PSION workabout

USER GUIDE

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NOTE: If magnetic materials are placed close to the underside of the Workabout they may be affected by the speaker magnet. For this reason it is best not to keep your Workabout in the same pocket as credit cards and/or travel passes with magnetic strips.

WARNING: *This equipment has been certified to comply with the limits for a Class B computing device, pursuant to Subpart J of Part 15 of FCC Rules. See the instructions overleaf if interference to Radio or Television is suspected.*

v1.0 February 95
English
Part no. 6104-0001-01

FCC Information for the USA

Radio and Television Interference

This equipment generates and uses radio frequency energy and if not used properly – that is, in strict accordance with the instructions in this manual – may cause interference to Radio and Television reception.

It has been tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules. These are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to Radio or Television reception, which can be determined by turning the equipment off and on, try to correct the interference by one or more of the following measures:

- Reposition the Radio or TV antenna.
- Relocate the Work*about* computer with respect to the Radio or TV.
- Move the Work*about* computer farther away from the Radio or TV.
- If you are powering the Work*about* by the mains supply, plug it into an outlet which is on a different circuit from that of the Radio or TV.

If necessary, consult an authorised Psion dealer or an experienced radio/television technician for additional suggestions.

Important

This equipment was tested for FCC compliance under conditions that included the use of shielded cables and connectors between the Work*about* and any peripherals that are attached. It is important that you use shielded cables and connectors to reduce the possibility of causing Radio and Television interference. Shielded cables, suitable for the Work*about*, can be obtained from an authorised Psion dealer.

If the user modifies the Work*about* computer in any way, and these modifications are not approved by Psion, the FCC may withdraw the user's right to operate the equipment.

The following booklet prepared by the Federal Communications Commission may be of help: "How to Identify and Resolve Radio-TV Interference Problems". This booklet is available from the US Government Printing Office, Washington, DC 20402 Stock No 004-000-00345-4.

Emissions Information for Canada

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Table of Contents

Appendices

1

Introduction

You should read this chapter first; it contains basic information that you need to know before you read the other chapters in this manual. In this chapter you will find details about:

- **The various Work*about* components.**
- **Fitting the the Work*about*'s batteries and connecting it to the mains.**

The notational conventions used in this manual are as follows:

- **Wherever there are things for you to do, the instructions appear as a numbered list.**
- **Extra notes, which you may find useful, are preceded by a ☞ symbol.**
- **Important information is indicated by the word Important:, or is printed in bold type.**
- **Technical or jargon terms appear in italic type the first time that they are referred to in the text.**

To move quickly to information about a specific subject, look in the index for an appropriate entry. Index entries are grouped according to topics; for example, to find out about batteries, look for an appropriate entry under the major entry "Batteries".

About the Workabout

The Work*about* is a robust handheld computer which uses the same Solid State Disks (SSDs) as the Psion HC and Series 3 ranges. Its advanced windowing and multi-tasking software system makes it simple to use and easy to integrate with existing computer systems.

Package contents

In the Work*about* box you will find:

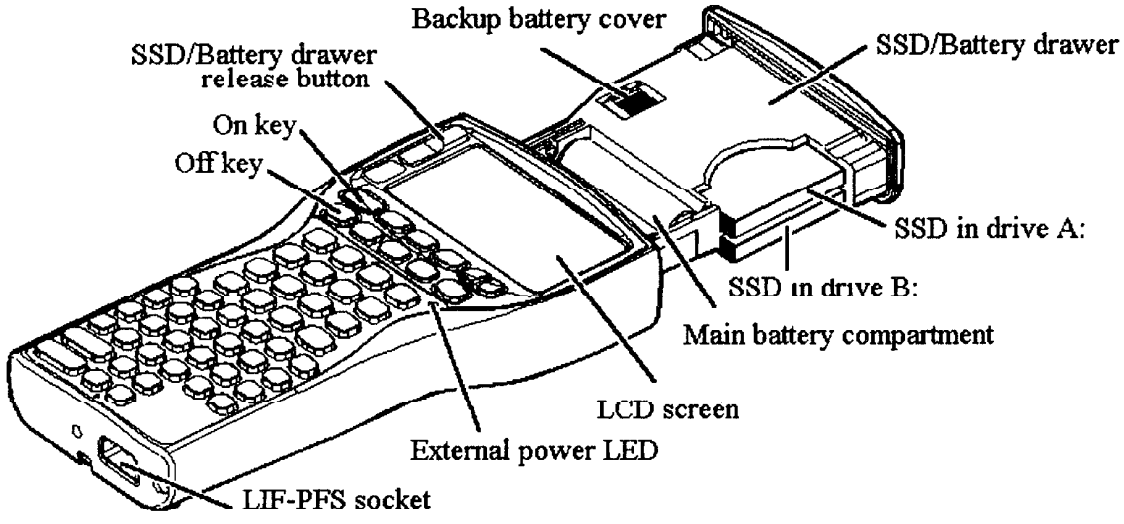
- The Work*about*
- This User Guide
- A lithium backup battery

Care of the Workabout

The Work*about* is dust proof and splash proof. Should you ever need to clean it, first turn it off and then gently wipe the keyboard and screen with a soft, clean, dry cloth.

Where things are

The following diagram shows where the main components of the Work*about* are:



Powering the Workabout

The Work*about* can be powered in four ways:

- by two AA batteries (not supplied). You should use alkaline batteries for best results.
- by a Psion *Ni-Cd* (Nickel-Cadmium) rechargeable battery pack, supplied separately from the Work*about* (Part no. 2802-0005). You can also use 2 standard Ni-Cd rechargeable batteries, however, you cannot recharge these batteries while they are fitted in the Work*about* and so they are not recommended for use.
- by the AC (mains) supply via a *LIF converter* (Part no. 2802-0011) and Work*about* mains adaptor (Part no. 2502-0010 for use in the U.K. Part no. 2502-0011 for use in the rest of Europe). Neither the LIF converter nor the mains adaptor are supplied with the Workabout, they must be purchased separately; see your Psion distributor for more information.
- by placing it in a Work*about* Docking Station.

A small lithium battery is supplied as a backup battery (battery type: 3V Lithium R16 battery - CR1620). When there is no other power supply, it will preserve information in the Work*about*'s internal memory (RAM) for approximately five days.

Important: When the main batteries and backup battery are removed, all the information in the internal memory (RAM) is lost. Before removing both batteries, you should therefore copy any important information in the internal memory to an SSD or PC.

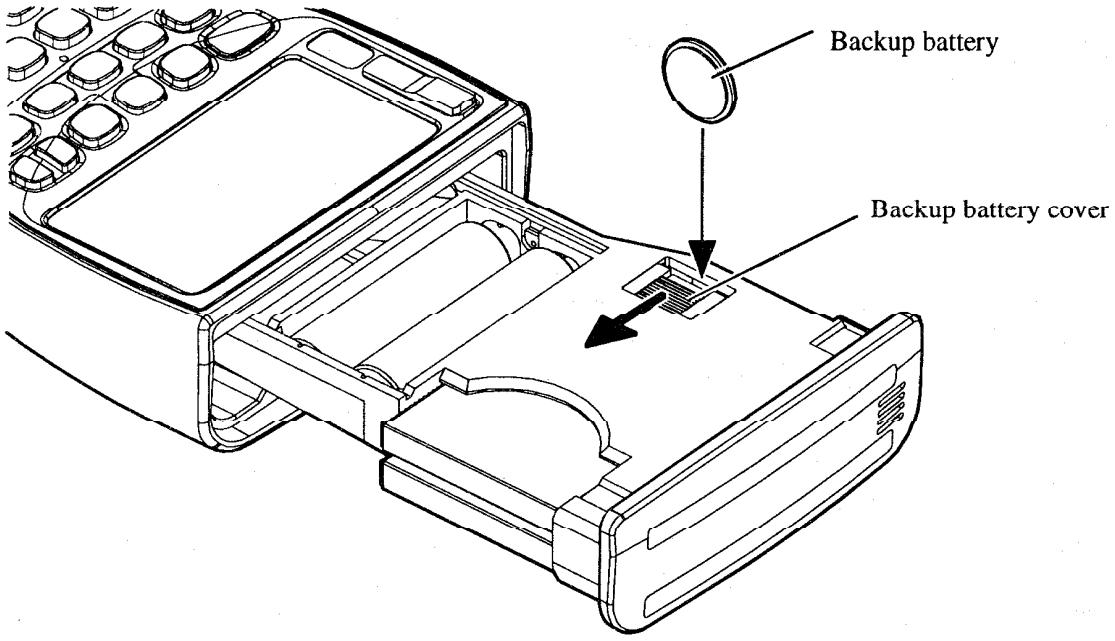
If you plan not to use the Work*about* for long periods of time, it is best to copy all the data on the internal disk (M:) to an SSD and then remove both the main and backup batteries.

Fitting / changing the backup battery

When the backup battery supplied with the Work*about* becomes discharged, you must replace it with the same or an equivalent type of battery as recommended by Psion. You can purchase them from your Psion distributor (Part no. 4900-0018, description BAT LITH. 3V 60mAH 2x16D) or from other battery stockists (Battery type: 3V Lithium R16 [CR1620]).

The backup battery is located in a slot in the SSD/Battery drawer that slides out of the centre of the Work*about*. To fit it:

1. Turn the Work*about* off.
2. Press down the SSD/Battery drawer release button (on the left hand side of the screen) to release the drawer and pull it out until the backup battery cover is revealed.
3. Slide open the backup battery cover in the direction indicated by the arrow, then fit the backup battery into its slot as shown in the following diagram:



Important: Make sure that the positive terminal of the backup battery (the flatter of the two sides and marked with a + symbol) faces towards the outer edge of the Work*about* as you insert it. There is a risk of explosion if you incorrectly replace lithium batteries.

4. Slide the backup battery cover back into its original position to secure the battery in place.
5. Close the SSD/Battery drawer.

☞ **Warning:** You should tape, or otherwise protect the terminals of discharged lithium batteries before you dispose of them. Do not incinerate or crush them, or attempt to recharge them.

Fitting / changing the main batteries

Rechargeable Ni-Cd battery packs are normally not charged when new. So if you are fitting a new one, you will probably need to charge it first. See the 'Recharging a Ni-Cd battery pack' section for details of how to do this.

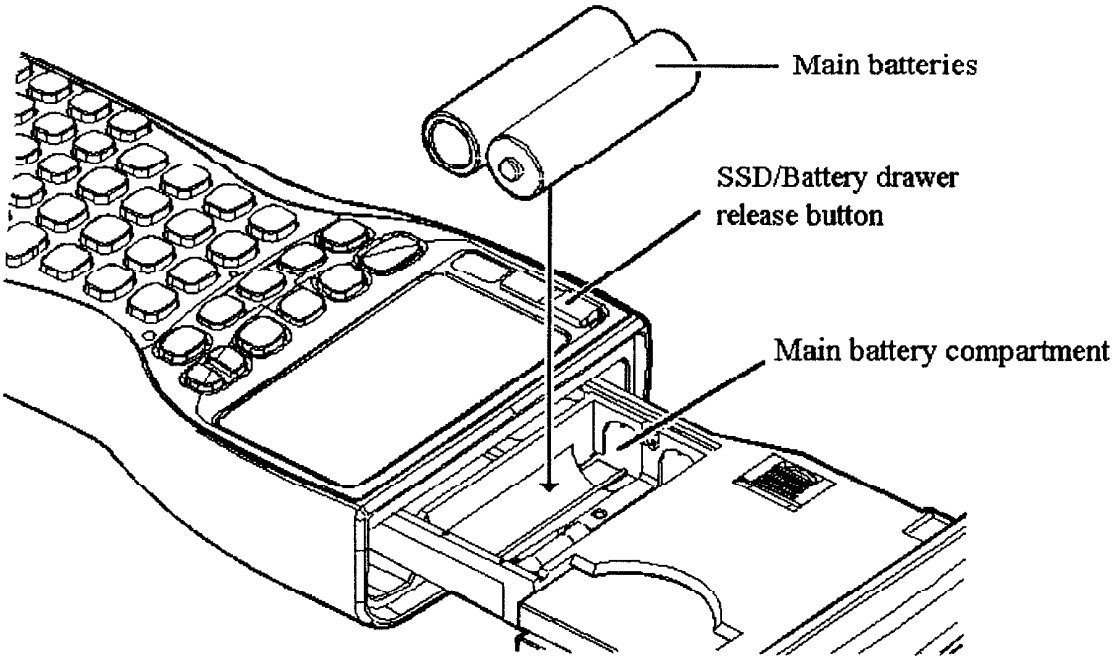
When the main batteries become discharged and need to be replaced, you should leave them in the Work*about* until you are ready to fit charged batteries; this will prolong the life of the backup battery. The backup battery preserves the contents of the internal memory while the main batteries are being changed; however, you should **not** rely upon it as a permanent source of power.

The main batteries (or rechargable Ni-Cd battery pack) fit in a recess in the SSD/Battery drawer that slides out of the centre of the Work*about*.

To fit or change the main batteries:

1. Turn the Work*about* off, then press down the SSD/Battery drawer release button to open the SSD/Battery drawer and pull it out until the main battery compartment is visible.

2. Remove any discharged batteries that are present.
3. Insert two AA batteries (alkaline ones are recommended) or a freshly charged Ni-Cd battery pack as shown in the diagram below:



4. Close the SSD/Battery drawer.

You can now turn the Work*about* back on.

Important: Ni-Cd rechargeable battery packs contain Cadmium, a toxic substance that is harmful to the environment. You should only recharge them by the recommended methods. Do not short circuit, dismantle or incinerate them – dispose of a spent or damaged Ni-Cd battery pack safely.

Recharging a Ni-Cd battery pack

A Ni-Cd rechargeable battery pack can be recharged in three ways:

- by placing the Work*about* in which it is fitted in a Work*about* Docking Station. You can insert a second, spare Ni-Cd battery pack in the Docking Station for charging at the same time. The battery pack will be fast or trickle charged according to the type of Docking Station used (see 'About the Work*about* Docking Station' later for more details).
- by placing the Ni-Cd battery pack directly in a Work*about* Docking Station. Again, the battery pack will be fast or trickle charged according to the type of Docking Station used.
- by connecting the Work*about* in which it is fitted to the mains with a LIF converter and the Work*about* mains adaptor. This method only trickle charges the Ni-Cd battery pack.

Fast charging a discharged battery pack takes about an hour. With trickle charging it takes approximately 14 hours to fully recharge a discharged battery pack, although it will be 90% charged within 12 hours.

Detailed instructions on inserting a Work*about* and battery pack in the Work*about* Docking Station are given in the manual supplied with the Docking Station.

Connecting the Workabout to mains power

You cannot plug a mains adaptor directly into the Work*about*; you must connect a LIF converter to the Work*about*'s LIF-PFS (Low Insertion Force Power & Fast Serial) socket and plug the mains adaptor into the LIF converter. See 'The LIF-PFS socket' section later in this chapter for more information.

When the Work*about* is connected to mains power, the External power LED becomes green.

About the Workabout Docking Station

The Work*about* Docking Station provides mains power to the Work*about* and recharges its Ni-Cd battery pack (if fitted) at the same time. Two models of the Docking Station are available: one for fast charging and one for trickle charging.

Detailed instructions on inserting a Work*about* are given in the manual supplied with the Docking Station.

When a Work*about* is placed in a Docking Station, its External power LED becomes green to indicate that it is being powered by the Docking Station.

What happens when the power is low

When the main batteries become low, a "Main battery is low" message is displayed. With low main batteries, the Work*about* may have enough power to display information on the screen and accept data that you type on the keyboard; however, it may not have enough to save information to an SSD or to transfer information to other devices, e.g. a printer, via its Internal Expansion ports.

If you try to do something for which the Work*about* does not have enough power, it will automatically switch off. You should fit a new set of AA batteries, recharge the Ni-Cd battery pack, or connect the Work*about* to an AC (mains) power supply (using a LIF converter and Psion mains adaptor) before trying the operation again.

☞ When the power in the main batteries gets very low, the Work*about* will automatically turn itself off and you will not be able to use it until you fit charged batteries. However, no information will be lost; the backup battery will maintain the information in the internal memory for several days.

☞ Applications running on the Work*about* may allow you to check the power in the batteries;see your application developer for details.

Power consumption

The Work*about*'s power consumption depends on the applications that you are running and the type of peripherals that are attached to the Work*about*. Using the Backlight or printing via an Internal Expansion port, for example,

dramatically reduces the life of the main batteries. For more information on battery life, contact your application developer.

In order to conserve its batteries, the Work*about* automatically switches off when you are not using it. The default switch off time is 5 minutes, however this time limit is under application control; you should contact your application developer for more details about the automatic switch off time on your Work*about*.

☞ No information is lost when the Work*about* automatically turns off; when you turn it back on, you can continue from where you were.

The Workabout components

The following Work*about* components are described in this section:

- the LCD screen
- the alphanumeric keyboard
- the Solid State Disk (SSD) drives
- the Buzzer
- the LIF-PFS socket
- the Internal Expansion ports

The LCD screen

The text displayed

Your application(s) may allow you to change the size of the characters displayed on the screen. If they do, you will be able to press a certain combination of keys to "zoom in" and "zoom out" to increase and reduce the font size.

In the built-in applications, press Psion-Z to zoom in; to zoom out again, press Shift-Psion-Z.

Zooming out (moving from a larger to a smaller font) will re-display some of the information that scrolls off the screen in a larger font size.

Screen contrast

The screen contrast setting controls how light or dark the Work*about* screen appears. There are 16 contrast settings, so you can "fine-tune" the appearance of the screen to suit your needs.

To adjust the contrast, simply press the Contrast key  until the screen reaches the desired appearance. Press the Shift and Contrast keys at the same time to reverse the direction of the change in contrast.

Backlight

The Work*about* can be fitted with a light behind the screen to help you view information in poor lighting conditions.

To turn the Backlight on simply press the Backlight key  and to turn it off press the Backlight key again.

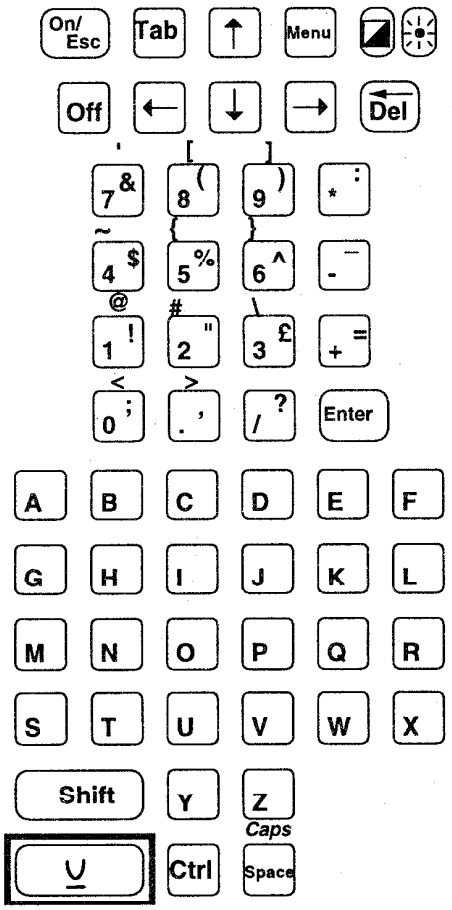
As you would expect, the Backlight switches off when you turn the Work*about* off. However, when you turn the Work*about* on again, the Backlight does not come on automatically; this is to prevent you from using it unintentionally and wasting battery power. Applications can change this behaviour, though.

Important: The Backlight is not designed to be used continuously. It switches off automatically when the Work*about* has been idle for a certain time to preserve battery power; the length of time that it remains on is under application control. See your application developer for more information about control of the Backlight.

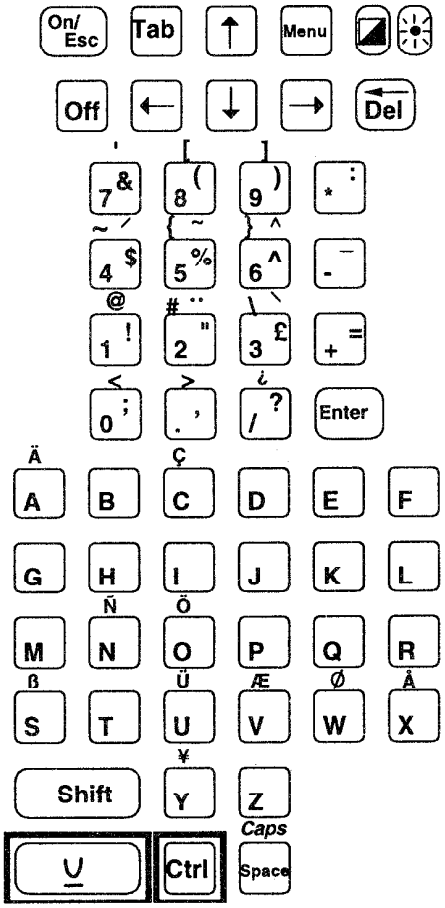
The Keyboard

The Work*about* can use two different keyboards - you may have the UK version or the Western European one (see your application developer for details). Each has a set of 57 keys as shown below:

ENGLISH KEYBOARD



WESTERN EUROPEAN KEYBOARD

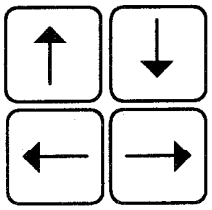


The main navigation keys - the On, Arrow and Enter keys - are yellow; they are positioned so that you can reach them with your thumb when you are holding the Work*about*, making one-handed operation easy. The accented characters indicated on the Western European keyboard surround are entered by pressing the Psion key and the appropriate letter key at the same time. For capital accented letters, press Shift–Psion and the appropriate letter key.

The Special function keys are not indicated on the machine; the lists that follow explain the uses of some of these special keys.

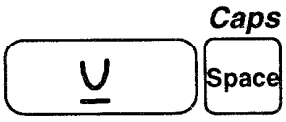
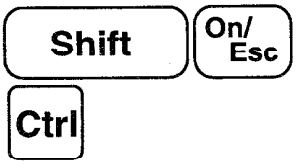
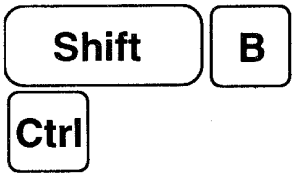
For information about other customised keyboards, you should contact your Psion distributor.

KEY	FUNCTION	USAGE
On/ Esc	ON	Turns the Work*about* on when the machine is off.
Off	OFF	Turns the Work*about* off when the machine is on.
	CONTRAST	Controls the contrast of the LCD screen.
	BACKLIGHT	Switches the Work*about*'s screen Backlight on and off.
On/ Esc	ESC	Under application control; see your application developer for details. In text editors it typically clears a line of text input when the machine is on.
Enter	ENTER	Under application control; see your application developer for details. In command processors it typically terminates a line of text input and in text editors it starts a new line of text.
Del	DELETE	Under application control; see your application developer for details. In command processors and text editors it is usually used to edit typing.
Tab	TAB	Under application control. In text editors it typically moves the cursor on the screen to the next tab position.
Menu	MENU	Under application control; see your application developer for details.
Space	SPACE	Inserts a space in a line of text input.
Shift	SHIFT	Gives access to upper case letters; press Shift and a letter key to type its capital.
Ctrl	CONTROL	Under application control; see your application developer for details.
U	PSION (SPECIAL FUNCTION)	Acts as an accelerator key in combination with other keys.

KEY	FUNCTION	USAGE
	ARROWS	Move the cursor around the screen. On command lines the ↑ and ↓ keys recall previous commands so that you can re-enter them without having to type them a second time.

Combination keypresses

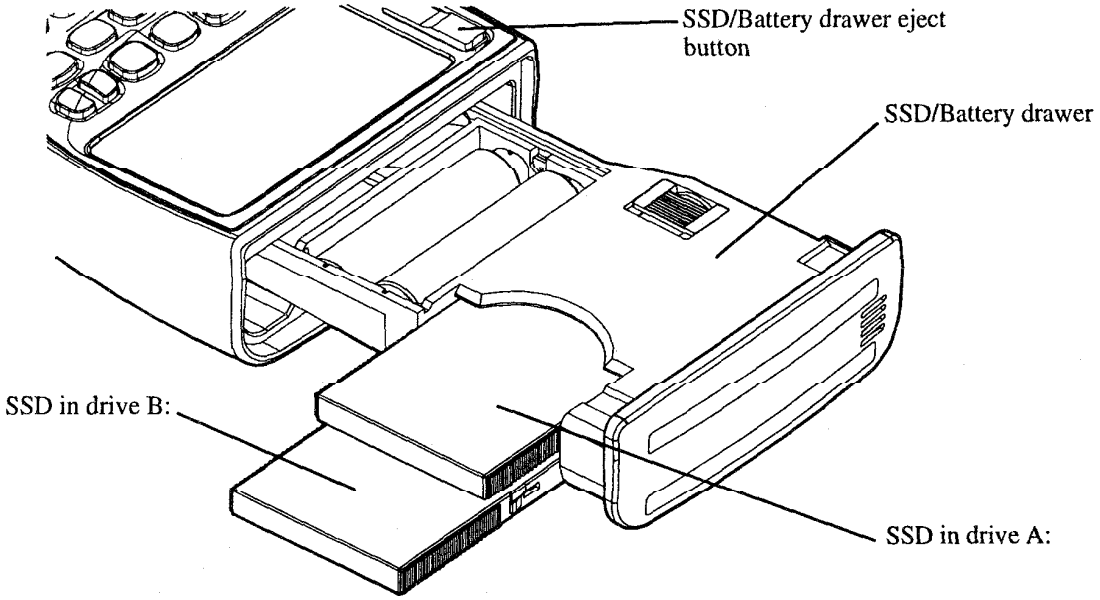
The following list shows the combination keypresses that give you access to the in-built special functions on the Work*about*. They are not indicated on the keyboard.

KEYPRESS	FUNCTION	USAGE
	TASK	Press Psion and Tab at the same time to Task (cycle) through all the running applications and tasks on the Work*about*. The keypress does nothing until at least two visible tasks are running.
	CAPS LOCK	Press Psion and Space at the same time to switch the keyboard to upper case letters.
	HELP	Press Shift and On/Esc at the same time for this function. It is under application control and typically displays help text for the current application. See your application developer for more details.
	HELP INDEX	Press Shift, On/Esc and Ctrl at the same time for this function. It is under application control and typically displays the index of help for the current application. See your application developer for more details.
	BATTERY INFO	Displays a dialog that gives you information about the current condition of the Work*about*'s batteries.

The Solid State Disk drives

The Work*about* has two *Solid State Disk drives* (SSD drives) which allow you to extend its data storage capacity with Solid State Disks (SSDs). SSDs are a highly secure and compact form of data storage. The speed of data transfer to and from them is much faster than with PC floppy disks and comparable to that with many PC hard disks.

The Work*about*'s SSD drives are located in the SSD/Battery drawer that slides out of the centre of the machine, as shown in the diagram below:



The uppermost SSD drive is called drive `A:` and the lower one drive `B:`.

To insert an SSD:

1. Press the SSD/Battery drawer release button to open the SSD drive drawer and pull it out until the SSD drives appear.
2. Slide the SSD into the slot – the arrow on its front edge should point towards the slot. Then close the drawer.

Removing an SSD is just the reverse of inserting it: press the SSD/Battery drawer release button to open the drawer, then pull the SSD out of its slot and close the drawer.

Important: It is best not to open the Solid State Disk (SSD) drive drawer while the Work*about* is accessing an SSD. However, most applications are designed to prevent you from losing data unwittingly and will prompt you to replace an SSD that you have removed while the Work*about* is reading information from or writing information to it.

The Buzzer

The Work*about* has a built-in buzzer for producing sounds which is under application control. See your application developer for more details.

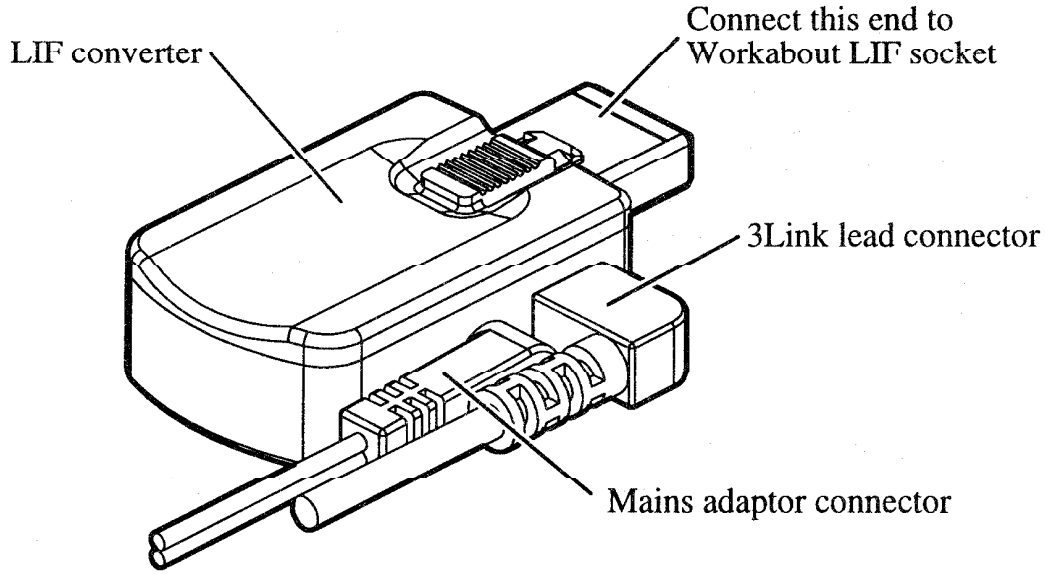
The LIF-PFS socket

The Work*about* is supplied with a LIF-PFS (Low Insertion Force – Power & Fast Serial) socket at the base of the unit. This can be used to connect the Work*about* to:

- a mains adaptor, via a LIF converter so that the Work*about* can be powered from the mains.
- a Work*about* Docking Station, so that a Ni-Cd battery pack in the Work*about* can be recharged without removing it from the machine.
- other computers and devices, for example printers, that can be connected and communicate via a serial port. In order to utilise the LIF-PFS socket for this purpose you need to attach a Psion 3Link lead to a LIF converter and then plug the LIF converter into the Work*about*'s LIF-PFS socket. The 3Link lead thus becomes the Work*about*'s serial port C.
- other computers and devices, for example printers, that can be connected and communicate via a parallel port. To use the LIF socket for parallel printing, you need a LIF converter and a Psion Parallel 3Link; see your Psion distributor for more information.

The LIF converter

A LIF converter is supplied with every Work*about* mains adaptor; they can also be obtained separately from your Psion distributor.



The Internal Expansion ports

The Work*about* supports Internal Expansion ports at each end of the machine which allow it to be connected to other computers and devices via Expansion modules. It can be supplied with the following Expansion modules factory-fitted and ready for use:

- RS-232 AT interface module in the bottom port A.
- RS-232 AT & RS-232 TTL interface module (suitable for connecting it to a number of computers and devices, for example industry standard barcode scanners and printers) in the top ports A and B.
- Barcode & RS-232 AT interface module in the top ports A and B.

A Barcode & RS-232 TTL interface module is **not** available.

Labels on the Work*about* indicate which Expansion modules are fitted (if any).

Important: The current drawn by a peripheral attached to the Work*about* must **not** exceed 200mA.

The Fuse

The Work*about* is protected against damage due to problems with its battery power supply by a main fuse. This is fitted beneath the main batteries in the SSD/Battery drawer. Under normal circumstances, you should never need to replace it; however the following situations can cause the fuse to blow:

- Batteries fitted the wrong way round if mechanical failure stops the normal mechanisms preventing them making contact.
- A short circuit across the main batteries.
- A fault with the Work*about* that causes an excessive current flow from the main batteries.

If the fuse does blow, the Work*about* will lose battery power and you will not be able to use it with battery power until a new fuse has been fitted. **You should not replace the fuse yourself.** Instead, you should send your Work*about* along with your name and address details by registered or recorded delivery to the Psion Production and Service Centre at the following address:

Psion Production and Service Centre
17-19 Bristol Road
Greenford
Middlesex UB6 8UP

where it will be tested for faults and the fuse replaced. You will be sent a return note to confirm receipt of your Work*about* and it will be returned to you as soon as possible.

2

Basic use

This chapter describes how to operate a Work*about* that is using the default settings. If the setup on your Work*about* differs from the standard one, some aspects of the keyboard and screen display may not match the descriptions that are given in this section. If you are in any doubt, contact your application developer.

This chapter tells you how to:

- **switch the Work*about* on and off.**
- **use a Startup file to run applications.**
- **reset the Work*about*, should it ever be necessary for you to do so.**

It also contains "Troubleshooting" information which you can refer to if anything ever goes wrong with the Work*about*.

Turning on and off

You can turn the Work*about* on as soon as you have fitted charged batteries or connected it to a mains power supply.

To turn on: press the On key. The Work*about* will switch on and continue from where it was when it was last turned off.

To turn off: press the Off key.

☞ When you turn the Work*about* off, no information is lost, but neither is any information saved; the Work*about* gets switched to a "stand-by" state in which the screen, Internal Expansion ports and processor are de-activated. If you remove both sets of batteries when the Work*about* is in this state you will lose all the information currently stored in the internal memory and on the internal disk `M:`.

The Work*about* switches off automatically when the machine has been idle for a certain time. The default automatic switch off time is 5 minutes, however this time limit is under application control; see your application developer for details.

Turning on for the first time

When you switch the Work*about* on for the first time, the Copyright screen is displayed for a short time. Meanwhile, the Work*about* searches all its disk drives (internal disk and both SSD drives) for a *Startup* file.

☞ A *Startup* file is a batch file that normally contains commands to set various system settings, for example the auto switch off time, and run applications. For more information, see the 'Advanced use' chapter later in this manual.

If a Startup file is found, the Work*about* runs it automatically. You will then see the screen prompts or application screen that your Startup file is set to display.

If the Work*about* doesn't find a Startup file, you will see a message on the screen that tells you what to do, it will typically say:

```
Insert Startup (autoexec) SSD and press Enter
```

You should, in the latter case, insert the SSD that contains your Startup file and press Enter.

Troubleshooting

If your Work*about* seems to be malfunctioning, read the relevant section below and carry out the recommended checks and corrective actions. If they do not solve your problem, you should seek assistance from your application developer; alternatively, you may wish to contact your Psion distributor.

Important: There are no user-serviceable parts within the Work*about*.

The Workabout won't turn on

When you first switch on the Work*about*, there may be a delay of a few seconds before any information is displayed. If the screen continues to remain blank, try pressing the Contrast key to adjust the screen contrast.

If this doesn't work, you will need to check that the Work*about* is receiving power: make sure that charged batteries are fitted and that the main fuse is not blown. If the fuse has blown you will need to return your Work*about* to a Psion Service Centre. See the 'Introduction' chapter earlier in this manual for more information about the fuse.

If the Work*about* has power and adjusting the contrast does not solve the problem, it may be that an application running on the Work*about* has disabled or wrongly set the contrast control; see your application developer for assistance.

Screen too dark, or insufficient contrast

Press the Contrast key to adjust the screen contrast.

Beeping

The Work*about* will beep if you try to type in too many characters in a particular place – for example, when typing filenames in a dialog. The volume of these beeps is controlled by the 'Sound' option in the in-built System screen.

The Workabout switches off

Make sure that the batteries are charged, or check that the LIF converter and mains adaptor are securely fitted if you are using mains power. If the Work*about* has power, it could be that the Work*about*'s auto switch off time is set to an unsuitably short interval.

Some keys do not work

There are a number of reasons why this may happen, most of them concern the applications running on the Work*about*. For example, an application may disable the use of certain keys, or it may not recognise your local country and keyboard layout.

The Workabout does not "auto switch off"

The most likely explanation for this problem is that an application running on the Work*about* has disabled this function. Contact your application developer for more information.

Important: You should ensure that the automatic switch off function is left active; otherwise, if you leave the Work*about* on for a long period of time by mistake, you could discharge both the main and backup batteries completely. You would then lose data and not be able to use the Work*about* again until the batteries have been recharged or replaced.

'Memory full', 'No system memory' or 'Disk full'

A 'Memory full', 'No system memory' or 'Disk full' message is shown when you have almost filled the internal memory with information on the internal disk. Many of the things you do on the Work*about* need just a little free memory in order to work – displaying dialogs, menus, or Help information; so when you get an out of memory message you will often be unable to enter more information or change any settings until you have freed some memory.

Don't worry if you fill up the internal memory – your information on the internal disk is still safe. Just try the following to free some memory:

- Open any Database files that you have stored on the internal disk and use the Database's 'Compress' option, then exit each file. This will reclaim any space taken up by deleted or edited information.
- Internal memory is used to keep each file or application open, so close down open files and applications that you don't need right now. To do this, press Psion-Tab to cycle through all the running applications and use their exit options to close them down; if an application doesn't have an exit option, just press Psion-Esc.
- Delete any unwanted files on the internal disk.
- Copy files to an SSD, then delete them from the internal disk.
- Sometimes you can free (temporarily) a certain amount of memory by moving to an open application, for example the in-built Database, and using its 'Copy text' option on as small an amount of information as possible. This places the small amount of text on the clipboard, deleting any previously stored text.

  ☞ If you edit a large file, then open a small file, the Program editor may under some circumstances still take up more internal memory than necessary for the new file. Exit the file, then open it again.

If you want to keep an eye on the amount of internal memory which is still free, use the 'Memory info' option on the 'Info' menu in the in-built System screen. This will show you the amount of internal memory used and the amount free. If you press the ← and → keys, more details are given of what is using up the memory – the internal disk, each open Database file, and so on. Memory is measured in K (short for *kilobyte*) – 1K can hold just over a thousand characters.

Problems with menus

You cannot use the Menu key to display a menu in these situations:

- While a dialog is being shown on the screen.
- While you are using Help on the screen.
- While full screen messages, such as alarms and disk error messages, are displayed.

The Workabout "locks up"

If an application "crashes" (i.e. you get no response when you type things on the keyboard, etc.), you need to reset the Work*about*. See the instructions given under 'Resetting the Work*about*' later in this chapter. However, if you are not able to save the information on your internal disk to an SSD, you should see your application developer for help before attempting to reset the Work*about*.

Problems with SSDs

It's best not to remove an SSD while information is being written to it, for example when you have chosen to copy or save a file on an SSD drive, or when you have exited a file, to look at a new file.

If you do remove an SSD while it is being written to, a message is usually displayed asking you to replace it. If the disk's *volume name* is `backup` , for example, the message will typically say something like 'Please replace volume "backup"'.

You must either reinsert the disk and choose to retry, or opt to abandon the operation; you cannot use the Work*about* until you do so.

Important: If a file was being saved or written to in any way, and you choose to abandon, the file will almost certainly be corrupted and become unusable. You should then delete the file.

A 'Media is corrupt' message means that the Work*about* cannot read the structure of a disk. You may see it when trying to access an unformatted SSD. If the SSD is formatted, remove it, then re-insert it and try again. If you still can't get the Work*about* to access it, there may be a hardware problem with the SSD. Contact Psion Technical Support for information.

Problems with the LIF-PFS socket and LINK software

If you cannot access Port C, or the LINK software refuses to run, you should try the following:

1. Turn the Work*about* off and on again.
2. Type `STOP LINK` on the command line in the Command processor to stop the LINK software.
3. Disconnect the LIF converter and 3Link lead from the Work*about*.
4. Plug the 3Link lead into the LIF converter and then connect the LIF converter to the Work*about*.

5. Finally, type `LINK` on the command line in the Command processor to run the LINK software again.

Password-protected files

If you have given a password to a Spreadsheet file, and then forgotten it, that file is no longer available to you.

If it is the only Spreadsheet file (perhaps still called 'Sheet'), you will need to create a new file in order to use Sheet again, and use that instead. Position the highlight under the Word or Sheet icon in the System screen, and use the 'New file' option on the 'File' menu. Enter a different name for the new file. However, you will still be unable to access the password-protected file, until you remember the password.

Resetting the Workabout

You should never normally need to reset your Work*about*. Most applications are designed in such a way that they exit automatically when anything goes wrong, without affecting any of the information you have stored in the internal memory (RAM) or on the internal disk `M:`. However, in the unlikely event of an application going wrong to the extent that it stops the Workabout responding to things that you type on the keyboard, you will need to perform a reset.

When an application "crashes" (fails) you should first try a *soft reset*, as follows:

- Press the Psion-Ctrl-Del keys at the same time.

When you turn the Work*about* on again, it will beep, briefly display the Copyright screen and then perform the normal startup routine, i.e. it will look for a Startup file and display a prompt if it doesn't find one. All the information that you had saved in the internal memory and on the internal disk `M:` should still be there.

If the soft reset doesn't work, you will need to perform a *hard reset*:

- Press the Shift-Psion-Ctrl-Del keys at the same time.

This action resets the Work*about* completely - you will lose all the information that you had previously stored in the internal memory and on the internal disk. For this reason, **you should only use a hard reset when a soft reset fails.**

If a hard reset doesn't work, you will need to "reboot" the Work*about*:

- Remove all power from the Work*about*, i.e. disconnect it from any mains supply and remove both the main batteries and backup battery for a few minutes.

Rebooting also removes all the information currently held in the internal memory and on the internal disk.

3

Advanced use

This chapter is intended for experienced computer users and developers. It gives information about:

- **setting up a new Work*about*.**
- **the Work*about*'s system-wide settings.**
- **creating a *Startup batch file*.**
- **developing applications for the Work*about* and downloading them from a PC.**
- **the Command processor, the command line editor and the commands available on the Work*about*.**
- **peripheral products for the Work*about* that extend its capabilities.**

Setting up a new Workabout

Setting up a new Work*about* can involve one or more of the following procedures, depending on what the machine is going to be used for and by whom:

- Setting the system-wide settings, for example the system date and time and the automatic switch off settings.
- Creating a Startup batch file (`AUTOEXEC.BTF`) that will be automatically run by the Work*about* whenever it is switched on. The Startup batch file can set system-wide settings and load applications and files so that the user does not have to do it manually.
- Developing applications for the Work*about*.
- Downloading applications from a PC to the Work*about*'s internal disk or to an SSD and installing them.
- Setting up the Internal Expansion ports for printing.
- Running applications.

Switching on for the first time

The first time you switch the Work*about* on you will briefly see a Copyright screen and then the following message will be displayed:

```
Insert Startup (autoexec) SSD and press Enter
or press Menu for System Interface
```

This screen is referred to as the Startup Shell throughout this manual.

Pressing Menu displays a menu of options that allow you to move to the Command processor and the System screen. There is also an option to 'Restart shell', i.e. restart the Work*about* and display the initial Copyright screen.

- You can use the *Command processor* in a similar way to a DOS command processor; unlike a DOS command processor, however, it also has a number of menu options for setting various system-wide settings.
- The *System screen* is a built-in application that provides a "front-end" to the other built-in applications on the Work*about*; it also has menu options for a number of file management and system settings. The System screen is described in 'The built-in applications' chapter later in this manual.

Changing the system-wide settings

You can change the Work*about*'s system-wide settings via the menu options provided in the Command processor. If it is not already displayed, press Menu in the Startup Shell and then select the 'Command processor' option. You can also set some of the system-wide settings with the Work*about*'s SETDEF command on the command line or in a batch file.

It is a good idea to set at least the current date and time for a new Work*about* since these settings are likely to be utilised by other applications.

The date and time

To enter the current date and time, use the 'Time and date' option on the 'Time' menu in the Command processor. The formats in which the date and time are displayed are those specified with the 'Formats' option described below.

☞ If you enter incorrect or unsuitable numbers for the date, the day and month numbers are corrected to the largest values allowed. For example, if you typed 88888888 for the date, the numbers would be corrected to 31/12/2049 (the last date allowed by the Work*about*).

When setting the time, you can press `A` or `P` to change between "am" and "pm".

☞ In "am-pm" format, midnight is written with a `12` , and not `00` . For example, half past midnight is `12:30am` .

The Work*about* is accurate to within a few seconds a week. You can use the 'Time and date' option again if you ever need to reset the system time.

The date and time formats

The 'Formats' option on the 'Time' menu in the Command processor allows you to change the date and time formats, for example from a 12 hour to a 24 hour format, and the characters that are used for the date and time separators. By default the Work*about* is set to use the DMY date format with / as the date separator, and a 24 hour time format with : as the time separator.

Summer time settings

Most countries set their clocks forwards by an hour during their summer. The timing of these "summer times" in different countries is not something that can be calculated precisely, so it is not something that can be done automatically by the Work*about*. Consequently you need to set summer time on or off manually with the 'Summer time' option on the 'Time' menu in the Command processor; by default summer time is off.

The sound settings

The Work*about* can make two sounds: beeps and key clicks. The default setting is for both sound options to be turned on with beeps set to 'Quiet' and keyclicks to 'Loud'. However, if you wish to you can use the 'Sound' option

on the 'Control' menu in the Command processor to turn one or both of them off, or change the volume of the sounds that are produced.

The auto switch off settings

To conserve power the Work*about* is able to automatically switch off the screen Backlight after a specifiable period of time (the default switch off time being 10 minutes). It is also able to switch itself off when it has been idle for a certain time, the default setting is after 5 minutes. To change either of these automatic switch off settings, select the 'Auto switch off' option on the 'Control' menu in the Command processor.

Important: If you set the 'Auto switch off machine' line to 'Off', the Work*about* will only turn off when you press the Off key. You should not in general disable 'Auto switch off machine' when using battery power - if you were to leave the Work*about* on by mistake, it would stay on until the batteries failed. The Work*about* would then turn itself off and you would not be able to turn it back on again until you replaced the batteries.

The Work*about* does not automatically switch off when it is busy - for example when it is printing or transferring a file to another computer.

Keyboard settings

Every Work*about* can be set to use a UK keyboard or a Western European one (see 'The keyboard' section earlier in this manual for keyboard layouts of both types). However, Work*about*s are supplied with keyboard surrounds that indicate either UK keypresses or Western European ones. So if you often need write in French, for example, you can set a UK Work*about* to use the special keyboard so that you can type accented characters, though you will have to know where these characters are as they will not be indicated on the keyboard surround.

To change the keyboard in use select the 'Special keyboard' option on the 'Control' menu in the Command processor.

☞ When the special keyboard is selected, you will not be able to use all the hot-keys, for example Psion-X to exit the built-in applications; you will need to use the menu options provided in the application.

By default the Backlight key is enabled for both the UK and Western European versions of the keyboard. If you wish to disable it, select the 'Auto switch off' option on the 'Control' menu in the Command processor and change its setting.

Text wrapping

By default, text is not wrapped to the Work*about*'s screen width. You can use the 'Wrap on/off' option on the 'Special' menu in the Command processor to alter text wrapping.

The SETDEF parameters

The following switches are used on the SETDEF command line to alter some of the system settings – the default settings are marked with a hash (#), with any numerical settings given in brackets:

SWITCH	SETS
TS+	Summer time on
TS- #	Summer time off
S+ #	Sound on
S-	Sound off
AMnn #(5)	Auto switch off machine at nn minutes
ABnn #(10)	Auto switch off Backlight at nn minutes
DDMY #	Set date format to DD/MM/YY
DMDY	Set date format to MM/DD/YY
DYMD	Set date format to YY/MM/DD
Dn #(0)	Set start of week to n (where 0 is Monday etc.)
K0 #	Standard (UK) keyboard
K1	Special (West European) keyboard

You would normally only ever use the SETDEF command in a batch file to set up a number of system-wide settings.

Creating a Startup (AUTOEXEC.) file*

A Startup file can be used to set system-wide settings and run applications automatically when the Work*about* is first switched on so that the user does not have to perform these actions manually. The Work*about* automatically searches all its drives for a Startup file and runs it when it is first switched on.

Startup files **must** have the filename `AUTOEXEC` and can have any one of the following filename extensions: `.IMG`, `.APP`, `OPO`, `.OPA`, or `.BTF`. The default filename extension is `.BTF`.

To create a Startup batch file from the Command processor:

1. Type `EDIT AUTOEXEC.BTF`

The file `AUTOEXEC.BTF` is then created in the `\BTF` directory on the default disk and the Work*about*'s text editor is displayed.

2. Type the commands for the actions that you want the Work*about* to perform on startup in the order in which you want them to occur; a list of all the Work*about*'s commands is given later in this chapter. For example, you might have the following list of commands in your Startup file:

```
SETDEF AM10
REM sets auto switch off to 10 mins
SETDEF AB5
REM sets Backlight auto switch off to 5 mins
SETDEF DMDY
REM sets date format to MMDDYY
```

```
SETDEF K1
REM sets special Western European keyboard
SETDEF T24
REM sets 24 hour time format
LINK
REM runs Remote Link software
START MYPROG CLIENTS
REM runs Myprog application and tells it to use the data
REM file CLIENTS
```

See the section on 'The SETDEF parameters' earlier in this chapter for details of all the system settings that you can define with the SETDEF command.

If you want to use a number of different Startup files, it's best to create them on separate SSDs (saving them in a `\BTF` directory on each SSD). You can then just insert the SSD that contains the Startup file for the setup and applications that you wish to run when you need it; every time you wish to change setup, simply turn the Work*about* off, insert a different "Startup SSD" and switch the machine back on again.

If you do not wish to use SETDEF to change the system-wide settings when the Work*about* is first switched on and just wish to run an application, you can create the following kinds of Startup file:

- for `.IMG` and `.OPO` applications (and all the built-in applcations) you can simply rename the application filename to `AUTOEXEC.BTF` to make the Work*about* run the application as its Startup file.
- for other application types, you can create a batch file called `AUTOEXEC.BTF` that simply contains the command(s) to run the application and load the required file(s). For example, to run an application called `MYPROG.APP` using a data file called `DATA2` , the `AUTOEXEC.BTF` file would contain the following command:
  `START MYPROG DATA2`

Developing applications for the Workabout

You can develop applications for the Work*about* in two ways:

- By creating them on the Work*about* in the in-built Program editor using the Work*about*'s OPL programming language. You can then translate and run them. The Program editor is described in 'The built-in applications' chapter later in this manual.
- Alternatively, you can base your development on the PC and create your applications with OPL, or 'C' if you prefer. For this method of development you will need to obtain a copy of the relevant Psion Software Development Kit (SDK).

For more detailed information about application development please refer to the SIBO OPL SDK (Software Development Kit). If you intend to program in

'C', please refer to the latest version of the Psion SIBO 'C' SDK (currently 2.1).

☞ Application files must have a .IMG, .APP, .OPO, or .OPA filename extension.

Downloading applications from a PC

You can link the Work*about* to a PC using a Psion Serial 3Link lead and a LIF converter.

Important: When connecting and disconnecting a LIF converter and 3Link lead, you should not have the LINK software running on the Work*about*. So you should plug the LIF converter and 3Link lead into the Work*about* **before** running the LINK software, and exit the LINK software before disconnecting the LIF converter and 3Link lead.

If you have an Internal Expansion module fitted, you can also connect Port A (the nine-pin one beside the LIF-PFS socket) to a PC via an ordinary serial cable and a null modem in the same way that you would connect two PCs.

When you have connected the Work*about* and PC, you need to run suitable communications software on both the computers. The Work*about* has its own built-in communications software; select the 'Remote link' option on the 'Special' menu in the Command processor or System screen, or type `LINK` in the Command processor to run it. The Psion Serial 3Link lead may be supplied with communications applications for Windows and DOS PCs. For more information about communications software for linking the Work*about* to PCs, see your Psion distributor.

Once the communications software is running on both computers you can simply copy application files from the PC to the Work*about*, either to the internal disk `M:` or to an SSD in the `A:` or `B:` drives. Drives on the PC are seen as `REM::` (remote) drives by the Work*about*; a PC's `C:` drive for example will be seen as `REM::C:` . (For more information about the Work*about*'s filing system, see 'Files and directories' later in this chapter.)

See your Psion distributor for more information about the products available for linking your Work*about* to other computers.

Setting up the Internal Expansion ports

Two Internal Expansion ports suitable for printing may be fitted to a Work*about*: Port A, the 9-pin serial port, and Port C, the LIF-PFS socket; both are situated at the base of the unit. Port A is a serial port, and Port C can be a serial or parallel port, depending on what is connected to it (see 'The LIF-PFS socket' section earlier in this manual for more information).

The Startup Shell sets the following two environment variables:

```
P$PP=C
P$SP=C
```

When you press Psion-P to print, data is therefore sent to Port C by default. If you wish to use Port A for serial printing, you must set the serial port variable to Port A by typing `SET P$SP=A` on the command line, or include this line in any batch file that you have created for printing.

There are no plans at this time for any parallel port other than C.

Running applications

You can run an application synchronously from the Command processor by simply typing its name, in the same way as you would at the DOS prompt on a PC. For example, you would type `JOBSHEET` to run an application called Jobsheet. The Command processor will be suspended by the operating system until you exit the application when you run it in this way (synchronously).

To launch an application asynchronously (without suspending the Command processor), use the START command. For example you might type `START JOBSHEET`. The Command processor will continue to run concurrently with the application and you will normally be able to press Psion-Tab to switch between the application and the Command processor.

You can run the built-in applications synchronously from the Command processor by typing their application names as follows:

Application	**Type**
Database	`DATA`
Calculator	`CALC`
Sheet	`SH3` or `SHEET`
Program/script editor	`EDIT`
Comms	`COMMS`

To run them asynchronously, use the START command, for example you might type `START CALC`

☞ Although the Work*about*'s multi-tasking operating system, EPOC, runs operations asynchronously by default, the Command processor is designed to run them synchronously (unless the START command is used) for the sake of compatibility with MS-DOS.

The Command processor

You can enter Work*about* commands at the Command processor prompt `M>` in the same way that you would enter them at a DOS prompt. The Command processor pauses automatically at the end of each screenful of information, except when commands are executed from a batch file.

The Work*about* can run batch files of commands from the Command processor; they have a `.BTF` filename extension. These will usually look just like DOS batch files - they may even be DOS batch files as the Work*about*'s commands are so similar to DOS commands. More information about batch files is given later in this chapter.

Files and directories

Just as under MS-DOS on PCs, files are stored on the Work*about* disks in directories and sub-directories. These are referred to in exactly the same way as they are on a PC's DOS command line. For example, a batch file called `BACKUP.BTF` in the `BTF` directory of the internal disk would be referred to as `M:\BTF\BACKUP.BTF`. Files on disks on a remote computer that is connected to the Work*about* via the LIF-PFS socket are referred to in exactly the same way, just add `REM::` to the start of the file specification; for example the file `BACKUP.BTF` in the `BTF` directory of a remote PC's `C:` drive would be referred to as `REM::C:\BTF\BACKUP.BTF`

Keys and keypresses in the Command processor

←→ move the cursor.
↑ and ↓ recall up to 31 previous commands as they do with DOSKEY.
Ctrl-← and Ctrl-→ move the cursor a word at a time.
Psion-← and Psion-→ go the the start and end of the command line respectively.
Del deletes the next character and any highlighted text.
Shift-Del deletes the next character.
Shift←→ highlights text.
Esc deletes the entire line.
Psion-Del deletes from the cursor position to the start of the line.
Shift-Psion-Del deletes from the cursor position to the end of the line.

Exiting the Command processor

If no application has been launched from the Command processor, you can press Psion-X (or select the 'Exit' option on the 'Special' menu) or type `EXIT` to exit and return to the Startup Shell screen.

The Workabout commands

The Work*about* has a number of DOS commands which perform similarly to their DOS counterparts, for example COPY, DEL, MD, RD and CD, and a number of other commands for which there are no DOS equivalents.

An alphabetical list of all the Work*about* commands and their usage is given below:

COMMAND	USAGE
`A:` `B:`	Changes the default disk.
`ATTRIB filename`	Displays and alters file attributes such as read-only, archive, etc.
`CALL filename`	Calls a batch file from another batch file.
`CD, CHDIR`	Displays or alters the current directory.
`CLS`	Clears the Work*about* screen.
`COPY [source ] [destination] [/S][/Y]`	Copies a file or files. The source and destinations can be specified as a drive letter and colon, a directory name, a filename or a complete path. If a destination filename is not specified, the new file(s) will have the same filename(s) as the source file(s). Use the /S switch on the command line to include files in sub-directories and the /Y switch to suppress a confirmation dialog.
`DATE`	Displays the current system date.
`DEL, ERASE filename(s) [/S][/Y]`	Deletes one or more files. You can also delete files in subdirectories by using the /S switch at the end of the DEL command line. For example, you would type: `DEL M:\DATA\*.* /S` to delete all the files in the DATA directory on the internal drive (M:), including those in subdirectories. You can use the /Y switch to suppress a confirmation dialog.
`DIR [/S][/B]`	Lists the files and directories in the current directory. You can use the /S switch on the command line to list the files in sub-directories. The /B switch will display files in bare format
`ECHO [text] [ON/OFF]`	Without parameters, ECHO displays the current ECHO state. `ECHO [text]` displays the given text on the screen. `ECHO [ON/OFF]` selects the ECHO mode for batch files.

COMMAND	USAGE
`EDIT filename`	Runs the Work*about*'s plain text editor. This is intended mainly for editing batch files
`ERRLEVEL`	Displays the current errorlevel state.
`EXIT`	Terminates the Command processor, returning you to the process that launched it, usually the Startup Shell.
`FILES drive`	Lists open files on the specified drive.
`FOR`	Runs the given command for each file in a set of files. The syntax is as follows: `FOR %var IN (set) DO command [params]` where %var specifies a replaceable parameter, (set) specifies the set of files (wildcards can be used) and [params] specifies the switches to use with the given command. When using FOR in a batch file, use `%%var` instead of `%var`.
`FORMAT drive [label]`	Formats a disk in the specified drive.
`GOTO label`	Jumps to the specified.a label in a batch file.
`HELP`	Provides Help information on the Work*about* commands. Type `help` for a full list and brief description of the commands. Type `help command` for detailed information about a specific command.
`IF`	Runs a command conditionally. This is mainly for use in batch files.
`KILL process`	Kills (terminates) all processes that match the specification; they do not need to have been launched from the Command processor. Note that the process is not sent a terminate message. This is intended for **emergency use only** - under normal circumstances you should use the exit command provided in the application or the STOP command to terminate processes.
`LABEL drive name`	Adds or alters the volume label of a disk.
`LLDEV [devicename]`	Lists all the logical device drivers that match a specified device name, or lists all logical device drivers if a device name is not specified.

COMMAND	USAGE
LINK	Starts the LINK software that is used when connecting the Work*about* directly to another computer. This command is intended mainly for use in batch files. Note that you need to enter the required port and Baud rate on the command line. STOP LINK exits the LINK software.
LPDEV [devicename]	Lists all the physical device drivers that match a specified device name, or lists all physical device drivers if a device name is not specified.
LPROC [process]	Lists all the running processes that match the specified process name, or lists all running processes if a process name is not specified.
LSEG [segment]	Lists all memory segments that match the specified segment, or lists all memory segments if a segment is not specified.
MD, MKDIR directory	Makes a directory.
MEM	Displays the current system memory.
PAUSE	Suspends batch file processing.
QUIT	Exits the batch file in which it appears.
RD, RMDIR directory [/Y]	Removes a directory. You can use the /Y switch to suppress a confirmation dialog.
REM text	Marks a line of text in a batch file as a comment.
REN filename	Renames a file or set of files.
SET variable variable=	SET variable displays the values for the variable. SET var= deletes the values in the variable. Note that variable names are case sensitive.
SETDEF	Alters system settings that are otherwise set by menu options. This command is intended for use in batch files. See 'The SETDEF parameters' section earlier in this chapter for more information.
SHIFT	Shifts batch file parameters.
START process [parameters]	Launches the specified process asynchronously and returns to the Command processor immediately. You can press Psion-Tab to switch between running processes.

COMMAND	USAGE
`STOP process [/Y]`	Terminates all processes that match the specification; processes do not need to have been launched from the Command processor for STOP to work. Use the /Y switch on the command line to suppress a confirmation dialog. Note that processes are sent a termination message. It is better to use the exit command provided in applications
`TIME`	Displays the current system time.
`TYPE filename`	Displays the contents of a text file.
`VER`	Displays the Work*about*'s version information.
`VOL drive`	Displays the volume label of a disk.
`WAIT process`	Waits for completion of the specified process which has been started by the Command processor.

Typing `help` at the M> prompt displays a full list and description of available commands. For detailed information about a specific command, type `help` followed by the command name, for example type `help copy` for help on the COPY command. Unless you have already set 'Wrap on', you may need to press Psion-W (or select the 'Wrap on' option on the 'Special' menu) in order to read all the help text. Alternatively, you can press Shift-Psion-Z to zoom out and view the text in a smaller font.

☞ The Work*about* records the return code from errorlevels after each command. You can use the DOS-standard IF command (IF ERRORLEVEL...) to test the success or otherwise of the previous command. You can also use ERRORLEVEL to display this information. The errorlevels returned are TRUE and FALSE.

Batch files of commands

You can create batch files for other purposes in the same way that you create a Startup file, just type `EDIT` and then the name of the new batch file, for example you might type `EDIT BACKUP.BTF`.

Batch files can have any filename (up to eight characters long), but **must** have the filename extension `.BTF`.

Running batch files

Startup batch files (AUTOEXEC.BTF) are run automatically when the Work*about* is first switched on. Other batch files can be run from the Command processor by typing the name of the batch file, followed by any required parameters.

Batch files are always run synchronously; if you enter the START command, it is ignored.

Error messages

The Work*about* displays the following messages in the Command processor whenever an error has occurred:

ERROR MESSAGE	MEANING
Remote link not connected	The remote link that connects the Work*about* to another computer is disconnected and you have tried to perform an action that relies on the existence of the link. You should physically connect the two computers, run the linking software on both machines, and then try again.
Bad command or file name	You have mis-typed a command or file name, or entered a command or filename that does not exist. You can use the HELP command to verify the command that you entered.
Invalid directory	You have selected or entered the name of a directory that does not exist.
Invalid drive specification	You have selected or entered a drive that is currently unavailable or does not exist.
Invalid parameters	You have used a command with a parameter that is currently unavailable or does not exist. Check the parameters available with the HELP command.
Syntax error	You have entered a command using the wrong syntax. Check the correct syntax using the HELP command.
Unknown process	You have tried to STOP, WAIT OR KILL an application that is not currently running on the Work*about*.
xx failed	The operation xx has failed.

Peripheral products for the Workabout

A number of peripheral products that extend the Work*about*'s capabilities are briefly described below. For more information about any of these products, please contact your Psion distributor.

Solid State Disks

Two types of SSD are available that provide extra data storage capacity: Flash SSDs and RAM SSDs. Both types are supplied in a variety of capacities - larger capacity SSDs are continually being developed.

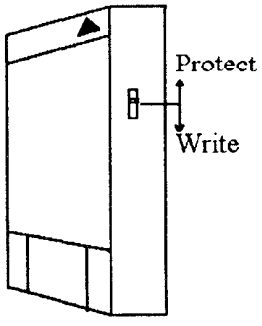
- **Flash SSDs** are a highly secure medium as they do not require a battery or other power supply to preserve data. Information on a Flash SSD should remain intact for at least ten years. Flash SSDs are best suited to storing data that is not frequently altered because they do not allow selective overwriting of information. When they become full, you must format them to make them blank again.

  There is a special Psion utility to format a Flash SSD which is available with version 2.1 of the Psion SIBO 'C' SDK (Software Development Kit). For more information please contact your Psion distributor.

- **RAM SSDs**, unlike Flash SSDs, require a power source to keep the information stored on them secure. When they are inside the Work*about* they use the computer's power supply to keep the data secure. They also contain a 3V lithium battery (the same as the Work*about*'s backup battery) which provides the power to keep the data safe when they are removed from a computer. When there is no other power supply, a **new** battery will preserve information on a RAM SSD for at least 3 months. Removing a battery from a RAM SSD, or removing a RAM SSD from an SSD drive when the battery is "flat", results in the loss of all the information it contained. Before changing the battery in a RAM SSD, you should copy all the data it contains to another SSD or the Work*about*'s internal disk.

  RAM SSDs are ideal for storing data that is frequently altered since you can overwrite information selectively.

If you wish to protect the data on an SSD, you can write-protect it. To do this you simply use something like the end of an opened paper clip to set the write-protect switch on the edge of the SSD to the 'Protect' position. To turn off write-protection, just set the write-protect switch back to the 'Write' position.



Solid State Disk drives for PCs

Although you cannot directly use SSDs with PCs, a Solid State Disk drive unit for PCs (and the software to control it) is available from Psion. SSDs inserted in the unit can be accessed by the PC like any other PC drive. For more information about SSD drives for the PC, please contact your Psion distributor.

The Holster

A rigid plastic Holster is available for storing the Work*about*. You can screw it to any convenient vertical surface, for example the side of a desk, or the dashboard of a vehicle. Two models of the Holster are available: a simple Holster and a Holster with a LIF converter.

The Docking Station

A Docking Station is available for the Work*about* which can be used to recharge the Work*about*'s Ni-Cd battery pack and transfer data to other peripherals, for example a printer. It is available in two models: one for fast charging the battery packs and another for trickle charging. Both models can charge the battery pack inside a Work*about* and a spare battery pack.

The leaflet supplied with the Docking Station explains how to use it.

The Mains adaptor

A mains adaptor suitable for connecting the Work*about* to an AC mains power supply is available. The mains adaptor cannot be plugged directly into the Work*about* – it is supplied with a LIF converter which plugs into the Work*about*'s LIF-PFS socket to which the mains adaptor can be connected.

The Accessory pack

The Accessory pack contains an elasticated strap which can be fitted to the back of the Work*about*. This allows you to wear the Work*about* on your arm or belt for easy carrying, leaving your hands free.

Internal Expansion modules

A number of Internal Expansion modules can be fitted to the Work*about* which allow it to communicate with other computers and devices. These are described under 'The Internal Expansion ports' in the 'Introduction' chapter earlier in this manual.

4

The built-in applications

This chapter tells you about the following applications:

- **The System screen that acts as a "front-end" to the other built-in applications.**
- **Data, the database application which you can use like a card index system for storing a variety of information, for example names and addresses.**
- **Calc, the scientific calculator which you can use in a similar way to a pocket calculator.**
- **Sheet, the spreadsheet that you can use to create tables, perform inter-related calculations and produce a graphical representation of your data.**
- **The Program editor which allows you to write and translate your own programs for the Work*about*.**
- **Comms, the communications software that provides terminal emulation, allowing you to connect the Work*about* to other computers or to other devices.**

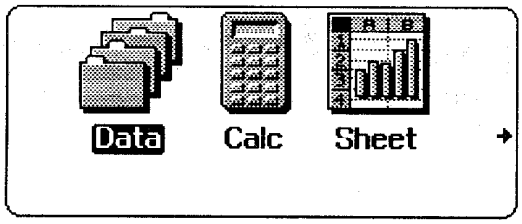
Introduction

Although the applications that are built into the Work*about* are fully functioning, they are only really intended to demonstrate the sophistication and flexibility of applications that can be developed for the Work*about*. They are included with the Work*about* as an aid to application development and would therefore only normally be used by application developers.

To display the built-in applications, press Menu in the Startup Shell and select the 'System screen' option. A copyright information message will appear briefly and then the System screen will be displayed, as described below.

The System screen

The System screen displays icons for all the built-in applications, some of which are shown in the following screenshot:



Menu options are provided for installing additional applications and removing applications that you no longer wish to use. Press Menu to display the menu bar and use the ←→ keys to move between the menus. (Menus and dialogs are described in detail later in this chapter.) The System screen menus are as follows:

- 'File' and 'Disk' menu options allow you to manage your files, directories and disks. For more information, see the 'File Management' section later in this chapter.
- 'Apps' (Applications) menu options which you can use to install, remove and exit applications.
- 'Info' (Information) menu options display information about the Work*about*'s batteries, disks and memory.
- 'Ctrl' (Control) menu options allow you to change system settings as described in the section that follows.
- 'Spec' (Special) menu options determine the default display of information, among other things; these are described later in this chapter.

System settings

The system settings are utilised in the built-in applications where appropriate. They are as follows:

- The 'Sound' option settings determine the sounds that applications on the Work*about* are able to produce via the buzzer. The initial setting is for all sounds to be on. However, you can turn some, or all of the sounds off, and change their volume.
- The 'Auto switch off' option specifies whether the Work*about* switches itself off after a certain period of idleness. You can disable automatic switch off, set the Work*about* to switch off automatically if it has no external power, and also alter the switch off time interval.

  ☞ **Important:** You should not, in general, disable 'Auto switch off' when using battery power - if you were to leave the Work*about* on by mistake, it would stay on until the main and backup batteries became completely discharged. The Work*about* would then turn off and you would lose all the data stored on the internal disk and not be able to turn it on again until you changed the batteries.
- The 'Set time and date' option sets the current system time and date.
- The 'Time and date formats' option sets the date and time formats and the characters that are used for the date and time separators. See 'Changing the system-wide settings' in the 'Advanced use' chapter earlier in this manual for more information.
- the 'Default disk' option sets the disk that is selected by default in any dialog where you specify the location of a file. The default disk is also the disk on which applications may save files as and when they are required.

User preferences

Display preferences that cannot really be classed as system settings are grouped together and alterable from the 'Set preferences' option on the 'Special' menu in the System screen, as follows:

- Press Tab on the 'Number formats' line to set the currency symbol, decimal point character, etc. that is used in the Calc and Sheet applications. These settings may also be used by other applications that have been installed on the Work*about*.
- Press Tab on the '"Evaluate" format' line to set the format in which the results of calculations performed using the 'Evaluate' option in the Database application are returned. You can set the number format, e.g. fixed or scientific, number of decimal places, and trigonometry units. These settings may also be used by other applications that have been installed on the Work*about*.
- Select 'Shift-Enter' or 'Enter' on the 'Open multiple files' line to determine the keypress that you should use to open an application file without closing any previously opened application file from the built-in System screen.
- The setting on the 'Font' line determines the font that is used for the Work*about*'s built-in System screen display; you can choose between a Swiss or Roman font.
- Set the 'Keyboard' line to 'Special' if you wish to use the special Western European keypresses on the Work*about*.

General application features

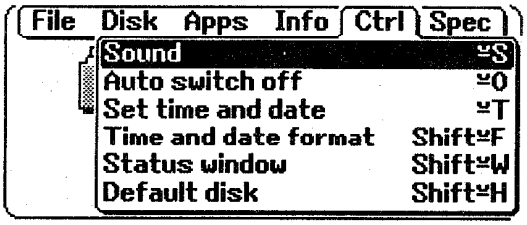
The following section gives you information about the features that are provided in all the Work*about*'s built-in applications.

Menus and dialogs

All of the built-in applications on the Work*about*, including the System screen described earlier in this chapter, have menus and dialogs to give access to commands. Each menu option also has a hot key that you can use to display its dialog that consists of the Psion accelerator key and a letter key that is appropriate to the option. If you press Menu to display the menu bar, you will see a hot key listed to the right of each option.

As you will see, the organisation of the menus and options broadly conforms to the standards used by many Windows-based applications. Since many computer users are familiar with this type of layout, it makes sense to implement it in the Work*about* applications.

The ←→ keys allow you to move between menus and the ↑↓ keys to move between the options in a menu.



To select a menu option, simply position the highlight over it and press Enter. For example, in the System screen, selecting 'Sound' from the 'Ctrl' menu displays the following dialog:

Within dialogs you can use the ↑↓ keys to move between the lines. Where the setting for a dialog line can be selected from a list of options, you can use the ←→ to cycle through the available options.

As is normal practice, Enter closes a dialog and Escape cancels it, leaving the original settings.

Where a dialog line requires the user to select a file, pressing Tab displays the File selector which allows them to navigate to the file. Pressing Enter then runs the file, if it is the type of file that can be run.

Sub-dialogs

Where a further sub-dialog is required from a dialog line, three dots are displayed at the end of the line and the user has to press Tab to move to the sub-dialog. To see an example of the latter, select the 'Set preferences' option on the 'Special' menu in the System screen; both the 'Number formats' and '"Evaluate" format' lines have '...' at the end to indicate a further dialog.

Special keys and keypresses

All the in-built applications support a number of special keys and keypresses, as described below:

KEY/KEYPRESS	ACTION
Shift + On/Esc	Displays help for the current screen. Use the ↑↓ keys to select a topic and press Enter.
Shift + On/Esc + Ctrl	Displays the index of help for the current application.
On/Esc	Press this key to remove Help, a menu or a dialog from the screen.
U	This key does nothing on its own. It is a modifier key that is used with other keys for extra characters and functions. These keypresses are written Psion-X for example.
Tab	Pressing Tab on lines in dialogs where you select or type the name of a file, displays the File selector. This allows you to navigate to your files and disks. Pressing the ↑↓ keys moves you up and down the directory structure, while pressing the ←→ keys switches between disk drives. When you have navigated to your file, press Enter and its name is entered in the dialog for you. Pressing Ctrl-Tab on a file name in the System screen displays the 'Specify filelist' dialog which shows the full path of the file. Press Enter and this dialog will disappear, leaving the File selector on display.

Help

All the built-in applications have their own help to which users can turn for guidance. Press Shift-Esc and you will see the index of help for the application. You can move the highlight to the required topic with the ↑↓ keys and press Enter to view the help text. Where there is more text than will fit on one

screen, a small arrow is displayed in the bottom right hand corner of the screen and you can press ↑↓ to scroll the screen. Pressing Esc moves you back up through the levels of help.

Opening and closing applications

You can run all the applications by highlighting the application icon on the System screen and pressing Enter. To close one, you can use the 'Exit' option in the application or highlight its icon in the System screen and press Delete.

You do not have to exit one application before opening another; the Work*about* is multi-tasking and can switch between applications without any need to close them. You can press Psion-Tab to cycle through all the running applications.

Cut/Copy/Paste, and Delete/Undelete

If you've used commands like these in other personal computer software, note that in the Work*about*'s in-built applications the 'delete' and 'cut' concepts are combined:

- When you *copy* highlighted information with 'Copy...' menu options (such as 'Copy text'), the information is copied to a *clipboard*. You can insert (*paste*) this information, as many times as you like, with 'Insert...' menu options. (This is usually called 'Insert text'; in the Spreadsheet it is called 'Paste'.)
- When you *delete* highlighted information with the Delete key, it is deleted from the file, but is **also** put on the clipboard. (This also happens if you delete part of a line with Psion-Delete or Shift-Psion-Delete. If you just delete a single character with the Delete key, however, the clipboard is not affected.)

  So if you delete information by mistake, you can use the 'Insert...' option to put it back (*undelete* it).

Each open application has its own clipboard. Whenever you copy, or Delete information to any application clipboard, information previously on the clipboard is lost. However, you can delete highlighted information **without** replacing the clipboard, by pressing Shift-Delete. (You cannot do this in the Spreadsheet, though.)

You can use the clipboard to copy and paste information between two files from the same application; just copy the information, open the second file and paste the information in. To copy information between files of a different type, you have to use the 'Bring' options.

File management

You can perform basic file management of most application files from the System screen and from within the application itself. Applications automatically save a file when an alternative file is opened.

- Many file management operations are available from options on the application's 'File' menu.

- Where operations must be done outside the application, for example copying, renaming and deleting files, as well as backing up and restoring files, there are options on the 'File' menu in the System screen.

Display features

Text wrapping

By default, text is not wrapped to the Work*about*'s screen width. A menu option is provided in all the applications that require them, for example the Command processor has a 'Wrap on/off' option on the 'Special' menu.

Status windows

The built-in applications support the display of a Status window on the right hand side of the screen. This contains text and graphical information, for example, the system time and date, battery information and the presence of SSDs:

Press Ctrl-Menu to turn the Status window on and off or to change its size in any built-in application. The 'Status window' option on the System screen's 'Ctrl' menu sets up Status windows in all the built-in applications (except the Command processor).

You can display a Status window temporarily by pressing Psion-Menu in all the built-in applications, including the Command processor.

'Zoom' settings

'Zoom in' and 'Zoom out' options are provided in applications for switching between the four different font (character) sizes supported by the Work*about*. As well as changing the size of text, this changes the amount of information displayed on the screen.

The four different zoom settings give the following number of characters per line and number of lines of text on the screen:

Zoom setting	1	2	3	4
No. characters	29	27	23	18
No. lines	9	7	6	5
Font size	8	11	13	16

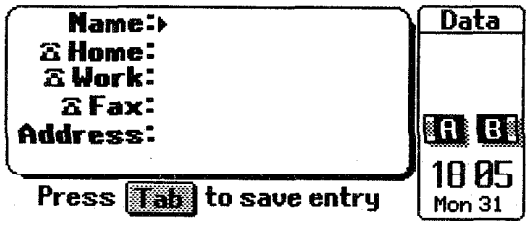
You can see four of the font sizes by pressing Psion-Z and Shift-Psion-Z in the System screen or Command processor - all but the smallest font size are implemented. The text editor launched by the EDIT command also supports zooming. The Command processor supports a fifth zoom setting that displays 39 characters on 12 lines in a size 6 font.

Data - the database

In the Work*about*'s Database, each field in the entry is called a line and each line has a label to indicate the information that should be entered on the line. The 'Edit labels' option on the 'Edit' menu allows you to change the default labels to reflect the information that is to be stored in the file. Labels can be turned on and off with the 'Hide/Show labels' option.

Adding, updating and removing entries

The first time you use the Database the 'Add' screen is shown so that you can type a new name and address entry straight away:



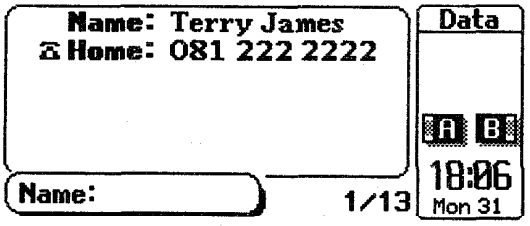
When you have finished adding entries, you can press Shift-Psion-F to switch to the 'Find' screen. To change an entry, you simply have to find it and then move to the 'Update' screen by pressing Shift-Psion-C.

As you have just seen, there is a different screen for each of the operations you might want to perform: adding an entry, finding an entry and updating an entry. Options on the 'Entry' menu allow you to switch between the screens. The text at the bottom of the screen lets you know which screen you are viewing and what you can do.

To completely remove an entry, you simply have to find it and Press Psion-D, (or select the 'Delete entry' option on the 'Edit' menu) or press the Delete key. As a security measure there is a confirmation prompt following the delete command.

Searching

You can only search for an entry, or for information in any entry, from the 'Find' screen. The search clue that you enter can be on any line in any entry, unless you have chosen to limit the search to particular lines with the 'Find by label' option on the 'Search' menu; in this case the text along the bottom of the screen will change to reflect the label that you have chosen to search on, e.g. "Name" rather than "Find":



If a match is found, the entry is displayed; if there is more than one matching entry, you can press Enter to look at them in turn. If no match is found, or there

are no more matching entries, a message is displayed such as 'Not found' or 'No more found'.

Moving directly to an entry

Entries in the Database file are numbered. The current entry number, along with the total number of entries, is displayed in the bottom right hand corner of the screen as, for example, 1/13 (entry 1 of 13 entries) in the previous screenshot.

If you know the number of an entry, you can move directly to it with the 'Jump to entry' option on the 'Search' menu.

☞ When you update and save an entry, it is moved to the end of the Database file, so its entry number changes to the last entry in the file.

Compressing a Database file

The space used by changed and deleted Database entries is not automatically reclaimed. A menu option is therefore provided on the 'File' menu to allow you to compress the Database file manually.

Important: You cannot compress Database files that are stored on Flash SSDs. You need to copy them to the Work*about*'s internal disk and compress them there, and format the Flash SSD before copying the file back again. Alternatively, you can use the 'Save as' option to create a new, compressed copy of the file on the Flash SSD.

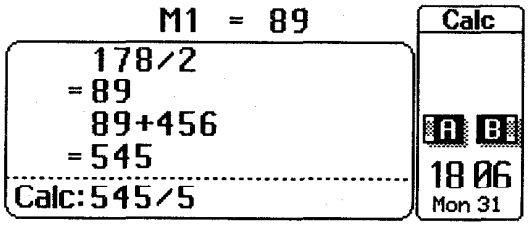
Other useful functions

- Options on the 'Display' menu allow you to change the way that information is displayed, you can for example, hide all the labels.
- The 'Merge in' option on the 'File' menu lets you merge the entries and/or display settings from another Database file. You might wish to do this to create a single Database file from two separate files, or to copy the settings from another Database file into the current one so that both files look the same.
- The 'Save as' option on the 'File' menu allows you to save a Database file as a file of plain text with line breaks, rather than separate entries. This can be useful if you wish to utilise the information in a Database file in other applications.
- The 'Bring text' option on the 'Edit' menu can be used to insert text that is highlighted in other applications and other Database files at the cursor position.

Calc - the scientific calculator

Calc is a programmable scientific Calculator. It can handle positive and negative numbers between 9.999999999999e99 and 1e-99.

The Calc screen is divided into three areas:



- the top line displays the contents of the current memory;
- the bottom line displays the calculations you type, and
- the central area above the calculation line shows your previous calculations and their results.

New calculations

To perform a new calculation, you can just type it without any spaces between the numbers and the *operators*, for example `34.5+23.6+89`, and press Enter. See 'Precedence of operators' below for the order in which calculations are done. Pressing Esc clears a previous calculation.

You can utilise the "result" or answer of a calculation you have just performed as part of a new calculation, just type the operator you want to use and then the next number.

Precedence of operators

Calc performs calculations in a specific order, according to the precedence (ranking) of the operators in the calculation:

First: ** ('. . . to the power of . . . ') then
- (make negative, as in -45) then
* / (multiplication and division)

Last: + - (addition and subtraction).

☞ Parts of calculations in brackets are worked out first.

For example, the result of the calculation 2+3*5 is 14 because the multiplication is done first.

If two operators have equal precedence (such as addition and subtraction) the calculation is worked out from left to right. For example, `7-3+2` is `6` (not 2). Powers, however, are worked out from right to left, so `2**3**2` is `512` i.e. `(2**9)` not `64` `(8**2)`. For more information, see the 'Operators and logical expressions' appendix.

Percentages

The percentage operator can be used like this:

60+5%	=	60 plus 5% of 60 = 63
60-5%	=	60 minus 5% of 60 = 57
60*5%	=	5% of 60 = 3
60/5%	=	What number is 60 5% of? = 1200
210>5%	=	What number, when increased by 5% becomes 210 = 200
210<5%	=	How much of 210 was a 5% increase = 10

For more information, see the 'Operators and logical expressions' appendix.

'Syntax error' messages

Typing errors produce a 'Syntax error' message at the bottom right hand side of the screen. The cursor also moves to the first mistake. Calc holds the previous "calculation" or sum in memory, so you can use the ↑↓ keys to bring back the old calculation, correct the mistake and then press Enter to re-calculate.

Very large and very small numbers

- Calc does not support the use of commas when you enter large numbers, you should enter 1000000 not 1,000,000.
- For very large or very small numbers, you should use e (upper or lower case) as the exponent of the number. An e usually follows a number between 1 and 10 and is itself followed by another number; 3.435e3 means 3.435 times 'ten to the power of' 3 (i.e. 1000), so 3.435e3 means 3435.

Changing the number format

Calc supports a number of different number formats, including hexadecimal numbers (or base 16) as used by some programmers. The 'Format' option on the 'Special' menu allows you to switch between them. You can use hexadecimal numbers in any calculation, regardless of the format used for the result. For example, &F9*2 is the same as 249*2 and gives the same result: 498, or &1F2 in hexadecimal format.

Arithmetical operators used with hexadecimal calculations always give a whole number as a result. Whereas 3/2 and &3/2 give 1.5 as the result, &3/&2 gives 1.

Calculator memories

Calc has ten memories (M0, M1, . . , M9) that can be used for saving the results of calculations. The 'Min', 'M+', 'M-', 'Mclear' and 'Mrecall' options on the 'Memories' menu all operate on the current memory. You can use the 'Change memories' option to change the current memory.

Advanced calculations - functions, powers, and logs

There are two ways to perform calculations using mathematical functions, powers and logs. Either:

- Select the appropriate option from the 'Trig', 'Powers', or 'Logs' menu and then type the numerical value in the brackets. Or:
- Highlight the numerical value and then select the appropriate option from 'Trig', 'Powers' or 'Logs' menu.

There are hot-keys listed beside each of the menu options to make entering calculations easier. If you want to do 'to the power of' calculations for which there is no menu option, use the ** operator. For example, 2**3 is 2 cubed or 2x2x2.

OPL modules in Calc

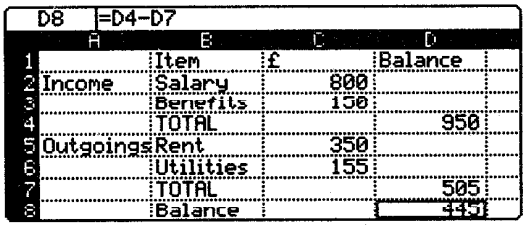
You can load and use OPL modules in Calc. If you do so, the module must be available for **all** future calculations. If you delete it, or remove the SSD which contains it, a 'Module does not exist' message will be shown **on every future calculation**. There are two ways to solve the problem:

- Reinsert or recreate the translated OPL module.
- Exit then reopen the Calculator.

Sheet - the spreadsheet

Sheet works in a similar way to Lotus versions 1a and 2, but there are some differences (see 'Notes and tips for advanced users' later in this chapter). Sheet creates files called worksheets.

As with most other spreadsheets, each "box" in a worksheet is referred to as a *cell* and each cell is referred to by its grid reference, i.e. A1, B2, etc.:



There are three types of information you can type into a cell:

Numeric	The first character is either 0123456789(.+- . The data is treated like a number and you can therefore use it in calculations
Formulae	These are used to perform calculations. To tell Sheet that the data in a cell is a formula type an = first. E.g. =SUM(D2:D7)
Text	These cells start with any other character. To make Sheet treat a number as text, type an apostrophe (') before the number.

You can start typing immediately to create a new entry in a cell. To change the contents of a cell, you simply move the cursor onto it and press Enter. A cursor appears on the editing line at the top of the screen along with the cell contents and you can edit the text in the usual way. Enter confirms any changes made.

Performing calculations using formulae

All calculations in Sheet are specified with formulae that contain references to appropriate cells rather than numbers. Formulae always start with an = character, not a +. For example you might have cells containing the following:

=A1+B1
=SUM(C1:C5)
=(A1+A2+A3)-(B1+B2+B3) or =SUM(A1:A3)-SUM(B1:B3)
=((A1+A2)*B1)/2

If the number in a cell referred to in the formula changes, the result of the formula then changes automatically. Formulae cells display the result of the calculation, not the formula itself.

Formulae can contain mathematical functions; see 'Calc - the scientific calculator' earlier in this chapter or press Shift-Esc in Sheet for more information.

Altering the appearance of a worksheet

- You can insert and delete cells, rows and columns with the 'Open/close gap' option on the 'Edit' menu.
- Options on the 'View' menu allow you to format cells in your worksheet, to change the column widths and the alignment of text and numbers in cells.
- Titles that you enter to label rows and columns can be "turned on" to lock them in position when you move away from the top left hand of the table. To switch 'Titles on/off' you need to move to the cell immediately beneath the column titles and next to the row titles (this will usually be cell B2) and select 'Titles on' or 'Titles off' from the 'View' menu.

  ☞ You cannot turn 'Titles on' if the cell pointer is in A1.

  ☞ You cannot edit the data in title cells when the 'Titles on' option is set.
- You can show or hide grid lines and labels with the 'Show' option on the 'View' menu. Set to 'Yes' the items you want to show and to 'No' those that you wish to hide. To hide any cell containing the number zero, or a formula returning zero set the 'Zero values' line to 'No'.

Notes and tips for advanced users

- An @ symbol is not needed at the start of function names.
- Ranges of cells are referred to with colons: e.g. A1:C3 not A1..C3.
- The power operator is ** not ^.
- To hide a column, set its width to zero.
- Logical operators, such as AND and OR, do not need # symbols around them.
- The Lotus @ function is called AT in the Spreadsheet.

Other useful functions

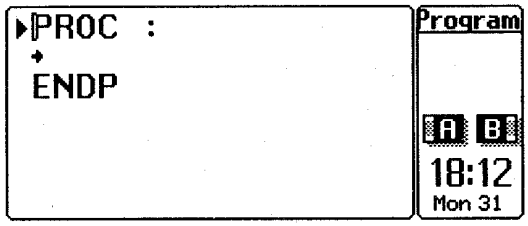
- 'Find' on the 'Search' menu allows you to find text or numbers in cells. You can also jump directly to a cell reference with the 'Jump to' option on this menu.
- You can highlight a range of cells and press Psion-/ (or select 'Graph' on the 'Special' menu) to plot their data as a graph. To change the range of data included in the graph, you must select a new range manually from within the 'Graph' view (use the 'Set ranges' option on the 'Ranges' menu).
- You can name ranges of cells with the 'Name range' option on the 'Range' menu. This allows you to jump directly to ranges, sort information and apply password protection to areas of the worksheet.
- Sheet has a database facility, available from the 'Data' option on the 'Special' menu. To use it, each column of your worksheet must have a field name in the first row. Thereafter, each row is a record and each column is a field. Each worksheet can have just one database; this becomes a named range called "database".

The Program editor

The Program editor lets you write your own programs for the Work*about* in the built-in OPL programming language and then translate and run them. It is the text editor that is run for .OPL files when you type EDIT in the Command processor. You can type and edit in the Program editor in much the same way as you would in a text editor, however, the text that you type does not word-wrap - you must press Enter at the end of each line to start a new one.

OPL is a procedure-based language, that is to say, the procedure is the building-block of OPL programs. Each specific task (or function) that you want the Work*about* to perform is defined by a procedure; this procedure can contain a number of statements or commands which the Work*about* acts upon. Although a simple OPL program may have just one procedure, a number of tasks or procedures can be grouped to form a module for sophisticated programs.

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:



These are the *keywords* that mark the start and end of procedures in OPL. You enter the statements for your procedure in order between the PROC: and ENDP. When you eventually run the program, the Work*about* goes through these statements, one by one.

When you have finished typing your program, you use the 'Translate' option to convert your procedure into a program that you can run on the Work*about*. To run a translated program, use the 'Run' option on the 'Prog' menu, or type the program name in the Command processor.

For more information about creating your own OPL programs in the Program editor, see the 'Creating and running programs' chapter later in this manual. Please contact your Psion distributor or refer to the SIBO OPL SDK (Software Development Kit) for further help.

Comms - the communications software

Comms is an application that allows you to use the Work*about*'s RS-232 serial port to communicate with:

- another computer directly. (Note that Comms would not normally be used to directly connect the Work*about* to another computer because there are a number of Windows and DOS packages available that make this operation seamless; please contact your Psion distributor for details.)
- other computers via a modem.
- text peripherals like electronic mail systems and bulletin boards via a modem.

It is the same application that you reach by typing `COMMS` in the Command processor.

What you need to use Comms

To link the Work*about* to another computer you will need a Psion Serial 3Link lead and a LIF converter. To connect it to a modem, you will need a Psion Serial 3Link cable, a LIF converter and a Psion modem adaptor. If you have an RS-232 Internal Expansion module, you could use a plain cable to connect Port A (the nine-pin D-type connector beside the LIF-PFS socket) directly to your modem in the same way that you would connect your PC to a modem. Please contact your Psion distributor for more information about communications products for the Work*about*.

About Comms

If the other computer allows direct input via its serial port, you can run Comms and use the Work*about* as a *terminal*, typing commands to the other computer and displaying its responses on the Work*about* screen.

Much of the power of Comms lies in using its *script language* to automate control of modems and remote systems. The Work*about* has a built-in editor for creating these files; see the 'Advanced use' chapter earlier in this manual for more details. Further information about the creation and use of script files is beyond the scope of this manual; see the manual supplied with the Psion Serial 3Link lead, the SIBO OPL SDK (Software Development Kit) or the latest version of the SIBO 'C' SDK (currently v2.1) for more information.

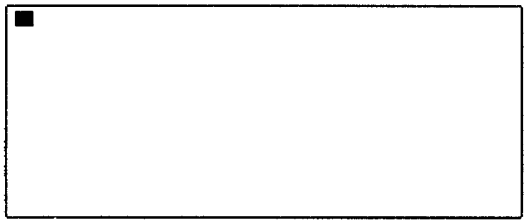
Setting up a link with Comms

There are three steps involved in setting up a direct or modem link to another computer with Comms:

- Physically connecting your Work*about* and the other computer or modem.
- Running Comms to display the Terminal Emulation screen.
- Setting up the serial port so that the Work*about* and the other computer can communicate with each other.

Running Comms - the Terminal emulation screen

When you first start Comms, it will automatically search for a free port; it will go through the ports that are fitted in alphabetical order. Unless you have specified a particular port in a script file, it will open the first one that it finds. It will then briefly display a message in the bottom right hand corner of the screen showing the port that is being used, for example 'Port TTY:A online...'; when the screen clears, the Terminal emulation screen will be displayed:

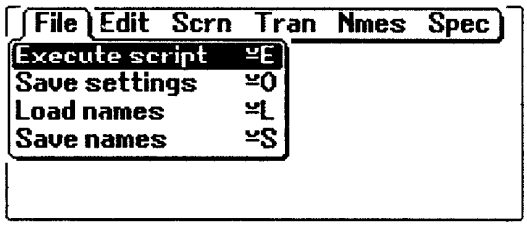


If there is no free port, you will see the message 'Failed to open a comms port. No port currently available'. You should press Esc to exit Comms. Most machines will only be fitted with one port, so if this happens it is likely that LINK or some other application is using the port. If this is the case, you will need to type `STOP LINK` in the Command processor to exit the LINK software.

If Comms has opened a port other than the one that you want to use, you can use the 'Port' option on the 'Special' menu to change it. If a message like the following: 'Cannot open comms port TTY:A' is displayed, the port is either not installed, not plugged in (in the case of TTY:C), or in use by another application.

Ports D: to I: are TTL ports and are therefore not suitable for modems etc.

If you press the Menu key, you will see the various Comms menus. There are options for, among other things, selecting and setting up the serial port, and for transmitting and receiving files:



When you have finished using Comms you should exit the application to save memory. You will return to the screen from which you launched Comms, if it is still running, if not you will move to another running application. If there are no running applications, you will return to the Startup Shell.

Port settings

The 'Port' option on the 'Special' menu sets up the serial port for communication. The settings for Baud rate (speed), Parity, Data bits and Stop bits must match those on the computer or modem with which you are communicating. If they do not, data transmitted in either direction will almost certainly be interpreted wrongly.

Without handshaking, the Work*about* can display received data at up to 4800 Baud, without losing data. (If you are saving received data as a file, you must use slower speeds.)

☞ If you set 7 data bits and 'Even' or 'Odd' parity, but set 'Ignore parity' to 'Yes', any data received will be treated as 7-bit data, with the eigth bit set to zero. The effect of this is that you can correctly receive data which is sent as 7-bit even parity, 7-bit odd parity, or even 8-bit no parity (for character codes below 128).

When communicating via modems, bear in mind that modern modems can sense the speed at which you are transmitting, and adjust to it. However, older modems may require that you communicate with them at a particular speed. See your modem manual for more information.

Handshaking settings

The 'Handshaking' option on the 'Special' menu can be used to alter the handshaking settings. The Work*about* is initially set to use XON/XOFF handshaking. The XOFF character is Control-S (character 19) and the XON character is Control-Q (character 17).

If the computer to which you are connected is set to use XON/XOFF handshaking, you should never lose any characters. If it uses a different method, change the handshaking settings on the Work*about* to match.

Special codes for Enter and Delete keys

By default Comms sends a "Carriage Return" character (character 13) when the Enter key is pressed and a "Backspace" (character 8) when the Delete key (sometimes known as Backspace) is pressed. However, different computers require different codes to be sent when these keys are pressed and you should change the Comms character code settings to match those required by the remote computer. To do this:

1. Select the 'Translates' option on the 'Special' menu.
2. Type the one or two character codes that you wish to be sent for each key between angle brackets. For example, you might set the 'Enter key' line to `<13><10>` (a "Carriage return" "Linefeed" pair) and the Delete line to `<127>`.

The numbers are shown in the dialog in hexadecimal format, beginning with a `$` sign. You can use hexadecimal yourself, if you prefer - the above example could be entered in hexadecimal as `<$d><$a>`, or `<$0D><$0A>`.

The type of terminal emulation

When you are using the Work*about* as a terminal connected to the serial port of another computer, Comms acts like a plain 80 by 25 character "teletype" - it does **not** emulate any type of terminal, such as the "VT100".

The display of information

Each character you type in the Terminal emulation screen is transmitted via the Work*about*'s serial port to the attached computer or modem. When a character is received via the serial port, it is displayed on the screen.

You can set the Work*about* to display characters as you type them, if you need this, by setting 'Echo' to 'On' from the 'Translates' option on the 'Special' menu.

The Work*about* screen has a border around the outside. You can turn it on and off with the 'Border on/off' option on the 'Screen' menu. Without the border, there is slightly more room for text. The 'Screen rows' option on the 'Screen' menu controls the numbers of rows of text on the screen. The default number of rows is 25, but you can set any number between 25 and 100.

☞ To see the 26th line with the 80x26 font, you must increase the 'Screen rows' setting.

When lines longer than the width of the screen are received, only the first part of them is displayed. You can, however, review any part of the screen area by using the ← ↑ ↓ → keys. The Work*about* screen "moves" as if it were a window on top of an 80 by 25 character screen.

If a character is received while you are using the arrow keys, or if you type a character yourself, the display moves back to the most recently received data, at the bottom of the 80 by 25 area.

Pausing the display

You can use the 'Pause screen' option on the 'Edit' menu to freeze the display of received information to give yourself more time to read it. (The screen is paused using whichever handshaking method is currently set.) You can then use the arrow keys to move around the 80 by 25 area.

Important: If you have no handshaking set, or if the other computer is not using your handshaking method, and you pause the screen display using the preceding method, you may soon begin to lose data.

To resume the display press a key, such as Enter or Space. The Work*about* will tell the other computer (via handshaking) that it can send characters again.

☞ The Control-S (XOFF) keypress has the same effect as 'Pause screen' (whichever handshaking method is in use). Press Control-Q (XON) to resume the transmission.

Sending commands to a modem

You can type commands directly to an attached modem from the Terminal emulation screen - for example, to tell it to dial a particular number. When the modem successfully connects with the modem of a remote system, it usually sends a CONNECT message via the serial port to the Work*about*, and the Work*about* displays this on the screen. You can then proceed with logging on to the remote system.

The commands for controlling modems are beyond the scope of this manual. See your modem's manual for more details.

File transfer to another computer

The Comms application on the Work*about* is an updated version of the Comms application that is supplied with the Psion 3Link lead. The 3Link manual gives full details of transmitting and receiving files using the protocols supported by Comms; this section merely provides a synopsis of that information.

Software on the other computer

To transfer files between the Work*about* and another computer via a modem, the other computer must have suitable communications software. This software should support one or preferably both of the following services:

- terminal emulation with the ability to transmit and receive/capture ASCII files.
- XMODEM or YMODEM file transfer.

These services may be provided by a specialised communications program or may be part of an integrated software package. Bulletin board and Electronic Mail systems usually have XMODEM and/or YMODEM capability.

☞ Instead of using terminal emulation, you may be able to configure the serial port and then copy to and from the other computer using its operating system commands - if its operating system is sufficiently advanced.

Setting the file transfer protocols

To use file transfer commands, you must use the same file transfer *protocol* on both computers. You can use the 'Protocol' option on the 'Transfer' menu to set Comms to use any of the following protocols:

XMODEM 128-byte checksum
XMODEM 128-byte CRC
XMODEM 1K-byte CRC
YMODEM 128-byte
YMODEM/G 128-byte
YMODEM 1K-byte

YMODEM/G 1K-byte
ASCII (straight binary - no protocol)

It is best to use an XMODEM or YMODEM protocol, if possible, for file transfer. Transmissions are then error-checked, and if any errors are detected the information is sent again. If the other computer does not support the XMODEM or YMODEM protocols, you can try using ASCII transfer (no protocol) to transfer plain text. With ASCII, no error-checking is done, and any errors during transmission result in a corrupted file.

If you have a choice of Baud rates, use the highest supported by both computers. The Work*about* supports up to 19200 Baud. (You may have to reduce the Baud rate for poor telephone lines.)

About the YMODEM protocols

Important: The YMODEM protocols in Comms are YMODEM BATCH protocols. These cannot be used with the original 'plain' YMODEM. Many computers have YMODEM options which are in fact YMODEM BATCH; if a computer has options for both, you must set it to use a YMODEM BATCH protocol. YMODEM BATCH protocols allow more than one file to be sent at a time.

YMODEM/G is designed for use with error-correcting modems. You should use it with RTS/CTS handshaking, whether you are connected via modems or directly. If you do not, files may be received incompletely. (You could see this by checking the file size at either end.) If you are in any doubt, use a different XMODEM or YMODEM protocol instead.

Filenames and directories

When you select a file 'Transfer' option, Comms initially offers files in the root directory of the default disk. If you wish to transfer a file in a different directory you can type its full file specification, or you can press Tab and navigate to it with the File selector.

☞ If you wish to change the default disk, you should change it before you start Comms in order to use the new default within Comms. (You can use the 'Default disk' option in the System screen to alter the current default disk.)

Comms remembers the directory of the file last used by a 'Transmit' or 'Receive' option. The 'Capture' option will always fill in an incomplete file specification with the root directory and the default disk.

☞ The TRANSMIT and RECEIVE commands in the Script language can also affect the directory or disk used.

Transmitting files

The general procedure that you need to follow to transmit files is as follows:

1. Set the other computer to a protocol that is supported by Comms and specify the filename to use on that computer. You may need to give the other computer a command to transmit or receive a file as well.

2. Select the 'Protocol' option on the 'Transfer' menu to set the Work*about* to use the same protocol.
3. Select the 'Transmit' or 'Receive' option on the 'Transfer' menu. Enter the filename or directory to use on the Work*about*.

A message will show that the transfer is going ahead, like this:

```
Block nn
```

where nn indicates the number of blocks successfully received or transmitted.

If all goes well, the block count will steadily increase, until a `Receive OK` or `Send OK` message is displayed.

If no connection is made: If you set the Work*about* to receive a file, it will "time out" if connection is not made within a certain time. When transmitting, however, it will not "time out" and will continue waiting for a connection.

To abandon the transfer: Press Esc at any time during the transfer. If you are receiving to the Work*about*, the file being received is not saved.

More detailed information about transferring files is beyond the scope of this manual. Please refer to your modem or PC application manuals for more information.

5

Creating and running programs

There are 3 stages to producing a program using OPL, the Work*about* programming language:

- ***Type in the program*, using the Program editor described in 'The built-in applications' chapter earlier in this manual.**
- ***Translate* the program. This makes a new version of your program in a format which the Work*about* 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 next 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.

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:

From the System screen:

1. Move to the Program icon and select 'New file' from the 'File' menu.
2. Type `test` as the name to use for this OPL module and press Enter.

From the Command processor:

1. Type `EDIT TEST.OPL`.

You will move into the Program editor.

Module names can be up to 8 characters long, like other filenames on the Work*about*. 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 Work*about* acts upon. You type these statements, in order, between `PROC :` and `ENDP`. When you come to *run* the program, the Work*about* 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.

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 ↓. 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 applications on the Work*about* at any time while you are editing an OPL module. Press Psion-Tab to task through all the running applications until the Program editor is displayed 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 Work*about* 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 an 'S3 translate' option, for translating the current program in a form which can run on a Psion Series 3 (as opposed to a Work*about* or Series 3a).

What happens when you translate a module?

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

If the Work*about* 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 Work*about* 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' section in the 'Basic use' chapter earlier in this manual

When 'Translate' can find no more errors, the translation will succeed, producing a separate version of your module in a format which the Workabout 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 following ways:

- Within the Program editor use the 'New file' option.
- From the System screen move to the Program icon and use the 'New File' option. Your existing 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.
- In the Command processor type `EDIT` and then the name for the new file including the `.OPL` filename extension.

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, or type `EDIT` and then the filename of the program in the Command processor.

Copying modules

You can copy existing modules (or translated modules) by:

- Using the 'Copy file' option in the System screen.
- Using the 'Save as' option in the Program editor itself.
- Using the COPY command in the Command processor.

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.

- Go to the Command processor and use the DEL or ERASE command. See the 'Advanced use' chapter earlier in this manual for more details.

'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 Psion-Tab (to task through all the running applications until you reach 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 Command processor

To run a module synchronously from the Command processor, simply type its filename – you don't have to include the filename extension. To run one asynchronously, type START and then the filename.

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.

While you're still editing and testing a module, 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 Psion-Tab to task to it 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 Psion-Tab keypress will still task 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.

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. Psion-Tab 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.

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.

The Program editor only ever uses one template for creating new files, called 'default'. 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 Program editor and any other text editor or word processor you have on the Work***about*.

'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.

SUMMARY

Move to the Program icon in the System screen and select the 'New file' option or type `EDIT filename.opl` in the Command processor.

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' on the 'Prog' menu, or directly from the filename under the RunOpl icon in the System screen, or by typing the filename in the Command processor.

6

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 Work*about* 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 Work*about* 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 ±9.99999999999e99 and as small as ±1e-99. (Intermediate results in calculations may even be up to about $\pm 10^{307}$.)

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 described in 'The built-in applications' chapter earlier. 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 the 'Operators and logical expressions' appendix.

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 $3.14*10^7$ (31400000), while 1E-9 is $1*10^{-9}$ (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 £1)?",
  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 in the 'Character set and character codes' appendix to this manual. 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.

7

Loops and branches

The programs in the previous two 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 in the above example.

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`	does the value of x equal 21? (Note – as this is a test 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** asssign 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	-1
	False if either c1 or c2 are false	0
`c1 OR c2`	True if either c1 or c2 is true	-1
	False if both c1 and c2 are false	0
`NOT c1`	True if c1 is false	-1
	False if c1 is true	0

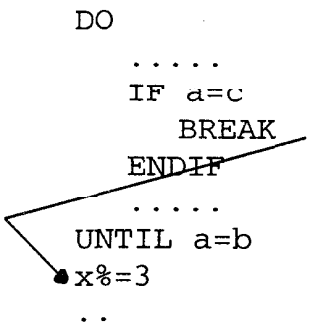
However, AND, OR and NOT become *bitwise operators* – something very different from logical operators – **when used exclusively with integer or long integer values**. If you use `IF A% AND B%`, the AND acts as a bitwise operator, and you may not get the expected result. You would have to rewrite this as `IF A%<>0 AND B%<>0`.

(Operators, including bitwise operators, are discussed further in the 'Operators and logical expressions' Appendix.)

Jumping to a different line

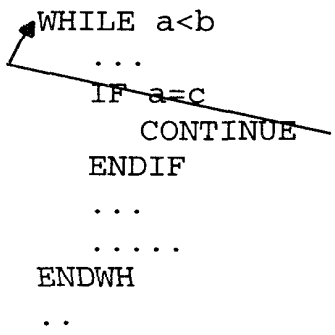
Jumping out of a loop: BREAK

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:



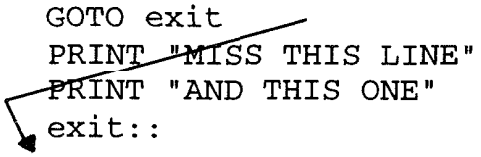
Jumping to the test condition: CONTINUE

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:



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.



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.

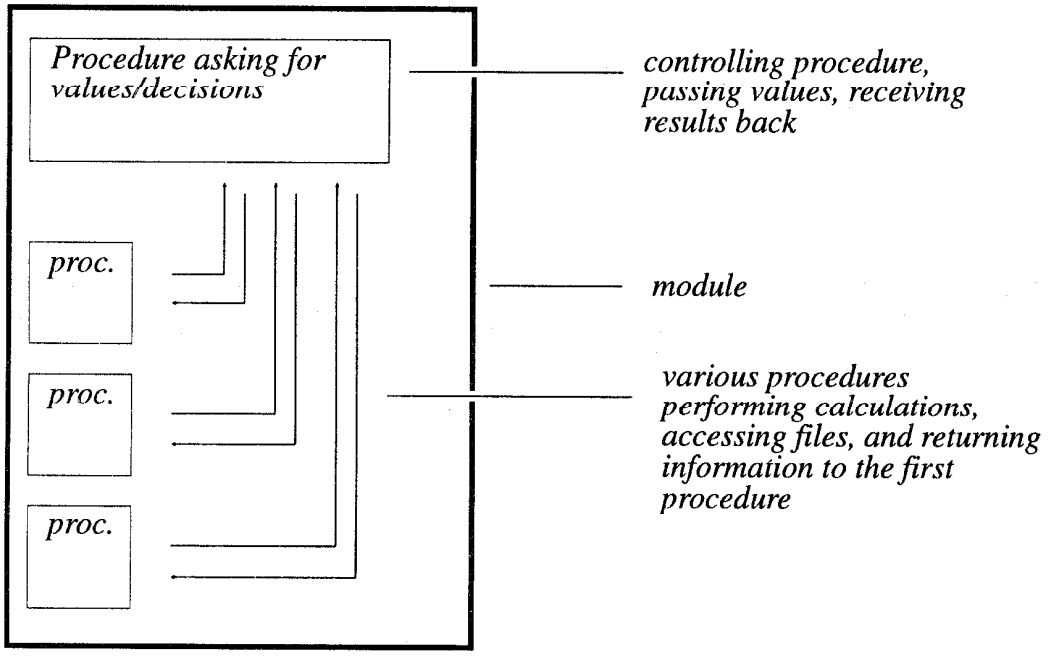
8

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 linked procedures – 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:



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, and
- 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:
  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:
  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:
  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.

9

Data file handling

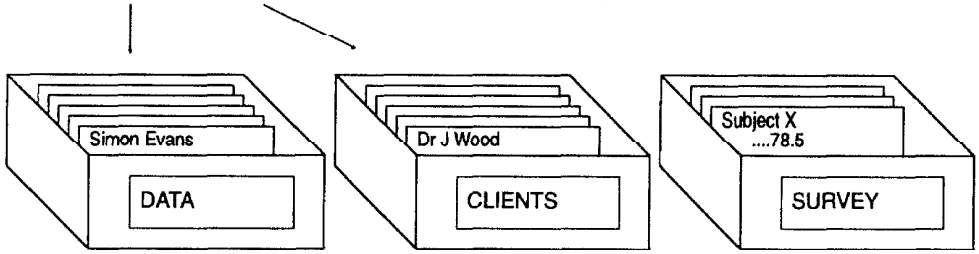
You can use OPL to create data files (databases) like those used by the in-built Database application described in 'The built-in applications' chapter earlier in this manual. You can store any kind of information in a data file, and retrieve it for display, editing or calculations.

This chapter covers:

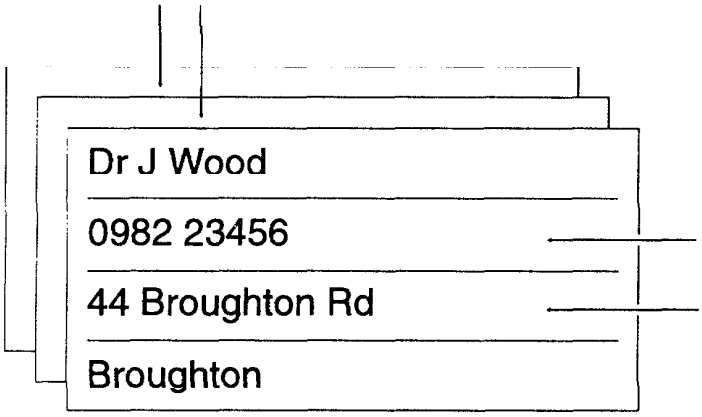
- **Creating data files**
- **Adding and editing records**
- **Searching records**
- **Using a data file both in OPL and in the Database**

Files, records and fields

Data files (or *databases*)



are made up of *records*



divided into *fields*

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.t%
```

```
  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 $\frac{1}{32}$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 string field to start looking in (1 for the first string field), and the third is the number of string fields to search in (starting from the string field specified by the second argument). For example, `FINDFIELD(a$,1,2,0)` will match with the 15th field, if that is the first string field. 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 16 for a case dependent match.
- 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-dependent search (16) forwards from the start of the file (3), use 16+3, i.e. 19. If you wanted to search only in the second and third string fields, the full statement might look like this:`FINDFIELD("brown",2,2,19)`

> ☞ 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 case-dependency (0/1), then the digit for the start/direction (0/1/2/3). In the previous example the digits are 1 and 3, producing the hexadecimal number `$13` (=19).

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 try 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 whch 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 in-built 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.

10

Graphics

OPL graphics allow 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 Work*about* screen is made up of a regular pattern of 240 points across by 100 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. 239,99 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' later in this chapter 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 90,40
  gLINEBY 60,0
  GET
ENDP
```

gMOVE moves the current position by the specified amount. In this case, it moves the current position 90 pixels right and 40 down, from 0,0 to 90,40. It does not display anything on the screen.

gLINEBY (g-Line-By) draws a line from the current position (just set to 90,40) to a point at the distance you specify – in this case 60 to the right and 0 down, ie 150,40.

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 Work*about* 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 90,40
  gLINETO 150,40
  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 90,40
  gLINEBY 60,0
  gMOVE 0,-20
  gLINEBY -60,0
  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 150,40. The second gMOVE moves the current position **up** by 20 pixels; the second gLINEBY draws a line to a point 60 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 300,40` will draw a line from the current position to some point on the right-hand screen edge, but the current position will finish as 300,40.

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 *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 in 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 0,20  :gGREY 1 :gLINEBY 240,0  REM grey only
  gAT 0,21  :gLINEBY 240,0
  gAT 0,40  :gGREY 0 :gLINEBY 240,0  REM black only
  gAT 0,41  :gLINEBY 240,0
  gAT 0,60 :gGREY 2 :gLINEBY 240,0  REM both planes
  gAT 0,61  :gLINEBY 240,0
  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 100,40, the four corners of this box would be at 100,40, 200,40, 200,60 and 100,60.

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.

The following procedure displays a "robot" face, using gFILL to draw set and cleared boxes:

```
PROC face:
  gFILL 60,60,0 REM set the entire face
  gMOVE 5,10 :gFILL 15,10,1 REM left eye
  gMOVE 35,0 :gFILL 15,10,1 REM right eye
  gMOVE -15,15 :gFILL 10,15,1 REM nose
  gMOVE -10,20 :gFILL 30,10,1 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 5,10 REM move to left eye
  gFILL 15,7,2 REM invert most of the eye
  PAUSE 10
  gFILL 15,7,2 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 5,4 :gLINEBY 50,0
  gMOVE 0,2 :gLINEBY -50,0
  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*.

☞ 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' section under 'Advanced graphics' 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 Work*about* 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 and Work*about*. So gFONT 11 or gFONT $9a both set the Work*about* 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' chapter 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 in bold. Except for the smaller fonts, most Work*about* 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:
  DEFAULTWIN 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 "ABCDEFGHIJK"
  gAT 180,35   :gTMODE 1 :gPRINT "ABCDEFGHIJK"
  gAT 180,50   :gTMODE 2 :gPRINT "ABCDEFGHIJK"
  gAT 180,65   :gTMODE 3 :gPRINT "ABCDEFGHIJK"
  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 "ABCDEFGHIJK"
  gAT 180,115 :gTMODE 1 :gPRINT "ABCDEFGHIJK"
  gAT 180,130 :gTMODE 2 :gPRINT "ABCDEFGHIJK"
  gAT 180,145 :gTMODE 3 :gPRINT "ABCDEFGHIJK"
  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(30,40,180,30,1,1)
  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(30,40,180,30,1,1)` creates a window with its top left corner at 30,40 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(30,40,180,30,1)`) 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 Work*about* 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' in the 'Advanced graphics' section 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 sophisticated 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 Work*about* 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 the example that follows). 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
```

11

Friendlier interaction

Everyday OPL programs can use the same graphical interface seen throughout the Work*about*'s in-built applications described earlier in this manual:

- ***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 Work*about*. 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 six 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 ← →, 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:, procld:, ...
  ENDIF
ENDIF
```

(This calls procedures `procua:`, `procuc:`, `procla:` and `procld:`). 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 or dINITS command to prepare OPL for a new dialog. (dINIT creates a dialog using the standard font, while dINITS creates one using a small font.) If you give a string argument to dINIT or dINITS 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. If you used dINIT you can define a maximum of five dialog lines; using dINITS you can define up to eight dialog lines.

  Note that if you use dINITS and define eight dialog lines, the top and bottom border of the dialog is severely clipped. To preserve the integrity of the dialog border, you must limit yourself to seven dialog lines.
- 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 ↑↓ to move from line to line, and enter the relevant information, as in any other Work*about* 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 a 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' chapter.

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' chapter 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 Work*about*. 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 selact:
  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 Work*about* 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' chapter.

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 or dINITS 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 or dINITS), defined (dEDIT etc) and displayed (DIALOG) in the same procedure.
- A dialog may consist of up to seven lines, including any title if you used dINIT or nine if you used dINITS. 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 Work*about*.

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 R 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
`'Aextent%(3)'` chapter = 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 and a clock. 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$.

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.

12

OPL and Solid State Disks

Types of Solid State Disk

Solid State Disks (*SSDs*) are explained in detail in the 'Advanced use' chapter earlier in this manual. 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 Work*about*).

There are two types – *Ram SSDs* and *Flash SSDs*. They fit into the *SSD drives* in the SSD/Battery drawer that slides out of the centre of the Work*about*. (For more information, see the 'Introduction' chapter earlier in this manual.)

- 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 that 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. Alternatively, type `EDIT filespec.OPL` in the Command processor, where *filespec* gives the full file specification (drive, directory and filename) of the module you want to create. For example, you might type `EDIT A:\OPL\MYPROG.OPL` to create a module called `MYPROG.OPL` in the `\OPL` directory on an SSD in drive `A`.

To copy an OPL module onto an SSD from the System screen: 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 an OPL module to an SSD from the Command processor: type `COPY sourcefile destination`. For example to copy the file OPLPROG.OPL from the \OPL directory on the internal disk to the \OPL directory on an SSD in the A: drive you would type `COPY M:\OPL\OPLPROG.OPL A:\OPL\OPLPROG.OPL`.

To copy the **translated** version of an OPL module from the System screen, move onto the name in the list under the RunOpl icon (to the right of the Program icon), then proceed as before. If you wish to copy them from the Command processor, you will find your translated OPL modules in the \OPO directory on the internal disk.

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.

13

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' chapter later in this manual.

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&
    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$="Edit matching record"
      IF showd%:
        UPDATE :BREAK
      ELSE
        NEXT
      ENDIF
      FIND("*"+search$+"*")
      IF EOF
        ALERT("No more matching records")
        BREAK
      ENDIF
    UNTIL 0
  ENDIF
ENDP

PROC showd%:
  LOCAL ret%
  dINITS 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. Alternatively, use the 'Exit' option in the Database.

Stopwatch

Here is a simple stopwatch with lap times. Note that the Work*about* 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); however, 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%<s&+b% REM find field to break at
        d%=d%+1
        IF LEFT$(i$(d%),1)=CHR$(20) REM line>255...
          b%=b%+1 REM ...so it's 2 fields
        ENDIF
      ENDWH
      b%=17
      WHILE b%>d% REM copy the fields down
        i$(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&=120 :dLONG x&,"Centre x pos",0,239
  y&=50 :dLONG y&,"Centre y pos",0,99
  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
  GET
ENDP

PROC circlef:
  LOCAL c&,d%,x&,y&,r&,h,y%
  dINIT "Draw a filled circle"
  x&=120 :dLONG x&,"Centre x pos",0,239
  y&=50 :dLONG y&,"Centre y pos",0,99
  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
  GET
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:
      gBORDER 0
    ENDIF
    g%=GET
    km%=KMOD
```

```
  UNTIL g%=27
ENDP

PROC dispinfo:
  LOCAL scrInfo%(10)
  SCREENINFO scrInfo%()
  PRINT "Left margin=";scrInfo%(1)
  PRINT "Top margin=";scrInfo%(2)
  PRINT "Screen width=";scrInfo%(3)
  PRINT "Screen height=";scrInfo%(4)
  PRINT "Char width=";scrInfo%(7)
  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
```

14

Error handling

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
`a$="text" PRINT a$`	`a$="text" :PRINT a$`

Omitting the space before the colon between statements :

Incorrect	Correct
`a$=b$:PRINT a$`	`a$=b$ :PRINT a$`

Omitting the colon after a called procedure name:

Incorrect	Correct
`PROC proc1:`	`PROC proc1:`
`GLOBAL a,b,c`	`GLOBAL a,b,c`
.	.
`ENDP`	`ENDP`
`proc2`	`proc2:`

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

Incorrect	Correct
`GOTO below:`	`GOTO below`
.	.
`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 name 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

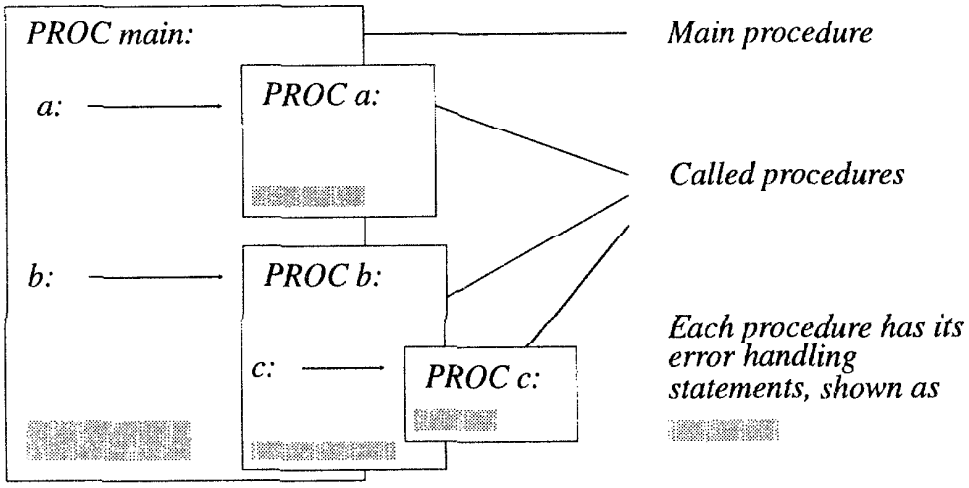
To prevent your program being stopped by OPL when an error occurs, include statements in your program which *anticipate* possible errors and take appropriate action. The following error handling facilities are available in OPL:

- 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:



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

```
PROC div0:
   ONERR errHand
   PRINT 1/0
   REM causes divide by zero error -8
   RETURN REM we don't get to this line
   errHand::
   ONERR OFF
   PRINT "Error:";err,err$(err)
   IF ERR =  8
   REM divide by zero error = -8
      PRINT "Division by zero is illegal"
   ENDIF
   GET
ENDP
```

Statements protected by ONERR

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:

```
PROC first:
   ONERR label
   a=log(-1)
   ...
   label::
   PRINT "Log error"
   next:
ENDP

PROC next:
   PRINT 2/0
   ONERR OFF
ENDP
```

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 – 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 'Erro messages' 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 (not applicable to standard Work*about*)
-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)

15

Advanced topics

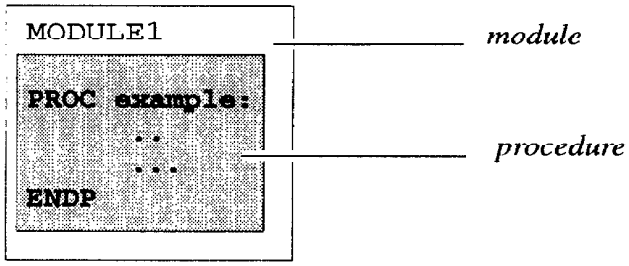
Many of the subjects covered in this chapter may provide benefits for all levels of programmers.

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 Work*about*, however, some of these keywords are touched on in this chapter.

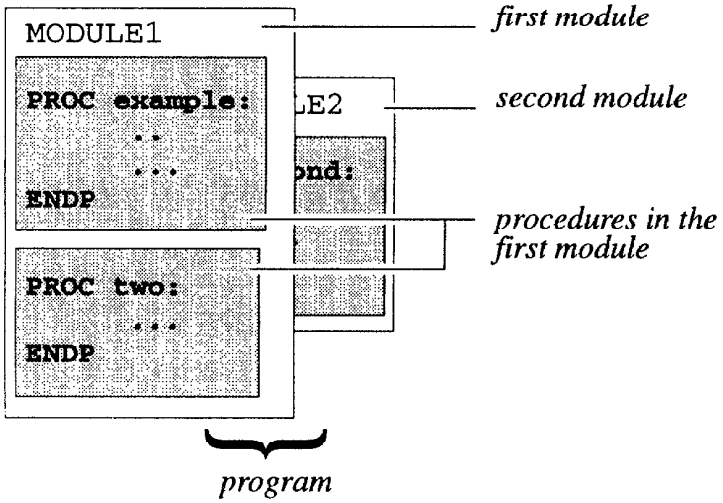
Programs, modules, procedures

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:



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



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, in the built-in applications on the Work*about* the complexities of this are hidden. 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 Work*about* is linked.

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

- The filing system usually specifies the computer, and is usually `LOC::` ('local' – the Work*about*) 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 Work*about* 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 Work*about* uses file extensions in this way, but hides this from you in the built-in applications.

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 Work*about* 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 Work*about* (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 Work*about*. 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`: 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 the in-built Data and Sheet applications): 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 Work*about* 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 Work*about* 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 Workabout talks to an OPA

When the Work*about* 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 10,16
  PRINT "Q to Quit"
  PRINT " or press Del 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$(128)
  STATUSWIN ON :FONT 10,16 :w$=CMD$(2)
  fset:(CMD$(3))
  PRINT "Create/change files"
  PRINT "in 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 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.

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 (256) 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 Work*about* to send a "machine switch on" event to the current program, whenever the Work*about* 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 Work*about* 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 that the beep sound is produced by a buzzer on the Work*about* rather than a loudspeaker and so it is not very loud.

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 Work*about* 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 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 Work*about* 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 reenable 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 (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 CREATESPRITE) 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%,bitmap$()`
`CHANGESPRITE index%,tenths%,bitmap$(),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, including the modifier keys (Shift, Control 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 ANDed with that array element to check whether the key is being pressed.

key	`scan%()`	*mask*
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
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 GETEVENTor 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 GETEVENTor 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 Work*about*, 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

'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%<maxLen%`, end of file has been reached. No error is returned by IOREAD in this case, but the next IOREAD would return the error value 'End of file' (-36).

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 in-built 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 Work*about* 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 status%,var a1,var a2`*`)`
`IOC(`*`handle%,func%,var status%,var a1`*`)`
`IOC(`*`handle%,func%,var status%`*`)` – 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%,status%,...)
IF ret%<0
  IF ret%=-46 :RAISE -1 :ENDIF
  status%=ret% :IOSIGNAL
ENDIF
```

IOC allows you to assume that the request started successfully – any error is always given in the status word `status%`. If there was an error, `status%` 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,x2%-x1%
  dLONG yy1&,"Top left y",1,y2%-y1%
  dLONG xx2&,"Bottom left x",2,x2%-x1%
  dLONG yy2&,"Bottom left y",2,y2%-y1%
  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
```

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 Work*about* 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 (i.e. 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 cacheing 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 `pcell%=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
```

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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	GOTO
...to one of a list of labels	VECTOR/ENDV
...to the end/start of a repeating set of instructions	BREAK, CONTINUE
...back to the calling procedure	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 Work*about* 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 character 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
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
Start a new dialog using small fonts	dINITS
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

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 Workabout

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

Cancel an aysnchronous 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
Perfom 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
Read cache index record	CACHEREC

17

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 (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%
```

or

```
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 and character codes' appendix at the end of this manual 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^{-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.

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.

(Note that sounds produced by the Work*about* are not as loud as those from the Series 3a; this is because the Work*about* has a buzzer and not a loudspeaker.)

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:

```
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%
```

or

```
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.

CHR$

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 given in the 'Character set and character codes' appendix to this manual.

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:

```
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 under 'Files and directories' in the 'Advanced use' chapter.

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 in-built 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 the following:

```
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.

DAYNAME$

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 these:

```
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. The 'Character codes' 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
```

See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.

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 ← → 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.

See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.

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. See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.

dEDIT

Usage:

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

or

```
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. See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.

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/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 under 'Files and directories' in the 'Advanced use' chapter.

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. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

`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
128	obey/allow wildcards

The first of the list is the most crucial. If you add 1 into `f%`, you will see a 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 Work*about* 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. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

`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 or dINITS 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.

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.

Use dINIT if the dialog contains less than 6 lines of text (or 4 lines if underlines are also utilised); for more lines use dINITS.

dINITS

Usage:

dINITS *title$*

or

dINITS

Prepares for definition of a dialog using small fonts, 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.

Use dINITS if the dialog is to contain more than 6 lines of text (or 4 lines if underlines are also utilised); for fewer lines use dINIT.

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. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

`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. Alternatively, you can use the STOP command in the Command processor to escape from the program.

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 or dINITS 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, dINITS 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. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

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. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

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. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

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. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

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 eoftest:
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. Alternatively, you can use the STOP command in the Command processor to escape from the program.

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, but cannot include variables (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 e^x – 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.

On failure to find a match FIND returns 0.

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 string field at which to start the matching (1 for the first field), and no% is the number of string 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 16 for a *case-dependent* match.
- 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.

On failure to find a match FINDFIELD returns 0.

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%. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

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%
```

or

```
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%,state%
```

Draws a 3-D black and grey button (or key) 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` draws a Series 3 style button; `type%=1` draws a Series 3a/Work*about* style 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. 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 for the system-wide setting
`%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 by the system-wide setting. 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 by the system-wide setting.
`%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 set as the system-wide setting. 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 selected as the system-wide setting. `"%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 system-wide settings 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%)
```

or

```
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 Work*about* 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 `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$, NUM$, SCI$.

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 the 'Character set and character codes' appendix at the back of this manual; this appendix also lists the full Work*about* character set.

You can use KMOD to check whether *modifier keys* (Shift, Control, Psion and Caps Lock) were used.

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 Work*about* 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$. See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.

GETLIBH

Usage:

```
cat%=GETLIBH(num%)
```

Convert a category number num% to a category handle. If num% is zero, gets the category 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. See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

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: The built-in Work*about* 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 `((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 gPRINTR, 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%
```

or

```
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%
```

or

```
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.

Note: The built-in Work*about* fonts are not held in memory and cannot be unloaded.

See also gLOADFONT.

gUPDATE

Usage – one of:

```
gUPDATE ON
gUPDATE OFF
gUPDATE
```

The Work*about* 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%
```

or

```
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 Work*about* 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 `&FFFFF` 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, 10^2 means 10x10, 10^3 means 10x10x10 and so on.

253 in decimal is:
$(2x10^2)+(5x10^1)+(3x10^0)$
$= (2x100)+(5x10)+(3x1)$
$= 200+50+3$

By analogy, &253 in hexadecimal is:
$(\&2x16^2)+(\&5x16^1)+(\&3x16^0)$
$=(2x256)+(5x16)+(3x1)$
$=512+80+3 = 595$ in decimal.

Similarly, &A6B in hexadecimal is:
$(\&Ax16^2)+(\&6x16^1)+(\&Bx16^0)$
$=(10x256)+(6x16)+(11x1)$
$=2560+96+11 = 2667$ in decimal.

You may also find this table useful for converting between hex and decimal:

hex.	*decimal*	
&1	1	$=16^0$
&10	16	$=16^1$
&100	256	$=16^2$
&1000	4096	$=16^3$

For example, &20F9 is
$(2x\&1000)+(0x\&100)+(15x\&10)+9$
which in decimal is:
$(2x4096)+(0x256)+(15x16)+9 = 8441$.

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<b`. If the expression returns logical true (non-zero) then the statements following are executed. If the expression returns logical false (zero) then those statements are ignored. For more details about logical expressions, see the 'Operators and logical expressions' appendix.

INPUT

Usage:

```
INPUT variable
```

or

```
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 in-built Calculator application, 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 and the use of 'var' variables 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.

`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 or IOC, 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 or IOC is given a chance to run.

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 the 'Character set and character codes' appendix 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 the 'Character set and character codes' appendix 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, including the use of 'var' variables.

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, including the use of 'var' variables.

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 the 'Operators and logical expressions' appendix.

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 DYL that is not in the ROM. If successful, this writes the category handle to cat% and returns zero. The DYL is shared in memory if already loaded by another process.

See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.

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 8 modules can be in memory at any one time; if you try to LOADM a ninth 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 the 'Variables and constants' chapter.

LOCK

Usage:

```
LOCK ON
or
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. In the Command procesor, the STOP command may not work.

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:C"`
- Either of the two serial ports, with `LOPEN "TTY:A"` or `LOPEN "TTY:C"`
- A file on the Work*about* 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.

You can open ports A and C at the same time. Use LCLOSE to close a device. (It will also close automatically when a program finishes running.)

See the 'Serial/parallel ports and printing' appendix for more information.

LOWER$

Usage:

```
b$=LOWER$(a$)
```

Converts any upper case characters in the string a$ to lower case and returns the completely lower case string.

Eg if a$="CLARKE", LOWER$(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 the 'Serial/parallel ports and printing' appendix for an overview of printing.

MAX

Usage:

```
m=MAX(list)
```

or

```
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%
```

or

```
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 six 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)
```

or

```
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
```

or

```
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 is 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.

See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.

MID$

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)
```

or

```
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, including the use of 'var' variables.

OFF

Usage:

```
OFF
```

or

```
OFF x%
```

Switches the Work*about* 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 4½ 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 Work*about* back on, and may have to reset the computer.

ONERR

Usage:

```
ONERR label or
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 file is read-only – in other words, you cannot APPEND 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%)
```

or

```
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 cos:
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%))
return peekF(di%)
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$`, filling in any missing information from `rel$`. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

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 or negative, 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
```

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. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

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:

1	0	= *1*
0	1	= *256*

  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:

0	0	1	0	= *65536*

  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:

3	65	66	67	= *"ABC"*

  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 Work*about*.

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 $^{PI*x}/_{180}$)

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$,b$
```

REPT$

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 102Ivariable` 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:

```
PROC price:
 LOCAL x
 PRINT "Enter price:",
 INPUT x
 x=tax:(x)
 PRINT x
 GET
ENDP

PROC tax:(price)
 RETURN price+17.5%
ENDP
```

RIGHT$

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
```

SCI$

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%
```

or

```
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)` and `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. See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.

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%
```

Returns the date that corresponds 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. See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.

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. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

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 Work*about* 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).

See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.

STD

Usage:

```
s=STD(list)
```

or

```
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:

SQR(Σ(xi-$\bar{x}$)^2/(n-1)) where $\bar{x}$ means Σxi/n. To convert to population standard deviation, multiply the result by 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*)

or

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 Work*about* 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. (See 'I/O functions and commands' in the 'Advanced topics' chapter for a description of the use of 'var' variables.)

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 `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 Work*about*.

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 `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 Work*about*.

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)
```

or

```
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:

$\Sigma(x_i-\bar{x})^2/(n-1)$ where $\bar{x}$ means $\Sigma x_i/n$. 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 which by default is Monday, though you can change it with the 'Time and date' option on the 'Time' menu in the Command processor. 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 the 'Loops and branches' chapter earlier in this manual.

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`.

Appendices

A

Character set and character codes

Character set

The Work*about* contains many fonts, but they all have the same basic character set: the IBM Code Page 850 character set. Characters with decimal codes from 32 to 127 are the same as ASCII characters. Those from 0 to 32 are special control codes.

The characters available on the Work*about* are as follows; for each character, first the decimal, then the hexadecimal code is given. 32 is the space character.

32	20		33	21	!	34	22	"	35	23	#	36	24	$	
37	25	%	38	26	&	39	27	'	40	28	(	41	29	)	
42	2A	*	43	2B	+	44	2C	,	45	2D	-	46	2E	.	
47	2F	/	48	30	0	49	31	1	50	32	2	51	33	3	
52	34	4	53	35	5	54	36	6	55	37	7	56	38	8	
57	39	9	58	3A	:	59	3B	;	60	3C	<	61	3D	=	
62	3E	>	63	3F	?	64	40	@	65	41	A	66	42	B	
67	43	C	68	44	D	69	45	E	70	46	F	71	47	G	
72	48	H	73	49	I	74	4A	J	75	4B	K	76	4C	L	
77	4D	M	78	4E	N	79	4F	O	80	50	P	81	51	Q	
82	52	R	83	53	S	84	54	T	85	55	U	86	56	V	
87	57	W	88	58	X	89	59	Y	90	5A	Z	91	5B	[	
92	5C	\	93	5D	]	94	5E	^	95	5F	_	96	60	`	
97	61	a	98	62	b	99	63	c	100	64	d	101	65	e	
102	66	f	103	67	g	104	68	h	105	69	i	106	6A	j	
107	6B	k	108	6C	l	109	6D	m	110	6E	n	111	6F	o	
112	70	p	113	71	q	114	72	r	115	73	s	116	74	t	
117	75	u	118	76	v	119	77	w	120	78	x	121	79	y	
122	7A	z	123	7B	{	124	7C	¦	125	7D	}	126	7E	~	
127	7F	⌂	128	80	Ç	129	81	ü	130	82	é	131	83	â	
132	84	ä	133	85	à	134	86	å	135	87	ç	136	88	ê	
137	89	ë	138	8A	è	139	8B	ï	140	8C	î	141	8D	ì	
142	8E	Ä	143	8F	Å	144	90	É	145	91	æ	146	92	Æ	
147	93	ô	148	94	ö	149	95	ò	150	96	û	151	97	ù	
152	98	ÿ	153	99	Ö	154	9A	Ü	155	9B	ø	156	9C	£	
157	9D	Ø	158	9E	×	159	9F	ƒ	160	A0	á	161	A1	í	
162	A2	ó	163	A3	ú	164	A4	ñ	165	A5	Ñ	166	A6	ª	
167	A7	º	168	A8	¿	169	A9	®	170	AA	¬	171	AB	½	

172	AC	¼	173	AD	¡	174	AE	«	175	AF	»
176	B0	⁞	177	B1	▒	178	B2	▓	179	B3	|
180	B4	┤	181	B5	Á	182	B6	Â	183	B7	À
184	B8	©	185	B9	╣	186	BA	‖	187	BB	╗
188	BC	╝	189	BD	¢	190	BE	¥	191	BF	┐
192	C0	└	193	C1	┴	194	C2	┬	195	C3	├
196	C4	─	197	C5	┼	198	C6	ã	199	C7	Ã
200	C8	╚	201	C9	╔	202	CA	╩	203	CB	╦
204	CC	╠	205	CD	═	206	CE	╬	207	CF	¤
208	D0	ð	209	D1	Ð	210	D2	Ê	211	D3	Ë
212	D4	È	213	D5	ı	214	D6	Í	215	D7	Î
216	D8	Ï	217	D9	┘	218	DA	┌	219	DB	▉
220	DC	▄	221	DD	¦	222	DE	Ì	223	DF	▀
224	E0	Ó	225	E1	ß	226	E2	Ô	227	E3	Ò
228	E4	õ	229	E5	Õ	230	E6	µ	231	E7	þ
232	E8	Þ	233	E9	Ú	234	EA	Û	235	EB	Ù
236	EC	ý	237	ED	Ý	238	EE	¯	239	EF	´
240	F0		241	F1	±	242	F2	‗	243	F3	¾
244	F4	¶	245	F5	§	246	F6	÷	247	F7	¸
248	F8	°	249	F9	¨	250	FA	·	251	FB	¹
252	FC	³	253	FD	²	254	FE	■	255	FF	

Entering characters using the "standard" keyboard

Any of the characters in the character set can be entered directly from the keyboard. To enter one:

1. Look up the decimal code of the character you want in the preceding table.
2. Hold down the Ctrl key and type the 3-digit code, then release the Ctrl key.

Make sure you add preceding zeros, if they are required, to make a code three digits long – for example, use Ctrl-096 to enter a left single quote, `

Accented characters

The Ctrl key turns the number keys 1 to 6 into accent keys (Ctrl-1 is a special case – see overleaf):

ACCENT		NUMBER TO PRESS WITH CTRL
"	(umlaut/diaeresis)	2
	(grave)	3
	(acute)	4
~	(tilde)	5
^	(circumflex)	6

The letters a, e, i, n, o, u, y (upper or lower case) can be accented, as appropriate.

To get the accent, hold down the Ctrl key while you press the accent's number. Then press the letter to be accented. It will appear on the screen with an accent.

Examples:

à -	type:	Ctrl-3 a
ü -		Ctrl-2 u
ñ -		Ctrl-5 n

To get the letters in upper case, either have Caps Lock on or hold down a Shift key while you enter the letter.

Example:

Ñ -	type:	Ctrl-5 Shift-n

Other characters

The following characters are also available:

Press Ctrl-1 and then:	Result:
a, A	å, Å
c, C	ç, Ç
d, D	ð Ð
e, E	æ, Æ
o, O	ø, Ø
t, T	þ Þ

To get the upper case versions, have Caps Lock on, or hold down either Shift key.

Press Ctrl-1 and then:	Result:
s	ß
l	«
r	»
q	¿
x	¡
p	£

All of these characters are part of the character set given above.

Character codes

To find out a character's character code either look up the character in the table given earlier in this chapter, or run the built-in Calc application 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 Work*about* 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

↑	256	↓	257
→	258	←	259
Pg Up	260	Pg Dn	261
Home	262	End	263
Menu	290	Help	291

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.

B

Specification

Physical characteristics

Size	180mm x 90mm x 35mm
Weight	325g (incl. batteries)
Screen size	6.24 x 3.00 cm (2.45 x 1.18 ")
Screen type	Backlit (optional), 240 x 100 pixel LCD Pixel size: 0.27 x 0.23 mm Pixel pitch: 0.30 x 0.26 mm
Sound	Piezo buzzer

Power supply

Internal	Nickel Cadmium rechargeable battery pack (Part no. 2802-0005) or 2 x AA alkaline batteries
Backup	3V Lithium R16 battery (CR 1620)
External	Psion Series 3 range mains adapter (Part no. 2502-0010 for the U.K. Part no. 2502-0011 for the rest of Europe) Note: This mains adaptor must be used in conjunction with a LIF converter (Part no. 2802-0011) Work*about* Docking Station
Fuse	1.25amp 20mmx5mm glass fast blow

Memory

Built-in	1Mb Masked ROM and 256KB/1MB/2MB RAM Two SSD drives allow extra storage space on Flash/RAM SSDs

System information

Processor	NEC V30 running at 7.68MHz
Operating System	EPOC

Expansion

Internal	One internal expansion card can be installed. Currently RS-232 AT, RS-232 AT & RS-232 TTL, and Barcode & RS-232 AT serial interfaces are available. Expansion modules must be factory or distributor fitted. Contact your Psion distributor for more information.
External	A combined external LIF-PFS connector - LIF converter unit - is available. This plugs into the standard LIF socket and allows standard 3Link peripherals, such as the Serial 3Link lead, Parallel 3Link lead and the mains adaptor to be connected to the Work*about*.
Peripherals	External peripherals (such as a modems, printers or barcode readers) can be plugged into any suitable socket connected to an internal expansion cards (where fitted), or connected to a Serial

3Link lead that is attached to the Work*about*, or connected to a Docking Station in which the Work*about* is placed.

Environment

Operating temp.	-20°C to 60°C
Storage temp.	-25°C to 80°C
Operating humidity	0% to 90% non condensing
EMC	For Europe: EN55022 Class B For the USA: FCC Part 15 Class B (Pending) For Germany: Vfg 243 Class B (Pending)
Safety	For Europe: EN 60950 (Pending)
Static	IEC801
Drop	1m onto concrete on any face
Other	Dust proof & splash proof (IP54)

C

Summary for experienced OPL users

OPL has evolved from the Psion Organiser II through the MC and HC computers to the Series 3, Series 3a and now the Work*about*. 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 and Work*about* OPL features may be incorporated into future releases in the HC and MC ranges.

Using OPL on the Workabout

To create an OPL module from the Command processor: type `EDIT filename.OPL`. You can edit an existing OPL module by typing its name on the command line.

To create an OPL module from the System screen: move the cursor to the Program icon. Select 'New file' from the 'File' menu and give the filename to use. 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.

Type in the module in the Program editor that will be displayed. You can type and edit in the Program editor in much the same way as you would in any text editor, the text you type does not word-wrap; you must press Enter at the end of each line to start a new one. The keywords that mark the start and end of your first procedure: PROC: and ENDP are already entered for you.

When you have finished your module, select the 'Translate' option on the 'Prog' menu to translate it, then use the 'Run' option to run it. You can also run the translated module from the System screen, its name automatically appears under a 'RunOpl' icon – you can simply move the cursor right to the RunOpl icon, down onto the module name, and press Enter to run it.

To stop a running OPL program that has no exit option, press Psion-Esc.

The Work*about* screen is 240 points (*pixels*) wide by 100 points deep.

OPL programs can be translated as applications which may be installed in the System screen. This is done with the APP keyword. You can also specify the type of application using the keyword TYPE, and the icon using ICON, the filename extension of data 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, Series 3a or Work*about*.

If you use the 'Translate' option on the 'Prog' menu, the translated program will run on the Series 3a and Work*about*.

Important: If you used the keyword DINITS to create dialogs in your program, you will not be able to run it on a Series 3 or Series 3a because the DINITS keyword is not supported by OPL on these machines.

Modules translated for the Series 3 (**not** the Series 3a and Work*about*) 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.

Procedures translated on the Organiser need re-translation, as they will not run on the Series 3a or Work*about*.

The Work*about* uses the same MS-DOS filing system as the MC, Series 3 and Series 3a. The directories and file extensions concerned with OPL are:

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

(unless specified with the PATH or EXT keywords.

On the MC, Series 3 and Series 3a, the directory structure is hidden from view for everyday use. In the Work*about*'s Command processor, however, it is not and you therefore have greater freedom over the organisation of files on the internal disk. Having said this, you are recommended to stick to the structure outlined above, unless you have a good reason not to.

The evolution of OPL

OPL has evolved from the early days of the Psion Organiser II through the MC and HC computers to the Series 3, Series 3a and now the Work***about***. The following sections explain the changes that were made at each stage of its development:

- changes from Organiser to MC OPL;
- changes from MC to HC OPL;
- changes from HC to Series 3 OPL;
- changes from Series 3 to Series 3a OPL;

and finally:

- changes from Series 3a to Work*about* OPL;

So if you have been used to the HC version of OPL, for example, you should look at all the sections from 'Changes from HC to Series 3 OPL' onwards to see how OPL is different on the Work*about*.

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 four 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 and Work*about*.)

The specification of the BEEP command has changed.

Different effects are produced by values below 32, used with `PRINT CHR$()`. See the 'Character set and character codes' 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.

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.

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 string field, or group of string 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 (*DYLs*), 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.

Changes from Series 3a to Workabout OPL

OPL on the Work*about* is the same as OPL on the Series 3a except for the following:

- The translator only allows 6 menu items to be defined for each menu tile due to the smaller size of the Work*about* screen.
- You cannot display an application icon or diamond list in status windows on the Work*about* because the status windows are not large enough. The DIAMINIT and DIAMPOS keywords are therefore not supported by OPL on the Work*about*.
- A new keyword, dINITS, has been provided for creating dialogs using a small font. This allows you to create dialogs that contain nine lines (including the title line); dINIT as provided on the Series 3a allows only six lines in a dialog on the Work*about*.

Compatibility between Series 3, Series 3a and Workabout

Programs translated for the Series 3 can run on the Work*about* without retranslation. Those translated for the Series 3a can run on the Work*about* without modification and retranslation **only** if they do not contain the keywords DIAMINIT and DIAMPOS which are not provided in OPL on the Work*about*.

The Work*about* has a much smaller screen than both the Series 3 and Series 3a. Information in Series 3 and Series 3a applications that does not fit on the screen is clipped - it is not rescaled to fit the smaller area available.

Slowing down Series 3 programs

Time dependent programs, such as games, written for the Series 3 will run too fast on the Work*about* and Series 3a. If you wish to slow down a Series 3 program, you can write a short OPL program to run in the background, like this:

```
proc slowdn:
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 Work*about* 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 Work*about* 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 Work*about* 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 Work*about* turned

on it would stay on until the batteries were 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 (with Psion-Esc) when you want to use the Work*about* at full speed again.

D

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
`60-5%`	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 evaluted 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<expenses
  doBad:
ELSE
  doGood:
ENDIF
```

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 less than b	-1
		False if a greater than or equal to b	0
>	a>b	True if a greater than b	-1
		False if a less than or equal to b	0
<=	a<=b	True if a less than or equal to b	-1
		False if a greater than b	0
>=	a>=b	True if a greater than or equal to b	-1
		False if a less than b	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    →    1
1 AND 0    →    0
0 AND 1    →    0
0 AND 0    →    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     →    1
1 OR 0     →    1
0 OR 1     →    1
0 OR 0     →    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 1111111111111000. 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.

E

Serial/parallel ports and printing

You can use LPRINT in an OPL program to send information (for printing or otherwise) to either of the two Expansion ports that can be fitted to the Work*about*:

- A 9-pin serial port, Port A.
- A *LIF (Low Insertion Force)* socket, Port C, which can be a serial or parallel port, depending on what is connected to it. See the 'LIF-PFS socket' section in the 'Introduction' chapter for a description.
- A file on the Work*about* or an attached computer.

You can also read information from the serial port.

Using the parallel port

In your OPL program, set up the port with the statement `LOPEN "PAR:C"`.

Provided the port is not already in use, the connection is now ready. LPRINT will send information down a parallel 3Link lead connected to the LIF-PFS socket – for example, to an attached printer.

Example

```
PROC prints:
  OPEN "clients",A,a$
  LOPEN "PAR:C"
  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"` or `LOPEN "TTY:A"` whichever port you require.

Now LPRINT should send information down the serial cable connected to the 9-pin serial port – for example, to an attached printer. If it does not, the serial port settings are not correct.

Serial port settings

`LOPEN "TTY:A"` or `LOPEN "TTY:C"` opens the serial ports A or C 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
value = 11 4 7 0 3

DSR XON+DSR RTS+DSR
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 `<CR>` or `<LF>` – 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 `<CR>` 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 Work*about* and the other computer.
- Type `LINK` in the Command processor or select the 'Remote link' option in the System screen and press Enter.
- Run the server program (supplied with 3Link) 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 Workabout

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:`.

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