gLINEBY (g-Line-By) draws a line from the current position (just set to 180,80) to a point at the distance you specify in this case 120 to the right and 0 down, ie 300,80.

When drawing a horizontal line, as in the above example, the line that is drawn includes the pixel with the lower x coordinate and excludes the pixel with the higher x coordinate. Similarly, when drawing a vertical line, the line includes the pixel with the lower y coordinate and excludes the pixel with the higher y coordinate.

On the Series 3a screen the y coordinate decreases as you move toward the top of the screen.

When drawing a diagonal line, the coordinates of the end pixels are turned into a rectangle. The top left pixel lies inside the boundary of this rectangle and the bottom right pixel lies outside it. The line drawing algorithm then fills in those pixels that are intersected by a mathematical line between the corners of the rectangle. Thus the line will be drawn minus one or both end points.

gLINEBY also has the effect of moving the current position to the end of the line it draws.

With both gMOVE and gLINEBY, you specify positions relative to the current position. Most OPL graphics commands do likewise. gMOVE and gLINEBY, however, do have corresponding commands which use absolute pixel positions. gAT moves to the pixel position you specify; gLINETO draws a line from the current position to an absolute position. The horizontal line procedure could instead be written:

```
PROC lines:
  gAT 180,80
  gLINETO 300,80
  GET
ENDP
```

gAT and gLINETO may be useful in very short graphics programs, and gAT is always the obvious command for moving to a particular point on the screen, before you start drawing. But once you do start drawing, use gMOVE and gLINEBY. They make it much easier to develop and change programs, and allow you to make useful graphics procedures which can display things anywhere you set the current position. Almost all graphics drawing commands use relative positioning for these reasons.

## Drawing dots

You can set the pixel at the current position with "gLINEBY 0,0".

## Right and down, left and up

gMOVE and gLINEBY find the position to use by adding the numbers you specify onto the current position. If the numbers are positive, it moves to the right and down the screen. If you use negative numbers, however, you can specify positions to the left of and/or above the current position. For example, this procedure draws the same horizontal line as before, then another one above it:

```
PROC lines2:
  gMOVE 180,80
  gLINEBY 120,0
  gMOVE 0,-20
  gLINEBY -120,0
  GET
ENDP
```

The first two program lines are the same as before. gLINEBY moves the current position to the end of the line it draws, so after the first gLINEBY the current position is 300,80. The second gMOVE moves the current position up by 20 pixels; the second gLINEBY draws a line to a point 120 pixels to the left.

For horizontal and vertical lines, the right-hand/bottom pixel is not set. For diagonal lines, the right-most and bottom-most pixels are not set; these may be the same pixel.

## Going off the screen

No error is reported if you try to draw off the edge of the screen. It is quite possible to leave the current position off the screen for example, "gLINETO 600,80" will draw a line from the current position to some point on the right-hand screen edge, but the current position will finish as 600,80.

There's no harm in the current position being off the screen. It allows you to write procedures to display a certain pattern at the current position, and not have to worry whether that position is too close to the screen edge for the whole pattern to fit on.

## Clearing the screen

"gCLS" clears the screen.

---

## Drawing in grey

### Initialising for the use of grey

To draw in grey you need to use "DEFAULTWIN 1" at the start of your program. (Note that this clears the screen.) Grey is not automatically available because it requires twice the memory (and takes longer to scroll or move) compared to having just black. So programs that do not need to use grey are not unnecessarily penalised.

"DEFAULTWIN 0" disables the use of grey again, also clearing the screen.

☞ It is not possible to have a screen using grey only.

"DEFAULTWIN 1" does not cause PRINT to print in grey it applies only to graphics and graphics text (see gPRINT later).

When you use "DEFAULTWIN 1" the existing black-only screen is cleared and replaced by one which contains a black plane and also a grey plane. The black plane is also sometimes called the the normal plane. These are referred to as 'planes' because intuitively it is simplest to think of there being a plane of black pixels in front of (or on top of) a plane of grey pixels, with any grey only ever visible if the black pixel in front of it is clear.

**If you draw a pixel using both black and grey, it will appear black. If you then clear the black plane only, the same pixel will appear grey.** If you draw a pixel using grey only it will appear grey unless it is already black, in which case it is effectively hidden behind the black plane.

If you need to use grey, you are recommended to use "DEFAULTWIN 1" once and for all at the start of your program. One reason is because DEFAULTWIN can fail with a 'No system memory' error and it is unlikely that you would want to continue without grey after trying to enable it.

☞ Note that gXBORDER, gBUTTON and gDRAWOBJECT all use grey and therefore can only be used when grey is enabled. If grey is not enabled, they raise a 'General failure' error.

## Using grey

Once you have used "DEFAULTWIN 1" you can use the gGREY command to set which plane should be used for all subsequent graphics drawing (until the next use of gGREY).

```
gGREY 0          draws to the black plane only.
gGREY 1          draws to the grey plane only.
gGREY 2          draws to both planes.
```

"gGREY 1" and "gGREY 2" raise an error if the current window does not have a grey plane.

As mentioned earlier, when you set a pixel using both black and grey, the pixel appears black because the black plane is effectively in front of the grey plane. So drawing to both planes is generally only used for clearing pixels. For example, if

your screen has both black and grey pixels, gCLS will clear the pixels only in the plane selected by gGREY. To clear the whole screen with gCLS, you therefore need "gGREY 2".

To draw in grey when the pixels to which you are drawing are currently black, you first need to clear the black.

A pixel will appear white only if it is clear in both planes.

## Example

The following procedure initialises the screen to allow grey, draws a horizontal line in grey, another below it in black only and a third below it in both black and grey. Pressing a key clears the black plane only, revealing the grey behind the black in the bottom line and clearing the middle line altogether.

```
PROC exgrey:
  DEFAULTWIN 1                      REM enable grey
  gAT 0,40 :gGREY 1 :gLINEBY 480,0  REM grey only
  gAT 0,41 :gLINEBY 480,0
  gAT 0,80 :gGREY 0 :gLINEBY 480,0  REM black only
  gAT 0,81 :gLINEBY 480,0
  gAT 0,120 :gGREY 2 :gLINEBY 480,0 REM both planes
  gAT 0,121 :gLINEBY 480,0
  GET
  gGREY 0                            REM black only
  gCLS                                REM clear it
  GET
ENDP
```

---

## Overwriting pixels

### Drawing rectangles

The gBOX command draws a box outline. For example, "gBOX 100,20" draws a box from the current position to a point 100 pixels to the right and 20 down. If the current position were 200,40, the four corners of this box would be at 200,40, 300,40, 300,60 and 200,60.

If you have used "DEFAULTWIN 1" and gGREY as described earlier, the box is drawn to the black and/or grey plane as selected.

gBOX does not change the current position.

gFILL draws a filled box in the same way as gBOX draws a box outline, but it has a third argument to say which pixels to set. If set to 0, the pixels which make up the box would be set. If set to 1, pixels are cleared; if set to 2, they are inverted, that is, pixels already set on the screen become cleared, and vice versa. The values 1 and 2 are used when overwriting areas of the screen which already have pixels set.

If you have used "DEFAULTWIN 1" and gGREY as described earlier, the filled box will be set, cleared or inverted in the black and/or grey plane as selected. Once again, it helps to think of the pixels being set or clear in each plane independently: so clearing the pixel in the black plane reveals the grey plane behind it where the pixel may be set or clear.

So with "gGREY 1" set for drawing to the grey plane only, inverting the pixels in the filled box will change the grey plane only black pixels are left alone but clear or grey pixels are inverted to grey and clear pixels respectively. Similarly, inverting the black plane changes clear pixels to black, but "clearing" black pixels displays grey if the pixel is set in the grey plane.

This procedure displays a "robot" face, using gFILL to draw set and cleared boxes:

```
PROC face:
  gFILL 120,120,0 REM setthe entire face
  gMOVE 10,20 :gFILL 30,20,1 REM left eye
```

```

gMOVE 70,0 :gFILL 30,20,1 REM right eye
gMOVE -30,30 :gFILL 20,30,1 REM nose
gMOVE -20,40 :gFILL 60,20,1 REM mouth
GET
ENDP

```

Before calling such a procedure, you would set the current position to be where you wanted the top left corner of the head.

You could make the robot wink with the following procedure, which inverts part of one eye:

```

PROC wink:
gMOVE 10,20 REM move to left eye
gFILL 30,14,2 REM invert most of the eye
PAUSE 10
gFILL 30,14,2 REM invert it back again
GET
ENDP

```

Again, you would set the current position before calling this.

The gPATT command can be used to draw a shaded filled rectangle. To do this, use "-1" as its first argument, then the same three arguments as for gFILL width, height, and overwrite method. Overwrite methods 0, 1 and 2 apply only to the pixels which are 'on' in the shading pattern. Whatever was on the screen may still show through, as those pixels which are 'clear' in the shading pattern are left as they were.

To completely overwrite what was on the screen with the shaded pattern, gPATT has an extra overwrite method of 3. So, for example, "gPATT -1,120,120,3" in the first procedure would have displayed a shaded robot head, whatever may have been on the screen.

Again, the shaded pattern will be drawn in grey if you have selected the grey plane only using "gGREY 1". And again, if you are writing to the black plane only, any pixels set in the grey plane can be seen if the corresponding pixels in the black plane are clear.

## Overwriting with any drawing command

By using the gGMODE command, any drawing command such as gLINEBY or gBOX can be made to clear or invert pixels, instead of setting them. gGMODE determines the effect of all subsequent drawing commands.

The values are the same as for gFILL: "gGMODE 1" for clearing pixels, "gGMODE 2" for inverting pixels, and "gGMODE 0" for setting pixels again. (0 is the initial setting.)

For example, some white lines can give the robot a furrowed brow:

```

PROC brow:
gGMODE 1 REM gLINEBY will now clear pixels
gMOVE 10,8 :gLINEBY 100,0
gMOVE 0,4 :gLINEBY -100,0
gGMODE 0
GET
ENDP

```

The setting for gGMODE applies to the planes selected by gGREY. With "gGREY 1" for instance, "gGMODE 1" would cause gLINEBY to clear pixels in the grey plane and "gGMODE 0" to set pixels in the grey plane.

## Other drawing keywords

- gBUTTON: draw a 3-D button (a picture of a key, not of an application button) enclosing supplied text. The button can be raised, depressed or sunken.
- gBORDER, gXBORDER: draw 2-D/3-D borders.
- gINVERT: invert a rectangular area, except for its

four corner pixels.

- **gCOPY**: copy a rectangular area from one position on the screen to another. Both black and grey planes are copied.
- **gSCROLL**: move a rectangular area from one position on the screen to another, or scroll the contents of the screen in any direction. Both black and grey planes are moved.
- **gPOLY**: draw a sequence of lines.
- **gDRAWOBJECT**: draw a graphics object. This can be used to draw the "lozenge" used to display the words 'City' and 'Home' in the World application.

☞ Note that commands such as **gSCROLL**, which move existing pixels, affect both black and grey planes. **gGREY** only restricts drawing and clearing of pixels.

---

## Graphical text

### Displaying text with **gPRINT**

The **PRINT** command displays text in one font, in a screen area controlled by the **FONT** or **SCREEN** commands. You can, however, display text in a variety of fonts and styles, at any pixel position, with **gPRINT**. **gPRINT** also lets you draw text to the grey plane, if you have used **DEFAULTWIN** and **gGREY** (discussed earlier).

☞ You **can** (to a lesser degree) control the font and style used by OPL's other text-drawing keywords, such as **PRINT** and **EDIT**. See "The text and graphics windows" at the end of this chapter.

**gPRINT** is a graphical version of **PRINT**, and displays a list of expressions in a similar way. Some examples:

```
"gPRINT "Hello",name$"
" gPRINT a$"
" gPRINT "Sin(PI/3) is",sin(pi/3) "
```

Unlike **PRINT**, **gPRINT** does not end by moving to a new line. A comma between expressions is still displayed as a space, but a semi-colon has no effect. "**gPRINT**" used on its own does nothing.

The first character displayed has its left side and baseline at the current position. The baseline is like a line on lined notepaper graphically, this is the horizontal line which includes the lowest pixels of upper case characters. Some characters, such as 'g', 'j', 'p', 'q' and 'y', set pixels below the baseline.

After using **gPRINT**, the current position is at the end of the text so that you can print something else immediately beyond it. As with other graphics keywords, no error is reported if you try to display text off the edge of the screen.

While "**CURSOR ON**" displays a flashing cursor for ordinary text displayed with **PRINT**, "**CURSOR 1**" switches on a cursor for graphical text which is displayed at the current position. "**CURSOR OFF**" removes either cursor.

## Fonts

The **gFONT** command sets the font to be used by subsequent **gPRINT** commands.

A large set of fonts which can be used with **gFONT** is provided in the Series 3a ROM. In the following list, Swiss fonts refer to fonts without serifs while Roman fonts either have serifs (eg font 6) or are in a style designed for serifs but are too small to show them (eg font 5). Mono-spaced fonts have characters which all have the same width (and have their 'pixel size' listed as width "x" height); in proportional fonts each character can have a different width.

font number	Description	pixel size
1	Series 3 normal	8
2	Series 3 bold	8

3	Series 3 digits	6x6
4	Mono	8x8
5	Roman	8
6	Roman	11
7	Roman	13
8	Roman	16
9	Swiss	8
10	Swiss	11
11	Swiss	13
12	Swiss	16
13	Mono	6x6

The special font number "\$9a" is set aside to give a machine's default graphics font; this is the font used initially for graphics text. The actual font may vary from machine to machine eg it is font 1 on the Series 3 and font 11 on the Series 3a. So "gFONT 11" or "gFONT \$9a" both set the Series 3a standard font, which gPRINT normally uses.

☛ Fonts 1,2 and 3 are the Series 3 fonts, used when running in compatibility mode.

See gINFO in the alphabetic listing if you need to find out more information about fonts.

The following program shows you examples of the fonts. ("!!!!" is displayed to emphasise the mono-spaced fonts):

**PROC fonts:**

```
showfont:(4,15,"Mono 8x8")
showfont:(5,25,"Roman 8")
showfont:(6,38,"Roman 11")
showfont:(7,53,"Roman 13")
showfont:(8,71,"Roman 16")
showfont:(9,81,"Swiss 8")
showfont:(10,94,"Swiss 11")
showfont:(11,109,"Swiss 13")
showfont:(12,127,"Swiss 16")
showfont:(13,135,"Mono 6x6")
GET
```

**ENDP**

**PROC showfont: (font%,y%,str\$)**

```
gFONT font%
gAT 20,y% :gPRINT font%
gAT 50,y% :gPRINT str$
gAT 150,y% :gPRINT "!!!!"
```

**ENDP**

## Text style

The gSTYLE command sets the text style to be used by subsequent gPRINT commands.

Choose from these styles:

```
"gSTYLE 1"      bold
"gSTYLE 2"      underlined
"gSTYLE 4"      inverse
"gSTYLE 8"      double height
"gSTYLE 16"     mono
"gSTYLE 32"     italic
```

The `mono' style is not proportionally spaced each character is displayed with the same width, in the same way that PRINT displays characters. A proportional font can be displayed as a mono-spaced font by setting the `mono' style. See the previous section for the list of mono-spaced and proportional fonts.

☛ It is inefficient to use the `mono' style to display a font which is already mono-spaced.

You can combine these styles by adding the relevant numbers together. "gSTYLE 12" sets the text style to inverse and double-height (4+8=12). Here's an example of this style:

**PROC style:**

```
gAT 20,50 :gFONT 11
```

```

gSTYLE 12 :gPRINT "Attention!"
GET
ENDP

```

Use "gSTYLE 0" to reset to normal style.

The bold style provides a way to make any font appear bolded. Except for the smaller fonts, most Series 3a fonts look reasonably bold already. Note that using the bold style sometimes causes a change of font; if you use gINFO you may see the font name change.

## Overwriting with gPRINT

gPRINT normally displays text as if writing it with a pen the pixels that make up each letter are set, and that is all. If you're using areas of the screen which already have some pixels set, or even have all the pixels set, use gTMODE to change the way gPRINT displays the text.

gTMODE controls the display of text in the same way as gGMODE controls the display of lines and boxes. The values you use with gTMODE are similar to those for gGMODE: "gTMODE 1" for clearing pixels, "gTMODE 2" for inverting pixels, and "gTMODE 0" for setting pixels again. There is also "gTMODE 3" which sets the pixels of each character while clearing the character's background. This is very useful as it guarantees that the text is readable (as far as the current plane is concerned).

As for gGMODE, the setting for gTMODE applies to the planes selected by gGREY. With "gGREY 1" for instance, "gTMODE 1" would cause gLINEBY to clear pixels in the grey plane and "gTMODE 0" to set pixels in the grey plane.

This procedure shows the various effects possible via gTMODE:

```

PROC tmode:
  DEFAULTTWIN 1          REM enable grey
  gFONT 11      :gSTYLE 0
  gAT 160,0     :gFILL 160,80,0 REM Black box
  gAT 220,0     :gFILL 40,80,1  REM White box
  gAT 180,20    :gTMODE 0 :gPRINT "ABCDEFGHJKLM"
  gAT 180,35    :gTMODE 1 :gPRINT "ABCDEFGHJKLM"
  gAT 180,50    :gTMODE 2 :gPRINT "ABCDEFGHJKLM"
  gAT 180,65    :gTMODE 3 :gPRINT "ABCDEFGHJKLM"
  gGREY 1
  gAT 160,80    :gFILL 160,80,0 REM Grey box
  gAT 220,80    :gFILL 40,80,1  REM White box
  gAT 180,100   :gTMODE 0 :gPRINT "ABCDEFGHJKLM"
  gAT 180,115   :gTMODE 1 :gPRINT "ABCDEFGHJKLM"
  gAT 180,130   :gTMODE 2 :gPRINT "ABCDEFGHJKLM"
  gAT 180,145   :gTMODE 3 :gPRINT "ABCDEFGHJKLM"
  GET
ENDP

```

## Other graphical text keywords

- gPRINTB: Display text left aligned, right aligned or centred, in a cleared box. The gTMODE setting is ignored. With "gGREY 1", only grey background pixels in the box are cleared and with "gGREY 0", only black pixels; with "gGREY 2" all background pixels in the box are cleared.
- gXPRINT: Display text underlined/highlighted.
- gPRINTCLIP: Display text clipped to whole characters.
- gTWIDTH: Find width required by text.

All of these keywords take the current font and style into account, and work on a single string. They display the text in black or grey according to the current setting of gGREY.

---

# Windows

So far, you've used the whole of the screen for displaying graphics. You can, however, use windows rectangular areas of the screen.

☞ Sprites (described in the 'Advanced topics' chapter) can display non-rectangular shapes.

OPL allows a program to use up to eight windows at any one time.

## Window IDs and the default window

Each window has an ID number, allowing you to specify which window you want to work with at any time.

When a program first runs, it has one window called the default window. Its ID is 1, it is the full size of the screen, and initially all graphics commands operate on it. (This is why '0,0' has so far referred to the top left of the screen: it is true for the default window.)

Other windows you create will have IDs from 2 to 8. **When you make another window it becomes the current window, and all subsequent graphics commands operate on it.**

The first half of this chapter used only the default window. However, everything actually applies to the current window. For example, if you make a small window current and try to draw a very long line, the current position moves off past the window edge, and only that part of the line which fits in the window is displayed.

## Graphics keywords and windows

For OPL graphics keywords, positions apply to the window you are using at any given time. The point 0,0 means the top left corner of the current window, not the top left corner of the screen.

Each window can be created with a grey plane if required, in which case gGREY is used to specify whether the black plane, the grey plane or both should be used for all subsequent graphics commands until the next call to gGREY, exactly as described in the first half of this chapter.

For the default window, the special command DEFAULTWIN is required to enable grey because that window is automatically created for you with only a black plane; "DEFAULTWIN 1" closes the default window and creates a new one which has a grey plane. All other windows must be created with a grey plane if grey is required.

Once a window has been created with a grey plane, grey is used in precisely the same way as in the default window with grey enabled: "gGREY 0" directs all drawing to the black plane only, "gGREY 1" to the grey plane only and "gGREY 2" to both planes. "gGREY 1" and "gGREY 2" raise an error if the current window does not have a grey plane.

gGREY, gGMODE, gTMODE, gFONT and gSTYLE can all be used with created windows in exactly the same way as with the default window, as described earlier. They change the settings for the current window only; all the settings are remembered for each window.

## Creating new windows

The gCREATE function sets up a new window on the screen. It returns an ID number for the window. Whenever you want to change to this window, use gUSE with this ID.

You can create a window with only a black plane or with both a black and a grey plane. You cannot create a window with just a grey plane.

Here is an example using gCREATE and gUSE, contrasting the point 20,20 in the created window with 20,20 in the default window.

```
PROC windows:
  LOCAL id%
  id%=gCREATE(60,40,240,30,1,1)
```

```

gBORDER 0 :gAT 20,20 :gLINEBY 0,0
gPRINT " 20,20 (new)"
GET
gUSE 1 :gAT 20,20 :gLINEBY 0,0
gPRINT " 20,20 (default)"
GET
gUSE id%
gGREY 1          REM draw grey
gPRINT " Back"
gGREY 0
gPRINT " (with grey)"
GET
ENDP

```

The line "id%=gCREATE(60,40,180,30,1,1)" creates a window with its top left corner at 60,40 on the screen. The window is set to be 180 pixels wide and 30 pixels deep. (You can use any integer values for these arguments, even if it creates the window partially or even totally off the screen.) The fifth argument to gCREATE specifies whether the window should immediately be visible or not; 0 means invisible, 1 (as here) means visible. The sixth argument specifies whether the window should have a grey plane or not; 0 means black only, 1 (as here) means black and grey. If the sixth argument is not supplied at all (eg. "id%=gCREATE(60,40,180,30,1)") the window will not have a grey plane.

gCREATE automatically makes the created window the current window, and sets the current position in it to 0,0. It returns an ID number for this window, which in this example is saved in the variable "id%".

The "gBORDER 0" command draws a border one pixel wide around the current window. Here this helps show the position and size of the window. (gBORDER can draw a variety of borders. You can even display the Series 3a 3-D style borders seen in menus and dialogs, with the gXBORDER keyword.)

The program then sets the pixel at 20,20 in this new window, using "gLINEBY 0,0".

"gUSE 1" goes back to using the default window. The program then shows 20,20 in this window.

Finally, "gUSE id%" goes back to the created window again, and a final message is displayed, in grey and black.

Note that each window has its own current position. The current position in the created window is remembered while the program goes back to the default window. All the other settings, such as the font, style and grey setting are also remembered.

## Closing windows

When you've finished with a particular window, close it with gCLOSE followed by its ID for example, "gCLOSE 2". You can create and close as many windows as you like, as long as there are only eight or fewer open at any one time.

If you close the current window, the default window (ID=1) becomes current.

An error is raised if you try to close the default window.

## When windows overlap

Windows can overlap on the screen, or even hide each other entirely. Use the gORDER command to control the foreground/background positions of overlapping windows.

"gORDER 3,1" sets the window whose ID is 3 to be in the foreground. This guarantees that it will be wholly visible. "gORDER 3,2" makes it second in the list; unless the foreground window overlaps it, it too will be visible.

Any position greater than the number of windows you have is interpreted as the end of the list. "gORDER 3,9" will therefore always force the window whose ID is 3 to the background, behind all others.

Note in particular that making a window the current window with gUSE does not bring it to the foreground. You can make a background window current and draw all kinds of things to it, but nothing will happen on the screen until you bring it to the foreground with gORDER.

When a window is first created with gCREATE it always becomes the foreground window as well as the current window.

## Hiding windows

If you are going to use several drawing commands on a particular window, you may like to make it invisible while doing so. When you then make it visible again, having completed the drawing commands, the whole pattern appears on the screen in one go, instead of being built up piece by piece.

Use "gVISIBLE ON" and "gVISIBLE OFF" to perform this function on the current window. You can also make new windows invisible as you create them, by using 0 as the fifth argument to the gCREATE command, and you can hide windows behind other windows.

## The graphics cursor in windows

To make the graphics cursor appear in a particular window, use the CURSOR command with the ID of the window. It will appear flashing at the current position in that window, provided it is not obscured by some other window.

The window you specify does not have to be the current window, and does not become current; you can have the cursor in one window while displaying graphical text in another. If you want to move to a different window and put the graphics cursor in it, you must use both gUSE and CURSOR.

Since the default window always has an ID of 1, "CURSOR 1" will, as mentioned earlier, put the graphics cursor in it.

CURSOR OFF turns off the cursor, wherever it is.

## Information about your windows

You don't have to keep a complete copy of all the information pertaining to each window you use. These functions return information about the current window:

- gIDENTITY returns its ID number.
- gRANK returns its foreground/background position, from 1 to 8.
- gWIDTH and gHEIGHT return its size.
- gORIGINX and gORIGINY return its screen position.
- gINFO returns information about the font, style, grey setting, overwrite modes and cursor in use.
- gX and gY return the current position.

## Other window keywords

- gSETWIN changes the position, and optionally the size, of the current window.

You can use this command on the default window, if you wish, but you must also use the SCREEN command to ensure that the text window the area for PRINT commands to use is wholly contained within the default window. See 'The text and graphics windows', later in this chapter.

- gSCROLL scrolls all or part of both black and grey planes of the current window.
- gPATT fills an area in the current window with repetitions of another window, or with a shaded pattern.

- gCOPY copies an area from another window into the current window, or from one position in the current window to another.
- gSAVEBIT saves part or all of a window as a bitmap file. If a window has a grey plane, the planes are saved as two bitmaps to the same file with the black plane saved first and the grey plane saved next. gLOADBIT, described later, can be used to load bitmap files.
- gPEEKLINE reads back a horizontal line of data from either the black or grey plane of a specified window.

## Copying grey between windows

The commands gCOPY and gPATT can use two windows and therefore special rules are needed for the cases when one window has a grey plane and the other does not.

With "gGREY 0" in the destination window, only the black plane of the source is copied.

With "gGREY 1" in the destination window, only the grey plane of the source is copied, unless the source has only one plane in which case that plane is used as the source.

With "gGREY 2" in the destination window, if the source has both planes, they are copied to the appropriate planes in the destination window (black to black, grey to grey); if the source has only one plane, it is copied to both planes of the destination.

## Advanced graphics

This section should provide a taste of some of the more exotic things you can do with OPL graphics.

### Bitmaps

A bitmap is an area in memory which acts just like an off-screen window, except that it does not have two planes so that gGREY cannot be used. You can create bitmaps with gCREATEBIT. They have the following uses:

- You can manipulate an image in a bitmap before copying it with gPATT or gCOPY to a window on the screen. This is generally faster than manipulating an image in a hidden window.
- You can load bitmap files into bitmaps in memory using gLOADBIT, then copy them to on-screen windows using gCOPY or gPATT. (If a black and grey window was saved to file as two bitmaps using gSAVEBIT, you must load them separately into two bitmaps in memory, and copy them one at a time to the respective planes of a window.)

OPL treats a bitmap as the equivalent of a window in most cases:

- Both are identified by ID numbers. Only one window or bitmap is current at any one time, set by gUSE.
- If you use bitmaps as well as windows, the total number must be eight or fewer.
- The top left corner of the current bitmap is still referred to as 0,0, even though it is not on the screen at all.

Together, windows and bitmaps are known as drawables places you can draw to.

Most graphics keywords can be used with bitmaps in the same way as with windows, but remember that a bitmap corresponds to only one plane in a window. Once you have drawn to it, you might copy it to the appropriate plane of a window.

The keywords that can be used with bitmaps include: gUSE, gBORDER, gCLOSE, gCLS, gCOPY, gGMODE, gFONT, gIDENTITY, gPATT, gPEEKLINE, gSAVEBIT, gSCROLL, gTMODE, gWIDTH, gHEIGHT and gINFO. These keywords are described earlier in this chapter.

## Speed improvements

The Series 3a screen is usually updated whenever you display anything on it. gUPDATE OFF switches off this feature. The screen will be updated as few times as possible, although you can force an update by using the gUPDATE command on its own. (An update is also forced by GET, KEY and by all graphics keywords which return a value, other than gX, gY, gWIDTH and gHEIGHT).

This can result in a considerable speed improvement in some cases. You might, for example, use "gUPDATE OFF", then a sequence of graphics commands, followed by "gUPDATE". You should certainly use gUPDATE OFF if you are about to write exclusively to bitmaps.

gUPDATE ON returns to normal screen updating.

As mentioned previously, a window with both black and grey planes takes longer to move or scroll than a window with only a black plane. So avoid creating windows with unnecessary grey planes.

Also, remember that scrolling and moving windows require every pixel in a window to be redrawn.

The gPOLY command draws a sequence of lines, as if by gLINEBY and gMOVE commands. If you have to draw a lot of lines (or dots, with "gLINEBY 0,0"), gPOLY can greatly reduce the time taken to do so.

## Displaying a running clock

gCLOCK displays or removes a running clock showing the system time. The clock can be digital or conventional, and can use many different formats.

## User-defined fonts and cursors

If you have a user-defined font you can load it into memory with gLOADFONT. This returns an ID for the font; use this with gFONT to make the font current. The gUNLOADFONT command removes a user-defined font from memory when you have finished using it.

You can use four extra arguments with the CURSOR command. Three of these specify the ascent, width and height of the cursor. The ascent is the number of pixels (-128 to 127) by which the top of the cursor should be above the baseline of the current font. The height and width arguments should both be between 0 and 255. For example, "CURSOR 1,12,4,14" sets a cursor 4 pixels wide by 14 high in the default window (ID=1), with the cursor top at 12 pixels above the font baseline.

If you do not use these arguments, the cursor is 2 pixels wide, and has the same height and ascent as the current font.

By default the cursor has square corners, is black and is flashing. Supply the fifth argument as 1 for a rounded cursor, 2 for non-flashing or 4 for grey. You can add these together eg use 5 for a grey, rounded cursor.

Note that the gINFO command returns information about the cursor and font.

## The text and graphics windows

PRINT displays mono-spaced text in the text window. You can change the text window font (ie that used by PRINT) using the FONT keyword. You can use any of those listed earlier in the chapter in the description of gFONT; initially font 4 is used.

The text window is in fact part of the default graphics window. If you have other graphics windows in front of the default window, they may therefore hide any text you display with PRINT.

Initially the text window is very slightly smaller than the default graphics window which is full-screen size. They are not the same because the text window height and width always fits a whole number of characters of the current text window font. If you use the FONT command to change the font of the text window, this first sets the default graphics window to the maximum size that will fit in the screen (excluding any status window) and then resizes the text window to be as large as possible inside it.

You can also use the STYLE keyword to set the style for all characters subsequently written to the text window. This allows the mixing of different styles in the text window. You can only use those styles which do not change the size of the characters ie inverse video and underline. (Any other styles will be ignored.) Use the same values as listed for gSTYLE, earlier in the chapter.

To find out exactly where the text window is positioned, use "SCREENINFO info%()". This sets "info%(1)/info%(2)" to the number of pixels from the left/top of the default window to the left/top of the text window. (These are called the margins.) "info%(7)" and "info%(8)" are the text window's character width and height respectively.

☛ The margins are fully determined by the font being used and therefore change from their initial value only when FONT is used. You cannot choose your own margins. gSETWIN and SCREEN do not change the margins, so you can use FONT to select a font (also clearing the screen), followed by SCREENINFO to find out the size of the margins with that font, and finally gSETWIN and SCREEN to change the sizes and positions of the default window and text window taking the margins into account (see example below). The margins will be the same after calling gSETWIN and SCREEN as they were after FONT.

It is not generally recommended to use both the text and graphics windows. Graphics commands provide much finer control over the screen display than is possible in the text window, so it is not easy to mix the two.

If you do need to use the text window, for example to use keywords like EDIT, it's easy to use SCREEN to place it out of the way of your graphics windows. You can, however, use it on top of a graphics window for example, you might want to use EDIT to simulate an edit box in the graphics window. Use gSETWIN to change the default window to about the size and position of the desired edit box. The text window moves with it you must then make it the same size, or slightly smaller, with the SCREEN command. Use 1,1 as the last two arguments to SCREEN, to keep its top left corner fixed. "gORDER 1,1" will then bring the default window to the front, and with it the text window. EDIT can then be used.

Here is an example program which uses this technique moving an `edit box', hiding it while you edit, then finally letting you move it around.

```

PROC gsetw1:
LOCAL a$(100),w%,h%,g$(1),factor%,info%(10)
LOCAL margx%,margy%,chrw%,chrh%,defw%,defh%
SCREENINFO info%() REM get text window information
margx%=info%(1) :margy%=info%(2)
chrw%=info%(7) :chrh%=info%(8)
defw%=23*chrw%+2*margx% REM new default window width
defh%=chrh%+2*margy% REM ... and height
w%=gWIDTH :h%=gHEIGHT
gSETWIN w%/4+margx%,h%/4+margy%,defw%,defh%
SCREEN 23,1,1,1 REM text window
PRINT "Text win:":GET
gCREATE(w%*.1,h%*.1,w%*.8,h%*.8,1) REM new window
gPATT -1,gWIDTH,gHEIGHT,0 REM shade it
gAT 2,h%*.7 :gTMODE 4
gPRINT "Graphics window 2"
gORDER 1,0 REM back to default+text window
EDIT a$ REM you can see this edit
gORDER 1,9 REM to background
CLS
a$=""
PRINT "Hidden:":
GIPRINT "Edit in hidden edit box"
EDIT a$ REM YOU CAN'T SEE THIS EDIT
GIPRINT ""
gORDER 1,0 :GET REM now here it is
gUSE 1 REM graphics go to default window
DO REM move default/text window around
CLS

```

```
PRINT "U,D,L,R,Quit";
g$=UPPER$(GET$)
IF kmod=2 REM Shift key moves quickly
  factor%=10
ELSE
  factor%=1
ENDIF
IF g$="U"
  gSETWIN gORIGINX,gORIGINY-factor%
ELSEIF g$="D"
  gSETWIN gORIGINX,gORIGINY+factor%
ELSEIF g$="L"
  gSETWIN gORIGINX-factor%,gORIGINY
ELSEIF g$="R"
  gSETWIN gORIGINX+factor%,gORIGINY
ENDIF
UNTIL g$="Q" OR g$=CHR$(27)
ENDP
```

---

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# Friendlier interaction

Everyday OPL programs can use the same graphical interface seen throughout the Series 3a:

- Menus offer lists of options for you to choose from. You can also select these options with hot-keys like Psion-A, Psion-B etc.
- Dialogs let a program ask for all kinds of information numbers, filenames, dates and times etc in one go.
- The status window, and screen messages such as 'Busy' are also available.

Menu keywords begin with an "M", and dialog keywords with a "D". In this manual a lower case is used for these letters for example, "mINIT" and "dEDIT" but you can type them using upper or lower case letters.

---

## Menus

Menus provide a simple way for any reasonably complex OPL program to let you choose from its various options.

To display menus in OPL takes three steps:

- Use the mINIT command. This prepares OPL for new menus.
- Use the mCARD command to define each menu.
- Use the MENU function to display the menus.

You use the displayed menus like any others on the Series 3a. Use the arrow keys to move around the menus. Press Enter (or an option's hot-key) to select an option, or press Esc to cancel the menus without making a choice. In either case, the menus are removed, the screen redrawn as it was, and MENU returns a value to indicate the selection made.

## Defining the menus

The first argument to mCARD is the name of the menu. This will appear at the top of the menu; the names of all of the menus form a bar across the top of the screen.

From one to eight options on the menu may be defined, each specified by two arguments. The first is the option name, and the second the keycode for a hot-key. This specifies a key which, when pressed together with the Psion key, should select the option. (Your program must still handle hot-keys which are pressed without using the menu.) It is easiest to specify the hot-key with "%" eg "%a" gives the value for "a".

If an upper case character is used for the hot-key keycode, the Shift key must be pressed as well to select the option. If you supply a keycode for a lower case character, the option is selected only without the Shift key pressed. Both upper and lower case keycodes for the same character can be used in the same menu (or set of menus). This feature may be used to increase the total number of hot-keys available, and is also commonly used for related menu options eg. "%z" might be used for zooming to a larger font and "%Z" for zooming to a smaller font (as in the built-in applications).

For example, `mCARD "Comms","Setup",%s,"Transfer",%t"` defines a menu with the title "Comms". When you move to this menu using " LEFT RIGHT ", you'll see it has the two options "Setup" and "Transfer", with hot-keys Psion-S and Psion-T respectively (and no Shift key required). On the other hand,

```
"mCARD "Comms","Setup",%S,"Transfer",%T"
```

would give these options the hot-keys Shift-Psion-S and Shift-Psion-T.

The options on a large menu may be divided into logical groups (as seen in many of the menus for the built-in applications) by displaying a grey line under the final option in a group. To do this, you must pass the negative value corresponding to the hot-key keycode for the final option in the group. For example, "-%A" specifies hot-key Shift-Psion-A and displays a grey line under the associated option in the menu.

Each subsequent mCARD defines the next menu to the right. A large OPL application might use mCARD like this:

```
mCARD "File", "New", %n, "Open", %o, "Save", %s  
mCARD "Edit", "Copy", %c, "Insert", -%i, "Eval", %e  
mCARD "Search", "First", %f, "Next", %g, "Previous", %p
```

## Displaying the menus

The MENU function displays the menus defined by mINIT and mCARD, and waits for you to select an option. It returns the hot-key keycode of the option selected, in the case supplied by you, whether you used Enter or the hot-key itself to select it. If you supplied a negative hot-key keycode for an underlined option, it is converted to its positive equivalent.

If you cancel the menus by pressing Esc, MENU returns 0.

When a set of menus is displayed, the cursor is positioned to the menu and option that the user selected previously (or, if no menus have previously been displayed, to the first option in the first menu).

This works only if your program has only one set of menus. If you have another set of menus, the cursor is still set to the position of the menu and option selected in the first set of menus (if that position exists in the new menus). To get around this, use "m%=menu(init%)" and set "init%" to zero the first time a set of menus is displayed. The cursor will in this case be positioned to the first option in the first menu. "init%" is set to a value which specifies the menu and option selected, and should be passed to MENU the next time that same set of menus is called. If your program has more than one set of menus, you should have a different "init%" variable for each set of menus.

## Problems with menus

When choosing hot-keys, do not use those such as the number keys which produce different characters when used with the Psion key. Unless you have a good reason not to, stick with "a" to "z" and "A" to "Z".

You must ensure that you do not use the same hot-key twice when defining the menus, as OPL does not check for this.

Each menu definition uses some memory, so 'No system memory' errors are possible.

Don't forget to use mINIT before you begin defining the menus.

If the menu titles defined by mCARD are too wide in total to fit on the screen, MENU will raise an error.

## A menu example

This procedure allows you to press the Menu key and see a menu. You might instead be typing a number or some text into the program, or moving around in some way with the arrow keys, and this procedure returns any such keypresses. You could use this procedure instead of a simple GET whenever you want to allow a menu to be shown, and its hot-keys to work.

Each option in the menus has a corresponding procedure named "proc" plus the hot-key letter so for example, the option with hot-key Psion-N is handled by the procedure "procn".

This procedure uses the technique of calling procedures by strings, as described in the 'Advanced Topics' chapter.

```
PROC kget%:  
LOCAL k%,h$(9),a$(5)  
h$="nosciefgd" REM our hot-keys
```

```

WHILE 1
  k%=GET
  IF k%=$122    REM Menu key?
    mINIT
    mCARD "File", "New", %n, "Open", %o, "Save", %s
    mCARD "Edit", "Copy", %c, "Insert", -%i, "Eval", %e
    mCARD "Search", "First", %f, "Next", %g, "Previous", %d
    k%=MENU
    IF k% AND (LOC(h$, CHR$(k%)) <> 0)    REM MENU CHECK
      a$="proc"+CHR$(k%)
      "@"(a$): REM procn:, proco:, ...
    ENDIF                                REM END OF MENU CHECK
  ELSEIF k% AND $200    REM hot-key pressed directly?
    k%=k%-$200        REM remove Psion key code
    IF LOC(h$, CHR$(k%))    REM DIRECT HOT-KEY CHECK
      a$="proc"+CHR$(k%)
      "@"(a$): REM procn:, proco:, ...
    ENDIF                                REM END OF DIRECT HOT-KEY CHECK
  ELSE REM some other key
    RETURN k%
  ENDIF
ENDWH
ENDP

PROC procn:
...
ENDP

PROC proco:
...
ENDP

```

...

Note: this procedure allows you to press a hot-key with or without the Shift key. So Shift-Psion-N would be treated the same as Psion-N.

Neither LOC nor the "@" operator (for calling procedures by strings) differentiate between upper and lower case. If you have Shifted hot-keys you will need to compare against two sets of hot-key lists. For example, with hot-keys "%A", "%C", "%a" and "%d", you would have upper/lowercase hot-key lists like "hu\$="AC"" and "hl\$="ad"", and the "MENU CHECK" section becomes:

```

IF k%<=%Z    REM if upper case hot-key
  IF LOC(hu$, CHR$(k%))
    a$="procu"+CHR$(k%)
    "@"(a$): REM procua:, procuc:, ...
  ENDIF
ELSE        REM else lower case hot-key
  IF LOC(hl$, CHR$(k%))
    a$="procl"+CHR$(k%)
    "@"(a$): REM procla:, procl:, ...
  ENDIF
ENDIF

```

(This calls procedures "procua:", "procuc:", "procla:" and "procl:"). If a hot-key was pressed directly you cannot tell from "k%" whether Shift was used; so make the same change to the "DIRECT HOT-KEY CHECK" section, but use "IF KMOD AND 2" instead of "IF k%<=%Z".

## Dialogs

In OPL, dialogs are constructed in a similar way to menus:

- Use the dINIT command to prepare OPL for a new dialog. If you give a string argument to dINIT it will be displayed as a title for the dialog, separated from the rest of the dialog by a horizontal line.

- Define each line of the dialog, from top to bottom. There are separate commands for each type of item you can use in a dialog for example, dEDIT for editing a string, dDATE for typing in a date, and so on.
- Use the DIALOG function to display the dialog. In general it returns a number indicating the line you were on when you pressed Enter (counting any title line as line 1), or 0 if you pressed Esc.

Use " UP DOWN " to move from line to line, and enter the relevant information, as in any other Series 3a dialog. You can even press Tab to produce vertical lists of options.

Each of the commands like dEDIT and dDATE specifies a variable to take the information you type in. If you press Enter to complete the dialog, the information is saved in those variables. The dialog is then removed, and the screen redrawn as it was.

You can press Esc to abandon the dialog without making any changes to the variables.

If you enter information which is not valid for the particular line of the dialog, you will be asked to re-enter different information.

Here is simple example. It assumes a global variable "name\$" exists:

```
PROC getname:
  dINIT "Who are you?"
  dEDIT name$, "Name:"
  DIALOG
ENDP
```

This procedure displays a dialog with "Who are you?" as its top-line title, and an edit box for typing in your name. If you end by pressing Enter, the name you have typed will be saved in "name\$"; if you press Esc, "name\$" is not changed.

When the dialog is first displayed, the existing contents of "name\$" are used as the string to edit.

Note that the dialog is automatically created with a width suitable for the item(s) you defined, and is centred in the screen.

## Lines you can use in dialogs

This section describes the various commands that can define a line of a dialog. In all cases:

- "prompt\$" is the string which will appear on the left side of the line.
- "var" denotes an argument which must be a LOCAL or GLOBAL variable, because it takes the value you enter. Single elements of arrays may also be used, but not field variables or procedure parameters. ("var" is just to show you where you must use a suitable variable you don't actually type "var".)

Where appropriate, this variable provides the initial value shown in the dialog.

Although examples are given using each group of commands, you can mix commands of any type to make up your dialog.

**More details of the commands may be found in the alphabetic listing.**

### Strings, secret strings and filenames

dEDIT var str\$,prompt\$,len%  
defines a string edit box.

**len%** is an optional argument. If supplied, it gives the width of the edit box (allowing for the widest possible character in the font). The string will scroll inside the edit box, if necessary. If "len%" is not supplied, the edit box is made wide enough for the maximum width "str\$" could be. (You may wish to set a suitably small "len%" to stop some dialogs being drawn all the way across the screen)

**dXINPUT var str\$,prompt\$**

defines a secret string edit box, such as for a password. A special symbol will be displayed for each character you type, to preserve the secrecy of the string.

**dFILE var str\$,prompt\$,f%**

defines a filename edit box.

Here is an example dialog using these three commands:

```
PROC info:
  dINIT "Your personal info"
  dEDIT n$, "Name:", 15
  dXINPUT pw$, "Password:"
  dFILE f$, "Log file:", 0
  RETURN DIALOG
ENDP
```

This returns `True' if Enter was used, indicating that the GLOBAL variables "n\$", "pw\$" and "f\$" have been updated.

dFILE automatically has a `Disk' selector on the line below it. The third argument to dFILE controls the type of file editor you see, and the kind of input allowed. See the `Alphabetic listing' for more details of dFILE.

## Choosing one of a list

**dCHOICE var choice%,prompt\$,list\$**

defines a choice list. "list\$" should contain the possible choices, separated by commas for example, ""Yes,No"". The "choice%" variable specifies which choice should initially be shown 1 for the first choice, 2 for the second, and so on.

For example, here is a simple "choice" dialog:

```
PROC dcheck:
  LOCAL c%
  c%=2          REM default to "Internal"
  dINIT "Disk Check"
  dCHOICE c%, "Disk:", "A, Internal, B"
  IF DIALOG    REM returns 0 if cancelled
    ... REM disk-check code
  ENDIF
ENDP
```

## Numbers, dates and times

**dLONG var long&,prompt\$,min&,max&**  
and

**dFLOAT var fp,prompt\$,min,max**

define edit boxes for long integers and floating-point numbers respectively. Use dFLOAT to allow fractions, and dLONG to disallow them. "min(&)" and "max(&)" give the minimum and maximum values which are to be allowed. There is no separate command for ordinary integers use dLONG with suitable "min&" and "max&" values.

**dDATE var long&,prompt\$,min&,max&**  
and

**dTIME var long&,prompt\$,type%,min&,max&**

define edit boxes for dates and times. "min&" and "max&" give the minimum and maximum values which are to be allowed.

For dDATE, "long&", "min&" and "max&" are specified in "days since 1/1/1900". The DAYS function is useful for converting to "days since 1/1/1900".

For dTIME, "long&", "min&" and "max&" are in "seconds since 00:00". The DATETOSECS and SECSTODATE functions are useful for converting to and from "seconds since midnight" (they actually use "seconds since 00:00 on 1/1/1970").

dTIME also has a "type%" argument. This specifies the type of display required:

"type%"	time display
0	absolute time without seconds
1	absolute time with seconds
2	duration without seconds
3	duration with seconds

For example, "03:45" is an absolute time while 3 hours 45 minutes is a duration.

This procedure creates a dialog, using these commands:

```
PROC delivery:
LOCAL d&,t&,num&,wt
d&=DAYS(DAY,MONTH,YEAR)
DO
    t&=secs&:
UNTIL t&=secs&:
num&=1 :wt=10
dINIT "Delivery"
dLONG num&,"Boxes",1,1000
dFLOAT wt,"Weight (kg)",0,10000
dDATE d&,"Date",d&,DAYS(31,12,1999)
dTIME t&,"Time",0,0,DATETOSECS(1970,1,1,23,59,59)
IF DIALOG    REM returns 0 if cancelled
    ...    REM rest of code
ENDIF
ENDP

PROC secs&:
RETURN HOUR*INT(3600)+MINUTE*60
ENDP
```

The **secs&:** procedure uses the HOUR and MINUTE functions, which return the time as kept by the Series 3a. It is called twice to guard against an incorrect result, in the (albeit rare) case where the time ticks past the hour between calling HOUR and calling MINUTE.

The INT function is used in **secs&:** to force OPL to use long integer arithmetic, avoiding the danger of an 'Integer overflow' error.

**d&** and **t&** are set up to give the current date and time when the dialog is first displayed. The value in "d&" is also used as the minimum value for dDATE, so that in this example you cannot set a date before the current date.

DATETOSECS is used to give the number of seconds representing the time 23:59. The first three arguments, "1970", "1" and "1", represent the first day from which DATETOSECS begins calculating.

## Results from dDATE

dDATE returns a value as a number of days. To convert this to a date:

- If you are dealing only with days on or after 1/1/1970, you can subtract 25567 ("DAYS(1,1,1970)"), multiply by 86400 (the number of seconds in a day), and use SECSTODATE.
- To handle days before 1/1/1970 as well, you can call the Operating System to perform the conversion. This procedure is passed one parameter, the number of days, and from it sets four global variables "day%", "month%", "year%" and "yrdy%". It calls the Operating System with the OS function:

```
PROC daytodat: (days&)
```

```

LOCAL dyscent&(2),dateent%(4)
LOCAL flags%,ax%,bx%,cx%,dx%,si%,di%
dyscent&(1)=days&
si%=ADDR(dyscent&()) :di%=ADDR(dateent%())
ax%=$0600 REM TimDaySecondsToDate fn.
flags%=OS($89,ADDR(ax%)) REM TimManager int.
IF flags% AND 1
  RAISE (ax% OR $ff00)
ELSE
  year%=PEEKB(di%)+1900 :month%=PEEKB(UADD(di%,1))+1
  day%=PEEKB(UADD(di%,2))+1 :yrdy%=PEEKW(UADD(di%,6))+1
ENDIF
ENDP

```

If you do use this procedure, be careful to type it exactly as shown here.

## Displaying text

dTEXT prompt\$,body\$,type%

defines "prompt\$" to be displayed on the left side of the line, and "body\$" on the right. There is no variable associated with dTEXT. If you use a null string ("") for "prompt\$", "body\$" is displayed across the whole width of the dialog.

"type%" is an optional argument. If specified, it controls the alignment of "body\$":

"type%"	effect
0	left align "body\$"
1	right align "body\$"
2	centre "body\$"

In addition, you can add any or all of the following three values to "type%", for these effects:

"type%"	effect
\$100	use bold text for "body\$".
\$200	draw a line below this item.
\$400	make this line selectable. (It will also be bulleted if "prompt\$" is not ".")

dTEXT is not just for displaying information. Since DIALOG returns a number indicating the line you were on when you pressed Enter (or 0 if you pressed Esc), you can use dTEXT to offer a choice of options, rather like a menu:

```

PROC select:
  dINIT "Select action"
  dTEXT "", "Add", $402
  dTEXT "", "Copy", $402
  dTEXT "", "Review", $402
  dTEXT "", "Delete", $402
  RETURN DIALOG
ENDP

```

In each case "type%" is \$402 (\$400+2). The "\$400" makes each text string selectable, allowing you to move the cursor onto it, while "2" makes each string centred.

## Displaying exit keys

Most dialogs are completed by pressing Enter to confirm the information typed, or Esc to cancel the dialog. These keys are not usually displayed as part of the dialog.

However, some Series 3a dialogs offer you a simple choice, by showing pictures of the keys you can press. A simple "Are you sure?" dialog might, for example, show the two keys `Y' and `N', and indicate the one you press.

If you want to display a message and offer Enter, Esc and/or Space as the exit keys, you can display the entire dialog with the ALERT function.

If you want to use other keys, such as "Y" and "N", or display the keys below other dialog items such as dEDIT, create the dialog as normal and use the dBUTTONS command to define the keys.

ALERT and dBUTTONS are explained in detail in the alphabetic listing.

---

## Other dialog information

### Positioning dialogs

If a dialog overwrites important information on the screen, you can position it with the dPOSITION command. Use dPOSITION at any time between dINIT and DIALOG.

dPOSITION uses two integer values. The first specifies the horizontal position, and the second, the vertical. "dPOSITION -1,-1" positions to the top left of the screen; "dPOSITION 1,1" to the bottom right; "dPOSITION 0,0" to the centre, the usual position for dialogs.

"dPOSITION 1,0", for example, positions to the right-hand edge of the screen, and centres the dialog half way up the screen.

### Restrictions on dialogs

The following general restrictions apply to all dialogs:

- Only one dialog may be in use at a time.
  - A dialog must be initialised (dINIT), defined (dEDIT etc) and displayed (DIALOG) in the same procedure.
  - A dialog may consist of up to nine lines, including any title. Filename editors count as two lines, and exit keys count as three. A 'Too many items' error is raised if this limit is exceeded.
  - If the width of any line would make the dialog too wide, a 'Too wide' error is raised when DIALOG is called.
- 

## Giving information

### Status window temporary and permanent

Pressing Psion-Menu when an OPL program is running will always display a temporary status window. This status window is in front of all the OPL windows, so your program can't write over it.

Use "STATUSWIN ON" or "STATUSWIN ON,type%" to display a permanent status window. It will be displayed until you use "STATUSWIN OFF". "type%" specifies the status window type. The small status window is displayed for "type%=1" and the large status window either when "type%" is not supplied or when "type%=2".

You might use "STATUSWIN ON" when Control-Menu is pressed, for consistency with the rest of the Series 3a.

The status window is displayed on the right-hand side of the screen.

### The rank of the status window

Important: The permanent status window is behind all other OPL windows. In order to see it, you must use either FONT or both SCREEN and gSETWIN, to reduce the size of the text window and the default graphics window. You should ensure that your program does not create windows over the top of it.

FONT automatically resizes these windows to the maximum size excluding any status window. It should be called after creating the status window because the new size of the text and graphics windows depends on the size of the status

window. Note that "FONT -\$3fff,0" leaves the current font and style it just changes the window sizes and clears them.

If you use SCREEN and gSETWIN instead of FONT, you should use the STATWININFO keyword (described next) to find out the size of the status window.

## Finding the position and size of a status window

```
curtype%=STATWININFO(type%,extent%())
```

sets the four element array extent%() as follows:

```
extent%(1) = pixels from left of screen to status window
```

```
extent%(2) = pixels from top of screen to status window
```

```
extent%(3) = status window width in pixels
```

```
extent%(4) = status window height in pixels for status window type%
```

"type%=3" specifies the compatibility mode status window and "type%=-1" specifies whichever type of status window is currently shown. Otherwise, use the same values of "type%" as for STATUSWIN.

STATWININFO returns the type of the current status window. The values are as for "type%", or zero if there is no current status window.

☛ If type%=-1 for the current status window and there is none, STATWININFO returns consistent information in "extent%()" corresponding to a status window of width zero and full screen height positioned one pixel to the right of the physical screen.

So to set a graphics window to have height "h%" and to use the full screen width up to the current status window (if any), but leaving a one pixel gap between the graphics window and the status window, you could use:

```
"STATWININFO(-1,extent%()) :gSETWIN 0,0,extent%(1),h%"
```

Alternatively you could simply use "FONT -\$3fff,0" as described under STATUSWIN above, which also sets the height to full screen height and sets the text window size to fit inside it.

## What the status window does

The status window always displays the OPL program name, a clock and, by default, an icon. This will be the default OPL icon, unless your program is an OPA with its own icon. (OPAs are described in the 'Advanced topics' chapter.) In addition, the settings selected in the 'Status window' menu option of the System screen are automatically used in OPL status windows. The status window will therefore also display all the indicators required, and a digital or analog clock as selected there.

The status window is inaccessible to, and does not affect, the OPL keywords gORDER and gRANK.

You can set or change the name displayed in the status window with SETNAME for example, "SETNAME "ABCD"" or "SETNAME a\$".

## Using a ♦ list in the status window

Your program may have several distinct modes/views/screens between which you would like the ♦ key to switch. The built-in applications use the ♦ key extensively Agenda uses it to switch to the different views, while Word switches between 'Normal' and 'Outline' view.

The ♦ list the list of modes/views/screens which the ♦ key goes between is displayed in the status window.

OPL programs can set up a ♦ list. Use

```
"DIAMINIT pos%,str1$,str2$,..."
```

to initialise the list (discarding any existing list). The list can be initialised before or after a status window is displayed.

"str1\$", "str2\$" etc. contain the text to be displayed in the status window for each item in the list.

"pos%" is the initial item on to which the ♦ indicator should be positioned, with "pos%=1" specifying the first item. (Any value greater than the number of strings specifies the final item.)

If "pos%=0", or if DIAMINIT is used on its own with no arguments, no bar is defined.

If "pos%=-1" the list is replaced by the icon instead in the large status window.

If "pos%>=1" you must supply at least this many strings.

Defining a list uses some memory, so 'No system memory' errors are possible.

"DIAMPOS pos%" positions the ◆ indicator in a list. You might move the indicator to the next item when the ◆ key is pressed and to the previous item when Shift-◆ is pressed. The ◆ key has keycode value 292 and KMOD returns 2 when the Shift key is pressed.

Positioning outside the range of the items wraps around in the appropriate way if there are three items in the list, "DIAMPOS 4" positions to the first.

"DIAMPOS 0" causes the ◆ symbol to disappear.

Use "chr\$(4)" to display a ◆ key in a menu. If you use it as a hot-key, a Shift will be added automatically.

## Information messages

GIPRINT displays an information message for 2 seconds, in the bottom right corner of the screen. For example, "GIPRINT "Not Found"" displays "Not Found". The string you specify can be up to 63 characters. If a string is too long for the screen, it will be clipped.

You can add an integer argument to control the corner in which the message appears:

value	corner
0	top left
1	bottom left
2	top right
3	bottom right

For example, "GIPRINT "Who?",0" prints "Who?" in the top left corner.

Only one message can be shown at a time. You can make the message go away for example, if a key has been pressed with "GIPRINT """.

## 'Busy' messages

Messages which say a program is temporarily busy, or cannot respond for some reason, are by convention shown in the bottom left corner. The BUSY command lets you display your own messages of this sort. Use "BUSY OFF" to remove it.

"BUSY "Paused..."", for example, displays ""Paused..."" in the bottom left corner. This remains shown until "BUSY OFF" is used.

You can control the corner used in the same way as for GIPRINT. You can also add a third argument, to specify a delay time (in half seconds) before the message should be shown. Use this to prevent 'busy' messages from continually appearing very briefly on the screen.

For example, "BUSY "Wait:",1,4" will display "Wait:" in the bottom left corner after a delay of 2 seconds. As soon as your program becomes responsive to the keyboard, it should use "BUSY OFF". If this occurs within two seconds of the original BUSY, no message is seen.

Only one message can be shown at a time. The string to display can be up to 19 characters long.

---

# OPL and Solid State Disks

## Types of Solid State Disk

Solid State Disks (SSDs) are explained in detail in the User guide. There are two main reasons for using them:

- To provide more room for storing information.
- To make backup copies of important information, in case you accidentally change or delete it (or even lose your Series 3a).

There are two types Ram SSDs and Flash SSDs. They fit into the SSD drives marked "A" and "B", at either side of the Series 3a.

- Flash SSDs are for storing or backing up information which is infrequently changed. This includes finished OPL programs.
- Ram SSDs are for storing or backing up information which changes frequently. This includes OPL programs you are still writing or testing.

You can, though, save programs and data files to either kind of SSD, as you see fit.

## How to put programs on an SSD

To create a new OPL module on an SSD, use the 'New file' option in the System screen as before, but set the "Disk" line of the dialog to "A" or "B" as required.

To copy an OPL module onto an SSD, move onto the module name where it is listed under the Program icon, and use the 'Copy file' option on the 'File' menu. Set the 'To file: Disk' line to "A" or "B". If you want this copy to have a different name to the original, type the name to use, on the 'To file: Name' line. The new copy will appear in the list under the Program icon, but with "[A]" or "[B]" after its name.

To copy the translated version of an OPL module, move onto the name in the list under the RunOpl icon (to the right of the Program icon), then proceed as before.

## SSDs from inside OPL

Your OPL programs can create or use data files on SSDs. To do so, begin the name of the data file with "A:" or "B:" for example:

```
CREATE "B:JKQ",A,X1$,X2$
```

tries to create a data file "JKQ" on an SSD in "B", while

```
DELETE "A:X300"
```

tries to delete a data file "X300" on an SSD in "A".

Don't confuse the drive names "A" and "B" with the logical names "A", "B", "C" and "D". Logical names are unaffected by which drive a data file is on.

The internal memory can be referred to as "M:", if required. For example:

```
PROC delx300:
  LOCAL a$(3),c%
  a$="MAB" :c%=1 REM default to "Internal"
  dINIT "Delete X300 data file"
  dCHOICE c%,"Disk:","Internal,A,B"
```

```
IF DIALOG REM returns 0 if cancelled
  DELETE MID$(A$,c%,1)+":X300"
ENDIF
ENDP
```

In this example, "MID\$(A\$,c%,1)" gives ""M"", ""A"" or ""B"", according to the choice made in the dialog. This is added on the front of "":X300"" to give the name of the file to delete ""M:X300"", ""A:X300"" or ""B:X300"".

When using data files with SSDs, follow the same guidelines as with OPL programs Flash SSDs are for one-off or "finished" information, while Ram SSDs are for information which is still being changed.

## **Directories and DOS structure**

The internal memory and SSDs use a DOS-compatible directory structure, the same as that used by disks on business PCs. For more details, see the 'Advanced Topics' chapter.

---

# Example programs

This chapter contains example programs written in OPL. The programs are not intended to demonstrate all the features of OPL, but they should give you a few hints. To find out more about a particular command or function, refer to the alphabetic listing.

There are some other example programs in the 'Advanced topics' chapter.

## When you're typing in

- You can type procedures in all uppercase, all lowercase or any mixture of the two. Be careful with character codes, though "%A" is different to "%a".
- When there is more than one command or function on a line, separate each one with a space and colon for example:

```
CLS :PRINT "hello" :GET
```

However, the colon is optional before a REM statement for example:

```
CLS REM Clears the screen
```

and

```
CLS :REM Clears the screen
```

are both OK.

- Put a space between a command and the arguments which follow it for example "PRINT a\$". But don't put a space between a function and the arguments in brackets for example "CHR\$(16)".
- It doesn't matter how many spaces or tabs you have at the beginning of a line.

## Errors

The following programs do not include full error handling code. This means that they are shorter and easier to understand, but may fail if, for example, you enter the wrong type of input to a variable.

If you want to develop other programs from these example programs, it is recommended that you add some error handling code to them. See the chapter on error handling for further details.

---

## Countdown Timer

```
PROC timer:
LOCAL min&,sec&,secs&,i%
CACHE 2000,2000
sec&=1
dINIT "Countdown timer"
dLONG min&,"Minutes",0,59
dLONG sec&,"Seconds",0,59
dBUTTONS "Cancel",-27,"Start",13
IF DIALOG=13
STATUSWIN ON
FONT 11,16
secs&=sec&+60*min&
WHILE secs&
PAUSE -20
REM a key gets us out
```

```

IF KEY
  RETURN
ENDIF
secs%=secs&-1
AT 20,6 :PRINT NUM$(secs&/60,-2); "m"
AT 24,6 :PRINT NUM$(mod&:(secs&,int(60)), -2); "s"
ENDWH
DO
  BEEP 5,300
  PAUSE 10
  IF KEY :BREAK :ENDIF
  i%=i%+1
UNTIL i%=10
ENDIF
ENDP

PROC mod&: (a&,b&)
  REM modulo function
  REM computes (a&)/mod(b&)
  RETURN a&-(a&/b&)*b&
ENDP

```

---

## Dice

When the program is run, a message is displayed saying that the dice is rolling. You then press a key to stop it. A random number from one to six is displayed and you choose whether to roll again or not.

```

PROC dice:
  LOCAL dice%
  DO
    CLS :PRINT "DICE ROLLING:"
    AT 1,3 :PRINT "Press a key to stop"
    DO
      dice%=(RND*6+1)
      AT 1,2 :PRINT dice%
    UNTIL KEY
    BEEP 5,300
    dINIT "Roll again?"
    dBUTTONS "No",%N,"Yes",%Y
    UNTIL DIALOG<>%y
  ENDP

```

**Random numbers:** in this example, the RND function returns a random floating-point number, between 0 and 0.9999999... It is then multiplied by 6, and 1 is added, to give a number from 1 to 6.9999999... This is rounded down to a whole number (from 1 to 6) by assigning to the integer "dice%".

---

## Birthdays

This procedure finds out on which day of the week people were born.

```

PROC Birthday:
  LOCAL day&,month&,year&,DayInWk%
  DO
    dINIT
    dTEXT "", "Enter your date of birth", 2
    dTEXT "", "Use numbers, eg 23 12 1963", $202
    dLONG day&, "Day", 1, 31
    dLONG month&, "Month", 1, 12
    dLONG year&, "Year", 1900, 2155
    IF DIALOG=0
      BREAK
    ENDIF
    DayInWk%=DOW(day&,month&,year&)
    CLS :PRINT DAYNAME$(DayInWk%), day&,month&,year&
  ENDP

```

```

    dINIT "Again?"
    dBUTTONS "No",%N,"Yes",%Y
UNTIL DIALOG<>%y
ENDP

```

The DOW function works out what day of the week, from 1 to 7, a date is. The DAYNAME\$ function then converts this to MON, TUE and so on. MON is 1 and SUN is 7.

---

## Data files

The following module works on a data file called "DATA", containing names, addresses, post codes and telephone numbers. It assumes this file has already been created with a statement like this:

```
CREATE "DATA",A,nm$,ad1$,ad2$,ad3$,ad4$,tel$
```

To use the "DATA" file which the Database application uses, you need to open ""\DAT\DATA.DBF"".

The first procedure is the controlling, calling procedure, offering you choices. The next two let you add or edit records.

### PROC files:

```

GLOBAL nm$(255),ad1$(255),ad2$(255)
GLOBAL ad3$(255),ad4$(255),tel$(255),title$(30)
LOCAL g%
OPEN "DATA",A,nm$,ad1$,ad2$,ad3$,ad4$,tel$
DO
  CLS
  dINIT "Select action"
  dTEXT "", "Add new record", $402
  dTEXT "", "Find and edit a record", $402
  g%=DIALOG
  IF g%=2
    add:
  ELSEIF g%=3
    edit:
  ENDIF
UNTIL g%=0
CLOSE

```

### ENDP

### PROC add:

```

nm$="" :ad1$="" :ad2$=""
ad3$="" :ad4$="" :tel$=""
title$="Enter a new record"
IF showd%:
  APPEND
ENDIF

```

### ENDP

### PROC edit:

```

LOCAL search$(30),p%
dINIT "Find and edit a record"
dEDIT search$,"Search string",15
IF DIALOG
  FIRST
  IF FIND("*"+search$+"*")=0
    ALERT("No matching records")
    RETURN
  ENDIF
  DO
    nm$=A.nm$ :ad1$=A.ad1$ :ad2$=A.ad2$
    ad3$=A.ad3$ :ad4$=A.ad4$ :tel$=A.tel$
    title$="Edit matching record"
    IF showd%:
      UPDATE :BREAK
    ELSE
      NEXT
    ENDIF
  DO

```

```

        FIND(""+search$+"")
        IF EOF
            ALERT("No more matching records")
            BREAK
        ENDIF
    UNTIL 0
ENDIF
ENDP

```

**PROC showd%:**

```

LOCAL ret%
dINIT title$
dEDIT nm$, "Name", 25
dEDIT ad1$, "Street", 25
dEDIT ad2$, "Town", 25
dEDIT ad3$, "County", 25
dEDIT ad4$, "Postcode", 25
dEDIT tel$, "Phone", 25
ret%=DIALOG
IF ret%
    A.nm$=nm$ :A.ad1$=ad1$ :A.ad2$=ad2$
    A.ad3$=ad3$ :A.ad4$=ad4$ :A.tel$=tel$
ENDIF
RETURN ret%
ENDP

```

---

## Re-order

When you use the Database application and enter or change an entry, it goes to the end of the database file. However, if, in your address book, each entry begins with a person's second name for example, "Tate, Hazel" you can use this program to re-order all of the entries. This doesn't change the way you find an entry, but after running it you can step through it like a paper address book, or print it out neatly ordered.

This procedure can be used as required for any data file in internal memory or on Ram SSDs. If used on a data file held on a Flash SSD it would use up disk space each time you run it. The dialog it shows is set to show data files used by the Database.

You can adapt this procedure to sort other types of data files in other ways.

**PROC reorder:**

```

LOCAL last%, e$(255), e%, lpos%, n$(128), c%
n$="\dat\*.dbf"
dINIT "Re-order Data file"
dFILE n$, "Filename", 0
IF DIALOG REM returns 0 if cancelled
    OPEN n$, a, a$
    LAST :last%=POS
    IF COUNT>0
        WHILE last%<>0
            POSITION last% :e%=POS
            e$=UPPER$(a.a$)
            DO
                IF UPPER$(a.a$) < e$
                    e$=UPPER$(a.a$) :e%=POS
                ENDIF
                lpos%=POS :BACK
            UNTIL pos=1 and lpos%=1
            POSITION e%
            PRINT e$
            UPDATE :last%=last%-1
        ENDWH
    ENDIF
    CLOSE
ENDIF
ENDP

```

If you try to reorder a file which is already open (ie shown in bold on the System screen) you will see a 'File or device in use' error. Move the highlight onto the file's name in the System screen, use the Delete key to exit the file, then try again.

---

## Stopwatch

Here is a simple stopwatch with lap times. Note that the Series 3a switches off automatically after a time if no keys are pressed; you may want to disable this feature (with the 'Auto switch off' option in the System screen) before running this program.

Each timing is only accurate to within one second, as the procedure is based on the SECOND function.

```
PROC watch:
LOCAL k%,s%,se%,mi%
FONT 11,16
AT 20,1 :PRINT "Stopwatch"
AT 15,11 :PRINT "Press a key to start"
GET
DO
CLS :mi%=0:se%=0:s%=SECOND
AT 15,11 :PRINT "   S=Stop, L=Lap   "
loop::
k%=KEY AND $ffdf REM ensures upper case
IF k%=%S
  GOTO pause::
ENDIF
IF k%=%L
  AT 20,6 :PRINT "Lap: ";mi%;":";
  IF se%<10 :PRINT "0"; :ENDIF
  PRINT se%;" ";
ENDIF
IF SECOND<>s%
  s%=SECOND :se%=se%+1
  IF se%=60 :se%=0:mi%=mi%+1 :ENDIF
  AT 17,8
  PRINT "Mins",mi%,"Secs",
  IF se%<10 :PRINT "0"; :ENDIF
  PRINT se%;" ";
ENDIF
GOTO loop::
pause::
mINIT
mCARD "Watch","Restart",%r,"Zero",%z,"Exit",%x
k%=MENU
IF k%=%r
  GOTO loop::
ENDIF
UNTIL k%<>%z
ENDP
```

---

## Inserting a new line in a database

If you insert a new label in a database, the entries will no longer match up with the labels. Rather than using the 'Update' option on every entry, to insert a suitable blank line in each one, you can use this program to do this for the entire data file.

The Database allows you to use as many lines (fields) as you want in an entry (record); OPL can only access 32 fields. This program only lets you insert a new field in the first 16 fields, although you can adapt the program simply to check up to 31 fields.

If, in the Database, you enter a line longer than 255 characters, it is stored as two fields, with a character of code 20 at the start of the second field. This program correctly handles any such fields.

The program checks that the 17th field is blank, as it will be overwritten by what was the 16th field. If a long entry has a 17th field, and it contains text, the program skips this entry. The rest of longer entries even if there are more than 32 fields will be unchanged.

If you insert a new field at a position below the last label, the Database will not show it, even when using 'Update'.

The maximum record length in OPL is 1022 characters. The OPEN command will display a 'Record too large' error if the file contains a record longer than this.

```
PROC label:
LOCAL a%,b%,c%,d%,s$(128),s&,i$(17,255)
s$="\dat\*.dbf"
dINIT "Insert new field"
dFILE s$,"Data file",0
dLONG s&,"Break at line (1-16)",1,16
IF DIALOG
OPEN s$,A,a$,b$,c$,d$,e$,f$,g$,h$,i$,j$,k$,l$,m$,n$,o$,p$,q$
c%=COUNT :a%=1
WHILE a%<=c%
  AT 1,1 :PRINT "Entry",a%,"of",c%,
  IF A.q$="" REM Entry (hopefully) not too long
    i$(1)=A.a$ :i$(2)=A.b$ :i$(3)=A.c$ :i$(4)=A.d$
    i$(5)=A.e$ :i$(6)=A.f$ :i$(7)=A.g$ :i$(8)=A.h$
    i$(9)=A.i$ :i$(10)=A.j$ :i$(11)=A.k$ :i$(12)=A.l$
    i$(13)=A.m$ :i$(14)=A.n$ :i$(15)=A.o$ :i$(16)=A.p$
    d%=0 :b%=0
    WHILE d%255...
      b%=b%+1 REM ...so it's 2 fields
    ENDIF
  ENDWH
  b%=17
  WHILE b%>d% REM copy the fields down
    i$(b%)=i$(b%-1) :b%=b%-1
  ENDWH
  i$(d%)="" REM and make an empty field
  A.a$=i$(1) :A.b$=i$(2) :A.c$=i$(3) :A.d$=i$(4)
  A.e$=i$(5) :A.f$=i$(6) :A.g$=i$(7) :A.h$=i$(8)
  A.i$=i$(9) :A.j$=i$(10) :A.k$=i$(11) :A.l$=i$(12)
  A.m$=i$(13) :A.n$=i$(14) :A.o$=i$(15) :A.p$=i$(16)
  A.q$=i$(17)
ELSE
  PRINT "has too many fields"
  PRINT "Press a key..." :GET
ENDIF
UPDATE :FIRST
a%=a%+1
ENDWH :CLOSE
ENDIF
ENDP
```

---

## Bouncing Ball

```
PROC bounce:
LOCAL posX%,posY%,changeX%,changeY%,k%
LOCAL scrx%,scry%,info%(10)
SCREENINFO info%()
scrx%=info%(3) :scry%=info%(4)
posX%=1 :posY%=1
changeX%=1 :changeY%=1
DO
  posX%=posX%+changeX%
  posY%=posY%+changeY%
  IF posX%=1 OR posX%=scrx%
    changeX%=-changeX%
    REM at edge ball changes direction
    BEEP 2, 600 REM low beep
  ENDIF
```

```

IF posY%=1 or posY%=scry% REM same for y
  changeY%=-changeY%
  BEEP 2, 200 REM high beep
ENDIF
AT posX%,posY% :PRINT "0";
PAUSE 2 REM Try changing this
AT posX%,posY% :PRINT " ";
REM removes old `0' character
k%=KEY
UNTIL k%
ENDP

```

---

## Circles

Here are two example programs for drawing circles the first hollow, the second filled:

```

PROC circle:
LOCAL a%(963),c&,d%,x&,y&,r&,h,y%,y1%,c2%
dINIT "Draw a circle"
x&=240 :dLONG x&,"Centre x pos",0,479
y&=80 :dLONG y&,"Centre y pos",0,159
r&=20 :dLONG r&,"Radius",1,120
h=1 :dFLOAT h,"Relative height",0,999
IF DIALOG
  a%(1)=x&+r& :a%(2)=y& :a%(3)=4*r&
  c&=1 :d%=2*r& :y1%=0
  WHILE c&<=d%
    c2%=c&*2 :y%=-SQR(r&*c2%-c&**2)*h
    a%(2+c2%)=-2 :a%(3+c2%)=y%-y1%
    y1%=y% :c&=c&+1
  ENDWH
  c&=1
  WHILE c&<=d%
    c2%=c&*2 :y%=SQR(r&*c2%-c&**2)*h
    a%(2+a%(3)+c2%)=2 :a%(3+a%(3)+c2%)=y%-y1%
    y1%=y% :c&=c&+1
  ENDWH
  gPOLY a%()
ENDIF
ENDP

```

```

PROC circlef:
LOCAL c&,d%,x&,y&,r&,h,y%
dINIT "Draw a filled circle"
x&=240 :dLONG x&,"Centre x pos",0,479
y&=80 :dLONG y&,"Centre y pos",0,159
r&=20 :dLONG r&,"Radius",1,120
h=1 :dFLOAT h,"Relative height",0,999
IF DIALOG
  c&=1 :d%=2*r& :gAT x&-r&,y& :gLINEBY 0,0
  WHILE c&<=d%
    y%=-SQR(r&*c&*2-c&**2)*h
    gAT x&-r&+c&,y&-y% :gLINEBY 0,2*y%
    c&=c&+1
  ENDWH
ENDIF
ENDP

```

If you use "gUPDATE OFF" after the "IF DIALOG" line, and "gUPDATE ON" before the "ENDIF", the procedure will run a little faster. However, all but the smaller circles will be drawn rather jerkily, piece by piece.

---

## Zooming

For each of the three types of status window, this program changes the font to implement zooming.

Press Psion-Z to cycle between small, medium and large fonts, and Shift-Psion-Z to cycle in the other direction. Esc changes to the next status window.

As well as changing the font and style for the text window (for PRINT etc.), the FONT command automatically changes the default graphics window size (ID=1) and the text window size to fit exactly in the space left by any status window. (A special feature not used here is that "FONT -\$3fff,0" just changes the window sizes without changing font).

The procedure "dispinfo:" uses the command SCREENINFO to display the margin sizes in pixels between the default window and the text window, the text screen size in character units, and the text screen's character width and line height in pixels.

```
PROC tzoom:
  STATUSWIN OFF   REM no status window
  zoom:           REM display with zooming
  STATUSWIN ON,2  REM large status window
  zoom:
  STATUSWIN ON,1  REM and small
  zoom:
ENDP

PROC zoom:
  LOCAL font%(3),font$(3,20),style%(3)
  LOCAL g%,km%,zoom%
  zoom%=1
  font%(1)=13 :font$(1)="(Mono 6x6)" :style%(1)=0
  font%(2)=4  :font$(2)="(Mono 8x8)" :style%(2)=0
  font%(3)=12 :font$(3)="(Swiss 16)" :style%(3)=16
  g%=%z+$200
  DO
  IF g%=%z+$200
  IF km% AND 2          REM Shift-PSION-Z
    zoom%=zoom%-1
    IF zoom%<1 :zoom%=3 :ENDIF
  ELSE                  REM PSION-Z
    zoom%=zoom%+1
    IF zoom%>3 :zoom%=1 :ENDIF
  ENDIF
  FONT font%(zoom%),style%(zoom%)
  PRINT "Font=";font%(zoom%),font$(zoom%),
  PRINT "Style=";style%(zoom%)
  dispinfo:
  PRINT rept$("1234567890",15)
  gBORDER 0
  ENDIF
  g%=GET
  km%=KMOD
  UNTIL g%=27
ENDP

PROC dispinfo:
  LOCAL scrInfo%(10)
  SCREENINFO scrInfo%()
  PRINT "Left margin=";scrInfo%(1),
  AT 17,2 :PRINT "Top margin=";scrInfo%(2)
  PRINT "Screen width=";scrInfo%(3)
  AT 17,3 :PRINT "Screen height=";scrInfo%(4)
  PRINT "Char width=";scrInfo%(7)
  AT 17,4 :PRINT "Line height=";scrInfo%(8)
ENDP
```

---

## Animation example

This program requires five bitmap files "one.pic" to "five.pic". Each of these would differ slightly they might, for example, be five `snapshots' of a running human figure, each with the legs at a different point in their cycle.

The program copies each bitmap into a window of its own, then makes each window visible in turn, each time slightly

further across the screen.

To make bitmap files, first draw the pattern you want with any of the graphics drawing commands. (Use "gLINEBY 0,0" to draw single dots.) When the pattern is complete, use gSAVEBIT to make the bitmap file. For advanced animation, you could use a sprite as described in the 'Advanced Topics' chapter.

```
PROC animate:
LOCAL id%(5),i%,j%,s$(5,10),w%,h%
w%=16:h%=28 REM example width and height
s$(1)="one" :s$(2)="two" :s$(3)="three"
s$(4)="four" :s$(5)="five" :j%=1
WHILE j%<6
    i%=gLOADBIT(s$(j%))
    id%(j%)=gCREATE(0,0,w%,h%,0)
    gCOPY i%,0,0,w%,h%,3
    gCLOSE i% :j%=j%+1
ENDWH
i%=0 :gORDER 1,9
DO
    j%=(i%-5*(i%/5))+1 REM (i% MOD 5)+1
    gVISIBLE OFF REM previous window
    gUSE id%(j%) REM new window
    gSETWIN i%,20 REM position it
    gORDER id%(j%),1 REM make foreground
    gVISIBLE ON REM make visible
    i%=i%+1 :PAUSE 2
UNTIL KEY OR (i%>(480-w%)) REM screen edge
ENDP
```

---

## Two-voice "ice-cream van" sound

The following program plays a rising and falling scale. It uses the amplifier-driven loudspeaker device (with device driver SND:) which allows you to play tunes using two-note chords ie it has two voices.

This program uses I/O keywords as described in the 'Advanced topics' section. Take care to enter them exactly as shown here.

```
PROC main:
local ret%,sndHand%
ret%=IOOPEN(sndHand%,"SND:",-1) REM open the device
if ret%<0
    print "Failed to start"
    print err$(err)
    get
else
    icecream:(sndHand%)
    ioclose(sndHand%)
endif
ENDP
```

```
PROC icecream:(sndHand%)
local notes1%(4),notes2%(14)
local slstat%,len1%,len2%
REM define 1st voice
notes1%(1)=1048 :notes1%(2)=96 REM freq, duration
notes1%(3)=524 :notes1%(4)=48
len1%=2 REM number of notes in voice 1
REM define 2nd voice
notes2%(1)=1048 :notes2%(2)=16
notes2%(3)=1320 :notes2%(4)=16
notes2%(5)=1568 :notes2%(6)=16
notes2%(7)=2092 :notes2%(8)=16
notes2%(9)=1568 :notes2%(10)=16
notes2%(11)=1320 :notes2%(12)=16
notes2%(13)=1048 :notes2%(14)=48
len2%=7 REM number of notes in voice 2
```

```
IOC(sndhand%,1,s1stat%,notes1%(),len1%)  
  REM voice 1 asynchronous  
IOW(sndHand%,2,notes2%(),len2%) REM voice 2 synchronous  
IOWAITSTAT s1stat%  
ENDP
```

**notes1%()** and **notes2%()** are set up to hold "len1%" and "len2%" notes to be played on voice 1 and voice 2 respectively. The number of notes to each voice must not exceed 16384.

Each note is composed of two consecutive integers in the array with the first of each pair giving the frequency in Hz (middle A is 440Hz) and the second giving the note duration in quarter-beats per minute.

---

# Summary for experienced OPL users

OPL has evolved from the Psion Organiser II through the MC and HC computers to the Series 3 and now Series 3a. This appendix explains the changes made. For more details of the following topics and keywords, look them up in the index or table of contents.

Bear in mind that some OPL keywords return or allow different values according to screen size and keyboard layout.

Note: the comparisons against HC and MC OPL in this appendix assume the original versions of these computers. Some of the Series 3/3a OPL features may be incorporated into future releases in the HC and MC ranges.

---

## Using OPL on the SERIES 3a

To create an OPL module, press the System button, and move the cursor to the Program icon. (You can also do this with Psion-Control-Word, as Control-Word is initially set to act like a 'Program' button.) Select 'New file' from the 'File' menu, give the name to use, and then type in the module. The editing features are the same as in Word, but the 'Paragraphs' and 'Styles' menus are missing, and the 'Word' menu has been replaced by a 'Prog' menu, containing new programming options. Select its 'Translate' option to translate the module, then the 'Run' option to run it. You can also run the translated module from the System screen, as its name automatically appears under a 'RunOpl' icon move the cursor right to the RunOpl icon, then down onto the module name, and press Enter.

Existing OPL modules are listed under the Program icon on the System screen. To edit one, move the cursor onto the module name and press Enter.

To stop a running program, press Psion-Esc.

The Series 3a screen is 480 points (pixels) wide by 160 points deep.

OPL programs can be translated as applications which appear in the System screen. This is done with the APP keyword. You can also select the type of application using keyword TYPE, and the icon using ICON, the filename extension of files to be listed under the icon in the System screen using EXT and the directory in which these files are stored using PATH.

## Files

If you use the 'S3 Translate' option on the 'Prog' menu, the Program editor will translate as if for the Series 3. The translated program can then be run on either a Series 3 or a Series 3a; on the latter it will run in compatibility mode.

If you use the 'Translate' option on the 'Prog' menu, the translated program will run only on the Series 3a.

Modules translated for the Series 3 (not the Series 3a) are also compatible with HC and MC computers, provided that they only use keywords also available on those machines. You can build code libraries which can be used on all four machines, bearing in mind differences between screen size, location of files etc.

There is more about compatibility with the Series 3 towards the end of this chapter. The information includes some rules for combining modules when some of them are translated for Series 3 and some for Series 3a.

Procedures translated on the Organiser need re-translation, as they will not run on the Series 3a.

The Series 3a uses the same MS-DOS filing system as the MC and Series 3, although for everyday use it 'hides' the directories from you. The directories and file extensions concerned with OPL are:

Type of file	Directory	File extension
OPL modules	\OPL	.OPL

translated modules	\OPO	.OPO
data files	\OPD	.ODB
bitmaps	\OPD	.PIC

---

## Changes from Organiser to MC OPL

### Procedures and modules

More than one procedure may be stored in a single .OPL file, or module. The beginning of each procedure is identified by the line "PROC procedure name:" and the end of each procedure by the line "ENDP". So a module might look like this:

```
PROC oneroot:
  LOCAL x
  PRINT "Type a number:"
  INPUT x
  root:(x)
  GET
ENDP

PROC root:(p)
  CLS
  PRINT "Root of",p,"is",sqr(p)
ENDP
```

When you run the module, the first procedure in the module is executed. Any other procedures in the module are available to be called by the first procedure.

Procedures can be called from other modules only if you've loaded the modules with the new LOADM command. Up to 4 modules can be held in memory at any one time. Use UNLOADM to remove a module from memory.

### Other changes

Data files now have a special format. Records can be a maximum of 1022 bytes long.

The FIND function compares a search string against entire text fields. To find text anywhere within text fields, add an asterisk at either end of the string eg "FIND("\*JONES\*")".

When you use REM at the end of a line you need only precede it with a space, not a space and a colon. So these two lines are equivalent:

```
RAISE -37 :REM disk full
```

```
RAISE -37 REM disk full
```

No calculator memories are available to OPL on the MC (although they are on the Series 3/3a.)

The specification of the BEEP command has changed.

Different effects are produced by values below 32, used with "PRINT CHR\$()". See the Character Set appendix for more details.

New functions and commands:

- SCREEN allows you to set the maximum size of the text window.
- LOPEN must now be used before LPRINTing, to specify the destination of the LPRINTs. Use LCLOSE if you then want to LPRINT to another device. You can also use LOPEN to print to a file.

- COMPRESS copies data files, and makes sure that erased records aren't copied to the destination device.
- FINDW, DIRW\$, COPYW and DELETEW on Organiser model LZ have been renamed FIND, DIR\$, COPY and DELETE the functions/commands which previously had these names having been removed.

These functions/commands have been removed from OPL: CLOCK, UDG, DISP, VIEW, FREE, MENU and MENUN. Also, the Comms Link commands are not available.

## Long integers

A new variable type has been added long integers, specified by adding an "&" symbol to the variable name instead of the "%" symbol, eg "price&", "x&(5)".

Long integers are 32-bit rather than 16-bit signed integers, giving the range +2,147,483,647 to -2,147,483,648 rather than +32767 to -32768.

Long hexadecimal constants should have an "&" instead of a "\$" sign in front of them. Even when the constant fits into an integer, you can use "&" to widen the constant to 32 bits.

## Advanced use

POKEL, POKEF and POKE\$ have been added to POKEB and POKEW, and PEEKL, PEEKF and PEEK\$ have been added to PEEKB and PEEKW. This means you can poke and peek the full range of value types strings, long integers etc.

There is a range of I/O file handling facilities, allowing you to open, read, write and position within any type of file.

To complement the keypress functions, KMOD allows you to detect any modifiers, such as Control, which have been pressed.

# Changes from MC to HC OPL

## Graphics commands

Many graphics commands are available. They can, for example:

- Draw lines and boxes.
- Fill areas with patterns.
- Display text in a variety of styles, at any position on the screen.
- Scroll areas of the screen.
- Manipulate up to eight separate windows and bit patterns.
- Read data back from the screen.

The TRAP command can be used with several new commands.

The CURSOR command can be still be used to switch the text cursor on and off, but can also define the shape and position of a graphics cursor.

The gUPDATE command affects anything that displays on the screen. It may make a noticeable difference in speed if, for example, you are using a lot of PRINT commands.

## Other changes

When a program runs, it is given the full screen on which to display text. Use the SCREEN command to define a different window size for text display.

The SCREEN command can position the text window anywhere on the screen. You can also use SCREEN repeatedly to change the size of the window.

A new function, OS, allows you to call any interrupt service in the Operating System, and read all returned registers and flags.

GETEVENT and TESTEVENT give details of system events of any kind.

---

## Changes from HC to SERIES 3 OPL

### Everyday features

Many of the interface features of the Series 3 applications for example menus, dialog boxes, shadowed boxes and status windows are available via OPL keywords.

Several keywords have been added for OPAs (OPL applications).

The two colons at the end of the label in ONERR or GOTO are optional. The colons must still be used where the label itself occurs in the program.

You can pause a running program by pressing Control-S. It will be paused as soon as it next tries to display something on the screen. Press any other key to let the program resume running.

The EVAL function evaluates a string and returns the result as a floating-point number.

The VECTOR command allows you to jump to one of a list of labels. This can save cumbersome IF statements.

Procedures may now be called using a string expression for the procedure name.

BEEP may be used with the duration made negative. It will first check whether the sound system is in use (perhaps by another OPL program), and return if it is. This stops BEEP waiting until the sound system is free.

There are new graphics keywords gINVERT, gXPRINT, gBORDER and gCLOCK.

DATETOSECS and SECSTODATE convert between standard system dates / times and the number of seconds since midnight on 1/1/1970.

The calculator memories M0 to M9 are available to OPL.

### Advanced features

MKDIR makes a new directory, RMDIR removes a directory, and SETPATH sets the current directory for file access.

The command line arguments of the OPL program you run, including its full pathname, are returned by CMD\$.

Two new I/O commands, IOWAITSTAT and IOYIELD, have been added.

PARSE\$ will produce a single full file specification from two separate parts, or break one down into its constituent parts.

---

## Changes from SERIES 3 to SERIES 3a OPL

## Everyday features

A new SCREENINFO command provides information about the screen size and type. You can use it to write machine-independent programs, as described later in this chapter.

All appropriate graphics keywords can now draw in grey as well as black. To allow drawing in grey use "DEFAULTWIN 1". By default grey is not available as drawing grey as well as black uses more memory and takes longer.

TYPE supports new larger black/grey icons, and allows you to specify different icons for the Series 3 and Series 3a.

New FONT and STYLE keywords set the font and style for displaying text with PRINT (etc).

gFONT and FONT can access many new fonts which are built into the Series 3a ROM.

gCLOCK supports many more types of clocks.

A dialog on the Series 3 can have up to seven lines including the title, whereas a dialog on the Series 3a can have nine.

A menu on the Series 3 can have up to six options whereas a menu on the Series 3a can have eight. The MENU function allows you to set which menu and item should be highlighted initially.

Series 3 programs will always run correctly in compatibility mode but if retranslated (in normal Series 3a mode) may need changing as follows:

- Menu keywords support case-dependent hot-keys. The hot-keys you specify should now be in the correct case upper or lower. If you specify "%P" (upper case), for example, this is the hot-key Shift-Psion-P. On selecting an option, MENU returns the hot-key keycode in the case which you specified.
  - ☞ On some very early versions of the Series 3, menus exited when any key was pressed together with the Psion key. Later Series 3 versions and all Series 3a versions exit menus only when valid hot-keys are pressed.
- "STATUSWIN ON" displays a large Series 3a status window containing an icon. This is 64 pixels wide, whereas it was 50 pixels wide on the Series 3.

DIAMINIT and DIAMPOS allow a ◆ list to be displayed in the status window.

STATWININFO returns information about the sizes of status windows and/or the current status window.

gBUTTON draws keys such as those displayed in certain dialogs.

gDRAWOBJECT draws a graphics object. You can use this to draw the "lozenge" used to display the words 'City' and 'Home' in the World application.

gXBORDER draws bordered boxes, such as those used to display dialogs. (The gBORDER keyword works as it did on the Series 3.)

FINDFIELD finds text in a particular field, or group of fields.

BEEP cannot play tones as high as those played on the Series 3.

gPEEKLINE can now read from the screen as a whole.

CURSOR can display new kinds of cursors, and gINFO can return this (and other) information.

TYPE supports new actions and icon types for OPAs.

## Advanced features

IOC performs an asynchronous I/O request, like IOA, but with guaranteed completion. IOCANCEL cancels any outstanding IOA or IOC.

A new set of keywords supports the definition of a sprite, which you can move around "on top of" the rest of the screen. The sprite can be animated, displaying a sequence of different bitmaps.

Cacheing keeping frequently used procedures in memory instead of loading them from file every time they are called can help increase the speed of OPL programs.

New keywords provide access to dynamic libraries (DYLLs), to the memory allocator and to Operating System data file calls.

UADD and USUB allow addition and subtraction of pointers/addresses without the risk of 'Integer overflow'.

GETEVENT now returns the event \$405 when the date changes.

☛ Some new system services, not available on the Series 3, are mentioned in this manual for example, the 'Foreground and background' section in the 'Advanced topics' chapter uses a "event on machine turn on" service.

Compatibility between Series 3 and Series 3a

## Compatibility mode and normal mode

A program translated for the Series 3 can run on the Series 3a without retranslation the program runs in compatibility mode. This mode makes use of the fact that the Series 3a screen has exactly twice as many pixels as the Series 3 screen in both the horizontal and vertical directions: the Series 3a screen has 480x160 pixels and the Series 3 has 240x80 pixels. When a Series 3 program runs on the Series 3a, four pixels (2x2) are actually drawn or cleared for each pixel that would have been drawn or cleared on a Series 3. Also, all keywords that explicitly or implicitly specify a screen position (eg. gAT, gMOVE, gBOX and AT) are automatically rescaled.

One or two of the special symbols (characters between 0 and 31 in the character set) are different on the Series 3a. However, in compatibility mode the fonts have the same character set as on the Series 3.

A program translated for the Series 3a runs in normal mode on the Series 3a. It will not run on the Series 3.

## Slowing down Series 3 programs

If you wish to slow down a program such as one of the games on Psion's Games SSDs you can write a short OPL program to run in the background, like this:

```
proc slowdown: local i%,j print "Slow down S3a" call($138b) rem "unmark as active" while 1 i%=10 :j=j+1 while i%  
:i%=i%-1 :endwh if j=300000 j=0 :pause 2 else pause 1 endif endwh endp
```

If you change the number 10 assigned to "i%" at the top of the WHILE loop, you can control the amount by which the Series 3a slows down a bigger value slows it down by more, and a smaller value by less. You may need to use different values for different Series 3 programs.

Warning: running this program will cause the Series 3a to use more battery power.

The loop which "j" counts is designed to do a "pause 2" instead of a "pause 1", roughly every twenty five minutes. A "pause 2" gives just enough delay for the automatic turn off of the Series 3a to have a chance to work. Without this, automatic turn off cannot work.

☛ Using "pause 2" in the main delay loop might cause the foreground process to have a noticeably jerky appearance.

☛ You can change the value 300000 to change the time before automatic turn off will occur. If you make it too small you may notice the "pause 2" occasionally. (If you make "i%" a lot bigger than 10 in the loop, you may also find the period before automatic turn off increases.)

If you do not allow automatic turn off like this, and you then forget to exit the "slowdown" program, no automatic turn off can occur. If you left the Series 3a turned on or if it woke up for an alarm when you were not present it would stay on

until the batteries run down. It would then turn off, and you would not be able to use it again until you changed the batteries.

Do not forget to exit the program from the System screen (use the Delete key) when you want to use the Series 3a at full speed again.

## Combining modules translated for Series 3 and Series 3a

The rest of this section relies on the following important rules:

- A program runs in normal mode if its top-level module was translated for the Series 3a, and in compatibility mode otherwise.
- When running in normal mode, a module translated for the Series 3 may be loaded but will run in normal mode.
- When running in compatibility mode, a Series 3a module cannot be loaded and will cause an 'Incompatible translator version' error (-107).

For a program to run on both machines, you could therefore do one of the following:

- translate the whole program for the Series 3, in which case it will also run on the Series 3a in compatibility mode.
- translate the top-level module only both for the Series 3a and for the Series 3, and the rest of the program for the Series 3 only. There are then effectively two programs, although they share all except for the top-level module.

The program with Series 3a top-level runs only on the Series 3a and only in normal mode. The program with Series 3 top-level runs in compatibility mode on the Series 3a or normally on the Series 3.

For this method to work you should not assume that the physical screen has a fixed number of pixels or that the text screen size and characters in its font have a fixed width and height. Use `gINFO`, `SCREENINFO`, `gWIDTH` and `gHEIGHT` to find out the values at runtime. eg. pixel "(120,0)" is half-way across the screen on the Series 3 but is only a quarter-way across on the Series 3a, whereas pixel "(gWIDTH/2,0)" is half-way across in both cases.

Clearly Series 3a keywords cannot be included in any program to be run on both machines. The following 'trick' may however prove useful. It relies on the failure to load an Series 3a module when running in compatibility mode on the Series 3a (or when running on the Series 3 itself). The steps are:

1. Create a module containing procedures using Series 3a keywords which are needed when running in normal mode. For example, module "s3aprocs.opl" might contain:

```
PROC scrinfo:(pinfo%)
  SCREENINFO #pinfo%
ENDP

PROC font:(font%,style%)
  FONT font%,style%
ENDP
```

2. Translate for the Series 3a (it won't translate for the Series 3 anyway).

3. Call the procedures in "s3aprocs.opl" as follows to set up global variables containing text screen information if running in compatibility mode, simply set the globals to known values that apply on the Series 3:

```
LOCAL err%,info%(10),...
```

```
TRAP LOADM "S3aprocs"
IF ERR=0 OR ERR=-104
  rem if not 'Incompatible translator' error
```

```

    rem or if already loaded, then in normal mode
err%=ERR
font%=$9a          rem system font
font:(font%,16)   rem mono-ised style
scrInfo:(ADDR(info%))
marginX%=info%(1) rem pixels from left of screen
marginY%=info%(2) rem pixels from top of screen
chrW%=info%(7)    rem character width in pixels
chrH%=info%(8)    rem character height in pixels
screenX%=gWIDTH/chrW%      rem char screen width
screenY%=(gHEIGHT+1)/chrH% rem char screen height
IF err%-104          rem if loaded here
    UNLOADM "S3aprocs"
ENDIF
ELSE
    rem else on Series 3 or
    rem in compatibility mode
    rem so just use fixed values
    rem no margins on Series 3
marginX%=0
marginY%=0
chrW%=6          rem default console char width
chrH%=9          rem ...and height
screenX%=40      rem character columns
screenY%=9       rem character rows
font%=1          rem font ID = 1 on Series 3
ENDIF

```

This example assumes that the default font has not been changed using the "IOW(-2,7,17,...)" function (as described in the Series 3 Programming manual) when running on the Series 3 or in compatibility mode on the Series 3a. In normal mode on the Series 3a, you must use the FONT command instead.

 A quick way to check that the program is not running on a Series 3 is to call gINFO and check the 31st integer of the information array. If it was 0 before the gINFO and still is afterwards, the program is running on a Series 3. This method cannot be used to distinguish between a program running in normal mode or compatibility mode.

---

# Operators and logical expressions

---

## Operators

These operators are available in OPL:

### Arithmetic operators

+	add
"-"	subtract
*	multiply
/	divide
**	raise to a power
"-"	unary minus (in negative numbers for example, "-10")
%	percent

### Comparison operators

	greater than
=	greater than or equal to
<	less than
<=	less than or equal to
=	equal to
<>	not equal to

### Logical and bitwise operators

AND  
OR  
NOT

### The % operator

The percentage operator can be used in expressions like this:

"60+5%"	ie 60 plus 5% of 60. Result: 63
"605%"	ie 60 minus 5% of 60. Result: 57
"60*5%"	ie 5% of 60. Result: 3
"60/5%"	ie what number is 60 5% of. Result: 1200.

It can also be used like this:

"105>5%"	ie what number, when increased by 5%, becomes 105. Result: 100
"105<5%"	ie how much of 105 was a 5% increase. Result: 5

### Examples

To add 15% tax to 345:

"345+15%"                      Result = 396.75

To find out what the price was before tax:

"396.75>15%"                      Result = 345

To find out how much of a total price is tax:

"396.75<15%"                      Result = 51.75

---

## Precedence

Highest:                      \*\*  
                                 - (unary minus)    NOT  
                                 \*     /  
                                 +     -  
                                 =     >     <     <>     >=     <=  
Lowest: AND    OR

So "7+3\*4" returns 19 (3 is first multiplied by 4, and 7 is added to the result) not 40 (4 times 10).

### When there is equal precedence

In an expression where all operators have equal precedence, they are evaluated from left to right (with the exception of powers). For example, in "a+b-c", "a" is added to "b" and then "c" is subtracted from the result.

Powers are evaluated from right to left for example, in "a%\*\*b%\*\*c%", "b%" will first be raised to the power of "c%" and then "a%" will be raised to the power of the result.

### Changing precedence with brackets

The result of an expression such as "a+b\*c" is the same whether you first add "a" to "b", or "b" to "c". But how is "a+b\*c/d" evaluated? You may want to use brackets to either:

- Make it obvious what the order of calculation is

or

- Change the order of calculation.

By default, "a+b\*c/d" is evaluated in the order: "b" multiplied by "c", then divided by "d", then added to "a". To perform the addition and the division before the multiplication, use brackets: "(a+b)\*(c/d)". When in doubt, simply use brackets.

### Precedence of integer and floating-point values

You are free to mix floating-point and integer values in expressions, but be aware how OPL handles the mix:

- In each part of the calculation, OPL uses the simplest arithmetic possible. Two integers will use integer arithmetic, and this can give unexpected results: "7/2" gives the integer "3". Otherwise floating-point arithmetic is used ("7.0" is a floating-point number, so "7.0/2" gives the floating-point number "3.5").

- Finally, the evaluated result of the right-hand side of an expression is automatically converted to the same type as the variable to which it is assigned.

For example, your procedure might include the expression "a%=b%+c". This is handled like this: "b%" is converted to floating-point and added to "c". The resulting floating-point value is then automatically converted to an integer in order to be assigned to the integer variable "a%".

Such conversions may produce odd results for example "a%=3.0\*(7/2)" makes "a%=9", but "a%=3.0\*(7.0/2)" makes "a%=10". OPL does not report this as an error, so it's up to you to ensure that it doesn't happen unless you want it to.

## Type conversions and rounding down

There are three numeric types floating-point, integer and long integer. You can assign any of these types to any other. The value on the right-hand side will be automatically converted to the type of the variable on the left-hand side. For example:

- If you assign an integer value to a floating-point variable, there are no problems.
- If you assign a floating-point value to an integer variable, the value is converted to an integer, always rounded towards zero for example, if you declare "LOCAL c%" and then say "c%=3.75", the value "3.75" is converted to the value "3".

Rounding down towards zero can sometimes cause unusual results. For example, "a%=2.9" would give "a%" the value 2, and "a%=-2.3" would give "a%" the value -2.

When you run a module, if the left-hand side of an assignment has a narrower range than the right-hand side, you may get an error (for example, if you had "x%=a&" where "a&" had the value 320000).

To control how floating-point numbers are rounded when converted, use the INT function.

## Logical expressions

The comparison operators and logical operators are based on the idea that a certain situation can be evaluated as either true or false. For example, if "a%=6" and "b%=8", "a%>b%" would be 'False'.

These operators are useful for setting up alternative paths in your procedures. For example you could say:

IF salary

You can also make use of the fact that the result of these logical expressions is represented by an integer:

- 'True' is represented by the integer -1
- 'False' is represented by the integer 0 (zero).

	Eg	Result returned	Return value
<	"a">"b"	True if a greater than b False if a less than or equal to b	-1 0
<=	"a"<=b"	True if a less than or equal to b False if a greater than b	-1 0
=	"a">=b"	True if a greater than or equal to b False if a less than b	-1 0
<>	"a"<>b"	True if a not equal to b	-1

	False if a equal to b	0
=	"a=b" True if a equal to b	-1
	False if a not equal to b	0

These integers can be assigned to a variable or displayed on the screen to tell you whether a particular condition is true or false, or used in an IF statement.

For example, in a procedure you might arrive at two sub-totals, "a" and "b". You want to find out which is the greater. So use the statement, "PRINT a>b". If zero is displayed, "a" and "b" are equal or "b" is the larger number; if -1 is displayed, "a>b" is true "a" is the larger.

## Logical and bitwise operators

The operators AND, OR and NOT have different effects depending on whether they are used with floating-point numbers or integers:

When used with floating-point numbers...  
 ... AND, OR and NOT are logical operators,  
 and have the following effects:

Example	Result	Integer returned
"a AND b"	True if both "a" and "b" are non-zero	-1
	False if either "a" or "b" are zero	0
"a OR b"	True if either "a" or "b" is non-zero	-1
	False if both "a" and "b" are zero	0
"NOT a"	True if "a" is zero	-1
	False if "a" is non-zero	0

When used with integer or long integer values...  
 ... AND, OR and NOT are bitwise operators.

The way OPL holds integer numbers internally is as a binary code 16-bit for integers, 32-bit for long integers. Bitwise means that an operation is performed on individual bits. A bit is set if it has the value 1, and clear if it has the value 0. Long integer values with AND, OR and NOT behave the same as integer values.

AND Sets the result bit if both input bits are set, otherwise clears the result bit.

For example, the statement "PRINT 12 AND 10" displays 8. To understand this, write 12 and 10 in binary:

```
"12    0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0
10     0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0"
```

AND acts on each pair of bits. Thus, working from left to right discounting the first 12 bits (since "0 AND 0" gives 0):

```
"1 AND 1    " RIGHT "    1
1 AND 0 " RIGHT "    0
0 AND 1 " RIGHT "    0
```

0 AND 0 " RIGHT " 0"

The result is therefore the binary number 1000, or 8.

OR Sets the result bit if either input bit is set, otherwise clears the result bit.

What result would the statement "PRINT 12 OR 10" give? Again, write down the numbers in binary and apply the operator to each pair of digits:

"1 OR 1 " RIGHT "	1
1 OR 0 " RIGHT "	1
0 OR 1 " RIGHT "	1
0 OR 0 " RIGHT "	0"

The result is the binary number 1110, or 14 in decimal.

NOT Sets the result bit if the input bit is not set, otherwise clears the result bit.

NOT works on only one number. It returns the one's complement, ie it replaces 0s with 1s and 1s with 0s.

So since 7 is 0000000000000111, "NOT 7" is 111111111111000. This is the binary representation of -8.

A quick way of calculating NOT for integers is to add 1 to the original number and reverse its sign. So "NOT 23" is -24, "NOT 0" is -1 and "NOT -1" is 0.

---

# Serial/parallel ports and printing

You can use LPRINT in an OPL program to send information (for printing or otherwise) to any of these devices:

- A parallel port "PAR:A"
- A serial port "TTY:A"
- A file on the Series 3a or an attached computer.

You can also read information from the serial port.

OPL does not provide access to the advanced page formatting and font control features of the Series 3a.

---

## Using the parallel port

In your OPL program, set up the port with the statement "LOPEN "PAR:A"".

Provided the port is not already in use, the connection is now ready. LPRINT will send information down the parallel 3 Link lead for example, to an attached printer.

### Example

```
PROC prints:
  OPEN "clients",A,a$
  LOPEN "PAR:A"
  PRINT "Printing..."
  DO
    IF LEN(A.a$)
      LPRINT A.a$
    ENDIF
  NEXT
UNTIL EOF
LPRINT CHR$(12); :LCLOSE
PRINT "Finished" :GET
ENDP
```

---

## Using the serial port

In your OPL program, set up the port with the statement "LOPEN "TTY:A"".

Now LPRINT should send information down the serial 3 Link lead for example, to an attached printer. If it does not, the serial port settings are not correct.

### Serial port settings

"LOPEN "TTY:A" opens the serial port with the following default characteristics:

9600 baud  
no parity  
8 data bits  
1 stop bit  
RTS handshaking.

- If your printer (or other device) does match these characteristics, the LOPEN statement sets the port up correctly, and subsequent LPRINT statements will print there

successfully.

- If your printer does not match these characteristics, you must use a procedure like the one listed below to change the characteristics of the serial port, before LPRINTs will print successfully to your printer.

Printers very often use DSR (DSR/DTR) handshaking, and you may need to set the port to use this.

## Setting the serial port characteristics

Calling the procedure The "rsset:" procedure listed below provides a convenient way to set up the serial port.

Each time you use an "LOPEN "TTY: "" statement, follow it with a call to the "rsset:" procedure. Otherwise "the" LOPEN will use the default characteristics.

Passing values to the procedure Pass the procedure the values for the five port characteristics, like this:

```
rsset:(baud%,parity%,data%,stop%,hand%,&0)
```

☞ The final parameter, which should be "&0" here, is only used when reading from the port.

To find the value you need for each characteristic, use the tables below. You must give values to all five parameters, in the correct order.

Baud =	50	75	110	134	150	300	600	1200
value =	1	2	3	4	5	6	7	8
	1800	2000	2400	3600	4800	7200	9600	19200
	9	10	11	12	13	14	15	16

Parity =	NONE	EVEN	ODD
value =	0	1	2

Data bits = 5, 6, 7 or 8

Stop bits = 2 or 1

Handshaking =	ALL	NONE	XON	RTS	XON+RTS	DSR	XON+DSR	RTS+DSR
value =	11	4	7	0	3	12	15	8

The "rsset:" procedure:

```
PROC rsset:(baud%,parity%,data%,stop%,hand%,term&)  
  LOCAL frame%,srchar%(6),dummy%,err%  
  frame%=data%-5  
  IF stop%=2 :frame%=frame% OR 16 :ENDIF  
  IF parity% :frame%=frame% OR 32 :ENDIF  
  srchar%(1)=baud% OR (baud%*256)  
  srchar%(2)=frame% OR (parity%*256)  
  srchar%(3)=(hand% AND 255) OR $1100  
  srchar%(4)=$13  
  POKEL ADDR(srchar%(5)),term&  
  err%=IOW(-1,7,srchar%(1),dummy%)  
  IF err% :RAISE err% :ENDIF  
ENDP
```

Take care to type this program in exactly as it appears here.

Example of calling the procedure

```
PROC test:  
  PRINT "Testing port settings"
```

```

LOPEN "TTY:A"
LOADM "rsset"
rsset:(8,0,8,1,0,&0)
LPRINT "Port OK" :LPRINT
PRINT "Finished" :GET
LCLOSE
ENDP

```

"rsset:(8,0,8,1,0,&0)" sets 1200 Baud, no parity, 8 data bits, 1 stop bit, and RTS/CTS handshaking.

### ***Advanced use***

The section of the "rsset:" procedure which actually sets the port is this:

```

srchar%(1)=baud% OR (baud%*256)
srchar%(2)=frame% OR (parity%*256)
srchar%(3)=(hand% AND 255) OR $1100
srchar%(4)=$13
POKEL ADDR(srchar%(5)),term&
err%=IOW(-1,7,srchar%(1),dummy%)
IF err% :RAISE err% :ENDIF

```

The elements of the array "srchar%" contain the values specifying the port characteristics. If you want to write a shorter procedure, you could work out what these values need to be for a particular setup you want, assign these values to the elements of the array, and then use the IOW function (followed by the error check) exactly as above.

## **Reading from the serial port**

If you need to read from the serial port, you must also pass a parameter specifying terminating mask for the read function. If "term&" is not supplied, the read operation terminates only after reading exactly the number of bytes requested. In practice, however, you may not know exactly how many bytes to expect and you would therefore request a large maximum number of bytes. If the sender sends less than this number of bytes altogether, the read will never complete.

The extra parameter, "term&" , allows you to specify that one or more characters should be treated as terminating characters. The terminating character itself is read into your buffer too allowing your program to act differently depending on its value.

The 32 bits of "term&" each represent the corresponding ASCII character that should terminate the read. This allows any of the ASCII characters 1 to 31 to terminate the read.

For example, to terminate the read when Control-Z (ie. ASCII 26) is received, set bit 26 of "term&". To terminate on Control-Z or "" or "" which allows text to be read a line at a time or until end of file set the bits 26, 10 and 13. In binary, this is:

```
0000 0100 0000 0000 0010 0100 0000 0000
```

Converting to a long integer gives &04002400 and this is the value to be passed in "term&" for this case.

☞ Clearly "term&" cannot be used for binary data which may include a terminating character by chance. You can sometimes get around this problem by using "term&" and having the sender transmit a leading non-binary header specifying the exact number of full-binary data following. You could then reset the serial characteristics not to use "term&" , read the binary data, and so forth.

### **Example reading from serial port**

This example assumes that each line sent has maximum length 255 characters and is terminated by a "" and that Control-Z signals the end of all the data.

```

PROC testread:
LOCAL ret%,pbuf%,buf$(255),end%,len%
PRINT "Test reading from serial port"
LOPEN "TTY:A"
LOADM "rsset"

```

```

REM receive at 2400 without h/shake
rsset:(11,0,8,1,0,&04002000) REM Control-Z or CR
pBuf%=ADDR(buf$)
DO
  REM read max 255 bytes, after leading count byte
  len%=255
  ret%=IOW(-1,1,#UADD(pbuf%,1),len%)
  POKEB pbuf%,len% REM len% = length actually read
  REM including terminator char
  end%=LOC(buf$,CHR$(26)) REM non-zero for Control-Z
  IF ret%<0 and ret%<>-43
    BEEP 3,500
    PRINT
    PRINT "Serial read error: ";ERR$(ret%)
  ENDIF
  IF ret%<>-43 REM if received with terminator
    POKEB pbuf%,len%-1 REM remove terminator
    PRINT buf$ REM echo with CRLF
  ELSE
    PRINT buf$; REM echo without CRLF
  ENDIF
UNTIL end%
PRINT "End of session" :PAUSE -30 :KEY
ENDP

```

**Note that passing -1 as the first argument to I/O keywords means that the LOPEN handle is to be used.** Also, OPL strings have a leading byte giving the length of the rest of the string, so the data is read beyond this byte. The byte is then poked to the length which was read.

---

## Printing to a file

### Printing to a file on a PC or Apple Macintosh

As if you were going to transfer a file:

- Physically connect the Series 3a and the other computer.
- Select the 'Remote link' option in the System screen and press Enter.
- Run the server program (supplied with 3 Link) on the other computer.

In your OPL program, specify the destination file with an LOPEN statement. For example, to a PC:

```
LOPEN "REM::C:\BACKUP\PRINTOUT\MEMO.TXT"
```

Any subsequent LPRINT would go to the file "MEMO.TXT" in the directory "\BACKUP\PRINTOUT" on the PC's drive "C:".

With a Macintosh, you might use a file specification like this:

```
LOPEN "REM::HD40:MY BACKUP:PRINTED:MEMO5"
```

An LPRINT would now go to the file "MEMO5" in the "PRINTED" folder, itself in the "MY BACKUP" folder on the hard drive "HD40". Note that colons are used to separate the various parts of the file specification.

### Printing to a file on the SERIES 3a

In your OPL program, specify the destination file with an LOPEN statement like this:

```
LOPEN "B:\PRINT\MEMO.TXT"
```

This would send each subsequent LPRINT to the file "MEMO.TXT" in the "\PRINT\" directory on an SSD in drive B:.

---

# Character codes

To find out a character's character code either look up the character in the table given in the back of your User Guide, or press the Calc button and type the "%" sign followed by the character for example "%P" returns 80. Characters with codes from 0 to 127 are the same as in the ASCII character set. Codes 128 to 255 are compatible with the IBM code page 850.

Codes from 256 upwards are for other Series 3a keys see the list below.

## Character codes of special keys

The GET and KEY functions return the character code of the key that was pressed. Some of the keys are not in the character set. They return these numbers:

Esc	27	Tab	9
Delete	8	Enter	13

### *Special keys*

UP	256	DOWN	257
RIGHT	258	LEFT	259
Pg Up	260	Pg Dn	261
Home	262	End	263
Menu	290	Help	291
◆	292		

The Psion key adds 512 to the value of the key pressed. For example, Psion-a is 609 (512+97), and Psion-Help (Dial) is 803 (512+291).

## Special character codes with PRINT

These values can be used with PRINT and CHR\$( ):

7	beep
8	backspace
9	tab
10	line feed
12	form feed (clear screen)
13	carriage return (cursor to left of window)

For example, "PRINT CHR\$(8)" moves the cursor backwards, one character to the left.

---