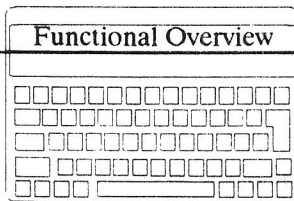


1. Functional Overview



Alternatively, the ease with which data can be transferred in both directions between the Z88 and other machines means that it can be regarded as a "portable extension" to existing desktop computers, where these are already installed.

1.1. General

The Cambridge Computer Z88 is an ultra-light-weight personal computer using RAM and ROM data storage techniques in conjunction with the Z80 8-bit processor and pre-programmed 128K ROM to achieve a combination of functions comparable with those of a conventional desktop computer.

It employs the latest super-twist liquid crystal display (LCD) technology to provide the maximum readability in a screen small enough to be incorporated in the same plane as the keyboard. This results in a single, solid case that is easy to use and handle. The unique keyboard is specially constructed to be extremely durable and at the same time almost totally silent in use.

Although in many circumstances the Z88 can be thought of as a direct replacement for a large desktop machine, its approach is radically different in several respects. Quite apart from the physical advantages of an almost silent, easily portable device that makes few inroads on your desk space, the internal software incorporates several advanced features to speed and simplify the business of working with a computer.

One unusual feature is the ability to run multiple "instantiations" of the various software modules supplied, allowing, for example, several copies of the wordprocessor to be active at the same time.

(Technical Note: Each "copy" is in fact the identical section of ROM-resident code, additional space being only taken up by data.)

Another radical development is the way the same software combines the duties of a spreadsheet and word processor, allowing you to embed calculated tables in ordinary text (and vice versa).

An extension of this principle allows the word processor to work in multiple columns on the screen — something beyond the capabilities of many of the leading "standard" office word processing software packages.

Solid State Storage. Unlike the low-cost memory used in most mains-powered desk-top computers, the CMOS RAM in the Z88 retains its contents even when the machine is switched off. This means there is no need for a disk drive — the usual way a desktop computer permanently stores data.

Heavy-weight portables often use disk drives, but this has the tremendous disadvantage of adding mechanically moving parts, which are vulnerable to damage as well as greatly adding to the battery consumption and of course the weight.

Instead of delicate moving parts, providing relatively slow access to data, the Z88 uses lightning-fast rugged solid-state memory modules, called "cards", measuring only 2 inches square. These can be slotted into any of the three sockets provided under the keyboard, automatically adding to the available memory pool for use as system memory or "disk-type" file storage.

The third slot has the special ability to take an EPROM (Electrically Programmable Read-Only Memory) card, which permanently retains data even when removed from the machine. EPROM cards are re-useable after they have been erased with the optional EPROM eraser.

Z88 Technical Specification

- **Weight:** Less than 2 lbs
- **Size:** 11.5 x 8.25 (A4). Less than one inch thick
- **Screen:** Total display area, 64 x 640 pixels. Main work area 8 lines x 80 characters, with additional display areas for command index, page map and system indicators.
- **Keyboard:** Full-size, 64 key, including Cursor, Index, Menu and Help keys
- **Processor:** CMOS Z80 at 3 MHz
- **Memory:** 128Kbytes ROM, 32Kbytes RAM internal. May be expanded to 416Kbytes (currently) or over 3Mbytes (planned)
- **Communications:** 9-pin female D-type socket, 2-way RS-232c. May be driven with dedicated internal Import/Export software; also supported by the internal Copy command and i/o redirection facilities.
- **Expansion:** 3 Card slots for RAM/ROM expansion beneath the keyboard. 46-finger connector provides bus expansion for future options.
- **Power:** 6v DC provided by 4 internal AA-type batteries or optional power supply. Gives estimated 20 hours use on unexpanded machine.

Battery Use

The Z88 takes four AA-size alkaline batteries, type MN2500 or LR6, easily obtainable world-wide.

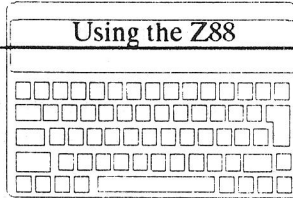
A fresh set of batteries should be able to sustain the memory for up to a year in "quiescent mode". In use, the batteries allow up to 20 hours of computing, depending on the number and type of expansion cards fitted.

An internal capacitor holds the charge long enough for batteries to be completely removed and changed without a supplementary power supply. The length of time memory is retained without batteries depends on the number and type of RAM cards fitted, varying from 6 minutes with no RAM cards, to 1 minute with RAM cards in all three slots.

1.2.Capabilities

- **The Word Processor:** PipeDream is a full-function text editing and printing system (via the RS232 port), allowing search and replace, and block deletion, moving and copying. Copying and pasting between multiple instantiations is also possible by way of a temporary file. Underlining and boldening are depicted on screen, and other text enhancements may be indicated by the insertion of character codes. An editable printer driver allows these text enhancements to be reproduced on a wide variety of printers. Running heads and footers may optionally appear on each printed page.
- **The Spreadsheet:** PipeDream also provides the full capability of a spreadsheet along the lines of Lotus 1-2-3. The program is not directly compatible with 1-2-3, but covers a substantial subset of the same commands in a way that will be quickly assimilated by Lotus users. PipeDream to Lotus 1-2-3 conversion is available as a function of the file transfer utility ImpExp88. PipeDream does not handle Lotus macros.
- **The Diary:** This feature allows a virtually unlimited amount of free-form text to be stored against each day. Search facilities mean that appointments can be looked up quickly, either across a block of marked days, or through the whole diary. As the search routine can generate a list of found items for display on the screen or for output to the printer, subsets of the diary can easily be produced in hard copy or electronic form. For example, a public version of the diary, suppressing private appointments, can quickly be run off for distribution to colleagues.
- **The Calendar, Clock and Alarm:** The calendar works in conjunction with the Diary as an aid to navigation, showing dates where appointments have been made. It can also be used on its own for general reference, being "popped down" in the middle of working on a document or spreadsheet. The Clock can be similarly evoked to show the time and date. The Alarm application allows a number of alarms to be set up, and any one of these can be made to repeat over a full range of intervals from seconds to years. The alarm can optionally display a reminder message, or alternatively, execute a program.
- **The Calculator:** Like the Calendar, Clock and Alarm, this utility can be popped-down in the middle of another application. As well as the usual arithmetic operators and standard calculator functions like Memory Store and Recall, the calculator also copes with unit conversions like litres to gallons, miles to kilometres and pounds to kilograms.
- **The Filer:** This is used for managing files within the system. It can rename, and delete files, as well as arrange them within separate directories. The file copy facility allows files to be moved between devices, and to be printed or passed through the serial port to external equipment.
- **The Panel:** This utility controls certain global characteristics of the machine, like the appearance of the screen, the rate at which the keys repeat when held down continuously, whether an electronic click is heard when the keys are used, and the time after which the machine will switch off if the keyboard is left unused.
- **Import/Export:** The Z88 design sets great store by the ability to transfer files between other machines of the same kind, or between larger desktop computers like the IBM PC and equivalents. The Import/Export utility is only one of the many ways that this can be accomplished: it uses the printer/comms RS232 port on the right hand side of the machine to send or receive files either singly or in batches. The simple protocol can be used in conjunction with a variety of standard communications programs on the other end of the connection, but for instant use, Cambridge Computer supplies the program ImpExp88 to run on machines like the BBC Computer and the IBM PC.
- **BASIC:** The Z88 is also equipped with BBC BASIC, a widely used version of the language that allows you to write programs for specific applications, tailoring the machine for your own use. The language allows random and sequential file access, user-defined functions (with parameter passing and local variables), full error handling, and FOR... NEXT and REPEAT... UNTIL structures (with automatic indentation). Unusually the BASIC includes an assembler, allowing knowledgeable users to manipulate the machine at the lowest level.

2. Using the Z88



software for DOS, with programs like Borland's SideKick and Lotus' Metro. These offer a measure of pseudo context switching.

Although its appearance is deceptive, the Z88 includes all of these advanced features in Oz, its operating system. This is because, unlike other operating systems that "just grew", Oz was purpose-built for the machine.

2.1. Operating System

Every computer needs an operating system, a layer of software that connects the "Applications" — the programs you run to do useful work — to the underlying hardware. The operating system usually provides a set of utilities to carry out activities like deleting or copying files, showing you a directory of available files, allowing you to choose between the available applications, and so forth.

Advanced operating systems might also be expected to provide:

- **Date and Time Stamping.** This allows you to determine when exactly a file was created or last used.
- **Hierarchical Directories.** A feature that helps you organise files into meaningful groups at a variety of levels, rather like a set of filing cabinets that each contain drawers, which in turn contain folders, each of which carries a set of documents... This is much more useful than having to wade through a single stack of documents, but it does put a responsibility onto the user to set up and maintain the system appropriately.
- **Redirectable I/O.** "I/O" stands for "Input/Output", and an operating system with redirectable i/o gives you the ability to decide where you would like the input stream to come from and where you would like the output stream to go. In general, output goes either to the screen, the communications/printer port or to a file; and input comes from the keyboard or from a file.

Redirectable i/o would allow you to capture screen or printer output into a file if you chose, or use the contents of a file to drive an application that would normally derive its input from the keyboard.

- **Context switching.** Ordinary operating systems like CP/M (the "industry standard" until about 1982, and still used on the Amstrad Word Processor) or today's major business operating system, DOS, are designed to run a single application at a time. This is rather like a TV set that can only get one station — OK when TV (or the computer) was a novelty, but hardly the best way of doing things. Any regular computer user knows the nuisance of having to exit from the word processor program in order to get into the spreadsheet, or even to have to close down one spreadsheet document in order to look at another. Context switching lets you swap between applications instantly, without having to exit from them. The general realisation of the need for context-switching has led to a huge market for add-on

In particular, Oz specialises in context switching, allowing you to move around between a number of applications via the "Index", or even work on several different "instantiations" of the same application at the same time.

And unlike a DOS-based machine, whether portable or otherwise, you can switch off at any time (simply by hitting both Shift keys together) in the middle of an application, without having to save your data file or take any special precautions. When you switch on again, whether minutes, days or up to a year later, your application will be exactly where you left it. And the cursor will be in the same place, ready to resume at the precise point you last stopped work.

2.2. Resident Applications

The Z88 comes with twelve built-in applications, the names of which are displayed on the Applications Menu towards the left hand side of the screen when you are at the Index level of the operating system.

These are:

- | | |
|------------------|-------------------|
| Diary | PipeDream |
| BASIC | Calculator |
| Calendar | Clock |
| Alarm | Filer |
| PrinterEd | Panel |
| Terminal | ImpExp |

Any one of these can be called up by sliding a moving highlighted bar over its name and hitting the Enter key. Subject to memory limitations, it will then join the list of activities in use, and will appear on the "Suspended Activities" list when you next return to the Index level of the operating system.

The Index level gives you a choice of starting a new application or reactivating an existing suspended activity. The picture opposite shows a simplified diagram of the screen at this level. The highlight bar over the row named "accounts" indicates that this is currently selected, and will be brought out of suspension

when you hit the Enter key. Alternatively the highlight can be moved with the cursor to select another activity, or moved left into the section marked "APPLICATIONS" to choose a new application to add to the Activities list.

Once inside any of the applications, beginners should find themselves instantly at home, thanks to the **Index, Menu and Help** keys.

- **The Index Key:** As its name implies, the Index key will always take you straight back to the Index level of the operating system, to choose another activity or application. This makes sure you never get lost inside the system.
- **The Menu Key:** This key gives you instant access to all the commands available inside the current application. The screens that appear when you use this key show the commands, grouped into similar functions, together with the keystrokes you need to evoke them. You can either treat these command lists as memory-joggers, or evoke the appropriate command directly by moving the cursor bar over the command you want and hitting the Enter key.
- **The Help Key:** This evokes the Z88's extensive help system, allowing future applications (see below) to come with their own on-screen manual. Help with the 12 Resident Applications is limited to a glossary of PipeDream functions, which you will primarily find helpful when using PipeDream as a spreadsheet.

2.3. External Applications

External applications are beginning to appear from third-party developers (ie, software writers other than Cambridge Computer and the Z88 users themselves), but what is described in this section is mostly a glimpse of the future.

The card slots under the keyboard serve several purposes, one of which is to allow third-party software developers to offer add-on ROM packs containing applications to supplement those on the internal application list shown at the Index level.

When the ROM card supplied by the third party is inserted into its socket, the new application adds itself to the application list shown in the Index, and

from then on can be used to all intents and purposes like an internal application.

The twelve internal applications, as well as the operating system, are all condensed onto a single 128Kbyte ROM chip, but third-party applications may have up to 128Kbyte all to themselves, or as much 1 Mbyte in the near future.

2.4. Word Processing

If you're already familiar with a word processor like WordStar you should be able to transfer your skills quite easily to PipeDream, although there are some differences in the way the commands work. New-comers to word processing can begin to use PipeDream straight away, thanks to the abbreviated command set listed on the bezel below the screen. Other commands can be reviewed and activated by way of the Menu key.

Although PipeDream doubles as a spreadsheet (see below) you can begin by ignoring all the calculation and columnar possibilities of the application, and start writing text straight away. As you might expect, whatever you type on the keyboard appears on the screen. "Word-wrap" automatically breaks the line at a convenient space when you reach the left hand margin, and continues on the line below. This feature can be switched off, if for any reason you want to work without it.

As you type you will see the "page map" develop on the right hand side of the screen. This is a picture of the general layout of the page when you finally come to print it — invaluable for locating your position in the document you are creating or editing.

Obviously because of the small scale it is not possible to display real text. In fact the page map uses a technique called "pixel mapping", using a pixel (an individual dot, the smallest element the screen can display) to represent each character. This gives the effect of looking at an actual page from some distance away — you can clearly make out the shapes of the separate paragraphs, but not, of course, the individual letters.

INDEX		APPLICATIONS	YOUR REF	SUSPENDED ACTIVITIES
NAME	KEY			APPLICATION WHEN SUSPENDED
Diary	* D		newfile	PipeDream Today 08:03:24
PipeDream	* P		accounts	PipeDream Today 12:36:25
BASIC	* B		myreport	PipeDream Yesterday 11:17:46
Calculator	* R		events	Diary Today 07:22:12
Calendar	* C			
Clock	* T			

The Z88 Screen at Index level

During text entry you can control the display of characters on the screen by adding underlining, emboldening, and other text enhancements. The screen will display underlines and bold characters; other text enhancements you make will appear when you print your text, but will not show on the screen.

You can mark blocks prior to moving them, copying them or deleting them. You can split lines, join lines, in fact do everything that you need to rearrange and edit your text. Lower case letters can be switched to upper case and vice versa at the touch of a key.

PipeDream will give you a word count at any time, a feature most good word processors supply. But unlike most other word processors on the market, PipeDream will also allow you to count the words in a marked block. So if you need to know how many words there are in a particular paragraph, all you do is set a marker at the beginning and end of the paragraph and activate the word count command.

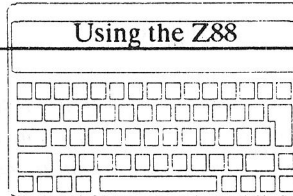
As you become more adept, you can use the advanced features like entering text in columns, incorporating spreadsheets and other calculations into your written material, and moving text between files. For example, you may have made some notes in the Diary that you want to develop into a full scale report. By marking a block and saving it as a separate file you can easily read the material into PipeDream for editing and expansion.

2.5. Spreadsheets

The spreadsheet is now a familiar concept to most computer users through well-known programs like Lotus 1-2-3, Microsoft Multiplan and SuperCalc. The Z88 picks up where the others leave off, because the spreadsheet concept is built into the machine, and in fact is an integrated part of the word processor, PipeDream.

If you already use a spreadsheet, you'll find that PipeDream provides all the facilities you would expect, and a few more that might surprise you. If you've never tried a spreadsheet before — don't worry! The spreadsheet functions are all there inside PipeDream when you need them, but if you don't, they won't get in the way.

One very simple way of using the spreadsheet is as a table of data you need to store — a name and address list, for example. That's a very elementary use of the power of PipeDream. You can also do most of the



things you would require of a PC-based spreadsheet. The syntax of the formulae is Lotus-like, but simpler — for example `@sum(A2..A4)` in Lotus becomes just `sum(A2A4)` in PipeDream.

With the help of Imp-Exp88, the utility supplied by Cambridge Computer, you can easily transfer files back and forth between the PipeDream and Lotus 1-2-3 (or similar programs) running on a PC-type computer.

2.6. Tailoring the Z88 to your Printer

Whether you use it as a spreadsheet or word processor or both, PipeDream allows you to decide exactly how you want your final text laid out on the printed page, including indentations, columns, underlining, as well as bold, italic and other print enhancements.

But printers have different ways of achieving these effects. By default the Z88 comes already set up to print on the very wide range of Epson dot-matrix printers, but if your printer uses a different set of commands, all you need to do is to evoke the Z88's printer editor utility (PrinterEd).

This will show you two screen pages of printing effects, listed against the commands necessary to achieve them. You can edit these entries, substituting the commands your own printer uses, and then save the setup in a file for future reference. You can even have several sets of PrinterEd files, one for each of the printers you are likely to use.

2.7. Using the Diary

The Diary is a simple text editor with commands that are similar to the way PipeDream works, but without the advanced features like column and number handling.

But the Diary can do one thing PipeDream can't — it is able to organise itself into automatically dated pages, one for each day of the year, and incorporates special cursor key commands for moving between them.

Only those day-pages that you make entries in will take up memory. When you first bring up the diary, either by hitting the SQUARE-D key combination, or by moving the cursor over the Diary entry in the

Index, the page that is displayed will show today's date. You can type free-form text into it, just as if it were PipeDream, and fill several screenfuls if you like.

Let's say that just as you are finishing entering the details of your eventful day, the phone rings, and it's the Head of Research at Intel inviting you to discuss your new project over lunch on the first Friday of next month. You can either page forward day by day by using the SQUARE key in combination with the Down Arrow key, or you can use the SQUARE key and letter C to pop-down the Calendar (this is the best way to jump forward or backwards if you have a long way to go).

Move the cursor to the appropriate day as shown on the Calendar, then hit the Escape key. You will return to the Diary on the day you have selected, and can now enter the appointment.

As your diary fills up with appointments you run no risk of becoming confused about whom you are meeting on which day. You can always find "Intel" by searching for the word, just as if the whole diary were a single word processing document.

MARCH 1988						
MON	TUE	WED	THU	FRI	SAT	SUN
7	1	2	3	4	5	6
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Z88 Calendar Screen

What if you would like a list of all the lunches you will be expected to eat next month? The flexibility of the Z88's software makes it quite easy to do this too. Just highlight the month with markers, search for the word "Lunch" (you can choose whether the search ignores upper and lower case differences) and ask the Diary to produce you a list of all the lines that contain the word.

Because the Diary works with free-form text, rather than being rigidly organised, you can design your own coding system. For example, a pair of exclamation marks might indicate important events, an asterisk could mean a business function, and so forth. That way you will always be able to produce a list of each category.

If you enter expenses into your diary and make sure you always include the currency sign, you can isolate those too. The list, whether printed out, or created as a file, will always show the date on which each event or expenditure occurred.

2.8. Communications

With the addition of a printer, the Z88 forms a powerful personal computing system in its own right. If you also work with other computers, a key question will be "How easily can I move data between the Z88 and the other machines I use?"

Very easily, in several ways, because data transfer was one of the primary design goals of the Z88. You can:

- Use the Z88's Imp-Export utility in conjunction with Cambridge Computer's ImpExp88 program running the other desktop machine. This is a two-way connection, with a "batch mode" that will also allow files to be transferred in groups.
- "Print" files out through the serial port of the Z88 to a simple file transfer program on the second computer.
- Use the i/o redirection capability to Copy a file out through the serial port from the Filer.
- Use the Terminal program with i/o redirection to capture incoming files and send outgoing files.
- Run a third party application package like PPS from WordMongers to transfer the file by means of the widely used X-Modem error-checking protocol.

All these methods need an appropriate cable connection between the Z88 and the other computer (the same cable may do double duty as the printer connector). Suitable cables are obtainable from Cambridge Computer, or can easily be made up according to the wiring diagram shown in the manual.

The Z88 allows for serial transfer speeds up to 38400 baud, but this is pushing on the limits of the processor's capability; 9600 baud is a safe speed for text transfer in both directions.

Cambridge Computer supplies other products for use in conjunction with the Z88, including:

- Printer or communications cables to a variety of serial devices.
- A six volt mains power supply unit.
- 32Kbyte and 128Kbyte RAM and EPROM cards for memory expansion and semipermanent data storage.
- EPROM eraser for the re-use of EPROM cards.
- ImpExp88 data transfer and translation utility.