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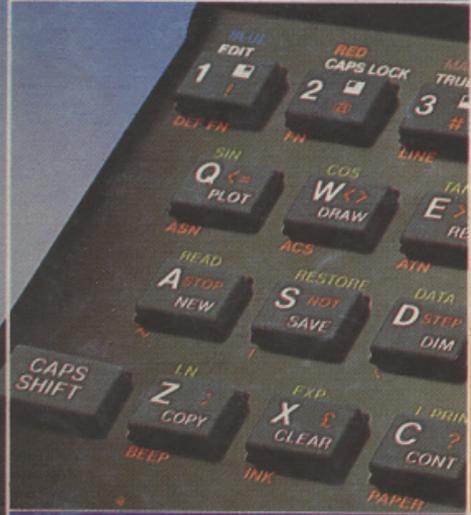
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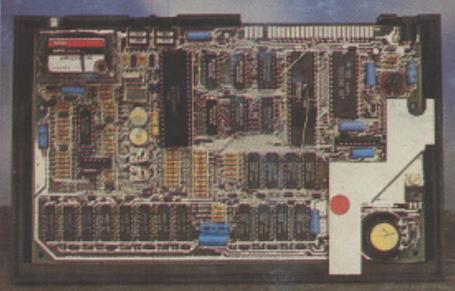


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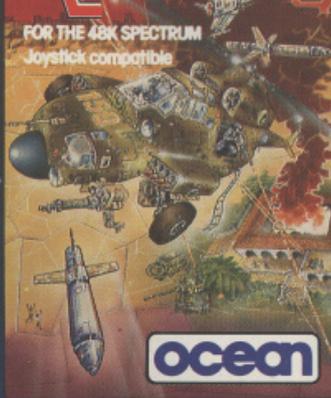


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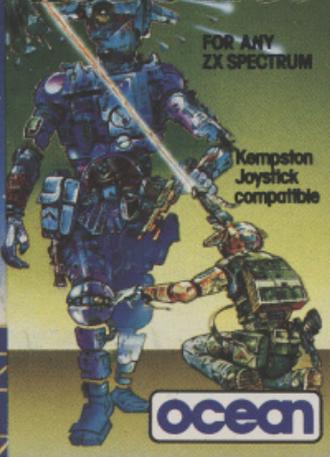
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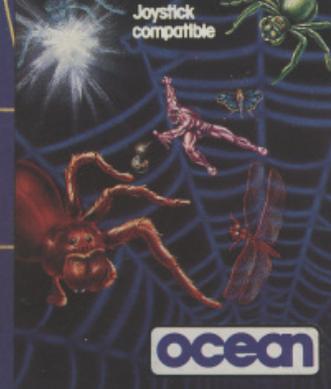
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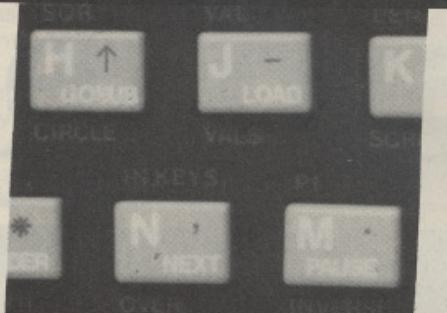
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## ELECTRONICS

**The Inside of the Z80** Now is your chance to delve into the inner sanctum of the Z80, and examine the interesting inside of the operation of the world famous chip, the processing brain. The development of this chip is traced through the article which explains all simply. **Pages 12-17.**

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# Sinclair Empire strikes out . . .

Clive Sinclair is out to give an even greater lease of life to the humble battery and overworked robot.



Sinclair aims to foster new products at the £2m MetaLab

## HISTORY

This magazine's very existence helps confirm a most extraordinary phenomenon of recent times – the creation in just four years of a new market supported by a complete infrastructure of suppliers, manufacturers of peripherals, software houses and magazines.

Since 1980, the year the Sinclair ZX80 was launched, the computer has rapidly shed its exotic, sometimes threatening 'big brother' image. It has become 'personalised'. It is a common item in many homes.

It may not yet be as understood or as acceptable a concept as, say, a car or washing-machine. But it is well advanced.

The development has been dramatic. Once the preserve of the hobbyist and programming enthusiast, the market now belongs to the general consumer. Its total turnover runs into hundreds of millions of pounds.

Independent estimates suggest that by the end of 1983 two million computers will be in use in the UK. Almost daily, the range and power of

home computers and of their software applications expand. A new world with marvellous potential has emerged.

At this point, as the early ZX80 begins quietly to depart to museums of technology and industrial design, it is perhaps appropriate to take stock, to explain how the market was created, and particularly to explain Sinclair's role. It is also possible to sketch some glimpses of the future, both generally and at Sinclair.

In the late 1980s, there was a limited microcomputer market. It was largely dominated by the Americans – principally Radio Shack, Commodore and Apple. These machines were targeted at the wealthy hobbyist and the business user. Most important, microcomputers were priced well out of the reach of the general consumer, typically at between £500 and £1,000.

Against this backdrop, Clive (now Sir Clive) Sinclair founded Sinclair Research in 1979 to pursue a number of projects in the consumer electronics field. He was almost alone in believing that a potential mass market existed for personal or home computers.

To produce a very low-cost computer (and the original was a world-first under £100) was not itself enough. The project was much more ambitious.

A company which, at the outset, employed just seven people was to sell not a new brand into a conventional market (as with, say Hoover against Zanussi, or Ford against BL), but a completely new concept – the 'home' computer.

At the first stage in the process, Sinclair Research identified two major categories of potential customers. The first was the electronics hobbyist, the compulsive radio-kit builder. The other was the 'informed layperson', who would buy for education, computer skills familiarisation, and not least for fun.

British people are compulsive tinkers with new gadgets. This partially explains the success of the personal computer and the world lead that we gained and retain. The UK has the highest *per capita* ownership of home computers in the world.

To convince people of the viability of the home computer we treated it from the beginning as a consumer, and not a specialist, product. We adopted a simple unjargonised approach in all media. We made little mention of ROMs and RAMs and paid particular attention to the production of a readable manual – often a neglected area in the electronics field.

The approach worked, and so far, so good. Prior to the launch of the ZX80, there were an estimated 40,000 micros in the UK. It alone sold 50,000 in the first year.

A greater problem awaited us. As we prepared to launch the ZX81, we were seeking to move from a strong but limited hobbyist sector into a mass consumer market. And its concerns were rather different.

Here interest focused not so much on the computer as on its use. Sale by application has become the dominant trend.

As our advertising approach became broader and embraced the consumer press, so the copy reflected the move to applications.

'Today, the Sinclair ZX81 is the heart of a computer system, said an

early ZX81 advertisement. 'You can add 16 times more memory with the ZX RAM pack.

'The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.'

From this point on, there began a 'virtuous circle' of growth. By mid-1981 we had sold our 100,000th computer – to a slightly bemused West London dentist who planned to store all his records on to the ZX81.

By the end of 1981 we had passed our 300,000 sales market.

Today the Spectrum is in full flood. We have sold more than two million Sinclair or Timex-Sinclair computers worldwide. In the UK it is now an accepted High Street item.

In the Spectrum's wake there grew up whole new industries, which not only helped develop the market, but also led to new employment opportunities.

Overall, according to Tim Hartnell, former editor of *ZX Computing*, one new Sinclair-related business was created every 36 hours, in the 12 months from the launch of the ZX81.

Despite this frenetic activity, the first four years of the home computer market may be, in retrospect, only the beginning. The fascinating new world may be only a springboard for further, perhaps unpredictable, developments.

The trend to purchase by application continues, and a pattern of expectation is established. Just as the man who turns on his hi-fi expects music, so today's computer buyer expects a wide range of uses – and to obtain them with the minimum of technical fuss.

This pattern is redefining the role of the home computer. To many people the micro is a medium and no different, qualitatively, from TV or hi-fi.

As the technology develops, we can reasonably predict the home computer's integration into home communications and entertainment systems. Perhaps, too, we can predict its combination with other media – broadcasting or video – in new and exciting approaches.

Equally, the computer can play a positive and creative role in the home, and in business. As Clive Sinclair said: 'In the next few years, many new products – some of which we can only guess at – will appear, based on or inspired by the new electronic and computer technologies.'

'These developments are not solely ends in themselves, but media for new and creative innovation in other fields such as intelligent machines and robots, bio-technology or health aids.'

For Sinclair Research as a company, the twin impact of the past four

years and of the potential future has meant considerable changes.

We maintain our strict policy of subcontracting where possible – particularly in production. This enables us to concentrate on research and development and marketing, and to avoid the almost inevitable problems of large and unwieldy management structures.

There is still a team approach in the company. And there is a 'family' atmosphere which many consider a major factor in our success – although we have grown from seven to the enormous number of 65.

We are investing heavily in the future, and we are recruiting high-quality engineers and technicians to support our plans.

Operationally, the company is organised into computer and advance products divisions – to be joined shortly by a TV division when our new 2 inch flat-screen Microvision is launched.

Under managing director Nigel Searle, the computer products division is responsible for marketing the existing personal computer range, and for a continuing research and development programme into new personal computers, computer peripherals, and software.

At present, it has launched a new bulk-storage system, the ZX Microdrive, together with the ZX Interface 1 which will also provide local area network and RS232 facilities.

Further on, it is working on a second new interface offering joystick and ROM cartridge options. In a short space of time, the Spectrum will be the basis of a considerably enhanced system, with multimedia software options – not only cassette but also the Microdrive and ROM cartridges.

Further ahead again, we plan to have launched by the end of the first half of 1984 a new 'business' computer, dubbed in-house as the ZX83. We are confident this will have a radical impact.

The most exciting development will have considerable long-term implications. This is the decision to establish MetaLab as a new £2 million centre for our advance products division.

MetaLab is briefed to carry out research on a broad scale and to explore revolutionary and high-risk ideas in areas where success is uncertain.

Clive Sinclair says that it 'will act as an incubator, fostering new products from initial idea to commercial launch.'

'It will not only complement research under way in the computer and television divisions, but also open up totally new fields ranging from battery technology to robotics.'

New worlds again!



Kieren Phelps

# Uncle Clive started it

From the beginning of the ZX80 to the colossal sales of the ZX81 and the Spectrum is a leap of only three years. Just how special is the Spectrum, and just exactly what can it do?



Ko-Kon Chung

Sinclair Spectrum has now become a household name and valued friend.

## MICROMETER

In 1980 Clive Sinclair launched his first computer, the now-famous ZX80. This was followed one year later by a modified version called the ZX81. Both were black and white computers selling for under £100.

In April 1982, the ZX Spectrum hit the market. It met with rave reviews and was hailed as a breakthrough in low-priced colour computing.

Two versions of the Spectrum are available from Sinclair Research: 16K and 48K. They are priced at £99.95 and £129.95 respectively, including VAT. If you want to upgrade your 16K machine to 48K later on, there is a range of suppliers who can supply the extra memory for less than £30. At the price, it is the best value for money around.

'It is our policy to reduce prices when we are able to, and not wait,' Sinclair's managing director Nigel

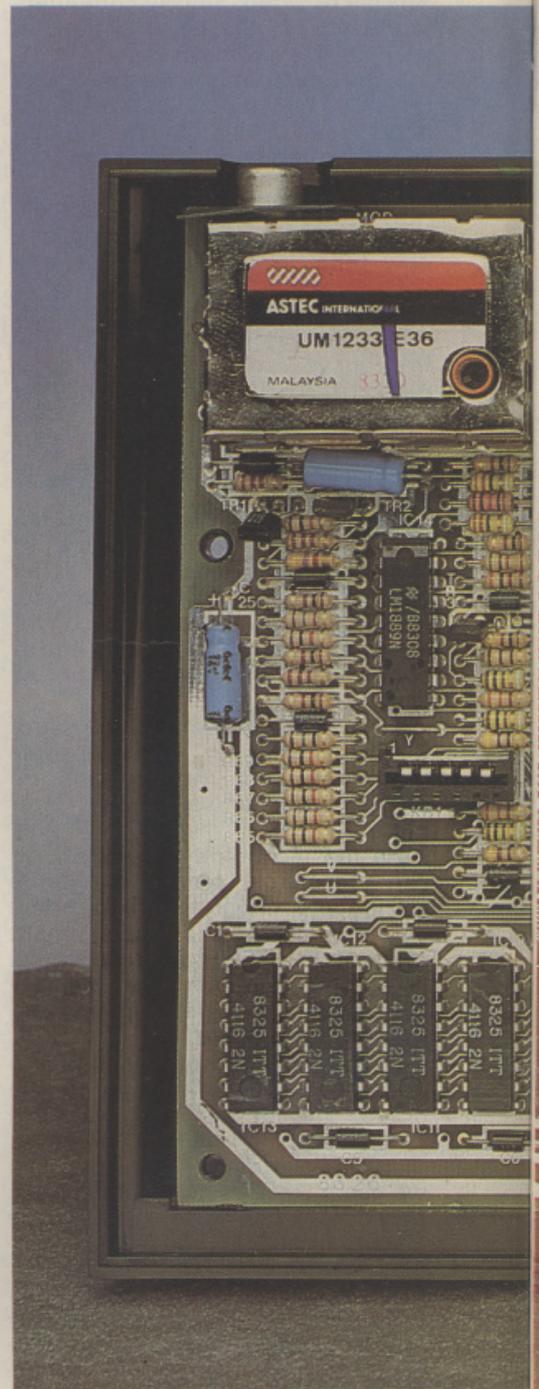
Searle stated. 'We do this even if the product is selling very well, as the Spectrum was. If we failed to reduce the prices under those conditions, it would simply attract more competition.'

Like most computers at this level, the Spectrum plugs into the domestic TV and uses a cassette recorder. The ZX printer can be attached for £39.95. And with a little modification, XZ81 programs will run happily on the machine.

The expansion port contains the full data, address and control buses from the Z80A. It interfaces with the ZX printer, the RS232 and NET interfaces and the ZX microdrives.

The Spectrum measures just 233 × 144 × 30mm. It weighs in at 520 grams, excluding the separate power supply and cables. It looks extremely elegant. Unlike its predecessors, it has keys that press down and give a 'tactile feedback'.

There are hardly any components



The innards of the famous Spectrum

inside the machine. 14 chips, a UHF modulator, a piezo-electric 'speaker' and an assortment of capacitors, resistors, diodes, crystals and a coil make up the complement. These are mounted on a single board.

There are two spare sockets to accommodate the 32K memory expansion board.

Every chip except the ULA is socketed. The reason the ULA is not is that it gets very hot, and putting it on the PCB allows the heat to dissipate better.

The keyboard is a one-piece grey rubber moulding mounted over a

pressure-sensitive membrane. The keys poke up through holes in a black metal plate. The feel is more that of a calculator than a typewriter.

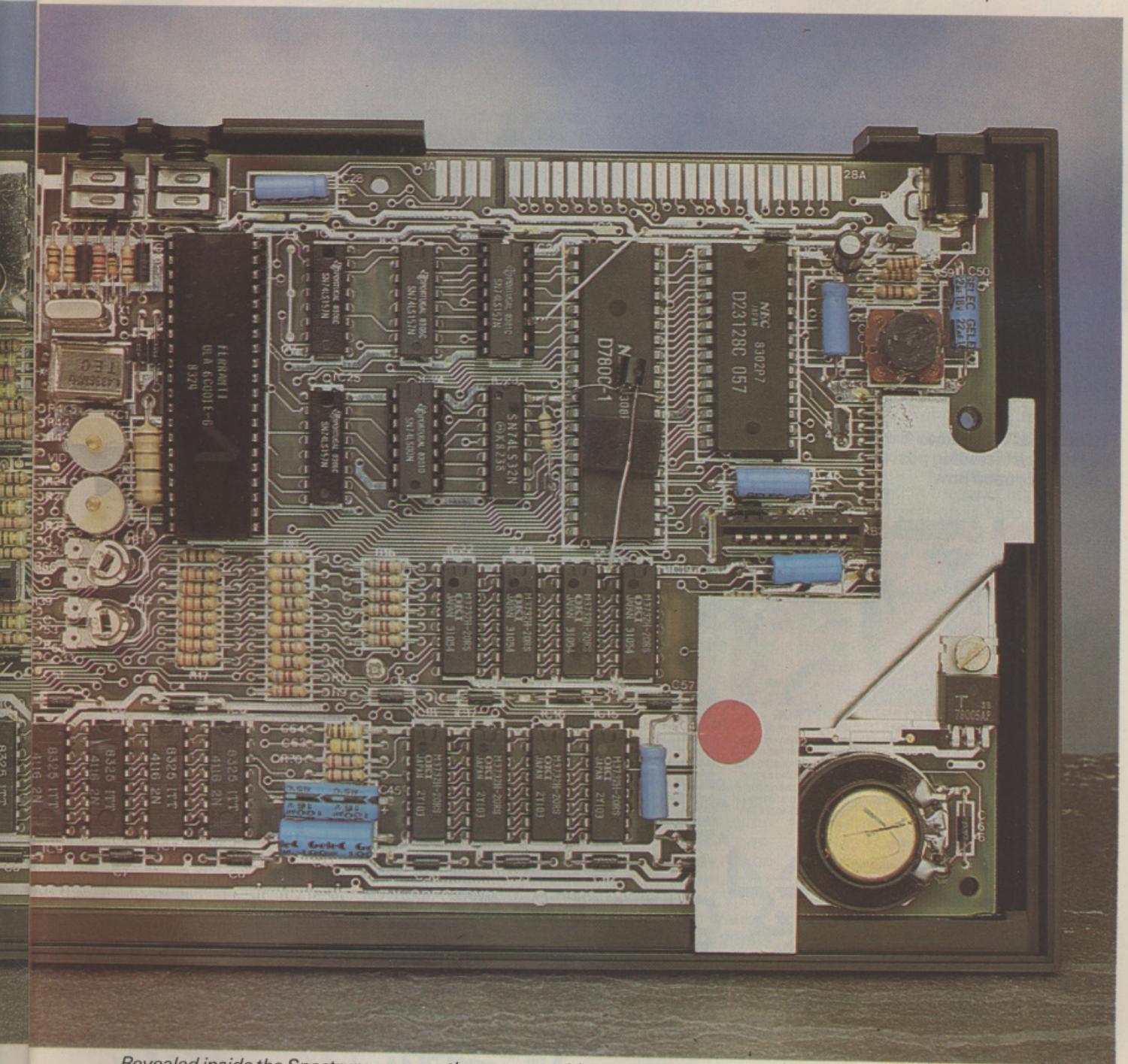
There are 191 legends on the 40 keys. Most keytops have three symbols on them, and another two associated inscriptions printed on the metal surround. At first, you may find yourself reading the whole keyboard each time you want to find a function. You do get used to it after a while.

A power supply is included in the price. The two cassette leads terminate in 3.5mm jack plugs. Be sure that they work with your recorder before

you embark on any major programs. It could take you a few tries before you find the right volume setting on your tape recorder. Once this is found, program loading presents no problems.

When the Spectrum was tested on three TVs, the results matched the quality of the sets used. The display is comprised of 24 lines of 32 characters. The bottom two lines are reserved for messages and entries.

The display can also be regarded as 256 × 176 resolution for graphics work. High-resolution graphics is best done in two colours.



Revealed inside the Spectrum case are the memory chips ranged along the bottom, with the big CPU, Logic chip and the rest of the brains in the centre. TV output is top left, and the "loud" speaker bottom right

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**LEAPFROG**  
A frog meets many dangers on his way home. Like 4 lanes of fast moving traffic, a swirling log-filled river, plus diving turtles, frog-eating snakes and nasty alligators. Do you have the skills to see him home safely?



**REVERSI**  
Two players locked in combat... one plays black, the other white. Only one colour will dominate. But which? Quick thinking is the key to this exciting game of skill and strategy. Especially when you challenge the computer itself.



**BOZY BOA**  
It's hectic being a boa in an English country garden. If you're lucky you'll find juicy beetles and snails. Quick left then right and in between the flowers. In a couple of hours you'll be boz-eyed like me!



**3D PAINTER**  
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The screen, border, and individual characters can each take on one of eight colours. In addition, characters can be bright or flashing. Other screen attributes like inverse and overprinting relate to the whole screen.

The single-channel BEEP facility is about what you would expect from a piezo-electric speaker. It does sound slightly better amplified from the cassette port. A couple of octaves round middle C are not bad. But the other eight are better used for sound effects. At the high end they warble and at the low end they grate.

You can control both pitch and duration. Notes below middle C are represented by negative numbers, those above by positive. Twelve numbers make an octave.

All the software on the review machine was in the ROM chip, which also contains the character set. This time Sinclair has gone for a basic ASCII set, upper and lower case, with the addition of built-in and user-defined graphics characters.

Outside the range SPACE TO QUOTES (32 to 126), many of the codes have special values relating to Spectrum keys and functions. You will find a copyright symbol key, for example. And you can define up to 21 characters of your own.

Two screen tables are maintained in memory. One is for the displayed characters. The other is for the attributes which describe how they are to be displayed. These attributes can be tested from within a Basic program.

The character colour is referred to as INK while the background colour is called PAPER. Each character can have its own value for INK, PAPER, FLASH, BRIGHT, INVERSE and OVER.

INVERSE simply means that the dots which form the character are printed in the PAPER colour while the PAPER is printed in the INK colour. OVER is special. It allows you to merge a new character with the one already at the screen position. The rules are that two INKS or two PAPERS print PAPER, otherwise it prints INK. So you have a neat way of removing the last thing printed and restoring what was there before it.

By now you have probably realised why it is best to stick to colours when doing graphics work. The colour of the INK and PAPER relates to a whole character position. Each time a new colour graphics point is set, all other set points in the boundary of that character are set to the new colour. This makes for a very curious effect.

ZX Spectrums are now so numerous—300,000 have been sold to date—that Spectrum Basic is rapidly becoming one of the most widely used versions of the language. It will be familiar to anyone who is used to the

Microsoft type of Basic. And it is a doddle to learn for those new to the language.

The Spectrum allows for two main data types: floating point numeric and character. Arrays may be formed of both.

Integer numbers have their own special internal format, but this is transparent to the programmer. There is no way of specifying a number as an integer, as on the Oric, for example.

Numeric identifiers must start with a letter which may then be optionally followed by an arbitrary number of letters or digits. But control identifiers (those used as an index in FOR NEXT loops) may consist only on a single letter.

Similarly, numeric arrays are identified by a single letter. They are declared by a DIM statement—one per array. They may have an arbitrary number of dimensions, and are subscripted starting at 1.

Character identifiers are a letter followed by a dollar sign. Character array names follow the same rule. They also have an arbitrary number of dimensions, but each string in the array is of a fixed size. This size is fixed when the array is declared, as the final number in the DIM statement.

Binary numbers can also be referred to using BIN. But this does not constitute another data type. All data structure space may be deleted using the CLEAR instruction.

Mathematical accuracy is to 9.5 decimal digits. A fairly full range of mathematical functions is accessible from the keyboard. Spectrum Basic uses the LET statement for assignments and calculations, the LET not being as optional as in many Basics.

Calculation expressions may also appear in many other instructions in place of a simple number, the evaluation being carried out when the instruction is obeyed.

The arithmetic operators used in numeric expressions are the familiar set:  $\uparrow$ /\*-+. The priority of their evaluation is in this order.

The plus sign may be used as a character operator, producing concatenation of strings. Strings may also be split into smaller parts using the keyboard TO to slice them. Character and string expressions may not be mixed. But of the several functions that can be used in expressions, some may be used to convert from character to numeric format and vice versa.

Spectrum Basic has the usual set of trigonometric and scientific functions. They include ABS, ACS, ASN, ATN, COS, EXP, INT, LN, PI, RND, SGN, SIN, SQR and TAN. Predefined string functions include CHR\$, CODE, LEN, STR\$, VAL and VAL\$.

The Spectrum allows conditional and unconditional transfers of prog-

ram control, using the IF and GOTO instructions respectively. The IF statement may have the form: IF condition THEN action, OR IF condition THEN action 1, ELSE action 2.

Multiple statements separated by colons may be included after THEN. But you must take care with this format. All the instructions after THEN up to the end of the line will be executed only if the condition is true.

The condition part of the instruction may consist of several complete subconditions separated by AND or OR. NOT can be used for negation. The relational operators used in conditions are:  $14 \geq = < = < >$ . Each is a single-key depression on the Spectrum.

The GOTO instruction is the unconditional transfer of control. But it may be followed by a numeric expression evaluating to a line number, thus making it a computed jump similar to the ON-GOTO of other machines.

Looping is provided by the FOR NEXT instruction. It is here that the Spectrum fails to measure up to some of its competitors. Good programming can be hindered by the absence of such constructs as REPEAT...UNTIL OR WHILE...DO. It is unfortunate that these are not available.

The instruction has the form: FOR control-variable = value 1 TO value 2:

With the optional addition of a STEP clause at the end. There must be an accompanying NEXT instruction to mark the end of the iterative section. The name of the control variable must be specified in the NEXT statement.

Nested iteration is also permitted. The only limit is the size of the stack, or perhaps the number of letters of the alphabet as control variables.

SAVEING and LOADING cassette tapes gives plenty of scope on this machine. You can save a program normally. You can save it so that execution starts automatically when it is reloaded. You can save arrays and particular chunks of memory. And if you want to keep a picture you have created, you can use the SCREEN option to save that, too.

All saved programs can be verified after saving. The screen save cannot be verified. This is because the display is changed during the verify program and would not match that held on tape.

The LOAD command can handle any tape created by SAVE. The MERGE command allows you to merge a program on tape with one already in memory. Program lines which are duplicated are overwritten, while all others are suitably interleaved.

The graphics facilities are great fun. You can draw straight lines, curves and circles on the  $256 \times 176$  pixel (picture element or dot) window. Position 0, 0 is at the bottom left-hand

corner of the screen. You can define up to 21 graphics characters of your own, a superb feature if you are writing your own games.

The nice thing is that you can do all this without leaving Basic. The BIN notation allows you to define numbers as a series of 0s and 1s. Each character comprises eight lines of eight points. So a succession of eight BIN numbers is all you need to define a character.

Another use for user-defined graphics is to squeeze some extra colours out of the machine. Lay out the 64 pixels like a chess board and choose suitable INK and PAPER colours. Some of the effects may be awful – but do persevere.

Line drawing and circle plotting are achieved using the DRAW and CIRCLE commands. A PLOT command allows you to plot single points. POINT enables you to find out whether a particular pixel is set.

You always DRAW from where Spectrum thinks you are on the screen. For example, a command DRAW 10,10,PI would draw a semi-circle ending up 10 places to the right and 10 above the current position. A fraction of PI would give another arc. Zero, or no third argument (DRAW 10, 10), would draw a straight line. The curve can be drawn on either side of the centre line by making the third argument a positive or negative number.

The CIRCLE command uses three arguments: x-axis, y-axis and radius. The OVER command can be used to erase something already drawn. You can use this feature in conjunction with DRAW, PLOT and CIRCLE to create cartoon effects.

OVER is also useful for embedding text in a drawing. When set on, the text merges with the existing lines in the drawing. When set off, it prints the full 8 × 8 character, completely replacing anything already displayed in that position.

You can use SCREEN\$ to return details of the contents of a character position. Used with the PRINT AT command, this could be a good way of making your program find a suitable place to print a 'label' on a drawing. The AT allows you to define the row and columns at which printing should start.

The Spectrum has a very flexible INPUT statement. It is equivalent to combined PRINT and INPUT statements on many other micros. You can enter several items of data in response to one INPUT. Several prompts may also be included. The INKEYS function is a means of reading one character from the keyboard without the user pressing ENTER.

Data may also be entered using combined READ and DATA lines. The pointer showing which item of data to

read next may be reset by using RESTORE followed by the line number of a DATA statement.

PRINT sends output to the screen. It may be followed by a series of identifiers or expressions, separated by semicolons or commas, depending upon the space you need. You can specify the positioning of the printing. It can be along a line using TAB or on the whole screen with the AT clause defining the line and column coordinates. The way in which the data is to be displayed is also given in the PRINT line, in terms of attributes such as INK and BRIGHT.

Three commands control output to the printer. COPY sends a screen of data to the printer. LIST produces a hard copy of the program listing. LPRINT is the printer equivalent of PRINT.

Direct memory access is achieved by POKE and PEEK. You may also access the processor ports by IN and OUT.

Cassette files are provided for using variations on the SAVE and LOAD commands. As on the ZX81, these commands transfer both program and variables. So a program can be restarted from where it was left on a previous occasion.

Data structures, memory areas or screens may be transferred to and from cassette. The presence of VERIFY is a bonus for checking the transfer. And MERGE allows incoming program lines to be merged with those already in memory.

Subrouting jumps are available through GOSUB. This may be followed by an expression as in GOTO. The RETURN instruction causes a sub-routine exit. Machine code sub-routines may be accessed byUSR.

User-defined functions are setup by DEF FN. They are referred to by FN and the functions name (single letter or letter and \$). Machines such as the BBC micro score heavily here against the Spectrum, as their procedures enable you to adopt much more sophisticated constructs.

Two manuals come with the Spectrum. There is a thin but useful introduction for the complete novice, and a thicker one which explains things in depth. A lot of effort has gone into the latter manual. It does seem to cover everything.

Sinclair has produced a very good 16K personal computer which offers colour, high-resolution graphics, and limited sound for less than £100. That is very good value for money, provided it is the sort of machine you want. It is ideal for people who want to learn about computing and have a lot of fun while they are doing so. Indeed, the Spectrum can be bought purely as a games machine.

Given the right sort of graphics-based educational software, the

Spectrum can bring pleasurable ways of learning subjects such as mathematics and geography. As of spring 1983, more than 25,000 ZX81s had been sold to schools. Sinclair Research hopes for a similar educational success with the Spectrum.

Part of these hopes are based on a £15 million scheme for 27,000 UK schools. The offer gives every school that orders a Spectrum under the government's Micros In Schools project a free ZX printer, a copy of Logo and 10 discount vouchers are valid until 1984.

The everyday running of Sinclair Research is now left to managing director Nigel Searle. His interest in the further development of the Spectrum has led to the development of plug-in ROM cartridges for the machine and possible updates to the video circuitry. It has also led to the release of the long-awaited microdrive low-cost storage unit.

The microdrive has two components: an expansion module to attach it to the Spectrum, and the drive itself. The former costs £30 and the latter £40.

The microdrive can store up to 100K at a rate of 16K per second. It has an average access time of 3.5 seconds. You can have up to eight microdrives running off one Spectrum. The communications facility built in to the microdrive's expansion module allows you to 'talk' to as many as 64 other Spectrums. Communication is allowed at baud rates of 9600, 4800, 2400, 1200, 600, 300, 200, 100 and 50. Few machines need feel left out.

Sinclair also offers commercial programs on microdrives. These should be of a more comprehensive nature than those currently available, as they will have built-in data storage.

The microdrive could be the start of a low-cost storage revolution that will change the face of microcomputing in the UK.

Dimensions: 233mm wide by 144mm deep by 30mm high  
CPU: 3.5 MHz Z80A  
Memory: 16K dynamic RAM, 16K ROM, 32K expansion option.

Or 16K ROM, 48K RAM.

Keyboard: 40 keys, rubber moulding. 183 functions and 8 colour labels. Auto repeat

Sound: 130 semitones via basic BEEP command. Jack sockets for external amplifier/speaker

Screen: domestic colour TV. Eight colours or six grey shades

Cassette: domestic recorder

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Ports: RS232, NET, ZX microdrive

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Notes on a few of the above applications are included in the manual.

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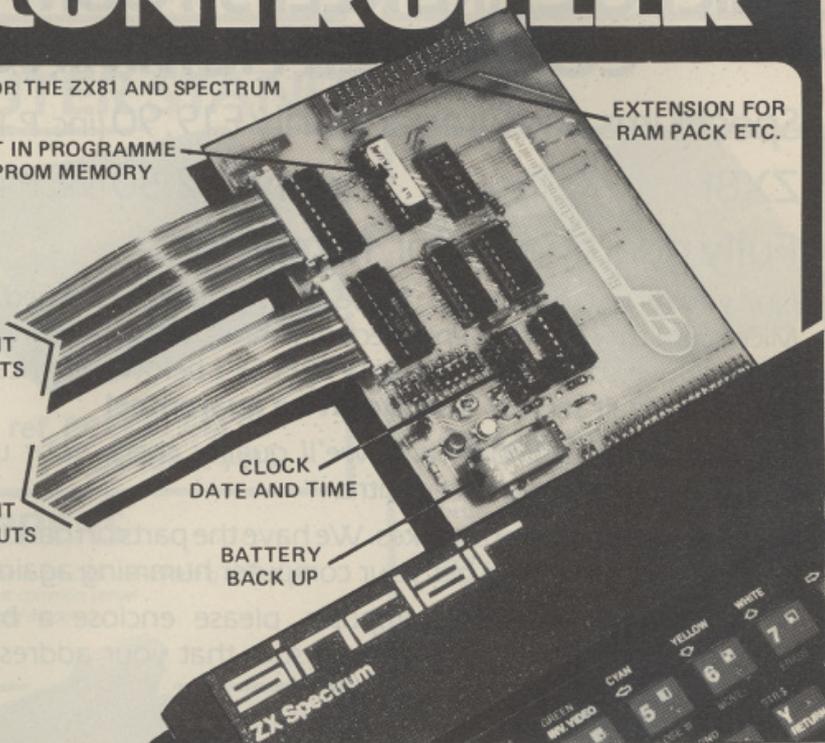
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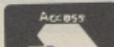
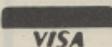
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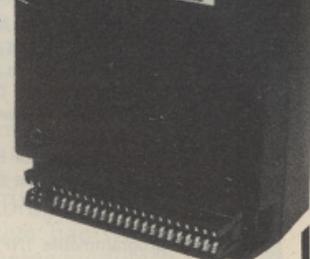
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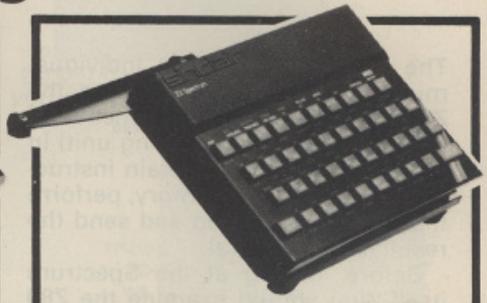
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# The inside of the Z80

The ZX Spectrum has at his heart the amazing Z80 chip, and that's where all the central processing is done. If you have a mind to, you can delve into its inner secrets... shared here by A Chanley.

The ZX Spectrum is an individual microprocessor package using the Z80 CPU. Essentially, the function of the CPU (central processing unit) in software terms is to obtain instructions or data from memory, perform the desired operation and send the result to a peripheral.

Before looking at the Spectrum itself, you should examine the Z80 CPU, its pin-out and how each signal pin functions. Then show how the CPU can be interfaced simply for input/output using TTL chips which are generally available.

All these introductory principles will be applicable to small micro-computer systems like the Spectrum. Some computer packages will, of course, have their quirks.

Historically, the microprocessor was developed for applications in control engineering. It was natural to develop a programmable device which would have a multi-function capability and be applied easily to various control processes.

In general terms, control engineering problems can be reduced to software instructions. A lot of the hardware problems have been eliminated through microelectronic packaging which makes configuring systems relatively straight-forward.

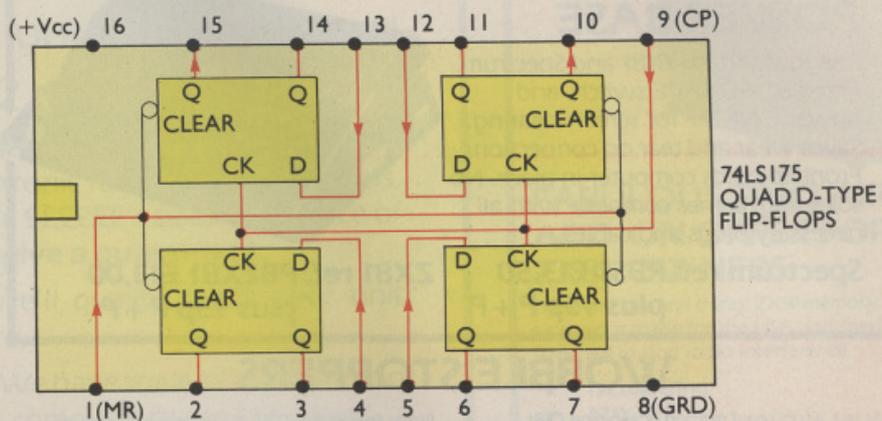
If you take a closer look at the Z80 CPU and the pin-out diagram in figure 1 (see page 16) you can define four areas of operation.

**\* D0 → D7, the data bus.**

As the name implies, these eight pins transmit data. Each pin has either a high state — logic 1 — or a low state — logic 0. These are voltage levels: +5V for 1 and 0V for 0. So if all pins are high — 11111111 — we have a binary pattern as shown in figure 2 (page 15).

The sum of the decimal figures in figure 2 is 255. So the binary pattern of eight bits has a maximum value of 255, and any intermediate value between 0 and 255.

By itself, this may not amount to much. But each number transmitted



INPUT (t=n, MR=H)	OUTPUT (t=n+1)	
D	Q	Q̄
LOW	LOW	HIGH
HIGH	HIGH	LOW

INPUTS			OUTPUT
EN1	EN2	D	
L	L	L	L
L	L	H	H
H	X	X	(Z)
X	H	X	(Z)

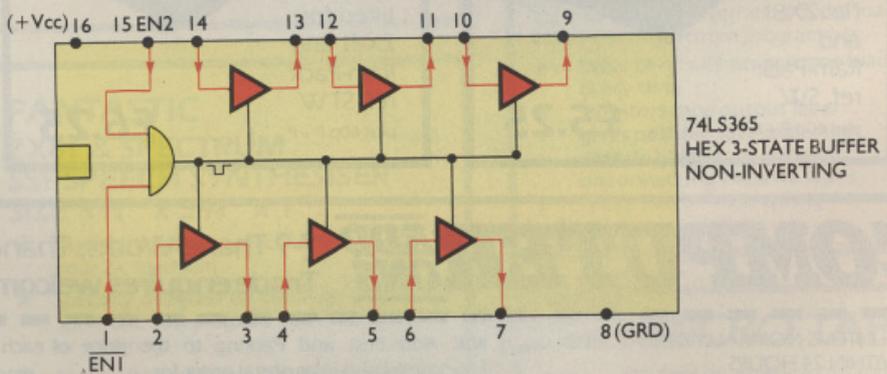


Figure 8: the pin out of the 74LS175

along the data lines will have special significance, either as an instruction or as raw measured data.

**\* A0 → A15, the address bus.**

This is similar to the data bus. The pattern of eight bits in the data bus can be arranged in 255 ways. If you ask yourself how many ways you can

arrange a pattern of 16 bits, the answer is very different: 65,535.

Figure 3 (page 15) shows the pattern. Each bit has two possible states, 1 or 0. The address lines are configured to ROM or RAM chips, which form the memory of a computer. The 65,535 ways of configuring the memory locations to the Z80 CPU

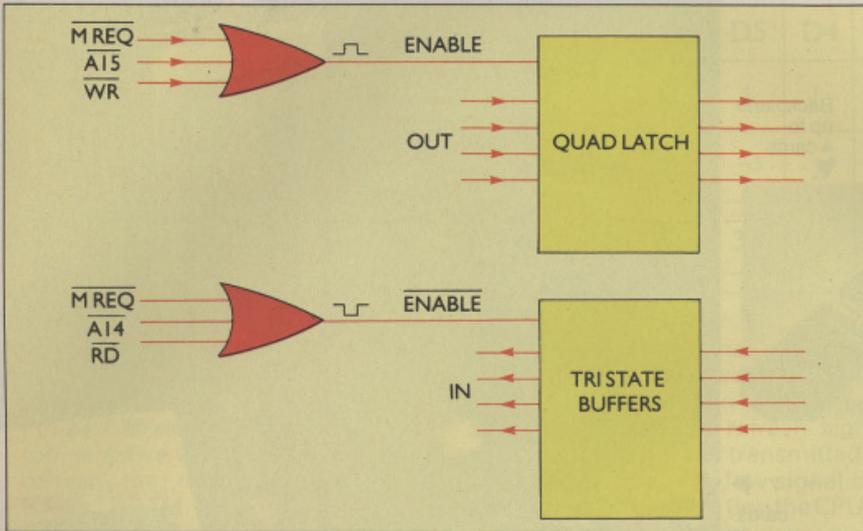
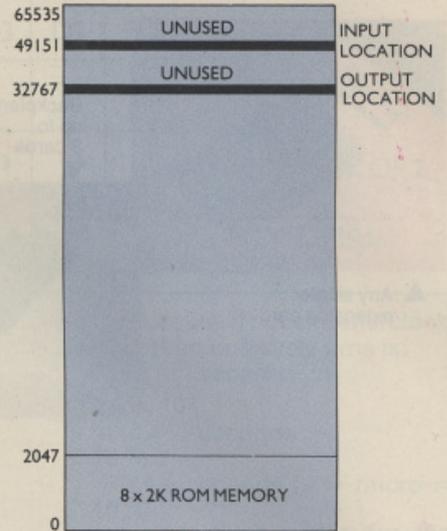


Figure 6: If you had this configuration . . .



MEMORY-MAP WITH MEMORY-MAPPED I/O  
you'd get this memory map

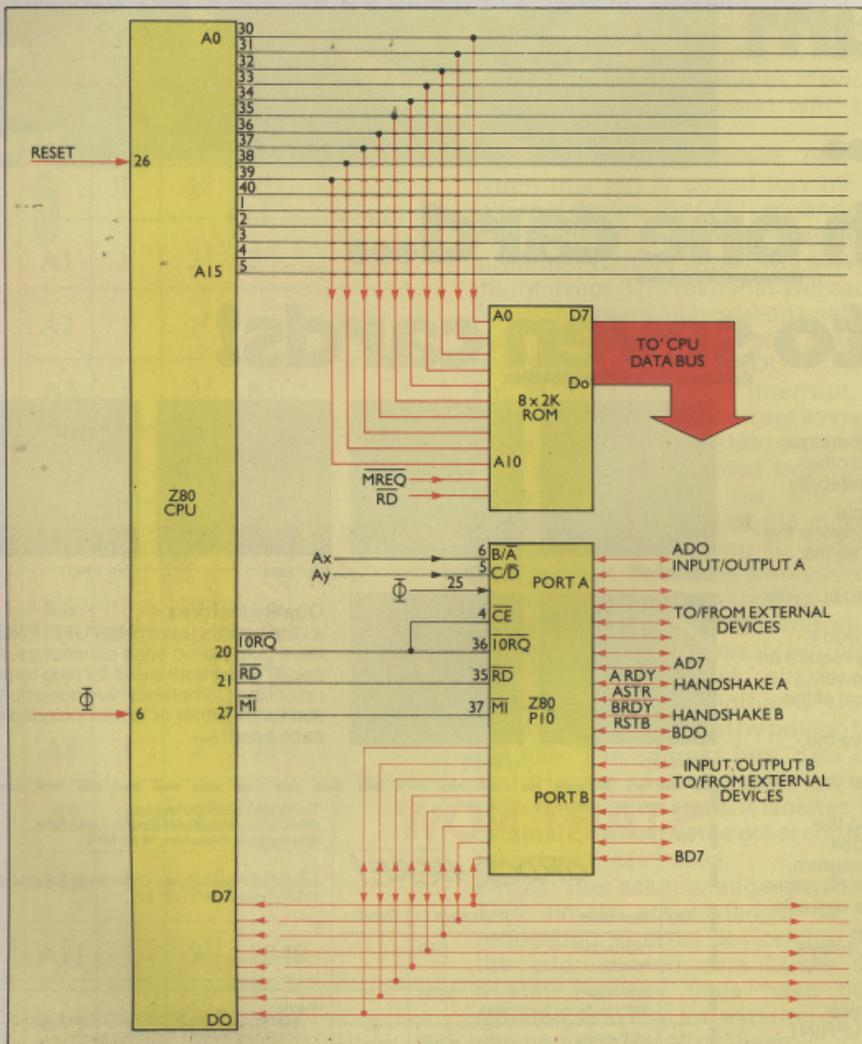
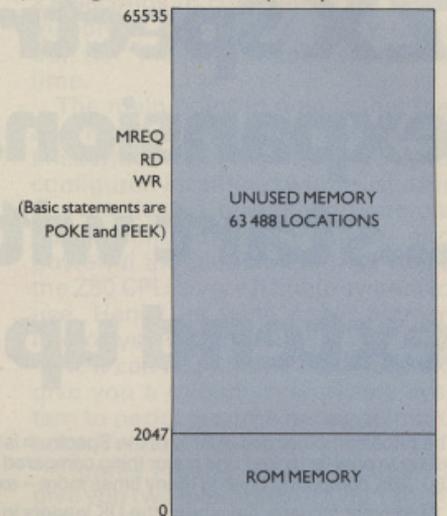


Figure 9: a minimum Z80 system



MEMORY MAP FOR Z80 SYSTEM

Figure 4: the memory map

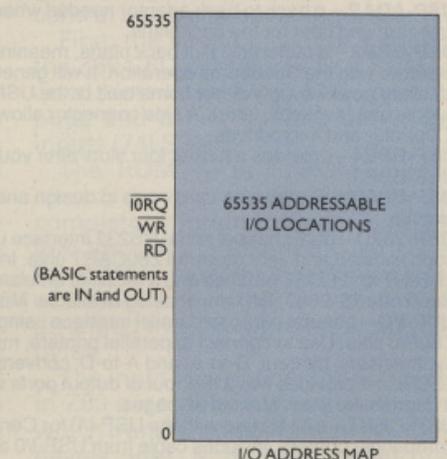


Figure 5: memory for input/output

give you the 65K-memory computer. For example, if you address line A4 = 0, the location being addressed is 65,535 - 16 = 65,519th location. Or if address line A4 = 0 and A7 = 0, but all the rest = 1, the location being addressed is 65,535 - 16 - 128 = 65,391st location.

Each location is capable of storing one eight-bit of instruction or data.

The CPU places this on the data bus and transmits it to the correct RAM location, where it is stored. The ROM stores a fixed set of data-bytes which the CPU can access but not overwrite.

**\* The control lines.**

Pin 27: Machine cycle one, or M1. The bar above the M1 means that this line is active when the signal is low. The

absence of a bar means a logic 1, or high signal.

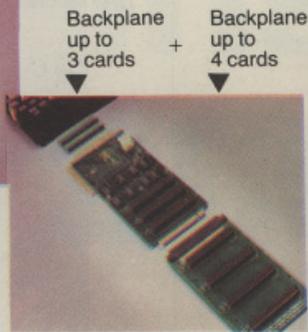
Pin 19: Memory request signal, or MREQ. When low, this signal indicates that the address bus holds the correct address for reading from memory or writing into it.

Pin 20: Input/output request, or IORQ. This signal goes low when the lower

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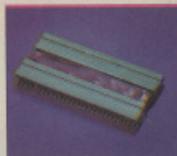
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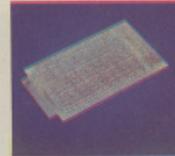
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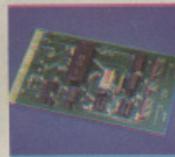
USP-BPE4



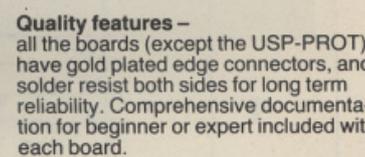
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byte of the address bus, A0-A7, holds a correct input/output address for an input/output read or write operation to a peripheral device.

Pin 21: Memory read, or RD. When low, this signal indicates that the CPU wants to read data from memory. Effectively, it would be gated with the MREQ signal, so both pull low simultaneously, and enable the correct memory chip.

Pin 22: Memory write, or WR. When low, this indicates that the CPU wants to store data memory. Both the WR and MREQ would be gated, to enable correct memory be written into.

Pin 28: Refresh, or RFSH. This signal, too, is active when low. It is used to refresh the contents of dynamic RAMs, DRAM. The latter are high-density memory chips, which operate by storing charge on a capacitor. This charge would leak if it were not refreshed by the CPU. The RFSH signal is usually gated with MREQ, RD and WR, to produce the signals necessary to refresh the contents of

#### BIT LEVEL POWER DECIMAL

	1	2 <sup>0</sup>	1
A1	1	2 <sup>1</sup>	2
A2	1	2 <sup>2</sup>	4
A3	1	2 <sup>3</sup>	8
A4	1	2 <sup>4</sup>	16
A5	1	2 <sup>5</sup>	32
A6	1	2 <sup>6</sup>	64
A7	1	2 <sup>7</sup>	128
A8	1	2 <sup>8</sup>	256
A9	1	2 <sup>9</sup>	512
A10	1	2 <sup>10</sup>	1024
A11	1	2 <sup>11</sup>	2048
A12	1	2 <sup>12</sup>	4096
A13	1	2 <sup>13</sup>	8192
A14	1	2 <sup>14</sup>	16384
A15	1	2 <sup>15</sup>	32768

TOTAL = 65,535

Figure 3: address bus configuration

Figure 2:

	D7	D6	D5	D4	D3	D2	D1	D0	BIT
	1	1	1	1	1	1	1	1	BINARY LEVEL
	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>	POWER OF 2
255 =	128	64	32	16	8	4	2	1	DECIMAL

the DRAM memory.

Pin 18: HALT. This signal will go low when the CPU is executing a HALT instruction. It will then stop processing, except for the refresh signal which continues to be transmitted to the DRAMs. The HALT low signal can be overridden by RESETING the CPU or if it receives an interrupt.

Pin 24: WAIT. This indicates to the CPU from a peripheral device or memory that these are not ready for data transfer. The signal is useful when slower input/output devices need to be synchronised with the CPU.

Pin 16: Interrupt request, or INT. When this pin is pulled low by an external device, the CPU responds by interrupting its current processing to jump to a routine which will service the interrupt. This response will occur only if the interrupt has been enabled from software, EI, and can also be disabled from software, DI.

Pin 17: Non-maskable interrupt, or NMI. This is also an interrupt system. It has a higher priority than INT in that NMI cannot be disabled from software. When pulled low, the CPU responds, at the end of the current instruction, by jumping to address 0066, or Hex. This is the start address of an interrupt service routine. At the end of this routine, the CPU will return to the program that was interrupted.

Pin 25: Bus request, BUSREQ. An external device — another CPU, for instance — can request by pulling this pin low. The address bus, data bus and tri-state control signals go to a high impedance state. It isolates the original CPU so that the other chip can take over these buses.

Pin 23: Bus acknowledge, or BUSACK. This simple acknowledges to the requesting external device/chip that the address and data buses and tri-state control lines have been isolated, and that the external device can now control all of these.

#### \* Power requirements and clock.

The Z80 CPU requires a single 5V supply and a single-phase TTL-compatible clock (I). This is a +5V square wave at 2.5 MHz to 4.0MHz. The clock operates continuously and is the means by which the CPU synchronises all of its operations.

In the instruction LD A, XX we can omit the actual meaning, but note that the instruction takes seven clock

cycles to execute. If our external clock is 2.5MHz, then one cycle time is:

$$\begin{aligned} & \frac{1}{2.5 \times 10^6} \text{ seconds} \\ & = 0.4 \times 10^{-6} \text{ seconds} \\ & = 0.4 \mu \text{ seconds } (\mu = \text{micro} = 10^{-6}) \end{aligned}$$

Seven such clock cycles for the above instruction will take  $0.4 \times 7 = 2.8$  seconds to complete. That is 2.8 millionths of a second, pretty rapid but not the most rapid execution time.

The main point to note is that the Z80 has a large number of control lines which make it a versatile chip to configure. Not all lines will be used for any one design, but coupled with the Z80 architecture of register and powerful instruction set, they make the Z80 CPU a very flexible system to use. Hence its wide application in micro systems.

How can this CPU be configured to give you a minimum workable system to perform some external input/output control functions?

Figures 1 (page 16) and 9 (page 13) give you two examples of a minimum Z80 system. They show in general terms how the data and address buses, together with some of the control lines, can be configured.

First, the circuit of figure 1 shows the Z80 CPU configured to a ROM, a quad data-latch (74LS175) for outputs, and a hex tri-state buffer for inputs (74LS365).

The ROM — or EPROM — has already been programmed and the complete program coding is 'burned' into the chip. In this particular case, the ROM is capable of packing a total of 16K bits — either a 1 or a 0 — arranged into 2K eight-bit words, or bytes.

The input instruction, for example, in Z80 assembler syntax is IN A, (n) which transfers data from an external device into a register called the accumulator, A. This instruction is coded in binary as IN A, (n) = 11011011.

Each of these instructions is a transistor. And transistors which have to give a logic 1 have their gates grounded. Transistors which have to give logic 0 are open circuit. So if eight such transistors are pre-set during manufacture of the memory chip in the above coding, the ROM chip then has the instruction IN A, (n) burned

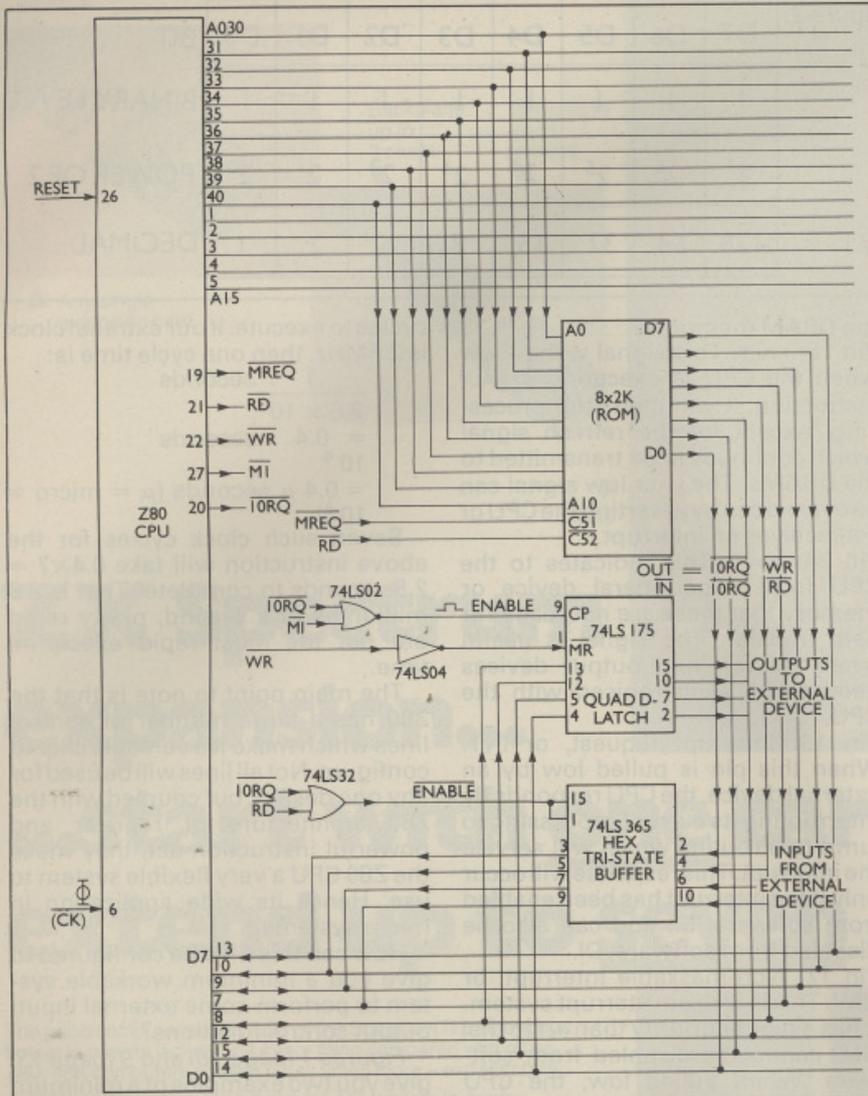


Figure 1: the four main areas of operation

into it. This particular chip containing 16,376 transistors is thus capable of storing 2,047 eight-bit instructions—a 2K program, which is quite big.

Notice that the address lines A0 → A10 are used to access the 2,047 eight-bit memory locations. Figure 3 (page 15) shows that, if the decimal equivalents are summed from A0 → A10 (1+2+4+8+...+512+1024 = 2,047), they total the correct number of memory locations. A0 → A10 can be arranged 2,047 different ways, with each of these address lines having either a logic 1 or 0.

This memory also has two chip-select lines, CS1 and CS2. When the pins CS1 and CS2 are pulled low, their ROM chip, and only this ROM chip, is selected. There is only one ROM chip in this particular case, but there may be several in more complex systems. Note that the CS pins are connected to the MREQ and RD control lines. So the ROM is enabled only for reading.

Figure 4 (page 13) shows the memory map for this system. You can see that the first 2,047 addressable memory locations are occupied by ROM memory. The remaining 63,488

(65,535 - 2,047) locations remain unused. In a more complex Z80 system, the remainder might be allocated to RAM or memory-mapped input/output.

If you apply the power and reset the CPU by a RESET switch, the CPU begins execution of the ROM program at location 0.

The other chips in this system are a 74LS175, a quad data latch and a hex tri-state buffer, a 74LS365, and some gates.

The 74LS175 is gated to the IORQ and M1 control lines. These provide the gated enable-high signal, CP, during the execution of an OUT instruction.

The enable-high output is provided by the 74LS02, a chip containing 4 NOR gates, only one of which is used. The output of one of these gates is high if, and only if, both IORQ and M1 or WR are low. This occurs only during an OUT instruction. So the four-bit latch receives the desired enable signal and transfers the data from the data bus (D0 → D3) to the external device.

Pin 1 of the latch (WR) is the master

switch, kept high because a low signal would reset the latches.

Note that WR could have been gated with IORQ to give the same chip enable signal:

$$OUT = IORQ \cdot WR$$

$$\text{or } OUT = IORQ \cdot M1.$$

The equivalent command in Basic is (OUT address, data). In this case, any input/output address on the map can be used.

The pin-out diagram of the 74LS175 is shown in figure 8 (see page 12). The D inputs are connected to the CPU data bus and the Q outputs to the external device. Q are the inverted Q outputs. The clock (CK) and master reset (WR) are common. The four flip-flops will store the state of their individual D inputs on the low-to-high clock transition at pin 9 (CP). The individual Q outputs then follow the D inputs and pin 9 is connected to the output of the NOR gate.

The 74LS365 is gated to the IORQ and RD lines, which this time provide a low chip-enable signal to enable the tri-state buffers. As you can see from the pin-out diagram, each buffer has three connections: the input line, output line and enable line.

When the enable line is high, the output is 'disconnected', and in a high impedance state. When the enable line is low, the output is then either logic 1 or 0 depending on the input. If IORQ and RD are both low, and only if both are low, the OR gate 74LS32 will produce a low output to enable pins 15 and 1 (EN<sub>1</sub>, EN<sub>2</sub>) and data from the external device(s) will then be placed on the data bus, to be read by the CPU. This will only occur during the IN Instruction IN = IORQ.RD and before any address can be used for this operation. The equivalent Basic command is (IN address).

These devices are not gated to the MREQ line, but to the IORQ line. As far as the CPU is concerned, there are 65,535 addressable MREQ locations and 65,535 addressable IORQ locations. So there are two separate address maps, one for memory read and write and one for input/output read and write. You can see this from figures 4 and 5 (see page 13).

The 65,535 input/output locations are known as input/output ports, to differentiate between input/output memory-mapped ports. In the latter case, the CPU treats the external device as a memory location because the device is gated to the MREQ control line.

Suppose the 74LS175 and 74LS365 were configured as in figure 6 (page 13). The LS175 is gated to the MREQ, A15 and WR line, and will produce an enable-high signal when the three lines are low. When A15 is low and all other address lines are high, the location is 65,535 - 32,768 = 32,767. If

our system also had a Basic ROM and a keyboard, POKE 32767, XX would enable the latch transfer data to the external device. So POKE 32767, XX = MREQ.WR.A15, the Basic equivalent of the relevant machine instruction.

Similarly, the LS365 is gated to MREQ, A14 and RD. When all three are low, you will get the necessary chip enable-low signal to this device. If A14 is low and all other address lines are high, you get the memory location 65,535 - 16,384 = 49,151. So from Basic, data transfer from outside to the CPU would occur on the PEEK (49141) command. PEEK (49151) = MREQ.RD.A4 would enable the tri-state buffers and transfer the data onto the last four bits of the data bus.

The memory map would now look like figure 7 (page 13). These memory-mapped locations could have been placed anywhere on the unused portion of the original map of figure 4 (page 13).

There are no major advantages in using memory-mapped input/output over port input/output. But micros do provide user ports, such as RML 3807, which are essentially memory-mapped locations.

We have used the first type of minimum Z80 system to introduce you to interfacing Z80 systems for input/output. The latch and buffer chips are by no means standard; any TTL latch or buffer could have been used, and eight-bit not four-bit from the 74/74LS family. You will need to understand these chips and their associated decoders when considering some of the ways in which a ZX Spectrum can be interfaced and the transducers, amplifiers, DACs and ADCs which can be hooked on to the interfaces.

The second type of minimum system dispenses with discrete latches and buffers and uses a custom-made chip for the Z80 CPU. This is called the Z80-PIO, a parallel input/output. Figure 9 (page 13) shows this type of system.

Again, the 8x2K ROM is there, but probably with a different dedicated program, and also the PIO chip. In essence, the chip presents two eight-bit input/output ports to the outside world. Both port A and port B can be used as input or both as output, quite a versatile combination.

The PIO has a bidirectional data bus which connects in parallel to the CPU data bus. It has a chip enable-low (CE) pin, an IORQ line, a RD and M1. All connect with the corresponding control lines on the CPU. There is no WR line, but this is generated by default if the RD line is high — ie, RD, IORQ, CE and C/D are all low.

This condition can occur only if IORQ is low, and you are then either reading from or writing to the PIO.

It has a select pin, B/A, which selects port B when this pin is high,

and port A when it is low. It has also a C/D pin — control or data. When this is high, you have the option of deciding whether the PIO will be an input or output device. When it is low — D — you tell the PIO that its action has been defined, and it can start to transfer data between the CPU and the external device(s).

There are also interrupt lines.

The PIO can operate in modes 0, 1, 2 and 3. This means that it can operate as an output device (mode 0) only, as an input device (mode 1) only, as a bidirectional device (mode 2) input/output, and as the control (mode 3). Initially, we can confine our description of its use either eight bits out (mode 0) or eight bits in (mode 1).

Suppose that  $A_x = A_8$  and  $A_y = A_9$ . In other words, the B/A and C/D pins are connected to A8 and A9 address lines of the CPU. Through these two lines you will tell the PIO whether it is to be an output or input device, and which port to use, A or B.

Look at figure 3a. Using location 65279 you must tell the PIO whether it is to be an input or output port A. Then you can start transferring data to port A via location 64767. Using location 65535 you tell the PIO whether port B is to be the input or output. Finally, you can start transferring data to port B via location 65023.

How does the programmer tell the PIO what it should do?

Look at figure 2, its data pins and their decimal equivalents. You define the PIO action by using pins D6 and D7

of the data bus, and keeping D0, D1, D2 and D3 all high. D4 and D5 do not matter, so you can keep them at 0.

If D6 and D7 are both 0, the PIO is to be an output device. If D7 = 0 but D6 = 1, the PIO is to be an input device. See figure 10 (this page).

To configure, say, port A of the PIO as an input you use OUT 65279. The bit pattern for input is placed on the data bus to the PIO. If, on the other hand, you want port A to be an output, you run OUT 65279, 15. Note that location 65279 is used, as you are defining the function of the PIO, port A.

Having completed this step, data transfer can start by using IN 64767, for reading inputs from an external device, or OUT 64767, XX, for outputting to an external device. The complete program sequence is

```
10 OUT 65279, 79
```

```
20 IN 64767
```

for inputting to the CPU, via the PIO, and

```
10 OUT 65279, 15
```

```
20 OUT 64767, XX
```

for outputting to an external device via the CPU.

The point you should note is that, since the ZX Spectrum has a rear-edge connector with all the Z80 CPU pin outs, it can in effect be regarded as a simple Z80 CPU chip and configured accordingly for input/output. The general principles outlined here apply to any further work, even if the interface chips used increase in complexity, though not to a great extent.

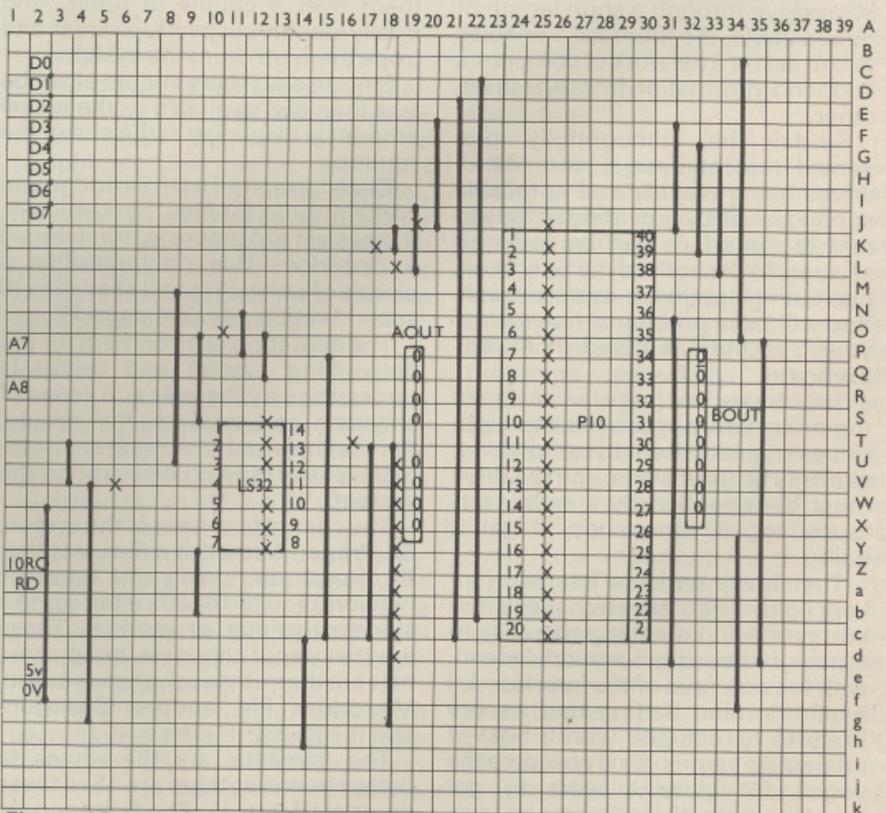


Figure 10: top view of PIO board

# Sinclair saver

Sinclair has done it again with the Microdrive – an alternative to expensive disk drives and slow cassette storage.

Mass storage has always been the weak link in the sub-£200 micro range. Until now there has been no useful alternative to cassette recorders except disk drives — and as these take the cost of your system well above the £200 mark they can hardly be termed an alternative in any case.

Sinclair's ZX Microdrive has been designed to provide an intermediate technology between the two, providing rather better access speed and file handling capabilities than the pedestrian cassette recorder, while keeping the price in line with the micro it serves.

## The drives

The Microdrive itself is about the size of an average fist. The real surprise is the Interface 1, cleverly designed to sit under and slightly behind the Spectrum. As well as connecting the Microdrive through a short length of ribbon cable, the Interface 1 enables you to set up a network of computers and send information from one to the other.

Sinclair has thoughtfully prevented the Interface 1 and Microdrives being wobbly and unreliable appendages by providing screws so that the interface can be fastened securely to the body of the Spectrum, preventing periodic system-crash. You will have problems, however, if your Spectrum is cased in a 'real' keyboard.

The drives, too, can be fastened together. You can have up to eight drives chained: each drive, however, can only be used alone, and the drive must be identified by a rather tortuous set of commands to get it going.

The drives and the interface are very light — you can envisage someone producing a small carry case to transport the system around. Indeed, with the potential of the Interface 1, I wouldn't mind betting that we are likely to be deluged with a host of interactive games. It may become the vogue for game players to get together with their Spectrum systems for an evening's entertainment.

## The cartridges

The Microdrives use endless loop cartridges (see illustration) with a tape width of five millimetres. The cartridge is about the size of an average ROM chip and contains about 16 feet of tape which is dragged past the magnetic head in the drive at about 30 inches per second. Our timings indicated about 10 seconds for the tape to run through.

Sinclair says the access time to load a 48K file can be as little as 3.5 seconds. This assumes that it's right at the beginning of the tape. Even if it's at the end, 10 seconds is a vast improvement over the ordinary cassette.

The 100K cartridges come unformatted. The formatting routine takes about 30 seconds, because it involves several tape circuits to first write the block header and lay down the check-sums, then go back to read them over a couple of times, and finally identify suspect tape areas and 'rope them off' from the system.

Sinclair says there should never be less than 85K available — the actual amount is displayed at the end of the routine.

Once formatted each cartridge can contain up to 50 files. Syntactically, the easiest procedure is to catalogue a cartridge. This only requires a couple of keystrokes and a seven to 10 second wait (see chart, page 38).

The operating environment for the networking system and drives is understood by the user as a series of channels and streams. Put simply, the channels and streams are conceptual ways of moving data around the system.

The channels consist of the screen, ZX Printer, Microdrive files, another ZX Spectrum (using the interface network) and the RS232 interface to a standard printer or modem. These are the output channels. Input channels are then obviously the keyboard, Microdrive file, another Spectrum and the RS232 interface.

The 'streams' are the routes to these channels: there are 16 of these numbered 0 to 15. The first four are linked to various channels, but the



remaining 12 can be specified in the command syntax for greater programming flexibility.

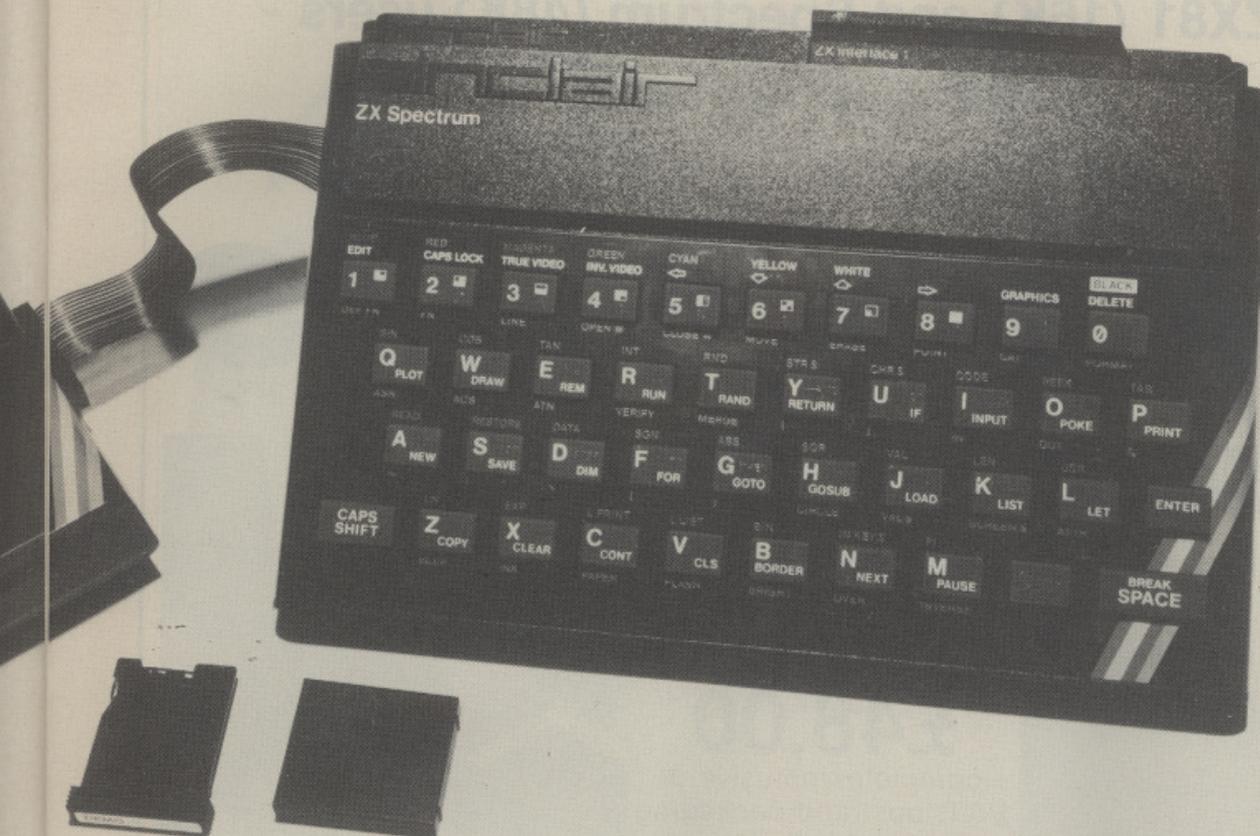
We will take a closer look at how and how well this all works in issue 25.

## The network

The biggest surprise of the Microdrive release was the local area network. Up to 64 Spectrums can be connected up to 100 metres apart. Unlike some other simple networking systems, this one does not require its components to be linked into a loop. The computers on either end can't be connected to each other.

A length of cable for netting is supplied with each Interface 1 and Sinclair claims all the Spectrums in the net need not be turned on for communication to take place. The only limitation is that individual Spectrums on the net may not be turned on or off while communication is in progress.

To use the net you have to give your computer an identification number — if there are only two computers each can call itself 1, without the need for any identification commands.



Chris Bell

Sending and receiving data involves a fairly simple series of commands. A program is sent by loading it into your own computer and saving it to its destination.

To send a program or some data requires a fairly high level of interaction among the participants. Unless you are within shouting distance, some form of telepathy would appear to be necessary to get things working. For instance, there is no way of breaking into a game or application on another computer to warn of an impending transaction. Participants should ideally be facing one another.

To send down a program requires the sender entering:

```
SAVE "*"n";2
```

The receiver has to prepare his station by entering:

```
FORMAT "n";2
```

```
LOAD "*"n";1.
```

The receiver then has to verify the correct reception of the transaction by another command.

There is also a broadcasting facility so every computer on the net can pick up a transaction – this feature is useful in the classroom network.

The crowning feature of the Interface 1 is the D-plug RS232 connector which gives the user access to peripherals like quality dot-matrix printers or modems. Using a printer, for instance, would seem to be a fairly straightforward procedure and we can probably soon expect a deluge of wordprocessing packages to take advantage of the situation.

#### Verdict

The Microdrive doesn't represent any technological quantum jump – 'stringy floppy' products of this type have been around for some time. Its importance lies in Sinclair's backing.

To be really useful, a storage medium must be tied in to software – it has, in effect, to be perceived by the industry as a likely 'standard' with a substantial market available for software products making use of it before it will be supported.

Once the ball is rolling, however, it becomes very difficult to replace it with something else – so the Microdrives are likely (all being well) to follow-through on Sinclair products for some years.

#### Spectrum with Microdrive

The average Spectrum owner wants to be able to run commercial games and applications on the chosen method of storage, not just load and save his own listings. The bugbear with third-party products of this type was that users found that the built-in protection, of the games programs especially, prevented them from listing and resaving on an alternative storage system.

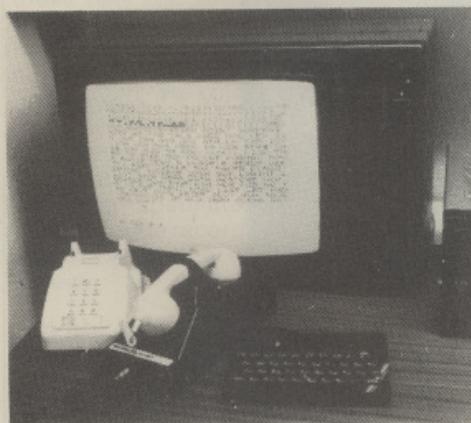
With Sinclair's backing, the software producers are likely to market several protected programs at a time on a Microdrive cartridge. Perhaps even more importantly, it should be possible to write significantly more flexible personal/business applications programs for the system than have hitherto been practical given the limitations of the cassette recorder.

**Item** Sinclair ZLX Interface £29.95 (with drive), £49.95 by itself. ZX Microdrive £49.95 per drive. Cartridges £4.95. **Available** Mail order, 2 drives and 1 Interface per customer until further notice. (Order forms are

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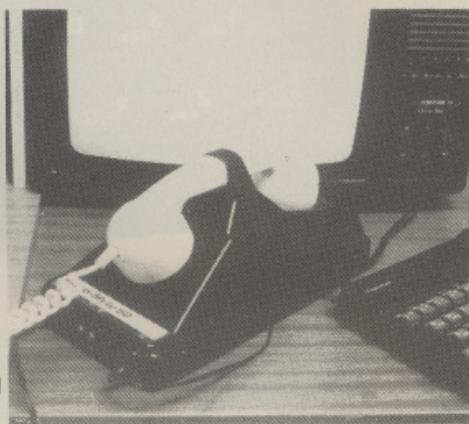


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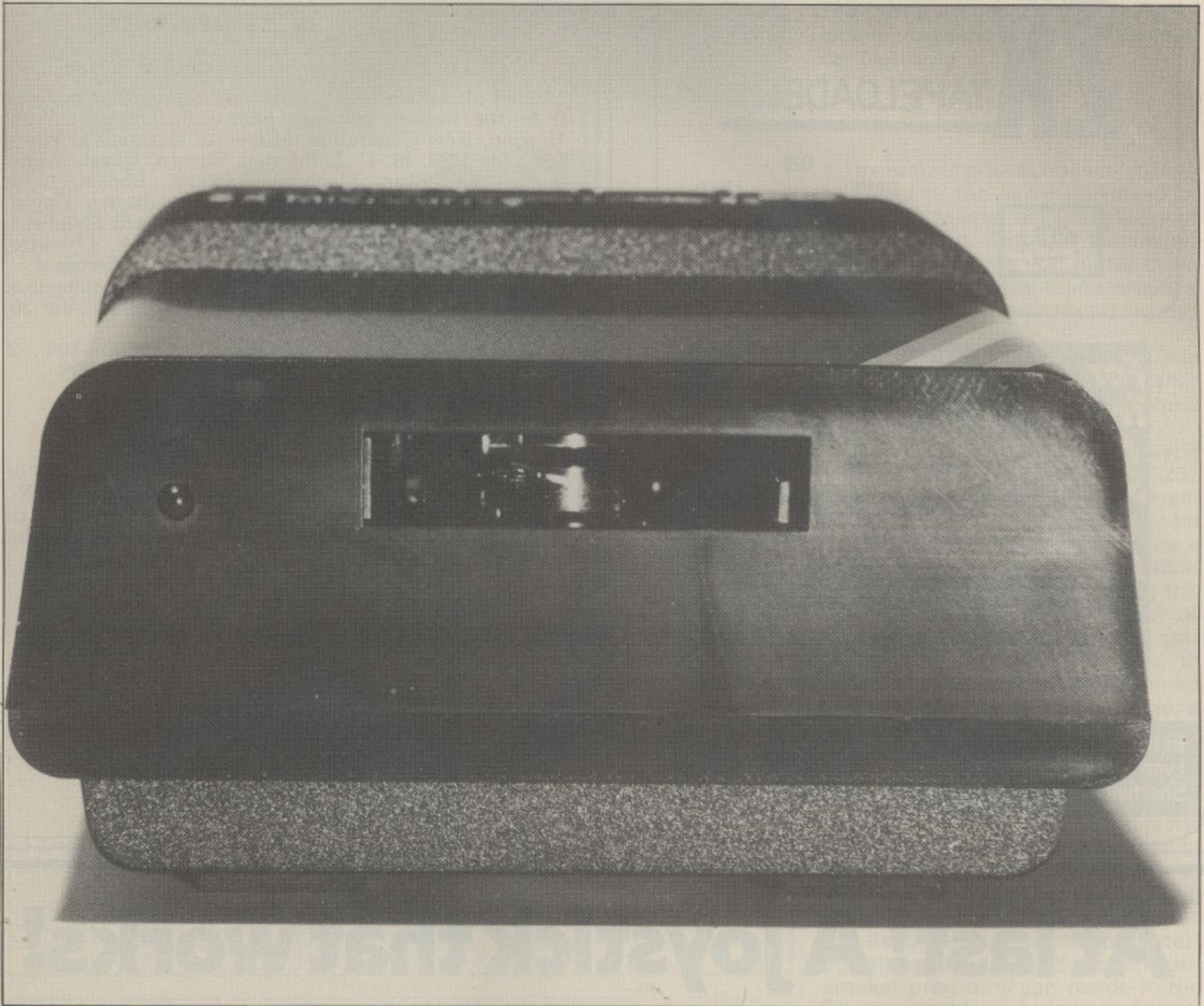
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*The underside of the Microdrive showing cartridge port*

being sent to those who bought Spectrums first as supply permits.)

CAT 1

Lists all the files in a cartridge in a given drive (1,2,3 and so on).

CAT#z;1

Sends the catalogue in drive 1 (or 2,3 etc) to stream z.

CLOSE# STREAM

Unlinks any channel from the specified stream.

ERASE "m";1;"name"

Erases the file with the specified name from the cartridge in drive 1.

FORMAT "m";1;"name"

Prepares a blank cartridge and gives it a name.

FORMAT "n";X

Sets the network station to number X.

FORMAT "t";X

Sets the baud rate for the interface (X can be 50,110,300,600,1200,2400,4800,9600,19200).

LOAD "\*"m";1;"name"

Loads up a named file from Microdrive 1.

SAVE "\*"M";1;"name"

Saves file to Microdrive 1.

The commands to control the Micro-

drives and the networking system are tied to the Basic keywords. As can be seen from the sub-set of the commands above, this aspect complicates the syntax necessary to do quite simple operations. For instance, it takes 11 to 21 keystrokes to accomplish the oft-needed loading of a file — most of the syntax also requires continual shift changes.

When Sinclair's Spectrum was launched in April 1982, there was much hoopla about the 'soon-to-be-available' cheap disk drive for the machines.

As it turns out, the Microdrive was neither available soon nor a real disk drive. It was launched last month and turned out to be a floppy tape with limited serial access — not the random access disk pack everyone had put their sights on. But it's probably not Sinclair's fault — after producing the ZX81 and the Spectrum, many people expected the impossible; random access drives for under £100.

Another expectation was that the operating system in the Spectrum was already set up to support the CAT, CLOSE, DELETE, ERASE, FORMAT, MOVE

and OPEN commands on the Microdrives. Again the original impression was wrong — the Microdrive interface module that you have to buy to run the drives actually contains the operating system.

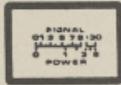
Sinclair Research itself had always been slightly more modest (read realistic) in its claims about the Microdrives, largely because the drives had been undergoing slight design changes all the way along.

Sinclair claimed that: 'Each Microdrive is capable of holding up to 100K using a single interchangeable microflop... All the Basic commands required for the Microdrives are included in the Spectrum.'

The big question was: What did they mean by microflop? The answer was oft-specified, many people reaching the correct conclusions about the impossibility of a 'real' disk drive and surmising that it would have to be a floppy tape or stringy floppy instead.

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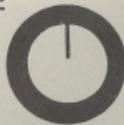
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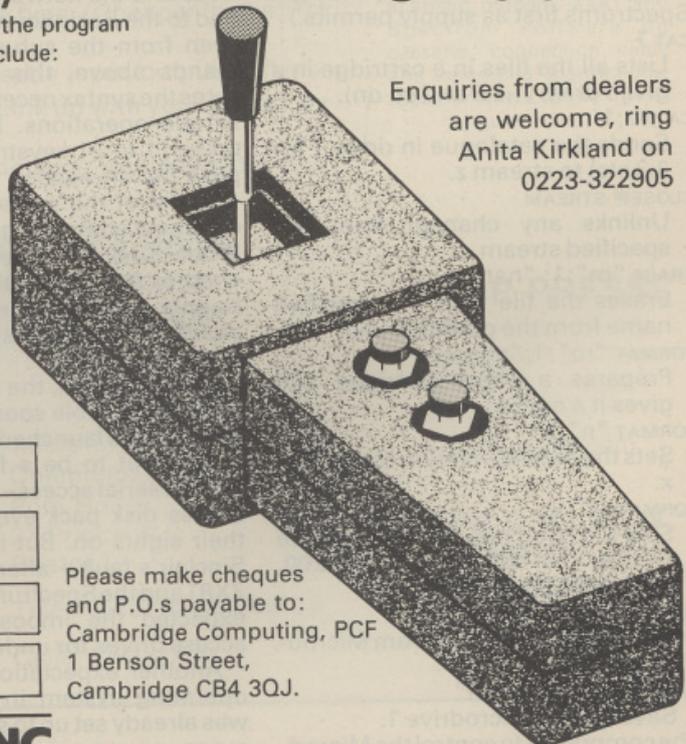
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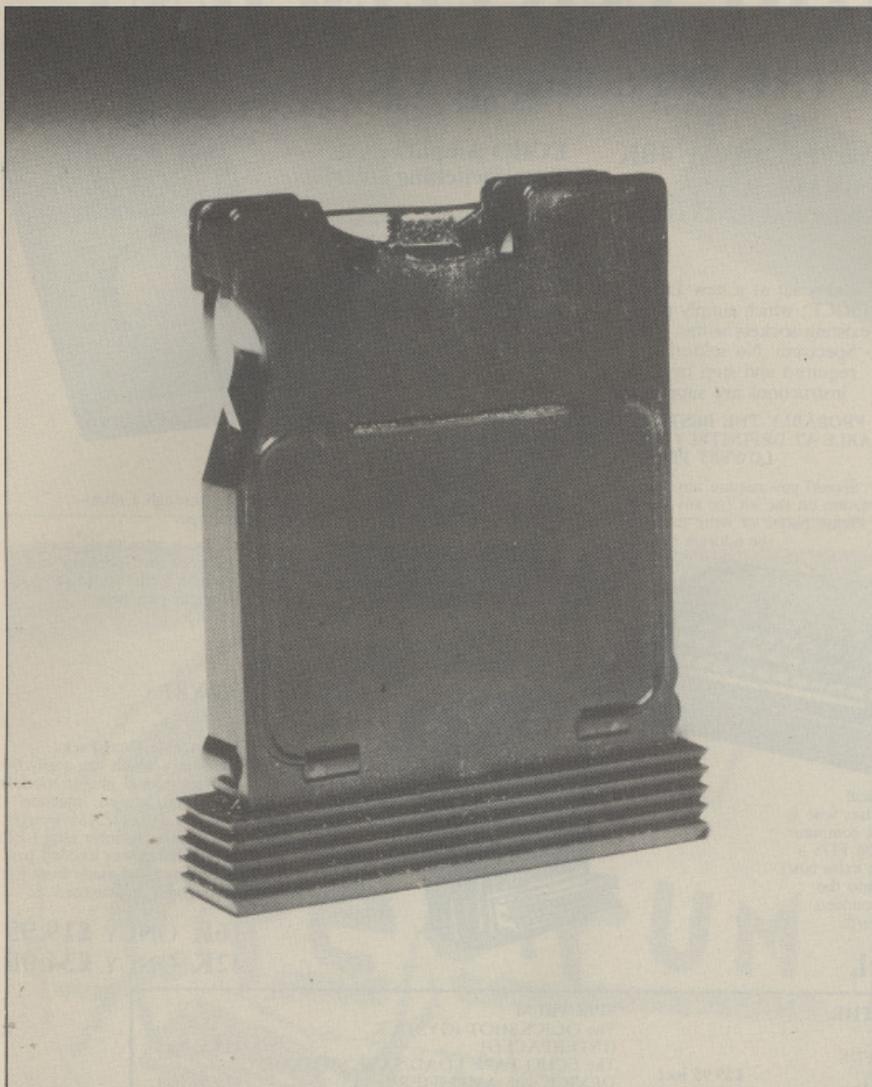
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**CAMBRIDGE COMPUTING**



*The cartridge consists of an endless loop of magnetic tape – over 50 files can be stored*

The real surprise is not in the drive itself but in the expansion module developed to interface the drive with the Spectrum. The £30 expansion module also gives you motor drive control over cassette-tape storage, a plug-in for local area networking and an RS232 interface.

The communications facility lets you network as many as 64 other Spectrums at baud rates as high as 9600 and as low as 50.

The inside word from a prototype Microdrive user is that the RS232 interface had some development problems, but if it proves to be reliable in the long-term it will be a great complement to the Microdrive. Imagine a small business using the Spectrum with a wordprocessor or spreadsheet in ROM (using the cartridge software. Sinclair plans to release for the Spectrum) combined with two Microdrives for storage, a network connecting perhaps other desks in a small office, and dot-matrix or even daisywheel printers running through the RS232.

Sinclair has also said it soon plans to release software on Microdrives, in addition to the existing base of cassette software and the planned release of ROM software. Cassettes will likely remain the cheapest storage alternative for the Spectrum, but smaller programs can reside in the plug-in cartridges and big programs can take advantage of the Microdrive's 100K.

#### **Documentation**

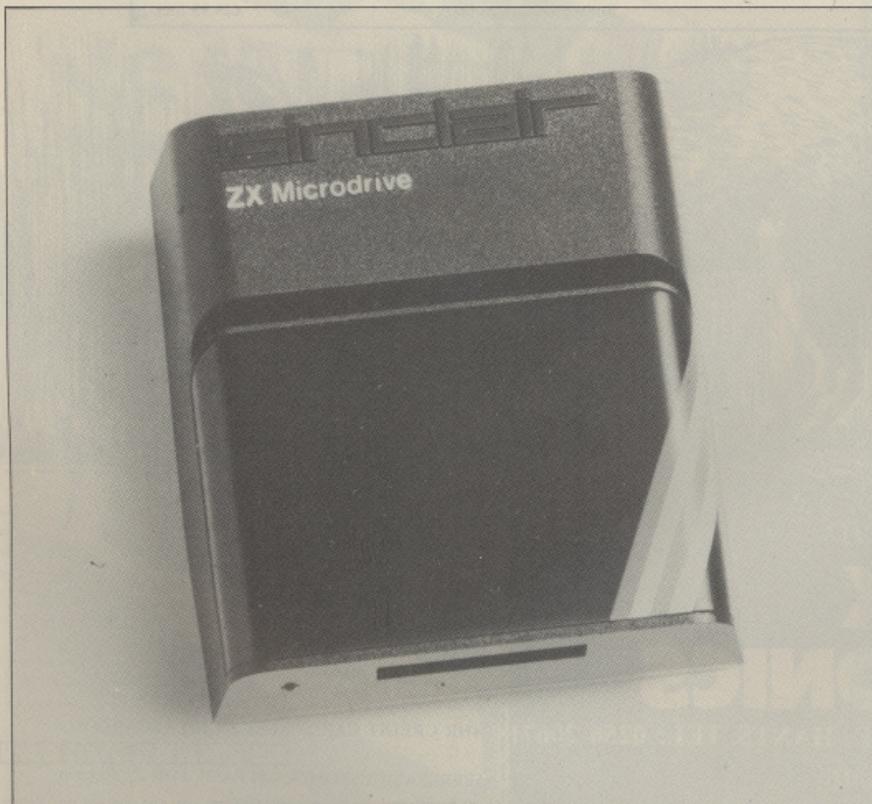
One of the first things that became apparent in actually using the Microdrives was that the manual is rather inadequate, to say the least.

It takes just 57 pages to cover all of the different features offered by both the Microdrive system and its networking facilities.

Some of the chapters are frankly breathtaking in their lack of detail.

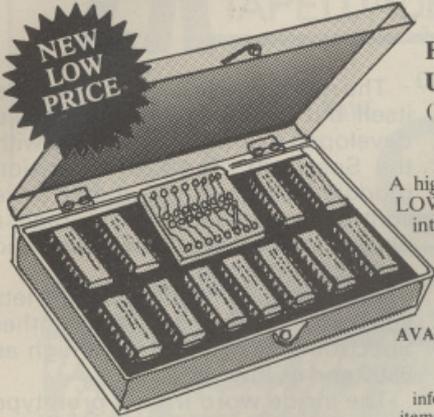
One of the most crucial concepts with which you must get to grips, having added the Interface 1, is streams and channels. This is granted a meagre two pages, although the concepts appear constantly through the rest of the manual.

The channels are the places in the system to and from which you and the



*The Microdrive itself – the networking news means 6,400 metres of spectrum data!*

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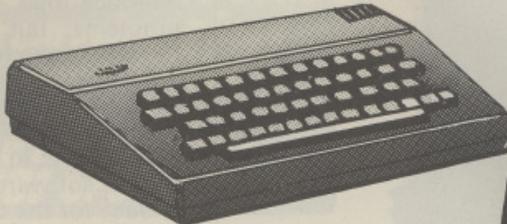
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From Fox the new **FDS for the SPECTRUM, ZX81, JUPITER ACE, and the ORIC as illustrated.**



This elegant desk top system, designed for the professional user. In its slimline case, the superior keyboard contains all the graphic characters for the above computers. With the additional function keys and SPACE-BAR, speedy and accurate data entry is made simple. The Fuller FDS is easy to install, based on the very popular FD42 system, it requires

no soldering or technical knowledge. For the user who is reluctant to install his computer circuit board inside the FDS a buffer is available (at extra cost) which simply plugs onto the expansion port and connects directly to the keyboard.

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## ECHO Amplifier and Tape Switching Interface



'ECHO' enables the ZX-Spectrum sound output to be brought into the audible range. The amplifier has separate Tone and Volume controls, for the harsh or mellow sounds, and DIN compatibility, allowing a greater range of tape recorders to be used for saving and loading programs.

The tape switching interface allows the user to plug 'Ear' 'Mic' and 'Power' leads to be plugged directly into the Echo and left there. No more frustrating lead swapping. Saving to, and loading from tape is made easier by merely switching to 'LOAD' or 'SAVE'.

A further switch position of 'CVE' enables an audio cue to precede the program on tape, a decided advantage when

searching through a multi-program tape.

The Echo is attractively cased to compliment the Spectrum and does not inhibit the use of the computer rear user port.

## HARDWARE ZX81

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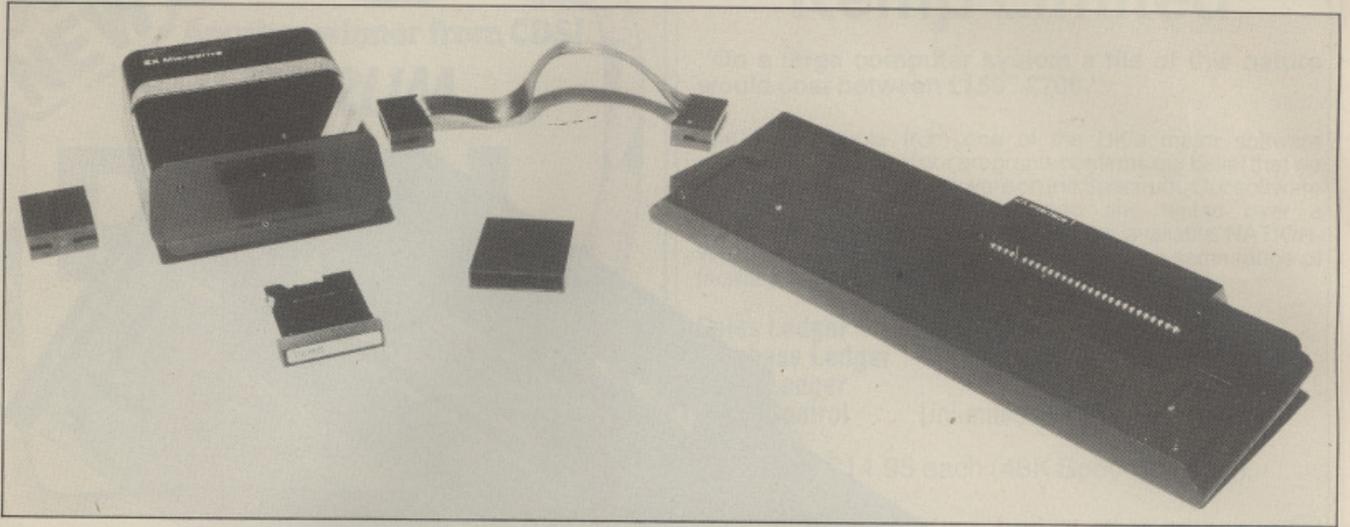
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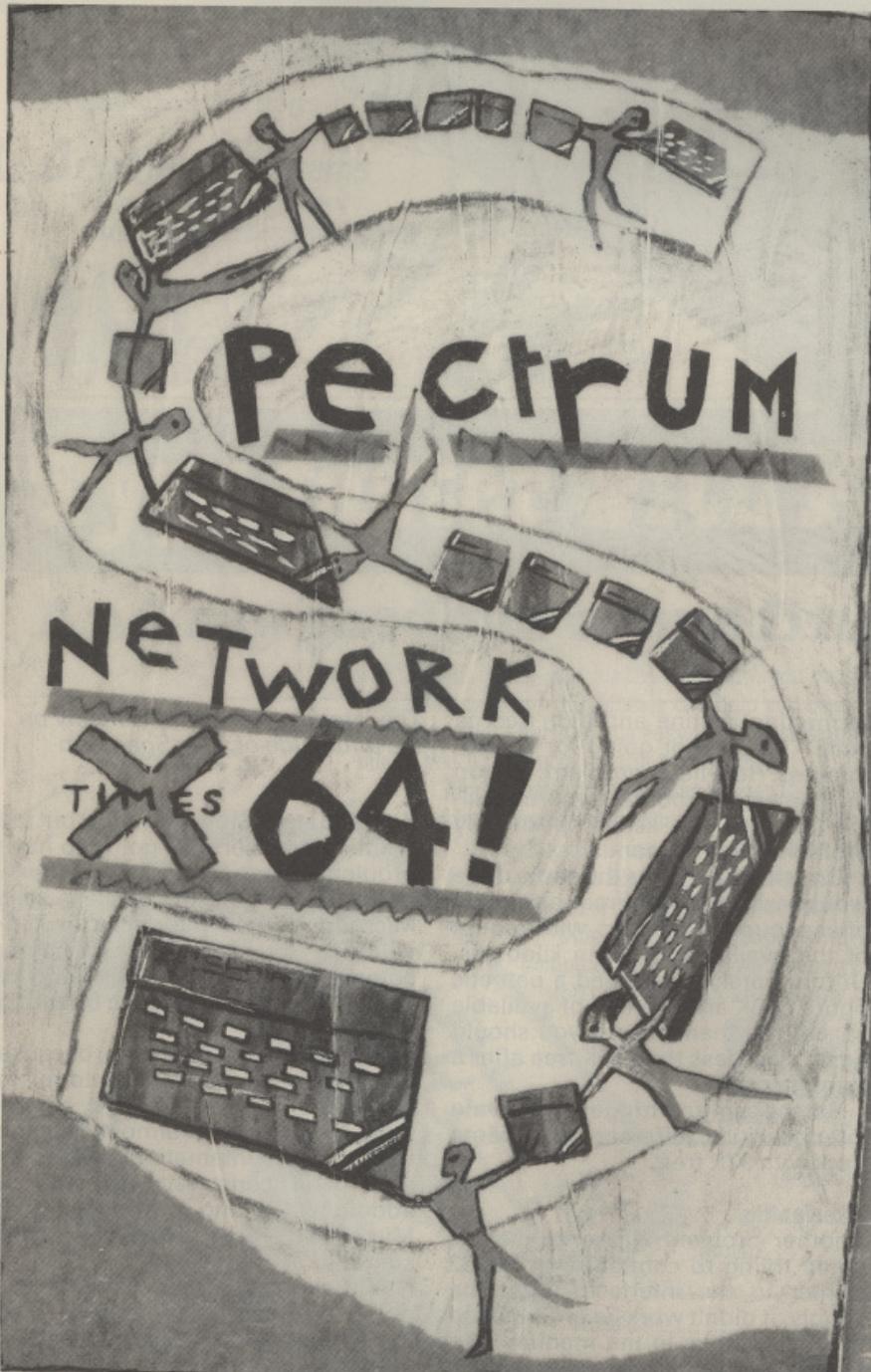
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*Pictured is the new ZX interface 1 which connects the Microdrive easily and neatly to the Spectrum computer.*



Dolores Fairman

computer send data – off to the screen, printer, Microdrive, RS232 or other Spectrum, or from the keyboard, Microdrive, RS232 with a modem, or other Spectrum on the net.

The streams are the routes along which data flows to and from the channels. The first four streams are linked to various components – the upper or lower parts of the screen, the keyboard or the ZX printer. This leaves streams four to 15 free to the user for sending data to Microdrive files or other computers on the net.

When using the networking facilities you have to differentiate between data and programs. While sending a program across the net is a fairly straightforward task, sending data involves a little more fiddling about.

Because the net uses a 255 byte buffer system, there must be a close stream statement at the end of the data to tell the buffer to send off the last block, even though (254 times out of 255) it hasn't been filled.

The same concepts are involved in manipulating data files with the Microdrives. You have to 'open' a stream and nominate the file name. The cartridge concerned is then searched and, depending on whether the file named exists already, is opened for reading (if it is) or is created (if it isn't).

All well and good: these features present no unsurmountable problems. But the chapter entitled 'Data and the Network', for instance, is just one and a half pages long!

There is only one short demonstration program and the terseness of the explanation reveals, perhaps, a mind



so used to dealing in bits and bytes that it's forgotten the average user can't SAVE with the same efficiency as the Microdrive itself.

Or can it? Much as I'd like to be overwhelmingly effusive in welcoming what appears to be a revolutionary product, I have to say that I'm a bit dubious about reliability.

Obviously at this stage it pays to give Sinclair the benefit of the doubt. Until large numbers of drives are out in the hands of the public it's difficult to tell how often such and such a feature is going to break down and under what circumstances.

But I did experience a disappointing number of faults. One of the Microdrives I was using seemed to develop a formatting fault.

Formatting always takes a fairly long time, because the system has to go right through each cartridge several times to write checksums, read them back and identify blocks. One of the drives I used set off the

formatting routine and didn't come back – it just kept going for several minutes. Here lies a problem: to stop the berserk Microdrive required pulling the plug – an action specifically prohibited by the manual.

On other occasions the same drive would achieve the format operation after a couple of minutes, with a count of the available space in kilobytes. Unfortunately it returned a pathetic figure of 6K and then 4K of available space. The manual says you should never have less than 85K free after a format.

But the same cartridge on the same interface in a different drive came back with 97K free.

#### Interfacing

Another problem was encountered when trying to configure an RS232 printer to the interface. Put quite simply, it didn't work (yes, I followed the instructions in the manual). I'm sure it can work, because I saw it

*The interface 1, which fits neatly on the underside of your Spectrum*

doing so at the Sinclair launch, but the point is that users are going to have problems when trying to do it themselves. After all, if Sinclair sells Microdrives and interfaces in kilovolumes the company is hardly equipped to deal with the flood of user-enquiries which seem bound to follow.

This is all a bit of a shame, because most of the problems seem to relate back to the shortcomings of the manual. One might almost imagine that the documentation offered is part of a conspiracy to sell an additional 'Getting to grips with the Microdrive' – type book at some later stage.

All I can say is that somebody is going to have to write one. And there'll be a market ready and waiting ...

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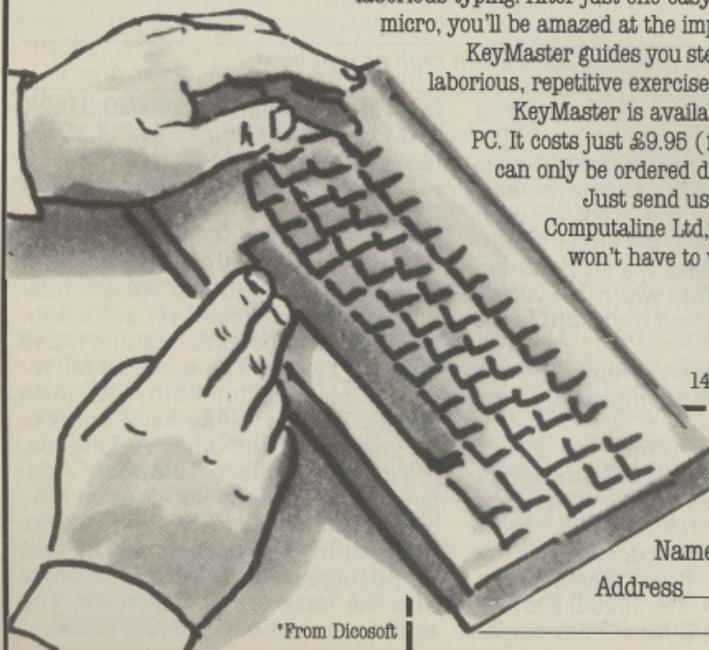
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MF-S

## PERIPHERALS

The Spectrum must have more peripherals designed especially for it than any other computer — micro, mini or mainframe — on the market. You can upgrade your machine's memory. You can add sound and speech to it. You can design graphics more easily, print in colour or change your keyboard.

If you want to enhance your Spectrum, don't worry. Your only problem will be making a choice — and it will no break your pocket. Peripherals for the Spectrum are very reasonably priced.

### UPGRADES

Perhaps the next most exciting peripheral for the Spectrum is Micronet's modem. With this, you can hook your machine into the Prestel-based information network. Software will be in ROM, and gives you a 40-column screen with full Prestel graphics. The modem will cost about £62.

The special adaptor connects to the expansion interface on the underside of the Spectrum, so you will not need acoustic couplers. The adaptor will also allow you to print the Prestel frames, save them or compose them off-line.

The only real alternative to the microdrive is Basicare's Organic Micro. This is a stack of upgrade modules connected with male and female connector pins. The modules can perform separate or integrated functions to produce a wide range of facilities.

An Organic Micro will give you up to four programs, immediately accessible in one 64K RAM. Up to four 64K RAMs can be installed, giving you 256K of memory. This is ideal for business use.

There are also sophisticated sound generators and a Centronics printer interface. Basicare suggests that a beginner's system could consist of a Persona (direct computer interface) and a 16K RAM. Modules can be added as needed.

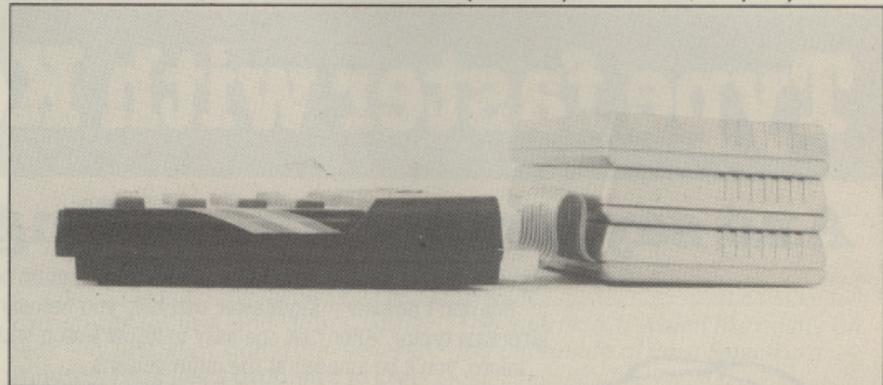
Prices are as follows: Persona £45.00, Minimap £34.45, RAM 08 (2K) £22.95, RAM 16 £25.25, RAM 64 £74.70, DROM (2K) £37.90, Toolkit £20.65, Pericon-a (gives 24 lines of input/output) £26.40, Pericon-b (24 lines of heavy-duty output) £32.15, Pericon-c (80-column printer with Centronics-type interface) £40.20.

You can contact Basicare Microsystem at 12 Rickett Street, London SW6 5EL. Tel: 01-385 2135.

Other memory upgrades for the Spectrum are less ambitious, giving you up to 48K additional RAM as a general rule. You should check to see if they are self-contained or come as part of a kit. You should also check if



The Sinclair Microdrive: 100K of memory at 16K per second, they say.



The Organic Micro modules. Stack 'em high as you like.

they operate with issue 1 or 2 Spectrums.

If in doubt whether your machine is issue 1 or 2, simply look at the metallic contact strips at the back of your machine. In issue 1, the space separating the strips and the strips themselves are the same width. In issue 2, the space is only half the width of the strips.

Prices fluctuate enormously here. It is worthwhile shopping around for the best value.

Fix Electronics offers the £21.00 Upgrade Kit for issue 2 machines. Simple insertion of 12 chips will upgrade from 16K to 48K. More details are available from Fox Electronics, 141 Abbey Road, Basingstoke, Hants RG21 9ED. Tel: (0256) 20671.

The Spectrum Budget Pack comes

from JRS Software. It consists of 32K RAM in kit form, priced at £44.95 for issue 1 and £34.95 for issue 2 machines. You can telephone JRS on (0903) 65691.

Computer Add-Ons supplies a number of memory expansions from various manufacturers. All are fully guaranteed and need no soldering. ME48 series A costs £34.50 and ME48 series B £24.50. The external ME16-48K is suitable for both and costs £39.95. It has a 'piggy-back' connector so you can add other peripherals.

You can contact Computer Add-Ons at 7-9 Thane Villas, London N7.

Kayde Electronic Systems offers the Plug-in RAM Pack for £44.95 plus £2 postage and packing. This plugs into the back of the Spectrum. The telephone number is (0493) 55253.

# Lots and lots of add-ons

Economic versatility is the name of add-on games, according to the Sinclair Empire which markets an amazing array of products available for addition to their systems.

Dk'tronics promises that fitting its 32K extra RAM (*above right*) to your Spectrum needs only 'a screwdriver and just two minutes of your time'. Memory Expansion Mk1 is priced at £35.00, and Mk II at £30.00. You will have to add £1.25 for postage and packing.

Dk'tronics can be contacted at Unit 2, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ. Tel: (0799) 26350.

Cheetah's RAM Pack (*see right*) will increase your Spectrum's memory from 16K to 48K simply by plugging into the user port at the rear of the machine. There is no need to open the computer. An injection-moulded case eliminates the 'wobble' problem. And the gold-plated edge connector has been treated to prolong life.

The price of £39.95 includes VAT and postage. Cheetah Marketing is at 359 The Strand, London WC2R 0HS. Tel: 01-240 7939.

## JOYSTICKS

The reason most people buy extra memory for their machines is to enjoy the many games designed for the Spectrum. So hand in glove with memory add-ons are joystick controls.

The trouble with the Spectrum is that it was not designed for joysticks. But where there's a will there's a way.

Sinclair Research promises an interface for games cartridges and a joystick controller. In the meantime, the Kempston joystick (*see right*) interface leads the market.

The Kempston Competition-Pro joystick has a self-centering stick, strong nylon and steel construction and comes complete with boxed interface. The handle can be swivelled in eight directions and includes two large fire buttons.

The joystick with interface costs £25, and Vic 20/Atari joysticks £16.50. The interface by itself costs £15.00. Kempston (Micro) Electronics can be contacted at Dept 180a Bedford Road, Kempston, Bedford MK42 8BL. Tel: (0234) 852997.

The Spectrum has more add-ons than any other micro you can name. Here Deirdre Boyd gives a run down on just what you can screw, glue, belt, bolt and otherwise just add on.



If you do not want to dig into your games programs, then the Pickard joystick may be the answer for you. It can convert any key-controlled program, whether joystick routines have been written into it or not.

The Pickard is a small box measuring 4.5" x 3" x 1.5". There are four rows of 10 miniature jack sockets, each corresponding to a key on the Spectrum keyboard. Above these are five cables, with a miniature jack plug. These are labelled up, down, left, right and fire. You plug in the cables like a switchboard operator to the relevant socket.

The Pickard is priced at £18.95 plus £1.00 postage and packing. It is manufactured by Success Services, tel: (0922) 40403.

AGF offers the Interface Module II and a Programmable Interface. The former plugs into the rear connector of the Spectrum and allows you to connect any standard Atari-type digital joysticks. It does need compatible games, but you can also use it in your own programs. Eight direc-

tions and fire are all read by Basic.

The Interface Module II costs £20.95 and joysticks cost £7.54 inclusive.

The Programmable Interface is a more recent offering. It offers you joystick compatibility with all games software through a hardware programming design. The price is £32.95 plus £1.00 postage and packing. AGF Hardware is located at 26 Van Gogh Place, Bognor Regis, West Sussex PO22 9BY. Tel: (0243) 823337.

Micro Power is advertising its Multi-purpose Sound Generator and Joystick-port Board. This gives you three-channel sound effects with amplification, two ports for potentiometer joysticks and one for switch-type joysticks. It, too, plugs into the back of your Spectrum. The price is £22.50 plus VAT.

The company also has potentiometer-type joysticks in a kit form for £5.35 plus VAT, or built for £6.75 plus VAT.

Write to Micro Power, Dept SU6, 8/8a Regent Street, Chapel Allerton, Leeds LS7 4PE. Tel: (0532) 683186 or 696343.



# AGF

# PROGRAMMABLE JOYSTICK INTERFACE



for

# sinclair ZX Spectrum 81

### ABOUT OUR PROGRAMMABLE INTERFACE

Surpassing the outstanding specification of our Interface Module II which still offers the best software support at its price, a Joystick Interface that is compatible with ALL SOFTWARE through its unique hardware programmable design.

The Interface plugs on to the rear connector of your ZX81 or ZX Spectrum.

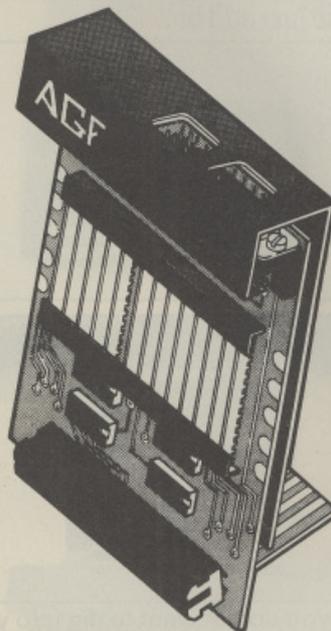
Quick clip-on connections, which are configured from a reference card supplied, allow you to define which of the forty keys are simulated by which action of the Joystick. A pack of ten Quick Reference Programming Cards makes setting for your favourite games even easier. These can be filled in to show at a glance the configuration required and stored in the cassette case of the particular game. When you change to a game using different keys the module is re-programmed in a few seconds.

As with our Interface Module II the Programmable Interface accepts all standard switch Joysticks that are Atari-compatible. Two sockets are available which are connected together for two player games which use the same keys for both players.

The Interface resides in the keyboard address space and does not affect its operation or interfere with any other add-ons. A rear extension edge connector will accommodate expansion of your system.

The unique AGF key simulation principle makes it extremely easy to incorporate Joystick action in your own programs. All eight directions and fire are read by simple BASIC.

With every order comes a free demonstration program called 'Video Graffiti' plus a full set of instructions.



### KEY FEATURES

- ★ Programmable design gives TOTAL software support.
- ★ Accepts Atari, Competition Pro, Wico, Starfighter, Quick Shot, Le Stick etc.
- ★ Rear extension connector for all other add-ons.
- ★ Free demo program and instructions.

### PACKAGE CONTENTS SUPPLIED

- Programmable Interface Module as illustrated, complete with clip-on programming leads.
- Self adhesive programming chart detailing how to define which key is simulated by UP, DOWN, LEFT, RIGHT, and FIRE. This can be fixed on to the case of your computer or if preferred the protective backing can be left on. The chart is made of a very durable reverse printed plastic and is extremely easy to read.
- One pack of ten Quick Reference Programming Cards for at-a-glance setting to your games requirements. The card allows you to mark the configuration in an easy to read fashion with space to record the software title and company name.
- Video Graffiti demonstration program which is written totally in BASIC to illustrate how all eight directions and fire can be read. This is also a useful high resolution drawing program.
- 12 months guarantee and full written instructions.

## JOYSTICKS

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	PACK(S) QUICK REFERENCE CARDS	1.00	
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DEALER ENQUIRIES WELCOME		EXPORT PRICES ON APPLICATION	
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Finally, there is the Fuller Box. This gives not only a joystick controller but also a sound chip, a bleep amplifier and a more reliable cassette interface. It will accept joysticks from Atari and Commodore. It costs £29.95 plus 80p postage and packing. More details can be gleaned from Fuller Micro Systems, Sweeting Street, Liverpool. Tel: (051) 236 6109.

## SOUND

The Namal Supertalker is perhaps the best known of the speech units. Designed around the Votrax SC01A phoneme speech synthesiser chip, words are pronounced by supplying a sequence of codes for the component sounds. Words can be spelt in sounds. Call, for example, is represented by the phonemes K-AW-L. A 23-page instruction booklet explains the phonetic principles.

The Namal has about 550 words in a dictionary ROM, and can download 200 to 250 words in a 2K internal RAM. It stores messages by sequencing the dictionary numbers.

You can buy this handy item for £69.95 plus VAT from Namal Associates, tel: (0223) 355404.

Sweet Talker is another speech synthesis module. It is based on the Allophone individual speech sound, so its vocabulary is unlimited.

Sweet Talker is built into a robust case which plugs into the user port of your Spectrum. It is powered from the existing supply and has a built-in speaker set at optimum. It works on both 16K and 48K machines.

With every module comes a demo tape, explaining how you use it, and an easy reference chart. The set is guaranteed and fully compatible with other accessories. 'No more lonely nights' Cheetah promises.

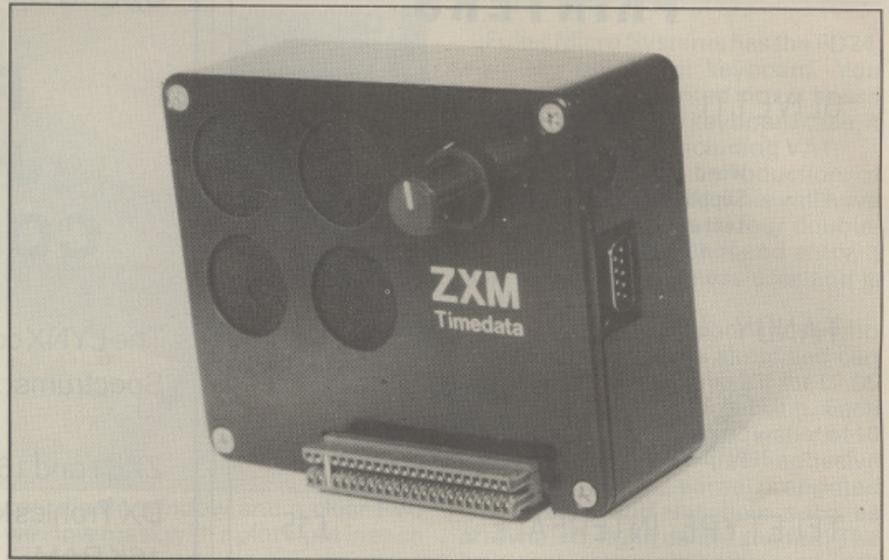
Sweet Talker costs £34.95 inclusive of VAT and postage and packing.

The DCP Speech Pack concentrates on ease of use rather than versatility. Every word is coded with a number. You just enter the appropriate number after the command OUT. The words will be generated where you want them when the program is run.

Each word is resident in ROM, so you are limited to the list supplied. But you can expand this with three additional chips, which cost £14.95 each.

The DCP Speech Pack is covered by a 12-month warranty on parts and labour. It costs £49.95 from DCP Microdevelopments, Tel: (0603) 712482.

The Trichord is a plug-in music and sounds peripheral from Petron Electronics. It promises you 6,134 three-note chords on the 48K Spectrum. It has a range of more than eight octaves with 'infinitely variable tempo'.



Sound effects include cannon fire, gunshots, explosions, missiles, sonar, helicopter and airplane engines, steam engines with optional whistle, train horns, bongs, blips, compressor, hammer and a selection of UFOs.

The Trichord plugs into your micro's edge connector, and is compatible with other Sinclair add-ons. A demonstration audio cassette costs £1.25. Manuals can be purchased separately for £1.25, refundable on purchase of a Trichord. The Trichord itself costs £26.95 inclusive.

For more details, contact Petron Electronics, 1 Courtlands Road, Newton Abbot, South Devon TQ12 1JA. Tel: (0626) 62836.

The TS 2000 SSI speech synthesiser comes from Computer Add-Ons. It plugs into the back of your micro and needs no power pack, leads or batteries. It produces speech effects and comes with a dictionary of sounds. It can be connected to your external hi-fi.

The TS 2000 SSI comes at the reasonable price of £39.00 plus 40p postage and packing.

The aptly named Chatterbox comes from William Stuart Systems. It is based on phonetic synthesis and has an unlimited vocabulary. The speaker/amplifier is self-contained. Ring 01-221 1131.

Prolific Fox Electronics' offering in this area is the Echo. It amplifies existing sound from the BEEP command, and has separate tone and volume controls for harsh or mellow sounds.

The Echo also has DIN compatibility, so you can use a greater range of tape recorders for saving and loading programs. There is no need to swap leads, as the tape-switching interface allows you to plug the ear, mic and power leads straight into the Echo. And you can precede each program with an audio cue, a decided advantage when searching through a multi-program tape. The price is

£19.00 including VAT.

Fox Electronics also offers a programmable sound generator at £29.00. And at the lowest end of the range is a Sound Box, complete with leads, volume control and speaker. This plugs into the MIC socket and costs £7.50.

Basildon-based Timedata offers the ZXM Sound Box (see above). It has a range of simple sound effects and a built-in amplifier and loudspeaker. It includes a nine-pin input/output socket, so can be used with Atari or Commodore joysticks. The cost is £29.95 from Timedata. Telephone the company on (0268) 418121.

Bi-Pak Semiconductors has produced the ZON X input-output mapped sound generator (see right). It is a self-contained unit which plugs into the back of your Spectrum. The unit uses the three-channel-plus-noise sound chip. Its effects can be added to your own programs with a few lines of Basic or machine code. The price is £32.75.

Bi-Pak Semiconductors can be contacted at PO Box 00, 63a High Street, Ware, Herts SG12 9AD. Tel: (0920) 3182.

## GRAPHICS

Graphics data is usually input to the Spectrum through the keyboard. You can simplify this task with widely



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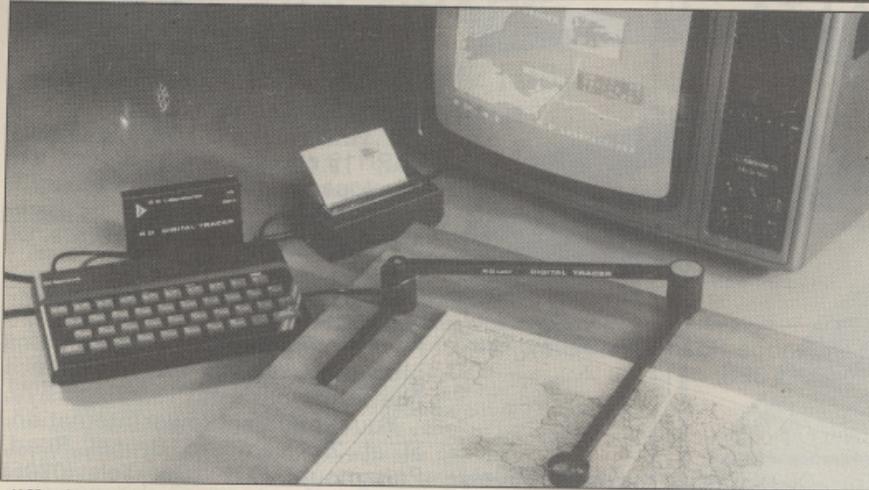
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differing accessories, ranging from joysticks, light pens and tracers to graph sheets and plot windows.

The digital plotter or tracer is probably the easiest way to transfer data from paper to the video screen. Just move the tracer around the drawing you want to copy — an analog-to-digital converter will do the rest for you.

RD Laboratories' digital tracer hooks up to the Spectrum through an interface plugged into the edge connector expansion port. It must be hooked up after all your other peripherals as it has only a 23-way edge connector and would otherwise plug up your interface.

The tracer is input/output mapped on the 48K Spectrum. It can be memory mapped on the 16K machine with adaptor, and costs £55.

Contact RD Laboratories, 5 Kennedy Road, Dane End, Ware, Herts SG12 0LU. Tel: (06333) 74333.

Light pens are also growing in popularity. You can produce high-resolution drawings on your monitor simply by moving the light pen around the TV/monitor. The hardware/software picks up its position on the screen. The software program accompanying the pen will allow you to erase, modify and save your designs.

Dk'tronics can supply you with a light pen for £19.95, plus £1.25 postage and packing.

A much cheaper alternative to buying software is the ZX Spectrum Graphics Sheet from Keyboard. The set consists of 50 sheets of graphic paper gummed together, a ruler and seven coloured felt-tip pens.

The margins and top of the sheets are marked with line and column numbers that correspond to the Spectrum's (0-21, 0-31).

You can use the set to design screen layouts for graphics, and to design them in input/output. It costs only £5.00.

Victa Ceramics has eased the graphics problem with its Victagraph plot window. This consists of a white PVC base sheet, a clear PVC offset

coordinate window and a clear PVC window mask with a plot sight in each corner.

The price is £7.50 including VAT and postage and packing. For more details, write to Victa Ceramics, 6A



Bow Street, Rugeley, Staffs, WS15 2BT. Tel: (08894) 2426.

## KEYBOARDS AND CONSOLES

The lack of tactile feedback from the Spectrum's 'dead flesh' keyboard has irked many users. This is evidenced in the numerous alternatives from independent suppliers to the original keyboard.

Some keyboards incorporate other add-ons, such as sound. So you will find the prices again vary widely.

Dk'tronics is represented in this market by a model that will set you back £45.00. It consists of a black case that measures 15" x 9" x 2.5". It is large enough for your micro and other add-ons, such as power supply, to fit neatly inside. But you will have to remove the micro from its original case to screw it inside Dk'tronics version. All connections are at the rear of the case.

The keyboard has 52 keys, 12 of which are for the numeric pad. Normal keys are grey and numeric ones red.

Dk'tronics can also supply Spectrum legends and details for updating your ZX81 case.

Fuller Micro Systems has the FD24, a 42-key full travel keyboard. You unscrew the ZX printed circuit board and screw it into the keyboard case. It is priced at £29.95 including VAT.

August sees the introduction of Fuller's FDS keyboard. This will have 50 keys, a space bar and four double-sized entry keys for shift and entry. It is aimed at the business user and is priced at £49.95.

Games enthusiasts and those who want their keyboards simplified can buy a Custom Keypanel Kit for £2.95 plus 25p postage and packing. Each kit comes in a clear plastic wallet of 10 matt keypanels and 140 self-adhesive command labels, some preprinted with words and symbols such as arrows, left, right, delete and fire! The keypanels are precision die-cut and fit over your Spectrum keyboard.

The kits are available from Sof-teach, 25 College Road, Reading,

Berkshire RG6 1QE.

Peter Furlong supplies the ZX Workstation, an ABS plinth that raises and tilts your TV for better viewing, and angles your computer for easier typing. The power supply is fixed underneath. Printer and cassette player can be used with it.

The workstation costs £16.00. Extras include a power switch for £3.00, an alloy base for £3.50 and a speaker for £3.50. You should allow another £2.00 for postage and packing.



Peter Furlong Products can be contacted at Unit 5c, South Coast Road Industrial Estate, Peacehaven, Sussex BN9 8NA. Tel: (07914) 81637.

Traffic Technology has updated its desk Console range to include the Spectrum. The Console will take your micro, tape recorder, two cassettes, printer, power pack and microdrive.

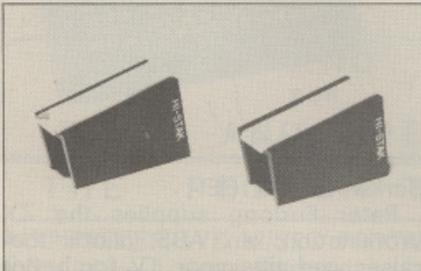
It also has a switch panel on the front so that you can change the cassette leads from LOAD to SAVE, plus an on/off switch for the power supply. Optional extras are stacking pillars should you need more than one unit, and dust covers.

The Console is priced at £42.18 including postage and packing. You can telephone the company on (037388) 316 or write to PO Box 2, Warminster, Wiltshire BA12 7QX.

The Spectrum Microcase claims to be both case and console. It looks like an ordinary, black travel case. But the base can hold your computer, power supply, printer, RAM pack, and cassette recorder. The top of the case is detachable and can act as a TV stand.

The manufacturer is Micro Aids, Freepost, 2 Boston Close, Culcheth, Warrington WA3 1BR. Tel: (092) 576 2613.

Treetop Designs supply a similar case-cum-console priced at £47.45 inclusive of postage and packing. If



you are not satisfied, the company promises to refund your money, if you return the case undamaged in 14 days of receipt.

Treetop Designs are at 61 Widmore Road, Bromley, Kent BR1 3AA.

Rounding off the trio, Computex Cases supplies an executive-type briefcase to hold the Spectrum, PSU, printer, tape recorder and cassettes. The case is priced at £34.95 plus £2.00 postage and packing.

You can write to Computex Cases



at Stanhope Road, Camberley, Surrey GU15 3PS.

## PRINTERS

The ZX Printer is the most widely used one for the Spectrum. Its drawback is that it requires special silver paper which comes in only one width. The printer is supplied by Sinclair Research and costs £40.00.

If you want an 80-column printout, there is a choice of printers and interfaces open to you. Again, Kempston Micro Electronics leads the field.

Kempston's Centronics interface can connect your micro to a wide range of printers, including all Epsoms, all Seikoshas, Oki microline 80 and Tandy CGP-115. It makes word processing feasible, and Kempston stock a range of business software for this purpose.

The interface recognises LLIST and LPRINT, and the control codes to be passed to the printer. Line width can vary from 32 to 128 characters per line, and TASWORD II compatibility allows 64 characters onscreen. There is a provision for incorporating a high-resolution screen dump.

The interface fits on to the edge connector. The one metre-long ribbon cable that accompanies it connects directly with the printer. Both are fully tested and come with a 12-month guarantee.

The interface costs £45.00 including VAT and postage and packing.

Morex Peripherals has developed a Centronics parallel and a bidirectional RS232 interface in the same box. It, too, has a line length limited only by printer, uses LLIST and LRPINT statements and gives high-resolution graphics with Epson and NEC printers.

Demo software is supplied with the interface. The package is priced at £35.95 inclusive of postage and packing. The printer cable is extra.

Morex Peripherals supply by mail order only. You can write to 2 Balliol Road, Caversham, Reading, Berkshire. Tel: (0734) 478854.

Euro Electronics also supply a Centronics Interface. This costs £39.95 including VAT. The ribbon cable is extra and costs £11.95. If you

(Top of page): Computex case. (Bottom left): Spectrum console systems. Just two add-ons for the popular Spectrum computer.

want high-resolution graphics, copy software is priced at £5.00.

You can telephone Euro Electronics on (0242) 582009.

If you want to use the Tandy CGP-115 colour printer, Softest has developed a hardware interface. It costs £35.00 from Softest, 10 Richmond Lane, Romsey, Hampshire.

## OTHER

Power International supplies a mains plug that contains an interference filter. The plug costs £15.50 inclusive.

You can contact Power International at 2A Isambard Brunel Road, Portsmouth PO1 2Du. Tel: (0705) 756715.

The most comprehensive memory test program is the Chipchek from Delta Research. The Spectrum does carry out a memory test on power-up, but it is limited and will not identify where the fault lies. The Chipchek will.

The Chipchek costs £3.50. You can get more details from Delta Research, 15 Church Street, Basingstoke, Hants RG21 1QG. Tel: (0635) 45373.

Computer Add-Ons stocks the Level-VU Prism which allows you to see your tape counter without moving from your seat. It costs £3.99.

The company also stocks the Vu-Load which ensures program load and monitors tape output level. This costs £19.99.

Stephen Adams has the Straight adaptor which converts the Spectrum to the same expansion port as the ZX81. So you can use the many ZX81 peripherals with your machine.

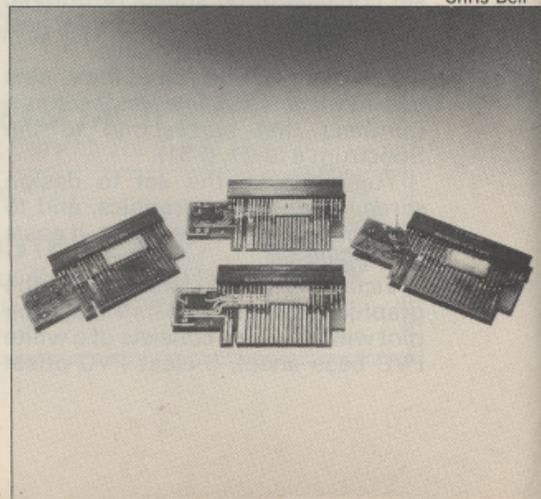
The Eve adaptor allows owners of 48K Spectrums to use ZX81 add-ons. The Adam adaptor allows owners of 16K Spectrums to add on a 16K RAM pack. And the Adam II adaptor allows use of both simultaneously.

All adaptors cost £9.00 inclusive of postage and packing.

Adams also supplies a programmable tape controller. This selects the appropriate tape recorder lead for saving and loading. It costs £20.00 inclusive.

You can contact Stephen Adams at 1 Leswin Road, London N16 7NL. Tel: 01-254 1869. © 1983 D Boyd

Chris Bell



## ROSE SOFTWARE

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**"O" LEVEL FRENCH REVISION** (16K or 48K Spectrum and 16K ZX81). 6 vocabulary programs for the Spectrum. 3 Grammar programs and 3 vocabulary programs for the ZX81. Both contain common words and phrases, and irregular verbs, etc.

**PRIMARY ARITHMETIC** (16K or 48K Spectrum and 16K ZX81). "add", "subtract", "multiply" and "divide". Numbers are in large size type, with entry of answer, units first. A balloon lifts-off as an incentive.

**INTERMEDIATE MATHS 1** (48K Spectrum and 16K ZX81). Long multiplication, Long division. Highest common factor, Lowest common multiple, Fractions 1 (+ & -), Fractions 2 (x & ÷).

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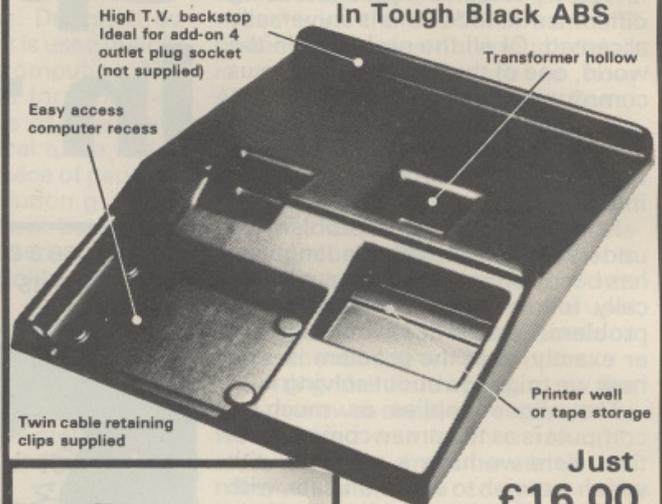
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## TASMAN SOFTWARE

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structures from the four main ones: integer, real, Boolean and char.

The Pascal program is normally indented, and this gives an idea to the user of the main blocks that make up the language.

Pascal has been used in education for some time, but it is now making an appearance in business as well. The two main complaints about the language are that its file handling is very limited, and that it is not strongly typed.

For example, if I created a date structure called 'months' which had the elements January, February, and so on, then I couldn't have another data type which incorporated elements which were months.

### Forth

Of all the languages that have been used in the years, Forth must be the most flexible. I say this not only because I am a fan of the language, but also because it is absolutely true.

Forth was developed in the early 1960s by Charles H. Moore as his own personal man/machine interface. The true power within the language is the ability to add to it as you need to. That is, if my Forth system didn't have a function (called 'words' in Forth), then all that I would have to do is define that new word or function, and when I was sure it was working, add it to the main dictionary of existing Forth words. My word would then become part of the language itself, and this adds great flexibility to programming, unlike other languages where you are stuck with what ever commands, functions, and procedures are in it to start with.

Forth was used by Moore for control applications at the Kitt Peak National Observatory in Arizona. It is an interger-based language, which is very fast in operation and excellent for I/O processing.

To give an idea of how Forth works, imagine we wish to print the numbers from 1 to 100. This is how we'd do it:

```
:COUNT 0 99 DO CT I. LOOP;
```

Here we have a definition called COUNT, which will print a carriage return 'CR' then a number '.' by fetching a value from the stack 'I'.

Once this has been compiled, other words can be defined by using existing ones, so if I wanted to count to 100 twice, then I could define the following:

```
:2COUNT COUNT COUNT;
```

This defines a word called 2COUNT which is defined as being COUNT twice, and the list of numbers would be printed twice.

Forth is being used in many applications, from control purposes to utility writing. It is popular on micros because of its great speed, and many games programmers prefer using this language.

### Logo

There are many people who think that Logo is much more than a programming language. Many think its a philosophy of what a computer language should be like. Designed by one Seymour Papert it is used mainly to introduce child to computing. The idea is that the child (or whoever) 'explores' the powers of Logo with the aid of a mechanical turtle which can draw on a large piece of paper or by using a high-resolution graphics turtle. It is a procedural based language which can be used at different levels rather than follow a strict approach.

Each Logo program is broken down into procedures, and more can be added to the main program at a later stage. This allows a child to 'build' upon an idea and some of the results children have produced with Logo are quite astounding.

Its very easy to draw shapes using Logo. If for example I wanted to draw a box then the Logo to do this would be:

```
TO SQUARE
REPEAT 4 (FORWARD 50 RIGHT 90)
END
```

This procedure denoted by 'to' repeats what happens in the brackets 4 times, that is go forward 50 steps, turn right by 90 degrees.

Even though it is designed for children, it is a very powerful language which is now being used in computer aided design frequently.

### Abersoft Forth

It has been said by many that the Abersoft Forth package is by far the best implimentation of Forth for the ZX Spectrum. The reasons for this are clear when you look at the features that it offers: full control over the Spectrum's colour, sound, and graphical commands, a screen editor as part of the main vocabulary, and so on.

It is also liked because it is quite easy to use - the saving and loading of programs (or screens) is one example.

For your money, you get a cassette which contains the Forth compiler and editor, and also a 29-page instruction manual which explains how to get the Forth running on the Spectrum. The manual also gives details of the non-standard words that Abersoft have added.

The Forth is based on the FIG-Forth implementation, and it was good to see that Abersoft have given the Forth Interest Group (FIG) credit in their instruction manual - many software houses that impliment FIG-Forth on micros do not. Abersoft have also tailored the FIG-Forth compiler to the Spectrum by including additional non-standard words. This will no doubt save the Forth enthusiast a lot

of effort as he or she will not have to bother defining words to do the same.

The manual that is supplied with the cassette points out the differences from the FIG-Forth standard quite well, but alas, not enough detail is made with reference to how Abersoft Forth works on the Spectrum. Detail was also lacking on the descriptions of the additional words, and it was left to me to find out how they worked.

It is however, pointed out in the introduction to the manual that it is not intended to be a tutorial on Forth and Abersoft recomend the the user obtains Brodie's *Starting Forth*, a recommendation which support.

Getting the Forth to run on the Spectrum was simple enough, all that was needed was to enter LOAD "", start the tape, and one and a half minutes later the compiler was loaded and auto-run.

All commands can be entered in upper or lower case, but the Forth compiler doesn't work like the Sinclair interpreter, where commands and functions can be entered by one keystroke. Instead all Forth words have to be entered in full.

The compiler proved to be very fast in operation, and this will no doubt attract many who wish to do graphical work. Abersoft realise this, and the demonstration program shows this. Here, the two programs do the same job, which is to fill the screen by plotting.

### In Basic

```
FOR J = 0 TO 255 : FOR I = 0 TO 175 : PLOT J,I
: NEXT I : NEXT J
```

### In Forth

```
: TEST 260 0 DO
176 0 DO
J I PLOT
LOOP LOOP;
```

In Basic, the program took 6 minutes 30 seconds to run, but in Forth, it took only 21 seconds.

As the Forth compiler run integer calculations only, it's bound to be fast, and a simple DO...LOOP of 32767 to 0 took three seconds to run.

One 'non-standard' addition that I was pleased to see was the addition of a screen editor as part of the main dictionary of Forth words.

This saves the hassle that would be involved when loading an editor which is external to the main compiler. Another fine feature of the package is the ability to 11 screens in memory at one time. Many Forth packages for the Spectrum only allow for a few. This can cause problems when compiling large Forth programs.

For the Spectrum owner who is looking for a Forth package to upgrade to, I have no hesitation in recommending Abersoft's Forth. You have the best of both worlds when

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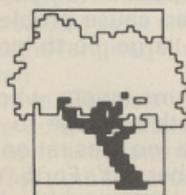
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you use this package: a good implementation of FIG-Forth and the facilities of the ZX Spectrum.

Abersoft intend to produce an upgraded version of their Forth to work on the Microdrives, and a Z80 assembler, a Forth cross-compiler, and floating point Forth are also on their way later this year.

**Name:** Abersoft Forth (FIG-Forth)

**Produced by:** Abersoft, 0970-828851

**System required:** 48K ZX Spectrum (printer optional) **Format:** Cassette

**Price:** £x.xx

#### Hisoft Pascal 4T

When using this package, it is immediately noticeable to the user that you are using a professional software package. Hisoft's Pascal 4T compiler and screen editor have been available for the Spectrum user for about four months, and in that time I haven't seen any other compiler that could match Hisoft's Pascal.

Maybe this is because software authors realise that they would have a tough job to match this product.

At £25, including postage and packing and VAT, you receive a cassette containing the Pascal compiler with integral screen editor, and a small run-time package which is situated just before the compiler on the tape. Also supplied is a 60-page user manual which gives details of Hisoft's implementation of Pascal, which is based upon the standard as defined in the *Pascal User Manual*, by Jensen and Wirth.

As Hisoft Pascal was upgraded from the Nascom 1, you will also receive a few notes on implementing the compiler for the ZX Spectrum. For example, which keys are used as control keys, and so on. It is interesting to note that Hisoft Pascal has become so popular that it is now available for the Sharp, the Newbrain, and some disk-based systems.

The compiler itself is only 12Kbytes in length, with the run-time system occupying a further 4K, yet the compiler supports floating point and has many scientific functions that you expect in a Pascal compiler.

Files are not supported, but this can be forgiven as it is difficult to support this feature on cassette based systems. Records (non-variant) are supported and variables may be dumped to cassette using the non-standard TIN and TOUT procedures.

Hisoft have also taken into account the fact that their compiler is going to be used on a popular micro, and several additions to the standard have been made. These include procedures and functions to access and alter areas of memory, plus several options to modify the compiler, editor, and table size.

There are no extra graphical or sound commands, but with a bit of

patience it is possible to call the relevant routines within the Spectrum's ROM. Colour - INK, PAPER, BORDER - can be changed by writing control codes directly to the screen, and Hisoft give details on how this is done in manual. It is also possible to toggle the ZX Printer on and off to provide hard copy.

The programmer's manual that is supplied with the package is the only let down as far as I am concerned. All the details are within the covers, yet the reader has to do a lot of cross-referencing. Details of the compiler and screen editor are included, and I would recommend a few readings before starting any work. However, the manual does have an excellent index in the front and this will no doubt facilitate quick referencing.

Getting started can be a little confusing. The compiler is loaded easily enough, but when loading is done and the Pascal auto-runs, you are faced with a couple of confusing questions about RAM space and Table size. These are here for those who wish to alter table size and/or include machine code within their programs. Pressing the ENTER key will result in default values being assigned.

As mentioned before, there is an internal screen editor within the compiler. This is used to enter and amend source code as well as save and load the source code or object code files. There are many com-

mands within the editor and it takes some time to get used to.

The source code is entered line by line, and line numbers can be generated by the editor if wished. At this stage, you may wish to use the ZX Printer to obtain a listing of your work so far.

Once the source code has been entered, you exist from the ENTER mode where you can either save your work for a later session, or compile it. If the option to compile is chosen, then the source code is listed as it is compiled (one pass only), and the memory address of the relevant line of code is displayed in hexadecimal, to the left of the screen.

If at this stage there are any mistakes, you can opt to re-enter the editor to amend them, or continue compiling. The compilation process is very fast indeed, as is the test of the compiler. After compilation, you can make the program run faster by switching off array bound checking and so on by means of compiler switches which are prefixed by the dollar sign.

Hisoft's Pascal 4T compiler is a true Pascal compiler insofar as it produces Z80 object code which can be run independently of the main compiler. A small run-time package is attached to the object code when saved and this is only 4K in length.

Pascal, as I have mentioned in the main text, is a structured language, and it is being taught in many





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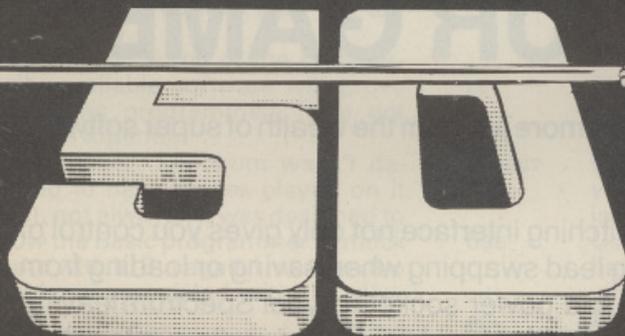
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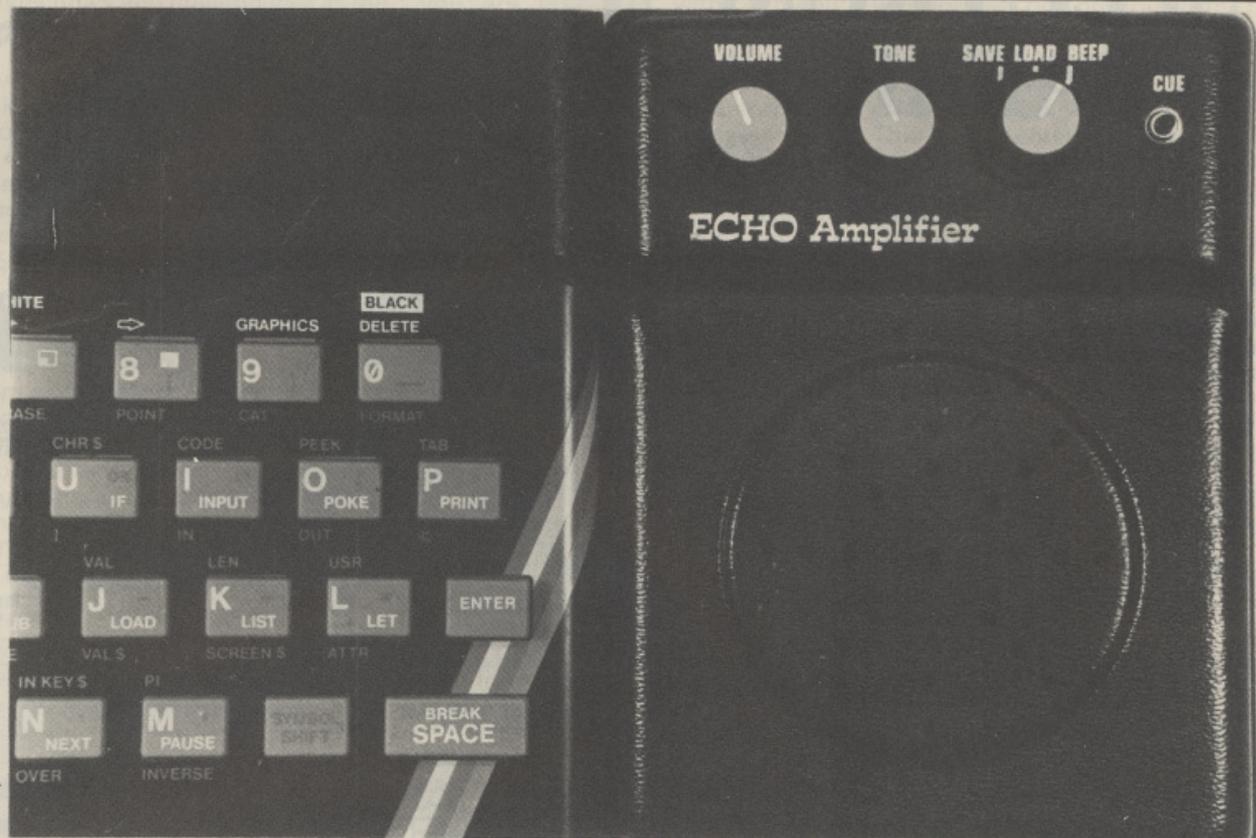
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## GRAPHICS

When a new micro is launched, most people are taken back at the facilities it has to offer. But, nevertheless these systems still come under heavy fire from potential buyers, for one reason, or another. In other words, there isn't a single micro on the market that can satisfy everyone.

This is true of the ZX Spectrum. When it was first announced, everybody was impressed with the features it had to offer – high resolution graphics, sound and so on. But after the excitement died down, the complaints started.

As far as the graphical capabilities are concerned, there are some problems with drawing lines and trying to cross them. Changing the colour of the PAPER without having to CLS is also a problem. But the biggest problem of them all is that the Basic is slow, and moving graphics in Basic are very hard to do, even for the experienced programmer.

There is a solution of sorts. You can always revert to machine code, and there are many good assemblers and disassemblers on the market which will facilitate the running of machine code. But there are also problems associated with this method.

For one thing, the Spectrum's memory map is very strange, not to say unique one. Trying to poke a character on to the screen can be quite a job, since it is divided up into a number of areas. But if you can get round these problems then you are on your way.

Looking at some of the commercially available software will prove that some programmers have got their act together.

But the ZX Spectrum wasn't designed to have games played on it (well, not always), it was designed to allow the Basic programmer to muck about with it. But again I mention the problems associated with the slow Basic.

To aid the Basic programmer. Computer Rentals Limited (CRL), are to release a new package in late September, which will allow the Basic programmer to write games in Basic, but with high resolution and fast graphics. The way this is done is to include an extra set of commands and functions which are written in REM statements.

## FEATURES

The biggest feature of the package, is that it allows you to write fast, smooth, colour graphic games without too much fuss. This is achieved by using the 25 Fifth commands, which allow you to do a variety of things from moving an object, or objects smoothly, to creating new and interesting sounds with the Spectrum's

# Product Line?

A computer system cannot be all things to all users — so where do you draw the line on graphics. Sinclair tried to find the answer. Have they succeeded?

## DIAGRAM 1

## FIFTH COMMANDS

TEMPS	Sets up colours for succeeding Fifth commands. Used with LARGE, FILL, REPLACE, COLOUR, PUT.
FILL	Allows you to change the screen colours PAPER and INK without affecting the screen display.
REPLACE	Similar to FILL but changes a specified colour for another ie 'change all blue squares with red ones.'
LARGE	Allows you to print large characters or strings of characters on the screen. The item to be printed is held in a string, and the size is placed in a number of numeric variables.
SOUND	Enhances the Spectrum's sound capabilities greatly. Uses four parameters to pass the required info to the command; a,b,c,f for repeat value, sound length, sound-tone and the step value.
GET	A powerful command which allows you to assign to a character string the contents of part of the display. Uses five parameters a,b,c,d,a\$.
PUT	Used in conjunction with GET, this command allows you to put the contents of a specified character string back on to the display. Uses three parameters – the first two to tell it where to put the string, and the third to specify what string.
LET	Similar to the Basic LET statement, except that the variable must be a single letter, non-subscripted numeric variable. Used to access Fifth functions.
OBJECT	One of the most powerful commands in Fifth. OBJECT allows you to define objects and then move them about the screen independently of Basic (a sort of parallel processing).
USE	Used to determine whether a particular object type is to have its subscripts accessed individually, or as part of a whole group.
ALL	Allows you to access all subscripts of a particular object type at the same time.
PRINT	Describes what character an object will print as.
COLOURS	This command determines what colour an object is to be printed in.
VECTOR	A command to determine what direction an object will move in. Gives a choice of 16 directions.
SPEED	Allows you to determine what speed an object is to move at, and at how many pixels each step.
MOVE	Used to move a particular object to a given position.
R MOVE	Similar to MOVE but moves the object relative.
FIND	Used to determine whether there is an object at a particular position. Returns the name of the object type.
DISABLE	Allows you to stop an object moved by interrupts.
ENABLE	Works in the opposite way to DISABLE.
LIMIT	Determines what line number the program will jump to if an object goes off the screen. Very good as a form of error trapping.
INTERACT	Similar to limit, but determines what line number will be jumped to when two objects collide.
LMTPARAM	Returns the name of the object that went off the screen.
INTPARAM	Similar to LMTPARAM but used for two objects colliding.
ERASE	Used to erase an object and then print it at a new position.

tiny bleeper. The commands and functions are listed in *Figure 1*.

Using the commands listed, it is possible to move a whole set of objects about the screen in a number of directions and speeds. This is done with a type of parallel processing.

The objects to be moved, (or displayed) can be created with the `OBJECT` command. The objects can then be moved by using `ALL` or `USE`. `COLOUR` determines what colour they will be printed in.

The two most powerful commands as far as moving graphics are concerned are `VECTOR` and `SPEED`, which allow you to determine what direction and speed they will move in. I should say here, that many of the Fifth commands apply to objects that move pixel by pixel, unlike the Spectrums `PRINT AT` command which allow you to print only at a whole character position.

As mentioned, it is possible to move a number of objects about the screen quite smoothly, but it should be noted that Fifth will use up more memory if more objects are being moved or displayed.

Another exciting feature, is the ability to detect whether the objects you are moving have 'fallen' off the screen, or whether they have collided. Fifth provides a number of commands to allow you to detect this.

The commands `INTERACT` and `LIMIT` perform this function, but the difference from any other routine is that you don't have to keep on checking within a loop whether the objects have collided, or gone off the screen.

If they have, then the program will jump to a predefined line number where the appropriate action can be taken, (such as sounding the beeper).

What caught my eye when I first looked at the package, was a command called `TEMPS` which allows you to change the colour of the `PAPER` or `INK` without affecting the object on the screen. The example depicted in the manual displays this quite well:

```
10 RANDOMIZE 1000
20 RANDOMIZE USR 61030
30 FOR a=0 TO 255
40 PLOT a,0
50 DRAW OVER 1;255-2*a,175
60 NEXT a
70 FOR a=0 TO 175
80 PLOT 0,a
90 DRAW OVER 1; 255, 175-2*a
100 NEXT a
110 PAUSE 50
120 PRINT PAPER RND*7; INK 9;
130 REM FILL
140 GO TO 110
```

This will print a 'moire' type pattern and then procede to change the paper and ink colours after a second without the need to redraw the pattern. The way it works will be explained later.

Fifth is not only a graphics extension to the Spectrum. It is best described as a graphics interface.

Many command extensions that you find on other machines, will only allow you to do one-way processing, but not Fifth. It is possible to interface existing Sinclair Basic with Fifth commands.

This is achieved by using the 13 Fifth functions and the Fifth command `LET`. The Fifth `LET` is similar to the Basic one, and it allows the programmer to do calculations on variables that Fifth uses. So:

```
100 REM LET X=COLUM invader
110 LET X=X+12
120 REM MOVE invader, x, line invader
Here, lines 100 and 120 are REM
statement containing Fifth com-
mands, which use the variable x. Line
110 however is an ordinary Basic LET,
and this means that external (to Fifth)
calculations can be performed on
variables, and the modified values
returned to Fifth.
```

To actually 'get' the information, the Fifth functions can be used. This enables the programmer to find out what is going on when the program is running. So if I wanted to find out the speed of a given object, I could then use the `VELOCITY` function.

## PRESENTATION

Computer Rentals Limited supplied me with a copy of their Fifth which was recorded three times on an ordinary cassette. The completed manual was also supplied. When the package is released in late September, it will have a box containing a professional cassette with the documentation.

The documentation consisted of a 43-page Fifth user manual which was written by 15-year-old Richard Taylor, the author of Fifth. This contains an introduction to Fifth with a description of the 25 Fifth commands and the 13 functions.

Unfortunately, the manual is badly written and the quality of printing lacks something to be desired. There is a lengthy description of each command, with example programs, but the descriptions are just not clear.

As far as the printing goes, the manual was riddled with dirty type which appeared in the text, and unfortunately in mthe program examples also. This is the bad part of the package, and I would suggest that CRL gets the thing rewritten.

There are some good points to the manual, it has an index and the functions are explained well.

## IN USE

Setting up the package was a bit of a problem because CRL omitted the `CODE` within their instructions to load Fifth. The package is completely written in machine code and when loaded, resides below the user definable graphics area, and it occupies

4338 bytes (just over 4K).

When loading, you have to reset `RAMTOP` below the area of Fifth by using `CODE`. I would have preferred CRL to have included a Basic loader to do this because lazy people like me will tend to forget.

The Fifth commands are placed in `REM` statements, and when the program is run, Fifth finds the `REM` statements and then acts accordingly. It is still possible to have genuine `REM` statements by including an `'*'` before any comment. The difficulty in using Fifth is in getting used to it.

The Fifth commands that use parameters are normally seperated by a comma, or space. There seemed to be some irregularities in this area, and I had to check to see if I had included all my commas and spaces.

As for the results? Well, impressive is the best way to put it. As I have mentioned earlier, it is possible to move objects (objects being single characters or UDGs) around the screen, pixel by pixel. The result is that the object appears to 'glide' and this is quite amazing to watch.

Manipulating objects is not too difficult, and after a while I wrote a program which moved several 'O's about the screen, colliding with each other and then going in a different direction. I couldn't have done this in Basic, and I wouldn't have bothered to try it in machine code.

This is the idea behind using Fifth. You now have the chance to try out new ideas, and have a chance of seeing them working within the hour, and not a whole day as is the case with machine-code programming.

Saving your masterpiece is possible by `SAVE`ing the area that Fifth occupied in memory. It is also advisable to save the user definable graphics areas as well because you will no doubt be using them a lot with this package.

## VERDICT

For anyone who is interested in graphical work of any kind on the Spectrum, Fifth must seriously be considered. It provides you with a labour saving means to produce some good graphical results, and with the ability to move objects pixel by pixel, will give a new meaning to the words 'flicker-free'

Above all, Fifth is excellent value for money, at £9.95 you get a sophisticated package which will keep you at the Spectrum.

Name: Fifth.

Application: Graphical extension.

System: 48K ZX Spectrum.

Language: Z8 machine code.

Format: Cassete.

Publisher: Computer Rentals Ltd.

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Available: Popular computer outlets (WH Smiths etc) Late September.

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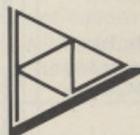
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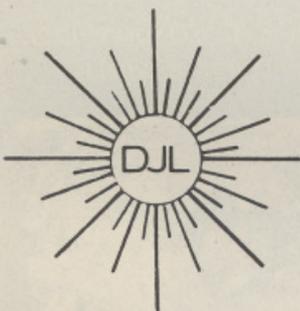
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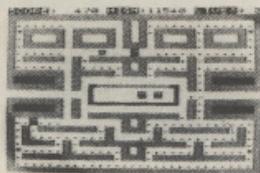
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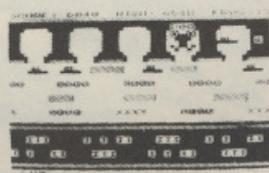
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## GAMES

The playing of computer games has been sweeping the country like a particularly virulent virus. Arcades and pubs are full of the worst victims — addicts who spend more than £1 a day on their fix of space invaders and asteroids.

They are foolish people. Four months' machine-money, about £100, could have brought them perhaps the best games machine of them all: the Sinclair Spectrum microcomputer. It offers the widest and most original range of games available, and it doesn't need 20p to start the play.

Spectrum owners are lucky. UK sales of the machine passed 500,000 in August 1983. That is more than any other machine except its predecessor, the ZX81 — and the Spectrum is catching up fast. This huge volume of potential games-players has resulted in an explosion of software, which has been unabated since early 1982.

Just as the Beatles were the catalyst to the tidal wave of music business 20 years ago, the Spectrum

has turned the software houses from a cottage industry into a major creative enterprise. Companies compete to spend tens of thousands of pounds on advertising, and programmers become rich overnight from a single game. Micros such as the Vic 20 and the BBC have done the same. But none beat the Spectrum for games sales.

The first popular Spectrum games were invariably variations on themes established in the arcades. Vertical shoot-up games, like Galaxions, and maze games such as Hungry Horace require no explanation. New games are often merely more of the same in thin disguise.

In the early Spectrum days, the adventure game flourished. A series of questions on an otherwise blank screen asked you which way — north, south, east or west — you wished to proceed in search of a dragon or the control room of a spaceship. They were about as thrilling as a street map of Rugby.

Since then, games have diversified and become sophisticated. Adventure games come with graphics, and graphics generally have improved in

quantum leaps. The Spectrum can make an object three-dimensional, so that it will jump out of the screen to get nearer your throat.

Ideas have bloomed. Your Spectrum enables you to climb Himalayan mountains, resist oral bacteria, round up sheep, avoid London tube trains, or glide through coloured blocks in a cerebral space. Even the old battle against the aliens takes diverse forms: some aliens spawn sinisterly in tracts of empty space while others haggle with you over foodstuffs.

Most games lose their appeal within weeks. It doesn't matter. There is always something different to buy. Besides, they may serve us well. Firstly, they encourage people to program their own games and thus become computer-literate. Secondly, they create a reservoir of astounding split-second reaction and tactical thinking that may come in handy when the hostile flying saucers float down over Westminster.

Spectrum owners will know what to do. Just hand them a joystick.

The following is a representative sample of Spectrum games:



**Name:** PSST  
**Machine:** 16K/48K Spectrum  
**Title:** Ultimate Play the Game  
**Price:** £

Ultimate Play the Game is a great name for a company, and PSST quite a different idea for a game. The packaging illustrates Robbie the Robot, sitting on a flower, and defending it from what look like tiny Weetabix with wings and eyes.

Robbie is moved about the screen by means of cursors, and is able to collect fly-swats, grow-bags, and

most importantly various spray-guns, which he uses to defend himself against an assortment of hungry parasites. The parasites wander about until they find a flower and then eat it, with negative effects on its growth.

Different sprays kill different sorts of bug. Until the first flower blooms, the attack is mounted by Interstellar Space Slugs, which look like ordinary slugs and whose connection with space is dubious.

The second wave includes Scuttling Leaches, which are fuzzy things, balls of static with roving eyes. If

you get the second flower to bloom, wasp-like Menacing Midges appear.

When a creature is sprayed (or shot with a laser, an ever-useful tool in the garden), it disappears in a satisfying cloud of coloured smoke. Without a joystick, spraying a creature is an especially difficult task, but the difficulty generally is such that players will enjoy improving their skills, if only for the reward of hearing the cheerful melody played when the flower blooms.

In this garden, Percy Thrower's expertise is of little use, but to those hardened by the trials of interstellar war, PSST is a pleasant and challenging respite.

More than any other micro manufacturer, Clive Sinclair has produced the people's computer. He did it first with the ZX80 and the ZX81, then again with the Spectrum.

Low prices have bred volume sales, which have inbred excellent software support — and a new generation of computer users and programmers.

It is easy to see the impact the Spectrum has had on

the micro market. It has 'state of the art' games like Timegate and Psion Flight Simulator to its credit. And software production generally is moving away from the Space Invaders/Pacman clones to genuine originality.

The Spectrum's popularity with games manufacturers is only partly attributable to its wide availability. The machine offers good high-resolution and user-defined colour graphics. It is relatively simple to use those facilities to transform Spectrums alphabet into almost any arcane script you care to mention.

When the machine first came out, in May 1982, the pundits hailed it with cries of 'Uncle Clive's done it again'. It was seen as the best you could get for the price — and it is still a lot better than many machines at twice the price.

Some reviewers even toyed with the possibility of the Spectrum being used as a machine for small-business users.

But such use hinged on the microdrives. Promised when the Spectrum was launched, they are now just about to be released.

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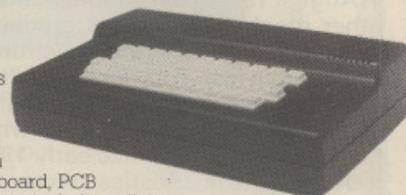
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facturers held fire, waiting for the storage revolution. And the Spectrum spiralled off as a highly lucrative games/hobbyist machine.

The Spectrum is cheap, available and well supported by software. Its Basic is workman-like and thoroughly debugged. Its single-key entry system, although irritating to the veteran keyboard artist, is a joy to the novice.

The Spectrum's grim determination to not let you enter a line that is not syntactically correct is a giant step for user friendliness. So is the way the Spectrum automatically spaces keywords in the program listing.

The basic machine, plus the 'cheap and cheerful' ZX printer is all the novice needs to learn how to program in glorious Specnicolour.

Sinclair also promises a low-cost cartridge system. Depending on the software offered, this will make a considerable difference to the machine's capabilities.

Sinclair machines are different, and the Spectrum is no exception. There are now enough of them about for users to be confident that they will not be stranded with an outmoded white elephant.

**Name:** Spawn Of Evil.  
**Application:** game.  
**Price:** £4.95.  
**Publisher:** DK' Tronics.  
**Contact:**

The respected astronomer Sir Fred Hoyle believes that life originates in deep space. If it does, it may

evolve strange breeding habits.

In this game, not only the breeding habits but the names as well are strange. Active Ectogenetic Galactic Gametes (EGGs) produce Pulsoids, which fuse to make Cycloids. Full Aliens, which look like mutant four-leaf clovers, also fuse to produce EGGs, ready to begin another cycle. When three EGGs are about, Aliens go on a seek-and-destroy rampage, hurling huge red globular plasma balls at you. This is only half of it. The game is so complex, one side of the cassette is taken up with instructions alone.

Another thing about space is that it is largely empty. The game accurately reflects this—your targeting screen is almost always empty. Occasionally, Aliens will flit by. To track them down, you must switch to the long-range scanner. The Aliens will be shown as black squares on a yellow background, and other things as loose clouds of dots.

Clouds of squares drift like dust, buffeted perhaps by interstellar winds. Catching spores and Aliens in your target area is like catching midges and dandelions in a shifting breeze. It is barely possible. Even in your hand they will slip your grasp. An Alien just won't keep still for a good, square shot at it.

This is one of the most difficult games I have ever played. Several attempts have scored minimal points, while the Aliens have inexorably pursued

their malignant breeding cycle. But for a space game, I must concede that the imagination in *Spawn of Evil* is excellent. With a programmable joystick, and the instincts and reactions of a keener player, I

would find this game totally absorbing. For me, the challenge is too great.

I leave the *Spawn* largely intact to sweep the galaxy. Any day now, we will see it in the skies. And it is my fault.



**Name:** The Train Game.  
**Application:** game.  
**Price:** £  
**Publisher:** Microsphere Computer Services Ltd.  
**Contact:**

Who would have believed that the Spectrum's modest loudspeaker could be made to reproduce the sound of a chugging locomotive? This addictive noise is only one of many marvellous aspects of the *Train Game*.

With the power merely to change railway points and stop trains at stations, you will soon find yourself embroiled in the desperate task of keeping impatient passengers happy and moving, preventing derailments and loss of entire trains in tunnels.

You may load one of two track layouts, each with three stations and a network of alphabetically labelled points. Starting at level one, a blue train appears and blue passengers start to wait on the platforms. By pressing the key corresponding to the point for which the train is heading, you can divert its course. Or you can prevent it crashing, with the loss of one of your four lives. Switch the point under the train, and another life is gone.

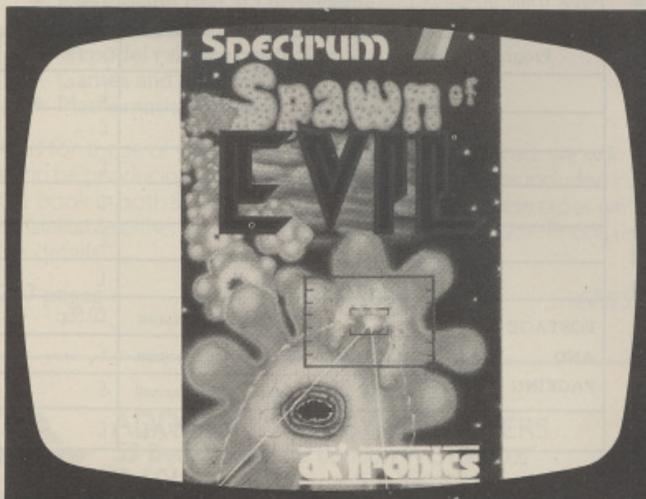
Hopefully, you will reach

a station, pick up passengers and a score, and move on. Leave the passengers too long and they will turn white with rage, hijack the train, refuse to pay the fare, let other passengers on, or help your score. Worse still, if the stations fill up, passengers will be pushed onto the rails, with subsequent loss of yet another life.

Pick up 25 blue passengers, and a red train will appear for red passengers. Next is a magenta train. By level four, you will have combinations of trains, each collecting different passengers. Soon, rogue express and goods trains will appear. These are incredible nuisances, and best shunted off where they came from.

Keeping the trains on the tracks and the travellers travelling is a nerve-racking business. Keys, the location of which you've known all your life, will suddenly disappear from your keyboard while the train puffs inexorably on to disaster. It is possible to freeze the action by pressing the 'space' key, but even this did not help me much.

The *Train Game* presents an intellectual puzzle as complex as any maze. It requires constant thinking ahead, split-second decision making.



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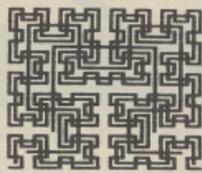
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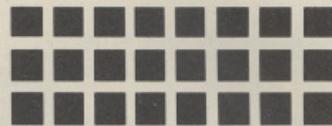
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# BIORHYTHMS

Here are three programs from *60 Programs for the Sinclair ZX Spectrum*, a new Pan/Pan book available for £4.95.

```

10 BORDER 1: PAPER 1: CLS
20 GO SUB 9000
100 LET total=0: LET total2=0:
PRINT INK 5;AT 0,10;"BIORHYTHMS
": PRINT : PRINT : PRINT
110 PAPER 0: INK 5: PRINT TAB (
3);"BIRTH YEAR: " : PRINT : PR
INT TAB (3);"BIRTH MONTH: " : P
RINT : PRINT TAB (3);"BIRTH DAY:
"
115 PRINT : PRINT
120 PAPER 0: INK 5: PRINT TAB (
3);"YEAR REQUIRED: " : PRINT : PR
INT TAB (3);"MONTH REQUIRED:": P
RINT : PRINT TAB (3);"DAY REQUIR
ED "
130 PRINT INK 5; FLASH 1;AT 21
,3;"Enter details now (numeric)"
140 PRINT PAPER 0; INK 7; FLAS
H 1;AT 4,3;"BIRTH YEAR:": INPUT
y: PRINT AT 4,20;y
150 PRINT PAPER 0; INK 7; FLAS
H 0;AT 4,3;"BIRTH YEAR:"
160 PRINT PAPER 0; INK 7; FLAS
H 1;AT 6,3;"BIRTH MONTH:": INPUT
m: PRINT AT 6,20;m
170 PRINT PAPER 0; INK 7; FLAS
H 0;AT 6,3;"BIRTH MONTH:"
180 PRINT PAPER 0; INK 7; FLAS
H 1;AT 8,3;"BIRTH DAY:": INPUT d
: PRINT AT 8,20;d
190 PRINT PAPER 0; INK 7; FLAS
H 0;AT 8,3;"BIRTH DAY:"
200 PRINT PAPER 0; INK 7; FLAS
H 1;AT 11,3;"YEAR REQUIRED:": IN
PUT y1: PRINT AT 11,20;y1
210 PRINT PAPER 0; INK 7; FLAS
H 0;AT 11,3;"YEAR REQUIRED:"
220 PRINT PAPER 0; INK 7; FLAS
H 1;AT 13,3;"MONTH REQUIRED:": I
NPUT m1: PRINT AT 13,20;m1
230 PRINT PAPER 0; INK 7; FLAS
H 0;AT 13,3;"MONTH REQUIRED:"
240 PRINT PAPER 0; INK 7; FLAS
H 1;AT 15,3;"DAY REQUIRED:": INP
UT d1: PRINT AT 15,20;d1
250 PRINT PAPER 0; INK 7; FLAS
H 0;AT 15,3;"DAY REQUIRED:"
270 LET total=(y-1)*365.25
280 LET total2=(y1-1)*365.25
300 IF m>1 THEN LET total=tota
l+m(m-1)
305 IF m1>1 THEN LET total2=to
tal2+m(m1-1)
310 IF m-1>1 AND y/4=INT (y/4)
THEN LET total=total+1

```

```

315 IF m1-1>1 AND y1/4=INT (y1/
4) THEN LET total2=total2+1
320 LET total=total+d: LET tota
l2=total2+d1
330 LET day=total2-total
335 IF m1=m AND d1=d THEN GO S
UB 5000
350 PAPER 7: INK 2: CLS
360 GO SUB 1000
370 LET p=day-(INT (day/23)*23)
380 LET e=day-(INT (day/28)*28)
390 LET i=day-(INT (day/33)*33)
490 PRINT FLASH 1;AT 0,0;"Phys
ical cycle"
500 FOR n=p*c TO (p*c)+255
510 PLOT n-(p*c),83.5+83.5*SIN
(n/(11.5*PI))
520 NEXT n
525 PRINT FLASH 1;AT 0,0;"Emot
ional cycle"
530 FOR n=e*c TO (e*c)+255
540 PLOT n-(e*c),83.5+83.5*SIN
(n/(14*PI))
550 NEXT n
555 PRINT FLASH 1;AT 0,0;"Inte
llectual cycle"
560 FOR n=i*c TO (i*c)+255
570 PLOT n-(i*c),83.5+83.5*SIN
(n/(16.5*PI))
580 NEXT n
590 PRINT PAPER 0; INK 5;AT 0,
0;"Biorhythm for "
595 PAUSE 100
600 PRINT PAPER 7; INK 2;AT 20
,3;"Press a key to restart"
610 IF INKEY$="" THEN GO TO 61
0
620 GO TO 10
1000 PRINT PAPER 0;"
"
1010 LET c=9.869565217
1015 PRINT PAPER 0; INK 5;AT 0,
0;"DIVISIONS=DAYS": PAUSE 100
1020 FOR x=1 TO 25
1040 PLOT c*x,0: DRAW 0,167
1060 NEXT x
1080 PRINT PAPER 0; INK 5;AT 0,
18;d1;"/";m1;"/";y1;"+"
1100 RETURN
5000 LET a=.2: LET b=.4
5010 BEEP a,0: BEEP a,0: BEEP b,
2: BEEP b,0: BEEP b,5: BEEP b,4:
PAUSE 10: BEEP a,0: BEEP a,0: B
EEP b,2: BEEP b,0: BEEP b,7: BEE
P b,5: PAUSE 10: BEEP a,0: BEEP
a,0: BEEP b,12: BEEP b,9: BEEP b

```

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# BIORHYTHMS

```
,5: BEEP b,4: BEEP b,2: PAUSE 10
: BEEP a,10: BEEP a,10: BEEP b,9
: BEEP b,5: BEEP b,7: BEEP b,5
5020 RETURN
9000 RESTORE : DIM m(11)
9010 FOR x=1 TO 11
```

```
9020 READ n: LET m(x)=n
9030 NEXT x
9040 DATA 31,59,90,120,151,181,2
12,243,273,304,334
9999 RETURN
```

# CHRISTMAS EVE

This program, Christmas Eve, is another good example of the exciting programs in the 280 page book. It takes the form of a race for Santa to deliver his presents.

```
1 PAPER 1: INK 7: BORDER 1: C
LS
2 REM *****
3 REM ** @ PAUL STANLEY **
4 REM *****
5 GO SUB 3000
7 LET hs=0
10 GO SUB 9000
15 LET sk=.98: LET s=0
20 LET a$="a": LET b$="b": LET
c$="c": LET x=27
21 DIM d$(28)
25 LET g=1: LET h=INT (RND*28)
+2
26 PRINT AT 0,18;"HIGH-SCORE:"
;hs
27 LET p=0
28 PRINT AT 0,0;"PRESENTS:";s
30 IF INKEY$="x" THEN LET x=x
+(2 AND x<27): LET a$="d": LET b
$="e": LET c$="f"
35 IF INKEY$="z" THEN LET x=x
-(2 AND x>1): LET a$="a": LET b$
="b": LET c$="c"
40 PRINT AT 10,x-2;" " ;A
T 10,x; INK 2;a$; INK 0;b$; INK
2;c$;
50 IF NOT p THEN LET g=g+1: P
RINT AT g-1,h;" " ;AT g,h; INK 6;
"g": IF g=10 THEN IF h=x+2 OR h
=x+1 OR h=x THEN LET p=1
60 IF g=12 THEN IF SCREEN$ (g
+1,h)="" THEN GO TO 1000
65 IF g=12 THEN PRINT AT 12,h
;" " : LET g=1: LET h=INT (RND*28
)+2
70 IF p THEN IF INKEY$="m" TH
EN LET g=10: LET h=x-1+(a$="d")
+(3 AND c$="c"): LET p=0
80 IF RND>sk THEN LET q=INT (
RND*7)+1: LET e=INT (RND*4): PRI
NT PAPER 3;AT 16,q*4-e+1;" " : L
ET d$(q*4-e)="p": IF d$(q*4-3 TO
q*4)="pppp" THEN GO TO 2000
90 GO TO 30
1000 PRINT AT 12,h;" "
```

```
1010 IF SCREEN$ (18,h)="_" THEN
GO TO 25
1015 LET s=s+1: PRINT AT 0,0;"PR
ESENTS:";s
1020 PRINT AT 18,h; INK 0; PAPER
6;"__";AT 19,h;"__"
1022 FOR f=1 TO 3: BEEP .001,30:
NEXT f
1025 FOR f=4 TO 28 STEP 4: IF SC
REEN$ (18,f)="_" THEN NEXT f: L
ET sk=sk-.02: CLS : GO SUB 9030:
GO TO 20
1030 GO TO 25
2000 IF SCREEN$ (18,q*4)<>"_" TH
EN GO TO 6000
2010 GO TO 30
5000 RESTORE 5100: LET z=.3: LET
c=.6: FOR f=1 TO 26: READ a,b:
BEEP a,b: NEXT f
5100 DATA z,6,z,6,c,6,z,6,z,6,c,
6,z,6,z,9,z,2,z,4,1,6,z,6,z,7,z,
7,z,7,z,7,z,7,z,6,z,6,z,6,z,9,z,
9,z,7,z,4,c,2,c,2
5200 RETURN
6000 FOR f=10 TO 1 STEP -.5: PRI
NT AT f,x; INK 2;a$; INK 0;b$; I
NK 2;c$;AT f+1,x;" " : BEEP .00
5,2*f: NEXT f
6002 IF s>hs THEN LET hs=s
6005 PRINT AT 1,x;" "
6006 PRINT AT g,h;" "
6010 PRINT FLASH 1;AT 18,q*4-1;
INK 0; PAPER 6;"__";AT 19,q*4-1
;"k_"
6030 PRINT AT 8,8; FLASH 1;"G A
M E O V E R"
6045 GO SUB 5000
6050 PRINT AT 11,2; FLASH 1;"PRE
SS ANY KEY TO PLAY AGAIN"
6060 IF INKEY$<>" " THEN CLS : G
O TO 10
6070 GO TO 6060
8000 PRINT INVERSE 1;AT 5,0;"
CHRISTMAS EVE "
INVERSE 0"" @ PAUL STAN
LEY": PAUSE 250: CLS
8010 PRINT "It is approaching m
```

# SPECTRUM Quickshot

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## CHRISTMAS EVE

midnight on Christmas eve and Santa is late. You play the part of Santa and you must deliver presents which are thrown down to you by your elves. Having caught a present (by flying directly below it) you must move over a chimney and drop a present down it."

8020 PRINT "When a present has been dropped down a chimney the family in that house immediately start work on opening up the present and they will turn the light on. Dropping another present down a chimney of a lit house will not count."

8030 PRINT "INVERSE 1; "PRESS ANY KEY TO SEE MORE.": PAUSE 0

8040 CLS : PRINT "Beneath each roof you will see a patch of snow which melts as time elapses. This melts at a rate which is proportional to the activity in the house."

8050 PRINT "As the presents must be placed down the chimneys before anyone sees you, if all the snow has melted under a particular roof without a present being dropped before this occurs it will indicate that the inhabitants are awake and you will have to return immediately."

8060 PRINT " Z-----  
 ---LEFT X-----  
 ---RIGHT M-----DROP

PRESENT"

8070 PRINT " INVERSE 1; " PRE  
 SS ANY KEY TO START " : PAUSE

0: CLS : RETURN

9000 RESTORE 9010: FOR y=USR "a"  
 TO USR "k"+7: READ x: POKE y,x:  
 NEXT y

9010 DATA 0,0,1,0,0,0,0,0

9020 DATA 192,64,160,224,127,126,  
 99,82

9030 DATA 8,28,8,124,156,72,63,1  
 28

9040 DATA 16,56,16,62,56,18,252,  
 1

9050 DATA 3,2,5,7,254,126,198,74

9060 DATA 0,0,128,0,0,0,0,0

9070 DATA 0,0,0,54,54,0,54,54

9080 DATA 0,1,3,7,15,31,63,127

9090 DATA 0,128,192,224,240,248,  
 252,254

9100 DATA 255,220,73,65,64,0,0,0

9110 DATA 24,60,BIN 01010110,60,  
 24,126,255,255

9300 FOR x=2 TO 26 STEP 4

9310 PRINT INK 3; AT 13,x+1; " ";  
 PAPER 3; INK 5; AT 14,x+1; "h"; P  
 APER 1; "i"; AT 15,x; "h i"; INK 7  
 ; PAPER 3; AT 16,x; "jjjj"; AT 17,x  
 ; PAPER 1; INK 3; " "; AT 18,x;  
 " "; AT 19,x; " "; AT 20,x;  
 " "; AT 21,x; " "

9320 NEXT x

9400 FOR x=48 TO 208 STEP 32: OV  
 ER 1: INK 3: PLOT x,0: DRAW 0,39  
 : NEXT x: INK 7: OVER 0

9450 FOR x=24 TO 216 STEP 32: PL  
 OT x,23: DRAW 15,0: NEXT x

9500 RETURN

## HORSERACE

The last program from the book - Horserace - illustrates the quality of the programs written by Walwyn, Erskine, Stanley and Bews for the new book.

BEEP .5,12: PRINT AT 1  
 4,0;"GO " : BEEP .5,18: PRINT  
 AT 14,0;" "  
 1001 LET ge=0: DIM x(6): FOR c=1  
 TO 6: LET x(c)=2: NEXT c  
 1002 FOR c=1 TO 6  
 1004 BEEP .03,-20: BEEP .03,-30  
 1005 LET x(c)=x(c)+(f(c)=1 AND R  
 ND<.8)+(f(c)=2 AND RND<.77)+(f(c  
 )=4 AND RND<.74)+(f(c)=8 AND RND  
 <.71)+(f(c)=16 AND RND<.68)+(f(c  
 )=32 AND RND<.65)  
 1006 PRINT INK c; AT c\*2,x(c)-1;

" a"

1008 IF x(c)=31 THEN LET ge=1  
 1009 BEEP .03,-20: BEEP .03,-30  
 1015 NEXT c

1020 IF ge=1 THEN GO TO 1050

1040 GO TO 1002

1050 DIM h(6): LET many=0: FOR c  
 =1 TO 6

1052 IF x(c)=31 THEN LET many=m  
 any+1: LET h(many)=c

1053 NEXT c

1054 IF many=1 THEN LET winner=  
 h(1): GO TO 1090

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## HORSERACE

```

1055 PRINT AT 20,0;"There is a p
hoto-finish between these horses
: "
1056 PRINT AT 21,15;h(1);" ";h(
2);" ";
1057 IF many=3 THEN PRINT ;h(3)
;
1058 IF many=4 THEN PRINT ;" "
;h(4)
1060 FOR c=1 TO 300
1065 NEXT c
1067 LET er=INT (RND*4)+1
1070 LET winner=h(er)
1071 IF winner=0 THEN GO TO 106
7
1075 IF RND<.33 THEN LET g#="a
short head": GO TO 1079
1076 IF RND<.4 THEN LET g#="a n
eck": GO TO 1079
1077 LET g#="1 length"
1079 PRINT AT 20,0;"
...
"
1080 PRINT AT 20,1;"The winner i
s ";winner;" who won by": PRINT
AT 21,1;g#
1081 PAUSE 130
1082 CLS
1085 GO TO 1100
1090 PRINT AT 20,1;"The winner i
s ";winner;" who won by ": PRINT
" ";INT (RND*3)+2;" lengths."
1095 PAUSE 130: CLS
1100 FOR r=1 TO a
1101 IF p(r)=0 THEN LET r=r+1:
GO TO (1101 AND r<a+1)+(1130 AND
r=a+1)
1105 IF e(r)=winner THEN LET p(
r)=p(r)+b(r)*f(winner): GO TO 11
15
1110 LET p(r)=p(r)-b(r)
1115 IF p(r)<=0 THEN GO TO 8000
1117 IF e(r)<>winner THEN GO TO
1125
1120 CLS : PRINT AT 10,4;"Well d
one punter ";r;" !""Your horse
won and you now have ";p(r): PA
USE 0: GO TO 1130
1125 CLS : PRINT AT 10,4;"Bad lu
ck punter ";r;" !""Your horse d
id not win, and so you now have
";p(r): PAUSE 0
1130 NEXT r
1150 GO TO 20
1999 LET races=races-1: IF races
=-1 THEN GO TO 6000
2000 DIM f(6): FOR c=1 TO 6: LET
f(c)=2^(INT (RND*6)): NEXT c

```

```

2020 PRINT "The tipsters reckon
the betting:"
2025 FOR c=1 TO 6: PRINT INK c;
PAPER (7 AND c<4)+(0 AND c>3);A
T 2*c,2;"HORSE ";c;" ";f(c);"
:1"
2026 IF f(c)=1 THEN PRINT INK
c; PAPER (0 AND c>3)+(7 AND c<4)
;AT 2*c,13;"EVENS"
2029 NEXT c
2030 DIM e(a): DIM b(a): FOR f=1
TO a
2031 IF p(f)=0 THEN LET f=f+1:
GO TO (2031 AND f<a+1)+(2050 AND
f=a+1)
2032 PRINT AT 14,1;"Punter ";f;"
:": PRINT "You have ";p(f);".
": PRINT "How much would
you like to bet?"
2033 INPUT b(f): IF b(f)>p(f) TH
EN GO TO 2033
2034 IF b(f)<>INT (b(f)) THEN G
O TO 2033
2035 PRINT "'On which horse is t
his to be placed?"
2036 INPUT e(f)
2037 IF e(f)<1 OR e(f)>6 THEN G
O TO 2036
2038 PRINT AT 17,0;"
"
2039 PRINT AT 19,0;"
"
2040 NEXT f
2050 CLS : RETURN
6000 PRINT "THE MEETING IS NOW F
INISHED"
6010 FOR f=1 TO a
6015 IF p(f)=0 THEN LET f=f+1:
GO TO (6015 AND f<a+1)+(6040 AND
f=a+1)
6020 PRINT "'Punter ";f;" finish
es with ";p(f)
6030 NEXT f
6040 PRINT INVERSE 1;"Press an
y key to play again.": PAUSE 0:
RUN
7000 PRINT ""
"
7010 PRINT ""
"
7020 PRINT "'A gambling game fo
r the whole family"

```

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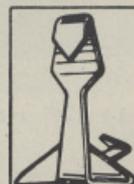
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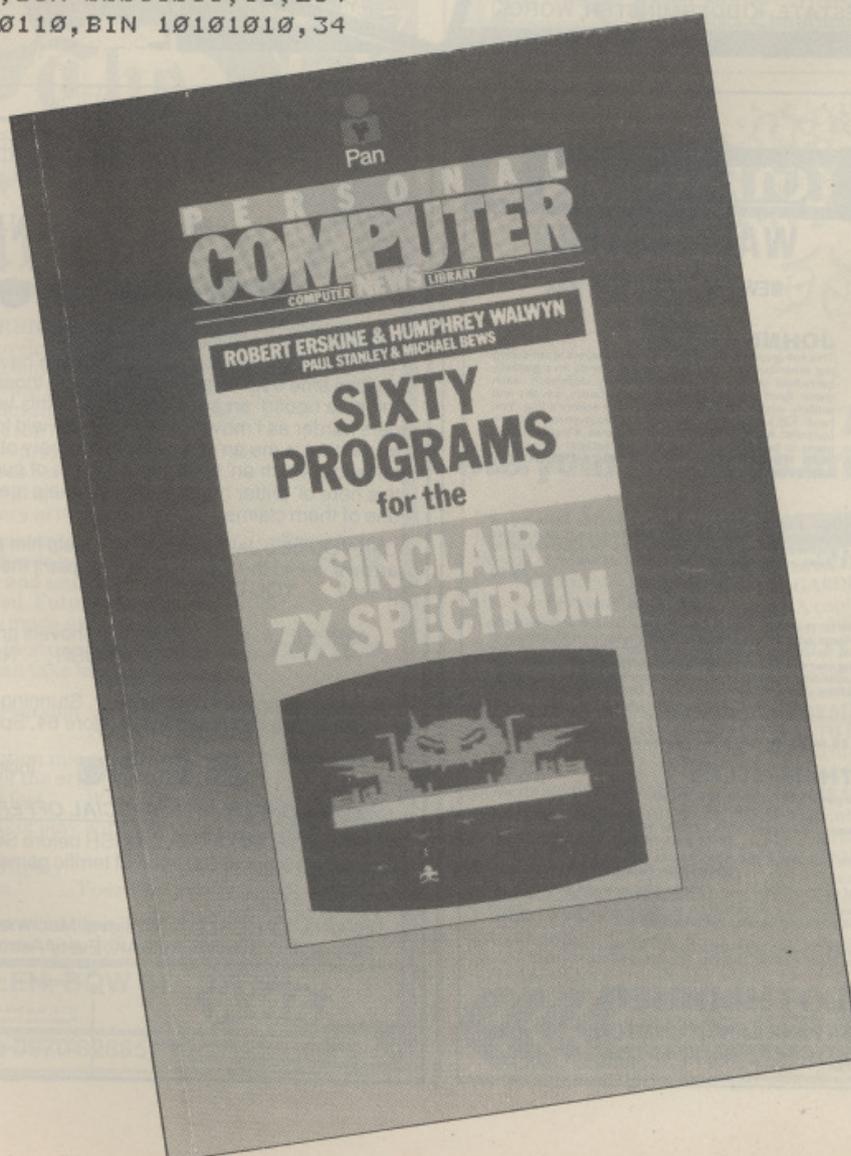
# HORSERACE

```

'''' @ Paul Stanley": PAUS
E 300: RETURN
8000 CLS : PRINT AT 5,0;"Tut Tut
! Punter ";r;", you have": PRINT
"run out of money."
8005 PRINT : PRINT "I must there
fore not let you bet any more."
8010 PRINT "However, if your ru
les are to allow cheating, if
you press "; INVERSE 1;"C";: PRI
NT ;" I will give you '50 more."
8020 PRINT "Otherwise press "; I
NVERSE 1;"X"; INVERSE 0;" and I
will cancel you from the game
"
8030 IF INKEY$="x" OR INKEY$="X"
THEN LET p(r)=0: GO TO 8050
8040 IF INKEY$="c" OR INKEY$="C"
THEN LET p(r)=50: GO TO 8050
8045 GO TO 8030
8050 CLS : GO TO 1130
9000 FOR c=USR "a" TO USR "a"+7:
READ v: POKE c,v: NEXT c
9001 DATA 16,BIN 00011011,18,254
,62,BIN 01100110,BIN 10101010,34
9999 RETURN

```

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A must manual for Spectrum speculators – really user friendly. Robin has achieved a rare objective – writing a good micro guide. Further support to the spectacular Spectrum is "Spectrum Spectacular".



### **The Complete Spectrum ROM Disassembly.**

By Dr Ian Logan and Dr Frank O'Hara.

Published by Melbourne House.  
Price £9.95.

Messrs Logan and O'Hara have carefully taken all 16K of the Spectrum's ROM to pieces, discovering what everything does, and how it does it. Rather than me.

The book is a long, commented source program starting at 0000 and continuing through to 386CH. There are a few helpful bits, such as an index to routines and some samples of basic, to explain some of the algorithms used in ROM.

It could do with some overview material, giving you a chance to see how basic works in general and explaining some of the more mathematical aspects in detail. As it is, it is something of a monster.

What do you get from the book?

It is an obvious aid for writing your own programs, as you can use the ROM routines. You could persuade the ROMS to do the fiddly bits for you, such as floating-point calculations and circle drawing.

### **Spectrum Spectacular.**

By Roger Valentine.  
Published by V&H Computer Services.  
Price £4.95.

This book should make a valuable addition to the library of the enthusiastic

Sinclair user.

With 50 program listings and subroutines, it should provide many happy hours of keying. The full range of applications – from games to business programs – is covered. It is also nice to see a British flavour: there is a program for keeping track of the football league table.

The opening chapter acquaints you with the machine's capabilities and includes short listings for producing large characters, and a clock.

'Not just your plaything' is a chapter that introduces 'serious' applications such as word processing and accounting listings.

Another nice touch is a practice game for arcade buffs before they get down to Firepower, Flying Saucers, and other games. Machine-dedicated books are improving as the competition heats up. They are still dogged by cheap production but, minor quibbles aside, this book offers some useful listings. And the light – you might also say acid – narrative is refreshing.

### **Learning Timex Sinclair Basic.**

By David A Lien.  
Published by Compusoft.  
Price \$14.95.

It would be nice if Sinclair's ZX81 manual was as lucid as *Learning Timex Sinclair Basic*. The book is aimed at the beginner with no computer knowledge or training in Basic.

There are eight chapters, starting with one on how to plug the various bits into each other, and the TV. Then the reader is introduced gently to maths operators, relationship operators, FOR ... NEXT loops, and how to use the cassette tape recorder.

In chapter three strings are covered, leading up to maths functions in chapter five. All the basic topics such as graphics, arrays, PEEK and POKE, are covered.

The chapters are well laid out with big, clear print. Listings are printed unusually large, and each

point is clearly explained and used in a program on the computer.

Most chapters have exercises to test your newly acquired knowledge and conclude with a list of the new commands.

The book has a light, conversational style which should make learning fun. *Learning Times Sinclair Basic* is ideal as a self-teaching aid. It would be equally at home in the classroom or on a training programme. **TJ**

### **Dynamic Games for the ZX Spectrum.**

By Tim Hartnell.  
Published by John Wiley & Sons Ltd.  
Price £5.95.

The author has selected 20 games ranging from board play to arcade action, from Chess and Pirandello to Jogger and Deathrace 2000.

He also includes an adventure game, Revenge of Castle Dread.

Each game has a detailed introduction. In most cases, the program is explained line by line, highlighting tricks the programmers have used, and suggesting how these can be applied in other programs.

At the end of the book is a chapter devoted to suggestions on how to improve your own programs.

### **Learning to use the ZX Spectrum Computer.**

By Robin Bradbeer.  
Published by Gower.  
Price £5.95.

Manuals are usually a neglected component in the typical micro package. But in this case, the publication of an alternative guide cannot be interpreted as an indictment of the manufacturer's offering.

Author Robin Bradbeer co-wrote the introductory booklet and edited the programming manual for Sinclair.

If you have a Spectrum, find the documentation reasonably useful and want to move on to bigger and better things, this is not the

book for you. But if you find the manual difficult to understand, the same information couched in different terms may shed a little light.

The book is a good pre-investment reading for prospective Spectrum owners. **IS**



### **The ZX Spectrum – Your Personal Computer.**

By Ian McLean, Simon Rushbrook Williams, and Peter Williams.

Published by Prentice Hall International.  
Price £5.95.

There must be a market for microcomputing books that start at the beginning, as this one does. But in this case, the beginning turns out to be a lot further back than you would have dreamed.

It's a pity, because the further you get into the book, the more useful it gets.

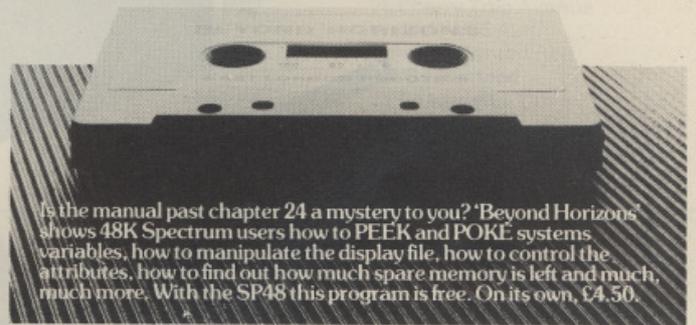
The introductions to the music section, for example, is over-elementary: 'You will probably have heard of the musical scale: doh, re, me ...'.

Once past this, however, you can learn quite a lot about music and the Spectrum. You will not learn that you need a fairly complex add-on set-up to get anything more useful than a half dozen kinds of beep.

The parts that are useful to anyone other than the absolute beginner are overshadowed by the rest. The authors should have aimed their sights a bit higher.

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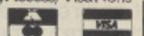
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Bob Maunder is co-author of 'The ZX80 Companion' and author of 'The ZX81 Companion'. He is a Senior Lecturer in Computer Science at Teesside Polytechnic, holds an MSc degree in Computer Science, and is a Member of the British Computer Society.

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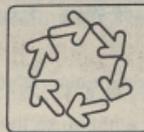
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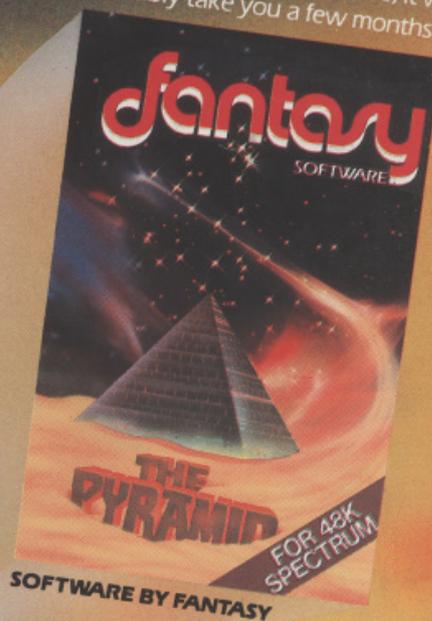
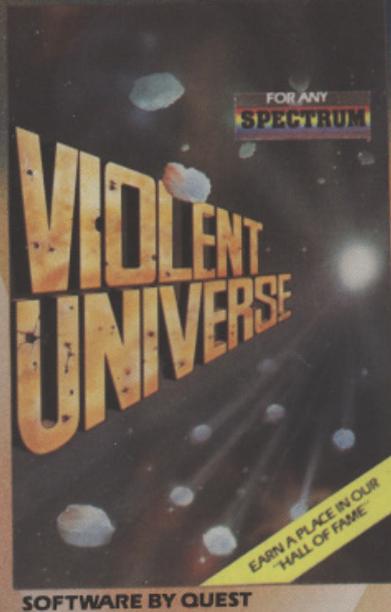
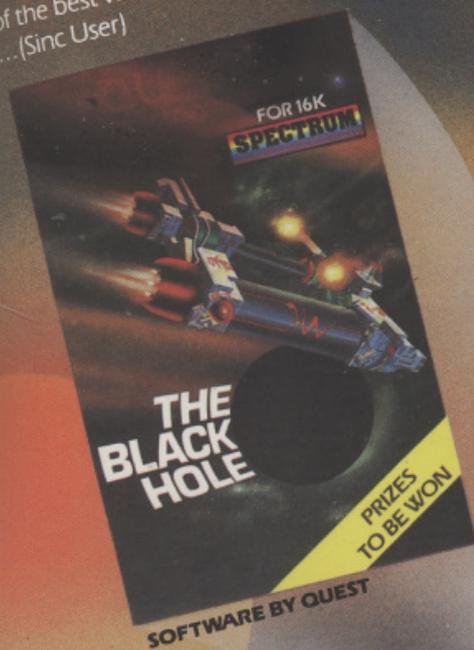
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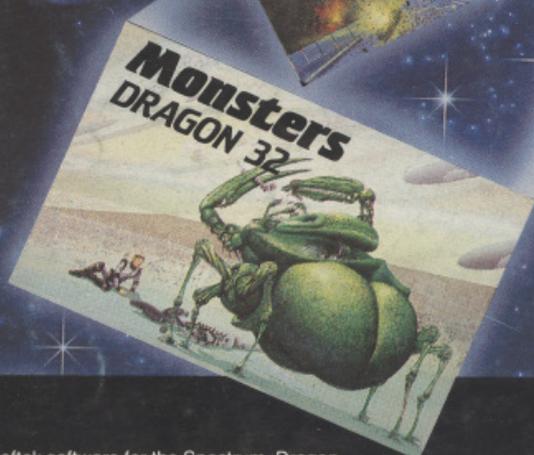
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