SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH CENTRE
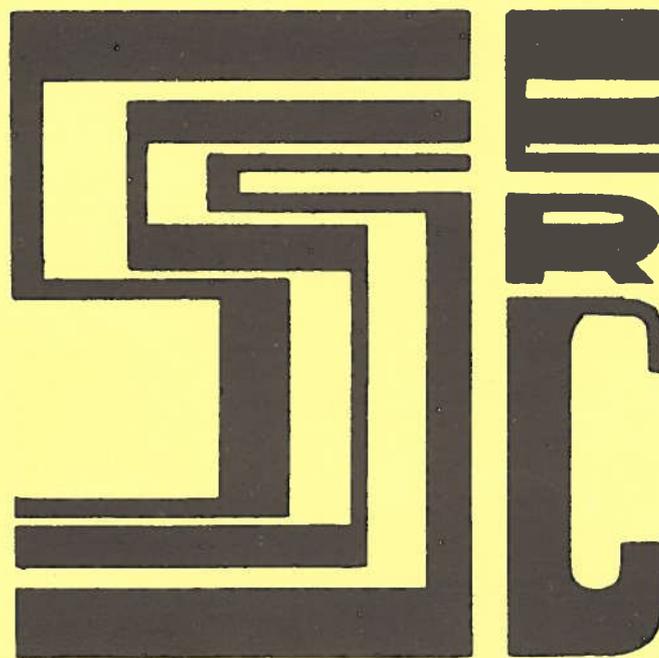
Bulletin No 135   **April 1983**

ADDRESS LIST

SSSERC, 103 Broughton Street, Edinburgh, EH1 3RZ. Tel. 031 556 2184.

Armon Electronics Ltd., Cottrel House, 53-63 Wembley Hill Road, Wembley, Middlesex, HA9 8BH Tel. 01 902 4321.

Artec (I for E) Ltd., Salewheel House, Ribchester, Preston, Lancs. PR3 3XU. Tel. (0254) 84215.

Bettix Ltd., Dunbar Road, New Malden, Surrey KT3 3RG. Tel. 01 942 8701.

J. Bull (Electrical) Ltd., 34-36 America Lane, Haywards Heath, Sussex RH16 3QU. Tel. (0444) 454563).

Cambion Electronics Products Ltd., Cambion Works, Castleton, S30 2WR. Tel. (0433) 2081.

Camlab Ltd., Nuffield Road, Cambridge CB4 1TH. Tel. (0223) 62222.

Coast-Air Ltd., Long Spring, Porter's Wood, Valley Road Industrial Estate, St. Albans, Herts. AL3 6NQ. Tel. (0727) 61669.

Griffin and George Ltd., Ledson Road, Wythenshawe, Manchester M23 9NP. Tel. 041 248 5680.

Harburn Hobbies, 67 Elm Row, Edinburgh EH7 4AQ. Tel. 031 556 3233.

Philip Harris Ltd., 34-36 Strathmore House, Town Centre, East Kilbride. Tel. (03552) 34983/4.

Irwin-Desman Ltd., 294 Purley Way, Croydon, CR9 4QL. Tel. 01 686 6441.

Industrial and Biological Electronics Ltd., 12 Royal Terrace, Glasgow G3 7NY. Tel. 041 332 1077.

Lascar Electronics Ltd., Module House, Whiteparish, Salisbury, Wiltshire SP5 2SJ. Tel. (07948) 567.

Limrose Electronics Ltd., Aerial Road, Llay Industrial Estate, Wrexham LL12 OTU. Tel. (097 883) 5555.

Magnet Applications Ltd., 323 City Road, London ECIV 1LL.

Model Flight Accessories Ltd., Como Drills, Mill Lane, Deal Kent. Tel. (0304) 612734.

RS Components Ltd., PO Box 427, 13-17 Epworth Street, London EC2P 2HA. Tel. 01 253 1222.

Scoonie Hobbies, 91 Sinclair Street, Kirkcaldy, Fife. Tel. (0592) 51792.

Scottcomms, 23 Morton Street, Portobello, Edinburgh EH15. Tel. 031 657 2430.

Sinclair Research Ltd., Unit F, Broad Lane, Cottenham, Cambs. CB4 4SW.

STEM Ltd., STEM Walton Unit, 65 Walton Lane, Liverpool L4 4HG. Tel. (051 207) 1869.

Technomatic Ltd., 17 Burnley Road, London NW10 2ED. Tel. 01 452 1500.

Unilab Ltd., Clarendon Road, Blackburn, Lancs BB1 9TA. Tel. (0254) 57643/4.

Watford Electronics, 33/34 Cardiff Road, Watford, Herts. Tel. (0923) 40588.

INTRODUCTION

Exciting times?

Not all science teachers would agree with us but from here we see an interesting period ahead. Then perhaps, as semi-detached observers, we see just a little more of the game. We do see a number of areas opening up for exploitation by imaginative science teachers.

In the areas of electronics, computer interfacing and control lie tremendous possibilities. Many of these are on a hidden, rather than an overt, agenda. They include chances to introduce all pupils to the real world of making and doing; for the use of electronics as a vehicle for teaching the principles of engineering and design; to introduce some overdue changes in learning/teaching styles and finally, yet another opportunity for bridge building to other areas of the curriculum most notably technical education.

The debate on these ends, and inevitably about the means, rages politely and quietly on mostly behind the scenes. It will be interesting to note the outcome. We at SSSERC hope for radical initiatives and not only from those outwith the present school system.

We can also only hope that these opportunities do not slip from the grasp of Scottish teachers. A pre-occupation with the ways of doing things rather than with the actual achievement of objectives could let that happen. We must all cross our fingers and fervently wish that the following cynical comment, overheard recently, does not become a reality:
"When people say that Britain is at the forefront of a particular technological development, what they really mean is that it will be imported from Japan next week."

The other areas of opportunity were touched on in the "Opinion" section of Bulletin 134. Current developments in the Munn-Dunning science programme should offer imaginative teachers opportunities to exercise more discretion on course content and learning style.

We are currently looking at the first of the draft materials which will eventually be sent out to Regional and Island Authorities as the "National Core Examplars" for foundation science.

Some of this material is nicely open-ended without being too ambitiously so. We even see, at the option stages, some possibility of simple project work. Add to that the opportunity to choose material from examplars and to mix it with material of one's own and the possibilities really open up. The distribution arrangements themselves have been designed to allow maximum flexibility in that rewrites, substitution and addition of individual modules should be possible.

SSSERC has been commissioned to look at this national material as part of the overall production and distribution arrangements. All of those involved in the development are concerned that the examplars contain the right level of detail on apparatus, experimental procedure and safety. To this end information on these aspects will form part of each examplar package.

It seems foolish therefore to provide such detail in these columns when it will eventually reach schools directly. We would wish to applaud and encourage the elements of flexibility in the course. It would indeed be unfortunate if the national examplar materials became an ossified course in the same way that the ISC worksheets became the S1, S2 course in many schools. To this end our own "Foundation Science Notes" will continue to be a source of "extras". They will concentrate on ideas for apparatus and practical activities which can be used to augment the nationally produced examplars. As before, we would be pleased to receive suitable ideas or designs from teachers or technicians.

Balance in the Bulletin

Way back, in Bulletin 86, we were foolish enough to brag about our success in achieving a subject balance in this publication. Of late we have found this almost impossible to obtain. Given the pressure from micro-electronics and Munn-Dunning referred to earlier, this is hardly surprising. In fact we now have an information log jam. Ironic isn't it with all the current talk about 'IT'! We have a great deal of material competing for limited space and unequal clamour for certain types of help. Add to that the phased production of Foundation Science examplars and you will see part of our problem.

Our main problem is the same as that of many science teachers. Too much is happening at once. When SSSERC was set up 17 years ago it had to deal with problems arising out of one major curricular upheaval. At present the Centre staff (= 3 scientific, 2 technical plus a secretary) are facing demand caused by two separate major upheavals.

So, bear with us please if this issue seems to you too physical, although we would hope that the notes on interfacing the 'beeb' would be of interest to all. Strictly subject minded biologists and chemists are promised more next time around. Foundation core material on "Environment" and "Healthy Bodies" is coming onto our desks! Also on the way, although a little further off is the prospect of one extra member of staff at SSSERC... Exciting times?

*   *   *   *   *

1

Safety Notes

Spectrum - faulty power supplies

We have been informed by **Griffin and George Ltd.**, that certain Sinclair ZX Spectrums may have been supplied with mains adaptor power supplies which could be faulty. Under certain conditions, this fault could be dangerous. You only need to check your equipment if you have received a 16k or 48k ZX Spectrum since 1st January, 1983.

Examine the mains adaptor carefully. If the lead to connect it to the Spectrum is black and white, please do the following:

—if necessary switch off the mains supply and disconnect from the socket

—remove any plug which you may have fitted

—package the mains adaptor for postal dispatch

—DO NOT INCLUDE THE COMPUTER ITSELF NOR THE HANDBOOK, TV CASSETTE LEADS NOR THE HORIZONS TAPE

—send the mains adaptor only to:

Sinclair Research Ltd., at the address on the inside front cover of this bulletin.

—ensure that your name and address is included in a covering letter. You will receive a new adaptor by return.

—your postage costs will be reimbursed if you request this in your covering letter.

It is not necessary to send back adaptors with red/black leads. The problem does not extend to any mains adaptor power supplies which have been included with ZX printers or ZX81's at any time.

Griffin and George apologise for any inconvenience which this may cause. For any further information you are advised to contact your local Griffin Office (i.e. for Scotland this means Manchester!)

*   *   *   *   *

Foundation Science Notes

Wind power - a Savonius rotor

The section on Energy in Foundation Science invites pupils to examine some potential sources of renewable energy, two of them being wave and windpower. An alternative 'windmill' to those shown in the two exemplars received here, is the Savonius rotor Apologies to those who follow the 'good life' or have visited the Centre for Alternative Technology at that famous quarry near Machynylleth in Powys. They will know much not only about Savonius rotors and other wind and water driven generators, but will also be conversant with other arts ranging from fish farming and composting to construction of methane generating toilets!

The traditional Savonius rotor as built by the alternative technologists consists of the two halves of a large oil drum (sliced vertically down a diameter) welded together so as to always present one open 'wind bucket', regardless of the wind's direction. Described here is the construction of a miniature generator using plastic detergent or squash bottles in place of oil drums. (Fig. 1).
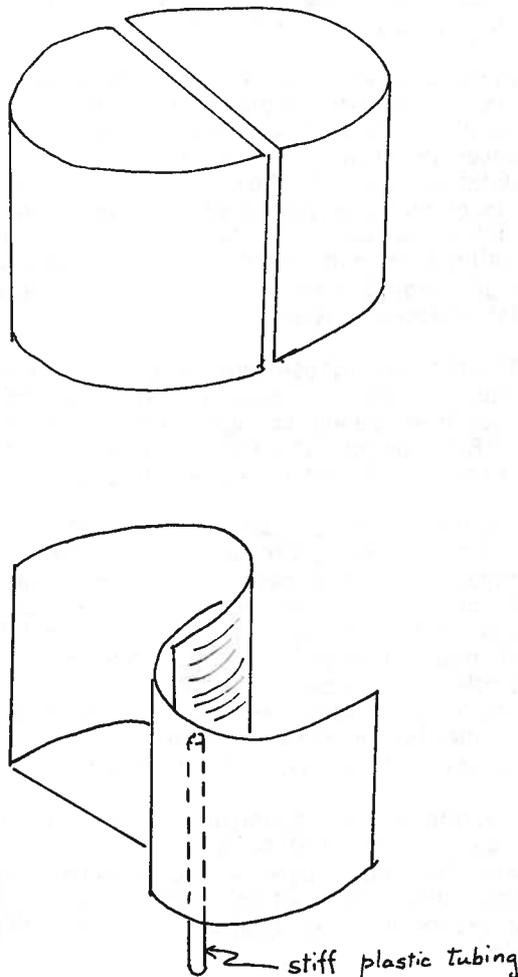
stiff plastic tubing

Fig. 1.

The two halves can simply be stapelled together and a shaft extension from a length of stiff plastic tubing caught between the staples. This is slipped onto the spindle of a IV. motor/generator held vertically in a clamp. An alternative procedure is to mount the plastic rotor in a slot cut in a small piece of blockboard into which a hole of diameter just smaller than that of the spindle has been drilled. (Fig 2). This provides a pushfit for the motor spindle. A drill size 43 was found to be satisfactory for the Orbit series 305-505 and a 42 or 41 for the Mabuchi motors.

plan

wooden boss

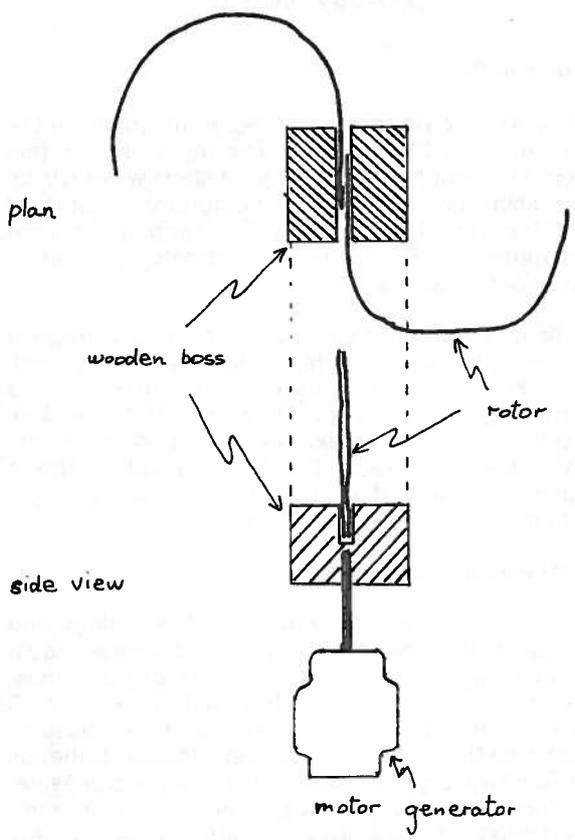rotor

side view

motor generator

Fig. 2.

Many schools will possess old stock of Orbit motors (which, unfortunately, are no longer available) but the alternative presently back in the Hobby shops seems to be the Mabuchi range. Both types of motor, Orbit (305, 405 and 505) and the Mabuchi 1½-4½ volt type were found to be satisfactory. For those without a convenient hobby shop three sources which will send motors by post are given **Harburn Hobbies, Model Flight Accessories** and **Scoonie Hobbies**. Their addresses and that of John Bull Electrical referred to in the Trade News are given on the inside front cover. With a small 60mm high rotor cut from a squeezy liquid detergent bottle of diameter 60mm the following similar outputs were obtained. Clearly dimensions are not critical.

mouth blown (gently)	hard	vacuum cleaner	hairdryer
30mA	100mA	100mA	50-60mA

The voltage measured across the generator varied from 0.1V to 0.2V. Increasing the size of the rotors with any of these motor sizes did not greatly affect the output. In fact larger rotors were found to be more difficult to start rotating.

Another problem is that of ensuring that the blower used generates a tube of air with cross section area greater than that of the rotors. This difficulty increases if the Savonius rotor size is increased or if a conventional windmill or propellor with long vanes is to be used. If however they are used outside in real wind this objection disappears! Some models of hairdryer have a relatively wider nozzle and hence a more diffuse blow than others. The Boots 'headway' 500W hairdryer selling at £5.45 seems to be adequate for the purpose.

For use as a model in schools the Savonius rotor has some advantages over the traditional long vaned rotor or windmill type which rotates in the vertical plane on a horizontal axis:-

- the simplicity and cheapness of construction

- its compactness not only aids storage but makes it easier to cover the whole rotor with artificial wind. It is less easy to make a large 'windmill' rotor turn and generate power

- its robustness.

A further aspect of this demonstration is that it can be easily extended. Pupils could easily investigate the effect on performance of varying the size of and shapes of rotors. The wooden boss fixing permits rotors to be fitted rapidly. Further a friendly competition to produce the highest output current could provide much motivation.

Whilst the Savonius rotor has the advantage of not requiring to be faced into the wind before it operates, it must clearly be less efficient than more conventional designs. It does prove difficult to start if the two lobes of the rotor happen to be stationary in the eclipsed position. (Fig. 3a) Producing rotors more the shape of an aerofoil reduces this problem and perhaps as an interesting aside demonstrates the principle of lift on an aerofoil. (Fig. 3b).

Such rotors are easily constructed from 20 gauge aluminium sheet. Again sizes are not critical. A height of 70mm and width (unfolded) of 150mm was found to be satisfactory. Sharp edges and corners should be smoothed even though the speed and momentum of such wind driven rotors is unlikely to cause injury. A further development is to make the aerofoils 'solid' by taping on a piece of stiff paper or card as in Figs. 4(a) and 4(b).

As an aid to fitting the card, the aluminium sheet and card can each have a vertical slot cut at their mid point so that they interlock at the centre. (Fig. 5).

*   *   *   *   *

3

Fig. 3(a). (Plan-not to scale)

direction of rotation

Fig. 3(b). (Plan – not to scale)

tape

card

aluminium

Fig. 4. (Plan - not to scale)

Fig. 5. (Elevation – not to scale)

Biology Notes

UV lamp spares

Some years ago we recommended an inexpensive UV lamp for use in CSYS Biology. The main use for this lamp was in detecting 'quenching' of short wave UV by nucleic acid bases on chromatograms. (Unit 3 "Chemistry of the Living Cell"). The lamp at that time was supplied by European Instruments **Ltd.** as a 'Quartray Shortwave' E101.

We have recently been informed that European Instruments no longer sell this model nor do they stock spares. However we have now traced the manufacturers of the lamp. They are **Coast-Air Ltd.** They still keep spare bulbs for the lamp (type no. OZ4 SW) at about £5 each. They make a wide range of UV equipment and their catalogue certainly bears inspection.

Constant volume dispensers

There is a particularly frequent need in biology and and in chemistry (biochemistry?) to dispense equal volumes of reagents into large numbers of test tubes. For example, in enzyme studies and in vitamin C experiments with DCPIP etc. It was partly because of this need that the d-i-y dispenser described in Bulletins 73 and 74 was designed. Some rather nice, inexpensive, dispensing containers are now coming onto the market. The attention of biologists is thus drawn to the description of one range of such dispensers from Bettix featured in the "Trade News" section.

*   *   *   *   *

Physics Notes

Some laser experiments

Optical transmission of an audio signal

This can quickly be achieved by stretching clingfilm across a loudspeaker cone and letting the laser beam glance off the clingfilm (Fig. 1). The loudspeaker is driven by a signal generator.

The lightbeam sweeps across the photodevice at the frequency of the audio signal. We used a TIL78 phototransistor as our detector. The TIL78 is an infra red detector, but it is sensitive to a helium neon laser. We used it because we had it to hand. The TIL78 can be obtained from **Technomatic** at 55p.

Other photodevices we have used with the laser are 2N5777 photodarlingtons and **RS** 305 434 light-activated switches. The former device operated satisfactorily for 6 months heavy usage before becoming insensitive. The latter device became insensitive after a few minutes.
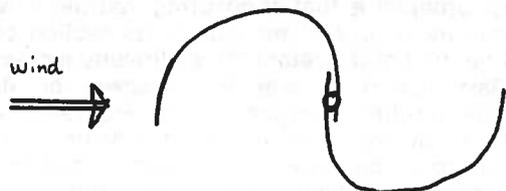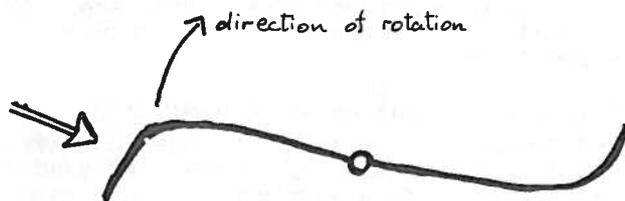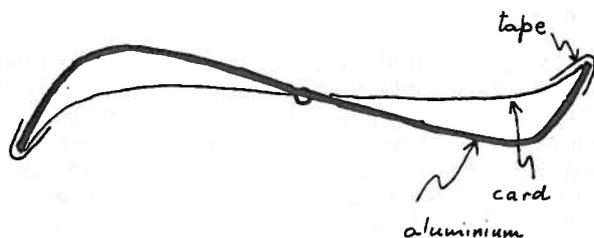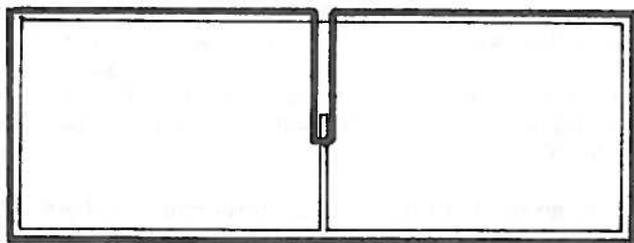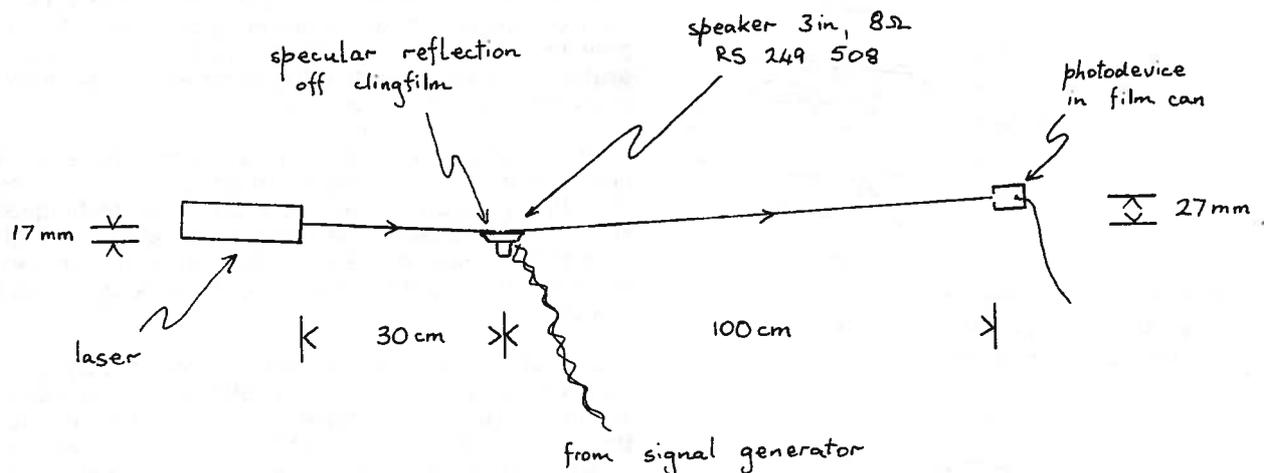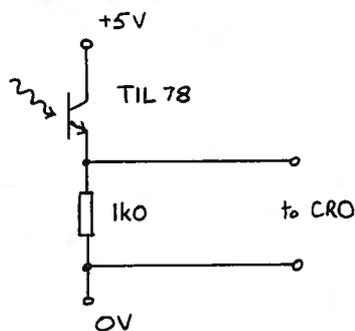
Fig. 1.

The phototransistor can be wired up to give either an analogue or a digital output and monitored on a CRO (Figs. 2 & 3). We mounted the phototransistor at the back of an empty 35mm film can to mask stray light (Bulletin 133, p.11).

Analogue output from phototransistor peak to peak signal approx 100 mV

TIL 78 pin configuration
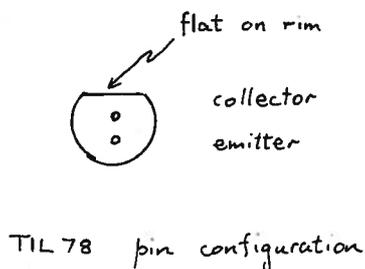
Fig. 2.
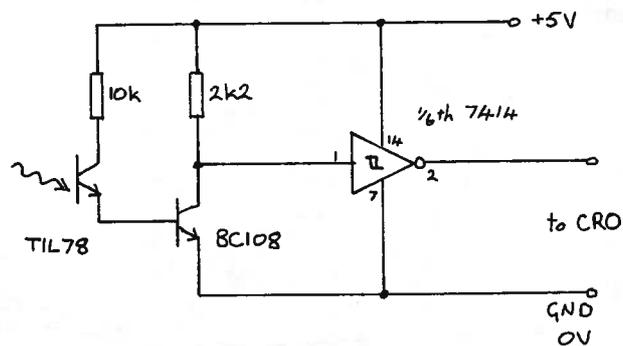
Digital output from phototransistor

Fig. 3.

The system works best at frequencies of around 1kHz. We were however able to transmit a signal of 20kHz.

Reflection off water waves

This is a variation of the last experiment. Circular water waves were produced in a Petri dish of diameter 5½″. The waves were generated by a loudspeaker that was clamped about 1cm above the surface and centred over the Petri dish. A U-shape of wire, 12x16x12mm, attached to the central cone of the speaker with Britfix, dipped into the surface to do the generating (Fig. 4). We used 0.6mm copper wire.

5
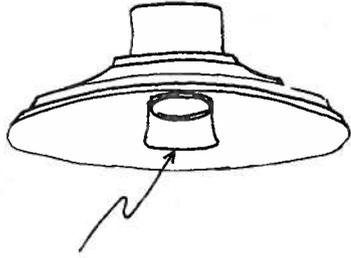
U-shaped copper wire
0·6mm diameter, 12 × 16 × 12 mm
attached to cone of speaker

Fig. 4.

The laser beam was directed at the side of the Petri dish so as to glance onto the waves (Fig. 5). As the reflected beam swept across the photodevice it was possible to obtain a signal of the frequency of the source.

What was also obtained at about 8kHz was a clear interference pattern on a screen placed next to the photodevice, the water surface acting like a reflection grating. The wavelength of the water waves was of the order of 1 or 2 millimetres.

We will stop this article here as it seems that a lot of open ended project work could stem from the techniques described. In particular the techniques should make possible the study of a variety of high frequency surface waves and also enable the accurate measurement of wavelengths and frequencies of these waves.

On a point of safety, it will have been noted by some that we have not specifically mentioned laser goggles. A more relaxed view is currently taken on the need for these. Certainly we would not think them necessary for experiments of this type using typical school lasers whose power output is of the order of 0.5mW, providing that due care is taken in setting up the experiment to avoid the possibility of direct laser light entering the eyes.
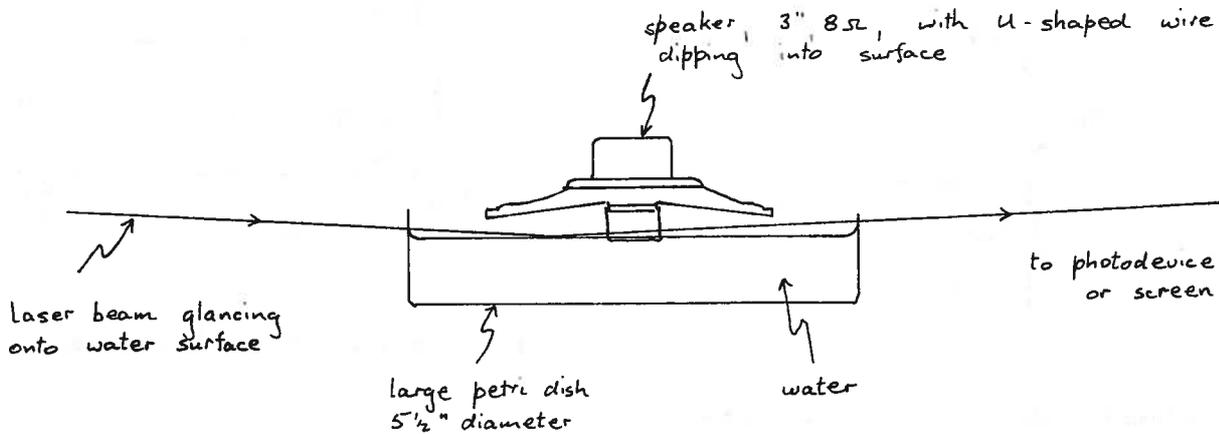
*   *   *   *   *

speaker, 3", 8Ω, with U-shaped wire dipping into surface

laser beam glancing onto water surface

to photodevice or screen

large petri dish 5½" diameter

water

Fig. 5.

Interfacing Notes

Have you read?

In an attempt to get on top of the information being published on interfacing in periodicals we have produced a reading list of articles on interfacing. The list gives you the title, author, journal and date, plus a brief description of the article. It is divided into sections based on models of microcomputer. The first list covers 1982. The second list, soon to be prepared, will cover the first few months of 1983 and is due out April/May. The list will be automatically posted to members of the Science Interfacing Register.

Copies of the first list are available from SSSERC. The second list is to be printed by SMDP. We have still to arrange its distribution.

Much of the compilation of the reading list is being done by Miss Janet Hughes of Montrose Academy. We are very grateful for this help from Janet and we are sure that many of us will find this service very helpful.

Interfacing with the BBC Model B

The remainder of these notes is taken up by the first of a series of articles on the 'Beeb' model B. With the BBC microcomputer looking set to become one of the commonest models in schools we thought it would be helpful to provide information on d-i-y interfacing as soon as possible. The model B has a number of features which make it relatively simple to interface to experiments or for control applications. Some of these features are explored and exploited in the articles we will publish.

User port - BBC model B

Part 1 Input and output

The BBC model B contains an interface chip known as the 6522 versatile interface adapter (VIA). The user port gives you access to one-half of the VIA (figure 1). The other half is reserved for use by a printer.
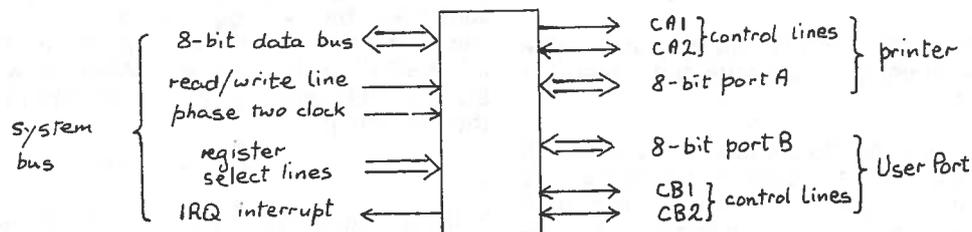
This article describes ways of connecting peripheral devices, such as breadboard experiments, to the user port and outlines how to control the 8-bit I/O lines.

Connecting to the user port

The user port has a 20-way plug. Of these twenty pins, eight are commoned to system ground, OV, and two are commoned to the +5V rail. The other ten pins are for input/output signals. It is handy to have a connecting system to link up the user port to a distribution board with 4mm sockets (Figure 2). One method of constructing such a board is outlined below. It is based on the circuit diagram in p503 of the BBC "User guide".

1. Insert twelve 4mm sockets into a board approximately 21cm long. A neat arrangement of the type illustrated uses half sections of rectangular drainpipe.

   Colour code and label the sockets as shown (Fig. 2).

OV	black
+5V	red
PBO...PB7	all blue, say
CB1, CB2	both brown, say

2. Connect 20-way "Speedblock" ribbon cable to a 20-way cable mounting socket RS 467 289, £2.09. Suitable assembly tools should be used for this operation. They are the R.S. Components common frame RS 468 197, £3.00, and special insert RS 468 232, £3.16. Assembly instructions are supplied with the common frame. Assembly is not a difficult operation.
   If you chance your luck and do without the assembly tools you run the risk of applying too great a pressure to the device and severing leads.

   RS Components Ltd., sell "Speedbloc" ribbon cable in 20m lengths. A reel of 20-way cable, RS 357 867, costs £26.20. If your needs are less extravagant than 20m reels then **Watford Electronics** supply 20-way grey ribbon cable at 25p per foot.

Fig. 1.   6522 VIA

20-way "Speedblock" ribbon cable

cable clamp

OV

+5V

CB1 CB2 PB0 PB1 PB2 PB3 PB4 PB5 PB6 PB7

20-way cable mounting socket

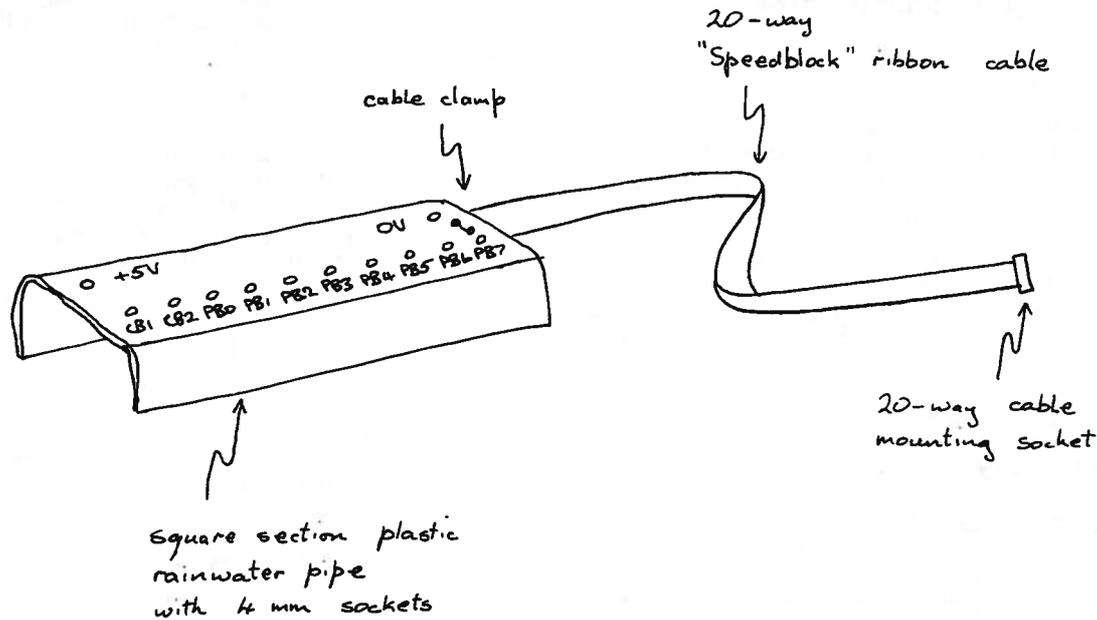*Square section plastic rainwater pipe with 4 mm sockets*

Fig. 2.

3. Wire up the free end of the ribbon cable to the 4mm sockets. The user port pins are shown labelled in Figure 3. Seven OV and one 5V wires should be snipped off.
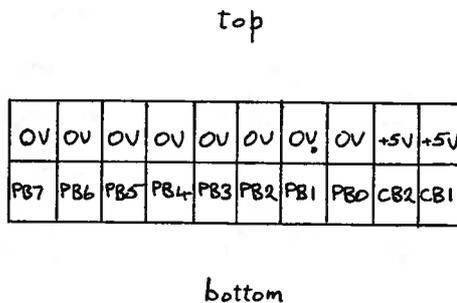
top

OV	OV	OV	OV	OV	OV	OV	OV	+5V	+5V
PB7	PB6	PB5	PB4	PB3	PB2	PB1	PB0	CB2	CB1

bottom

Fig. 3. User Port pin connections

4. Make a strain relief device to grip the ribbon cable to the plastic drainpipe. Two bolts and a metal or plastic strip will do.

5. Plug the ribbon cable into the user port and switch on power to the computer. Each of the lines should be tested using the programs listed in the second half of this article. A high impedance voltmeter such as a digital meter or CRO should be used to measure potential.

Rectangular plastic drainpipe can be obtained from plumber's merchants. We tried three out of the Yellow Pages (Edinburgh) having heard that it was becoming difficult to acquire. Two out of the three main merchants we contacted still stock rectangular plastic drainpipe.

UBM - do not stock it.
Stockists -
PDM - 4 m at £9.37
Plum Center (sic! formerly 'Marley') - 2.5m at £7.24, 3m at £8.70.

A different connector system that is well worth considering uses a 12-way quick connect block (RS 423 576), £2.30, which has strong spring grips for wires (Fig. 4). This connector system is useful when linking a breadboard circuit to the user port.

Software control

Operation of the user port is governed by several 8-bit and 16-bit registers in the VIA. The registers are controlled by 'writing' operations which 'set' or 'reset' the bits within them. When we write a 1 into a bit, that bit is said to be 'set'. When we write a 0 into a bit, that bit is said to be cleared or 'reset'. For example the instruction:

$$?\&FE60 = \&C4$$

writes a 1 into bits 2, 6 and 7 of the I/O register B. The bit pattern of this register looks like this:

7	6	5	4	3	2	1	0	bit number
1	1	0	0	0	1	0	0	bit pattern of &FE60

20-way ribbon cable
cable clamp
12-way quick connect block
spring grips for wires to peripheral devices
PB7 PB6 PB5 PB4 PB3 PB2 PB1 PB0 CB2 CB1 0V +5V
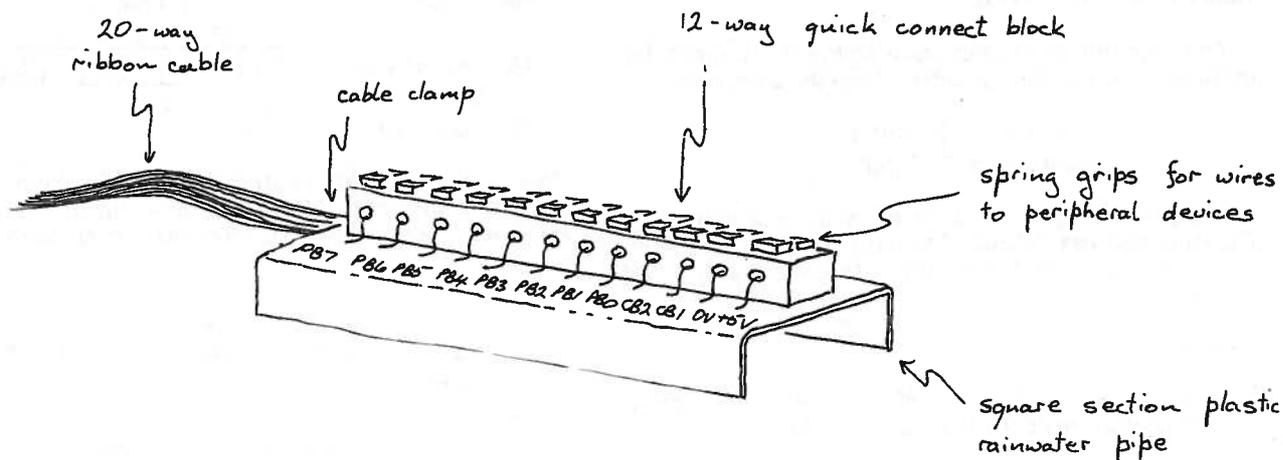square section plastic rainwater pipe

Fig. 4.

You have to be fluent in three number systems, hexadecimal, decimal and binary, in this game.

Therefore you should have to hand a conversion table up to decimal 255.

The VIA registers have addresses and are addressable just as though they were locations in memory (Table 1). By 'addressable' we mean that they can be written to or read. There are some exceptions to this which we need not go into in this article.

Registers are very different from memory locations. The latter are passive beasts whereas the former are active. Each register bit controls a logic gate, or a series of logic gates, within the VIA microprocessor. Thus setting the bit pattern of a register is like controlling a gigantic signal box, routing and rerouting signals. Each register has 256 different switching combinations. The whole set of registers in the VIA has thus an immense number of modes of operation which perhaps is the reason why the 'BBC User Guide' does not even attempt to explain its working.

We will conclude this article with a description of just two of the VIA registers, Input/Output Register B (IORB) and Data Direction Register B (DDRB). These two registers operate the 8-bit port B, the 8-bit, parallel, bidirectional, data lines on the user port.

Hex address	Relative address	Register	Description	
			Write	Read
&FE60	BASE	IORB	Output Register B	Input Register B
&FE61	BASE + 1	IORA	Output Register A	Input Register A
&FE62	BASE + 2	DDRB	Data Direction Register B	
&FE63	BASE + 3	DDRA	Data Direction Register A	
&FE64	BASE + 4	T1C-L	Timer 1 Low-Order Latches	Timer 1 Low-Order Counter
&FE65	BASE + 5	T1C-H	Timer 1 High-Order Counter	
&FE66	BASE + 6	T1L-L	Timer 1 Low-Order Latches	
&FE67	BASE + 7	T1L-H	Timer 1 High-Order Latches	
&FE68	BASE + 8	T2C-L	Timer 2 Low Order Latches	Timer 2 Low-Order Counter
&FE69	BASE + 9	T2C-H	Timer 2 High-Order Counter	
&FE6A	BASE + 10	SR	Shift Register	
&FE6B	BASE + 11	ACR	Auxiliary Control Register	
&FE6C	BASE + 12	PCR	Peripheral Control Register	
&FE6D	BASE + 13	IFR	Interrupt Flag Register	
&FE6E	BASE + 14	IER	Interrupt Enable Register	
&FE6F	BASE + 15	IORA	as register 1, but without handshake	

Table 1. VIA Registers

Data Direction Register B

This register configures each of the 8 I/O lines for input to the computer, or output from the computer.

Rules: set bit (=1)- output
clear bit (=0)- input

The bits are set or cleared by write instructions to DDRB at address &FE62. The 8-bit I/O lines are called PBO, PB1, ..., PB7. The 'PB' stands for peripheral port B.

Examples:

1. Configure all 8 lines PBO to PB7 for input. (Therefore write 0 into all 8 bits of &FE62).

instruction	bit pattern of &FE62							
	7	6	5	4	3	2	1	0
?&FE62 = &00	0	0	0	0	0	0	0	0

2. Configure all 8 lines PBO to PB7 for output. (Therefore write 1 into all 8 bits of &FE62)

instruction	bit pattern of &FE62							
	7	6	5	4	3	2	1	0
?&FE62 = &FF	1	1	1	1	1	1	1	1

3. Configure lines PBO to PB5 for output. (Therefore write 1 into bits 0 to 5 of &FE62)

instruction	bit pattern of &FE62							
	7	6	5	4	3	2	1	0
?&FE62 = &3F or ?&FE62 = 63	0	0	1	1	1	1	1	1

You can write both hexadecimal and decimal numbers to addresses. It is probably simpler converting from binary to hex than from binary to decimal. We tend to use hex more often for this reason.

Output

We will assume in this section that all 8 I/O lines have been configured as output lines.

Each line is made high or low by setting the appropriate bit in the Input/Output Register B (IORB).

Rules   set bit (= 1) output high
clear bit (= 0) output low

The bits are set or cleared by write instructions to IORB at address &FE60.

Example:

Set data lines PBO, PB2, PB4 and PB6 high. (Therefore write 1 into bits, 0,2,4 and 6 of &FE60)

instruction	bit pattern							
	7	6	5	4	3	2	1	0
?&FE60 = &55 or ?&FE60 = 85	0	1	0	1	0	1	0	1

We have now covered sufficient ground to be able to construct a program to test the labelling of the 8-bit data lines, PBO to PB7, in the user port connector system.

```
10   ?&FE62=&FF
20   REM all data lines made output
30   REPEAT
40     INPUTX
50     REM X can be any integer
60     REM between 0 and 255
70     ?&FE60=X
80     REM data lines set high or low
90     REM according to value of X
100    UNTIL FALSE
```

Program 1

To set the data lines PBO, PB1, ..., PB7 high one at a time make X 1,2,4,8,16,32,64 and 128.

We would prefer to see the above program written in a more comprehensible style.

```
10   BASE=&FE60
20   IORB=BASE
30   DDRB=BASE+2
40   ?DDRB=&FF
50   REPEAT
60     INPUTX
70     ?IORB=X
80     UNTIL FALSE
```

Program 2

This style features

1. Naming registers according to their initials rather than according to their addresses.

2. Referencing the registers to the base address of the VIA (Table 1).

One of the attractive aspects of programming the BBC micro is the ability of giving a numeric variable or constant almost any name you fancy. Therefore we make use of this facility in our programs and call the VIA registers after their own names. It is simpler working with IORB, DDRB, and PCR than &FE60, &FE62 and &FE6C. The only catch is that certain labels may be misinterpreted by the computer. For example if you call the Interrupt Flag Register IFR the computer interprets this as IF R. We get round this snag with another name. FLAGS does.
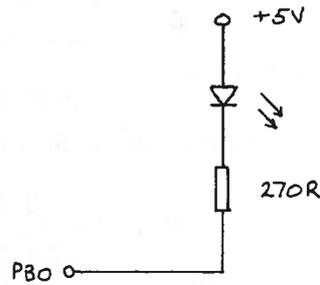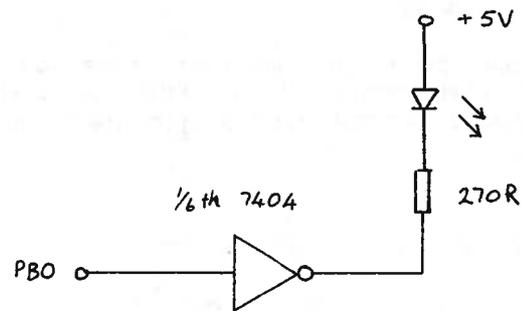
Fig. 5.

Each one of the 8-bit I/O lines is designed to sink a current up to 10mA or source a current up to 1mA or drive one TTL load. In practice then you would not attempt to use the I/O lines as a current source (except for the case of driving one TTL load). Two arrangements for controlling an l.e.d. are shown in Figure 5.

We prefer version (b) for two reasons. One, there is a chiasmus in the logic of version (a). This is not so in (b). Two, the 7404 buffers the VIA.

We suggest you control eight l.e.d.s from the user port. They can be quickly assembled on prototype board. This will make manifest one of the principal features of 8-bit data lines, the fact that you are processing data in parallel. Each single software instruction operates eight different devices similtaneously.

By way of example you can send a rippling effect along the eight l.e.d.s using program 3.

Input

The bits in the Input/Output Register B (IORB) are set or cleared by incoming signals according to the following rules

Rules: input high   bit set (= 1)
            input low   bit cleared (= 0)

```
10  BASE=&FE60
20  IORB=BASE
30  DDRB=BASE+2
40  ?DDRB=&FF
50  REPEAT
60    Y=0
70    REPEAT
80      READX
90      ?IORB=X
100     Y=Y+1
110     T=TIME
120     REPEAT
130       UNTILTIME>T+5
140     UNTILY=18
150   RESTORE
160   UNTIL FALSE
170 DATA&FF,&FE,&FD,&FB,&F7,&EF
180 DATA&DF,&BF,&7F,&FF,&7F,&BF
190 DATA&DF,&EF,&F7,&FB,&FD,&FE
```

Program 3.

Input signals are sensed by read instructions on IORB at address &FE60.

We can input a high or low signal to the 8-bit I/O lines by either connecting the line to the +5V rail via a 1k0 resistor or by directly connecting the line to ground (Fig. 6).
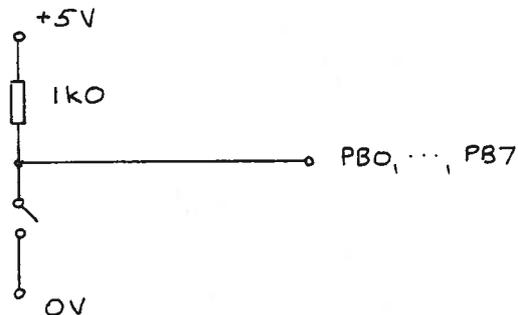

Fig. 6.

The software for configuring the 8-bit I/O lines for input and sensing whether they are high or low is

```
10  BASE=&FE60
20  IORB=BASE
30  DDRB=BASE+2
40  ?DDRB=0
50  X=?IORB
60  PRINTX
```

Program 4.

The value of X depends on the state of all eight lines PB0 to PB7 because as mentioned above we are in the business of processing data in parallel. For example if X = 192 then PB0 to PB4 are low and PB5 to PB7 are high

	7	6	5	4	3	2	1	0
IORB =	1	1	1	0	0	0	0	0

Logical masking

The technique for operating a single, or several I/O lines, but not them all, is known as logical masking. Some examples will illustrate the technique.

Examples

1. Output a 1 on PB5. Leave the other seven I/O lines undisturbed.

The instruction

$$?IORB = \&20$$

will not do. It sets bit 5, but clears the other seven.

	7	6	5	4	3	2	1	0
IORB =	0	0	1	0	0	0	0	0

The instruction
$$?IORB = ?(IORB) \text{ OR } \&20$$

sets bit 5 and leaves the other seven bits unaffected

	7	6	5	4	3	2	1	0
IORB	a	b	c	d	e	f	g	h
OR &20	0	0	1	0	0	0	0	0
?(IORB) OR &20	a	b	1	d	e	f	g	h

2. Output a 0 on PB2 and PB3. Leave the other six I/O lines undisturbed.

The instruction is

$$?IORB = ?(IORB) \text{ AND } \&F3$$

	7	6	5	4	3	2	1	0
IORB	a	b	c	d	e	f	g	h
AND &F3	1	1	1	1	0	0	1	1
?(IORB)AND &F3	a	b	c	d	0	0	g	h

3. Wait until PB1 goes low

The instructions are

```
100  REPEAT
110    X=?(IORB)AND2
120    UNTILX=0
130  PRINT"PB1 low"
```

Program 5.

	7	6	5	4	3	2	1	0
IORB	a	b	c	d	e	f	g	h
AND 2	0	0	0	0	0	0	1	0
?(IORB) AND2	0	0	0	0	0	0	g	0

**Model train control**

The above mentioned ideas are embodied in this example of control. The example illustrates

1. parallel processing of data
2. bi-directional data lines
3. logical masking
4. software control of hardware
5. power boosting with hardware

The layout is a single length of track (Fig. 7). The train is controlled to run up and down it (preferably without falling off the ends!)

An external 6V smoothed d.c. supply should be used to operate the relays in the circuits below.

SWA   railway track   SWB

reed switch
connected to PB2

reed switch
connected to PB3
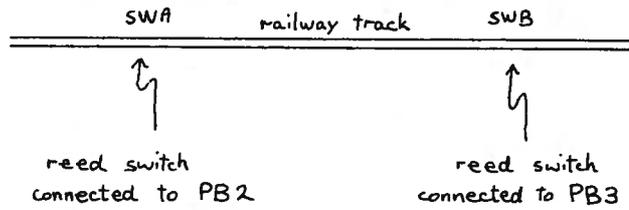
reed switches normally open
switch closes when train passes

Fig. 7.

1. Data direction register B

    pin   function   I/O

    PB0   current polarity   output
    PB1   current on/off   output
    PB2   sensing SWA   input
    PB3   sensing SWB   input

    Use instruction

            ?DDRB = 3

    to set bits 0 and 1 high.

2. Reverse polarity control

+6V

IN4148

RS 349 642
relay used to reverse
polarity of train supply

BC108

PB0

10k

BF751

1kΩ

0V

IORB								state of train
7	6	5	4	3	2	1	0	
							0	reverse
							1	forward

3. On/off control

+6V

2

RS 349 383 DIL reed
relay used to switch
on/off train supply

6

PB1

10k

BC108

0V

IORB								train
7	6	5	4	3	2	1	0	
						0		off
						1		on

13

software instructions

?IORB = 0						0	0	off
?IORB = 1						0	1	off
?IORB = 2						1	0	on reverse
?IORB = 3						1	1	on forward

4. Sensing position of train

Position B on track

reed switch
normally open

```
        +5V
         |
        1kO
         |
         +————————o PB3
         |
        SWB
         |
        OV
```

	IORB						SWB	
7	6	5	4	3	2	1	0	
				1				open
				0				closed

software instructions

```
REPEAT

Z = ?(IORB)AND8

UNTIL Z<>8

REM Z = 8 switch is open

REM Z = 0 switch is closed
```

Assembling these ideas we can put the train into perpetual motion with the following program.

```
 10  BASE=&FE60
 20  IORB=BASE
 30  DDRB=BASE+2
 40  ?DDRB=3
 50  REPEAT
 60    PROCforward
 70    PROCreverse
 80  UNTIL FALSE
 90  END
100
110  DEFPROCforward
120  X=3:Y=8:PROCjourney
130  ENDPROC
140
150  DEFPROCreverse
160  X=2:Y=4:PROCjourney
170  ENDPROC
180
190  DEFPROCjourney
200  ?IORB=X
210  REPEAT
220    Z=?(IORB)ANDY
230    UNTILZ<>Y
240  ENDPROC
```
Program 6.

The train should initially be placed on the track between A and B pointing towards B. The program can be stopped by pressing ESCAPE. However to stop the train you will have to disconnect power from the track.

This program has been developed further to cause a gradual acceleration and deceleration at the start and finish of each journey. This is achieved by pulsing the current with a varying mark space ratio.
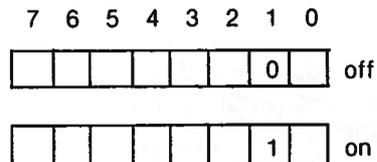
14

```
 10 BASE=&FE60
 20 IORB=BASE
 30 DDRB=BASE+2
 40 ?DDRB=3
 50 PROCdisplay
 60 INPUT"how many journeys",N
 70 FORI=1TON
 80   PROCdisplay
 90   PRINT"Train for Hither"
100   PROCforward
110   PROCdisplay
120   PRINT:PRINT"Train for Thither"
130   PROCreverse
140   NEXTI
150 PROCdisplay
160 PRINT"journeys' end"
170 END
180
190 DEFPROCforward
200 A=3:B=1:C=8:PROCjourney
210 ENDPROC
220
230 DEFPROCreverse
240 A=2:B=0:C=4:PROCjourney
250 ENDPROC
260
270 DEFPROCjourney
280 PROCacceleration
290 REPEAT
300   Z=?(IORB)ANDC
310   UNTILZ<>C
320 PROCdeceleration
330 TIM=TIME
340 REPEAT
350   UNTIL TIME>TIM+200
360 ENDPROC
370
380 DEFPROCacceleration
390 FORT=25TO1STEP-1
400   ?IORB=A
410   DELAY=T
420   REPEAT
430     DELAY=DELAY+1
440     UNTIL DELAY>25
450   ?IORB=B
460   DELAY=1
470   REPEAT
480     DELAY=DELAY+1
490     UNTIL DELAY>T
500   NEXTT
510 ?IORB=A
520 ENDPROC
530
540 DEFPROCdeceleration
550 FORT=1TO25
560   ?IORB=A
570   DELAY=T
580   REPEAT
590     DELAY=DELAY+1
600     UNTIL DELAY>25
610   ?IORB=B
620   DELAY=1
630   REPEAT
640     DELAY=DELAY+1
650     UNTIL DELAY>T
660   NEXTT
670 ENDPROC
680
690 DEFPROCdisplay
700 CLS
710 row=8
720 REPEAT PRINT
730   UNTIL VPOS=row
740 ENDPROC
```

Program 7

Regular readers of the Bulletin will be well accustomed to remarks made tongue in cheek, not to mention faded metaphors. We would at this point in the story, like to draw your attention to a form of movement well beloved of setters of SEB examinations, namely acceleration from rest, followed by constant velocity, followed by deceleration to rest.

Questions on this pattern of movement are normally set in a completely abstract fashion, devoid of any means of relating to observation and measurement. Now the train under control of the above program follows this pattern of movement, which of course could be observed and analysed.

Control lines

Two of the four VIA control lines are accessible at the user port, CB1 and CB2. They have many functions and they differ from the 8-bit I/O lines in many ways. Some of their features are listed below.

1. The control lines are used singly, not in parallel.
2. They can be used to sense transitions as opposed to logic levels.
3. They give access to the VIA timers.
4. They can generate interrupts.
5. CB2 can be used to transmit 8-bit data, in or out, in serial form.

Their mode of operation is controlled by the bit pattern setting of two special registers, the Auxiliary Control Register (ACR) and the Peripheral Control Register (PCR). Details of this can be found in Section 2.4 of '6502 Interfacing'.

We will conclude this article with two program listings, one program being used to wait for a positive transition on CB1, the other to output pulses on CB2.

Wait for a positive transition on CB1.

```
10  BASE=&FE60
20  IORB=BASE
30  PCR=BASE+12
40  FLAGS=BASE+13
50  REM set bit 4 of PCR to detect
60  REM a positive transition on CB1
70  ?PCR=&10
80  REM wait for a positive transition
90  X=?(FLAGS)AND&10
100 IFX=0THEN90ELSEPRINT"+ve transition"
110 REM clear flag in IFR
120 REM by reading IORB
130 Z=?IORB
140 END
```
Program 8.

You will have to use a debounced switch to check this program's operation.

Output pulses on CB2

```
10  BASE=&FE60
20  PCR=BASE+12
30  REPEAT
40    ?PCR=&E0
50    ?PCR=&C0
60  UNTIL FALSE
```

Program 9.

The pulses should be viewed on a CRO since the frequency lies between 300 and 400 Hz. The effect is jittery since the Basic program is continually interrupted by machine language programs which service housekeeping tasks.

There will be other articles in future Bulletins continuing the story of BBC interfacing.

Surplus Equipment Offer

The following items of equipment are offered for sale, subject to the conditions laid down in Bulletin 116. Items with numbers less than 236 have already appeared in previous bulletin issues. Details of these items can be found in the relevant issue (number given in list). Items 236 to 240 are new stock. Because of the small number of new items we do **not** intend to hold a ballot. All of the items below are therefore offered on a first-come, first-served basis.

In addition to the listed items we also have stocks of switches, capacitors, other small components and a range of general chemistry/biology items. This latter stock comprises soda glass test tubes, plastic specimen containers, rubber bungs, tubing and filter paper, etc. Stocks of any particular item are fairly small but let us know your requirements and we will try to meet them.

Item 84	Bulletin 125	Photographic Fixer	30p per box
Item 89	Bulletin 125	Dry cells 1½V	£1.50 per 24 £8.00 per gross
Item 165	Bulletin 129	Bimetallic strip, 30cm	40p
Item 176	Bulletin 132	Impact adhesive, ½l tin	75p
Item 178	Bulletin 132	Bromide paper, WSG4, 16.5 x 21.6cm, box 100 sheets	£5.00
Item 179	Bulletin 132	As above but WSG2, 20.3 x 25cm, box 100 sheets	£6.00
Item 180	Bulletin 132	As above but WSG1, 20.3 x 25cm, box 100 sheets	£6.00
Item 183	Bulletin 132	35mm b/w film, 60-80ASA in cans of 1000'	£5.00
Item 185	Bulletin 132	35mm colour neg. film, 100ASA 61m in can	£10.00
Item 205	Bulletin 132	Kodak multipurpose developer for papers, 5l bottle	£3.00
Item 206	Bulletin 132	Ilfospeed paper developer, 5l bottle	£3.50
Item 207	Bulletin 132	Ilfospeed fixer, 5l bottle	£2.50
Item 209	Bulletin 132	Milliammeter, centre zero	£3.50
Item 212	Bulletin 132	Large wirewound potentiometer, 25W, 8R	80p
Item 215	Bulletin 133	12V motor by Smiths, double ended, 2″ spindles	£2.50
Item 216	Bulletin 133	'J24' 12V power supply	£3.50
Item 221	Bulletin 133	BC107/BC108 transistors	5p
Item 222	Bulletin 133	Speaker/microphone insert	30p
Item 223	Bulletin 133	Time clock and set switch by Smiths, mains,	£3.50
Item 226	Bulletin 133	Bromide paper, WSG2, 16.5 x 21.6cm, box 100 sheets	£5.00
Item 227	Bulletin 133	As above but WSG1 and 30.5 x 40.6cm, box 100 sheets	£6.00
Item 230	Bulletin 133	Veribrom F1, size as last item, box 100 sheets	£12.00
Item 231	Bulletin 133	35mm colour slide film Ektachrome, per cassette	60p
Item 234	Bulletin 133	Polaroid land film, per pack	£1.50
Item 235	Bulletin 133	6V lantern battery, spring terminals	70p
Item 236		Photographic paper, Kodak bromide, WSG3, 16.5 x 21cm (6½ x 8½″), box of 100 sheets	£5.00

Item 23 '   Black and white 35mm film, Ilford FP4
cine, 125 ASA, 200' in can   £6.00

Item 23J   Photographic timer, 0-60s (0-6s x 10)   £6.00

Item 23.)   Colour slide film, 120 size, Ektachrome
160ASA, (artificial light - tungsten)   70p

Item 24.)   Prismatic compass, hand bearing type
by Stanley of London, each   £7.00

*   *   *   *   *

Display Laboratory

Those of you who have visited SSSERC will know our distinctive Victorian premises. Many will also know that the building, from time to time, reminds us of its age. The last major reminder was when the display laboratory ceiling fell down in 1982. We are now pleased to announce that repairs, redecoration and reorganisation are virtually complete. The display area is thus again open for business. Teachers coming to Edinburgh are welcome to visit us, 9 a.m. to 5 p.m. every weekday and 9 a.m. to 1 p.m. on the first two Saturdays of every month (excepting national holiday weekends).

We give below some indication of the type of equipment which will be on display during the next two to three months. However, because we also run such exhibitions on a national basis, on occasion some items may be out of the Centre. If you are coming to see some specific item it is always wise to telephone us first.

At present the display is organised around three themes.

a) Microelectronics, interfacing and simple control

A variety of demonstrations is set up using a selection from the following:

Apple II; BBC model B; Pet; Vic 20; ZX81 and ZX Spectrum.

b) Foundation Science

A growing collection of d-i-y items is on display, including our versions of items from National Examplar materials as well as SSSERC suggestions for additional or optional activities. These include experiments on 'alternative' energy; materials testing, health and fitness and human behaviour.

c) New commercial apparatus

A collection of the newer items from a variety of manufacturers or suppliers. This currently comprises:

i) i)   Laboratory apparatus, for example -

The new range of microscopes from **Philip Harris**. Three models, 'Junior', 'Intermediate' and 'Advanced'.

Dispensing containers from **Bettix Ltd.** (See "Trade News").

From Griffin and George we have a number of items including -

- the Ohaus 'Brainweigh' dual range electronic balance B3000D.
- the 'minimag' magnetic stirrer
- new chemistry and physics power supplies
- pressure sensor / transducer
- digital meter and accessories.

ii)   Electronics apparatus and microprocessor tutor/ demonstrators

- 'Experimental Electronics Kit' (for primary) from **Cambion**
- part of the 'Micropippa' range from **Irwin-Desman**
- 'Digital Electronics Units', Griffin and George
- 'Digital Logic Kits - STEM board and mini-board' by **STEM**

Out on evaluation but due back soon are:

- 'Microprocessor Tutor/Demonstrator MkII', Philip Harris
- 'Microprofessor' from Philip Harris
- 'Microprocessor Tutor Kit' by **Limrose**
- 'One-bit Microprocessor' from **Unilab**.

*   *   *   *   *

Trade News

Bourdon Gauges

It is interesting to watch how equipment comes onto the market in surges. We mentioned in Bulletin 134 the splendid looking Bourdon gauge with 6″ dial from **Artec**. The same firm now stock a range of inexpensive gauges with 1¾″ dials at £4.90 each. There is of course a penalty to pay for investing such a tiny sum of money in a pressure gauge. The scales are marked in bars and $lbfin^{-2}$ and the pointer indicates zero at normal atmospheric pressure. The latter snag can be overcome by removing the meter from its case and redirecting the pointer to read 1 atmosphere. This operation is straightforward. The pointer is friction held on the spindle and can be prised off by careful levering. The gauge ranges available are 0 to 1.6 bar, 0 to 4 bar and 0 to 10 bar.

Digital multimeters

The March '83 edition of "Wireless World" carries adverts for eleven different models of digital multimeter costing under £40. It is obvious that inexpensive digital multimeters are now widely available. We have bought and used three models. Unfortunately the performance of our samples has been disappointing. The details are given below.

1. Metertech, model no. 3T

18 ranges, made in Taiwan, supplied by **Industrial and Biological Electronics Ltd.** at £43.50 plus VAT.

- performs well.

2. Lascar, model DP 2010

20 ranges and diode test, made in England, supplied by **Lascar Electronics Ltd.** at £27.40, available also in kit form at £23.62.

- the instrument has to be calibrated by a multiturn trimming potentiometer on delivery. Ours has developed an intermittent fault that reduces readings by 10% of their true value.

3. Hung Chang, model 6010

28 ranges, made in Korea, supplied by **Armon Electronics Ltd.** at £29.95.

- meter has developed an intermittent switch fault preventing it measuring current or voltage. Armon say they will replace faulty meters within one year of purchase.

Whilst we cannot condemn cheap digital multimeters as a whole, based on a sample of three there is a cautionary tale in this. The market does seem to be catch as catch can at the moment. It does seem significant that RS Components have had severe manufacturing difficulties with their "slimline" meter introduced in November '82 and discontinued in March '83.

Will you let us know of your experiences please? We will be better placed to offer advice if we have a larger sample to go on.

Finally, a feature to which we should draw your attention is that digital multimeters are sometimes available from local firms in the electronics trade. For example in our own case **Scotcomms** of Portobello have at present a small batch of ARC digital multitesters, model KD-200, at £29.95. This model features auto-ranging and bipolarity making it very easy to use and ensuring that 'switching perhaps a weak point in such meters is kept to a minimum.

Magnets

We recently obtained a catalogue on permanent magnets from a firm called **Magnet Applications Ltd.** Some of their items, with prices, are shown below:

- rectangular ferrites

12 x 7.7 x 6mm	7p each
20.5 x 7.7 x 6mm	12p each
42 x 25 x 6mm	20p each

- circular ferrites

12 x 6mm	10p each
20 x 8mm	25p each
29.6 x 9.5mm	29p each

- alnico 600 bar magnets

square bar	103 x 6 x 6mm	£2.53 each
round bar	30 x 6mm	46p each

Other items of interest are:

1. Lattam magnets which are manufactured into blocks and used where sheer strength is more important than direct pull.

2. Flexible magnets which are produced by loading a suitable elastomer such as rubber with a ferrite powder. The resulting mix can be manufactured into sheet, ribbon or strip. Flexor ribbon is available at 89p per metre.

3. Placor magnetic sheet which is obtained by bonding flexor sheet on to steel sheet. This produces a thin magnetic sheet which is almost rigid.

Motors

Besides the usual sources of electric motors referred to in the article on Windpower in "Foundation Science Notes" one cheap source is **John Bull (Electrical) Ltd.** Their battery motors are intended to operate at voltages above 1 volt but not above 12V. The type most akin to the old Orbit series or to the Mabuchi 1½V to 4½V motors found in hobby shops, is their BM8 which sells at 60p. Postage and packing is 60p extra for orders under £12.00. This motor is in fact made by Mabuchi, but has a number of differences to the Mabuchi referred to above. The John Bull motor has no mounting bracket nor external terminals. The plastic end cap may be prised off and leads soldered to the contacts at the end of the copper brushes. A further slight disadvantage is that these leads are most easily brought out through the same end as the spindle and would require to be taped to the motor body.

John Bull also makes available a sample kit of one each of six sizes of motors for £2.95 plus 60p p&p. The idea is that you can identify the motor most suitable for a particular task and order it. Discounts are available for quantity, 10% for 10-49 of any one motor and higher discount for larger quantity. A number of accessories such as switches, reversing switches, speed controllers are also available.

Dispensing containers

These have been coming on to the market from a variety of suppliers over the last year or two. Our attention was recently drawn to one relatively inexpensive source of these. Bettix Ltd. actually manufacture such dispensing containers. These Bettix containers are designed to dispense measured amounts of liquid by a single handed operation.
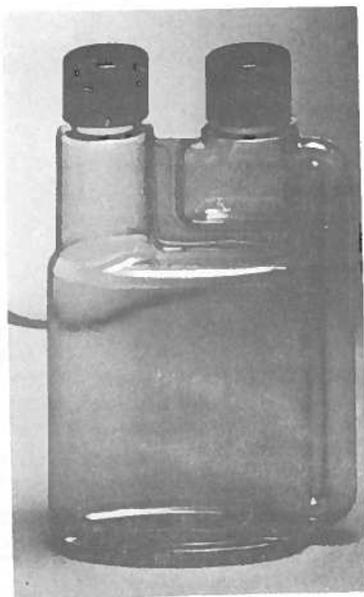
Fig. 1.

In use the double chambered dispenser is gently squeezed, transferring liquid from the main chamber to the smaller, dispensing chamber. The cap is then removed and the measured amount dispensed. Dispensing chamber sizes of 5cm³ upwards are available with main chambers of 100;250;500cm³ and 1 and 2 litres. Guide prices for these per 100 are £9;£13; £18 and £30 respectively. The only snag is that to obtain these dispensers at such competitive prices means meeting the Bettix minimum order conditions of £50 per order.

'Stick-off' labels

Self adhesive labels guaranteed to wash off in warm water have obvious advantages. Such labels are available from **Camlab**. The sizes range from 25 x 25 to 76 x 32mm at prices from £5 to £16 per carton. Each carton contains 2,500 labels on a dispenser reel. It is claimed that these labels can be used with a typewriter as well as felt-tip or ballpoint pens and that they will withstand periods in fridges or freezers without affecting the ''wash-off'' facility.

Stop press - Olympus HSC

We have just been informed that due to a frustrated export order Griffin and George are offering the Olympus HSC 'H' grade microscope at a special price. This model catalogue number MJA-500-F is reduced from £148 to £105 whilst these current stocks last. At this price the HSC offers exceptional value for money to anyone looking for an 'H' grade/'A' level microscope.

*　　　*　　　*　　　*　　　*

THE SCOTTISH ASSOCIATION FOR BIOLOGICAL EDUCATION
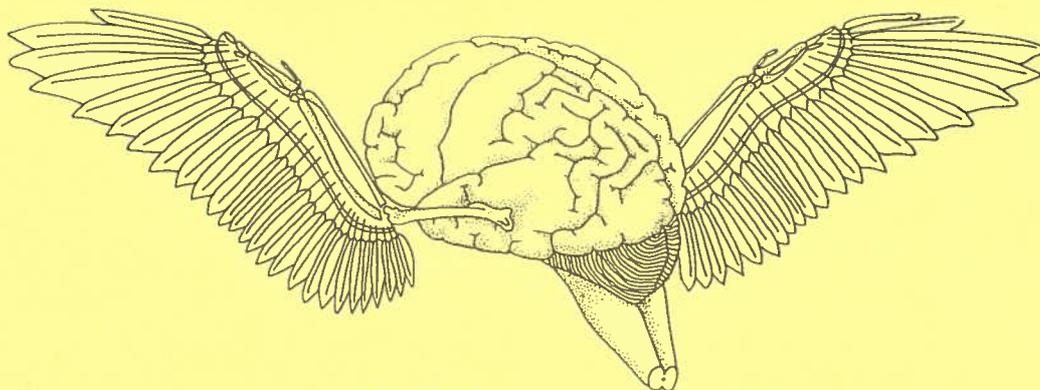
SABE

SIXTH ANNUAL SYMPOSIUM MAY 14TH 1983

at THE COUNTRYSIDE COMMISSION FOR SCOTLAND, BATTLEBY, PERTH

SYMPOSIUM COMMENCES 9.30 a.m.

Programme includes:

Presidential address by Professor W.D.P. Stewart, F.R.S. of the
University of Dundee.

Illustrated talk on the Work of the Countryside Commission for Scotland
by the Deputy Director, Mr T. Huxley.

Lecture by Dr D. Lilley of the Department of Biochemistry, University of Dundee,
on 'Recombinant DNA Practice and Potential'.

Colloquy: H.M.I.s Mr H. McLaren, Dr S. Milne, Dr J. Jackson,
Implementation of Munn-Dunning Development Programme.

Fee for Symposium, including lunch and morning coffee, £5.50.

Please send cheques, or request detailed programme to:

Gordon Swann, Hon. Secretary, S.A.B.E.,
1 Dovecot Road,
Edinburgh EH12 7LF.
Tel. 031-334 4769, at work 031-443 7111, Extn. 220.

S.S.S.E.R.C.

CONTENTS

Bulletin 135

April 1983