50p

# YOUR COMPUTER

OCTOBER 1981

Vol.1 No.3


**ZX programs tested**

**Reviews: Tandy colour computer**

**Microtan 65**

**Vic-20 software**

**Atom strings and arrays**

**Draughts game**

**Win a ZX-81**

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Although primarily designed for the Sinclair ZX81, many of the cassettes are suitable for running on a Sinclair ZX80 – if fitted with a replacement 8K BASIC ROM.

Some of the more elaborate programs can be run only on a Sinclair ZX Personal Computer augmented by a 16K-byte add-on RAM pack.

This RAM pack and the replacement ROM are described below. And the description of each cassette makes it clear what hardware is required.

## 8K BASIC ROM

The 8K BASIC ROM used in the ZX81 is available to ZX80 owners as a drop-in replacement chip. With the exception of animated graphics, all the advanced features of the ZX81 are now available on a ZX80 – including the ability to run much of the Sinclair ZX Software.

The ROM chip comes with a new keyboard template, which can be overlaid on the existing keyboard in minutes, and a new operating manual.

## 16K-BYTE RAM pack

The 16K-byte RAM pack provides 16-times more memory in one complete module. Compatible with the ZX81 *and* the ZX80, it can be used for program storage or as a database.

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## Cassette 1 – Games

*For ZX81 (and ZX80 with 8K BASIC ROM)*

ORBIT – your space craft's mission is to pick up a very valuable cargo that's in orbit around a star.

SNIPER – you're surrounded by 40 of the enemy. How quickly can you spot and shoot them when they appear?

METEORS – your starship is cruising through space when you meet a meteor storm. How long can you dodge the deadly danger?

LIFE – J. H. Conway's 'Game of Life' has achieved tremendous popularity in the computing world. Study the life, death and evolution patterns of cells.

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GOLF – what's your handicap? It's a tricky course but you control the strength of your shots.

## Cassette 2 – Junior Education: 7-11-year-olds

*For ZX81 with 16K RAM pack*

CRASH – simple addition – with the added attraction of a car crash if you get it wrong.

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TRAIN – multiplication tests against the computer. The winner's train reaches the station first.

FRACTIONS – fractions explained at three levels of difficulty. A ten-question test completes the program.

ADDSUB – addition and subtraction with three levels of difficulty. Again, wrong answers are followed by an explanation.

DIVISION – with five levels of difficulty. Mistakes are explained graphically, and a running score is displayed.

SPELLING – up to 500 words over five levels of difficulty. You can even change the words yourself.

## Cassette 3 – Business and Household

*For ZX81 (and ZX80 with 8K BASIC ROM) with 16K RAM pack*

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BANK ACCOUNT – a sophisticated financial recording system with comprehensive documentation. Use it at home to keep track of 'where the money goes,' and at work for expenses, departmental budgets, etc.

## Cassette 4 – Games

*For ZX81 (and ZX80 with 8K BASIC ROM) and 16K RAM pack*

LUNAR LANDING – bring the lunar module down from orbit to a soft landing. You control attitude and orbital direction – but watch the fuel gauge! The screen displays your flight status – digitally and graphically.

TWENTYONE – a dice version of Blackjack.

COMBAT – you're on a suicide space mission. You have only 12 missiles but the aliens have unlimited strength. Can you take 12 of them with you?

SUBSTRIKE – on patrol, your frigate detects a pack of 10 enemy subs. Can you depth-charge them before they torpedo you?

CODEBREAKER – the computer thinks of a 4-digit number which you have to guess in up to 10 tries. The logical approach is best!

MAYDAY – in answer to a distress call, you've narrowed down the search area to 343 cubic kilometers of deep space. Can you find the astronaut before his life-support system fails in 10 hours time?

## Cassette 5 – Junior Education: 9-11-year-olds

*For ZX81 (and ZX80 with 8K BASIC ROM)*

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VOLUMES – 'yes' or 'no' answers from the computer to a series of cube volume calculations.

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BASES – convert from decimal (base 10) to other bases of your choice in the range 2 to 9.

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# YOUR COMPUTER



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# EDITORIAL

BUYING COMPUTERS mail-order is occasionally risky. That reassuring phrase "please allow 28 days for delivery" is no guarantee that the eager entrepreneur advertising the goods will make any special effort to deliver within 28 days.

If you have any problems with a *Your Computer* advertiser, we shall be only too glad to help. Most mail-order companies will go to great lengths to reassure us that they are handling their customers in the proper way. On the surprisingly rare occasions when we receive complaints, there are all too often no copies of the order, no copies of the letters and no record of the dates — keep copies of everything.

The number of complaints we receive is only a tiny fraction of the number of happy customers. All the same, we cannot help feeling that too many of you are willing to put up with too much. How many of you have had to wait more than the usual 28 days? Of all of you who have had to wait more than 28 days, how many of you have bothered to complain, either to the company or to *Your Computer?* If customers were faster on the draw with their complaints letters we would be rid of more of the cowboys.

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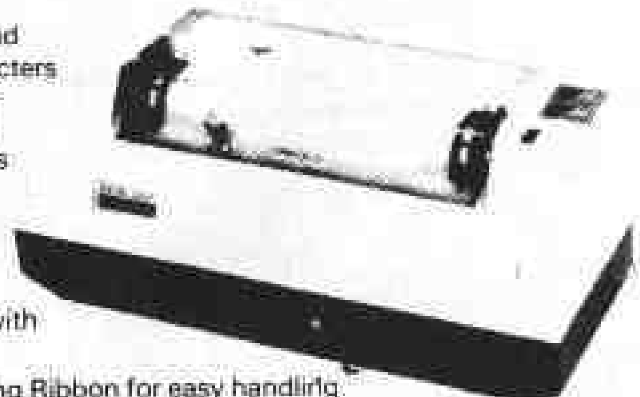

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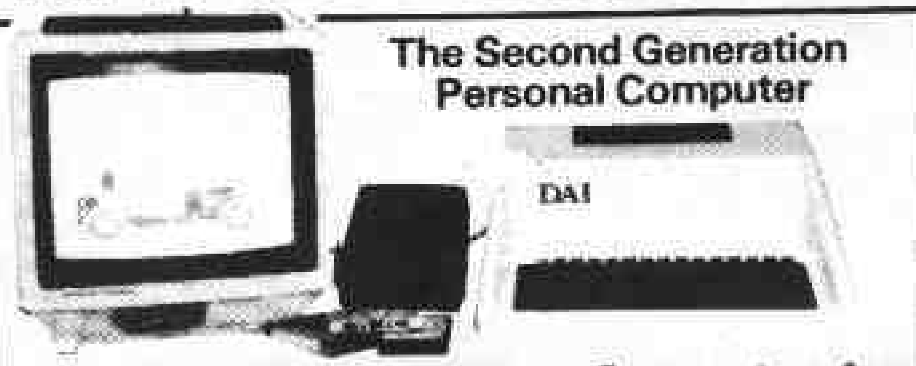



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# YOUR LETTERS

## RADIO CONTROLS

As micro users and radio-controlled model aircraft enthusiasts, we are a little concerned at the possible effect of your article "Beyond games into micro applications", in the August/September issue.

In the article reference is made to the use of an Acoms AP-435 35 MHz proportional radio-control system. In view of all the recent controversy relating to the 27 MHz band and the illegal use of citizens' band radio, representatives on behalf of model aircraft enthusiasts have been to great lengths to negotiate for an exclusive clean band for model aircraft use.

The Home Office has responded by allocating the 35 MHz band solely for this purpose. It would appear, therefore, that the implications and conclusions from your article are in direct contrast to the safe use of model aircraft on this newly acquired 35 MHz band.

Although we do not wish to discourage innovatory thinking in the use of microcomputer systems, it should be pointed out that if a system, developed as suggested by your article, were operating within range of a flying radio-controlled model, the results could be devastating.

The chances of this occurring are, we appreciate, quite low, but the risk will still exist. Bear in mind that the average model aircraft weighs between 5 and 10 pounds and can travel at speeds approaching 100mph. In an uncontrollable state, it becomes a potentially lethal projectile.

We feel, therefore, that any such practice of using 35 MHz radio control equipment for anything other than controlling model aircraft, should be strongly discouraged and that your readership be advised to this effect before considering computer-control projects involving telemetry.

*P J Morrell,*
*A V O'Malley,*
*Stockport, Cheshire.*

**Mr Morrell and Mr O'Malley confuse two ideas in order to make a point in their letter. The analogue input to the radio control transmitter mimics manual movement of the joystick and the signal radiating from the transmitter is entirely different to that from the citizens' band voice transmitter. At worst, the computer control transmitter could appear to be another aircraft control system in the neighbourhood. This is a common problem at the open locations where model aircraft are flown and its importance is reduced still further by the geographical separation between sites for flying model aircraft and the predominantly urban or suburban locations in which microcomputers are used.**

**Nevertheless, I agree that if a band has been allocated solely for model aircraft users, this should be respected. There are many excellent digital proportional radio control systems available operating on 27 MHz which would be preferable for the control applications described in the series.**

***John Dawson***

## CHESS CHALLENGE

I have several points to make about the two chess articles by John White in the August/September issue of *Your Computer*. I am an author of chess books and magazine articles and have an international rating of 2,250.

Before my criticisms of his review of chess machines, I should like to point out an error in the second article concerning the British Chess Federation grading system. The anomaly whereby you could, in theory, increase your rating by playing and losing many games against people much stronger than yourself has long ago been eliminated.

If Joe Bloggs, with a rating of 100, plays Grandmaster Tony Miles, with a rating of 240+, and loses every game, his rating for those games is his present rating. If by some chance he draws a game, his rating for that game is 150. If Miles has a brainstorm and loses, Bloggs gains 200 for that game, and Miles' rating for losing that game is not 50 — as John White implies — but 140 as the 50-point cut-off works in both directions.

In his conclusion, he says that: "Sargon 2.5 remains the strongest and fastest chess computer". He appears unaware that the Morphy cartridge he mentions in passing has been available since March this year from the Great Game Machine — along with an openings' cartridge to play the early phase of the game, and with an end-games' cartridge due for release soon — and is also available in stand-alone form as the Morphy Encore.

This computer, playing on its level 8, can make 40 moves in two hours and I estimate its rating at around 1,800 — 150 on the BCF scale. With the two extra cartridges, that rating may possibly reach 1,900.

Other strong and fast computers available shortly are the Chess Champion Mark V from Philidor Software and SciSys with a rating estimated around 1,900, the Champion Sensory Challenger, the Novag Savant and probably before long from West Germany, a new version of Mephisto.

Intelligent Chess is recommended by White but to be frank, it costs two or three times as much as other computers which play as well, it is bulky and hard to use without a TV set and it is slow — it starts to play well only on level six in my opinion.

Super System III is obsolete by now and the Sensory 8 Challenger and Challenger 7 are threatened because computers which play as well can be bought at a fraction of the price and by Christmas, there will be two or three at least for £80 or less with sensory boards or other aids to communication with the computer which will make the keying of moves a thing of the past.

*T D Harding,*
*Firhouse, County Dublin.*

**First, all the machines surveyed are still available, according to the latest catalogues, obsolescent or not. Harding seems to think that I know little of Morphy; I have owned one since the U.K. launch in March. I fail to understand why Harding brings in the Philidor program — Chess Champion or Mark V — or the Chess Champion Challenger or the others named. I made it clear that I was reviewing only machines I had tested myself and which were available commercially. These machines are still unavailable in the U.K.**

**Harding estimates the Morphy Level 8 rating as about 1,800. I flatly reject this assessment — I would say about 1,650. To turn to his other criticism, the cut-off rating which Harding mentions is, indeed, correct — an oversight on my part — but this does not affect the substance of the article. Harding must be aware of criticism in the chess magazines, to the effect that some players have stronger ratings than others because they avoid weaker players. My article was aimed to test this theory. I should be interested to know whether Harding himself plays in any of the British or Irish leagues, or whether he confines his games to strong tournaments.**

***John White***

## MACHINE CODE

On page 36 of the August/September issue, Trevor Sharples assumes that USR on the ZX-80 is the same as ZX-81 whereas Sinclair states that USR gives the resultant value in "HL", of n if it does not alter HL when using the ZX-80.

However, when using the ZX-81 the result of using USR is the value in the "bo" register pair. Thus the short routine to reduce 17000 to 16999 if carried out on the ZX-81 should be:

```
10 POKE 170000, 11     dec bo
20 POKE 17001, 201     ret
30 Print USR (17000)
```

As a beginner in machine code, I rely on magazines such as yours — which I find to be excellent apart from this error.

*Peter Push,*
*Ramsgate, Kent.*

**The routines listed in the August/September issue of *Your Computer* will not work on the ZX-81 because the ZX-81 USR function refers to the BC register rather than the HL register.**

**However, the following routines can be substituted for those given in the article so you can run them on your ZX-81.**

```
DECREMENT BC BY ONE:
10   POKE 17250, 11
20   POKE 17251, 201
30   PRINT USR 17250

TEST FOR NO. OF AVAILABLE
BYTES:
10   POKE 17250, 33
20   POKE 17251, 0
30   POKE 17252, 0
40   POKE 17253, 57
50   POKE 17254, 68
60   POKE 17255, 77
70   POKE 17256, 201
80   PRINT USR 17250-16366

HEX LOADER:
10   LET A = 17250
20   LET B = A
30   LET A$ =
     "21000039444DC9"
40   POKE A, 16*CODE A$ +
     CODE A$(2) - 476
50   LET A$ = A$(3 TO)
60   LET A = A + 1
70   IF A$ <> "" THEN
     GOTO 40
80   PRINT USR(B) - 16366

TO FIND THE ADDRESS OF ANY
GIVEN POINT IN THE BASIC
PROGRAM:
17300  21
17301  7B
17302  40
17303  3E
17304  08
17305  23
17306  BE
17307  28
17308  02
17309  20
17310  FA
17311  23
17312  3E
17313  09
17314  BE
17315  44
17316  4D
17317  C8
17318  20
17319  F1
```

**Because line numbers are stored in a completely different manner in the ZX-80 and ZX-81, the line renumber program can be modified to run on a ZX-81.**

***Trevor Sharples***

## Database for Sharp MZ-80K

THE SHARP MZ-80K is a versatile and useful home computer. Not only does it make a good machine for playing games, but there is also a range of useful software available for the machine. One such item is a database designed to work with the MZ-80K cassette unit.

The database is a useful method of keeping records. In this particular case, the program allows the user to consider each record as a card in an index file. The program can accommodate up to 255 cards each of 10 lines.

Records are created containing one to 25 cards. The search, browse and print facilities are standard. A special report, say, a mailing list, can be printed. The data resides in the memory and is transferred to cassette for storage.

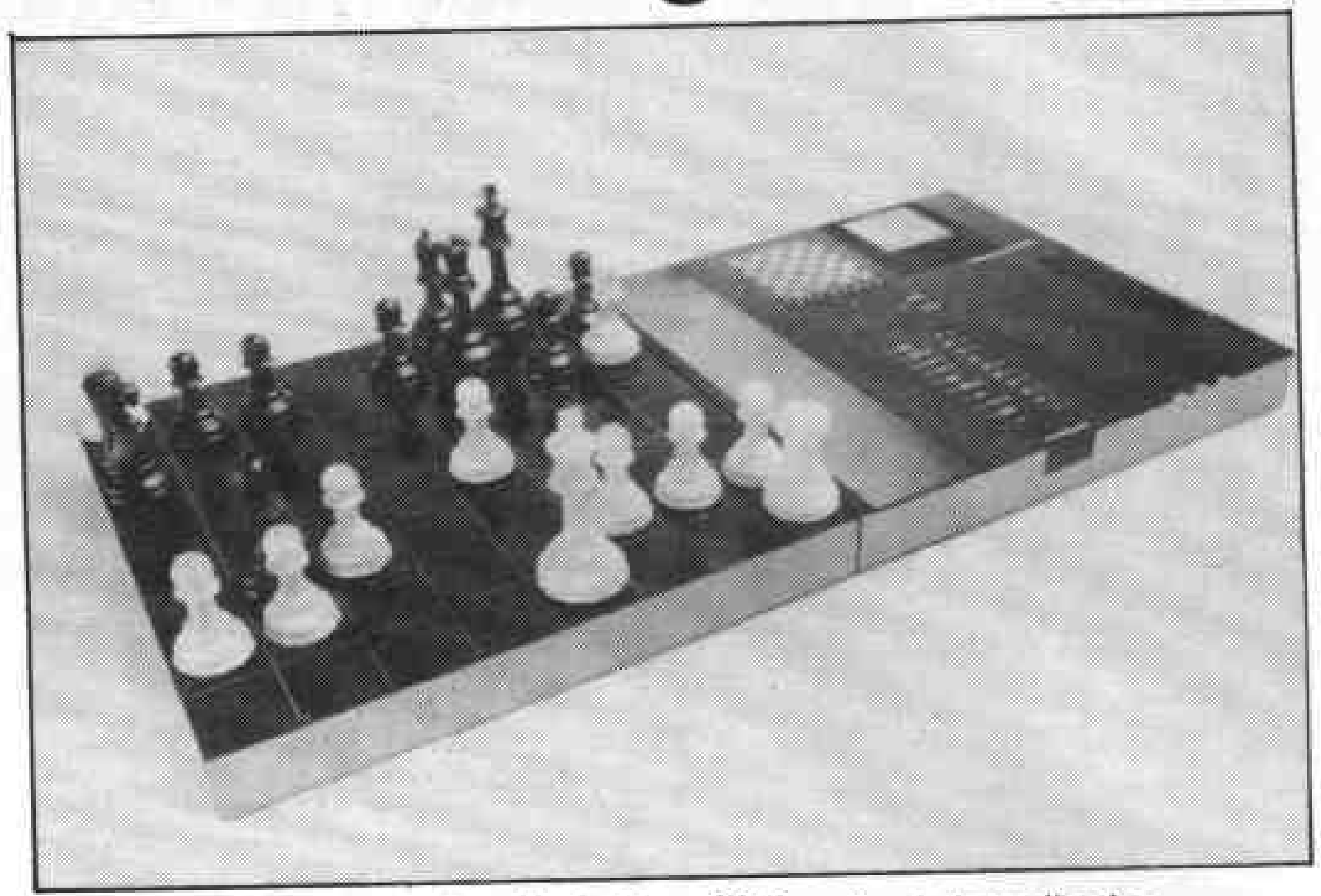
The possible uses for the database are legion — that is, there are many items which could be filed on such a system. For further details contact Jon Day of Newbear Computing Store Ltd, 40 Bartholomew Street, Newbury, Berkshire. Telephone: 0635 30505.

# Latest computer chess games

ELECTRONIC chess-playing games are becoming increasingly popular these days. That is hardly surprising — it is the marriage of one of the oldest and most respected games to the newest technology which appeals to so many. Others just like to have an opponent who is available 24 hours a day.

Vulcan Electronics is a leading company in the marketing of chess-playing machines and has recently introduced three more machines into a range which now totals six. The machines are among the most advanced ever seen in the U.K. and are of British design. Manufactured by SciSys, the machines bear the emblem of FIDE, the world chess federation, showing that they are endorsed by that organisation.

The three new machines cover the spectrum from the hand-held Executive Chess up to the sophisticated Chess Champion Mark V. The machine most likely to be filling the stockings of businessmen this Christmas is the Executive Chess. Incorporating the state-of-the-art microprocessor technology, the machine features a LCD chessboard display.



*Vulcan's Chess Champion Mark V — £249 projected retail price.*

Electronic chess pieces move across the display by a cursor control system as if the pieces were real pieces on a real chessboard. There are eight levels of play from beginner to expert and the machine can be operated either from batteries or from the mains. It even plays against itself. Vulcan's Executive Chess costs £89.95 including VAT.

The other two chess machines are further upmarket and are very sophisticated. Chess Champion Mark V is claimed to be the "Rolls Royce of chess machines", and retails for £249. The Super System IV retails at £119, and has add-ons available: it is likely to appeal to a wide audience.

Vulcan Electronics is located at 45 South Street, Bishop's Stortford, Hertfordshire.

# Hand-held NewBrain sold to Grundy

AFTER SPENDING more than two years trying to make the hand-held NewBrain computer work, Newbury Laboratories has sold it to Grundy Business Systems. The NewBrain was originally conceived by Clive Sinclair's company Sinclair Radionics and was passed to Newbury Laboratories during his involvement with the National Enterprise Board.

The sale was negotiated by the new British Technology Group — formed by the recent merger of the National Enterprise Board and the National Research and Development Corporation. The British Technology Group, which now owns Newbury Laboratories, is to invest £235,000 in Grundy Business Systems in return for a 30 percent shareholding.

When the plans for the NewBrain were first announced, it sounded both novel and competitive but the endless delays in its development mean that it has now lagged behind a new generation of personal computers. It is now almost certain that the NewBrain will never repay its development costs.

Criticism of the Government's involvement in new technology products and companies has been steadily mounting in recent months. There is a growing suspicion that the Whitehall involvement in any product is a guarantee not only of failure but also of a good deal of irretrievably-wasted public money.

Tory MP Michael Grylls has been trying to find out how much money has been spent by the Government on surveys of the market. Grylls suspects that effort and money have been wasted in four overlapping studies, but so far he has received only evasive replies to his questioning of the Department of Industry.

# Utility ROM for Atom

A UTILITY ROM has just been released for the Acorn Atom. This adds new commands to the Atom, some of which can be used within Basic programs. The ROM plugs straight into the spare slot on the Atom; no hardware changes are required. The commands are available for use as soon as the machine is switched on and it will work with an unexpanded Atom.

The 17 commands allow Atom users to re-number programs, delete a range of statements, do a string search, line-number automatically, keyboard scan, zero all Basic variables, print all non-zero Basic variables, remove Rems and spaces from programs, give a short sound on each keystroke, print size of program, and a full-feature disassembler.

The utility ROM is supplied with a full instruction manual for an all inclusive price of £35. For further details, Willow Software, PO Box 6, Crediton, Devon EX17 1DL.

# Acornsoft launches plug-in WP pack

ACORNSOFT — the software company dealing in programs for the Acorn Atom, seems to be very busy these days. The range of software developed by Acornsoft and that written by outsiders and approved is ever increasing.

Of the software to date the most important must be the Acornsoft Wordpack. The Wordpack is supplied in the form of a ROM, which is inserted into the spare socket on the Atom board. The pack provides a number of facilities which convert the humble Atom into a text editor or simple word processor. By connecting the Acorn GP-80 printer, a unsophisticated but effective word processor can be yours for around £300.

The price tag of the Atom word processor is enough to tell you that it has a limited application but, nevertheless, none of the Atom's features are lost by the addition of this ROM. The package is ideal for the preparation of leaflets, letters, booklets and documents. Text may be saved on cassette and printed in a number of formats. The Wordpack is complete with a manual giving full instructions.

The Wordpack costs around £30 and is available from Acornsoft. Other Acornsoft software packages for the Atom computer include games, mathematics and simple business software. A database program, Atom Forth Mathspacks 2 and 3, Peeko-processor and Games Pack 8 all cost £11.50. Acornsoft, 4a Market Hill, Cambridge. Telephone: 316039.

## Interface produced for ZX-80/81

BOLTON Electronics has produced an interface unit for the Sinclair ZX-80 and 81 computers. It consists of a printed-circuit board which plugs on to the rear of the computer and provides eight TTL output lines and eight TTL input lines.

The state of the output lines can be set by a simple Poke command and the input lines are read by Peeks. The addition of suitable drivers, e.g., relays, allows the control of systems from model railways to central heating to disco lights.

The unit is priced at £15.90 plus £1.00 postage and packing. Bolton Electronics, 44 Newland Drive, Bolton, Lancashire. Telephone: Bolton 64772.

# Prestel TVs go public

FORTY PUBLIC-access Prestel TV sets are to be placed for a year in places such as post offices, information and advice centres, shops and other places used by the public in Gateshead, Kingston-on-Thames and Brighton.

The ways in which the sets are used will be monitored and the results will be fed back to Prestel information providers. All the sets will be attended by staff whose job it is to give information to the public, so that people will see how to use Prestel effectively.

The experiment was devised by the Social Information Providers' Group which wants to encourage the use of social information on Prestel — about people's legal rights and so on.

The cost of the scheme has not been disclosed but the Department of Industry is providing £65,000 towards the project. Assuming that the Department has provided less than half the cost, this means that rather than installing 40 sets for a year the group could have bought more than 800 Prestel adaptors.

*The New University of Ulster has produced a special keyboard for the physically handicapped to be used in conjunction with the Acorn Atom. On the special keyboard, which has only eight large keys, two presses are used to select a character. When a key is pressed, its number appears at the top of the VDU, and when the second key is pressed the character is printed on a line below. Normal Edit facilities are retained, so mistakes can be easily corrected. The auxiliary and the normal keyboard can operate totally independently, and at all times — it is not a switched arrangement, thus giving maximum flexibility. The University has donated a unit to Fleming Fulton Special School, Belfast where it is very much in demand by students. The Acorn computer was donated by CEM Microcomputer Services and a printer was provided by the Lady Hoare Trust. The keyboard and program are being marketed by CEM, Belfast.*

## Microtan add-ons developed by Tangerine user group

THE TANGERINE users' group has developed a range of add-ons for the Microtan 65 system. The devices are all developed by members of the user group and are available to both members and non-members.

The first package to become available from the group is an EPROM programming package. The package is in the form of a kit and provides Tangerine users with an inexpensive alternative to those higher cost units already on the market. Another factor is that this programmer has been designed for Tangerine users by fellow users.

The kit provides the PCB together with construction notes, instructions on use and programming tips along with a powerful software program which allows automatic programming of the 2716 EPROM directly from the memory contents. The programmer requires three PP3 batteries to eliminate the need for a purpose-built power supply.

The price is £21 to non-members and £17 to members of the Tangerine users' group. Membership of the users' group can be doubly beneficial because the newsletter contains programs and routines which may be programmed into the EPROM for use.

The newsletter has been revamped with more pages and more information. The main reason for this has been the "thirst for information" which Tangerine fans seem to have.

The group hopes to soon become an information provider on British Telecom's Prestel system. There is a close affinity between Tangerine users and Prestel — largely due to the success of the Tantel adaptor.

*Maplin, the electronics and hardware mail order company, is to take to the road. The Maplin Roadshow will feature the Atari personal computers, and customers will be able to gain hands-on experience with these machines and see the colour graphics for themselves. The show is completely free. Five cities are on the Maplin itinerary: Birmingham, Edinburgh, Manchester, Newcastle-upon-Tyne and Norwich. The venues chosen are all in the centre of the respective cities. Shows will last from 6pm until 10pm and all the family is welcome. For details of when the whole circus arrives in your town etc., telephone Maplin on 0702-554155.*

## ZX-80/81 chess program

ANOTHER chess game for the ZX-80 and ZX-81 computers has been released. The company, Artic Computing, says that the program is written entirely in machine code, is 9K long and has six levels of difficulty. According to Artic: "It easily beats Z-Chess and annihilated Phillip Joy's chess program".

The program also allows the user to set positions on the board and then play from there. The pieces are represented graphically on a board which occupies most of the screen. The program is available for both the ZX-80 and ZX-81 for £10 from Artic Computing, 396 James Reckett Avenue, Hull, North Humberside HU8 0JA.

## New viewdata adaptors

TANGERINE is still setting the pace in the Prestel market not only with sales of its Tantel adaptor, with which it claims to have captured 78 per cent of the market, but also with its new products. The company is now aiming to capture the personal computer/Prestel market as well by converting the Tantel adaptor so that it can interface with almost all popular personal computers.

This adaptor costs the same, £170, as the existing Tantel unit. One of the advantages of the adaptor is that it can convert a personal computer into a colour computer and might eventually replace many colour boards. Its other new product is an alphanumeric Tantel unit costing £200. Details from Tangerine, Telephone: Ely 3633.

## BBC computer goes to ICL

ACORN, which makes the Atom computer and designed the new BBC computer, has announced that the BBC computers will be built by Cleartone of Gwent and ICL, the loss-making, Government-backed computer company.

The first 1,000 will be built by Cleartone and ICL will start production in early October. It will have produced 2,000 BBC computers by the end of the month. By November, the combined output from both companies will be 5,000 per month. A third assembly contract may be awarded for 1982.

It has been reported that ICL should make £250,000 on the first 5,000 units it makes, with Acorn supplying the components. If ICL makes the components for the next 7,000 computers the company would make £3.4 million.

## Green Paper on copyright

ONE OF the problems with selling software for personal computers is that it is very difficult to stop other people making copies and selling it themselves. The law of copyright for software has always been confused.

In response to all the fuss about computer software privacy, the Government has after years of delay published a Green Paper discussion document inviting ideas from anyone and everyone on the best way to provide protection for computer programs. If you have ideas, write to the Patent Office, 25 Southampton Buildings, London WC2A 1AY.

**Computer Club is here to encourage you to start your own local computer club or, if one already exists, to join it and become involved. Each month we will devote the page to new ideas from local clubs. We would like to hear of anything which has made a club a success, or of any projects or programs you are developing.**

# Liverpool tries computers in youth centre

A COMPUTER SHOP and mail-order company in Liverpool, Microdigital, has decided, very generously, to give more than £5,000's worth of computer equipment to a local Liverpool charity called the Victoria Settlement. The Settlement is run on Manpower Services Commission, MSC, grants to offer some kind of retraining for unemployed school-leavers.

To date, the courses have included electrical fitting, plumbing, woodwork, brickwork and bricklaying, painting and decorating, refurbishing and printing. At any one time, there are about 200 people in the Settlement.

"Many people talk about the effects of the new technologies", says Settlement director Gordon Rudd: "I decided that we needed to work at minimising the damaged caused by new technology and to maximise the advantages and social benefits. I was worried that people here in Liverpool were going to miss the computer bandwagon.

"We have to react to the needs not being met by society", says Rudd, and so 18 months ago the Settlement bought its first Pet. One of the problems they have faced is that no-one at the Settlement had any experience of programming. When Rudd applied to the MSC for a grant to hire a programmer, to train the youngsters, he was told that "it would serve no functional purpose".

According to Rudd: "At the local level at least they were not interested".

The possibility that Microdigital would supply some computer equipment was first raised some months ago. The company was running down its computer-hire operation and decided that much of the equipment had become difficult to sell. Bruce Everiss, Microdigital's General Manager, approached Gordon Rudd and offered him the equipment.

It includes two ITT 2020s, four Video Genies, three Atoms, two 8K Pets, and two floppy disc drives for the ITT systems. As Gordon Rudd says: "Industry is often reluctant to get involved in a scheme like ours. Yet business can do a great deal for the community at no great expense to itself".

Bruce Everiss has also given the scheme a good deal of support by lending Rudd one of his technical staff and giving away a selection of computer books, programs and games. Only one of the supervisors at the Settlement has any experience on computers. Terry McDonnell qualified with an HND in computing in the summer of 1980 and after many months of fruitless job-hunting in Liverpool was recruited by the Settlement in March. He now plays a key part in running the computer room.

"At the moment the computers are regarded as extra-curriculum activity", says McDonnell. "There is give and take, though. The kids can be given permission to be released from one of their courses to do computing; they can arrange it with their supervisor".

**Liverpool is hardly famous for its computer clubs; in recent months it has been brought to our attention more as a centre of rioting and social deprivation. Our report this month is not on a Liverpool computer club as such, but on an interesting new experiment in community computing, writes Duncan Scot.**

The children are allowed to stay at the Settlement only for a year, so there is a constant turnover. Newcomers arrive every Wednesday and now that the computers have been installed, the newcomers are introduced to them on their first day.

"I bring them in, show them how to use and load programs and games", says McDonnell. "Mostly they write their name and address on the screen at first and then learn to use the delete and insert keys".

Few of the youngsters will have the time to become expert at using the systems — at the moment, the hope is that the short experience they can gain at the Settlement will encourage them to pursue their interest further outside — perhaps by trying for an HND course at one of the local colleges.

Gordon Rudd is now hoping that more local companies will become interested in the project and help with donations of equipment.

▲ *Terry McDonnell in the computer room demonstrating the use of the 8K Pet.*

◀ *Gordon Rudd, Victoria Settlement director, now plans to launch a community computing centre in Liverpool.*

They need to upgrade the Pets, floppy disc drives, books, television sets — some of the computers cannot be used yet because they have no television — and software.

Rudd's next plan is to take over the local Methodist Hall and convert it into a community computing centre. Anyone will be able to visit and discover for themselves that one does not need a degree in computer science to enjoy playing with computers.

If anyone would like to start a similar scheme elsewhere in the country, let Computer Club know and we will do what we can to help. We would also be extremely interested to hear from any community computer centres which are already up and running. ■


# TANDY'S COLOUR COM

**The TRS-80 Colour Computer is Tandy's answer to the Commodore Vic-20. Tim Hartnell runs through its key features including its game-playing ability and its potential for expansion. Prices start at £349 for a basic system with 4K of memory.**

THE MANUFACTURER of the Tandy Colour Computer has not, in my opinion, made any major design errors. The computer is housed in a standard alpha-numeric keyboard, about the size of the TRS-80, but slightly thicker. The only design problem I found was that a push-button switch at the back, which is an on/off switch, did not appear to turn off the internal transformer, so although the machine appeared to be turned off, the transformer continued to operate.

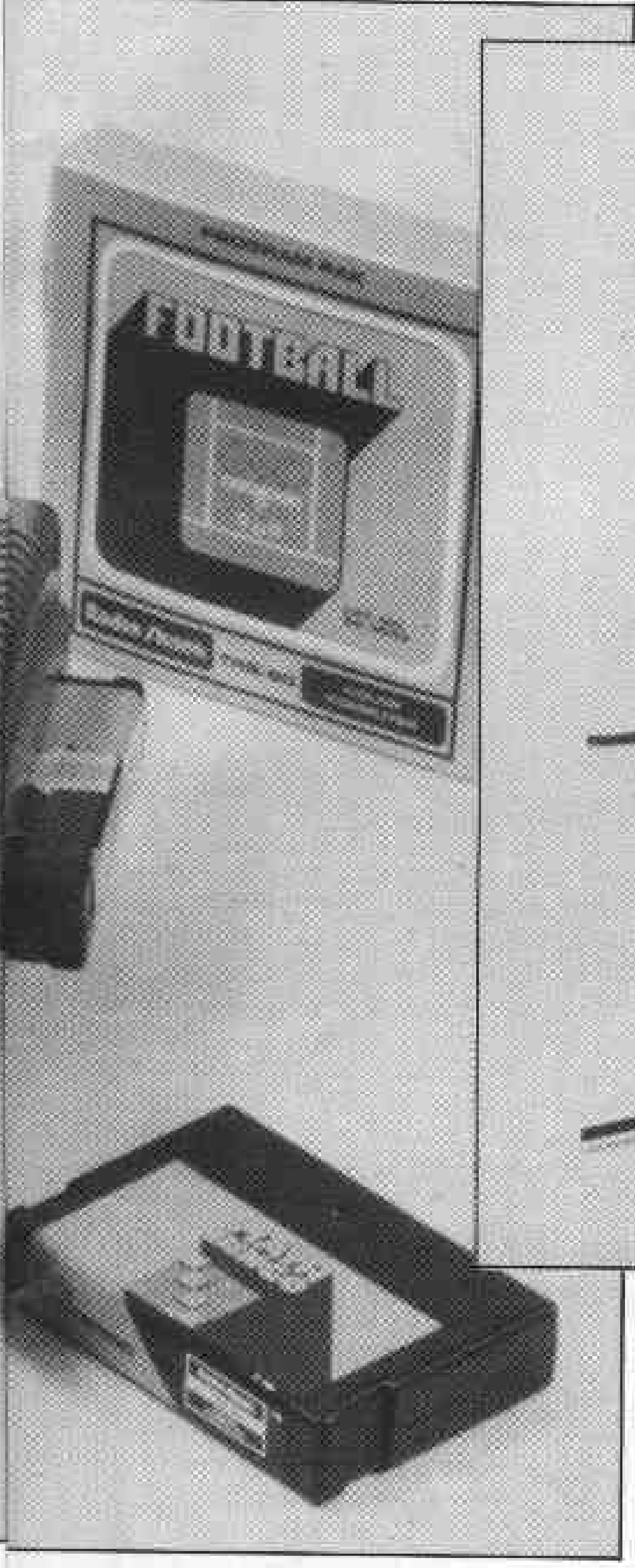
After a few hours of being "off", the computer grew very hot. This, coupled with the fact that it was impossible to tell if it was off or on without turning on the television display, meant the push button was, literally, a complete waste of energy — you still have to turn the computer off at the power point.

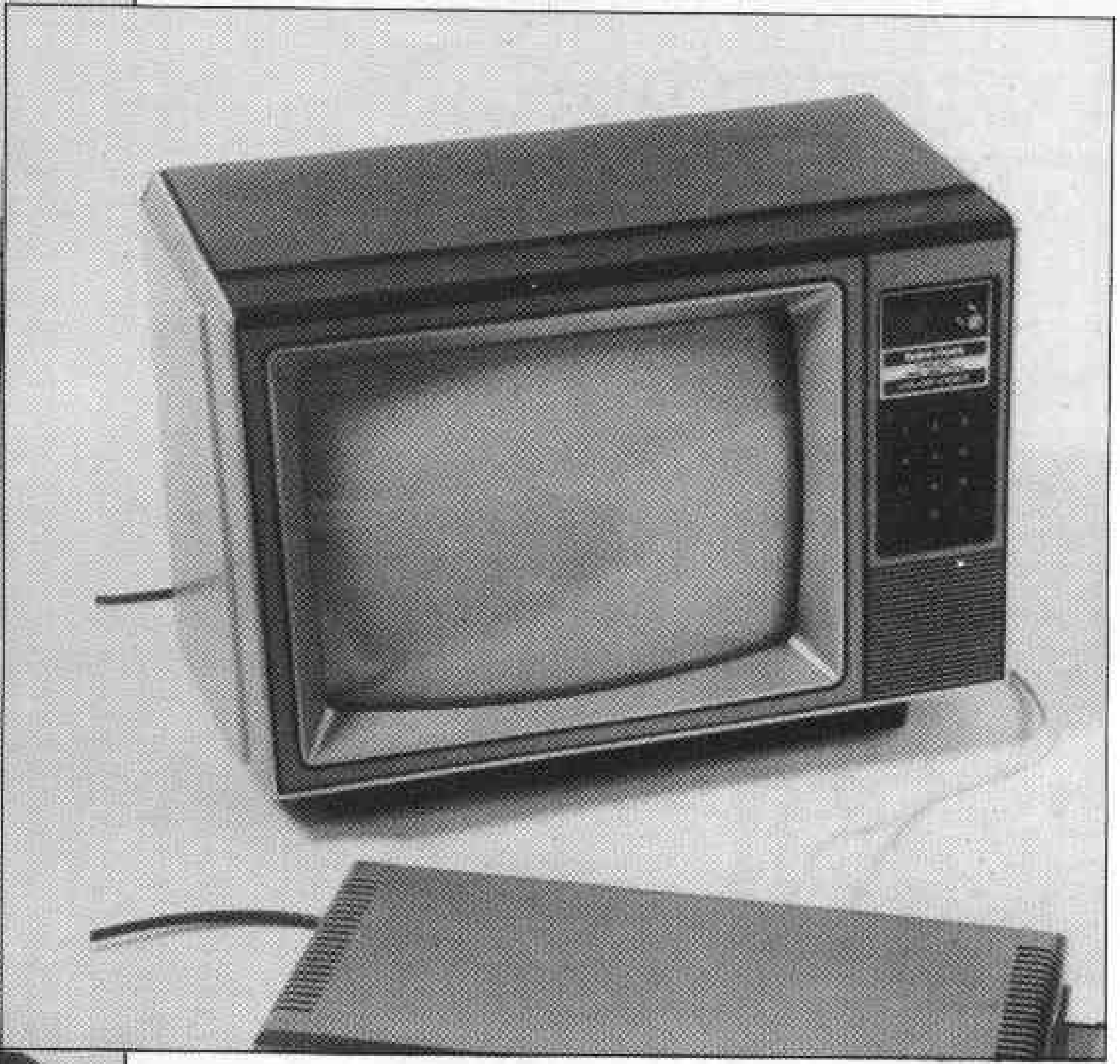
Apart from this, the computer was a joy to use. The keyboard is full-size, the Basic almost completely standard Microsoft and its only non-standard features were some very useful extra commands and statements.

An oblong cursor, which cycles through the eight available colours, appears when you turn the computer on. If you do not specify a colour-graphic mode, you obtain black letters on a pale-green background. The text on the screen is clear and easy to read. There are no graphical characters obtainable directly from the keyboard — you need to use CHR$n for them.

Although there are eight colours available — green, yellow, blue, red, buff, cyan, magenta and orange — only black on green is available when using text. The command CLS clears the screen to green for text, or if a graphic mode has been previously selected, CLSn clears to the colour specified by n.

If you do not want to use the colour immediately, and you have had some experience using other Basic computers, you will find you can probably use the Tandy Colour





# UTER

Computer from the moment you first turn it on, without even referring to the manual.

The standard Basic supplied on the machine — the review machine had *Extended Colour Basic* — is such a common subset of Microsoft you should find you can use it without any problems at all — a very big plus for the machine.

The only slightly non-standard feature is the generation of random numbers. To obtain a random number in the range 1 to 10, for example, you enter RND(10) rather than the more usual

```
INT(RND*10)+1
```

Tandy Colour Basic and Extended Colour Basic require the use of the word Then in an If statement, but do not need Let, as in

```
IF A = 6 THEN LET B = 7
```

the Let is not needed, whereas the Then is required. The extended Basic will allow the word Let to be in a listing, and will ignore it, while the standard Basic will hang up on the word.

I predict that Tandy will find a ready market among the ex-ZX-80 fraternity, because the standard Basic is almost exactly the same as ZX-80 Basic. Apart, that is, from the character set; Tandy uses ASCII, Sinclair uses its own. The vast majority of ZX-80 programs I tried — except those using screen Peeking and Poking — worked perfectly, when entered without modification on the Tandy.

A simple arithmetic modification allowed even many Peek/Poke programs to run. The address in the first line of a program after the word Rem on the Tandy is 7686, on the ZX-80 it is 16427.

It is in the special features of the Tandy extended Basic that the computer really moves into its own. Here are a few of the unusual commands and functions available:

Audio: This connects or disconnects the cassette output to the TV speaker.

Circle: Draws a circle at a specified location, of specified radius and colour, with a height/width ratio of your choice — so ellipses can be plotted. All the required information can be entered in a single program line.

Color: Sets foreground and background colour.

Defuser: This command defines the entry point for the USR function.

Draw: This draws a line beginning at a specified starting point, of specified length and colour. As with circle, all the information is entered as a single line.

Joystr: A splendid command, it functions somewhat like an Inkey$ command, returning the horizontal or vertical co-ordinates of the left or right joystick.

Paint: Another useful command which fills an area from a specified point with a chosen colour, and stops at a border of a specified colour.

Play: This triggers the sound output, heard through the TV speaker, and plays music of a specified note, A to G over five octaves. The note duration and volume can be set with the same line. The music played is held in a string.

Pos: Returns current cursor position.

Renum: An apparently instantaneous re-number function, used in the direct mode, which also re-numbers Gotos and Gosubs.

Timer: Cycles from zero, or from a number specified, to 65535.

This is a selection of some of the most interesting commands available in the Extended Colour Basic. As you can see, it is highly flexible. You can also program and output in decimal, hexadecimal or octal without any problems. There is also a

```
PRINT AT (PRINT @)
```

function, plus Set and Re-set — called ambiguously PSet and Preset. They make dramatic graphic displays relatively easy to achieve.

*(continued from previous page)*

The only real complaint I have about the Basic is the Edit function. I was unable to understand the instructions in the manual for using Edit — there seem to be about four different procedures which have to be followed, depending on what and where you wish to edit. So I was reduced to re-typing lines whenever I wanted to change them.

I also feel brickbats should be awarded to the supplied software. You can save and load your own programs through the DIN-jack at the back of the computer, but can use commercial software supplied as firmware, plug-in cartridges. The general standard of the supplied software was very low.

The space attack game Quasar Commander and Pinball use PSet and Preset and were apparently written in Basic, so they were slow, jerky and unimpressive. The Football program is incomprehensible without a detailed knowledge of Grid-Iron. Music is a reasonably impressive machine-code program, but entering a melody was slow and laborious, although it played well once entered.

The three most interesting games included Dinowars, which features two dinosaurs moving in three dimensions — that is, towards and away from the players, as well as right to left on the screen. There was a most impressive death howl when one of the beasts was injured.

Backgammon had good graphics and a rapid response, but I could not help feeling the computer was cheating, throwing itself good dice. When I confided this feeling to the distributor of the Tandy, he said he had had the same impression.

Checkers has eight levels of play, an auto-play facility and good graphics. As I have long been interested in computer draughts and have studied many of the game algorithms, I was impressed to be beaten by this Checkers program on level four. My pride would not let me attempt a complete game at level eight.

The colour was bright and vivid from the review computer, although the one supplied was of U.S. origin, running off 110 volts and producing a picture on an American TV. I will be most interested to see if the colours are as well-defined and intense on a U.K. set.

The colours are relatively easy to access from the keyboard, although they are a rather unusual selection. You are never quite sure, as the manual frankly points out, exactly which colour will be produced. Despite this, I managed to produce some splended, high-resolution designs with short programs. ■

## CONCLUSIONS

- Although it is a splendid computer which I found almost impossible to crash, with a good range of standard Basic functions and an imaginative set of additional features, it could well be overshadowed by the Vic, simply because Commodore started to market the Vic aggressively long before it was available here, and may well have better back-up in terms of software, literature and dealer distribution.
- I would think, however, that the Tandy Colour Computer, which has proved very popular in the U.S., should be considered very carefully — especially if you are more interested in writing your own programs than buying commercial software.
- Although the colours are easier to access than are the Vic's, there are fewer of them and they are slightly less predictable.
- There are a number of useful commands to make using machine-code simple on the Tandy, including Cloadm which loads a machine-language program from the cassette; Defuser; Dload which loads a machine-language program at a choice of baud rates, 300 or 1,200; and Exec, which transfers control to machine-language programs at a specified address.
- Also, you can work in decimal, octal or hexadecimal as you choose — or even mix them.
- In short, I feel the Tandy Colour Computer is a flexible and impressive machine which, despite having limited Edit facilities and an unconventional colour system, features a good range of extended Basic commands.
- The close similarity between the Tandy standard Basic and ZX-80 Basic may well make it an attractive next computer for Sinclair users who outgrow their first machine.

# J-Checkers — game of strategy

**J-Checkers has been written in Basic to illustrate many of the concepts underlying computer-based games. Many of the ideas John White presents will be useful when you write your own games.**

SINCE THE interpreted Basic found on virtually all microcomputers runs very slowly because of the time taken interpreting each statement, it is very unusual to find a game of strategy written in this language.

Compiled languages — including the rare compiled Basic — run about 100 times faster, while machine language, the choice for commercial games programs, is faster still. It is customary for most programs to estimate the value of moving a piece by assessing the position which then arises. For Checkers, this would mean an assessment for each possible move of all 64 squares of the board by two For-Next loops. This is prohibitively slow in interpreted Basic.

An alternative approach is used in Checkers, a 3.5K checkers program described in that famous and inspirational book *101 Basic computer games* by *Creative Computing*. I gratefully acknowledge the permission of *Creative Computing's* David Ahl to reproduce and adapt the original Checkers for this article.

Checkers evaluates the merit of each move, instead of the position arising after the move. The evaluation table used for this is shown in table 1.

The major problem with this approach is the program's poor strategic vision. A piece threatened with capture will not be moved unless the move itself achieves something — other than saving the piece. The evaluation function can be built to recognise such threats to a limited extent, but the best protection is a look-ahead facility which evaluates the opponent's moves. Then the program can see that a capture by the opponent can be averted only by moving the threatened piece.

I do not have the space to consider the theoretical background behind look-ahead facilities. The interested reader is referred to David Levy's *Chess and Computers* published by Batsford. However, it is not easy to implement recursive programming in Basic — a subroutine calling itself — and this leads to an unavoidable amount of duplication of program statements at each level of search in J-Checkers.

J-Checkers was written for a Sharp MZ-80K computer. I have used standard Microsoft Basic, but could not resist using the programmable music generator to give an audible prompt — these are the lines or subroutines with Tempo and Music statements. The use of a real-time clock is essential for the feature called iterative deepening.

Sharp owners will require a Toolkit or Expanded Basic for the string inequalities, e.g.,

A$<>"Y"

in some lines, and for the logical operators And and Or. I also used Newbear's *Basic Extensions*. Print "C" is a clear-screen command.

J-Checkers occupies 9K as written, or 8.3K without the instructions. Removal of all program spaces and Rem statements should reduce memory requirements to less than 8K. You will be invited to select a search method from simple one-move look-ahead — one-ply — iterative deepening from one-ply or, at two-ply search, between pruned search, minimax or alpha-beta search.

Here is a list of the features of computerised games of strategy simulated in J-Checkers:

**Evaluation function:** The evaluation function for J-Checkers is held in its own subroutine, and is summarised in table 2; compare it to table 1. A score is assigned to each projected move: by convention, a positive score is taken as good for the program and a negative score as bad.

I make no claim to be a good checkers player. Table 2 represents my idea of how to play — many readers will undoubtedly wish to change the values.

**Evaluation of captures:** Most programs evaluate captures until no more can be made. J-Checkers evaluates all captures to a depth of three-ply only. This is included solely for illustration and is a waste of time for J-Checkers. Note that double jumps are only seen by the program as a particularly favourable single jump, and it may assume that the opponent's best reply is to use the second, captured, piece to retake the machine's. It would take a great deal of extra programming to avoid this.

**Mini-max search:** It is obvious that a program's moves can be influenced by the opponent's reply. J-Checkers contains two levels of calculation — two-ply: machine move-man move — with a third level for evaluation of captures only. At the second level, all of the opponent's replies are evaluated for each of the machine's moves.

This is a slow business. The best opponent move is deducted from the machine's move to give the score for that move; obviously, the lower the opponent's score, the better for the program.

The best backed-up score is stored in location R(O) together with the moves which led to it. This avoids the necessity of storing all the moves. Finally, when all the moves have been considered, the best move is displayed together with the best response it considers you have at your disposal.

This method of minimising the best opponent's move to maximise the program's score is the famous Mini-max search.

**Alpha-beta search:** It is not necessary to search all of the opponent's replies to see if a machine move is viable. If any opponent move makes the machine move worse than the one already stored as best, the machine need not consider any further opponent moves in response to that one machine move. This is the principle underlying the modern Alpha-beta search, which gives identical results to Mini-max search but in a shorter time since fewer moves are considered.

If you want to check this, be sure to remove the randomising lines 730 and 1760 first. Similar considerations would apply at higher levels — the machine does not need to consider any further responses to opponent moves after finding one which is worse for the opponent.

To be really fast, the first moves generated would normally be sorted into order before applying the alpha-beta search, but this takes so much time in Basic as to be counter-productive for J-Checkers. The opponent's best response is not printed, unlike the Mini-max search, since only a good response has been found — not the best one.

**Iterative deepening:** A very modern way of assessing moves is that of iterative deepening. A time is pre-set — for J-Checkers, use 20-150 seconds — and the machine evaluates its best move at the first, one-ply level. These moves are sorted and subjected to alpha-beta search until there is no more time: then the best move so far discovered is displayed.

Move-sorting wastes too much time for J-Checkers, but the best move at level one is examined first at level two if iterative deepening has been selected. As is customary with this type of search, the move being considered by the machine is constantly displayed.

Iterative deepening is only available for microcomputers with a real-time clock. Otherwise, this function will operate as a slightly slow alpha-beta, two-ply search.

**Pruned search:** Another popular way of searching moves in depth, without spending an excessive period of time, is by cutting all moves which fail to meet a pre-determined criterion. J-Checkers can be selected to prune all first-level moves which do not achieve a positive score.

This accelerates execution tremendously — see table 3 — and can give results similar to those derived by other means of searching — provided that the evaluation function is a good one. The great playing strength of the older Chess Challenger models, which used pruning, provides an excellent example.

**Material evaluation:** The screen display of J-Checkers provides the opportunity to count the number of pieces on each side — one for a man, three for a king. This serves to tell whether one side has won — the piece count is zero for opponent — and can also be used as in lines 1100 and 1110 to measure which side is ahead and to provide a parameter P3 which encourages exchange of material if the program is ahead, or discourages exchanges if the program is losing. The use of P3 can be found in the third search level, in line 1970. This is a commonly-used algorithm found in many games programs.

**End-game:** For a variety of reasons, the end-game play of most computer programs — especially chess — is weaker than in the mid-game. The best chess programs use extra evaluation functions when a pre-determined level has been reached. Using the material

(continued on next page)

**Table 1**

**Evaluation function used by original Checkers**

| Projected move | Score |
|---|---|
| Capture of opponent | +5 |
| Advance of man to eight rank — promotion to king | +2 |
| Move to side of board | +1 |
| Back-up own piece from behind | +1 |
| Do not approach enemy piece | −2 |
| Do not move off first rank | −2 |

**Table 2**

**Evaluation function used by J-Checkers**

| Projected move | Score |
|---|---|
| Capture of opponent | +10 or +30 |
| Ability to make a second capture after first | +9, +10 or +11 |
| Advance man to eighth rank — promotion to king | +2 |

```
100 PRINT"█"
110 PRINTTAB(16);"J-CHECKERS"
120 PRINTTAB(5);" by Creative Computing: J.F.White"
130 DIM R(4),T(4),S(8,8)
140 FORX=1TO8:FORY=1TO8:READJ:IFJ=15 THEN 160
150 S(X,Y)=J:GOTO170
160 RESTORE: READS(X,Y)
170 NEXT Y: NEXT X
180 DATA 1,0,1,0,0,0,-1,0,0,1,0,0,0,-1,0,-1,15
190 FORZ=1TO2000:NEXT:PRINT:PRINT:PRINT
200 PRINT"THIS IS THE GAME OF CHECKERS. BLACK IS 'X' AND WHITE IS 'O'"
210 PRINT"SQUARES ARE REFERRED TO BY A COORDINATE SYSTEM"
220 PRINT"(1,1) IS THE LOWER LEFT CORNER"
230 PRINT"(1,8) IS THE UPPER LEFT CORNER"
240 PRINT"(8,1) IS THE LOWER RIGHT CORNER"
250 PRINT"(8,8) IS THE UPPER RIGHT CORNER"
260 PRINT:PRINT"THE COMPUTER WILL TYPE '+ TO' WHEN YOU HAVE ANOTHER JUMP"
270 PRINT:  PRINT   "TYPE '0,0' IF YOU CANNOT JUMP."
280 PRINT:PRINT"YOU WILL BE ASKED WHICH TYPE OF COMPUTER SEARCH YOU WANT"
290 PRINT"PRUNED SEARCH IS FASTER"
300 PRINT:PRINT:INPUT"SEARCH LEVEL(1-3)";L
310 IFL=1 THEN 330
320 GOTO 360
330 INPUT"DO YOU WANT ITERATIVE DEEPENING(Y/N)";ID$
340 IFID$="Y"THEN INPUT"SET TIME FOR SEARCH (SECS)";ST:AB$="Y":GOTO410
350 GOTO 410
360 INPUT"DO YOU WANT PRUNED SEARCH(Y/N)";FA$
370 IF FA$="Y"THEN 410
380 INPUT"DO YOU WANT ALPHA-BETA SEARCH (Y/N)";AB$
390 IF AB$="Y"THEN 410
400 PRINT"DEFAULT TO MINIMAX SEARCH"
410 INPUT"DO YOU WANT TO GO FIRST(Y/N)";C$
420 GOSUB2000:TB=TA
430 R(0)= - 99: G= -1:P1= 12:P2=12
440 IF C$="Y" THEN C1$="X":C2$="O":C3$="O":C4$="X":M=M+1:GOTO 910
450 C1$="O":C2$= "X": C3$ = "X": C4$="O"
460 M=M+1
470 IFID$="Y"ANDL=2THENX=R(1):Y=R(2):G=G:FORA=-1TO1STEP2:GOSUB570:NEXT
480 IFM=2 ANDS(2,6)=0THENR(1)=3:R(2)=7:R(3)=4:R(4)=6:GOTO790
490 FOR X = 1TO 8:FOR Y = 1 TO 8:IF S(X,Y)>-1 THEN520
500 IFS(X,Y)=-1 THEN B=A:FORA=-1 TO 1 STEP2:GOSUB570:NEXT
510 IFS(X,Y)=-2 THEN FORB=-1TO1 STEP2:FORA=-1 TO 1 STEP2:GOSUB570:NEXT:NEXT
520 NEXT Y : NEXTX
530 IFID$="Y" AND ID=0 AND L<2 THEN L=L+1:GOTO 470
540 ID = 0:IF ID$="Y" THEN L=1
550 GOTO 780
560 REM FIRST MOVE GENERATOR
570 IF ID=1 THEN RETURN
580 U=X+A:V=Y+B:IFU<1 OR U>8 ORV<1 OR V>8 THEN RETURN
590 IFS(U,V)=0 THEN GOSUB640:RETURN
600 IFS(U,V)<0 THEN RETURN
610 U=U+A: V=V+B: IFU<1 ORU>8 ORV<1 OR V>8 THEN RETURN
620 IFS(U,V) = 0 THEN GOSUB640
630 RETURN
640 UA=U:VA=V:XA=X:YA=Y:E=1:Q=0
650 GOSUB 2040:Q0=Q
660 IF ID$="Y"THEN 700
670 IFQ0>0 THEN GOSUB 1480:GOTO720
680 IF FA$="Y" AND Q0   >0THEN GOSUB 1480:GOTO 720
690 IF FA$="Y" THEN 720
700 IF AB$="Y" AND L=2 THEN GOSUB 1480:GOTO720
710 IFL=2THEN GOSUB 1400:GOTO720
720 IFQ0 >R(0) THENR(0)=Q0:R(1)=X:R(2)=Y:R(3)=U:R(4)=V:GOTO 750
730 IFQ0=R(0)AND RND(1)>.5 THEN R(0)=Q0:R(1)=X:R(2)=Y:R(3)=U:R(4)=V:GOTO750
740 GOTO770
750 IFID$="Y"THENPRINT"I AM CONSIDERING "; R(1);",";R(2);" TO ";R(3);",";R(4)
760 T1=T(1):T2=T(2):T3=T(3):T4=T(4)
770 Q0=0:RETURN
780 IFR(0)=-99 THEN 1420
790 PRINT"██FROM ";R(1);",";R(2);" TO ";R(3);",";R(4):R(0)=-99
800 IFR(4)=1THENS(R(3),R(4))=-2 :GOTO820
810 S(R(3),R(4))=S(R(1),R(2))
820 S(R(1),R(2))=0:IFABS(R(1)-R(3))<>2THEN910
830 S((R(1)+R(3))/2,(R(2)+R(4))/2)=0
840 X=R(3):Y=R(4):IFS(X,Y)=-1THENB=-1:FORA=-1TO1STEP2:GOSUB880
850 IFS(X,Y)=-2THENFORA=-1TO1STEP2:FORB=-1TO1STEP2:GOSUB880:NEXT B
860 NEXTA:IFR(0)<>-99THENPRINT" TO ";R(3);",";R(4):R(0)=-99:GOTO830
870 GOTO910
880 U=X+A:V=Y+B:IFU<1 OR U>8 OR V<1 OR V>8 THEN RETURN
890 IFS(U,V)=0 AND S(X+A/2,Y+B/2)>0THEN IG=0: GOSUB 640
900 RETURN
910 PRINT:GOSUB2000:TD=TA:TF=TF+INT((TD-TB)/60*100+.0001)/100
920 P1=0:P2=0
930 FOR Y = 9 TO 0STEP-1:FORX=0TO 9
940 IFY=9AND(X=0 OR X=9)THEN 1030
950 IFY=0 AND (X=0 OR X=9)THEN 1030
960 IFY=0 OR Y=9THEN PRINTTAB(2*X-1);X;:GOTO1030
970 IF X = 0 OR X=9 THENPRINTY;:GOTO1030
980 IFS(X,Y)=0THENPRINTTAB(2*X)".";:GOTO1030
990 IFS(X,Y)= 1THEN PRINTTAB(2*X)C1$;:P1=P1+1:GOTO1030
1000 IFS(X,Y)=-1THENPRINTTAB(2*X)C2$;:P2=P2+1:GOTO1030
1010 IFS(X,Y)=-2THENPRINTTAB(2*X)C3$;:P2=P2+3:GOTO1030
1020 IFS(X,Y)=2THENPRINTTAB(2*X)C4$;:P1=P1+3
1030 NEXTX
1040 IFY=6 THENPRINTTAB(25)"MOVE NO. ";M;
1050 IFY=4 THENPRINTTAB(23)"MY TIME= ";TF;
1060 IFY=2 THEN PRINTTAB(21);"YOUR TIME= ";TG;
1070 PRINT:NEXT Y:PRINT
1080 IF P1=0 THEN 1410
1090 IFP2=0THEN1420
1100 IFP1>P2THENP3=(P1-P2)*P1/P2
1110 IFP2>P1 THEN P3=(P1-P2)*P2/P1
1120 IF P1<7 OR P2<7 THEN PRINT"END GAME "
1130 IFL=2 AND AB$<>"Y" AND FA$<> "Y" THEN 1150
1140 GOTO 1170
1150 PRINT"I have evaluated your best move as: "!
1160 PRINTT1 ",";T2;" TO ";T3 ",";T4
1170 GOSUB 1390
1180 GOSUB 2000:TE=TA
1190 PRINT:INPUT" FROM ";E,H:E=INT(E):H=INT(H)
1200 GOSUB 1390
1210 IFE<1ORE>8 ORH<1ORH>8THENGOSUB1440:GOTO1190
1220 IFS(E,H)<=0THENGOSUB 1440: GOTO1190
1230 INPUT" TO ";A,B:A=INT(A):B=INT(B)
1240 GOSUB 1390
1250 IFA<0ORA>8 ORB<0ORB>8THEN GOSUB1440:GOTO1230
1260 IFS(A,B)=0 AND ABS(A-E)<=2 AND ABS(A-E)=ABS(B-H) THEN1280
1270 GOSUB 1440: GOTO1190
1280 IFABS(A-E)=2 AND S((A+E)/2,(B+H)/2)<1THENGOSUB1440:GOTO1190
1290 S(A,B)=S(E,H): S(E,H)=0: IF ABS(E-A)<>2 THEN 1350
1300 S((E+A)/2,(H+B)/2)=0
1310 INPUT" + TO ";A1,B1:GOSUB1390: IF A1<1 THEN 1350
1320 IFS(A1,B1)<>0 OR ABS(A1-A)<>2 OR ABS(B1-B)<>2 THENGOSUB1440:GOTO1310
1330 E=A:H=B:A=A1:B=B1:IF B= 8 THEN S(A,B)=2
1340 GOTO1290
1350 IFB=8 THEN S(A,B)=2
1360 GOSUB2000:TB=TA:TG=TG+INT((TB-TE)/60*100+.0001)/100
1370 ID=0: GOTO 460
1380 REM BEEP-BEEF
1390 TEMPO3: MUSIC"*C0","*C0"
1400 RETURN
```

(continued on next page)

| | |
|---|---|
| Advance man to seventh rank | +.3 |
| Advance man to sixth rank | +.2 |
| Move man to side of board | +1 |
| Move king to side of board or first or eighth rank | −.5 |
| Do not move man to eighth edge of board if it is moving to eighth rank | −1.2 |
| Do not approach enemy piece from front | −3 |
| Do not approach enemy king from rear | −3 |
| Back-up own piece from behind | +1 |
| Do not move man from first rank | −2.2 |
| Attack enemy men from rear with king | +1 |
| Move piece attacked from rear by enemy king | +2 |
| Move king rather than man | +.2 |
| Occupy centre squares with king | +.25 |
| Bridge two enemy pieces with king | +3 |
| Whether to exchange pieces — see text | +P3 |
| Maintain opposition | +.5 |
| Do not move from square 3,5 — if enemy move — or from 6,4 — if program move | −.2 |

**End-game: Additional functions called in the end-game**

| | |
|---|---|
| Advance man with unopposed path to eighth rank | +1 |
| If program is winning: | |
| Attack enemy pieces on side or edge of board with king | +2 |
| If program is losing: | |
| Keep king in double corner | +1.5 |
| Move king towards double corner | +.3 |
| Keep king off side or edge of board | −.35 |

**Table 3**

**Average time spent on a move**

| Level | Search | Time in minutes | Percentage of maximum time |
|---|---|---|---|
| 2 | Mini-max | 2.24 | 100 |
| 2 | Alpha-beta | 1.35 | 60 |
| 2 | Pruned | 0.45 | 20 |
| 1-2 | Iterative Deepening set to 45 seconds | 0.71 | 30 |
| 1 | Level 1 | 0.21 | 10 |
| 1 | original Checkers | 0.10 | 5 |

**Facsimile of screen detail in mid-game.**

```
From 6, 6 to 7, 5

  1 2 3 4 5 6 7 8
8 . X . 0 . X . . 8
7 0 . . . . . . . 7     Move number 19
6 . . . 0 . . . 0 6
5 . . . . . . X . 5     My time = 4.06
4 . . . . . . . X 4
3 . . X . . . . . 3     Your time = 8.14
2 . . . . . 0 . . 2
1 . . 0 . 0 . 0 . 1
  1 2 3 4 5 6 7 8

End-game

From?
```

*(continued from previous page)*

evaluation outlined, this feature has been mimicked in J-Checkers with an end-game subroutine — the program announces that it has entered its end-game.

**Book openings:** Book openings can be essential if the program is to avoid opening traps. J-Checkers includes just one at line 4801 to prevent the disastrous opening line:

2,6-1,5; 3,3-4,4; 1,7-2,6; 4,6-5,5; 4,6×6,4; 7,3×5,5; 6,6×4,4; 5,3×3,5×1,7

when white is a piece up.

**Random moves:** To prevent the machine always playing the same responses to its opponent, J-Checkers includes two randomising lines, 730 and 1760, which randomly select between moves of equal merit.

**Screen display:** Far too many commercial programs provide beautiful and incomprehensible graphics for their game of strategy. J-Checkers uses the barest possible display to save memory. The number of moves are displayed as are the times elapsed for each player — the elapsed times are given in minutes and hundredths.

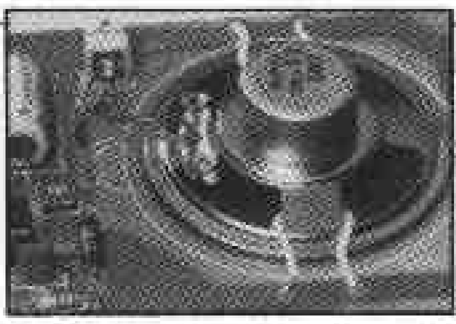
**Input of moves:** Several error-trapping routines have been written for J-Checkers, but the computer will not force you to make a capture — although it will force itself to do so.

In summary, J-Checkers, which uses a superior evaluation function and move searching, plays a much stronger game than the original Checkers, at the cost of 2.5 times the memory requirement and between two and 22 times the original response period. It is, of course, unlikely to play as well as any machine-code program. ■

*Continued from previous page*

```
1410 PRINT:PRINT:PRINT"   I WIN !":PRINT:PRINT:END
1420 PRINT:PRINT:PRINT"  YOU WIN !":PRINT:PRINT:END
1430 REM REJECT MOVE
1440 TEMPO6:MUSIC"-C5"
1450 PRINT"ILLEGAL MOVE - TRY AGAIN"
1460 RETURN
1470 REM SECOND LEVEL
1480 IFID$="Y" THEN GOSUB 2000:IF TA-TB > ST-5 THENID=1: RETURN
1490 T(0)=-99:B1=1
1500 A7=S(X,Y):A8=S(U,V):S(U,V)=S(X,Y):S(X,Y)=0
1510 IF ABS(X-U)=2 THENA3=S((X+U)/2,(Y+V)/2):S((X+U)/2,(Y+V)/2)=0
1520 FOR X1=1TO8: FOR Y1=1TO8:IFS(X1,Y1)<1 THEN 1550
1530 IFS(X1,Y1)=1 THEN B1=B1:FORA1=-1TO1STEP2:GOSUB1620:NEXT
1540 IFS(X1,Y1)=2THENFORB1=-1TO1 STEP2:FORA1=-1TO1STEP2:GOSUB1620:NEXT:NEXT
1550 NEXTY1:NEXTX1
1560 S(X,Y)=A7: S(U,V)=A8
1570 IFABS(X-U)=2 THEN S((X+U)/2,(Y+V)/2)=A3
1580 Q0= Q0-T(0):IF FA$="Y"THEN Q0=Q0+3
1590 IFID$="Y"THEN Q0=Q0+ 3
1600 AB=0
1610 RETURN
1620 IF ID=1 OR AB=1 THEN RETURN
1630 U1=X1+A1: V1=Y1+B1:IFU1<1 ORU1>8 ORV1<1 OR V1>8 THEN RETURN
1640 IF S(U1,V1)=0 THEN GOSUB 1700:RETURN
1650 IF S(U1,V1)>0 THEN RETURN
1660 U1=U1+A1: V1=V1+B1:IF U1<1 OR U1>8 OR V1<1 OR V1>8 THEN RETURN
1670 IF S(U1,V1)=0 THEN GOSUB 1700
1680 RETURN
1690 REM SECOND MOVE GENERATOR
1700 UA=U1:VA=V1:XA=X1:YA=Y1:ED=8:GA=G1
1710 GOSUB 2040
1720 Q1=Q
1730 IF ID$<>"Y" AND Q1>0 THEN GOSUB 1800
1740 IFAB$="Y"AND Q0-Q1 < R(0) THEN AB=1
1750 IFQ1>T(0) THEN T(0)=Q1:T(1)=X1  :T(2)=Y1:T(3)=U1  :T(4)=V1
1760 IFQ1=T(0) AND RND(1)>.5 THEN T(0)=Q1:T(1)=X1:T(2)=Y1:T(3)=U1:T(4)=V1
1770 Q1=0
1780 RETURN
1790 REM THIRD LEVEL
1800 IFID$="Y"THEN GOSUB2000:IFTA-TB>ST-5THEN ID=1:RETURN
1810 A4=S(X1,Y1):A5=S(U1,V1):S(U1,V1)=S(X1,Y1):S(X1,Y1)=0
1820 IFABS(X1-U1)=2 THEN A6=S((X1+U1)/2,(Y1+V1)/2):S((X1+U1)/2,(Y1+V1)/2)=0
1830 FOR X2=1TO8: FOR Y2=1TO8
1840 IFS(X2,Y2)>-1 THEN 1870
1850 IFS(X2,Y2) = -1 THEN B2=G:FORA2=-1TO1 STEP2:GOSUB 1920:NEXT
1860 IFS(X2,Y2)=-2THEN FORB2=-1TO1STEP2:FORA2=-1TO1STEP2:GOSUB1920:NEXT:NEXT
1870 NEXTY2: NEXTX2
1880 S(X1,Y1)=A4:S(U1,V1)=A5
1890 IFABS(X1-U1)=2 THEN S((X1+U1)/2,(Y1+V1)/2)=A6
1900 RETURN
1910 REM THIRD MOVE GENERATOR
1920 U2=X2+A2:V2=Y2+B2:IF U2<1 OR U2>8 OR V2<1 OR V2>8 THEN RETURN
1930 IF S(U2,V2)<=0THENRETURN
1940 U2=U2+A2:V2=V2+B2:IF U2<1 OR U2>8 OR V2<1 OR V2>8 THEN RETURN
1950 IF S(U2,V2)=0 THEN GOSUB 1970
1960 RETURN
1970 Q1 = Q1 + P3 -9
1980 RETURN
1990 REM TIMER
2000 T1$=TI$
2010 TA=3600*VAL(LEFT$(T1$,2))+60*VAL(MID$(T1$,3,2))+VAL(RIGHT$(T1$,2))
2020 RETURN
2030 REM EVALUATION
2040 Q=0: IF ID$="Y"THENGOSUB2000: IFTA-TB>ST-5 THENID=1:RETURN
2050 IFP1<7 OR P2<7 THEN GOSUB 2530
2060 CP=0:IF ABS(VA-YA)=2 THEN Q=Q+10:CP=1:IF GA=-1 THENQ=Q+20
2070 IF GA=-1 AND XA=3 AND YA=5 THEN Q=Q-.2
2080 IF GA =1 AND XA=6 AND YA=4 THEN Q=Q-.2
2090 FOR C =-1 TO 1 STEP2:IFUA+C<1ORUA+C>8 OR VA+GA<1ORVA+GA>8THEN2250
2100 IFS(UA+C,VA+GA)=GA OR S(UA+C,VA+GA)=2*GA THENQ=Q+1
2110 IFUA-C<1ORUA-C>8ORVA-GA<1ORVA-GA>8THEN 2250
2120 IFS(XA,YA)=2*GA THEN 2140
2130 GOTO2170
2140 IFS(UA+C,VA-C)=0ANDS(UA-C,VA+C)=0ANDS(UA-1,VA+C)=-2*GA THEN 2160
2150 GOTO2170
2160 IFS(UA+1,VA-C)=-2*GA THEN Q=Q+3
2170 IF(S(UA+C,VA+GA)=-GA OR S(UA+C,VA+GA)=-2*GA)THEN 2190
2180 GOTO 2200
2190 IF S(UA-C,VA-GA)=0 OR (UA-C=XA AND VA-GA=YA)THEN Q=Q-3
2200 IF S(UA+C,VA-GA)=-2*GAAND(S(UA-C,VA+GA)=0OR(UA-C=XAANDVA+GA=YA))THENQ=Q-3
2210 IF S(UA+C,VA+GA)=-2*GA AND (UA-C=XA AND VA-GA=YA) THENQ=Q-3
2220 IFUA+2*C<1ORUA+2*C>8 OR VA+2*GA<1OR VA+2*GA>8THEN 2250
2230 IFS(UA+C,VA+GA)=0AND S(UA+2*C,VA+2*GA)=0 AND S(UA,VA+2*GA)=-GATHENQ=Q+.5
2240 IFS(UA+C,VA+GA)=0ANDS(UA+2*C,VA+2*GA)=0AND S(UA,VA+2*GA)=-2*GATHENQ=Q+.5
2250 NEXT C
2260 IF S(XA,YA)=2*GA THENQ=Q+.2:GOTO 2380
2270 REM MAN ONLY
2280 IFVA=ED THENQ=Q+2
2290 IFCP=1THEN FC=-2:FORFC=-2TO2STEP4:GOSUB2470:NEXT
2300 IFVA=ED - GA*2 THEN Q=Q+.2
2310 IFVA=ED - GA THEN Q=Q+.3
2320 IF YA=ED - 7*GA THENQ=Q-2.2
2330 IFXA=1OR XA=8THEN2360
2340 IF XA+1>8OR XA-1<1 OR YA-GA<1 OR YA-GA>8 THEN 2360
2350 IFS(XA+1,YA-GA)=2*GA OR S(XA-1,YA-GA)=-2*GA THENQ=Q+2
2360 IF UA=1 OR UA= 8 THENQ=Q+1:IFVA=ED THENQ=Q-1.2
2370 RETURN
2380 REM KING ONLY
2390 IF CP=1 THEN FORFB=-2TO2STEP4: FOR FC=-2TO2STEP4:GOSUB2470:NEXT:NEXT
2400 IFVA=5 AND(UA=3ORUA=4ORUA=5)THENQ=Q+.25
2410 IFVA=4 AND (UA=3ORUA=4ORUA=5)THENQ=Q+.25
2420 IFUA-1<1 OR UA+1>8 OR VA-GA<1OR VA-GA>8 THEN 2440
2430 IFS(UA-1,VA-GA)=-GA AND S(UA+1,VA-GA)=-GA THENQ=Q+1
2440 IFUA=1 OR UA=8 THENQ=Q-.5
2450 IF VA=1 OR VA=8 THEN Q=Q-.5
2460 RETURN
2470 UC=UA+FB:VC=VA+FC
2480 IFUC<1ORUC>8 OR VC<1ORVC>8THEN RETURN
2490 IFS(UC,VC)=0AND S((UC+UA)/2,(VC+VA)/2)=-GA THEN Q=Q+10
2500 IF S(UC,VC)=0 AND S((UC+UA)/2,(VC+VA)/2)=-2*GA THEN Q=Q+11
2510 RETURN
2520 REM ENDINGS
2530 IF GA = 1 THEN RETURN
2540 IF P2<6 AND P1>P2 THEN 2610
2550 IFV=3 AND S(U,1)>0 THEN Q=Q+2
2560 IFS(X,Y)<>-2 THEN 2650
2570 IFU=3 AND S(1,V)>0 THENQ=Q+2
2580 IFU=6 AND S(8,V)>0 THEN Q=Q+2
2590 IFV=6 AND S(U,8)>0 THEN Q=Q+2
2600 GOTO 2650
2610 IF(U=7AND V=1)OR(U=8ANDV=2)OR(U=1ANDV=7)OR(U=2ANDV=8)THENQ=Q+1.5
2620 IFS=U(U-1 AND V+1)(V+1 AND S-V)S-V THENQ=Q+.3:GOTO2650
2630 IF 8-U<X-1 AND V-1<Y-1 THENQ=Q+.3
2640 IFU=1 OR U=8 OR V=1 OR V=8 THEN Q=Q-.35
2650 IFS(X,Y) <> -1 THEN 2740
2660 FOR I= V TO 1 STEP -1
2670 IF S(U,I)>0 THEN 2740
2680 IF U>8 AND S(U-1,I)>0THEN 2740
2690 IF U+1 >8 THEN 2740
2700 IF U<1 AND S(U+1,I)>0 THEN 2740
2710 IF S(U-1,I)>0 OR S(U+1,I)>0 THEN 2740
2720 NEXT I
2730 Q = Q + 1
2740 RETURN
```


## THE AM SPEECH BOARD



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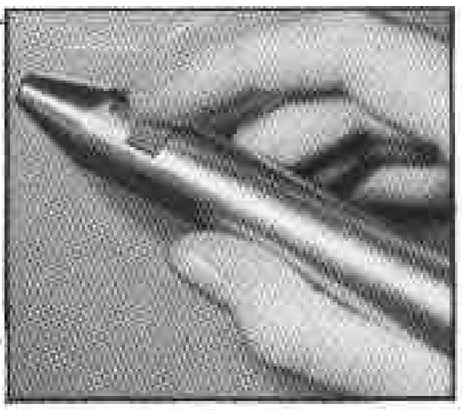

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FRONT ELEVATION

# High-resolution displays on the Vic-20

BY NICK HAMPSHIRE

**The Vic-20 is a versatile machine capable of displaying normal alpha-numeric characters, user-definable characters and high-resolution point plotting. In this first of a series of articles on programming the Vic-20 Nick Hampshire explains how.**

THE 255-CHARACTER alpha-numeric character set includes both upper- and lower-case characters and graphics characters. The standard character set can be displayed using Print commands or by Poking the character or ASCII code value into one of the video memory locations.

To generate user-definable characters or to plot points in high-resolution requires some special programming techniques. They are needed to change the system configuration to allow these display formats — displays which are possible only because of a very sophisticated integrated circuit, the 6561 Video Interface Chip. It is this chip which gives the Vic its name.

The Vic has three areas of memory which are utilised in displaying a character on the screen, these areas are:

- The video memory: where the code value of each character displayed on the screen is stored. Each memory location corresponds to a particular position on the screen, thus location 7680, the beginning of the 506 location video memory, corresponds to the top-left character space and 7681 is the next one to the right, and so on.
- The colour memory: this is another 506 location block of memory starting at location 38400. It contains the foreground and background colour for each character displayed. To give an example, by Poking the value 2 into location 38400, the top-left character is displayed as a red character on a white background.
- The character generator: this section of memory contains information on the appearance of each of the 255 characters in the character set. Each character uses eight memory locations to describe the pattern of dots from which the character is made. If the code value stored in a location in the video memory is 48, the pattern of dots to be displayed on the screen is stored in the 48th eight-location block of the character generator. The character generator uses 2,048 memory locations and the ROM containing information for displaying the normal character set starts at location 32768.

To use the display capabilities of the Vic to the full, it is essential that the function of each of these three memory locations is clearly understood. Part of the versatility of the 6561 integrated circuit which controls the Vic video display is that the user can change the location of either the video memory or the character generator.

If the position of the memory block used to contain the character generator is changed so that instead of a ROM with pre-defined characters it contains RAM memory, then user-definable characters can be created.

The location of the character-generator memory block is changed by altering the contents of one of the control registers of the 6561. The control registers can also be used to select whether the displayed character occupies the normal eight-by-eight dot matrix or an elongated eight-by-16 matrix.

The first stage in creating a user-definable character set is to allocate a block of RAM memory for storage of the character generator. If characters on an eight-by-eight matrix are being displayed, then 2,048 memory locations are required; if an eight-by-16 matrix is to be used, 4,096 locations are required.

Since a standard Vic only has 3,584 RAM memory locations available to the user, an eight-by-eight matrix user-definable character generator using 2,048 of these locations is the only one feasible.

The user RAM on a standard unexpanded Vic starts at memory address 4096 and goes on to address 7679. The character generator can be programmed to start at any of the following addresses within that range; 4096, 5120, 6144 or 7168. Since 2,048 locations are required for the character generator, the only possible starting location is clearly 5120.

This leaves 1,024 bytes free for user programs — which is not much; purchase of the standard 3K RAM expansion module is strongly recommended and its use will not change any of the programs or data in this article. This area of RAM chosen for use by the character generator must be protected from being overwritten by a Basic program or data. If this happened, the display would be destroyed.

The user-definable character generator can be protected from being overwritten by lowering the top of memory pointers, thus:

```
10 POKE 51,255 : POKE 52,19
11 POKE 55,255 : POKE 56,19
12 CLR
```

The next stage is to put the data about each character into the new character generator. This is done by using Poke commands to put information into the 2,048 memory locations. Before this can be done, each of the new characters must be designed which entails drawing each character on an eight-by-eight grid. See figure 1.

Once the character has been designed, it can be converted into the block of eight numerical values for storage in the character generator. Each line in the grid corresponds to a byte of data, and each of the eight bits in that byte corresponds to a dot or column position.

Information is stored in memory in binary, thus by considering each bright dot to be a logical "1" and each space a logical "0", a line of dots in each character can be converted into

*(continued on next page)*

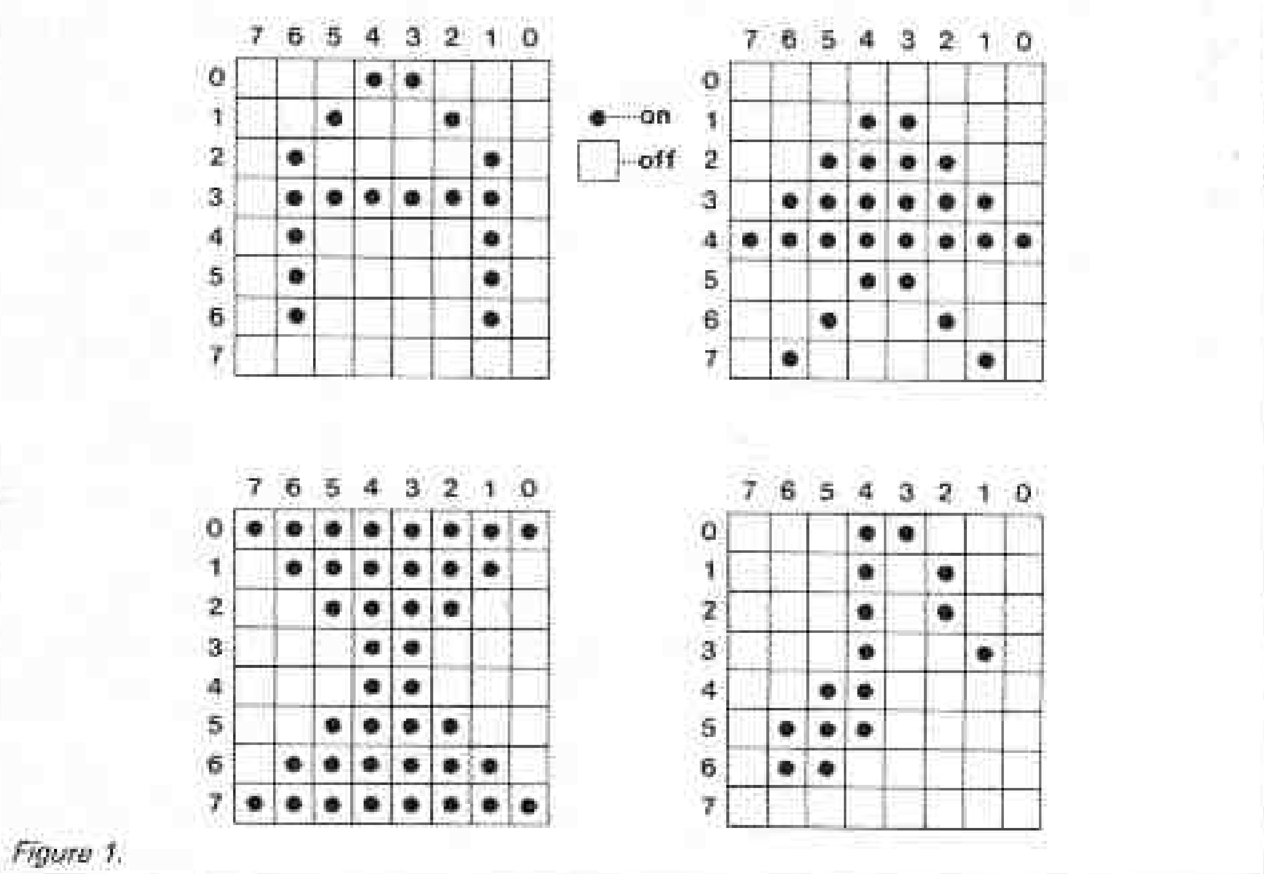


*Figure 1.*

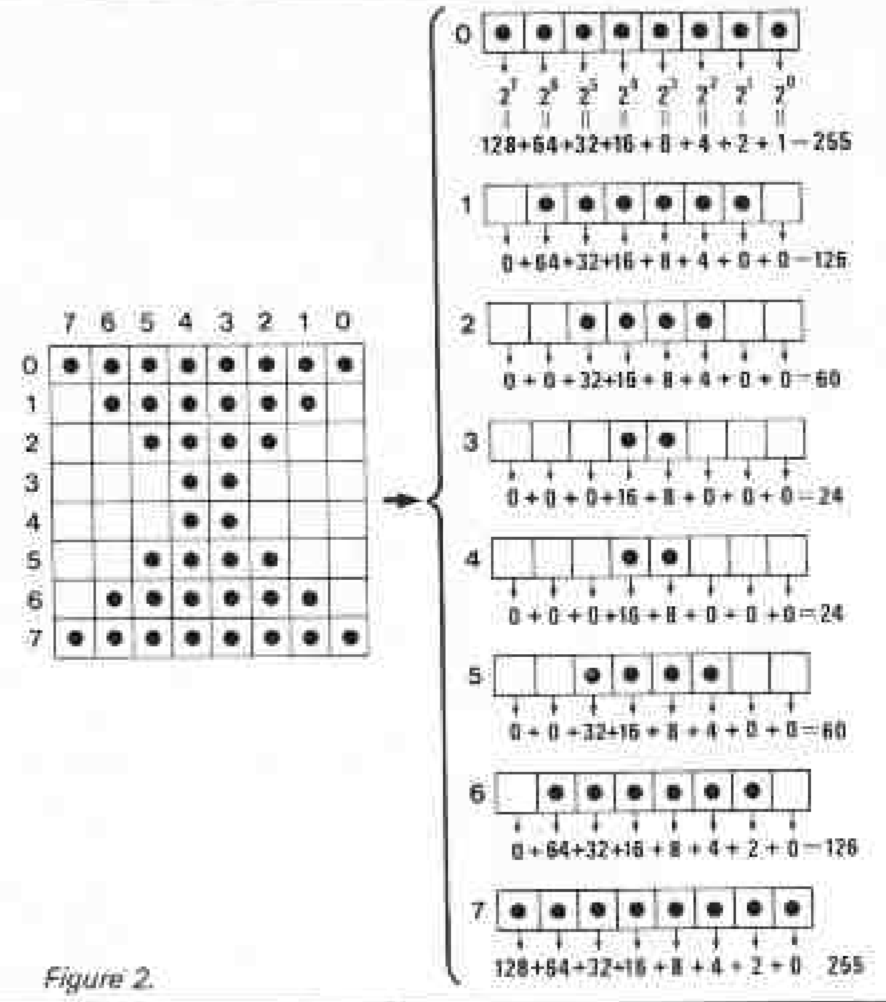

Figure 2.

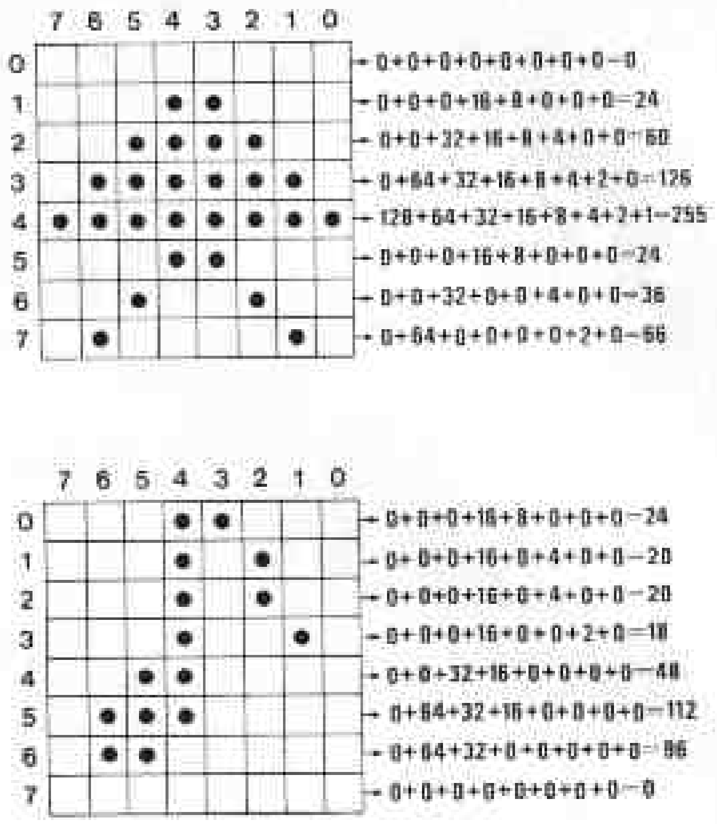

Figure 3.

(continued from previous page)
a numerical value. Figure 2 demonstrates this.

Some examples of character designs and their conversion to numerical values are shown in figure 3. From these values a table can be created. One column has the character-generator address. The corresponding entry in the second column has the value to be put into that location.

The table is divided into blocks of eight entries, each block containing the data for one character. Each of these blocks of eight entries is numbered starting at 0 and going up to 255. These numbers correspond to the ASCII or character-code number stored in the video RAM when the characters are displayed.

An example table using the character designs in figure 3, is shown in figure 4. The table need contain only the number of characters required — all 255 possible character blocks do not have to be filled. It is advisable, though, that the table starts at the first location in the character generator. Any gaps left should be filled with zeros. The values in the table are best stored as data statements. These values are then entered into memory using Poke commands, thus:

```
20 FOR I=0 TO 2048
21 READ A
22 IF A="*" THEN 30
23 POKE 5120+I,A
24 NEXT
30 END

100 DATA 24,20,20,18,48,112,96,0
110 DATA 0,24,60,126,255,24,36,66
120 DATA 255,126,60,24,24,60,126,255
130 DATA*
```

In the majority of applications, alpha-numeric characters are required in addition to user-defined graphics characters. In such cases, part of the data in the ROM-based character generator must be transferred to the new RAM character generator.

The first 128 characters of the ROM character generator are transferred to the new RAM character generator using a combination of Peek and Poke commands, thus:

```
20 FOR I=0 TO 1024
30 POKE 5120+I, PEEK(32768+I)
40 NEXTI
```

This leaves 128 possible user-definable characters starting at address 6155. These characters can be filled as described, and will have an ASCII code starting value of 128. An example of the routine to enter the character-generator data will be as follows:

```
20 FOR O=0 TO 1024
21 POKE 5120+I, PEEK(32768+I)
22 NEXT I
30 FOR I=0 TO 1024
31 READ A
32 IF A="*" THEN 200
33 POKE 6144+I,A
34 NEXT
60 REM DATA FOR ASCII CODE
   CHARACTERS 128, 129, AND 130
100 DATA 24,20,20,18,48,112,96,0
110 DATA 0,24,60,126,255,24,36,66
120 DATA 255,126,60,24,24,60,126,255
130 DATA *
```

Having loaded the user-definable character generator, it can be used. It will remain in the Vic until the machine is switched off and can thus be used by more than one program. To use the RAM character, two of the 6561 registers must be changed:

```
200 POKE 36869,253
210 POKE 36866, PEEK(36866) OR 128
```

Once the user-definable RAM character generator has been set up and the 6561 registers changed to utilise the new character generator it can be used to generate special displays. If Poke commands are used to place the characters in the video RAM memory, the ASCII code values of the new characters are used. If the new characters are incorporated into strings, it is essential to know which character in the normal character set the new character replaces.

This can be determined by using the table of Vic ASCII codes and looking for the character with the same code value as the new character. When the program is written, the normal characters are inserted into the string. When the program is run, they will be replaced by the new characters automatically.

It is important to note when using Poke commands that the colour RAM location corresponding to the location where the character is to be displayed must also be set to give the required colour — otherwise the display will be white on white and, therefore, invisible. To restore the normal function of the Vic ROM character generator, use the following two lines:

```
500 POKE 36869,240
510 POKE 36866,150
```

| | | |
|---|---|---|
| 5120 — 24 | | |
| 5121 — 20 | | |
| 5122 — 20 | | |
| 5123 — 18 | Character code # 1 — (musical note) | |
| 5124 — 48 | | |
| 5125 — 112 | | |
| 5126 — 96 | | |
| 5127 — 0 | | |
| 5128 — 0 | | |
| 5129 — 24 | | |
| 5130 — 60 | | |
| 5131 — 126 | Character code # 2 — (Space invader) | |
| 5132 — 255 | | |
| 5133 — 24 | | |
| 5134 — 36 | | |
| 5135 — 66 | | |
| 5136 — 0 | | |
| 5137 — 0 | | |
| 5138 — 0 | | |

Figure 4.

High-resolution point plotting uses exactly the same principles as the generation of user-definable characters. Briefly, it entails filling the video RAM with each of the 255 character codes — only half the screen can be used with eight-by-eight characters.

The RAM character generator can then be used as a high-resolution memory-mapped display. If all bytes in the RAM character generator are set to zero, the screen is blank; set one bit in one of the characters and a single high-resolution dot will appear. ■

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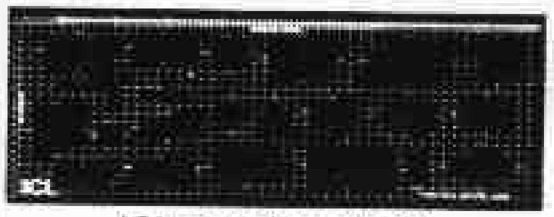

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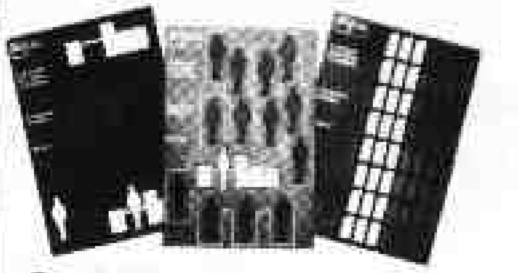

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# Old or new ZX Rom: how to make the switch

BY STEPHEN ADAMS

**Converting programs written for the old Rom ZX-80 to run under the new Rom is time-consuming. Many owners of the new Rom have preferred to scrap their old programs and start building a new collection. In this article Stephen Adams presents his own alternative — putting both Roms into the ZX-80 and switching between them.**

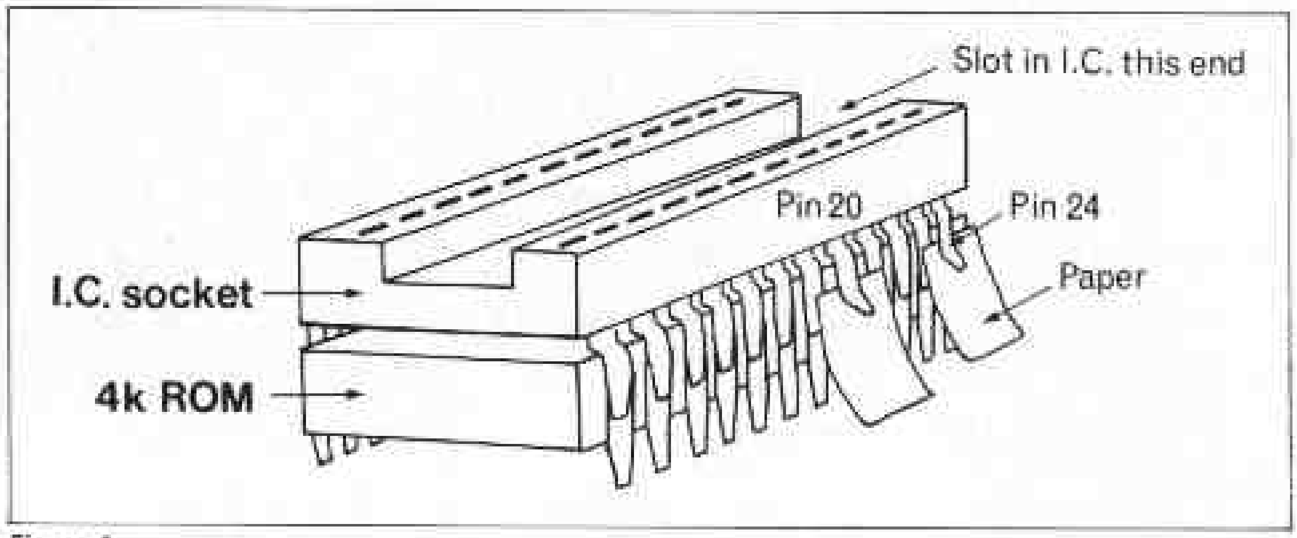


*Figure 1.*

AFTER WAITING six months for my new ROM from Sinclair, a brown paper package finally popped through the door. I fitted it and sat back to read the manual — then I realised I had a problem. It seems that the set-up of the RAM and various stacks meant that there was very little chance of converting my taped programs to run on the new ROM without re-typing in every listing again.

Not only would the listing have to be re-typed, but all the Peeks and Pokes in some of them would have to be different. This meant I would also have to discover how the programs work before doing that. Plus some of the programs contain machine code which uses routines within the ROM which are not there in the new 8K ROM.

Thus all my 60 old programs were so much old tape unless I could find some way of fitting the old 4K ROM back into the ZX-80. Yet, I still wanted to have my new ROM as well, so some method would have to be found of fitting them both in unless I wanted to pay for another ZX-80.

Having already found that both ROMs go into the same socket with no changes to the internal circuitry, my first task was to go to the circuit diagram to see what the connections were to the ROM.

Both ROMs are connected to all the address lines A0-A12 giving an 8K range, but I suspect that the A12 pin is disconnected internally in the 4K ROM as it has no effect. The other lines were +5 volts — pin 24 — 0 volts — pin 12 — not chip select line — CS, pin 20 — and, of course, the data lines.

This means that the two ROMs could be turned on separately if only the CS signal could be switched to only one ROM at a time. The only problem is that both ROMs occupy the same address space and cannot be moved as the Basic depends on them being there.

The only answer, therefore, was to put in a manual switch and either use the ZX-80 as a 8K ROM machine or 4K ROM one. That meant that any changeover of the ROM would also have re-set the ZX-80 so that the Basic might set itself properly. This Newing clears the RAM memory so that no programs or variables can be swopped between Basics. To re-set the ZX-80, pull out the power plug at the back and re-insert it after five seconds.

A 24-pin Dual In Line, DIL, integrated-circuit socket was bought from a local electronics shop and soldered to the top of the old 4K ROM as in figure 1. As the 4K ROM had been replaced by the 8K ROM in the machine, this was easily done, but remember: never do any soldering with the power on.

The only pins which were not soldered to the 4K ROM were pins 20, CS, and pin 24, +5 volts power. These were left to protrude at the sides with a piece of paper between the pins of the ROM and the socket to isolate them. These pins were then soldered to four 6 in. long pieces of coloured wire. Different colours were used to identify the different pins, and it is a good idea if you write down the colours for each pin as you do it.

Having done that, the 8K ROM was removed from the socket on the board very carefully using a small screwdriver to ease it gently from both ends. Great care should be taken not to bend the pins. Now, just as gently, re-insert the 4K ROM into the ZX-80 making sure that pins 20 and 24 of the ROM do not go into the holes in the socket, but protrude at the side of it. Also check that all the pins that protrude make no contact with any other components on the printed-circuit board.

| Quantity | Components |
|---|---|
| 1 | Double-poled change-over switch. Cost: £1 |
| 1 | 24-pin IC socket. Cost: 50p |
| 6 | 6in. pieces of coloured wire. Cost: 10p |

**Tools required**
Soldering iron, solder, pliers, paper, screwdriver

Next, remove the entire printed-circuit board from its case. First pushing out the pins holding down the keyboard by applying a screwdriver to the centre of the fastener beneath the ZX-80 and pushing upwards until the centre pin rises from the top.

Secondly, the other fasteners inside the ZX-80 should be removed by pinching the tops with a pair of pliers and pushing them out of the bottom of the case. Both methods are shown in figure 2.

Turn the printed-circuit board over so that the integrated circuits are on the bottom, and find the ROM socket — it is the only one with 24 pins. Pin 20 is the fifth pin down from the right-hand side if you have the keyboard nearest to you. Solder another coloured wire on to this pin, making sure it cannot make contact with any other printed-circuit track or adjacent pins.

Mount the board back into the case securing it with the fasteners, but do not put on the top. Also make sure that the wire from pin 20 of the boards ROM socket runs up the side of the board to lay over the outside edge of the case. Solder a further coloured wire on to the large metal pad next to pin 24 of the ROM socket — this is the top pin on the right-hand side near the cassette sockets. This pad is at +5 volts from the ZX-80 internal regulator.

Now we have six coloured wires, four from the PROM and new socket, and two from the board. I hope you know which is which. The switch I used was a slide switch, but any switch can be used that will:

- Fit in the case without shorting out or touching any components on the printed-circuit board.
- Is a double-sided change-over switch.

The switch wiring is given in figure 3 and a

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circuit diagram in figure 4. Any badly-soldered joints here can result in a lost program, so pick a good switch and check all the joints after doing them.

Mount the switch in any spare space on the case — but not too far away from the ROMs as this can lead to problems. Do not forget to mark the switch positions as to which ROM you are using.

To test, switch to the 4K ROM position and apply power to the ZX-80. The reverse "K" cursor should appear showing that the ROM is being used. If if does not, check the switch and other connections. Having made the 4K ROM work, remove the power lead again and insert very carefully the new 8K ROM into its new socket on top of the 4K ROM.

Change the switch to the 8K ROM on the change-over switch and put back in the power lead. The reverse "K" cursor should appear, but this time with a long wait from switch-on. Again check the connections if this does not occur.

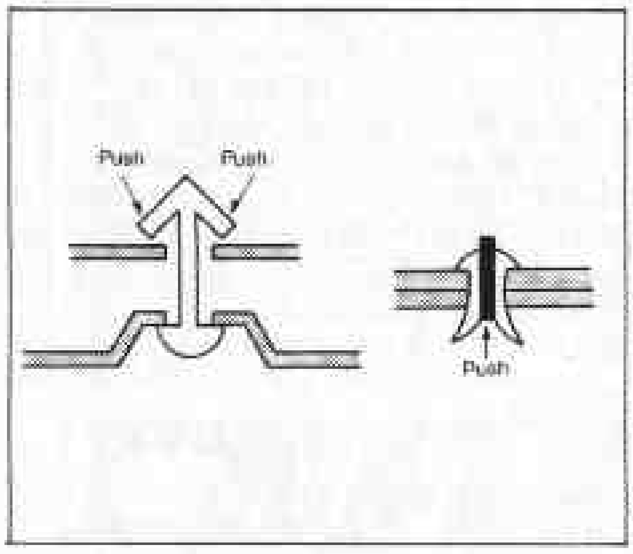
Now replace the top of ZX-80. If you have difficulty in making the cover secure because of the protruding ROMs, replace the pins holding the cover with six BA screws and nuts. This will leave about .5in. gap at the right-hand side of cover, but if it is unsightly cover the gap with some 1in. wide insulating tape.

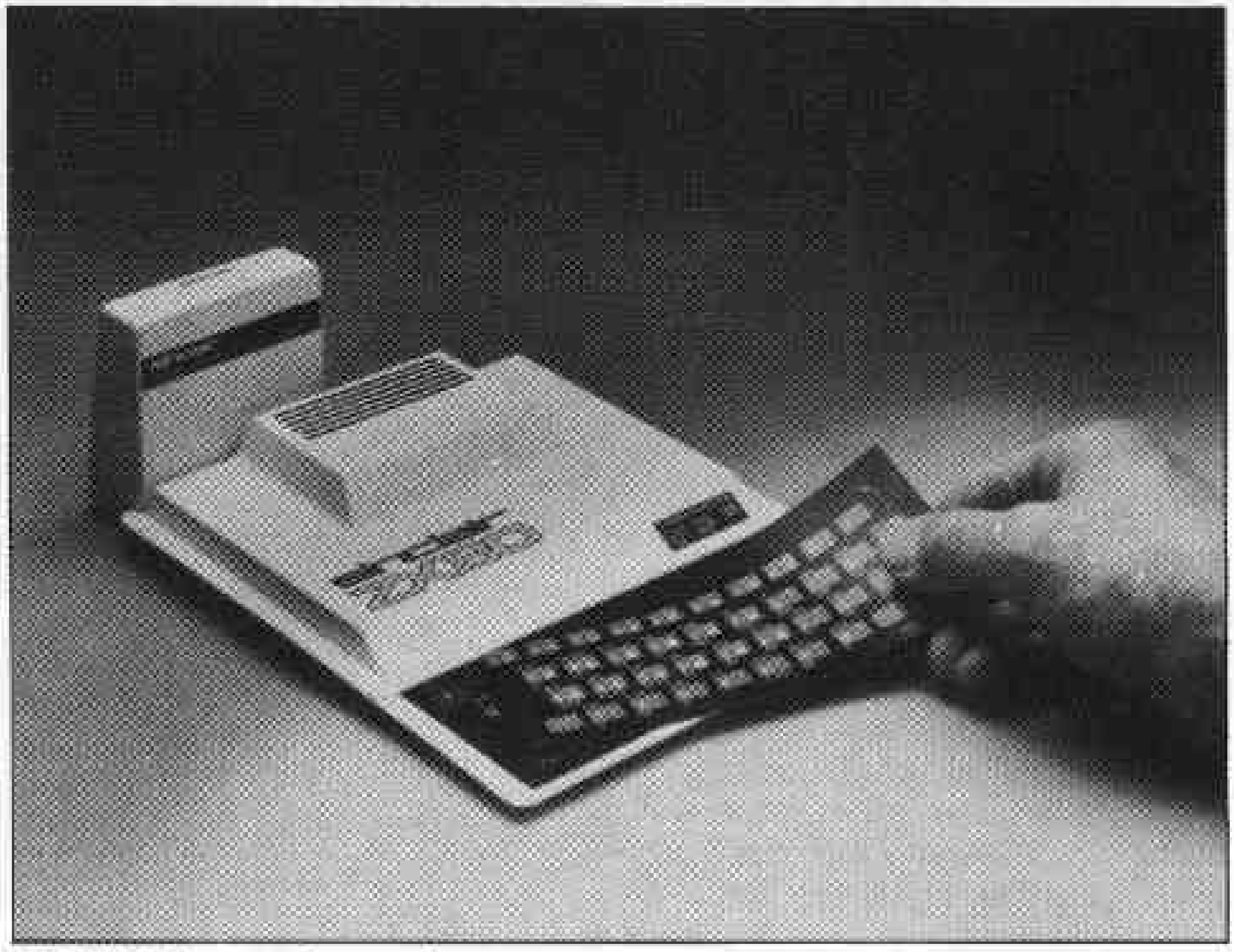
Always remove the power from the ZX-80 before switching ROMs. This not only stops damage to the ROMs, but also re-sets the ZX-80 so that at switch-on, the ROM will set the correct operating conditions for its Basic in RAM. Failure to do this will lead to the ZX-80 becoming stuck or a crash. The only way out of a crash is to re-set the ZX-80 by removing the power or if you have fitted a re-set switch, by pressing it.

As the first thing both ROMs do is to clear the memory from top to bottom, there is no way to transfer anything in memory between different ROM programs. So, 4K and 8K ROM programs can now be run on the ZX-80, but not together. So that you do not lose your program, always Save it before changing ROMs to run another.

I still find that the 4K ROM has advantages over the 8K ROM when writing some programs as, although it only has integer arithmetic, it is much more economical on memory than the 8K one. So, some programs are written in 4K ROM and some in 8K ROM, but the choice is at last mine. ■

*Figure 2. Fasteners.*



*The ZX-80 with a new Rom template.*

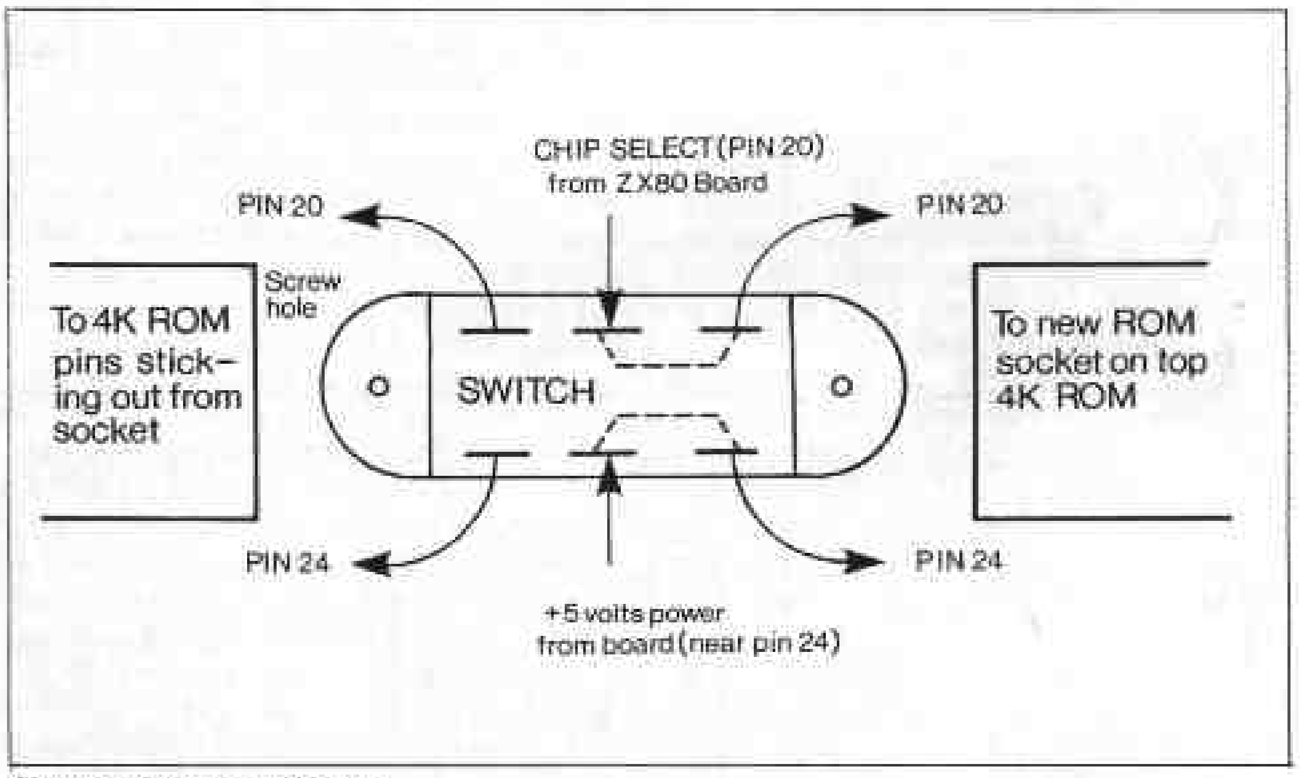
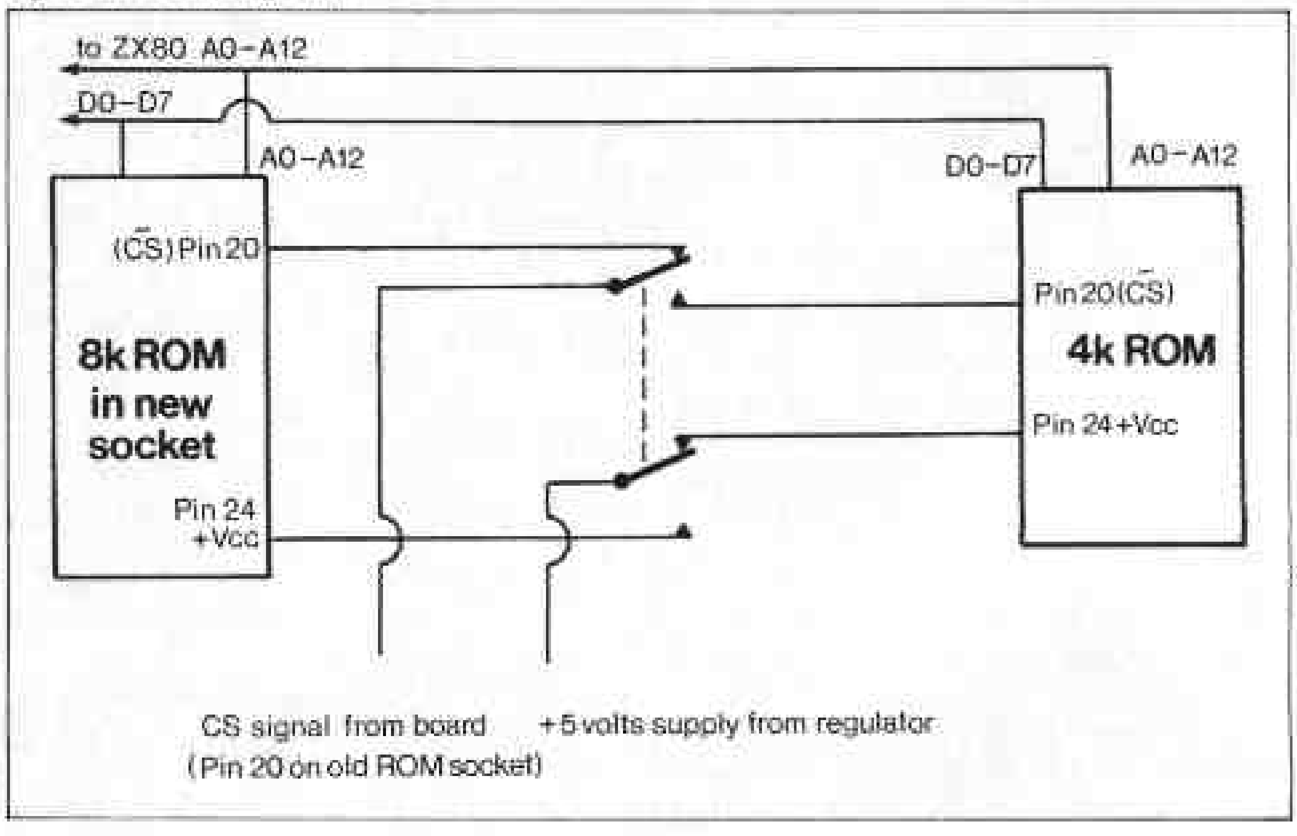



*Figure 3. Switch connections.*

*Figure 4. Circuit diagrams.*



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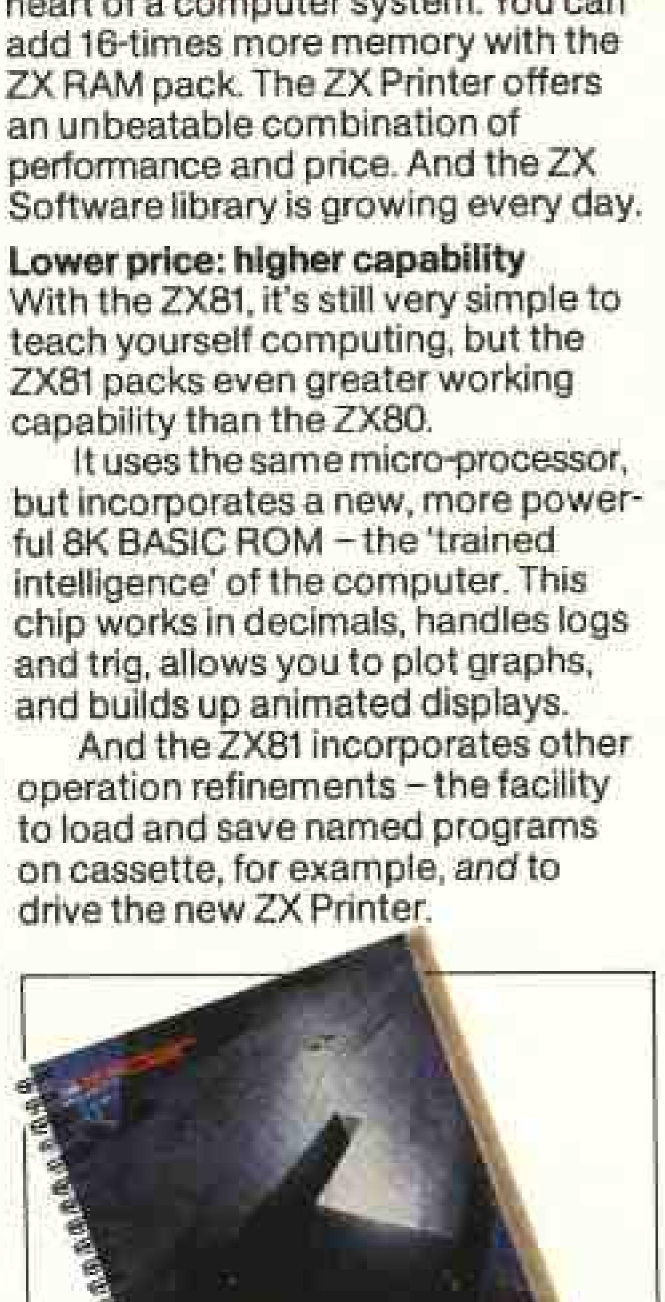


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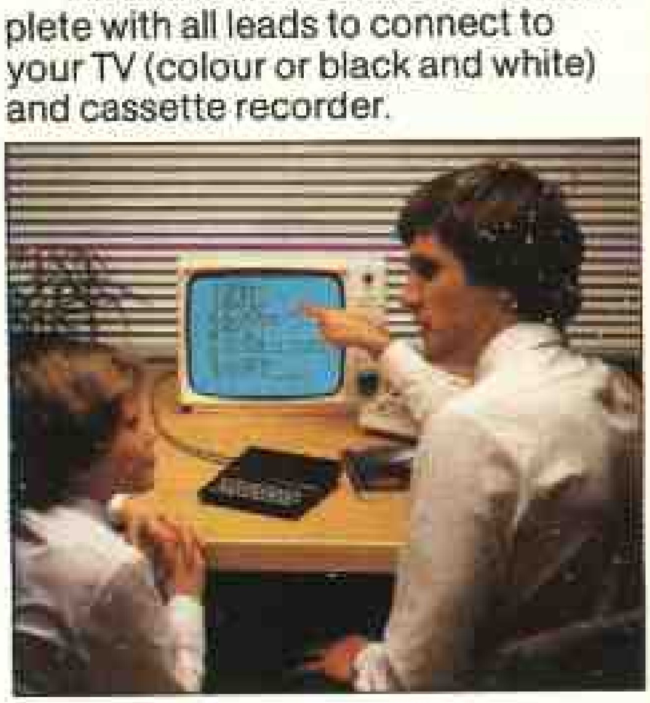

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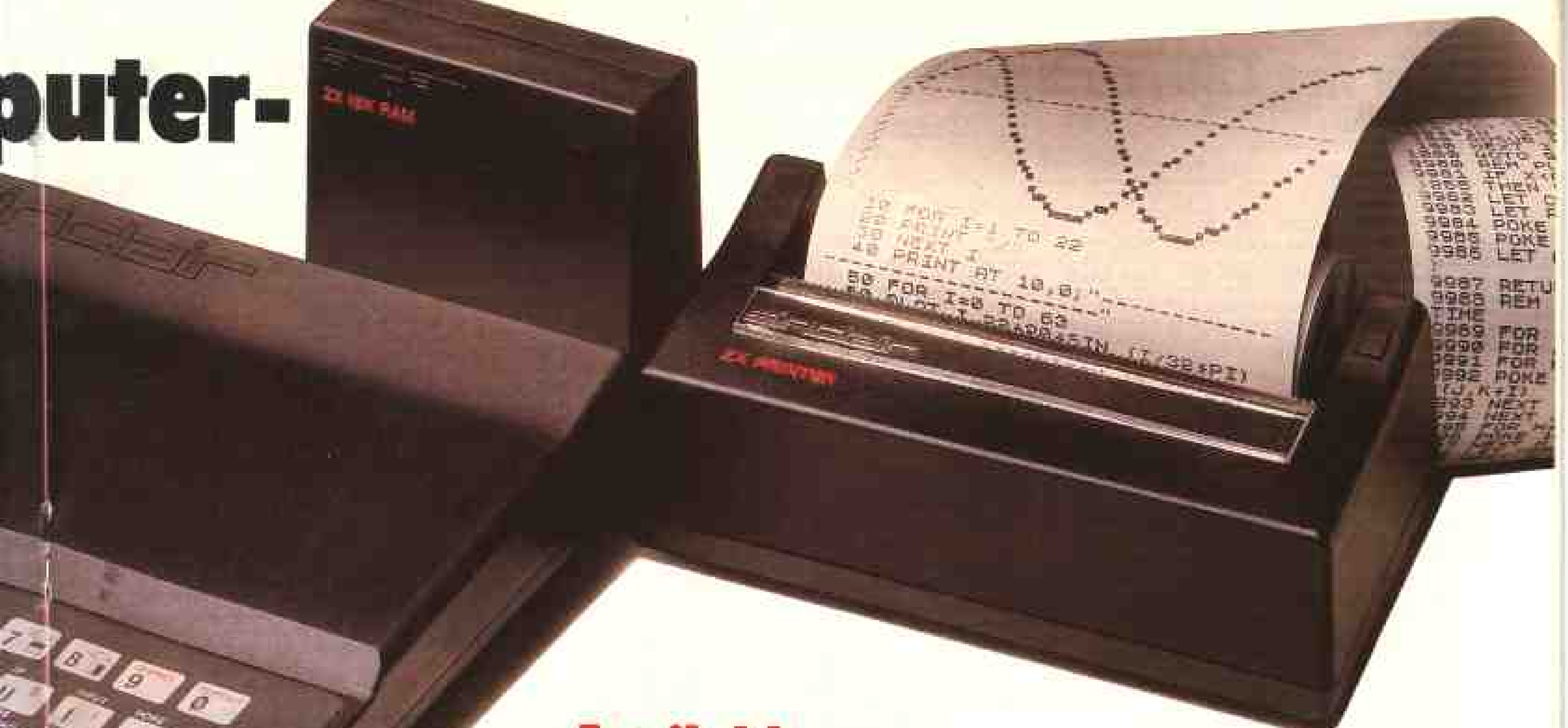

# How the ZX81 compares with other personal computers

| SYSTEM IDENTIFICATION | | ZX81 | ZX80 | ACORN ATOM | APPLE II PLUS | PET 2001 | TRS 80 LEVEL I | TRS 80 LEVEL II |
|---|---|---|---|---|---|---|---|---|
| ROM | | 8K | 4K | 8K | 8K | 14K | 4K | 12K |
| GUIDE PRICE | Basic unit – inc. VAT | £70 | £100 | £175 | £630 | £435 | £290 | £375 |
| | Unit plus 16K RAM (*12K RAM) | £120 | £150 | £285* | £630 | £530 | £360 | £375 |
| COMMANDS | LIST, LOAD, NEW, RUN, SAVE | ● | ● | ● | ● | ● | ● | ● |
| STATEMENTS | PRINT, INPUT, LET, GOTO, GOSUB/RETURN, FOR/NEXT IF/THEN | ● | ● | ● | ● | ● | ● | ● |
| | STEP | ● | | ● | ● | ● | ● | ● |
| | TAB | ● | | | ● | ● | ● | ● |
| ARITHMETIC | ABS, RND | ● | ● | ● | ● | ● | ● | ● |
| FUNCTIONS | INT | ● | | | ● | ● | ● | ● |
| | ATN, COS, EXP, LOG, SGN, SIN, SQR, TAN | ● | | | ● | ● | | ● |
| | ARCSIN, ARCOS | ● | | | | | | |
| STRING | CHR$ | ● | ● | | ● | ● | | ● |
| FUNCTIONS | LEN | ● | | ● | ● | ● | | ● |
| | ASC(CODE), STR$, VAL, INKEY$ | ● | | | | ● | | ● |
| NUMBERS | FLOATING PT ±10^±38 | ● | | | ● | ● | ● | ● |
| | INTEGERS | | ● | ● | ● | ● | | ● |
| NUMERIC | A-Z | | | ● | | | ● | |
| VARIABLES | AA-ZØ | | | | ● | ● | | ● |
| | An-Zn, n=any alphanumeric string | ● | ● | | | | | |
| STRING | A$ & B$ | | | | | | ● | |
| VARIABLES | A$ to Z$ | ● | ● | ● | | | | |
| | An$ to Zn$ n=any alphanumeric character | | | | ● | ● | | ● |
| NUMERIC | SINGLE DIMENSIONAL | | ● | ● | | | ● | |
| ARRAYS | MULTI DIMENSIONAL | ● | | | ● | ● | | ● |
| DISPLAY | ROWS | 24 | 24 | 16 | 24 | 25 | 16 | 16 |
| | COLUMNS | 32 | 32 | 32 | 40 | 40 | 64 | 64 |
| | LOW RES GRAPHICS (<7000 pixels) | ● | ● | ● | ● | ● | ● | ● |
| | HI RES GRAPHICS (>40000 pixels) | | | ● | ● | | | |
| SPECIAL | USR (CALL, LINK) | ● | ● | ● | ● | ● | | ● |
| FEATURES | PEEK, POKE (OR EQUIV) | ● | ● | ● | ● | ● | | ● |

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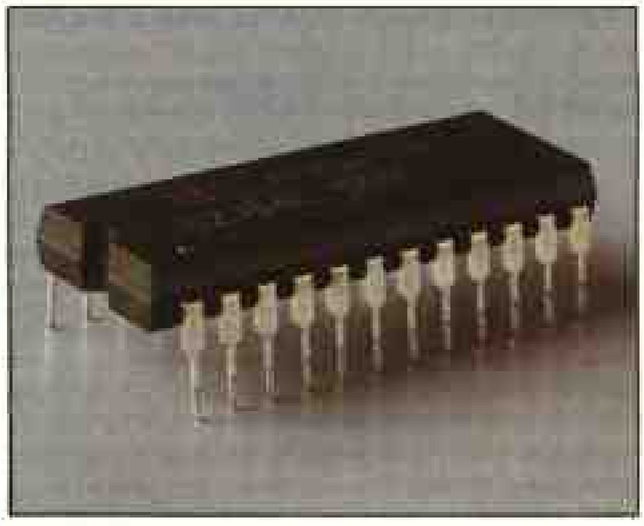

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# REVIEW

# MICROTAN 65

BY JOHN DAWSON

**The construction of the kit version of the Tangerine Microtan was described by John Dawson in *Your Computer* June/July 1981. This review covers the use of the Microtan central processor unit and Tanex boards.**

THE TANGERINE Microtan 65 is an excellent computer system both for laboratory/school use and for those who are learning about computing and/or who want a computer system which can be started for very little money and genuinely expanded at a rate that the user can afford.

The *Microtan companion* and the Toolkit EPROM — for which Microtanic Software has gained official approval from Tangerine — are indispensable additions to the system for anyone wishing to develop non-trivial software or who wants to know about the intricacies, the nooks and crannies of the machine and how it may be used most efficiently.

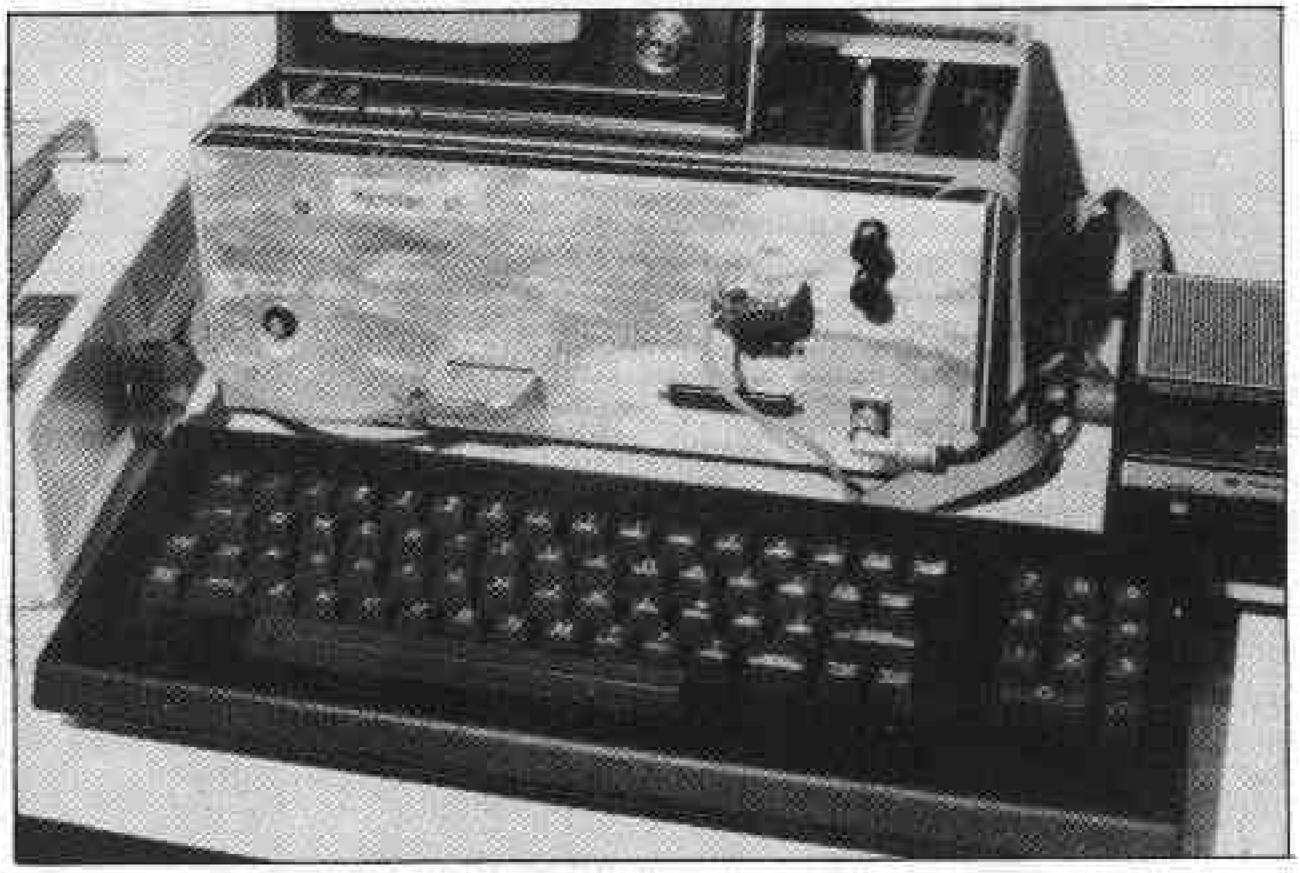
The Microtan computer system is constructed on a number of boards which plug into a rigid backbone or mother board. Figure 1 is a block diagram of the CPU card and Tanex, the expansion board. Both cards are necessary before the system can be expanded any further since the data bus is buffered on the expansion board. There are also dedicated links on the mother board from the CPU card to the Tanex. The remaining slots on the back plane are supplied by way of Tanbus lines.

Each board measures 20.3cm. by 11.5cm. and is connected to the back plane by a high-quality plug and socket. Half Eurocards will also accept the same connector and Vero make a half Eurocard prototyping board which can be plugged directly on to the Tanbus. The Eurocard dimensions are 10cm. by 16cm. and will fit into the system rack although, if it is to be supported by the rack slides, it will require a small amount of additional work.

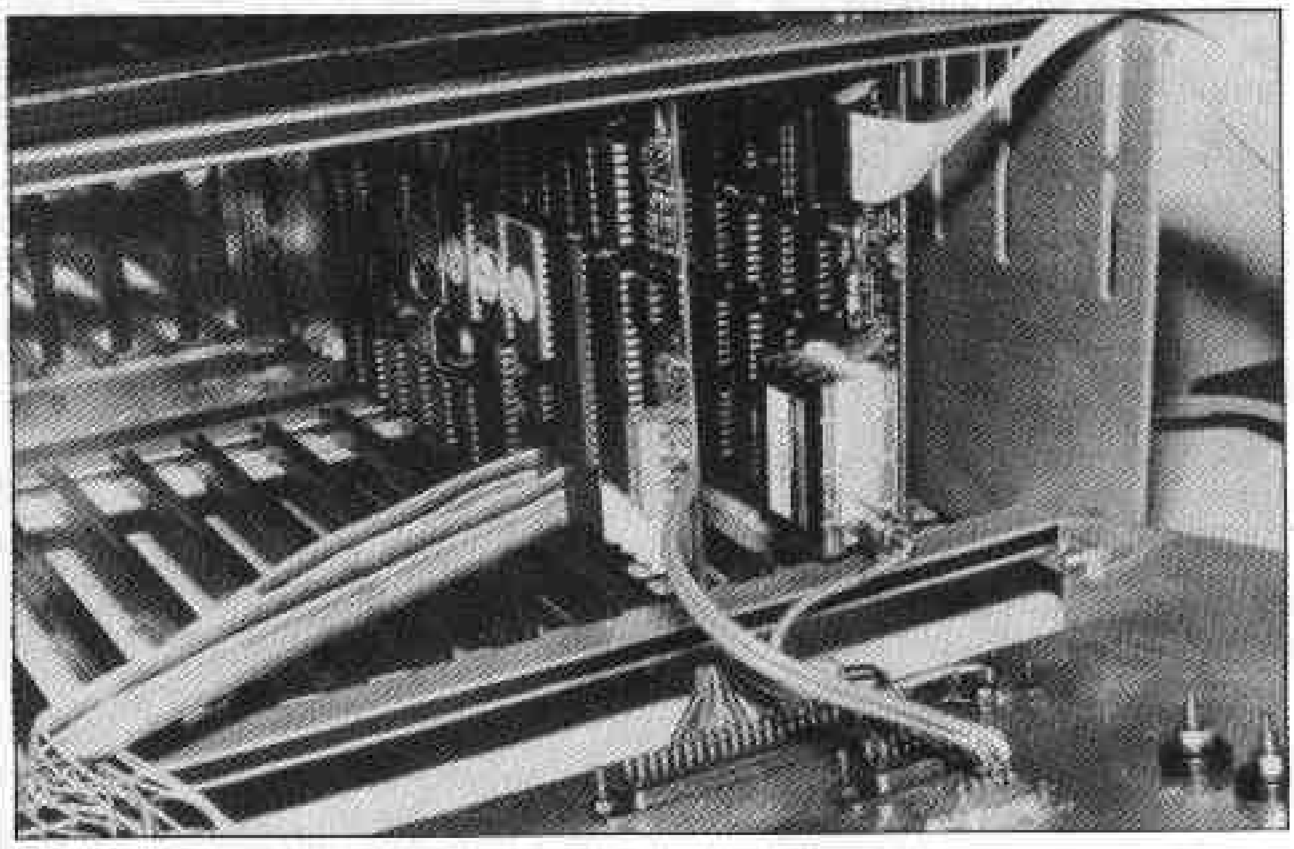
You can use the CPU board as a microcomputer in its own right — it has an input capability — either the alpha-numeric keyboard or the Hexadecimal keypad — and an output function — the UHF modulator which connects to a standard 625-line television aerial socket. It is, however, only possible to save data and programs on tape if the Tanex board is connected into the system.

The Tanbug monitor allows machine-code processing using the 1,024 bytes of RAM on the board. Half the RAM is used by the video-display logic to provide a memory-mapped

*(continued on next page)*



*Close view of Microtan 65 — note the excellent keyboard*



*Mounted Tanex and Microtan 65 cards*

*Figure 3. Graphics demonstration routine to produce a sine wave*

```
LIST

 10 £10,0: FOR J=1 TO 63
 20 £0,J,31+20 * SIN(J/5)
 30 NEXT J
 40 WAIT 49139,128
 50 £9,32
OK
```

*Figure 4. Routine displays zero-page activity on top half of screen*

```
L1FCF,8
1FCF A9 4C 85 10 A9 E9 85 11
1FD7 A9 1F 85 12 A9 C0 8D E8
1FDF BF 8D EE BF 8D E5 BF 4C
1FE7 48 FC 48 8A 48 A2 00 BD
1FEF 00 00 9D 00 02 E8 D0 F7
1FF7 A9 C0 8D E7 BF 68 AA 68
1FFF 40
```

*(continued from previous page)*

display of 32 columns by 16 rows. The type font produced by the character generator is unusually clear.

The second phase of the clock is used to avoid conflict between the CPU and the video logic and, consequently, the display is rock-solid without the snow on the screen which characterises less well-designed systems.

Additional integrated circuits to enhance the upper-case display are available from Tangerine and give lower-case letters and the ASCII graphics characters, and a set of 256 chunky graphics pixels 64×64=256. Again, for someone wishing to invest in a system at a price which corresponds to his spending power, this is convenient. The Microtan works perfectly with the original upper-case display and this can be enhanced by plugging in the extra chips as and when the user decides. No changes are necessary to the CPU board itself.

Figure 2 sets out the Tanbus connections — the lines which begin with DMA are intended for direct memory access and DMAPOT and DMAPIN establish a daisy-chain for setting priority of access in a DMA operation. There is both a non-maskable interrupt line and an open-collector interrupt request line.

The 6502 differs from the Z-80 CPU in that all input and output is memory-mapped and there are no separate I/O ports. An I/O line is provided on Tanbus so that you need decode only input/output addresses in the 1K I/O memory space rather than the full 65K address range.

Although it is not stated in Tangerine advertisements, the Tanram board which holds 40K of dynamic RAM can be paged by the new version of Tanbug, and the system rack, holding eight Tanram cards, can be expanded to a total core capacity of 328Kbytes.

Tanbug has evolved through a number of versions, of which the most recent is Tanbug 2.3. Tanbug is the machine-code monitor for the Microtan 65 and contains the fundamental input and output routines for the computer as well as the routines necessary for implementing the monitor commands.

At least 14 commands are available to the user — full documentation for the 2.3 version is being prepared — from either the Hexadecimal keypad or the full alpha-numeric keyboard. The commands, with a brief description of their function, are set out in table 1.

A major change in the new issue is the provision of software to drive a Centronics interface to a printer. The printer is turned on and off manually by typing Control P and data that is sent to the VDU is then echoed to the printer. The printer may also be switched on or off in a program by Basic instructions:

```
POKE 0, 144   turns the printer on
POKE 0, 128   turns the printer off
```

Command of the printer depends on one bit in memory location 0 and it would be better practice to logically-And the bits in the location, but the Poke instruction works well.

Tanbug is an elegant, logical and easy-to-use monitor. The terminator keys — carriage return, line-feed and escape — are used when modifying a memory location to execute a command and return to the main monitor, execute a command and proceed to the next higher memory location, and execute a command and return to the previous location.

These actions are carried through consistently into the editing commands for the Basic interpreter. The line-feed key, for example, updates the current line of Basic and then opens the next line for further editing. Uniformity of the system commands is part of the dialogue design standards which are a crucial element in making a computer friendly to the person who uses it.

The heavy manual supplied with the Microtan 65 CPU board lists the monitor software and gives, among many other things, details of Tanbug and examples of how routines in the monitor can be built into programs written by the user.

Xbug is a 2716 EPROM which contains cassette file-handling routines, and a simple assembler/disassembler package. The Tanbug monitor recognises the presence of Xbug on the Tanex board and the Xbug facilities can be accessed directly by monitor commands. The Xbug commands are described in table 1 and it seems a shame that the cursor and terminator keys could not have been standardised completely with the rest of the software.

The line-by-line assembler — Translator — and disassembler allow you to type standard 6502 assembler mnemonics. When the Microtan receives a carriage return, the line is checked for errors in the syntax and then translated into machine code.

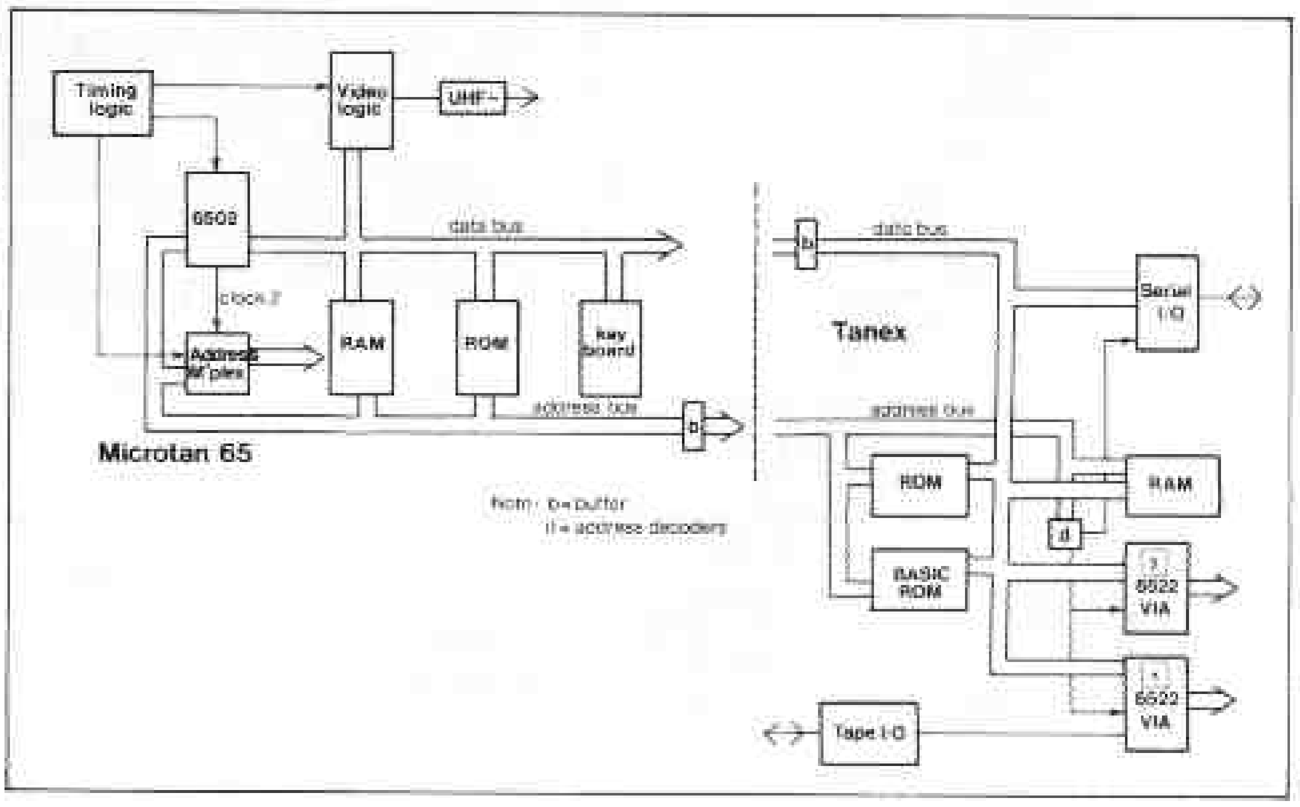
There is a considerable saving in effort compared to entering the same instructions in machine code. The spacing of the op-code and other fields on the line is important. The free format acceptable to Zen and other, more sophisticated assemblers is not permitted. In the same way, there is no provision for labels and it is not possible to store the source code on tape for later editing.

The disassembler — Interpreter — coexists with the assembler and will recreate 6502 mnemonics from machine code; jump instructions and subroutine calls display the absolute address to which the jump will be made. Once again, it is not possible to edit the disassembled lines. The fact that the two

| Command | Function |
|---|---|
| RESET | Initialise system and display Tanbug mesage |
| Mxxxx | Modify memory at Hexadecimal address xxxx |
| LF | Step up through memory |
| esc | Step down through memory |
| space | Re-open currently-displayed memory location |
| cr | Close currently-displayed memory location |
| Lxxxx,y | List y lines of memory starting at address xxxx |
| Gxxxx | Go, begin program execution at address xxxx |
| R | Display pseudo-processor register locations |
| S | Set single-step mode |
| N | Return to normal mode — clear single step |
| P | Proceed, past break-point or next instruction — single step |
| Bxxxx,y | Set break-point number y at location xxxx |
| B | Clear breakpoints |
| Oxxxx,yyyy | Calculate offset between addresses xxxx and yyyy for branch instruction |
| Cxxxx,yyyy, zzzz | Copy block of memory starting at xxxx to yyyy to zzzz |
| Cntrl P | Switch on/off parallel printer |
| Cntrl V | Switch on/off serial printer |
| Cntrl S | Switch on/off screen |
| Cntrl L | Clear screen — in Basic |
| BAS | Basic cold-start |
| WAR | Basic warm-start |
| C | Set CUTS standard cassette speed — 300 Baud |
| _f | Set fast cassette speed — 2,400 Baud |
| Dxxxx,yyyy, zzzzzz | Dump to tape from xxxx, to yyyy, using file name zzzzzz |
| Fxxxx,yyyy, zzzzzz | Fetch from tape from xxxx, to yyyy, using file name zzzzzz |
| Exxxx,yyyy, zzzzzz | Examine, verify, from xxxx, to yyyy, using file name zzzzzz |
| Txxxx | Enter Translator — assembler — at address xxxx |
| Ixxxx | Interpret — disassemble — from address xxxx |

*Table 1. The Tanbug commands*

*Figure 1. Block diagram of Microtan and Tanex boards*



| b | a | |
|---|---|---|
| +5 | +5 | 1 |
| CLK | DMAREQ | 2 |
| 01 | 02 | 3 |
| RST | I/O | 4 |
| A1 | A0 | 5 |
| A3 | A2 | 6 |
| A5 | A4 | 7 |
| A7 | A6 | 8 |
| A9 | A8 | 9 |
| A11 | A10 | 10 |
| A13 | A12 | 11 |
| A15 | A14 | 12 |
| DMAGNT | IRQ | 13 |
| FB | NMI | 14 |
| DMAPOT | DMAPIN | 15 |
| IOE | RAME | 16 |
| ROME | R/W | 17 |
| SYNC | HB | 18 |
| | DB0 | 19 |
| | DB1 | 20 |
| | DB2 | 21 |
| | DB3 | 22 |
| | DB4 | 23 |
| | DB5 | 24 |
| | DB6 | 25 |
| | DB7 | 26 |
| | | 27 |
| | | 28 |
| | | 29 |
| +12 | +12 | 30 |
| −12 | −12 | 31 |
| GND | GND | 32 |

*Figure 2. Tanbus connections*

packages are permanently in the system and can be called instantly by a single-letter command reduces some of the disadvantages I have mentioned.

Why do you need to keep source code on tape when machine code can be stored, read back into the computer and disassembled instantly? However, the lack of the facilitiy to introduce new lines of code into a program displacing the rest of the program upwards, and re-computing any relative or absolute jump instructions is a noticeable limitation.

The Translator calculates relative jumps automatically and is probably worth having for that reason alone, as it requires less keyboard work and thought than the Offset command in the monitor.

The hardware and software combination in the Microtan 65 for dumping and fetching data to and from cassette tapes is extremely reliable at the standard Computer User's Tape System, CUTS, speed of 300 baud. The high-speed Tangerine format runs at 2,400 baud and requires more careful adjustment of the volume control level and a little more care in choosing a suitable cassette recorder. There is, of course, a test program in the Xbug manual.

The Basic interpreter for the Microtan 65 is supplied in three ROM chips which plug into the Tanex board. The interpreter occupies 10Kbytes and uses Xbug for the tape input and output routines. The Basic users' manual supplied by Tangerine with the interpreter integrated circuits has more than 80 pages of well thought-out and presented information.

The text is interspersed with many examples and would be a good general teaching manual for Basic. The value of the manual is increased in comparison to other Basic interpreters and has been written in English for a U.K. computer.

You do not have to cope with U.S. witticisms or translate the text from the Kim, Sym, Aim and Apple, Pet system specific tracts. The examples range from an immediate print statement:

PRINT 1/2, 3*10 (*means multiply, / means divide)

to the derivation of trigonometric functions such as the hyperbolic and inverse hyperbolic ratios and a simple routine for sorting lists of string data.

The examples are pure in that they are intended to show how the Basic language works rather than to demonstrate specific applications for the machine. The machine does not have the Acorn Atom's instant facility for entering assembler/machine code; nor are there instructions such as 'Print Using', If-Then-Else, or Print @.

Deek and Doke are absent and you cannot directly open and close a data file on tape. I confess that none of these omissions is particularly worrying or limiting except perhaps the If-Then-Else instruction, which I can achieve in any case with one extra line in a program.

On balance, I think that the machine's advantages lie with orthodoxy particularly when the *Microtan companion* book is available for those who wish to adopt a radical approach to their programming. The techniques in the *Microtan companion* for extending the machine-code call instruction, USR (I), should keep many people occupied for a considerable time.

The *Microtan companion* and the EPROM Toolkit give an extra dimension to the Tangerine Microtan. The EPROM contains a number of extraordinarily useful additional commands including, among others:

| | |
|---|---|
| Control A | Clear screen and set alpha mode |
| Control G | Clear screen and set graphics mode |
| Control N | Autoline numbering |
| Append | Append a named file from tape |
| Re-number | Re-numbers lines, Goto and Gosub instructions |
| Control Z | Calculates a decimal number from an entered Hexadecimal number |
| # 0 to # 10 | Powerful machine-code graphics routines |

The Append command is worth the price of the chip alone as it makes serious programming possible by the development of subroutines which can be stored on tape and then incorporated into other programs at a later date. For example, I shall store a standard set of printer routines on tape for use with an Epsom MX-80 F/T.

The graphics instructions are another giant leap forward for Tangerine owners. The routines are very fast and flexible, the VDU can be filled faster than your eye can twinkle and figure 3 is a listing of a demonstration program.

Having started by saying grandly that the Tangerine system reminds me of fine equipment, it is a little embarrassing to have to confess that the first integrated circuit containing the new Tanbug 2.3 which I received appeared to be faulty. Even Rolls Royces go wrong sometimes and then malfunctions occur; it is the attitudes of the manufacturer which are vitally important.

I have visited many small computer companies and there is an enormous diversity of management styles and staff attitudes. Some are disorganised, others are autocratic and repressive, others are friendly and enthusiastic. When I visited Tangerine I liked the attitudes as well as any I have seen anywhere. It should be self-evident that staff motivation and attitudes to work are an integral part of running a business successfully. ■

## CONCLUSIONS

- The next product from Tangerine will be the Tangerine Tiger, which may be a packaged twin processor computer aimed at the domestic rather than the laboratory/hobby markets.
- External expansion from the Tiger may be by connection to the Microtan range of cards.
- Such a logical expansion based on bus compatibility between the Tiger and the Microtan would provide peace of mind for anyone who is considering buying a Microtan 65.
- Apart from its successful sales figures, the company's future plans are based on a complementary development of another system rather than the production of a second changed model of the Microtan.
- A high-resolution board offering 256 by 256 points and black-and-white graphics should be available soon and a disc operating system is also under development.
- Finally, you may like to try a program from the *Microtan companion* to whet your appetite for the book.
- Figure 4 is a machine-code program which displays the zero-page activity on the top half of the screen when another program is running: the machine-code instructions use a 6522 VIA in the second socket on the Tanex board.
- Enter the code, execute the program by G IFCF and enter Basic; protect the program by answering 8100 to "Memory Size?" and then be fascinated.
- Both the Toolkit and the *Microtan companion* enhance what is already a most attractive computer.

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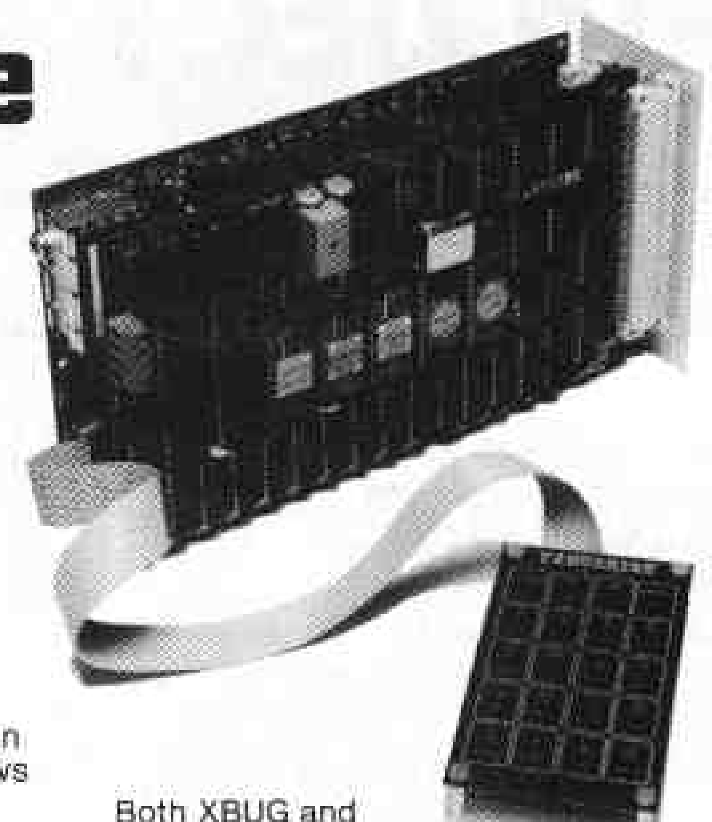

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For absolute beginners we can supply an easy to use 20-way Hex keypad; for the more experienced user there is a full typewriter style ASCII keyboard. Either way, Microtan will work out exactly which type you are using and act appropriately.

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- ★ 1 Serial I/O port
- ★ XBUG
- ★ Cassette Interface

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**XBUG and BASIC**

XBUG is a 2K extension to TANBUG that contains a mnemonic assembler and disassembler and cassette firmware running at 300 Baud CUTS, standard or high speed, 2400 Baud Tangerine standard with 6 character filenames. Tangerine have taken out a full O.E.M. licence for Microsoft BASIC, the microcomputer industry standard, this is a full feature implementation with interrupt and machine code handling, and a superb program editor.

Both XBUG and BASIC plug directly into Tanex and are supplied with comprehensive user manuals.

**Parallel I/O**

When fully expanded Tanex includes two V.I.A.s (Versatile Interface Adaptors) which implement the cassette interface and the parallel I/O ports. Software in TANBUG V2.3 enables you to plug in and use a Centronics type printer. The two V.I.A.s also contain counter timers that can be used for a variety of applications enhanced by the use of the integral handshake facilities.

**Serial I/O**

Also on the expanded board is a serial I/O port that can be used to interface RS232 or 20Ma loop terminals or VDU's, again all controlled by TANBUG V2.3.

Whether Tanex is purchased in a minimum or maximum configuration, Tanex will buffer the data bus and configure the system memory map for maximum expansion.

To complete Tanex, a comprehensive user guide is supplied which contains full constructional details. This manual is also available separately.

**TANEX options**

10K extended MICROSOFT BASIC
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Extra RAM (2114s)
XBUG
6522 V.I.A.
2716 EPROM for your own software

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# PROJECT

# CONTROLLING ELECTRIC

**In his last article John Dawson showed how a radio-controlled transmitter and receiver could be used with a computer, and built a radio-controlled pen recorder. Having shown in principle that a computer can be used as a remote device he now explains how DC electric motors can be controlled.**

THE CHARACTERISTICS of shunt and series-wound DC motors can be complex. In them, electromagnets are used to generate a magnetic field inside which the rotor spins. The development of magnets made from rare-earth ceramic materials has produced far greater field strengths. Permanent-magnet DC motors are now used in many applications which would not have been feasible 10 or 15 years ago.

The concurrent development also of large power transistors, Darlington power transistors and, most recently, power field-effect transistors, FETs, permits the regulation of DC motors by using techniques such as pulse-width modulation, PWM, of the voltage applied to the motor.

New DC permanent-magnet motors are still expensive, but the excellent high-torque motor illustrated is available at a cost of £3 to £5. The motor is a windscreen wiper motor from a Datsun 120A and I obtained it from a car breakers.

The motor runs on 12V, can be reversed by reversing the polarity of the applied voltage, weighs 1kg. and consumes slightly less than 1 amp with no load. There are three brushes on the commutator inside the motor which are set at different angles, and various speeds can be achieved by switching the power supply between them.

The output shaft of the motor drives a worm-reduction gear which has a ratio of approximately 80:1 which slows the final shaft output speed to between 40 and 60 revolutions per minute, rpm. The gear driven by the worm is made of plastic, and inside the housing for the reduction drive there are two contacts which are connected when a metal segment on the plastic gear rotates past them.

At the output shaft, the motor has considerable torque. When the motor is stalled, which is impossible by gripping the shaft, the current consumption rises to between 3 and 4 amps.

The output shaft on the motor in the illustration is just under 2.5cm. — 1in. — long, which is unusual and makes this model much simpler to use. The wheel in the photograph is 15cm. in diameter — 6in. — and is available from many hardware shops. It is intended as a replacement wheel for domestic appliances and children's toys.

The wheel is a loose fit on the output shaft from the motor and if the retaining nut from the windscreen wiper motor shaft is forced into the hub of the wheel, a mechanically-inelegant but practical connection may be made.

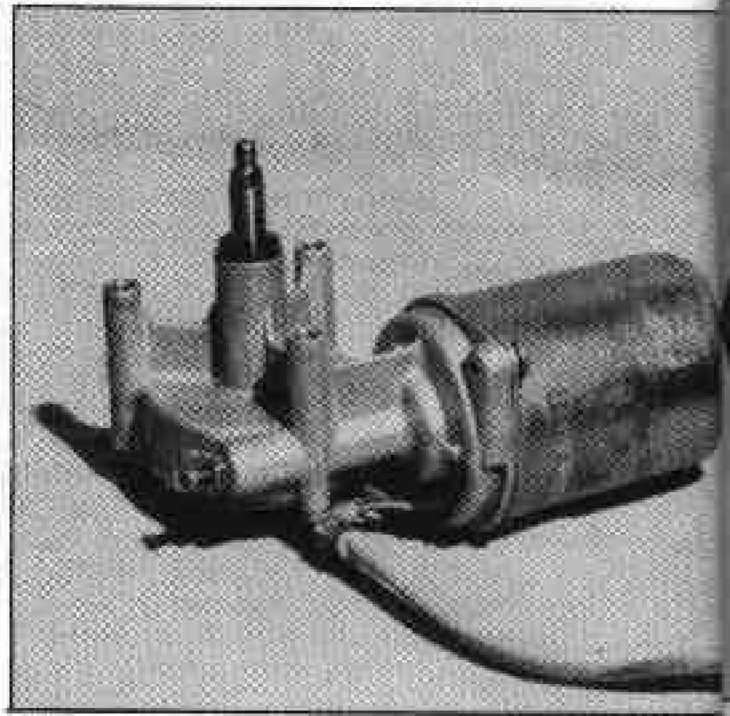
When the motor unit is mounted as one of two drive units on a remotely-controlled trolley, it will need a pin through the wheel hub and the axle to transmit both forward and reverse drive.

The Acoms AP-435 digital proportional radio-control system, which serves as our radio-control interface, was described in the last article. The servos used as actuators for model control are connected to the receiver by three wires. The red and black wires carry power from the 6V receiver battery to the servo and the control signal is transmitted as a series of variable width pulses down the third, white wire.

Figure 1 illustrates the PWM signal that sets the output from the servo. The horizontal scale in the figure is distorted to emphasise the change in width of the signal pulses.

Within the 20ms. period, a pulse for each of the four proportional channels is transmitted. One of the purposes of the receiver is to demultiplex the incoming stream of digital information, routeing information from the correct input channel, used for joystick movement, on the transmitter to each servo.

Clearly, the transmitter will need to send some information with each package of control data to synchronise the receiver. Taking into



*The motor*

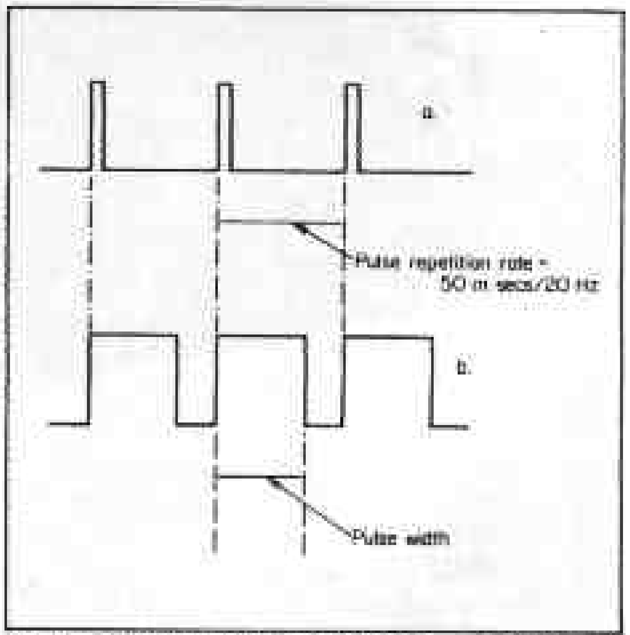
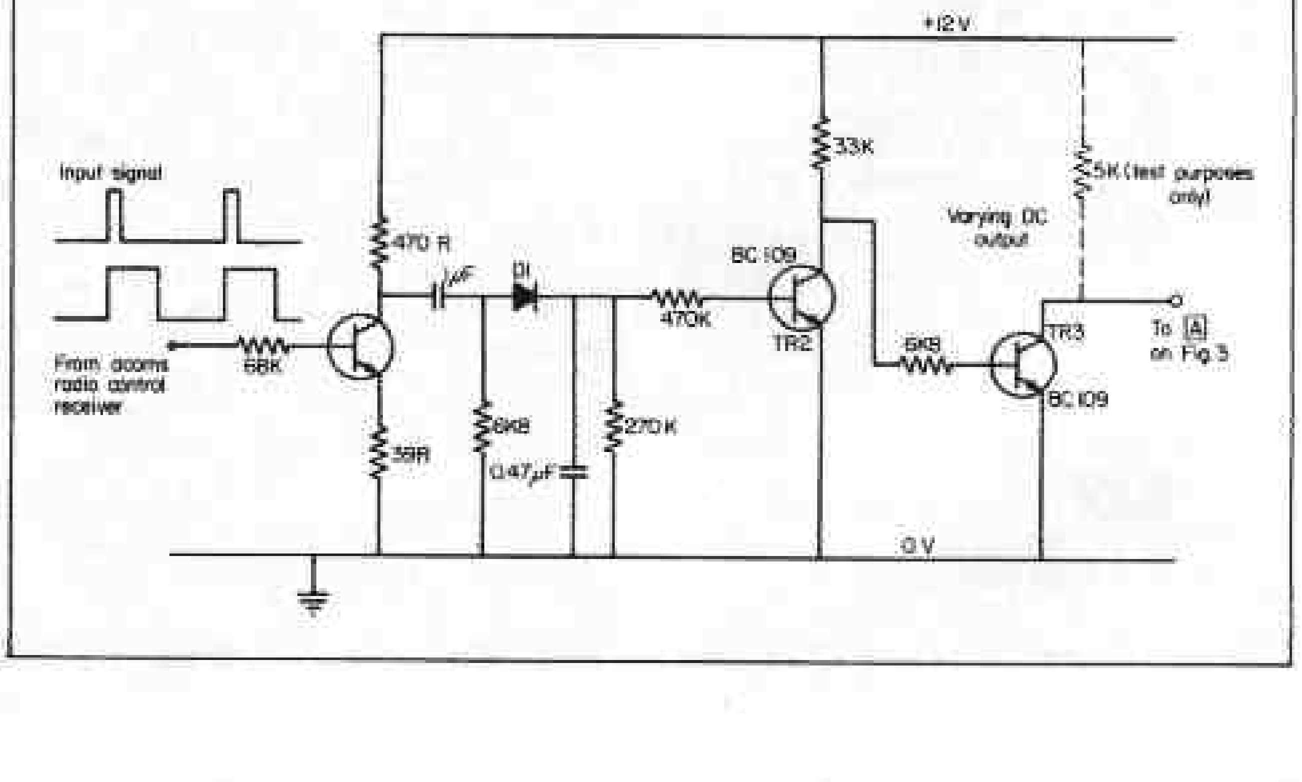
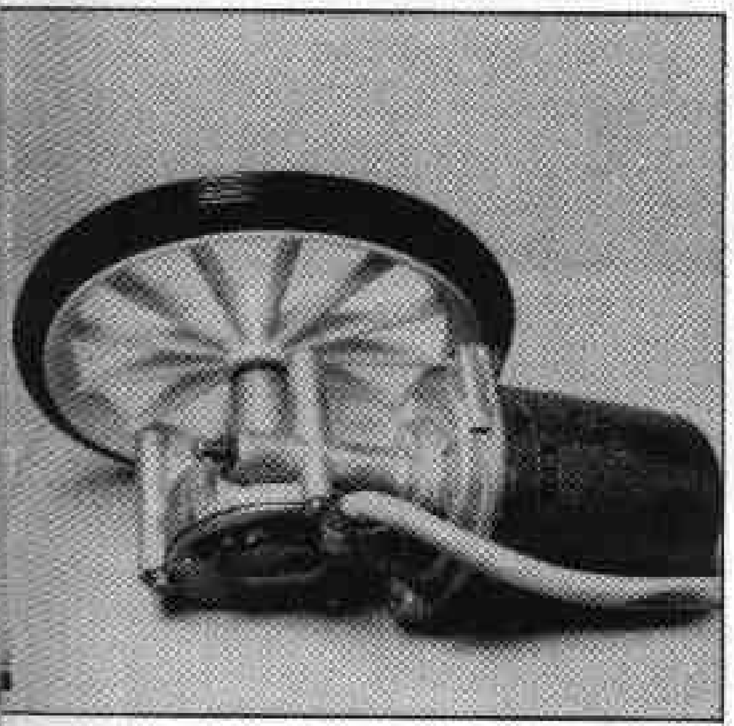



*Figure 1. Pulse width modulation — one channel output from radio control receiver*

*Figure 2. Radio control PWM to analogue interface*



# C MOTORS



*The motor with wheel attached*

account the fifth output socket on the radio-control receiver, you might expect that the maximum pulse width from one channel would be between 3 and 4 ms. — 3.5 × 5 = 17.5ms. total.

In fact the pulse width varies from 0.5ms. to 3.5ms. when the input to the transmitter encoder chip is connected to ground or +5V respectively.

The pulse stream output from the radio-control receiver cannot be used directly to control a motor as the duty cycle varies over a limited range — 0.5 to 3.5ms. repeated every 20ms. equals 2.5 percent to 17.5 percent. Effective PWM of a DC motor requires a duty cycle which is variable from close to zero to 100 percent.

Figure 2 is the circuit diagram for an interface to convert the PWM signal from the radio-control receiver to an analogue DC output at the collector of TR3. To test the circuit on its own, a load of approximately 5,000 ohms should be connected between the collector of TR3 and the +12V supply line.

The transistor types should not be critical in this application and most small-signal NPN transistors should work successfully. Using the joystick on the radio-control transmitter — varying the width of the receiver output pulse from 0.9ms. to 1.7ms. — I obtained a swing in the collector voltage of TR3 of 2 to 7V.

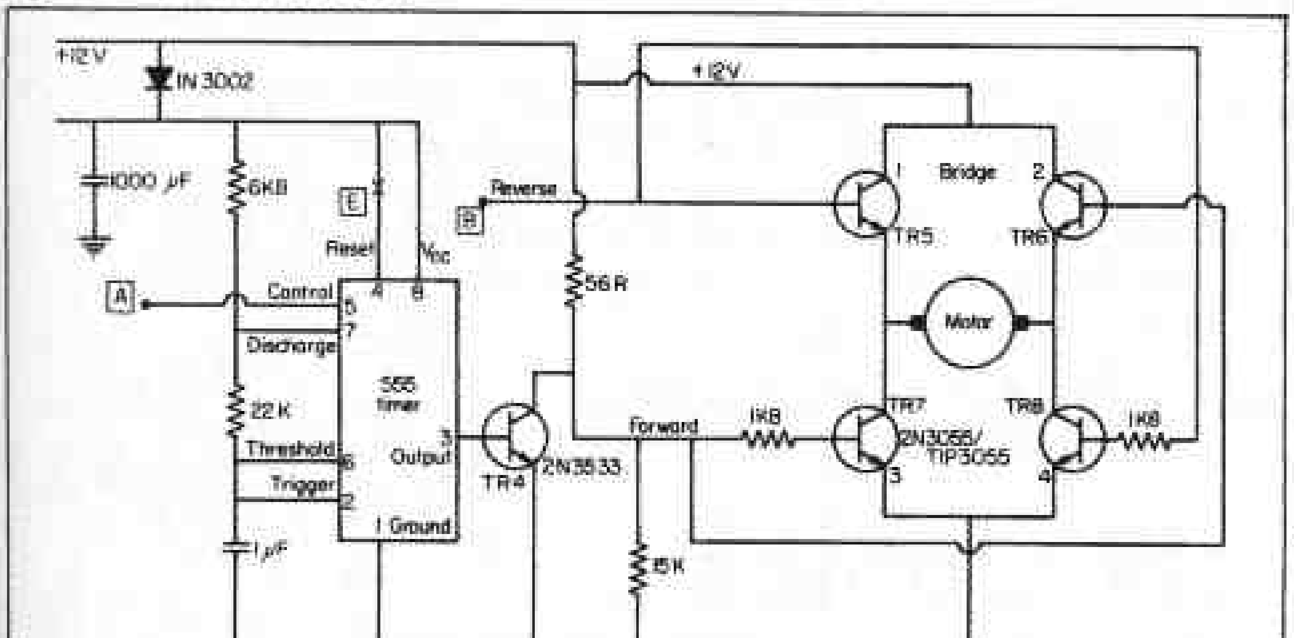
Figure 3 shows the circuit I used to vary the power applied to the windscreen wiper motor. Four TIP3055 NPN power transistors, equivalent to 2N3055, are connected in a bridge and must be arranged so that either transistors 2 and 3 are conducting, which drives the motor in one direction; or transistors 1 and 4 conduct, driving the motor in the reverse direction.

The transistors on the same side of the bridge, i.e., 1 and 3, must never be allowed to conduct simultaneously as this will short-circuit the power supply and burn out the transistors.

The 555 timer IC is connected as a free-running oscillator with a variable mark/space ratio. In other words, the period of time for which the timer is turned off is constant while the time for which it is turned on can be varied by changing the DC voltage applied to pin 5.

The arrangement shown in the circuit diagram is unsophisticated and cannot have an ideal duty cycle from zero to 100 percent. A more complex circuit utilising a dual timer, the 556 made by several manufacturers, could be constructed in which one half of the IC generates a constant-width pulse when it is triggered by variable-frequency pulses from the other half of the chip.

*Figure 3. Motor interface circuit*




In my experience, the minimum period for which the motor is turned on should be not less than about 50ms. to take account of the inertia of the rotor.

The fixed-space period in the simple circuit cannot be overcome by increasing the frequency at which the 555 chip operates since the mark period also shortens, and the point is reached at which the motor turns sluggishly while singing quietly to itself at the frequency of the applied modulation. This is unsatisfactory.

The IN3002 diode is intended to prevent voltage surges caused by the motor from interfering with the operation of the timer. Despite adding a 7812 voltage regulator IC to the positive supply line to the timer, there are conditions using the radio-control interface in which the system locks up, turning either full on or completely off.

I expect that replacing the 1,000 μfarad smoothing capacitor with a 20,000-30,000 μfarad capacitor will help. Putting the motor drives on to a trolley powered by a car battery should reduce the problem, and the battery has a lower internal resistance than the mains power supply used for the initial construction and testing.

The motor can be reversed by applying the PWM signal to point B which will turn on transistors TR5 and TR8 — 1 and 4 in the bridge. Probably the simplest way to achieve this is to duplicate the 555 or 556 timer circuit for the reverse input to the bridge, breaking the pin 4 connection at E and connecting the re-set pin on each timer to alternate outputs on a 7474 flip flog IC — see figures 4 and 4a.

Using the Q and Not-Q outputs will guarantee that both arms of the bridge cannot be turned on at the same time and the motor can be reversed by putting a pulse into the clock input on the 7474 chip.

Alternatively, it should be possible to gate the stream of pulses from one 556 to either the forward or reverse inputs to the bridge using a flip-flop and some simple TTL 7400 Nand gates. The DC voltage which varies the frequency of the timer is applied at point A and could be derived from a local sensor as well as the remote computer.

For example, the classic tortoises built by Dr Grey-Walter had only two sensors — a rotating photocell on the top of the tortoises' "shell" and a sensor to detect a collision. Yet two of the machines would generate quite

*(continued on page 53)*

(continued from page 51)
complex behaviour when put together in a room, approaching each other and then retreating or circling.

Returning for a moment to figure 1 clarifies one aspect immediately — the servos used by Acoms can be controlled directly by the Microtan. The 6522 Versatile Interface Adaptor, 6522 VIA, contains timing circuits which can be used to generate variable-width pulses depending on data values stored in the appropriate memory locations. It should be a simple matter to run the pen recorder or many other devices directly from a Basic program in the Microtan.

The Tanex expansion board for the Tangerine Microtan computer uses the 6522 VIA to implement two eight-bit, bi-directional, parallel data ports, two 16-bit programmable timer/counters and a serial TTL data port. The board has sockets for two VIAs.

The 6522 VIA is truly a remarkable integrated circuit with more different functions built in than the Z-80 parallel input/output chip, PI/O. A block diagram of the 6522 IC — figure 5 — illustrates the internal organisation of the chip. The parallel ports allow each bit to be set up as either an input or an output by loading a profile or mask into the data direction register — DDRA/DDRB.

The second timer, T2, operates as an interval timer when a control bit is set in the auxiliary control register. The counting period for the timer is established by loading data using a write-T2C-H operation after the low byte has been loaded by "write T2L-L". Approximate outside values for the range of pulse length required — 0.5 to 3.5ms. — will be 325 decimal to 2250 decimal. The timer is triggered by the write-T2C-H operation.

The first timer, T1, consists of two eight-bit latches and a 16-bit counter. This timer can be programmed to act as a free-running variable-frequency oscillator. A number to control the width of the output pulse can be loaded into the low-byte latch and when a second number is written into the high-byte latch with a write-T1C-H operation, the data from both the latches is transferred to the 16-bit counter and the timing process started.

The counter is decremented at the system clock rate of 750kHz. When the counter passes zero an interrupt is generated and can be used to initiate a write operation to the high byte of timer 2 and, consequently, to produce an output pulse which will recur 20ms. later.

The circuits and devices in this article are not glossy, finished products — they work, certainly, but are intended primarily as a source of ideas on which you can build and explore. Unfortunately an oscilloscope is almost essential for examining variable pulse widths but it does not need a sophisticated specification to cope with the pulse trains produced by these circuits. The only other test instruments I have used are a 20,000 ohm/volt multimeter and a resistance substitution box.

It is very easy to imagine that something you wish to achieve can be done only with exactly the required tools, and the expansionist era of the 1950s and early 60s in the universities and other sectors of education tended to reinforce the philosophy that you had to have the proper equipment to conduct good research.

Yet an earlier generation of scientists were used to adapting what was often military surplus equipment. Many great men such as Faraday or Rutherford were used to constructing their own apparatus. When Lord Rayleigh was separating the rare gases from nitrogen he needed a dry room in which to carry out an experiment and he hung freshly aired blankets around the walls of his laboratory.

Resourcefulness of this nature can allow the production of effective equipment from simple materials whose original design often have no direct relevance. ■

Figure 4. Connection diagrams

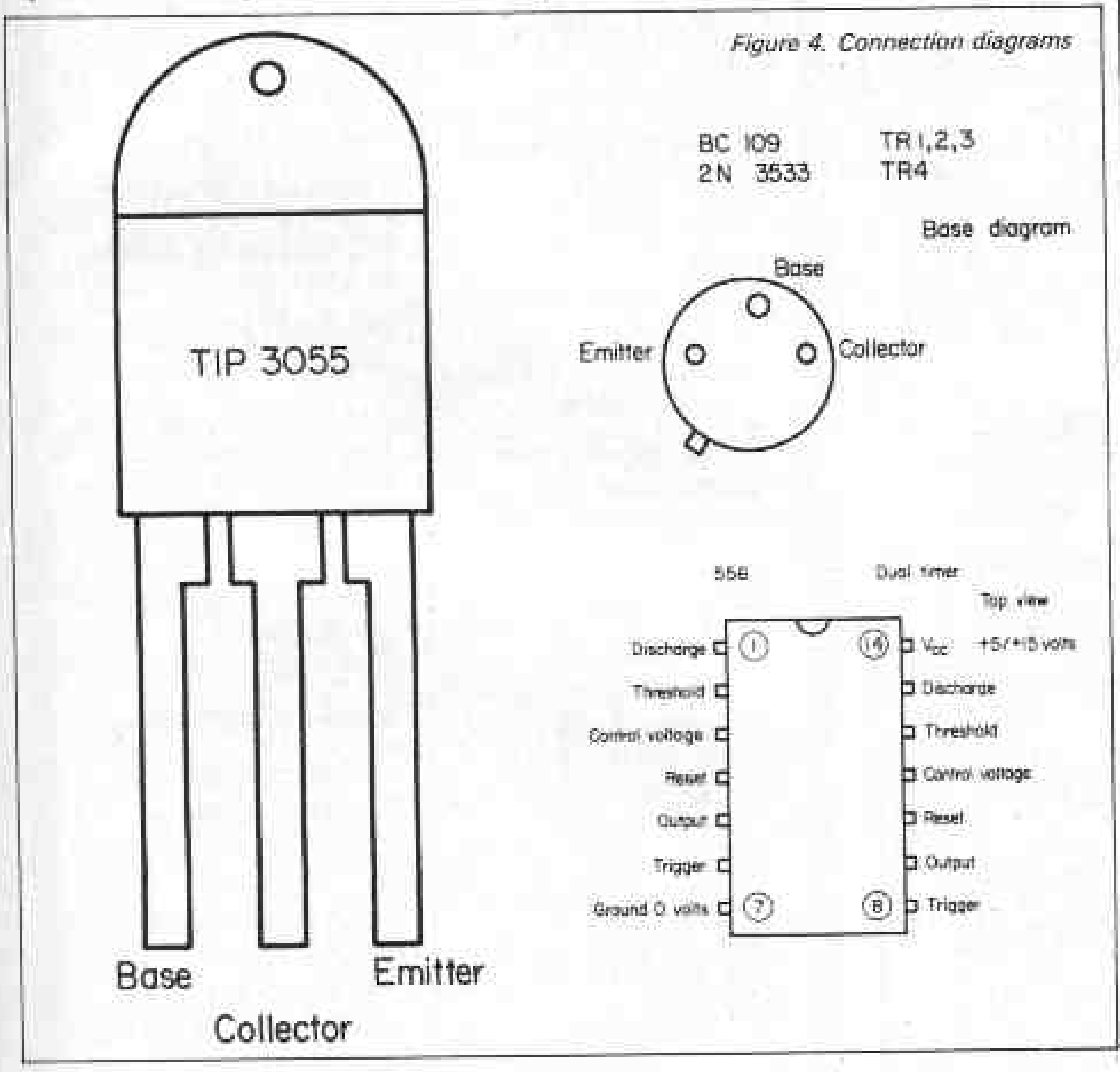



Figure 4a: 555 timer internal connections

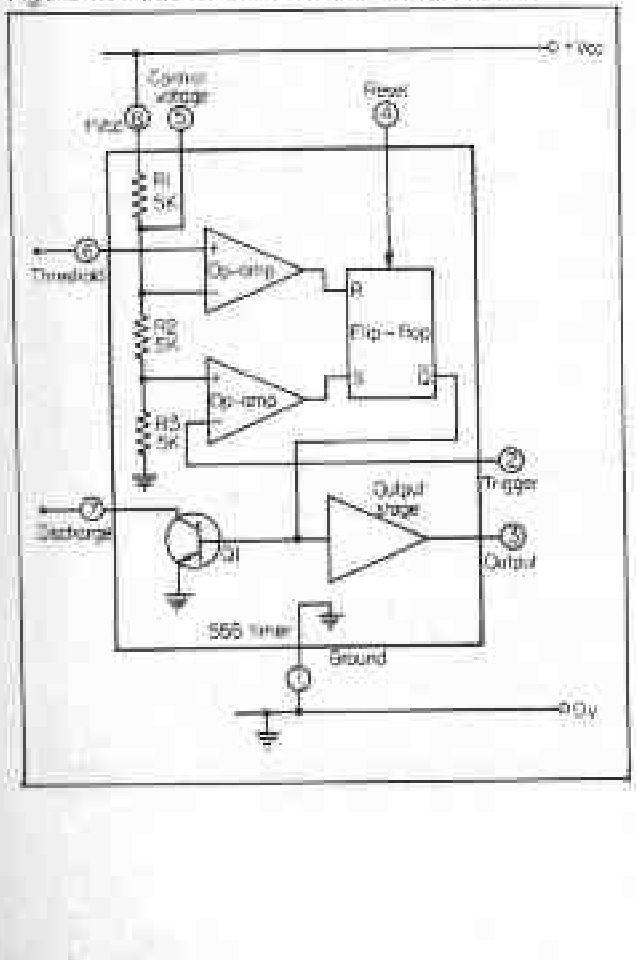
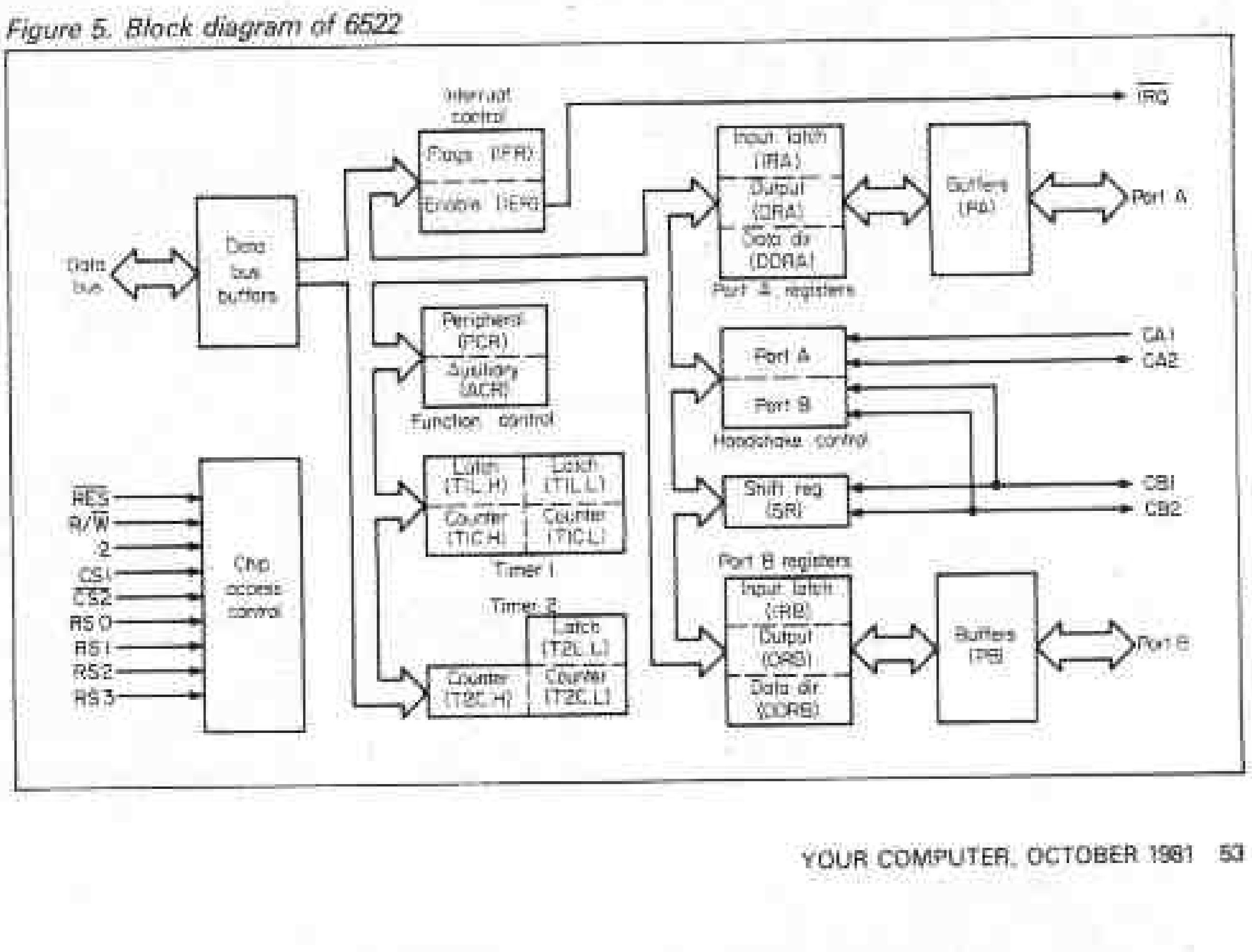



Figure 5. Block diagram of 6522



# JRS SOFTWARE

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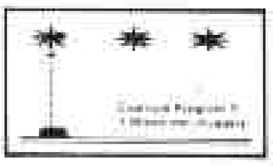

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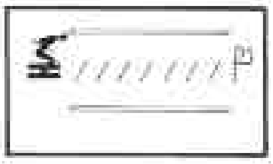

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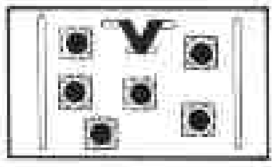

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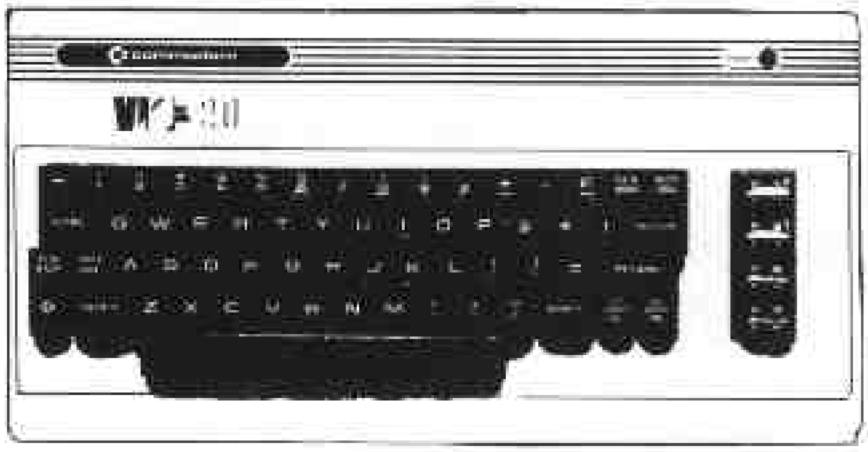

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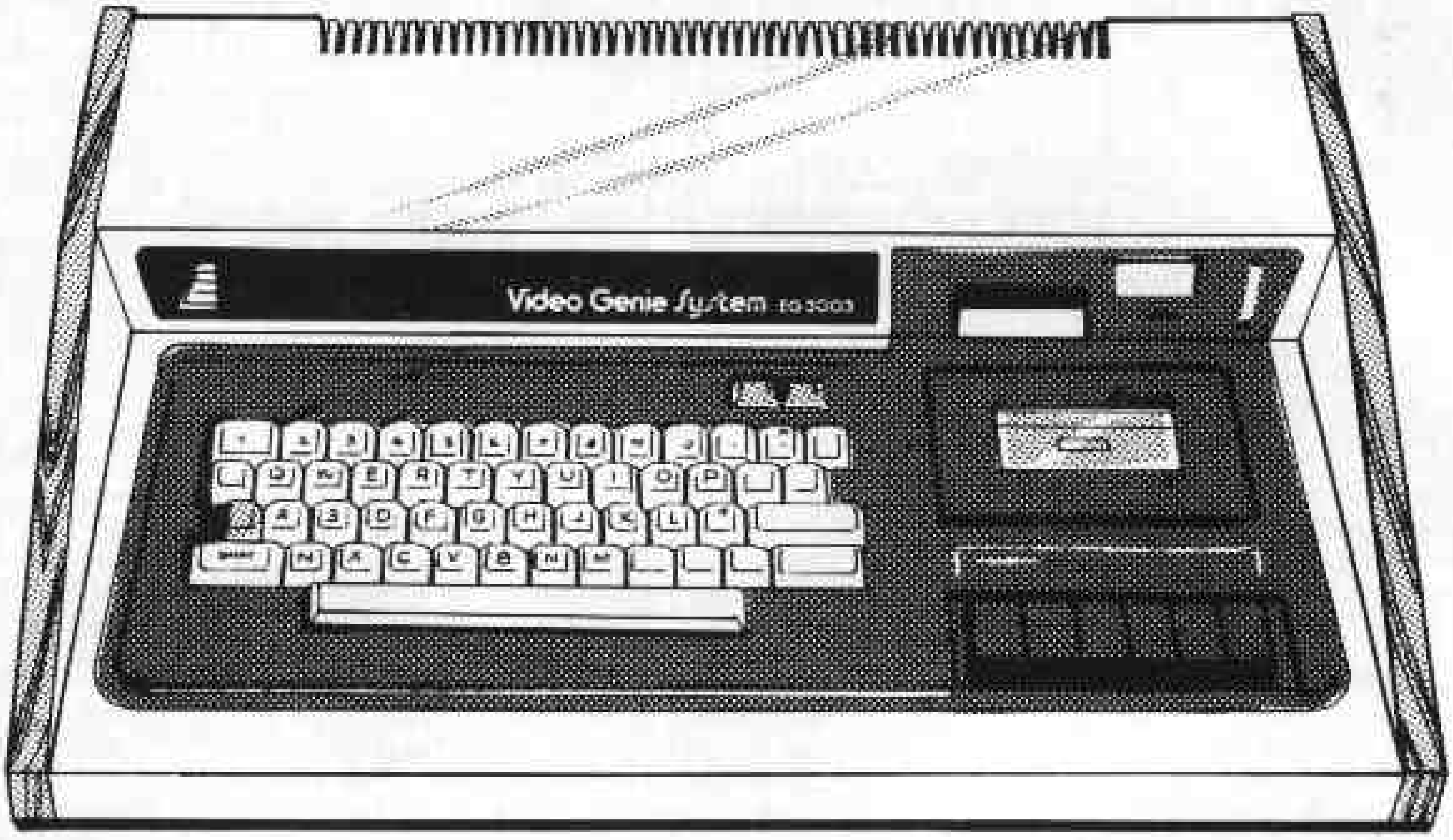


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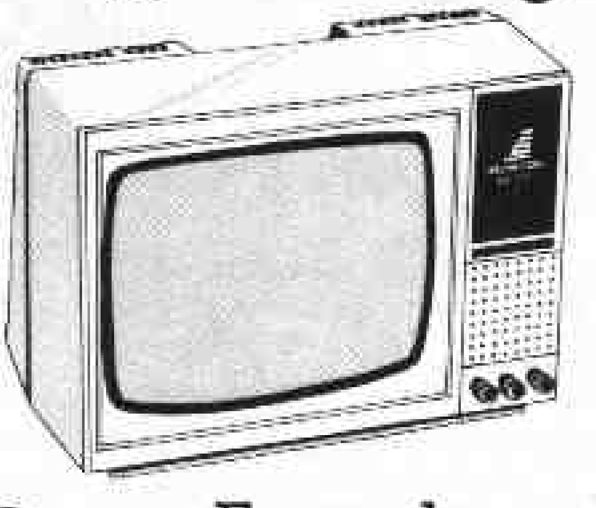

The additional purchase of the EG 100 Monitor offers 3 distinct advantages

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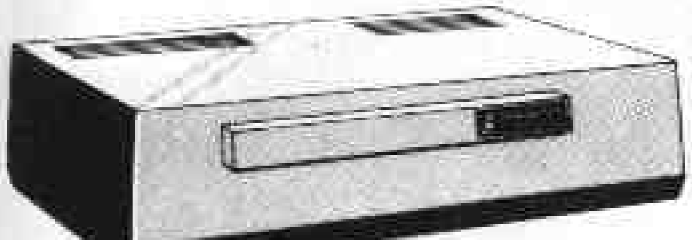

## Expander.

The expansion box unleashes the full possibilities of the Genie. It contains a selection of interfaces, allowing the connection of up to 48K RAM, 4 disk drives, printers and S100 cards.

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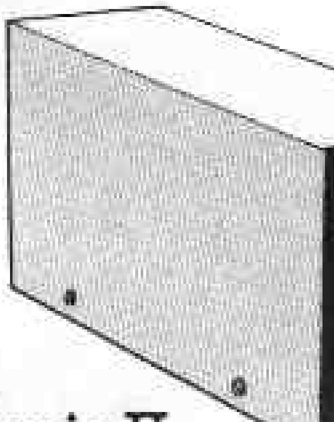

As well as the obvious advantage of mass-storage, the addition of the disk system to the Genie means much faster access to other languages and full random access file handling. Up to 4 drives can be used on a system.

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