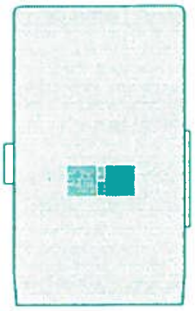
SCOTTISH SCHOOLS EQUIPMENT RESEARCH CENTRE



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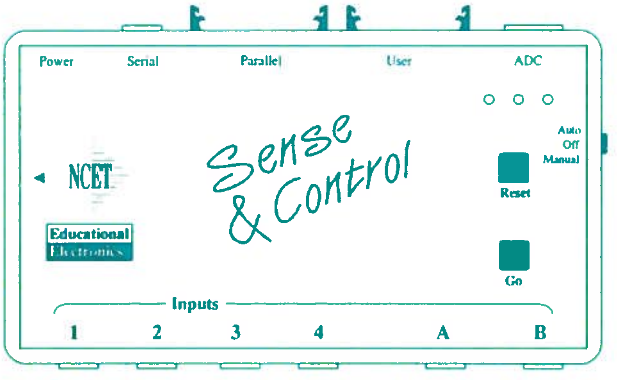
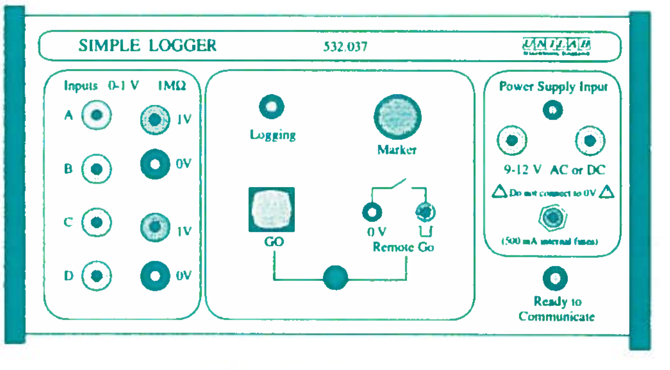


Sense & Control

Which datalogger?



Simple Logger

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STERAC (Science and Technology Equipment Research and Advisory Centre).

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INTRODUCTION

Apology

We apologise for the late appearance of this issue of the Bulletin. This was caused partly by loss of staff from the JSA project team and partly by diversion of effort into additional management meetings. The major reason for the latter was yet another crisis over the future funding of the Centre.

Heisenberg's Principle rules, OK!

Dates for your diary

SABE Symposium

The Annual Symposium of the Scottish Association for Biological Education will take place on Saturday the 20th of April at the Royal Botanic Gardens, Edinburgh. SSERC will provide one of the practical workshop sessions.

Technology Education Courses

In mid-year Northern College (Dundee Campus) will again be running its highly successful Summer School in Technology. The School will run from 17th to the 28th of June. There will be a range of courses on offer covering technology teaching at a number of levels. SSERC will, as usual, be providing tutors for a practical workshop for a course relevant to Technological Studies. That will run from 17th - 19th June. Further details from Dr.F.R.Partington, Northern College, Dundee Campus (see Address List).

Other Announcements

TTA - change of name

We have recently received official correspondence confirming the change of name adopted by the then "Technical Teachers' Association" at their Annual Meeting last year in Perth.

The new title is: "The Technology Teachers' Association" and this should be used in future correspondence with, or reference to, the association. The current Secretary of the TTA is Mr.T.K. McIntyre and his address is given on the inside front cover of this bulletin issue.

SSERC Practical Guides

Chemistry

The third and final (sighs of relief) volume of our "Practical Guide for Standard Grade Chemistry" was printed and published in February of this year. This volume covers Topics 14 to 16 inclusive. It also contains short form versions of printouts from our Chemistry Equipment and Chemicals Database together with details of the SSERC Graphics Library.

Copies of Volume 3 should by now have been distributed, one copy per school, from SCCC in Dundee. Further copies of Volume 3 are available from SSERC at £5 per copy inclusive of postage and packing. Payment please, with any order totalling less than £15. This should be by cheque or postal order made out to SSERC and crossed. Overseas customers please note that we only accept payment in Sterling.

Physics

Guides for Standard Grade Physics are entitled "Technical Guides". With the benefit of hindsight, this we now recognise was a mistake. Modern school managements with all of that sophisticated internal communication theory (Mushroom systems etc.) at its command coped with this title in an entirely rational and predictable way. They sent the "Technical" guides for Physics to the Technical Education Department - where else?

To date, only Volume 1 covering Units 1 and 2 has been published in final, bound and glossy form. Attention was then switched to ensuring coverage of the whole course by means of "Provisional" guides. These were distributed through Advisers. Work has started on revising those draft versions. Posh printed and bound volumes to cover the rest of the course will appear - eventually.

Biology

For a variety of reasons - not the least being shortage of specialist staff - there will not now be any equivalent practical guides for Standard Grade Biology.

SSERC made a significant, if quiet, contribution during the initial phases both before and during the life of the local writing groups. Since then our effort has had to be concentrated on evaluating equipment for more novel aspects of the course (e.g. within Topics 5 and 7) and in sorting out a number of practical activities which were causing difficulties. Technical articles and notes on these minor problems have been published in the Bulletin from time to time. That continues, see - for example - the "Technical Articles" section in this current issue.

TVEI OLNET

"OLNET" is (was?) an acronym for "Open Learning Network" centred on a project in Fife and funded by the Training Agency (who they?) through TVEI (what that?). This project produced a lot of potentially useful material for science and technology related topics and courses. TVEI/FIFE/OLNET is now ONM (Officially No More - sorry Magnus - no pun intended!).

(These OLNET materials - where they?).

Latterly, because of our Joint Support Activity (JSA) for TVEI we have been getting such enquiries. Dissemination of the OLNET materials was patchy. Packages were distributed to all TVEI Projects in Scotland but, as we understand it, there were no arrangements to make them more widely available. A list of the materials should however be obtainable, we are assured, from the TVEI Unit Offices in Glasgow (see Address List, inside front cover of this Bulletin).

Industrial Study Videos

In the latter part of last year SATRO North Scotland produced a video pack as an aid to the teaching of Technological Studies at Standard Grade. The package consists of four videos, supporting notes and problem solving briefs. It provides examples of the types of engineering problems met with in industry. These examples then provide opportunities for problem solving activities in the Final Project exercise.

The material draws from the experiences of four North-east of Scotland companies: Glenfiddich Distillery; Wiggins Teape Fine Papers Ltd.; Aberdeen Journals Ltd., and Allarburn Farm Dairies Ltd. Teaching staff in Grampian Region schools assisted in the production of the material which was supported financially by the DTI (through the Industry Department Scotland) and the Standing Conference on School Science and Technology. This allowed for one free package to be sent to each secondary school in Grampian Region and one to each of the other Scottish EAs.

These resources are now being made available for wider circulation. Each package, consisting of the four videos plus the supporting booklet in a presentation case costs £45 inc.p.& p. Orders to SATRO North Scotland at the address given on the inside front cover of this issue.

Technicians in school science

The long awaited results of the deliberations of the ASE's Laboratory Technicians' Sub-committee have recently been published. Their 91 page report is entitled : "Technical Support for School Science" ASE, December 1990 ISBN 0 86357 142 5.

This is now available from the booksales department of the ASE (see Address List) at £7-50 per copy plus postage. Not the least useful sections are those copyright free pages with policy statements on the importance of technicians and an updated formula for calculating levels of provision.

Fig. 1. a few seconds after ignition

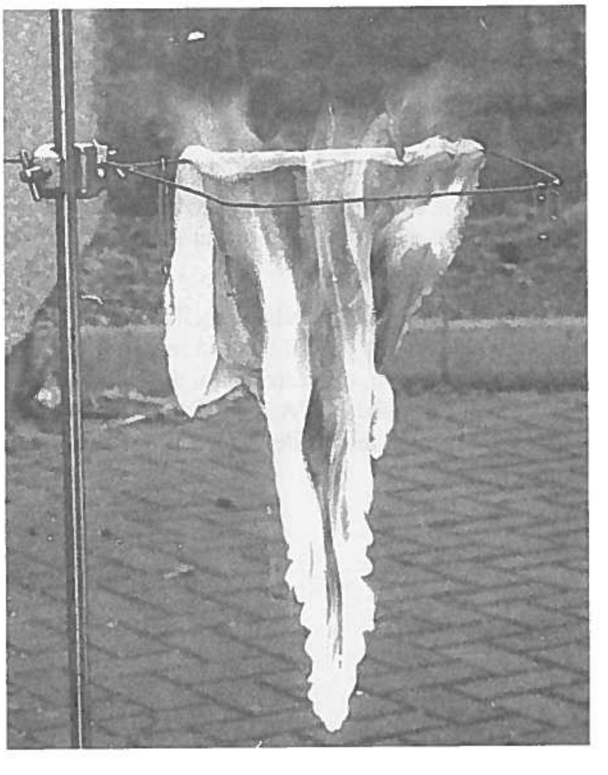


Fig. 2. half a minute after ignition

SAFETY NOTES

Shell suits

"Shell" suits, for all you other old fogies out there, are lighweight versions of track suits usually varied in hue and shiny in appearance. They are the latest fashion in "smart casual" wear. Well, they were when I heard about them. Which probably means that now they aren't.

It has been pointed out to us that these garments are often made of non-flameproofed, man made fabrics. Some carry a warning label to the effect that they should be kept away from flames. It seems that, in schools with a relaxed (modern, enlightened, sloppy, spineless pinko - what you will) attitude to pupil standards of dress, shell suits are regularly being worn in practical subjects. We have therefore been asked whether or not we consider such clothing to present a significant fire hazard in laboratories and practical rooms.

We have a preliminary opinion from one major manufacturer that their suits (polyamide and polyester outer with a cotton/ polyester lining) are not suitable clothing for laboratory work. Our initial flammability test on one of their garments certainly bears out that opinion (Figure 1 opposite).

Obviously other clothing which may be worn in labs may also be made of flammable man-made materials. That is, to use COSHH-speak, the hazard may be similar. However no one has yet suggested that all such clothing (nylon shirts or blouses for example) be banned from laboratories. To continue the COSHH parallel though, whilst the hazard may be similar, the risk with shell suits may be much greater.

In the particular garment shown in the photographs, the cotton polyester mix lining had a very open weave. When a flame was applied to the nylon outer it tended just to melt and itself was difficult to fully ignite. Once the flame penetrated to the open weave inner the whole garment was quickly consumed by flame. Add to that the usual loose fit of these suits, the tendency for them to be worn open with the lining exposed, their corners possibly flapping over a bench and the risks of a serious accident may well become significant.

We have now written to a number of other firms and are obtaining further samples for testing. We would also like more information, from a wider cross section of schools, on the likely extent and seriousness of any problems. To that end we would be pleased to hear from anyone in a school where this type of clothing has already been recognised as a potential safety problem.

Asthmatics and practical work

We have received a report of an S3 pupil experiencing a severe asthmatic attack as a result of carrying out a practical exercise as part of the Standard Grade Biology course.

This activity is described in the Exemplar material for Topic 3 "Animal Survival" sub-topic "Water and Waste" (Water in Breath) Pupil Sheet G3. The investigation involves breathing out into a tube cooled in iced water. The pupil misinterpreted the instructions and breathed both in and out through the cooled tube rather than as indicated on the sheet - in from the surrounding air and only out into the cooled tube.

The resultant prolonged breathing of the cold air brought on the severe attack of asthma (as can happen in more natural circumstances, in very cold weather for example). We have therefore been asked to bring this incident to the attention of a wider audience. It is obviously important that the described procedure for this pupil activity is adhered to.

There is however the wider principle that teachers of practical subjects should be made aware, through the school's guidance and other procedures, of such potential health problems in individual pupils.

Pupils with breathing difficulties, particularly those involving sensitisation and allergy should surely be made known to science staffs. They tend also to be more acutely affected than usual by a range of gases and fumes even at concentrations so low as to have negligible effects on others. Specific examples of such may include zinc oxide fume (philosopher's wool) and mere traces of chlorine gas[1]

There are other instances where even mild physical exertion could in some cases cause problems for such pupils. Many of these involve the use of pupils themselves as the experimental subjects, usually in fitness monitoring or related topics. Most by now are well documented (see, for example Hazcards, original 1981 edition, biology cards on Stress). Others need nothing more than common-sense to spot.

One difficulty is that pupils rarely volunteer to identify themselves as potentially at risk. This is for a variety of reasons. Peer group pressure is not the least of these. Some schools and departments may thus need to take more positive action to identify and protect such children without restricting unduly their participation in practical work.

Reference

1. "Respiratory Sensitisers : A guide for employers", HSE, 1990. (From local HSE offices and HSE Enquiry Point 1).

[1] Many materials of natural origin can also cause sensitisation and allergy. The HSE have recently published a guide on respiratory sensitisers for employers [1] which provides useful background information to this subject.

"Competent persons"

This subject was touched on in the "Safety Notes" section of Bulletin 167. There the contexts were provided by the Pressure Vessels etc. Regulations and HSE Guidance Note GS23 on electrical safety in schools. We were encouraging educational managers to think more carefully about what constitutes competence to carry out certain tasks required by Health and Safety legislation. In so doing we may have left individual employees, those who actually carry out such tasks, feeling more than a little exposed.

Fear not! The position has now been elegantly clarified by no less a personage than Mr.J.A.W. McDonald, Head of HSE Policy Branch A. This was in a reply to correspondence in "The Safety & Health Practitioner" [1] on the meaning of "competent person" in the context of the Pressure Vessels etc. Regulations [2].

Lack of space precludes quoting the letter in full and interested readers are directed to the original reference. The nub of the matter lies in Mr McDonald's useful clarification of what is meant by "person". He points to a history of ambiguity because of inherited Health and Safety law which has not previously laid any specific duties on "competent persons" but only on the user of their (or its?) services. Therefore the ambiguity, it is claimed, caused little or no difficulty.(We're not sure we would wholeheartedly agree with that).

The 1989 Regulations [2], for the first time, have imposed specific duties directly on the "competent person". It thus became necessary to define the term and to say whether it means the company, the individual employee carrying out tests and examinations, or both.

Consultation led HSE to the conclusion that the "person" who is "competent" has to be the company (or other corporation providing a legal entity - such as a Council) as a corporate body or person and not the individuals employed by it to carry out the examinations. The two major reasons behind this conclusion were:

a). the generally accepted principle that employers are responsible for the work of their employees; and

b). that the work requires to be co-ordinated and managed.

This is important for the individual school technician or other employee who is required to undertake this kind of inspection and testing work on an in-house basis. It provides reassurance as to the limits of their individual responsibilities. Their signing of an equipment test report form, for example, merely records that the examination was carried out according to a set procedure and that, to the best of their knowledge and belief, the condition of the equipment was as then recorded.

Unless the individual has been deliberately negligent in some way, they would seem to have nothing to fear from signing such records. The overall duty rests with their employer - as the corporate, competent person - to ensure that the systems are sound, properly set up, managed and monitored. If things go wrong it is those aspects which will be looked at first.

References

1. Correspondence, p.11., "The Safety & Health Practitioner", November 1990.

2. "Health and Safety Commission : The Safety of Pressure Systems and Transportable Gas Containers Regulations 1989 : Approved Code of Practice (ACoP)" COP 37, HMSO, ISBN 0 11 8855 14 X.

The HSC and Stress - correlation or causality?

Yes, a subject not entirely divorced from a discussion on perceived duties and responsibilities. These days, it seems, accountability is an altar at which all must worship. There can be no objectors - however conscientious. That trend, together with a host of other professional pressures, may make for misery in any walk of life.

A while ago, the Health and Safety Commission identified occupational stress in education as a health problem which needed to be more seriously addressed. The results of the deliberations of their Working Group have now been published under the Education Service Advisory Committee's banner as:

"Managing occupational stress : a guide for managers and teachers in the schools sector" [1].

After our discussion, above, on their responsibilities some technicians must be wondering why they weren't included in that title.

Stress is not something normally covered in our Health and Safety remit. We admit though to fascination at the HSC's choice of illustration for the cover of its guide. This shows a clearly miserable teacher, heavily lined of face. In front of him is a pile of ring-binders and files. At the top of this pile is a bulky file, from the National (sic) Curriculum Council, entitled "Technology". The next, immediately below, is a guide to the Local Management of Schools.

It would be asking too much, I suppose, of the HSC and of the HSE's well-known and deep-seated sense of humour, that at least one the folders so illustrated should be entitled "COSHH" or "Electrical Safety in Schools".

It is nevertheless an interesting wee guide. It's one we recommend that you read. We did. Now at least we know why we sometimes get so miserable!

Reference

1. "Health and Safety Commission : Education Service Advisory Committee : Managing occupational stress : a guide for managers and teachers in the schools sector", HMSO, 1990, ISBN 0 11 88559 X. (£2.00 per copy).

COSHH Risk Assesments

Speaking of professional pressures - by the time you read this our booklet on risk assessments for project work and novel activities [1] should be back from the printers.

We apologise for the time it has taken to get this guide into its final printed form. Allen Cochrane, SSERC Depute Director and its principal author could have finished it months ago were it not for a number of problems. The biggest of those was lack of time for writing and researching the guide. This was because he was far too busy meeting EAs' demands for COSHH courses and answering their questions in 'phone calls and correspondence!

Allen's other major problem has probably made the publication more useful in the longer run. It turned out that a number of important pieces of data were just not widely or freely available, at least not in any meaningful and usefully organised form. Specifically there were problems over sensitisers and carcinogens - both proven and potential.

As a result of that work, the booklet now has appendices with a wealth of basic data. For those who wish it there is also further information on risk assessment techniques. For those whose roles require them to do so, there are details of how to go beyond the relatively simple methods and approaches needed just to complete the risk assessment forms in the body of the guide.

For Scottish EA establishments and Scottish independent schools currently in membership the booklet will be £4 per single copy. Discounts are available on bulk orders and SSERC/EA correspondents will receive details of these. The price to all other customers will be £7-50 per copy (including postage).

Reference

1. "Preparing COSHH Risk Assessments for Project Work in Schools", SSERC, 1991.

Autoclaves - liquid loads

We have already evaluated a number of models of autoclave both for use in Standard Grade Biology Topic 7 ("Biotechnology") and in connection with work for the Strathclyde Microbiology Review Group. We still have one or two models to look at, but a summary of our results will eventually appear in the Equipment Notes section of a bulletin issue.

In the meantime we have come across a problem which is worth mentioning here in Safety Notes. This is the difficulty in ensuring sterility in larger liquid loads such as of the relatively large volumes of media required for work with fermenters - especially those available on the commercial market [1]. Volumes in excess of a litre are not unusual and often upwards of 1.5 l may be needed for a fermenter or bioreactor vessel.

We draw your attention to the results of our tests which suggest that particular care is needed when such large volumes of liquid are to be autoclaved. There may be serious difficulties if media are autoclaved in situ, inside the fermenter vessel itself.

We found that ensuring proper heat penetration meant using lengthy cycle times. It was not unusual to find with ca. 800 cm^3 of medium in a 1 l polycarbonate vessel that even a double cycle (30 minutes holding time at 121°C) failed to kill spores of *Bacillus stearothermophilus* within the medium. Glass vessels of similar geometry seem to allow better heat penetration. Approximately 1.5 l of medium in a Harris fermenter was effectively sterilised by a double cycle at 121°C.

Once the scale of container is reduced, the problem effectively ceases. Over 1.5 l in say, 4 lots of 400 cm^3 (in 4 x 500 cm^3 glass medical flats) may be reliably sterile even after only a normal 15 to 20 minute holding time. This procedure of course brings its own problems since aseptic transfer of medium from four medical flats to a fermenter vessel will rarely be a 100% sterile transfer. That in turn may mean restrictions on the kinds of organisms and media which may be used [2].

We must emphasise that the biological test with *B. stearothermophilus* spore strips is a particularly demanding one. Few, if any organisms, likely to contaminate freshly and properly prepared media would even come close to surviving the way it can. In addition, some of our positive results only occurred after prolonged incubation of the autoclaved spore strip broth cultures - indicating that only a very few spores had survived. Long before such time had elapsed in a practical exercise with a fermenter its contents would have been disposed. It is also necessary to consider the other means used to limit risk in fermenter work - use of a large inoculum etc.

What we do conclude is that care should be taken to prolong the holding time when liquid media are sterilised in lots where the volume in any one container exceeds 500 cm^3 or so. Regular inclusion of a test strip in an appropriate part of the load (one of the vessels with medium) is recommended. Spore strips are inconvenient for such routine testing and one of the proprietary time and temperature colur indicators should be substituted.

References

1. "Fermenters - Part I", Science and Technology Bulletin 166, SSERC, June 1990.

2. "Topics in Safety", Chapter 5, ASE, revised edition 1988.

Environmental Protection Act 1990

Yes, 'fraid so, yet another piece of leglislation aimed mainly at others but which may cause some problems for schools. At the time of writing, it seems though that its practical implications for the education sector may be minimal.

The Act [1] is however such a ragbag of provisions, that it was difficult at first to be sure about its likely effects on school practices. For example, the provisions on waste disposal will marginally affect schools but the relevant bits have to be sorted out from other sections. Those include things like whose responsibility it is to round up stray dogs and abandoned supermarket trollies. Currently it looks likely that we may only have to fully brief EAs on detailed but minor changes to their responsibilities.

Teachers and technicians may however appreciate a brief summary of the changes which affect arrangements for the disposal of "special waste". Broadly there will be little change from what was required under previous leglislation the provisions of which we outlined in Bulletin 167 [2].

Solid waste

The regulation of ordinary or "controlled" waste collected regularly by District Councils remains much the same as before under the provisions of the Control of Pollution Act 1974 [3]. The 1974 provisions for, and definition of, "special" waste also still apply in pretty much the same way [2]. Two significant changes however are that:

- the "producer of waste" is now responsible for ensuring that the carrier who collects such special waste from the producing premises is reputable and reliable (in common parlance - is not a "cowboy") and

- the definition of "special waste" has been broadened.

Previously the criteria for deciding whether waste was "special" hinged on its potential for harming the health of humans or animals. It is now proposed to also explicitly include substances which present a risk of harm to the environment. A new hazard warning symbol (a pictogram of a fish beside a tree) will be used for such "ecotoxic" substances.

Disposal via drains

In Bulletin 167 we gave examples of levels of "permitted discharges" to drainage systems, as consented to by one Scottish River Purification Board (RPB) [2]. Had we then also quoted figures from other boards (or NRA regions in England or Wales) the variations would have been obvious. Under the 1990 Act the Secretary of State for the Environment has taken powers whereby he may require discharges of some specific substances to be more severely and uniformly restricted.

Such substances are published in a "Red List" [4] the first edition of which contains 23 named chemicals. All RPBs and NRA areas are now required to set strict environmental quality standards for these listed substances. In the first issue of the red list many of the chemicals are pesticides, mostly insecticides. Some others however are likely to be held in school science departments notably:

- mercury and its compounds;

- cadmium and compounds;

- certain chlorinated hydrocarbons namely

1,2-dichloroethane and

"trichlorobenzenes".

That does not necessarily mean, for example, that you are prevented absolutely from using mercury salts or Millon's reagent. It does mean that you should make every effort to reduce the quantity which may have to be disposed of. This involves looking at the need to use such substances at all, at possible substitution, reductions of scale and recycling through recovery and re-use.

Yes - shades of COSHH - risk assessment questions return to haunt you! Here the aim is to control pollution and risks to the environment rather than the more direct risks to individuals. It comes however to the same thing in the end.

/continued

Integrated pollution control

Commercial undertakings are encouraged to carry out such assessments and to set up integrated pollution control schemes ("IPCs"). The overall aim is build pollution control planning into production processes in order to produce less waste and to recycle as much as possible.

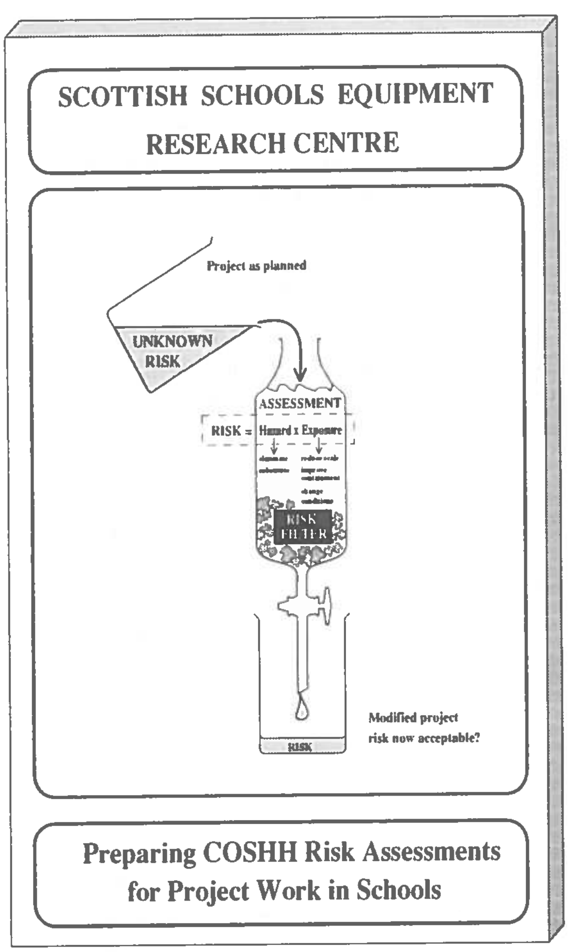
In educational laboratories the scale of working is relatively small but there is value in adopting such a philosophy wherever possible. For example in the case of Millon's reagent substitutes are available. Even where Millon's is used it can be treated afterwards with warm, acidified sodium hypophosphite (phosphinate). This reduces the mercury(II) ions to metallic mercury which later can be re-dissolved in nitric acid, so making fresh Millon's reagent.

Other processes which lend themselves to such simple recycling include ester preparation in one lesson and subsequent hydrolysis in another and salt preparations with subsequent usage for electrolysis [5].

It would be no bad thing if syllabus writers too began to think about integrated pollution control as a desirable element of curriculum development. That would not only allow valuable teaching points to be made. It could begin also to address part of a serious and growing problem in science education. This is the irony that a significant number of young people see the sciences as fundamentally unfriendly to the environment. For that and other reasons far too many are already voting with their feet.

References

1. "Environmental Protection Act, 1990", HMSO, 1990, ISBN 0-10-544390-5
(To you, only £14-45 a copy).
2. "Disposal of chemicals", Science and Technology Bulletin 167, SSERC, September 1990.
3. "The Control of Pollution Act (Special Wastes) Regulations 1980, S.I. 1980 No. 1709.
4. "Proposals to Control Inputs of Dangerous Substances to Water", News Release 1269/89, Scottish Office.
5. "Disposal", Chapter 13, "Topics in Safety", ASE, 1988. ISBN 0 86357 104 2



*** For Scottish EA establishments and Scottish independent schools currently in membership the booklet will be £4 per single copy.**

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*** The price to all other customers will be £7-50 per copy (including postage).**

Feature Article

Electronics "Systems Boards" - Friend or Foe?

The results of a SSERC survey are summarised. Information and comment on reliability, ease of use and effective learning are presented.

Introduction

Our thanks to all who completed and returned the questionnaire and our apologies for the delay in publishing the results. Those who have been following the editorials in recent bulletins will be aware of some of our problems in attempting to keep all of our technological balls in the air.

Analyses of results are given mostly on a quantitative basis, with a summary of the written comments. Where percentages are used these are the relevant replies as a fraction of all respondents given as a rounded percentage. Totals not equalling 100% usually result from such roundings.

The Survey Results

Level and quality of response

Many of the comments made on the number and nature of returns for our recent survey on eye protection could probably equally apply here.

A total of sixty six replies were received which gives a percentage return and sample size comparing favourably with those of polls on matters political. From the comments section on the form it would appear that a number of returns were departmental distillations. It can thus be reasonably assumed that each would encompass more than a single teacher's experience. For the sake of simplicity, and the small numbers involved, we have integrated all replies.

The majority of returns were thought to be from Physics Departments, the clue being the numbers using Alpha and MFA kits. E&L boards are more popular with Technology Departments. The boards were in use roughly in the order: Alpha 79% (including MFA), E&L 18% and 3% other. In contrast much of the discursive comment came from members of Technical Education Departments.

Experience in use of boards was from one to four years.

Analysis

Reliability and Board Failure

Interestingly the number of years the boards had been in use did not make for any significant differences in the answers on reliability or board failures. Responses were as follows:

67% fairly reliable

18% reliable

11% unreliable

Therefore just over a tenth of respondents reported the boards they used to be "unreliable". What does this mean? Because of the nature of the question put, it can only be taken to mean that one school in ten considered that their boards were unsatisfactory because of unreliable connections, component failures etc (see however our comments in "Summary : recommendations p.11).

Reported component failure patterns reinforced our own findings from both direct, practical and third party narrated experiences. The major failures mentioned were:

transducer driver 24%

thermistor 20%

power regulator 15% (Alpha)

solenoid 8%

Safety and Ease of Use

There was 100% agreement that the boards are safe and simple to use. (But please refer to our caution in Bulletin 168 [1] regarding the Alpha Power Regulator, diode failures and eye protection).

Classroom Management

Although there was total agreement as to ease of use there was no unanimity as to whether this is to be seen as an advantage to classroom management. 11% felt the ease and speed of use was a disadvantage. While it could be fun and all the pupils experienced success - to paraphrase the comments from more than one reply - "the level of understanding developed is minimal".

Integration of boards -in main unit projects.

This question, which refers to Technological Studies, was not seen as relevant by some respondents; 23% not even answering it. Responses from those who did were:

simple 8%

fairly easy 65%

difficult 27%

These responses we found confusing. They contrast with our own experience from the courses we run for teachers of Technological Studies. Those teachers have made us aware of problems in both material management and in using boards with other components - structural and mechanical - both in main unit and final project models. The answer to this question could have been distorted by the greater number of replies from physics departments, where there is no syllabus requirement for such projects.

Back-up materials

Such materials include pupil workcards, teachers' guides etc. Of those departments which had been using Alpha boards for less than three years, 70% suggested there was not enough supporting resource material. Of those departments which had been using the boards over a longer period, 57% opined that back-up materials were sufficient.

With E&L boards there was no such difference of opinion, 79% suggested that back-up material was deficient.

These results probably reflect differences in the quantity and quality of the manufacturer's printed support material provided with sets of boards and resources produced by third parties. The latter are frequently linked directly to a specific course or syllabus. For some kits, third parties have also published technical guides on fault finding and repairs. Differences in responses from less and more experienced users thus may reflect the time needed just to discover such third party sources of support.

Electronic concepts.

There were four questions asked on pupil understanding.

"Does the pupil now understand the difference between analogue and digital signals?

	yes	no (%)
	78	22
Have knowledge of:	%	%
logic levels?	68	29
how voltage dividers work?	28	65
small scale systems?"	74	24

We were not surprised that the answer to the third part of this question should be so different from those for parts one, two and four. The concept of voltage, or potential, division is on a different plane. It is more difficult to comprehend than logic levels or the differences between analogue and digital signals. That certainly has been our own experience in running courses for teachers and technicians.

However, since voltage dividers are the building blocks for so many electronic circuits, it was assumed that teachers would stress their importance. It may be that not enough teachers are aware of the critical importance in electronics of an understanding of potential division. This is possibly also true of the application in electronics of a small number of other, equally basic, electrical concepts.

If this is the case, then it is one of the more significant findings of our survey. It brings to the fore one of several major items on the hidden agenda of electronics in the curriculum. This applies equally whatever the context of the electronics course whether in a physics, science or technology syllabus. Electronic circuits provide an ideal practice ground for fundamental concepts of electrical theory.

General comments

Reliability of the boards was the main concern in the section for more discursive comment. Some teachers did suggest or admit that vandalism may play a part. This may be a trifle harsh on the pupils. The design of some boards may contribute to failures, the temperature sensor being an example, where the manipulation of the thermistor encourages faults. Examples were given of Alpha power regulators where wrongly, but easily, made connections may cause damage (see Bulletin 168[1]).

The flimsy connnection to the jack plug from the E&L power supply came in for criticism. There a broken connection can cause a failure on an output voltage rail which may in turn cause failure of the transducer driver.

There was general agreement that all of the board based kits provide a quick and easy introduction to electronics. This was seen as one method to ensure successful experiences for pupils more generally capable of lower attainment levels.

Technology teachers commented on the difficulty of interfacing boards with stand-alone sensors. Lack of published support materials also came in for specific criticism as did the large quantity of boards required if a pupil centred approach is to be properly followed. (This is a particular problem where numbers of pupils are all building up relatively complex circuits for projects etc.).

The responses from physics departments were more varied. The major concern was the difficulty with the connectors on Alpha boards. This was not generally directly reported under the reliability question, but nonetheless was specifically mentioned by most of the respondents in this general comments section.

The cost of duplicating boards for use in both physics and electronic short courses, where there are timetable clashes or other causes, was also a major concern.

Levels of understanding of basic electronics were seen to depend more on the written support material being used than on hardware features of particular models of boards. If teachers worked within the limitations of both the boards and pupils, then the boards were seen to have a useful role in introductory electronics courses.

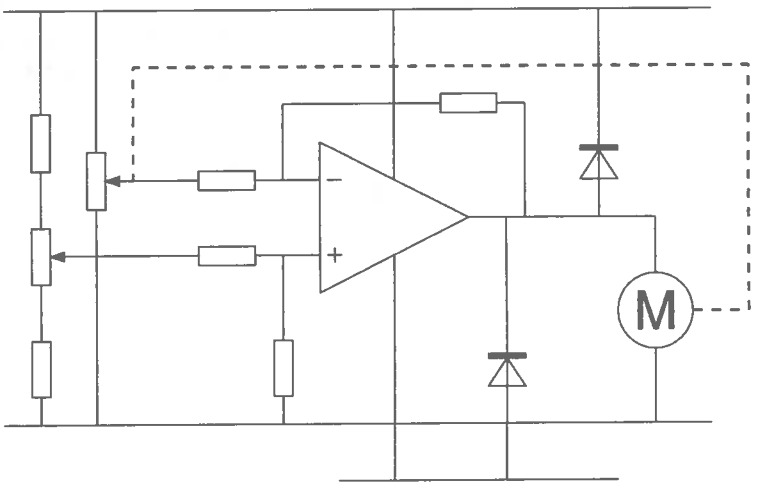


Fig. 1 - position control circuit

But what of Electronics Short Courses or Technological Studies? There such problems may be serious.

The exemplar material from Tayside, with its description of a position controller circuit, illustrates this problem . For the sample controller circuit (diagram in Fig. 1) you can use either eleven modular boards, with a massive overall footprint on the bench (Fig. 2), or eleven simple components on a bread- board taking up a fraction of the space. The costs of the two solutions are in similar ratio.

Even if costs are put to one side: How many schools have the resources and storage facilities to allow a class of sixteen to carry out this exercise? In SSERC we could not find enough boards from our total stock to verify the given circuit board solution.

Conclusions

Specific points

It is difficult to draw many hard, specific conclusions from our sample. Reliability, which is always of concern, seems though now to be at a reasonably acceptable level. There is little doubt that at least part of the problem lies with pupils, and some teachers, as naive users.

The problem of unreliable interconnection of boards increases the more boards are used in any one circuit layout. At anything over 7 or 8 boards such connection difficulties are likely to be significant.

This is just one of the penalties of pursuing the twin aims of simplicity in linking kit parts and having components clearly laid out on open boards (see Summary).

Unilab however, certainly have been right to make such strenous efforts to improve their method of connecting boards with Alphalinks. In recent correspondence they now assert that the latest design of connector, as supplied with their boards over the last two years or so, has resulted currently in a low frequency of complaints on the unreliability of board connections. This recent design is the latest in a long line of modifications. Clearly many users, for whatever reason, found some of the earlier arrangements to be unsatisfactory.

Economatics should be addressing the problem of improving and adding to their printed support materials.

Levels of provision

Such specific problems of reliability or of support material are insignificant when compared with those of overall levels of resourcing and of insufficient understanding. In physics departments, resources (numbers of any one board required) and understanding are said not to present serious problems. That could be because, in physics, much of the practical work is carried out on systems comprising a small number of boards.

Levels of understanding

Ease of use was seen as a positive reason for choosing modular boards. This is certainly behind their use for introductory work.

But what of understanding? We would suggest it may be too easy for pupils or teachers to solve problems with boards. They just use 'black box' theory or even crude trial and error. This may be in the absence of any real understanding of the basic electronic principles involved.[1]

The answer to the questionnaire section on the fundamental concept of voltage division surely supports this premise and the returns suggest that this applies equally to physics and technical departments.

It may be, as some of the comments suggested, that depth of treatment and understanding depends on the "written material used".

Does this "written material" mean commercial resource material specifically supporting the manufactured product, or national "exemplar" materials, or examination papers or combinations of these? They all have their place but they make poor scapegoats. Perhaps these findings might be better expressed as:

"understanding greatly depends on the quality of the teaching".

Summary : recommendations

Circuits fail to work when connections are improperly or incorrectly made. Components often fail when wrongly connected. This is generally true of any electrical or electronic circuit.

Teaching kits based on modular boards are no more immune to such fault conditions than are circuits built on prototype board. Such faults are a fact of life.

1. For example, a "system" is always a concept and never merely a thing or artefact. For that reason we have never liked the description "systems boards" for the modular components of these kits.

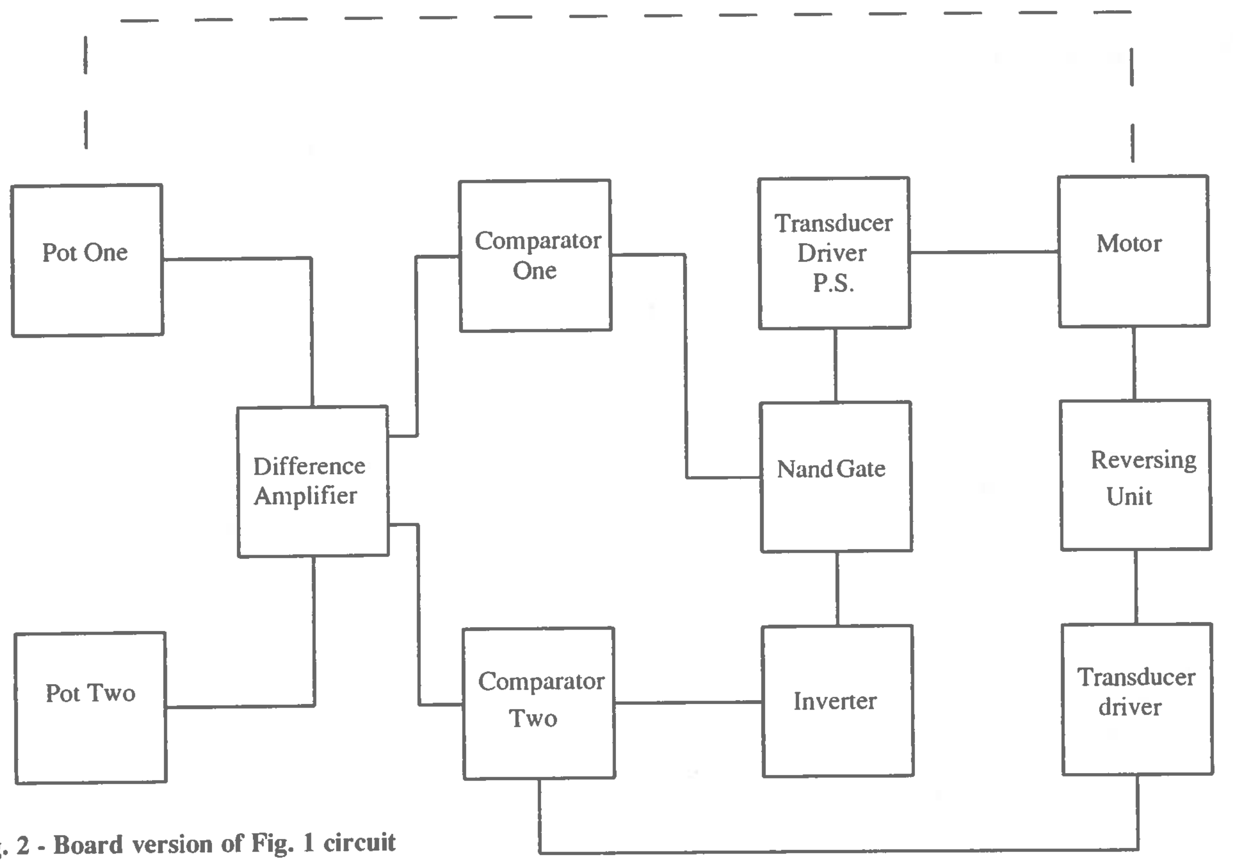


Fig. 2 - Board version of Fig. 1 circuit

Make virtue of necessity therefore and build systematic diagnosis and fault finding into the teaching. It is another of the central disciplines of electronics. It needs to be taught. Boards particularly lend themselves to sussing out faults - in power supplies, in components and in poorly made connections. Electronics is not all theoretical design and sophisticated problem solving. It is technological. It is about the practical business of getting devices to work. That includes the mundane business of checking through circuits and connections.

Limit the number of boards in any one layout to less than eight. Where a kit based solution to a problem requires more boards, consider using something else.

This is for four reasons. Unreliability of connections increases dramatically once more than about eight boards are used. Unrealistic stocks of boards are needed when many pupils carry out such work. The resulting, grossly oversized, layouts mock the term "micro-electronics". As Figure 2 bears out, they may also be quite incomprehensible.

We suggest that a move be made at some reasonably early stage in secondary education from a purely kit based approach to some use of components, either on breadboard or hardwired on stripboard. That may lead to the pupils having both a greater awareness and a deeper understanding both of the principles and practicalities of the subject.

A restricted number of central concepts have to be taught and understood at a basic level. Pupils need to apply them. In so doing they will come to a better and deeper understanding.
They should not however be left to discover these key ideas entirely for themselves. If crude trial and error be all, some never will.

Endpiece

The experience of those teachers progressing from Standard to Higher Grade Technological Studies will be of great interest.

Will they find that the level of knowledge and understanding gleaned from the use of boards at Standard Grade stand their charges in good stead for Higher?

Answers, on a postcard, please.

Reference

1. "Unilab Alpha Kit", SSERC, "Equipment Notes", Bulletin 168, December 1990.

Acknowledgement:

The position control circuit diagram and board layout have been redrawn from "Op-Amps", exemplar material for Technological Studies prepared by Tayside Region.

Technical Articles

Standard Grade Biology - more practical tips

This article is one of a series of short, technical notes intended to assist in refining suggested practical activities as described in the National Exemplar materials. The notes which follow deal with such a practical in Topic 1 "The Biosphere" Sub-topic C - "Control and Management".

Testing river water for bacteria

Methylene blue method

This is dealt with on Pupil Workcard G2. The test procedure described is also suggested for use in the Standard Grade Science Core Topic, "Environment". The test involves the addition of methylene blue to a simulated polluted sample prepared by adding organic material (such as torn up newspaper) to water.

The idea is that such a sample will contain large numbers of bacteria which will deplete the oxygen dissolved within it. This should result in the reduction of the methylene blue, decolorising it. In a closed container the time to decolorise the dye should be proportional to the numbers of bacteria present and thus to the degree of pollution.

An alternative method

We have had reports that the practical as described is unreliable. More positively we have received a suggestion for an alternative method. This uses a yeast suspension in a glucose solution to simulate polluted water. Janus Green B (Diazine green) is substituted as the redox indicator. This alternative practical is the work of Dr.John Wheeler, Principal Teacher of Biology at Grangemouth High School.

Advantages

The method developed by Dr Wheeler has the following advantages over the original:

- less likelihood of contamination by pathogens;
- rapid results, even at room temperature;
- a more obvious and definite colour change and
- no need for an oil layer and thus easier washing up.

Our trials

We have trialled this suggested variant at the bench and found it to work well. We give details below of the procedures which we found most appropriate for use in the Standard Grade courses.

As is often the case, our investigations at the bench posed questions as well as answering them. We therefore end by suggesting how the method might be adapted and extended for use in further investigations and projects.

Procedures

Samples

The *polluted river water* is simply a yeast culture suspension in an aqueous glucose solution (Solution A - 5% w;v). The culture originally suggested by our correspondent was made up by suspending 5 g of fresh baker's yeast in 100 cm^3 of that 5% glucose solution (Suspension B).

Samples may be afforded a more realistic appearance by colouring them. Grangemouth High had used gravy browning and had also suggested that cold tea might do equally well (it doesn't - see "Further suggestions" below). We confirm the efficacy of a colouring of the gravy browning type. For some of our trials we added 0.1 g of *Bovril* granules to each 200 cm^3 of glucose solution (Solution A).

Indicator solution

The indicator is Janus green B (Diazine Green) at a 1:2000, w:v dilution made up by dissolving 0.05 g in 100 cm^3 distilled or deionised water. This needs to be stirred for about 15 minutes to ensure that all the dye has dissolved. A magnetic stirrer would thus be useful here. The resulting solution is then filtered. This preparation of the indicator solution should be carried out by an experienced technician or teacher. Take the usual precautions to avoid raising dust and to keep the powder or solution of the skin. Wear gloves. (See also the sub-section on "COSHH" below).

Yeasts

Fresh yeast was suggested by Grangemouth High. All of the dried yeast types they tried didn't work, even when left to stand before attempting the practical. We confirmed that suspensions of fresh yeast gave the most rapid results. Because of their lag periods, ordinary proprietary dried yeasts were far too slow[1].

[1] We did however get reasonable results with our old faithful - DCL Active Dried Yeast but typically the change took two to three times longer than with fresh yeast. Dried yeast tended also to produce more turbid samples so that eight rather than four drops of indicator were needed per sample. Vigorous agitation of the suspension by stirring assists initial activation. The process may be speeded up further through initial depletion of oxygen by boiling and cooling Solution A. This adds a further chore and, in our view anyway, gets us closer to cheating.

Materials and apparatus

For preparative work:

D-glucose powder; fresh baker's yeast;
distilled or deionised water; Bovril granules (optional);
Janus green B powder (BDH/Merck £18-30 for 10 g);
disposable gloves; 25 cm^3 measuring cylinder;
balance weighing to 0.01 g; magnetic stirrer & flea;
stirring rods; calibrated beaker; filter funnel;
filter paper; retort stand and clamp, spatula.

Pupil scale items

Screw cap bottles (25 cm^3 *Universal*, or
30 cm^3 *McCartney*, bottles);
measuring cylinders and calibrated beakers;
5% glucose solution;
Janus green solution in small dropper bottle;
timer or stopclock; water bath (optional).

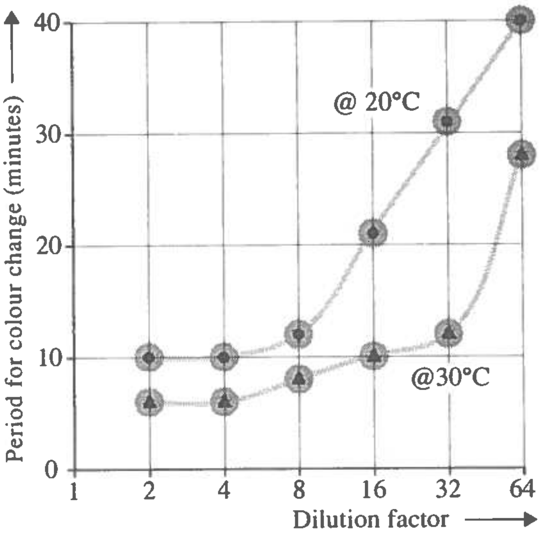


Fig. 1 - times for colour change v. dilution

Method

In what follows, volume measurements need not be precise. The use of measuring cylinders and calibrated beakers will suffice.

Samples with varying levels of *pollution* are made up as follows:

Make up a one in two dilution by adding one volume of glucose solution A to one volume of yeast suspension B. From this *stock* polluted sample serial dilutions of *pollutant* may be made using further volumes of glucose solution A as diluent (all v:v):

1 in 4; 1 in 8; 1 in 16; 1 in 32; 1 in 64.

a). For each such dilution place equal volumes of:

-the mixture used as the previous sample in the series and

-glucose solution A

into a 25 cm^3 *Universal* or *McCartney* bottle or other small screw cap container.

b) When all such dilutions are complete, for each bottle:

-add four drops of the Janus green indicator solution.

-close the screw cap and invert the sample to mix.

c). Start the clock and time the colour changes from green-blue to purple-pink. (Previously made colour standards may be useful here).

Results

In our trials with fresh yeast suspensions (without additional colouring) we obtained results even more quickly than originally reported (Fig.1). Even at room temperature (ca. 20°C) the colour change is observable within a typical laboratory teaching session as far down as a 1 in 16 dilution of the original sample. The use of a water bath is therefore not really necessary.

However results were also obtained at 30°C (Fig.1). In a water bath at that temperature all dilutions - down to 1 in 64 - had changed colour within half an hour.

Samples coloured with gravy granules to simulate turbid, polluted water also produced results. Even a 1:64 dilution underwent the colour change in 40 minutes at 30°C. Interestingly, the addition of Bovril granules to the glucose stock solution did slow down the process somewhat. Whatever the cause of that, it wasn't the effect of a pH change - we checked. All of the samples for which results are shown had the same pH (6.95).

The use of cold tea as additional colouring had a more marked effect. This trebled the time for even the least dilute sample to bring about the colour change at 30°C. At room temperature the slowing effect was even more marked. The pH of cold tea is about 5.5 and adding even a little did lower the pH of the samples (to just over 6 rather than almost 7). We doubt however that this order of pH shift could explain the observed degree of inhibition of the yeast.

Further investigations

Dr Wheeler reports that his own work suggests that the rate of the process is "unaffected" by low levels of other added pollutants such as "slight" acid pollution, lead salts or detergent.

However, we are intrigued by the observed effects of tea and gravy granules. Could it be the effect of salt or something else in the Bovril, tannic acid or some other substance in the tea? Do we have here a useful microbial model for physiological investigations? The system may well be worthy of least initial further investigation with an eye on its use for CSYS projects.

COSHH

As well as being an interesting practical exercise this procedure also provides an object lesson on aspects of COSHH Risk Assessment.

Janus green

Many dyes and indicators are toxic. Some are known or suspected carcinogens. We therefore looked up Janus green, in our usual references, seeking toxicological data. We found none. An MSDS (Materials Safety Data Sheet) was then requested from BDH (Merck). This states that the dye is a carcinogen in animals.

This is far from the most alarming of such statements which may be made on an MSDS. The data thus referred to is likely to be based on ingestion trials at high dose rates. The resulting advice of the supplier will also usually relate to large scale handling in an industrial, rather than a laboratory, context. Several substances with a similar toxicological background are regularly used in educational laboratories.

Normally, even with this kind of evidence, of effects in animal trials only, we would advise substitution of the indicator. Regrettably, neither of the two we would normally choose actually work. In our view the risk in handling the dilute indicator (1 in 2000 w:v) is minimal. So is the preparation of 100 cm^3 of a solution containing only 0.05 g of the dye. Since the stain is in aqueous solution, and any contact time is likely to be minimal, the use of ordinary latex disposable gloves will suffice.

The precautions described above, under "Indicator solution" however must be taken. Indeed they are precautions we would take with any vital stain. These are biologically active compounds which bind to certain cell parts or organelles. All such substances should be handled with due care.

Finally, it is worth noting that other dyes in use in schools may well be subject to similar MSDS statements. Janus green itself has already been used in CSYS practical work as a mitochondrial stain and is cited several times in "Nuffield" texts.[2]

Acknowledgement

We have already identified within the body of the article the original source of these ideas. We would like also to more formally record our thanks to Dr.John Wheeler for his interest and assistance. This also gives us the excuse to quote some excellent sentiments from our correspondence with him:

"The work was carried out because *"experiments"* are needed which deliver the goods and reassure. It must be admitted that it was also linked to a need to get away, if only for a short time, from the in-tray labelled *"administration"*."

Do we detect cries of "Hear! Hear" out there?

2 What the eye doesn't see?

Technical Articles

An Ultrasound Project

We originally undertook this project in the hope that it would be of use in the SEB Short Course in Electronics, Telecoms I. It turned out to be far too difficult for this application, but we found that it touched on a lot of important technological and scientific issues. There should be much to be gleaned from it for Technology; and it would make an excellent project in Physics. It is open-ended, and we would be interested to hear if anyone takes it further.

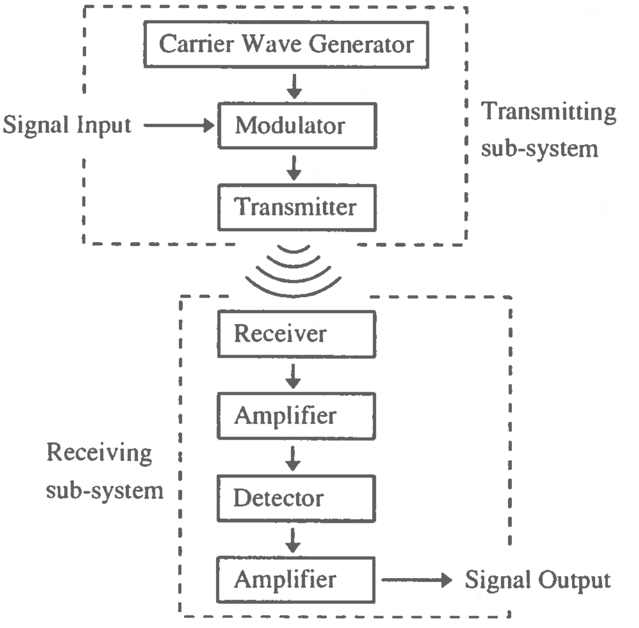


Fig. 1 - ultrasound communication system

Introduction

The original brief called for transmission of information, analogue and or digital, through water, using the medium of ultrasound. Obviously it was desirable that costs should be kept to a minimum.

Maplin sell a piezo-transducer, QY13P, for under 30p. It's really designed to operate in air, resonating mechanically at 4.2 kHz, which is audio frequency, not ultrasound! However, we suspected that immersed in water its resonant frequency would be higher, and that there was probably a series of harmonics at which it would resonate anyway. The construction is very simple, and we hoped that it would prove reasonably resistant to deterioration in water!

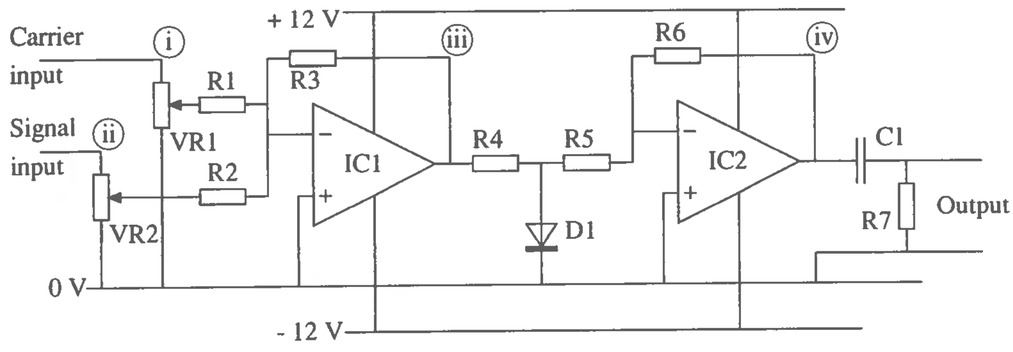


Fig. 2 - modulator circuit

R1,2,5	47K	5%	Resistor
R3	330K		
R4	1K		
R6	3K9		
R7	4K7		
VR1,2	10K	20%	Potentiometer
IC1,2	741		Op-amp
D1	1N4148		Diode
C1	10nF		Capacitor

Components for Fig. 2

We duly bought a handful. The fundamental frequency was higher in water, and there were a series of higher resonances.

Our first sample disintegrated quite quickly. However, we discovered that we had overdriven it. The impedance of the device is considerably lower in water than in air, due to the more efficient transfer of energy to water. It is rated at 30 V peak to peak, at 4.2 kHz, in air; we found it necessary to reduce this to 0.5 V peak to peak at 100 kHz in water.

One cannot expect the device to last forever: soldered joints don't like being immersed in water. Nonetheless, if it is kept dry between sessions it should last a long time. Ours was still functioning, though showing signs of corrosion, after continuous immersion for several weeks. Whether any kind of coating would be effective or worthwhile could be a matter for further investigation.

The system

Fig. 1 shows the system. This would be essentially the same for other transmission media, such as radio, infrared, or microwave.

We used one signal generator to provide the input signal, and another as the carrier wave generator. The rest of the electronics was homespun; none of the components cost more than a few pence. Once the system is working and understood, there's a lot of scope for improvement.

Fig. 2 shows our modulator circuit. This uses a very quick and dirty way of amplitude modulating a carrier wave with a signal! The pukka way is to multiply the two signals together. Our circuit achieves a similar effect by adding the two signals, half-wave rectifying the result, and filtering. Fig. 3 shows this process.

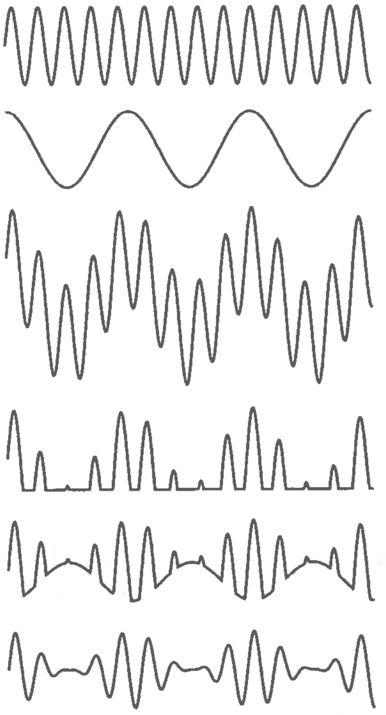


Fig. 3 - amplitude modulation

Fig. 4 overleaf, shows our receiver circuit. This uses two stages of amplification (IC1 and IC2) before the detector diode, as the signal is too small otherwise. C2 stores the peak voltages passed through D1; R6 causes them to droop between peaks of the carrier, to follow the falling edges of the (much lower) modulating frequency. Fig. 5, (also overleaf) shows this process.

Unfortunately there is a d.c. offset at this point. This is compensated for by connecting it equally to both the inverting and non-inverting inputs of IC3 (via R7 and R8)! The wanted alternating signal is applied to the inverting input, but is shorted out at the non-inverting input, through C3. C4 serves to filter out most of the surviving carrier frequency before TR1, which is an emitter follower providing an increased current capability to drive a small speaker.

We used two 9 V batteries for the receiver circuit, so that we could isolate it completely from any possible RF leakage through the power supply wiring.

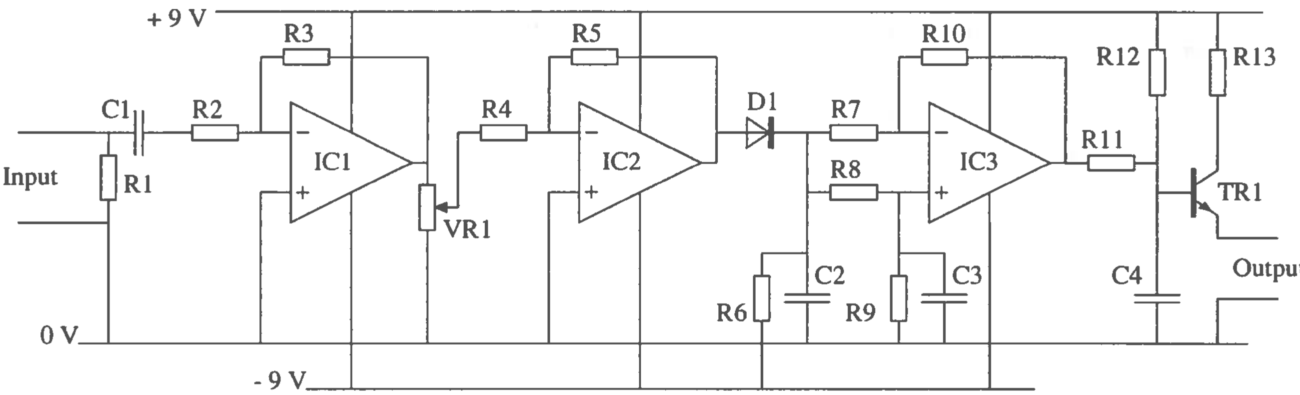
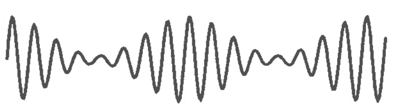
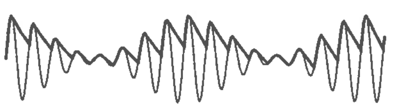


Fig. 4 - receiver circuit



Received signal - the carrier wave is modulated at signal frequency, but the middle line is straight: there is no signal left if you filter out the carrier.



The voltage on C2: the detection process makes the middle line follow the signal. Note you still need to filter out some carrier.

Fig. 5

R1	100K	5% Resistor
R2,7,8,11	10K	
R3	330K	
R4	220R	
R5,12	47K	
R6	22K	
R9,10	470K	
R13	390R	
VR1	10K	20% Potentiometer
IC1,2,3	741	Op-amp
D1	1N4148	Diode
C1	10nF	Capacitor
C2,3,4	100nF	
TR1	BC184	Transistor

Components for Fig. 4

Getting it working: practical details

The connecting leads between circuits and transducers should be a twisted pair of 1/0.25 mm miniature solid wires. One (0 V - use black) should be soldered to the brass backing plate of the transducer, near the edge. The other (yellow) should be soldered to the silver electrode on the face of the transducer, again near the edge of the electrode (see Fig. 6). This is a delicate job, and should be done with as brief a touch of the soldering iron as possible, or damage will be caused to the electrode. Use the finest available bit, and the finest possible solder.

We simply dangled the transducers in a plastic tray full of water!

Set the carrier generator to about 100 kHz and the signal to about 200 Hz, both about 5 V peak to peak. Connect an oscilloscope to the output of the modulator, and adjust VR1 and VR2 until you see a modulated carrier wave, about 0.5 V peak to peak, on the ‘scope (as in Fig. 7).

If you vary the frequency of the carrier wave, you should be able to spot the frequencies at which the transmitting transducer resonates. These may vary widely from one transducer to another, probably according to the exact size and location of the solder blobs. You may need

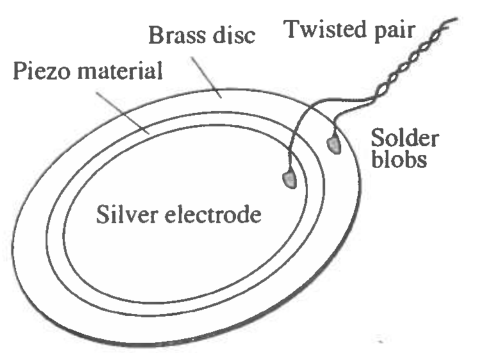
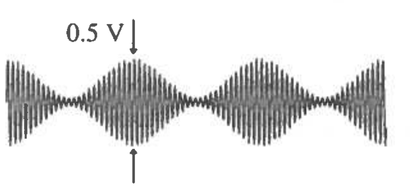


Fig. 6 - ultrasonic transducer



Note: getting your oscilloscope to display waveforms like this may be tricky: the trigger level has to be set to catch the largest peaks of the carrier frequency, while ignoring the smaller ones. Otherwise the ‘scope displays the carrier wave, but the modulating wave occurs at random locations across the screen. The carrier frequency is so much higher than the signal frequency that you probably won't be able to resolve the individual waves, just the overall outline. This outline is called the envelope, and carries the signal information.

Fig. 7

to readjust VR1 and VR2 again once you have found a resonance.

On the receiver, you may find you need to adjust VR1 to a very low level, as you seem to have an enormous signal . . . beware! All may not be what it seems.

Problems

Tap water is a moderately good conductor of electricity. Both the brass plate and the silver electrode of the transducers make contact with quite large areas of the water; although the brass is at 0 V, the silver is carrying the signal. The main conductive paths through the water are simply fairly high resistance shorts from signal to ground at each end of the system - but there is a path from one transducer to the other. We're only expecting a very small signal - is our signal really ultrasonic transmission and reception at all, or simply plain conduction?

Our first attempt to distinguish the two was to place one of the transducers in a glass beaker of water, standing in the water in the tray. The system still worked, almost as well as before. Ultrasonics passes through rigid solids quite well. Unfortunately, at 100 kHz, simple electrical signals also pass quite well through capacitors - and our glass beaker forms the dielectric of a capacitor with plates made of water.

Next we used a copper beaker, and earthed it. Our signal seemed to disappear - but no, there it still was, just an order of magnitude or two smaller. And at last, other clear evidence that the signal was ultrasonic: moving the transducers, we were able observe standing wave patterns in the tray, with wavelengths of the order of 15 mm - the size expected for 100 kHz ultrasound in water! Further, the transmission became much more efficient at the resonant frequencies of the transducers, whereas the electrical signals were not much affected.

Another problem arises from the fact that our receiver is very broadband - it isn't tuned to the frequency of the carrier at all. Any noise, particularly structure borne sound in the bench supporting the tray, is picked up by the receiving transducer acting like a microphone. This can easily swamp the signals you're looking for. The worst problems arise when you have a loudspeaker on the output from the receiver: care is then needed to avoid 'howl-round' - the same effect as where the microphone in a PA system picks up too much of the sound from the loudspeakers[1].

The last difficulty, and fortunately the least, is to distinguish between ultrasonic communication and radio: at 100 kHz, we could be unwittingly transmitting and receiving radio signals, the wiring of our circuitry forming unintentional aerials. This possibility is easily dismissed: simply lift a transducer out of the water, and the signal disappears.

[1]This occurs if the total gain all around the system - say from the microphone, through the electronics, out of the speaker, across the room, and back to the microphone - is greater than unity.

Further work

The simple technique used in modulating the carrier wave results in considerable distortion. Simple signals from signal generators pass through the system very well, but audio signals are badly distorted[2], and we haven't attempted to transmit data at all. It wouldn't be very expensive or difficult to produce a much improved modulator using a multiplier IC such as SG1495N (RS stock number 301-690; £1.94).

Similarly, using a tuned receiver circuit rather like a simple radio would enable one to pick the signal out from amongst more noise. One could then detect much smaller signals, perhaps making it possible to communicate between sites at some distance, along a stream for example.

It would even make it possible to pick out one particular carrier from amongst others at different frequencies, carrying other signals. This idea is general, regardless of the transmission medium; conversely, simple untuned receivers like ours can be made for any medium, even radio, as long as the signal one is looking for dominates all others.

Interestingly, tuned reception might not completely eliminate interference from low frequency noise. The standing wave patterns in the carrier wave are affected by changes in the position of the surface of the water, which itself moves slightly due the pressure variations in sound.

Another simpler application could be a level detector. Here you would detect the difference in impedance of a piezo transducer according to whether it was in air, or immersed in liquid. This would have obvious application in, for example, 'H' grade Technological Studies. We haven't tried it.

If at first you don't succeed . . . be persistent. We found the system quite fiddly to get working, but very rewarding.

[2]much worse than shown in Fig. 3, which relates to a pure sine wave signal.

Technical Articles

DIY Computer Interfacing III

(for the BBC Model B, Master, and Archimedes)

This is the third in a series of articles which will be of interest to anyone who wants to build their own interfaces for BBC Model Bs, Masters, or Archimedeses, for datalogging or control.

Hereinafter Arc includes A3000; Beeb means Master or Model B.

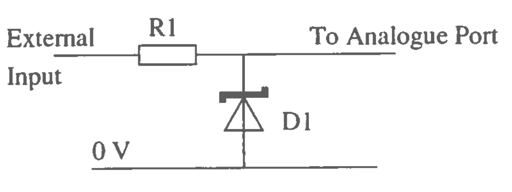
Protecting your computer

All the circuits we've published in this series provide adequate protection for your computer *as long as they are constructed as specified.* It isn't possible to design a circuit which gives protection even when constructed incorrectly!

However, some mistakes are easier to make than others. One common one is to connect transistors or ICs incorrectly. If the transistor or IC is directly connected to the computer, this can be disastrous. Generally, circuits can be designed so that the only components connected directly to the computer are resistors with reasonably high resistance. Then *as long as the correct value of resistor* is interposed between the circuit and the computer, no harm will come to the computer whatever other mistakes are made. This is not intended to encourage carelessness!

The analogue inputs are an exception to this: they have a very high input impedance (~ 1000 MΩ) and are therefore given no protection by any reasonably low resistor in series with the input. We cannot use a high resistance in series as we are interested to know the input voltage precisely, not merely to distinguish two possible signal levels each with a wide tolerance.

Fig. 1 shows the basic method of protecting the analogue inputs. Over the input voltage range of interest (0 to 1.8 V), D1 is high impedance; but outside this range *in either direction* it becomes low impedance. It then provides a current path in parallel with the port, allowing



R1 3K3 5% Resistor

D1 BZX55C3V9 or similar (Zener diode)

Fig. 1 - Simple Analogue Port protection

almost all the excess voltage to be dropped in R1. This gives protection up to moderate overvoltages, without great loss of accuracy, as long as the driving signal has a fairly low impedance (~ 1 kΩ). A higher value for R1 would give protection against higher voltages, at the expense of accuracy at the top of the input voltage range.

Fig. 2 shows an alternative circuit you can use if your driving signal has a higher impedance, or you require greater accuracy, or you need to protect the computer against higher overvoltages. Again, a higher value for R1 would give protection against higher voltages, and less loading of the input signal, at the expense of accuracy at the top of the input voltage range.

In either case, it is paramount that the whole circuit is correctly connected, that the diodes are not open circuit, and that there are no dry joints. Before connecting it to the computer, test the circuit by connecting the input, each way round, to the highest voltage likely to be encountered, and measuring the output with a digital multimeter. It should not be greater than + 5 V, or less than - 0.7 V.

Conditioning analogue inputs

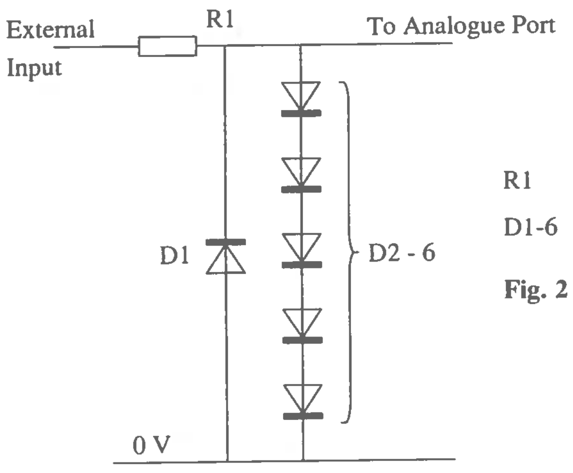
Both the above circuits assume that the signal you are interested in already varies only over the range covered by the analogue inputs of the computer (0 to 1.8 V). In general this won't be the case! If the range is larger, the solution is to use a voltage divider; if the range is smaller, use an amplifier.

Fig. 3 shows a voltage divider input. We use the diode chain rather than the Zener diode protection circuit to minimize the loading of the voltage divider, which itself needs to use reasonably high resistances to avoid loading the driving signal. VR1 and R2 form the voltage divider; you could use a fixed resistor in place of VR1 if you don't need to adjust the range, or if accurate calibration is required.

If the impedance of the driving signal is too high, it may be necessary, even with a large input signal, to use an amplifier - with a voltage amplification less than unity.

Fig. 4 shows a simple amplifying input. The zener protection circuit is adequate, because the output impedance of IC1 is low, and the maximum voltage we need to protect against is only ± V, which might be perhaps 9 V to 15 V. This allows us to use a lower resistance for R3, which means that the small currents drawn by D1 won't cause significant errors. It cannot be used for amplifications less than unity.

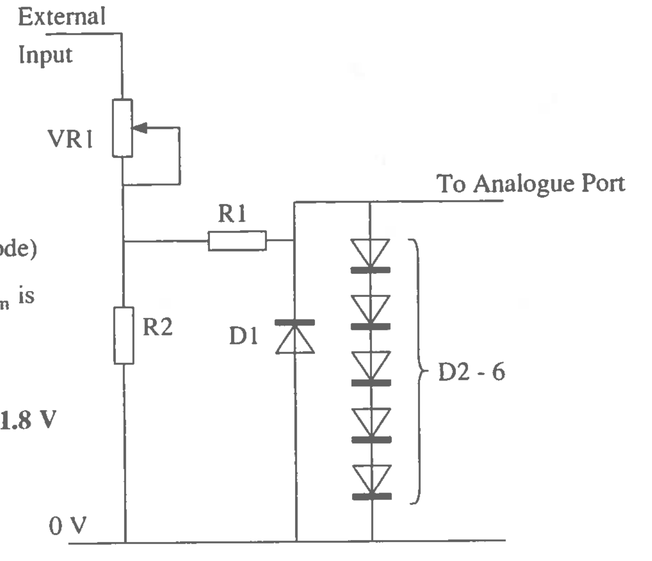
Fig. 5 includes a zero offset adjustment, making it possible to measure signals whose voltage may be positive or negative. It also allows amplifications less than unity, by using the inverting input of the op-amp. The software can easily take care of the resulting inversion of the signal, and the zero offset.



R1 10K 5% Resistor

D1-6 1n4148 or similar (signal diode)

Fig. 2 - Alternative Analogue Port protection

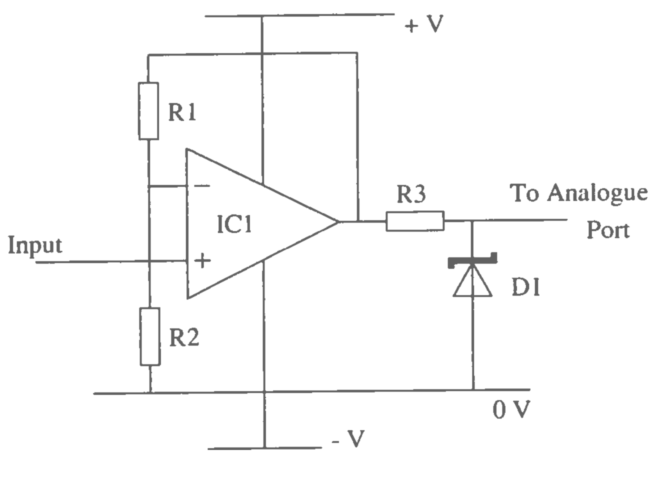


R1,2 10K 5% Resistor

D1-6 1n4148 or similar (signal diode)

VR1 = R2 × ((v_m / v_a) - 1) where v_m is the maximum voltage range to be measured, and v_a is 1.8 V.

Fig. 3 - Circuit for inputs of over 1.8 V



R2 10k 5% Resistor

R3 470R 5%

D1 BZX55C3V9 or similar (Zener diode)

IC1 741 Op-amp

R1 = R2 × ((v_a / v_m) - 1) where v_m is the voltage range to be measured, and v_a is 1.8 V.

Fig. 4 - Circuit for small inputs

R1 10k 5% Resistor

R3 470R 5%

R4,5 22K 5%

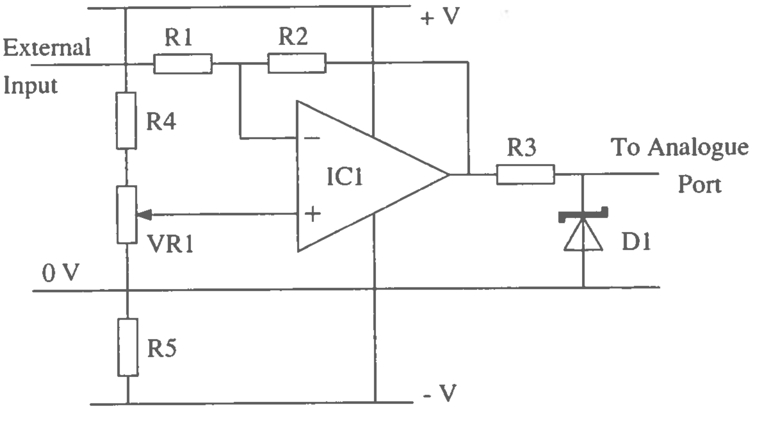
VR1 10K 5% Potentiometer

D1 BZX55C3V9 or similar (Zener diode)

IC1 741 Op-amp

R2 = R1 × v_a / v_m where v_m is the range of voltage to be measured, and v_a is 1.8 V.

Fig. 5 - Input circuit for almost any signal



Analogue input software

The BASIC statement to use to get information from the Analogue Port is ADVAL; look it up in your BBC Micro User Guide, or the I/O Podule Guide or BBC BASIC Guide if you've got an Archimedes. It is exactly the same on both.

Continuing from the article in Bulletin 168 (p.22 - 26), we can now produce a bi-directional analogue output with feedback:

```
DEF PROCMotor(WhatElseIsOn,SetSpeed,Time)
MotorPower = 0 : T = TIME
REPEAT
Speed = 32768 - ADVAL(0)
IF Speed < SetSpeed MotorPower = MotorPower + 1
IF Speed > SetSpeed MotorPower = MotorPower - 1
MotorBits = 128 + MotorPower * 8
PROC Output(WhatElseIsOn + MotorBits,0)
UNTIL TIME - T > Time * 100
ENDPROC
```

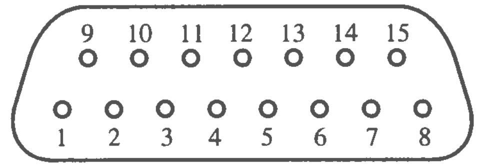
Note that at the end of this procedure, the power output to the motor is left at whatever level it happened to need, at the instant time was up, to maintain setspeed. You could easily alter the procedure to switch it off at the end; but perhaps the next call to the procedure might simply be a small increase in SetSpeed. Similarly, it might be better to set MotorPower = 0 before the first call to PROCMotor, and then not zero it within the procedure; up to you.

The input signal could be derived from a tachometer. Any precision d.c. motor can be used as the tachometer simply by driving it mechanically, and connecting its leads to External Input and 0 V of Fig. 5. Adjust VR1 to give about 0.9 V at the non-inverting input of IC1; choose R1 according to the voltage produced by your tachometer when it is driven at the maximum speed you want to be able to control. Don't forget that the *range* of voltage will be twice this - from positive to negative.

The easy - the only reliable - method of getting the connections to the tachometer and motor the right way round, is trial and error. There are only two possibilities for each!

Connections to the computer

The 0 V line of all these circuits should be connected to the analogue ground of the Analogue Port. Fig. 6 shows the connections. Our use of ADVAL(0) corresponds to the use of Channel 0 - that is, pin 15. We could equally well have used ADVAL(1) with pin 7, etc. More importantly, you can use each channel with a different circuit, accessing each with its appropriate ADVAL.



View on solder side of plug

1	+5 V
2	Analogue Ground
3	Analogue Ground
4	Channel 3
5	Analogue Ground
6	Analogue Ground
7	Channel 1
8	Analogue Ground
9	Light Pen Strobe
10	Fire 1
11	V Ref
12	Channel 2
13	Fire 0
14	V Ref
15	Channel 0

Fig. 6 - Analogue Port connections

EQUIPMENT NOTES

Bench power supplies for electronics

We report on voltage regulated bench power supplies for use in electronics.

Introduction

What are the relative merits of some of the dual, triple and multiple rail power supplies for electronics on the market? This article aims to tell you.

The report is restricted to portable supplies with multiple outlets. It neither looks at technology benches with integral supplies, nor at single rail power supplies. Buying advice on both of these categories can however be obtained by telephone or letter enquiry.

Which type to get?

Please refer to the article in Bulletin 164 [1] in which we specified the types of supplies required for different forms of work in electronics. In that article also, we pointed out that certain electrical loads should in general be driven from a separate supply from that used to power the control circuit.

Some further guidance is given here:

Triple rail supply: These units typically have a fixed 5 V outlet to drive digital circuits, and dual ±12 V outlets to drive op-amps. We think that they offer an economical choice because they meet most of your needs in the one item.

Some triple rail rail supplies have variable voltage outlets, which makes them more versatile, and expensive.

Op-amp requirements: ±12 V is a reasonable dual rail voltage to use with most op-amps. It lies within the usual operating range, which extends to ±18 V. This is also a common standard for other electrical components such as lamps, motors, relays, etc. (but remember that it's bad practice to drive electronic circuits and high power loads off the same supply).

Less usual requirements: Some op-amps have a lower voltage range than this. The one used by Unilab in their Amplifier Investigations Board (223.047), brought out for H Grade Physics, has a maximum of ±8 V. Some D-A converters need ±5 V. A supply with a variable voltage outlet extending from ±3 V to ±15 V meets these less usual needs.

Current capacity: 100 mA is adequate for most op-amp circuits that don't drive loads. Extending the capacity to 250 mA, or to 500 mA, should take care of a modest amount of loading.

500 mA is adequate for most digital circuits and should look after a fair amount of loading from LEDs and LED displays.

Mixed purchasing: As in many other fields of laboratory purchasing, it is often best to cover your varied needs by buying some of this and some of that. It may be prudent, for instance, to buy one variable voltage, but expensive, dual rail supply to every three or four fixed voltage dual rail units.

Supply for power loads: What's required in general is a smoothed d.c. supply with variable voltage control. This type of supply is not reviewed in this report.

Tests

Our test programme covered three areas: performance, safety and standard of construction. The results are summarized in cryptic fashion in Table 1. Our codes follow a consistent A-B-C classification where A can loosely if vulgarly be called barrie, C, not on your nellie, and B, an interpolation between the two!

Where needed, qualifications or explanations are given as notes in a small typeface (our footnote style).

Performance

We looked at the loading characteristics to find out whether voltage regulation was effective. We looked to see what happened under overload conditions, watching for signs of thermal or electrical stress. We examined the effectiveness of overload protection mechanisms. We monitored the amount of noise and ripple on each supply rail. We assessed the effectiveness and accuracy of operational markings, and we subjected each supply to prolonged running on full load. Our findings can be found under the headings: Performance, Ripple and noise, Electrical protection and Markings, operational.

A surprisingly large number did not perform to specification. For some supplies, this points to poor circuit design rather than to exaggerated specifications. It is hard to see why. Good quality voltage regulator circuits can be found in manufacturers' databooks and power supply design is a common engineering textbook exercise.

Safety

We looked to see whether the samples complied with the relevant British Standards and, where necessary because of the special stresses of school laboratories, with our own more exacting requirements.

We were disturbed to find that one product has been designed with an apparent cavalier disregard for standards. It is of concern that an outcome of a period of low capitation budgets is the appearance on the educational market of products which are cheap and shoddy.

Interestingly, none of the sample complied fully with British Standards. A common failure was the lack of certain statutorily required markings such as of the earth bond point on the enclosure, or the supply voltage. Another common, but more disturbing, failure was the incompleteness of the earth bond system, not every external conducting part being connected to earth.

Over-heating is the hallmark of a poorly designed power supply. It is an engineering art to ensure that neither internal nor external excessive temperature rises are possible, even with overloading. Only one of the sample, in this repect, was found to be artless.

Our findings on safety are shown under the headings: Electrical safety, Heating and Markings, safety.

Construction standard

We have made assessments under the headings: Construction, Mechanical endurance and Reliability. To a certain extent these are subjective, unlike the other assessment categories which are wholly objective.

The integrity of the enclosure and mechanical fitments, the materials employed, the siting of ventilation apertures relative to internal parts, and the mechanical robustness are summarized under "Construction".

The expected working life is assessed under the heading "Endurance". This is based on comparisons with other educational products and our experience of their ability to withstand classroom treatment. It is worth pointing out that the products from the main-stream school suppliers, Griffin, Harris, Irwin and Unilab, come out ahead of the rest.

"Reliability" is our assessment of the likelihood of electrical faults, and is based on our operational experience of, and reports from schools on, the products assessed. Some products haven't been assessed either because they are new, or because we do not have enough operational evidence.

Best buy?

The triple rail **BBH Model 5007** comes out best. It should meet with 95% of your needs and is sold at £60.67, an agreeable price.

In terms of quality, the best supply on the market is judged to be the **Variable Dual 15 V Regulated Power Supply** made by Unilab (022.110) (£144.47). This is closely followed by Irwin's **Stabilised Power Supply ±15 V** (EJ0392) (£135.00). A little behind is the **S-Range Regulated Supply** from Harris (P70215/3) (£107.78).

If all you are after is a power supply for op-amps and you cannot afford any other features, the **Irwin model EA3026** at £49.86 is worth considering.

Table A

Manufacturer	BBH	BBH	Global	Global	Griffin	Harris	Irwin
Model name	Triple Power Supply 5007	Triple Power Supply 5017	Powered Proto-Board	Triple Power Supply 1300	Regulated Power Supply	S-Range Regulated Supply	Stabilised Supply ±5 to ±15 V
Supplier	Farnell Instr.[1]	Farnell Instr.[1]	E & L Instr.	E & L Instr.	Griffin	Harris	Irwin
Stock number	E895007	E895017	CDA-1	1300	EKR-522-010J	P70215/3	EJ0392
Specification:						6 outputs:	
Output 1 (V)	+4 to +6	12 ± 0.2 [2]	+5	5	+5/6/9/12/15	-15 V, 200mA	+5 to +15
(mA)	500	1000	1000	1000	800	-5 V, 800 mA	500
Output 2 (V)	+12 to +15	12 ± 0.2 [2]	+5.5 to +18	0 to 20 [1]	-5/6/9/12/15	+5 V, 800 mA +9 V, 300 mA[1]	-5 to -15
(mA)	500	1000	500	250	800	+12 V, 300 mA[1]	500
Output 3 (V)	-12 to -15	5 ± 0.2 [2]	-5.5 to -18	0 to 20 [1]	--	+15 V, 200 mA[1]	--
(mA)	500	1000	500	250			
Performance	A	A	A	A	C [1]	A	A
Ripple and noise	A	A	A [1]	A	C [2]	A	A
Electrical safety	A [2]	A [3]	B [2]	A [2]	A	B [2]	A
Electrical protection	A	A	A	A	A	A	A
Heating	B	B	C [3]	A	B	A	A
Enclosure, materials	metal	metal	metal [6]	metal, plastic	metal	metal, plastic	metal, plastic
apertures	yes	yes	none	yes	none	yes	none
ext. heatsink	none	none	none	yes	none	none	yes
Construction	A [2]	A [3]	A	A [3]	A	A	A
Endurance	B	B	B	B	A	A	A
Markings, safety	B	B	C [4]	B	A	B	B
operational	A	A	A	A	B	B [3]	A [1]
Reliability	A	U	C [5]	U	A	A	U
Meter	none	none	none	analogue	none	none	none
Price (£)	60.67	65.64	89.50	89.50	99.90	107.78	135.00
Assessment	A	B	C	B	C	A	A

Definition of codes

Performance

A - performs to specification; there are no significant factors about the performance which cause concern
B - does not perform completely to specification, but loss of performance is unlikely to be significant to use in schools
C - does not perform to specification and loss of performance is likely to be significant

Ripple and noise:

A - pk-pk voltage ≤ 10 mV
B - pk-pk voltage > 10 mV and unlikely to cause significant deleterious effects to school circuits
C - generally outrageously large

Electrical safety

A - sound standard of construction including the earth bonding system and insulation system; might apparently fail safety test procedures on unimportant, minor technicalities
B - generally of a reasonably sound construction, but with either the earth bonding system or insulation system not being completely adequate; carries with it some risk of danger but one which is judged to be insignificant
C - unsound with significant risk of danger

Electrical protection

A - adequate protection to primary and secondary circuits (e.g. at least two effective measures of: fusing, thermal cut-out, e.m. cut-out, or electronic shut-down)
B - some weakness in protection system
C - inadequate protection system

(codes continued over)

Notes on Table A

BBH Triple Power Supply 5007

1. This is also stocked by Farnell Electronic Components (148-585) at the same price.

2. In one version, the enclosure was secured by plastic locking studs which were removable by hand. This defect has now been put right. If you have defective units, contact BBH for proper fastenings.

Verdict: This supply performs outstandingly well and is very reasonably priced. Notwithstanding some minor reservations on the construction and design, we have no hesitation in recommending it.

BBH Triple Power Supply 5017

1. This is also stocked by Farnell Electronic Components (150-062) at the same price.

2. Outputs can be connected in series by external links to give a dual rail ±12 V supply, or other output combinations. However we think that there is a fair chance of this being misused by younger, or inexperienced, pupils.

3. In one version, the enclosure was secured by plastic locking studs which were removable by hand. This defect has now been put right. If you have defective units, contact BBH for proper fastenings.

Verdict: Apart from the qualification in point 2, we can recommend this supply. It is soundly designed, performs well and is moderately priced.

Global Powered Protoboard CDA-1

1. At up to 8 mV pk-pk this is higher than specified.

2. Some minor parts are not bonded to earth.

3. There is a temperature rise of 40°C on a part of the enclosure that might be gripped for carrying. Although this does not comply with British Standards it is not too badly out to be dangerous.

4. Statutory markings are absent.

5. One of the positive voltage regulators frequently has to be replaced.

6. There are three prototype wiring boards mounted on the top sloping panel. They provide 202 pairs of 5 common spring contacts.

Verdict: We cannot recommend this supply because of its unreliability.

Global Triple Power Supply 1300

1. These outputs can be connected in series to provide a variable voltage dual rail supply. At 20 V, the maximum setting is considered to be excessive. It exceeds the maximum operating voltage of many op-amps, which might thereby be damaged. With the two outlets commoned, you can get 40 V, which exceeds our limit of 35 V d.c., beyond which pupils should not be allowed to work.
2. Weaknesses were found in the earth bond system. We understand that the manufacturer has sorted this.
3. The transformer fastening is not sufficiently secure. We understand that the manufacturer has put this right.

Verdict: The electrical performance is excellent, and for this reason the supply is certainly worth considering. However, we do have some minor reservations on the construction. The maximum voltage output is a little high.

Griffin Regulated Power Supply EKR-252-010J

1. Excessively large ripple leads to a loss of regulation at higher currents.
2. Ripple rises to 1.5 V pk-pk.

Verdict: Although this supply is soundly engineered from an electrical safety standpoint, its regulation circuit is unusual and possibly unsound. This may be the cause of its excessive ripple. We cannot therefore recommend it.

Harris S-Range Regulated Supply P70215/3

1. The sum of the currents which can be drawn from all of the +9 V, +12 V and +15 V rails together cannot exceed 300 mA.
2. There are minor defects in the earth bond and insulation system.
3. Maximum current outputs are not shown on the front panel.

Verdict: This is a reasonably well designed supply which we can recommend.

Irwin Stabilised Power Supply ±5 to ±15 V EJ0392

1. There is a slight loss of registration on the voltage selector control.

Verdict: This is a well engineered product with an excellent performance. We can recommend it.

Definition of codes (continued)

Heating

A - temperature rises complying with BS and not exceeding 25°C on exterior parts except for heatsinks
B - temperature rises complying with BS
C - temperature rises not complying with BS; risk of danger

Construction

A - very sound
B - generally sound, but some features cause concern
C - unsound

Mechanical endurance

A - can be expected to be mechanically sound after 20 years handling in schools
B - can be expected to be still fairly sound after 10 years handling in schools
C - not expected to last 10 years without significant mechanical failure

Markings, safety

A - complete as per BS
B - incomplete set of required markings
C - absence of markings

Markings, operational

A - clear and complete
B - reasonably clear and complete, but with significant defects
C - unclear, or so incomplete as to be misleading

Reliability

A - no evidence to indicate that the supply will not work reliably unless subjected to severe handling
B - evidence that failures may occur from time to time
C - evidence that failures occur frequently
U - unassessed because the product is new, or because we have no evidence

Assessment

A - most suitable for use in Scottish schools and non-advanced FE
B - satisfactory for use as above
C - unsatisfactory

Table B

Manufacturer	Irwin	Irwin	Linnaeus	RS	RS	Unilab
Model name	Stabilised Power Supply ±15 V 100 mA	Stabilised Power Supply ±3 to ±15 V	DC Power Supply ±15 V Regulated	Microcomputer Power Pack Triple Output Unit	Professional Prototyping Board with PSU	Variable Dual 15 V Regulated Power Supply
Supplier	Irwin	Irwin	Harris	RS	RS	Unilab
Stock number	EA3026	EA3027	P70236/0	654-455	489-100	022.110
Specification:						
Output 1 (V)	+15	+3 to +15	+15	+5 ± 0.1	+5	+5 or +1.25 to +15
(mA)	100	100	300	2000	1000	1500
Output 2 (V)	-15	-3 to -15	-15	+12 ± 0.4	+5 to +15	-1.25 to -15
(mA)	100	100	300	300	500	1500
Output 3 (V)	--	--	--	-12 ± 0.4	-5 to -15	--
(mA)				300	500	
Performance	B [1]	C [1]	C [1]	A	A	A
Ripple and noise	C [2]	A	C [2]	A	A [1]	A
Electrical safety	A	A	C [3]	B [1]	B [2]	A
Electrical protection	A	A	C	A	A	A
Heating	A	B [2]	C [4]	A	B	A [1]
Enclosure, materials	plastic, metal	plastic, metal	plastic mould'g	metal	plastic, metal [3]	metal
apertures	none	none	none	none	yes	none
ext. heatsink	none	none	none	none	none	yes
Construction	A	A	C [5]	B [2]	A	A
Endurance	A	A	C	B	B	A
Markings, safety	C [3]	C [3]	C [6]	B	B	C [2]
operational	A	A	A	A	A	A
Reliability	A	B	U	U	A	U
Meter	none	none	none	none	none	digital
Price (£)	49.86	58.47	25.75	73.45	114.90	144.47
Assessment	B	C	C	A	A	A

Notes on Table B

Irwin Stabilised Power Supply ±15 V 100 mA EA3026

1. The supply nearly performs to specification, but sizeable ripple at currents ≥ 90 mA causes a loss in regulation.

2. Ripple below 90 mA never exceeds 2 mV pk-pk. However, at 90 mA it shoots up to 200 mV and leads to a loss in regulation.

3. Statutory markings are absent.

Verdict: This supply has been designed to power op-amp circuits, and since these circuits typically draw very little current, it adequately meets this need. However it cannot be used to drive sizeable loads, nor drive power semiconductors. Its loss of regulation at the top end is disappointing.

Irwin Stabilised Power Supply ±3 V to ± 15 V EA3027

1. The unit is unable to continuously sustain a current in excess of 60 mA without the regulator overheating and folding back.

2. The temperature rise on the regulator can exceed 100°C. Temperature rises on the enclosure are insignificantly low.

3. Statutory markings are absent.

Verdict: The performance is well below its specification. We cannot therefore recommend it.

Linnaeus DC Power Supply ±15 V Regulated

1. Voltage regulation is poor.

2. Both rails go into a high frequency oscillation (350 kHz to 700 kHz) which reaches a maximum of 13 V pk-pk.

3. The unit can dangerously overheat under high loading.
Several electrical components are underrated.
The mains cord is improperly clamped at the enclosure.
Other than internal mechanisms within the regulator, there is no form of overload protection.
There is a lack of supplementary insulation on conductors.
Components are inadequately mounted.

4. Excessive temperature rises caused the plastic of the enclosure to soften and deform, a paper label on the transformer to char, and epoxy resin used to fasten the heatsink to fracture.

5. See points 3 and 4.

6. Statutory markings, including the double insulation symbol, are absent.

Verdict: What can we say other than don't buy it!

RS Microcomputer Power Pack Triple Output Unit 654-455

1. The mounting flange on the transformer yoke has been found to be weak. We understand that the manufacturer has modified the transformer clamp to provide better support.
2. Good, apart from the transformer flange and the absence of feet.

Verdict: A useful triple rail supply at quite a reasonable price. Provided you are prepared to check the transformer mounting for signs of buckling as part of your routine maintenance checks on equipment, this product would have our recommendation.

RS Professional Prototyping Board with Power Supply Unit 489-100

1. Although both ripple and noise are very low, they are not quite as low as the specification asserts.

2. The earth bond conductor is too thin. Some minor external parts are not bonded to earth.

3. There are two prototype wiring boards mounted on the top panel. They provide 94 pairs of 5 common spring contacts.

Verdict: A very useful triple rail supply which gets our recommendation, although we have some minor reservations about its construction.

Unilab Variable Dual 15 V Regulated Power Supply 022.110

1. The temperature rise on the external heatsink can reach 42°C.

2. Statutory markings are absent.

Verdict: This is a well designed, quality product that does what it's designed to do and is adequately robust for school use. It gets our recommendation.

Reference

1. "Power supplies for electronics and technology course", SSERC, "Technical Articles", Bulletin 164, December 1989.

Equipment Notes

Interfacing - The datalogger cometh

This article provides an up-date on the main developments in commercial equipment and software for science and technology interfacing since our last such review article in 1986.

A general overview is followed by three detailed reports on *LogIT*, *Sense & Control* and the Unilab *Simple Logger*.

Introduction

In Bulletin 154 we said that three years was a long time in interfacing. Almost five years have since slipped by and that quote is no less valid. If anything the pace of change has accelerated. Additionally, software and hardware features specified back in Bulletin 137 and iterated in Bulletin 160 still hold true.

We concentrate first on what's been happening since the end of 1986. We look both at new interfacing items and those soldiering on in original or evolved form. The second half of the article continues with detailed reviews of that new genus - the datalogger that can also act as a real-time interface and talks to the computer through the serial port. Next issue we cover interfacing software and interfaces which cannot log data unless connected to a computer. We attempt to give answers to questions such as:

Is the Philip Harris *Universal Interface* universal?

Is *Softlab* a padded environment for disruptive pupils?

What's new for interfacing the Archimedes? and

Where does all this leave your wee, black, analogue port box?

And, for the technologists, in some future issue we will discuss interfacing facilities for control.

From discussions with those involved in current datalogger developments it appears that they want now to concentrate their efforts on meeting certain needs in implementing the *National Curriculum* in England and Wales. This means that they are all producing curriculum support materials, hardware and software for "simple" datalogging. Too often in the past, they say, rushed development work has meant unfulfilled promises. The advertising of the resulting *vapourware* has led to disillusionment and disappointment amongst teachers. Certainly, that gets our vote!

Developments post 1986 - an overview

Serially speaking

Life was relatively simple for interfacing developers during the mid 80's. Then the BBC B and Master were the only machines around on which it was worth hanging an interface. Now there are a number of different models of computer in quantity (Macs, IBM compatibles {a.k.a. PCs}, Archimedeses) which don't come with such standard niceties as an analogue port, user port or a 1 MHz bus.

The logical step was to look for a common method by which an external device, be it datalogger, interface or controller could communicate with any computer. The answer was to take the *RS232* route. This is a standard method of connecting business machines through serial interfaces. It is one which has been used in the data communications and data processing industry for many years. The unreliability of earlier serial links may explain why this route was not previously more vigorously pursued. Now, provided you write software which will interpret and analyse incoming data for each computer, the same datalogger device can download information through any computer's serial port.

LogIT, *Simple Logger* and *Sense & Control* are all results of following such a development route. There are others. The big plus which makes these three devices stand out is that, attached to a computer, they can act also as real-time interfaces. Other dataloggers such as the Philip Harris *EMU* and Educational Electronics *VELA* stand alone when actually logging the data.

The *Universal Interface* from Philip Harris also provides a serial communication route to a range of computers. It allows interfacing hardware previously only compatible with the BBC B and Master to now talk to other models of microcomputer.

Sensor recognition

These interfaces are accompanied by a new generation of sensors. Several of these can send signals to the computer via the datalogging device. Each sensor has a unique coding which is sent to and read by the datalogger or interface. The system can thus recognise different sensor types and convert voltages into appropriate units. Graphs are then automatically scaled in the correct units.

With many of these new packages you thus don't need to calibrate the input to the computer. Some regard this as not necessarily being "educationally a good thing". This is because they see calibration against secondary or primary measurement standards as a central concept of instrumentation. In turn, they regard instrumentation as a key part of science and technology education.

Another apparent boon is that through multi-wire cabling most sensors no longer require separate power supplies. This is because they are powered by the interface or datalogger through robust multi-pin D-type or DIN-type connectors. Now the clutter of wires and the worry of wrong polarity connections is seemingly lessened.

Life however is never without its little surprises. For example, we have heard that the DIN-type Philip Harris *First Sense* sensors can be physically connected to LogIT and vice versa - with potential for mutual destruction. Similarly, the connection of LogIT's serial output to a Philip Harris Universal Interface is also possible. This too may lead to tears.

Curricular support

With the advent of serial dataloggers and the pressing needs of the National Curriculum another evident trend is the keenness of the hardware and software developers to work with third parties. Their prime aim has been to produce ready-to-use curricular material in support of their products. For too long this has been left to teachers. With little enough time for preparation and meagre provision of in-service (sorry *staff-development* nowadays) they had often not only to figure out for themselves complex hardware and software but also to prepare their own learning materials.

Software for all?

We have detected recently a "lets-keep-everything-simple" lobby of software developers. A laudable aim no doubt. Major pressure has undoubtedly come from Primary science and technology. This is a large market. It is now to be served with interfacing equipment, software and curriculum material. There is now pressure for simplicity and uniformity across computers such as BBC B and Archimedes. This is well and good so long as it doesn't leave the Arc waddling around in the software equivalents of lead wellies.

Toolboxes

One particularly interesting development is *Softlab.* This comes from a team at Homerton College, Cambridge under the auspices of NCET (National Council for Educational Technology). The software has "an on-screen Toolbox which holds apparatus icons which pupils select to build a design for data capture and the control of actual relays". It is claimed that it works with LogIT, Universal Interface, Simple Logger and Sense & Control.

The bad news is that currently Softlab only runs under *Microsoft Windows 2 or 3* on PCs. We will find out by next Bulletin if a 2 Mb Arc can run the program under PC Emulation on Windows 2. More direct help also may be at hand. We hear that Leicester University, under the DES Software Support Scheme, is developing a datalogging package for Archimedes and Nimbus computers - it uses windows and will permit multi-tasking with standard data handling software.

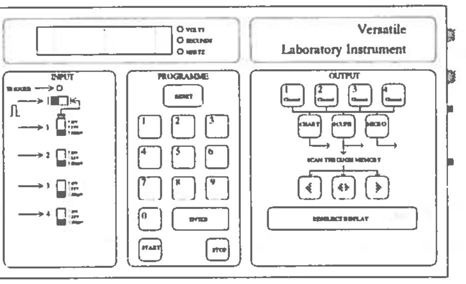
Who has been doing what?

Now we take a brief look at what each of the principal players on the interfacing stage (and some of those with bit-parts) have been doing over the last four years.

ISL & Edinburgh Peripherals

VELA

Although launched over 8 years ago, *VELA* is a show that will run and run. At £280 it initially looks expensive compared to the newcomers. Remarkably, it is still the only schools datalogger that can be truly termed stand-alone. All the others (with the exception of a



djb/Unilab prototype called *Motion QED - Quick & Easy Display*) either require a computer to program them for logging or to display the data once logged.

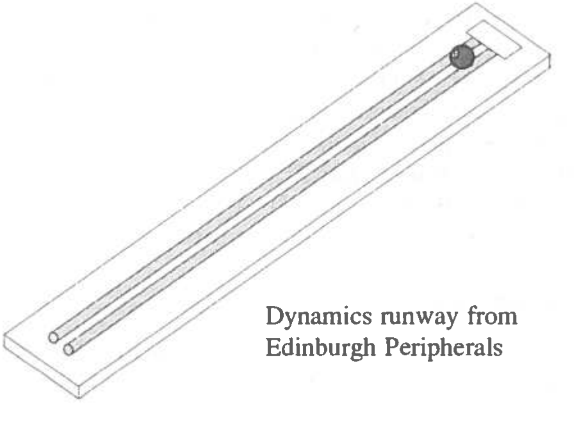
We hear from the weel-kent VELAphile (maniac?), Ashley Clarke, that he is not to be outdone. He is now developing software to give VELA full RS232 capability. That will enable it to communicate serially (and cheaply) to PCs and Macs. There may be hope yet for those of you out there sitting with a *Spectrum 48K* and *Interface 1*! (The cognoscenti are aware that this has an RS232 port). If you want to use an Acorn computer to analyse data logged on VELA then *Datadisc Plus* from Philip Harris is probably the most appropriate software.

You may be tired of hearing it, and in many ways people claim it simply complicates matters, but VELA, even in its basic form, is not just a datalogger. It can also be a digital voltmeter, frequency meter, ramp generator, pulse counter etc.

VELA Support

Another factor in VELA's favour is a wealth of curriculum material, user group knowledge and peripherals. Many of these have been refined over 8 years of development. For a totally biassed but knowledgeable view on how VELA can help, contact Dr. Ashley Clarke of the *VELA Users' Group* at Leeds University or in his entrepreneurial guise at *ISL (Instrumentation Software Ltd.)*. See also the *Get to know your VELA* series of books for *Chemists, Physicts, Biologists* and *Technologists.*

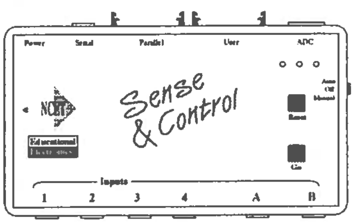
In Scotland resides another famous (notorious) VELA enthusiast. This is Adrian Watt who teaches Physics and Electronics at Merchiston Castle School, Edinburgh. In the guise of *Edinburgh Peripherals* Adrian markets some novel items of equipment for teaching dynamics with VELA timing programs. They include a dynamics runway (£29) and reflective light switch (£17). On the former a ball



Dynamics runway from Edinburgh Peripherals bearing rolls in the gap between two metal rails with metal to metal contact interrupted by non-conducting tape. This can be used as an alternative to light gates, trolleys and slotted cards. The light switch box houses an infra-red source and detector which can detect a reflective card as it passes. Contact Edinburgh Peripherals for more details. Incidentally Adrian has just completed a number of worksheets (photocopiable) to support these and other VELA add-ons. The price is £15.50 to Scottish schools.

Educational Electronics

Sense & Control



Meanwhile, back at the factory and a different one at that (see inside front cover)! For Educational Electronics (EE), its manufacturer, VELA takes a back-seat (and the back page of their broadsheet "Keeping In-Touch") to a Central Government funded development - *Sense & Control*. We review this system fully in the last section of this article. Technology teachers should, for the moment, not be seduced by the second part of this beast's name. The official line from Educational Electronics is that "software and curriculum applications addressing control technology are currently being considered". Do we smell vapourware? In a stricly science context control is available to PC users with a relay box and the Softlab software from NCET.

Plain Sense

A four channel analogue port box called *Sense* is also available from Educational Electronics. This is for use with a BBC B or Master, Arc or Nimbus provided these last two have been fitted with analogue interface . Looking like a cut-down Sense & Control box it can use the same sensors (with D-type connectors) and software as its big brother. It can actually be used with Datadisc Plus software.

NCET and others have developed, and are still developing, a number of resources to support both *Sense* and *Sense & Control*. They include *PriSM - Primary Science Monitor*, *Practical Science with Computers*, *Measurement in the Field*, *Softlab* and *Practical Science with Microcomputers 1991*. We hope to review them and their associated software soon. Dr. Laurence Rogers, of Leicester University and to S & C what Ashley Clarke is to VELA, has started *Data FORUM*, a users' group newsletter. With the same impartiality of the VELA newsletter it seeks to keep users informed of developments.

Motion sensor

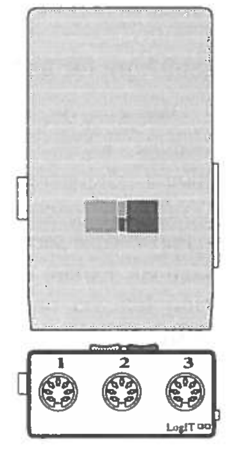
Yet another way of examining the dynamics of moving bodies is with the *Motion Sensor*, also from Educational Electronics. This is an ultrasonic rangefinder which is linked to the User Port of the BBC Computer. We reviewed this excellent device and the associated software in Bulletin 163.

Griffin & George (Fisons) & DCP Microdevelopments

LogIT

Have G & G laid to rest that terrible Romany curse?[1]

The answer may have come from DCP Microdevelopments. These are the people who gave you *Interpack* interfaces for the ZX Spectrum and *Interbeeb* for the BBC Micro. LogIT is a new device made by the same firm. With it, Griffin would seem to have a good chance of recapturing a significant part of the datalogging market. The LogIT package is reviewed fully in the second half of this article. The wee LogIT box is a super piece of design. It is simplicity itself to operate.



The first release versions of the accompanying software were less than perfect and detracted from the rest of the product. After comments from ourselves and others, SCC Research - the software partners of DCP - have worked to sort out these problems. They now have much improved versions. These are available as a free update to original purchasers.

There are 8 pages in the latest Griffin catalogue set aside for LogIT and its range of accessories. However, every other entry says "Available early/April/mid 1991". This at least shows that they are seriously committed to supporting the system with a wide range of kit. We feel though that they might sell more LogITs now merely by promoting only what is available now. They have little to fear if people judge only that, fairly, on its merits.

Having got that off the chest - ideas for the future look good. Still under development are *Fitness Analysis Software*, *Prog Packs* for programming LogIT away from a computer and data transfer to database and spreadsheet packages. Also "coming soon" is hardware compatibility with the old *Interpack* interfaces to allow motors, lamps, and solenoids etc. to be controlled.

LogIT stands apart from Sense & Control and the Unilab Simple Logger in its ability to log data without any prior setting up with a computer (*AutoLog*). Programmed logging is still possible through an option called *ProgLog*. Finally, it is particularly interesting to note one wee picture in Griffin's catalogue. This shows a *1 volt sensor* adaptor set for LogIT to which are attached some of Philip Harris's *Blue Box* sensors!

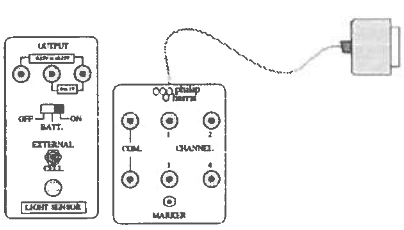
1 - GiPSI I

Philip Harris

The Datadisc dynasty

It all started to happen for Philip Harris with the birth of their *Datadisc* software and wide range of *Blue Box* sensors. Progeny since include *Datadisc Plus, Datadisc 40, Datadisc Plus Connections* and *Dataplot*. Bulletins 160 and 163 provide detail of the facilities of Datadisc and its daughters.

It had to come. The main criticism of Datadisc Plus we now get from teachers is of its apparent complexity. We are told that it does far more than any "average" interfacing novice would need. This is the twelth educational commandment - you just can't win! Philip Harris have responded to such criticism in offering a cut-down menu option on Datadisc Plus. They will also still supply Datadisc 40 (40-track disc version). This has facilities akin to the original and simpler Datadisc but adopts the menu styles of the newer software.



In Bulletin 154 we suggested that the advent of the Master would allow programmers to "integrate data capture software with spreadsheet, database and wordprocessor". The Datadisc Plus Connections software seeks to achieve just that. Through it data can be saved in a variety of formats dependent on the computer system in use. For example on the BBC Micro *Key, Intersheet, Masterfile, Quest* and *Viewstore* are all supported.

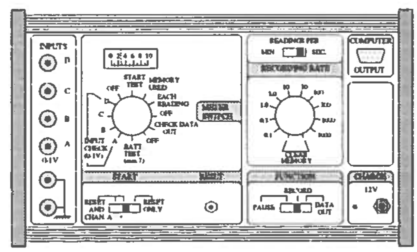
Dataplot is a useful piece of software for use alongside Datadisc Plus. It lets you plot X-Y values from sensors or the keyboard. Graphic trends which are time-independent can thus be built up. Data can be sorted and edited, even after it has been displayed graphically (unlike in Datadisc Plus). Dataplot's large digit displays of sensor values are another additional facility.

Universal Interface

All Harris's updated software can log data not only via the conventional analogue port but also through their new Universal Interface. This device will be reviewed fully in a forthcoming Bulletin. Note that the Universal Interface is not only a datalogger but also a real-time interface. It can be attached to most computers with serial ports. To put things in perspective however, the Philip Harris datalogger *EMU* (Easy Memory Unit) plus the Universal Interface are only capable together of doing what LogIT does on its own.

First Sense

At the ASE Annual meeting in Birmingham, Philip Harris launched a package which makes use of the Universal Interface. This is *First Sense* which is aimed at the primary and early secondary school market. It has new, icon-based software and a range of professionally designed sensors. The designers took both ergonomics and aesthetics into consideration. A related program *First Control* enables the sensors to be used to control devices such as motors and lights through a control interface e.g. *LEGO Interface 'A', Deltronics* etc. We hope to review these packages along with the Universal Interface in Bulletin 170.



EMU

The EMU has created a niche for itself amongst biologists since it was really the first datalogger to challenge VELA - long perceived, rightly or wrongly, as a physicists' machine. It is questionable, even on a simple knobs and switches count, whether EMU is really less complex to operate than VELA. In today's market EMU looks a shade expensive when compared to the new serial dataloggers. In its favour though it relates well to others in the established Datadisc family. Newer software equivalents are generally more limited in scope.

Unilab

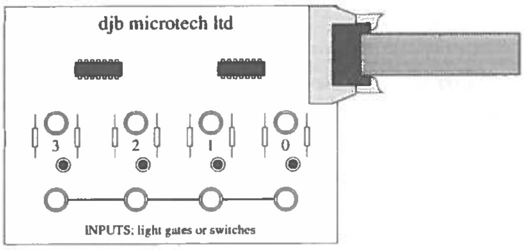
Since our last review of their *Microcomputer Interface*, Unilab seem to have rested on their software laurels. As far as we are aware there have been no updates since 1986 to *Grapher, Unicos, Teller, Uniscope, Scanner* or *Unicore.* Although these pieces of Unilab software had good reviews at that time, there is no doubt that they could have been improved upon. Even Grapher for the Archimedes, which has been two years or more in development, is identical to the BBC B/Master version and runs only under emulation. It certainly was given a low-profile at the Birmingham ASE. If any program deserved full RISCOSsification it was Grapher.

To cope with the new version of Grapher, the only Arc product in the Unilab software range so far, Unilab have developed their *I/O-Box 3000* (Cat. No. 532.011, £77.58). This has an analogue port, a 1 MHz Bus, 2 User Ports (with conventional Beeb-type 20-way sockets and a third User Port (with Beeb-type 26-way printer port socket).

Just as we were going to press a new Unilab Primary Science catalogue arrived. This contains details (available June) of a *Beaver Sensing Card & Control Card* for use with NCET PriSM (Primary Science Monitor) software.

djb microtech

Unilab's software development seems to have been farmed out in large part to a Scottish company - djb microtech limited. This firm has extended their product range greatly since last we reported. All djb software can run with the Unilab Microcomputer Interface or the *djb digital interface* (below).



Available from djb for £24 + £1 p. & p.

Newer djb products include:

Time/speed acceleration (Cat. No. 532.073, £21) for making dynamics measurements with keyboard timers, timing with light gates and other digital inputs, speed and acceleration with masks (either falling or attached to vehicles).

Mechanics Applications I (Cat. No. 532.074, £22) for studying the straight-line motion of trolleys on runways etc. Six investigations are included - displacement/time, velocity/time, acceleration/time, displacement/velocity, falling ball and acceleration/slope.

Mechanics Applications II (Cat. No. 532.075, £22) for further kinetics investigations which include - acceleration/force, acceleration/mass, kinetic energy/ velocity, kinetic energy/mass, the motion of an object catapulted up a slope - velocity/time and finally the last analysed as displacement/time.

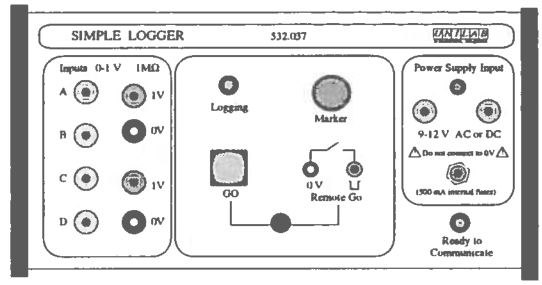
Speed of Sound (Cat. No. 532.078, £20) for the investigation and analysis of the speed of sound.

Simple Data Handling (Cat. No. 532.076, £22) for the presentation of data recorded by hand in graph, histogram, bar chart or pie chart form.

Relational Investigations Program (djb, £26) for the analysis and manipulation of data imported from the Unilab Simple Logger, Mechanics Applications packages or data entered from the keyboard. A copy of this arrived just as we went to press so watch this space for a review.

Simple Logger

The latest offering from Unilab (developed by Derek Walker of djb) is the *Simple Logger* (fully reviewed here, later). This is another serial datalogger. Its main limitation is that it can *only* be used with a BBC Master. Unilab however also use that now well-worn phrase "software for the Archimedes Microcomputer and others is planned". Like LogIT and Sense & Control this logger can also be used as a real-time interface. Unlike the others, it has no internal batteries. It must be connected to



an external supply of 9-12 V a.c. or d.c. at all times, à la *VELA*. This is similar to Sense & Control in that the logging configuration must be set by the computer before any logging can take place.

If you buy a wee circuit board assembly with molex connectors (*Simple Logger Input Card*, Cat. No. 532.038, £5.95) you can connect the sensors from *Control Pathways* or *Alpha Boards* to the Simple Logger. Two such boards allow the attachment of up to 4 sensors.

"Coming soon", June or thereabouts, is a package called the *Box of Delights*. This is intended for simple interfacing in primary and early secondary stages. It uses light sensor, fibre optic cable, colour filters and light boxes. When it does actually see the light of day (sorry!) we will review it.

Deltronics

Well known for their *Control IT* package, Deltronics offer good value for money on a wide range of interfacing products. We have regard for the Control IT box and its software written by the Resource people based in Doncaster. We see it as one of the better choices for teachers of Technological Studies looking for computer control facilities.

These same partners also market a complementary *Sense IT - Science Kit*. This is meant to cope with the type of datalogging experiments required in the English and Welsh National Curriculum. This package (Cat. No. 670, £96) brings together a number of items from the *Liecester Toolkit* range, developed by Laurence Rogers of Sense & Control fame. The *Sense IT* box (Cat. No. 674, £38.60) looks very similar in layout to Educational Electronics' Sense box. It has four analogue input channels (*1-4*) and two digital inputs *A* and B. It uses DIN type sockets for the sensors as opposed to D-type. The whole caboodle connects up to the analogue port of the BBC Micro (B, B+ and Master) or to an Arc or Nimbus with analogue ports fitted.

The complementing Science Kit comes with 3 stainless steel temperature probes (-10-100°C), 2 infra red light gates, 1 phototransistor light switch and a light level sensor. Datalogging software and ideas worksheets are also provided.

More toolkits

Other interfacing products marketed by Deltronics include the Leicester *Computer Measurement Toolkit*. This contains a number of *Modules* with *Toolkit* software designed for specific physics experiments:

Temperature Module (3 thermistors can simultaneously measure temperature);

Capacitor Discharge Module (exponential discharge through a resistor plus calculate gradients, ratios and areas),

Current-Voltage Module (examines the current-voltage characteristics of low voltage tungsten lamps, resistors, diodes and transistors plus plot current, voltage, resistance and power graphs);

Light Switch Module (2 light gates or other digital switch inputs used for experiments on motion) and

Analogue Sensors Module (a simple 4-channel analogue port connecting box).

We have seen all of these packages in use at an interfacing workshop run by Dr. Peter Craig of Northern College. The teachers and technicians on the course were impressed by the simplicity of the software and hardware.

RESOURCE

These software writers, partners with Deltronics in some ventures, have now come up with an analogue port box of their own. It forms part of a package called *Measure IT*. For £64.50 you get simple software (Archimedes, BBC or Nimbus with the Liecester Toolkit software), the box with connecting lead to the analogue port, 2 temperature sensors, 1 light sensor and 1 push switch. This is another system meant to meet some of the requirements of the National Curriculum. It can also be used with the PriSM - Primary Science Monitor materials developed by NCET.

We hope to review both Deltronics and RESOURCE hardware in the not too distant future. Do I smell paperware?

Three Dataloggers Reviewed

How they measure up

Fig. 1

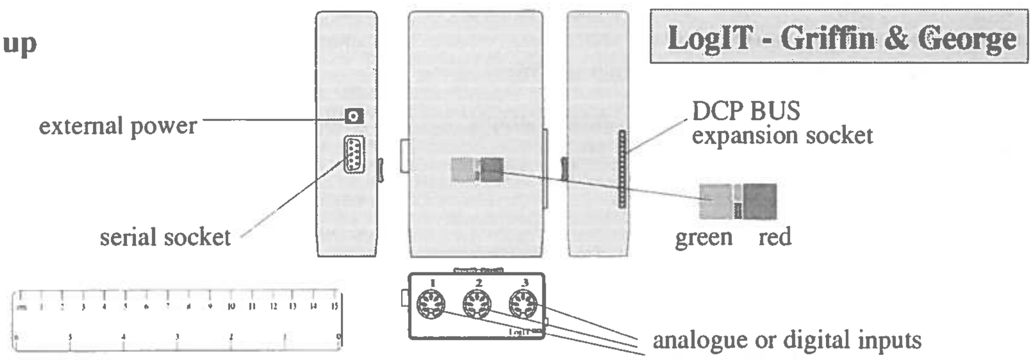


Fig. 2

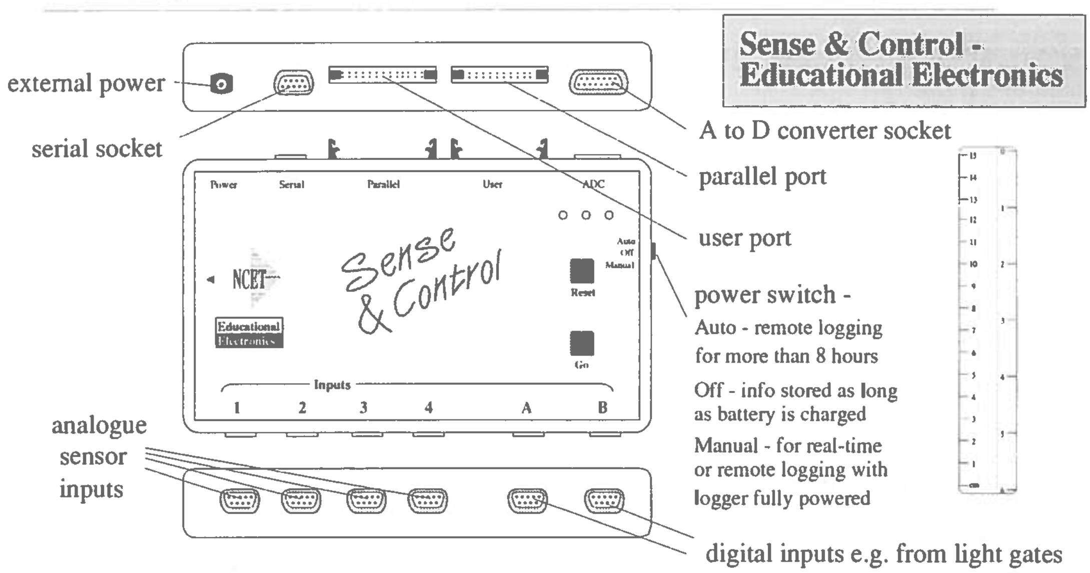
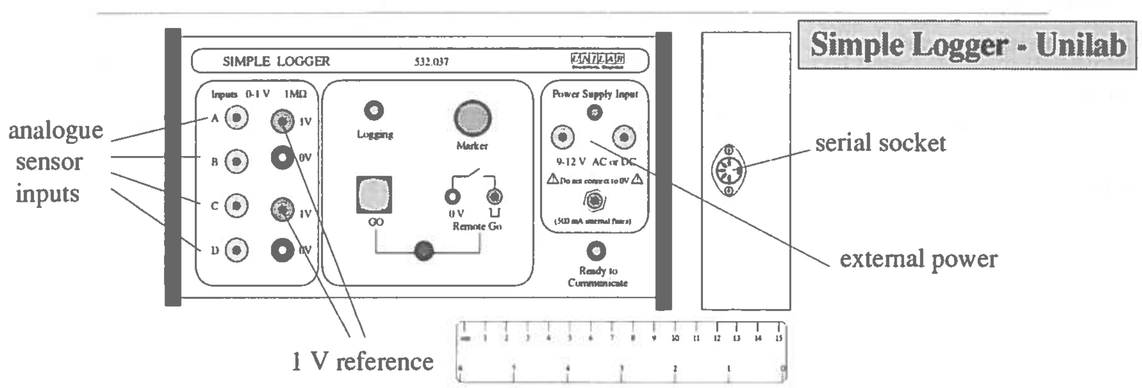


Fig. 3



LogIT

Description:- *Starter Pack* - rigid case with LogIT datalogger; light level sensor; lens & filter set; general temperature sensor; guide card and manual. Foam cut-outs to house other accessories and sensors.

Supplier:- Griffin & George, CRD-100-Q, £169.90

SIMPLE LOGGER

Description:- *Simple Logger*, 80-track, DS, 5¹/₄" program disc, serial lead & manual.

Supplier:- Unilab, 532.037, £119.28

Essential accessories for portability, lab power or transfer of data to/from host computer:-

Link Pack - software and serial lead computer type dependent: *BBC B/B+/Master* - 40-track single-sided 5¹/₄" program disc & connecting lead. Cat. No. CRD-110-010G, £29.90

Archimedes - 3¹/₂" program disc & connecting lead (A3000 must have serial upgrade fitted) Cat. No. CRD-110-030A, £29.90

Charge Pack - 240 V a.c. dual battery charger & PP3 rechargeable battery. Spare PP3, 8.4 V, NiCd rechargeable cells (RS Stock No. 591-089, £4.56)

Mains Power Pack - 240 V a.c. plug-in power supply with cable & plug (Cat. No. CRD-120-510C)

For remote logging - 8, AA, 1.2 V NiCd rechargeable cells (e.g. RS Stock No. 591-051, £11.12) in 2, 4-way battery holders (RS 488-179), £1.10 or SSERC Item No. 730, £0.40) or

- lead/acid 12 V, 1.1 Ah sealed, rechargeable cells (RS 591-922, £13.44). Also stocked by burglar alarm wholesalers.

recharging NiCd cells - e.g. 2 x nickel-cadmium battery chargers (RS 592-414, £12.60)

for lab work - any laboratory power supply capable of delivering 110 mA at 9-12 V a.c. or d.c. (e.g. Unilab 12 V Stepped Transformer, Cat. No. 022.107, £40.88)

Input Card - attachment allows up to 2 sensors from *Control Pathways* or *Alpha boards* to be connected via Molex connectors (Cat. No. 532.038, £6.57)

Hardware features

Weight (with/without batteries):- 0.195/0.237 kg. Lightest of 3 tested.

Connections (see Figure 1):-

3 analogue/digital DIN-type inputs:

0-2.5 V with *1 Volt Adapter Set* (Cat. No. CRD-130-545W, £19.90),

0-25 V with *Voltage Measurement Set* (Cat. No. CRD-130-540J, £22.90) *or*

LogIT sensors (LogIT recognises sensor type)

serial/I^2C D-type socket

DCP BUS expansion socket and

low voltage power socket.

Portability:- Best of 3 tested. *Autolog* feature requires no prior programming by computer. Double click on green button to start logging. Green then red to stop. Not waterproof. The purpose made carrying case is liked. Recent field trials led to favourable comment from a biology teacher on LogIT's compactness, ease of changing batteries, simple start/stop operation and marking of events.

Hardware features

Weight (with/without batteries):- 0.919/1.232 kg with AA cells or 1.474 kg with lead/acid. Heaviest of 3 tested.

Connections (see Figure 2):-

4 x analogue 4 mm inputs for 0-1 V sensors

Input Card (see above)

4 x 1 V, 4 mm reference sockets

serial DIN-type socket

2 mm *Remote Go* sockets - external events can be used to start logging and/or log voltages at specific event times

4 mm power sockets

Portability:- Worst of 3 tested. *Simple Logger* must be pre-programmed in chosen mode by the computer. Because the unit is externally powered rechargeable cells may be inadvertently or deliberately shorted. We advise that rechargeable cells are enclosed in a box (lead/acid version should also include charging circuit). No carrying case available.

SENSE & CONTROL

Description:- *Sense & Control* datalogger with integral rechargeable batteries, charging circuitry, *Practical Science with Microcomputers* software; mains power supply; serial lead & manual. A second disc is quoted in this package but was not available at time of testing. Note - no sensors supplied at this price.

Essential accessories

Supplier:- Educational Electronics, 6000, £155.00

None required. *Data Logging Package* needed for recommended National Curriculum activities - 3 general temperature sensors (-10 to +100°C), 2 light gates, light level probe, light switch and position sensor plus *Sense & Control* as in the *Description* section above - £295, Cat. No. 6010. The temperature sensor is resistant to most weak acids but is not be left in them.

Sensors are claimed to be self-identifying but the software supplied does not exploit this. The type of logging intended has to be chosen before the graph is plotted (see "Logging Options" below). A light probe used with the *temperature* against *TIME* program resulted in it quite happily plotting temperature!

Hardware features

Weight (with/without batteries):- 0.611 kg with integral rechargeable batteries - 2nd lightest of 3 tested.

Connections (see Figure 3):-

4 x analogue D-type inputs for *Sense & Control* sensors (logger recognises sensor type);

2 x digital D-type inputs for light gates (recognised by logger);

26-way Parallel Port;

20-way User Port & D-type analogue port sockets (all à la Beeb);

serial D-type socket;

low voltage power socket.

Portability:- Second best of 3 tested but chosen mode must be pre-programmed at the computer. Rechargeable batteries (soldered in) are inaccessible to pupils. Cannot be easily removed or replaced. Battery life is 8-12 hrs depending on sensors used. Recharging time is 12-16 hrs. Logger isn't waterproof. No carrying case available.

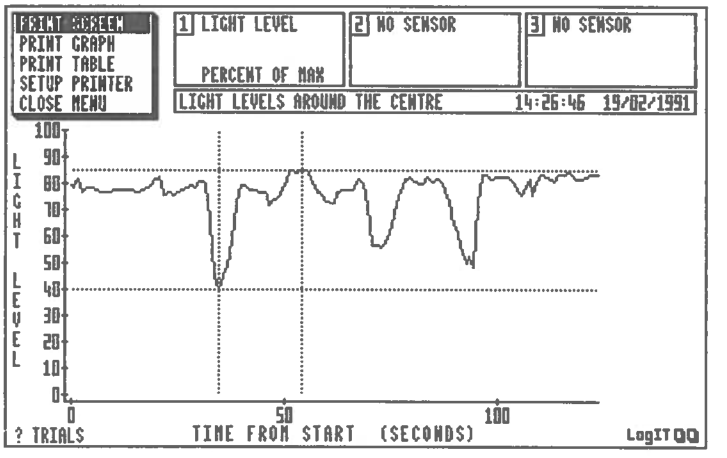


Fig. 4 LogIT screen display/dump/sprite

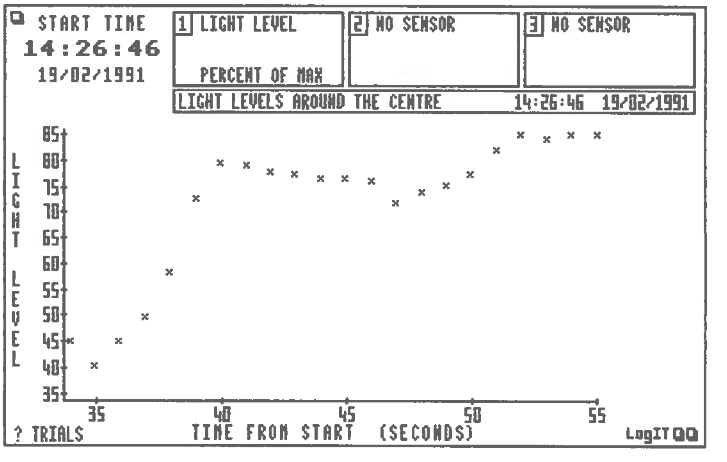


Fig. 5 LogIT screen - marked zoom & points not joined

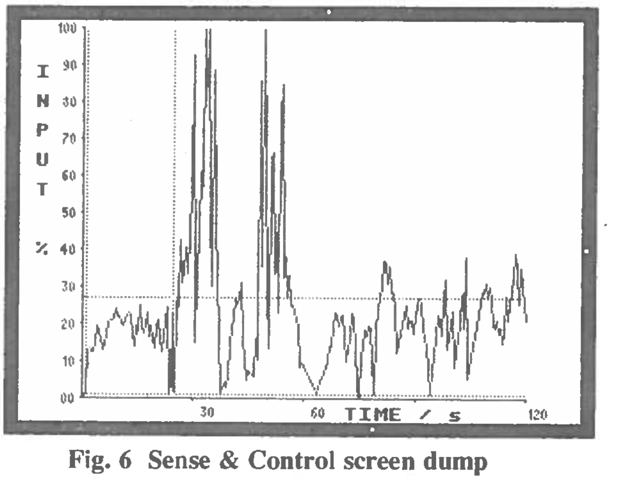


Fig. 6 Sense & Control screen dump

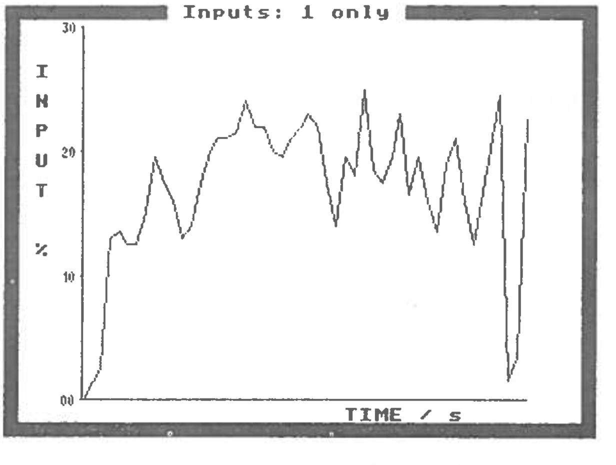


Fig.7 Sense & Control screen - zoomed in view

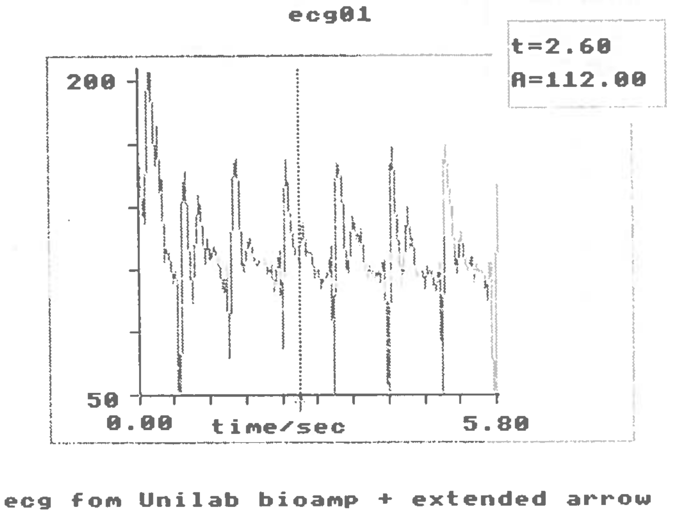


Fig. 8 Simple Logger screen dump - ECG

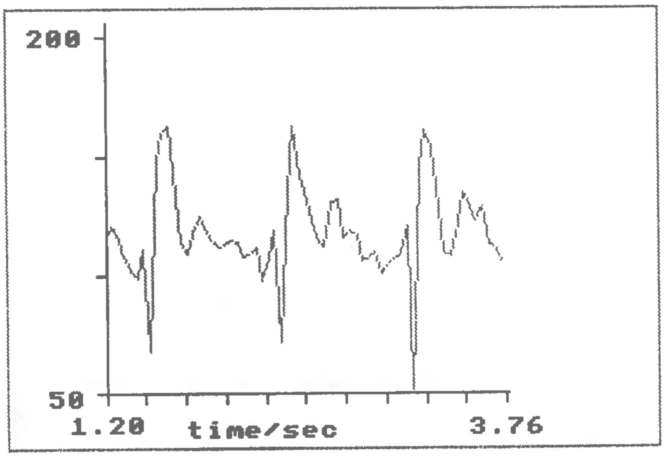


Fig. 9 Simple Logger screen - zoomed in view

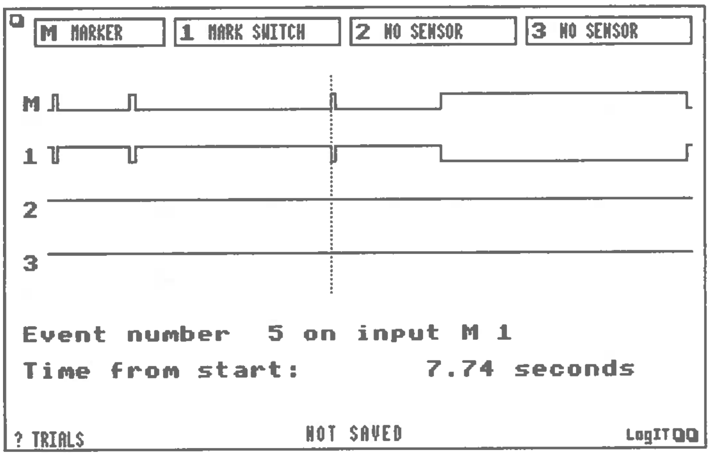


Fig. 10 LogIT event timing display

LogIT

Accuracy

Voltage:- very satisfactory. Well within 1% error with 0-1 V sensor (1 V f.s.d. assumed). Software and sensor can be used up to 2.5 V f.s.d. Error exceeds 1% only over the last 100 mV.

Temperature sensor within 1% over 0-100°C. Satisfactory. Claimed resolution better than 0.1°C. Zooming in allows temperature differences of 0.02°C to be resolved.

Timing:- satisfactory but not the best tested. 2% error over 11 s period, 0.44% over 2 hours. A 1 Hz square wave test gave a clipped trace. This, and the timing errors, according to the software writer, were caused by averaging before plotting and an error in the review software. Averaging works well for ironing out noisy traces (a bit like smoothing as you go) but is a disadvantage when you want detail in a trace (e.g. an ECG). At logging rates >1/s, via ProgLog, there is now no averaging.

Triggering:- reasonable (up to 2% error) but nowhere near the best and let down by quirky definition of "sensor level". See "Logging options - triggering" below.

Software features

Menus:- most pleasing of the 3 packages. Archimedes version is mouse compatible and extremely slick. On-screen "HELP" information is available at any time - excellent. Menus are nearly always present (tucked away in top left hand corner of screen) so you know where you are at any time. <ESC> brings up the current menu if hidden. Cursor keys move up, down and highlight menu selections. In *Version 2* software function keys are configured to switch: traces and guide lines on and off, points to lines and to auto-zoom.

Graphical display:- (see Fig. 4) is the most pleasing and informative of the 3 examined with filename, date, time and sensor status/type neatly laid out. The default style is to join the data points but this can be switched off (Fig. 5). Scaling of axes on Version 2 software is always in sensible divisions.

Tabular information:- is the best of the 3 tested. As well as sensor readings it contains information about filename, start time and date, time elapsed and the actual time for each logged sensor value with choice of the number of data points to be printed.

Saving, loading & deleting data files:- Easily done from the Load/Save menu. <Esc> backs out of the operation at any stage. The user is sheltered from the vagaries of the disc filing system. Files can be selected, saved or deleted by moving an arrow with cursor keys or mouse. Data files are named or

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SIMPLE LOGGER

Accuracy

Voltage:- satisfactory. Well within 1% error over 150-850 mV. ±2% over extremities of 0-1 V range.

Temperature sensor as used with *Control Pathways* - not recommended for accurate temperature measurement and useful for trends only.

Timing:- very satisfactory. Well within 1%. Accurate to 1 s over 2 h. test.

Triggering:- very satisfactory. Rising and falling trigger levels were generally within 5 mV of those set by the user.

Software features

Menus:- The whole package is inconsistent in style and frustrating. Menus in double and single height *Teletext* characters are particularly easy to read. Cursor keys move you up/down, and highlight, main selections. Submenus are accessed by pressing initials e.g. of <L>oad, <S>ave and <A>ccept. Other selections revert to cursor key cycling e.g. data drive: <0>, <1>, <2> or <3>. Laborious plodding through over-protective decision screens then confirm acceptance of earlier instructions. Function keys are used to select e.g. main graph, values, zoom, channels on/off, markers, screen dump, screen save, label graphs, overlay, area, gradient, re-scale y-axis and main menu.

Graphical display:- is second in quality and usefulness to LogIT's. It is informative, giving time elapsed and sensor data but daft scales appear with *"zoom-in"* on data (see Fig. 9). Graphs can be labelled with relevant channel letters and screen saves given a *Screen title* and *Comment* of up to 40 characters (Fig. 8). All of these facilities are useful and make graphs more informative.

Tabular information:- Second best of three tested for the printing of tabular information. Try as we might we couldn't get our Epson MX-82F/T to print out tables with carriage returns. Time and sensor readings were displayed. The software had the option to display sensor readings as calibrated or un-calibrated, the full scale being 250. The default units for time had the annoying habit of coming up with readings such as 0.72 x 10^{-2} ms but time units could be changed by a menu selection. This part of the software did however have greater scope for data analyses than did the others.

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SENSE & CONTROL

Accuracy

Voltage:- satisfactory but no software facility to plot voltage vs. time - nearest is the % input reading in the *General Sensors* part of the disc. Beware inaccuracies of analogue port connectors with Zener diode protection. Educational Electronics do not recommend the use of analogue port connectors designed for the BBC micro. They sell an *ADC Connection Module*, (Cat. No. 6280, £31.50) which provides overvoltage and reverse polarity protection. The useful range with a Beeb type analogue port box is 0-1.5 V, with <1% error. A 4-channel box without protection or the ADC Connection Module can be used up to 2.5 V (100%).

Temperature probe (thermistor housed in a stainless steel tube) is accurate to ±0.5°C over -10 to 40°C, ±1°C over 40 to 90°C and ±1.5°C over 90-100°C.

Timing:- satisfactory. No measurable error on 1 Hz oscillator test - but software only displays a reading for every 0.5 s over a minimum logging time of 2 mins. The chance of showing a good 1 Hz square wave is minimal. Accurate to 1 s over 2 hrs. Another disc, to be made available later, should provide smaller sampling intervals.

Software features

Menus:- Selection is nicely consistent both in main menus and datalogging parts of the software. Archimedes, Nimbus and Beeb versions function virtually identically. Cursor keys or the spacebar move highlighted bars up and down a *Teletext* display. Once the graph display appears a menu bar at the bottom of the screen remains and <Spacebar> cycles through and highlights the menu selections. Teletext colour usage in the *Time & Motion* routines is confusingly varied: *Time* being seen as cyan or red on black, blue on cyan and white on black (applies also to *Speed*, *Velocity* and *Acceleration*). On a monochrome monitor red text all but disappears!

Graphical display:- (Figs. 6 & 7) is the least pleasing of the 3 examined. *Replot*ting marked text (zooming in) may result in total disappearance of the time scale! (Fig. 7). Time and sensor data on the top line of the screen curled around the top edge of our CUB monitor. Up to 15 characters can be entered to label the y-axis. The real-time display default plot not joining data points is liked but data points are joined on Re-plotting. There is no way of switching back to the original.

Tabular information:- The printing or displaying data tables is not a currently available option.

Saving, loading & deleting data files:- Accessing/saving data from/to disc is as quick as with *LogIT* software. Curiously, data is saved only on drives 0 or 1 and data

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LogIT

described with up to 30 characters - a good feature. There is no access however, to drives other than 0.

We were able to save 12 sets of data on the Beeb version and 18 on the Arc before getting a "No more space" message.

Saving, loading & printing screen dumps:- On the Arc sprites of the whole screen can be saved by keying Ctrl-S. The sprite (saved as "$.screen") can then be loaded into Draw, DTP etc. for labelling, re-scaling etc. It does however appear in colour which generally prints badly on monochrome printers. A wee program from SSERC will convert this screen into the form you see in Figs. 4 & 5. You can print the whole screen or the graph alone. Printing out screens on our Epson MX-82F/T was trouble free. Thus far the disc only supports Epson printers.

Logging options

Calibration:- *Microsense* sensors are self identifying and calibrations automatic - that assumes their response does not vary with time. There are no facilities to allow calibration of 0-1 V sensor inputs for y-axis display in user-defined units. However, temperature can be displayed as °C, °F or K and the 0-1 V input can be displayed as 0-14 pH, 950-1050 mB, 0-100% or 0-1000 mV. Harris sensors can connect easily enough but interpretation of graphs is hindered by the mV or % scaling. LogIT has protection up to ±10 V using the 1 V sensor lead. A *Technical Manual*, available from SCC Research, covers d-i-y sensor designs to allow applications software identification with appropriate linear calibrations or look-up tables.

Real-time interface:- LogIT *Linkpack* software is the best of the three packages and is easy to use. An initial screen helpfully gives LogIT's battery state;date and time of the experiment with sensor type and output on a histogram/bar display. This gives a useful check facility before starting logging. A press of <Return> gives a graph. In the default *Autolog* mode you just dive in and start logging, unlike other models with pre-programming. The "real-time" graph automatically re-scales to a longer time-period if the logging extends beyond the initial set time. Events can be marked with a press of LogIT's green button. These are all useful features.

Remote logging:- This is simplicity itself and here the others cannot compete. To use *AutoLog*: plug in the sensors, 2 presses on the green button and away you go. Green then red stops the logging. Four such runs can be done and the information stored before coming back to the computer to analyse the results. *Proglog* settings only last for a single run, being started by a double click on the green button or triggered by a voltage change. Since LogIT goes to "sleep" between readings it should run for several months on one battery. (continued on page 38)

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SIMPLE LOGGER

Saving, loading & deleting data files:- Unilab recommend separate discs be kept for data, sensor calibrations and screen saves (can also mean separate sides of discs). Offering the means to save on different drives obviously makes it more complex than in the other 2 packages to set up where and how data is saved. The system forgets information entered previously about "drive for; data, screens or calibration files". Menu format inconsistencies extend to saving and loading files. Pressing either <Return>, <Spacebar>, cursor keys or individual letters all cover similar types of menu operation.

Saving, loading & printing screen dumps:- Saving screens (Mode 1) is easily done by pressing <Shift/ function key>. The bottom line may be labelled with up to 40 characters of text - a useful facility. Screens are saved in two temporary files called *SCREEN1* and *SCREEN2* - beware saving any more than two such screens as subsequent ones simply overwrite. You give the screen a name but this has nothing to do with its filename. The Disc Filing System must be entered to *RENAME these files. This should not be necessary in current commercial software.

Logging options

Of the 3 packages tested, this has the widest range of facilities for logging and analysis.

Calibration:- Only its software can calibrate any of the 4 inputs for sensors with an output of 0-1 V and then display graphs with the chosen units. In similar manner to calibration procedures on *Datadisc Plus*, two set-points are entered. The computer interpolates and extrapolates between and beyond these values. This assumes linear sensor output. These calibrations can be saved on disc. Another handy feature is retrospective calibration of data originally logged as raw data files.

Real-time interface:- This is easy to set up. A useful *sensor check* facility informs if all is well. The fastest rate of data capture, on up to 2 channels, is readings every 40 ms. Up to 200 readings may be taken in this mode but graph plotting over an 8 s timescale, takes 14 s. Other packages may let you analyse the displayed graph but here you must exit to the main menu to select *analyse data* etc. Immediate screen to printer dumps are possible.

Remote logging:- These facilities are extensive in this the best of these packages for rapid datalogging. Set up to go *Flatout*, it logs 5000 readings at 200 µs intervals on one channel a feature the physics department is most likely to exploit. At the other extreme 2004 readings on can be logged on four channels over intervals up to 7 days with as many as six *markers* to flag events.

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SENSE & CONTROL

file descriptions are restricted to 7 characters, as per DFS, to describe your data file. This aspect is less satisfactory than in the other two packages reviewed. Up to 31 separate data files can be saved on one disc. Deleting files means an exit to the operating system. Without a "Finish Off" selection on the main menu this is a difficult task unless you know <Ctrl/Break> or remove the disc and switch off the computer! Educational Electronics say this is deliberate because they don't want children exiting from the software by pressing the Break key.

Saving, loading & printing screen dumps:- There is no screen-save to disc. A screen is easily dumped with a PRINT option on the main menu. Information on data points - graph lines displayed on-screen - does not appear on the printer dump (Figs. 6 & 7). Dump sizes cannot be controlled. Dumps to our Epson Mx-82F/T were problem free.

Logging options

Calibration:- There are no software facilities for y-axis calibration of graphs for *general sensors* connected to a 4-channel box attached to an analogue port. You are stuck with 0-100%, although you may label this also as the measurand. Datalogging bits of the software simplify setting up the logging but restrict you to 2 broad categories:

Plotting against TIME and *Plotting against POSITION*. The first allows set logging of: temperature; pH and temperature; "thermometer", "pendulum/oscillator"and "general sensors" versus time. The second allows: magnetic flux density, light intensity, temperature and general sensors versus position. This software was tried with a position sensor, light level and temperature probes only.

Real-time interface:- is easy to set up. Sense & Control is in this respect as good as good as LogIT and both are better than the Simple Logger. First the number of "Inputs" and logging "Timespan" (2, 8, 20, 40, 60 mins or 2, 4, 8, 16, 24, 48 hrs) are "Set-up". Then two key presses on the computer and a <RESET> on the logger get you going. This software is unsuitable for fast data capture such as an ECG.

Remote logging:- is similar to that above with a menu selection, "remote" and a press of "Go!" to start the logging. It is second in convenience terms to the LogIT.

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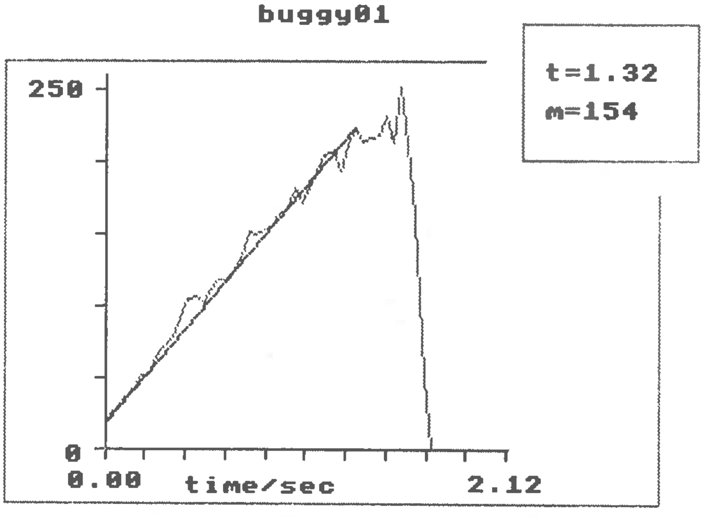


tach-gen buggy running down slope

Fig. 11 Simple Logger - calculating gradient

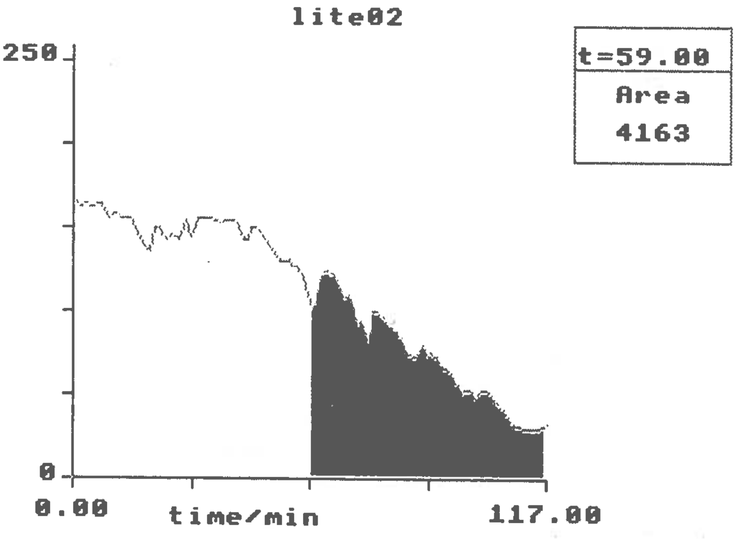


Fig. 12 Simple Logger - calculating area

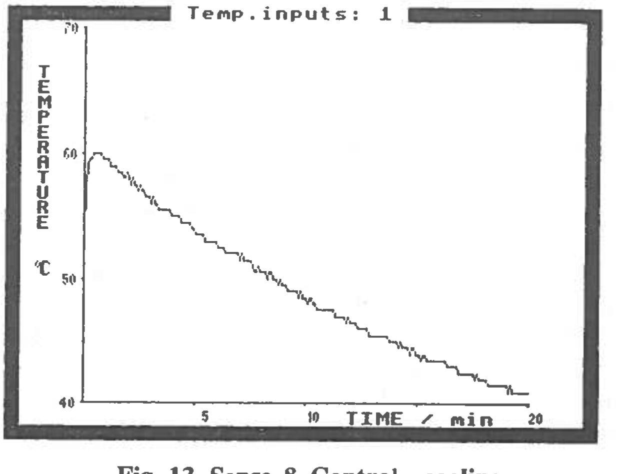


Fig. 13 Sense & Control - cooling curve with temperature sensor

165	Bimetallic strip, length 10 cm or 30 cm, high expansivity metal: Ni/Cr/Fe - 22/3/75 low expansivity metal: Ni/Fe - 36/64 (invar)	15p or 40p
385	Pressure switch, operable by water or air pressure. Rated 15 A, 250 V (low voltage operation therefore possible). Dimensions 2" x 3" dia.	65p
419	Humidity switch, operates by contraction or expansion of membrane. Suitable for greenhouse or similar control project. Rated 3.75 A, 240 V.	75p
349	Dual action water valve, 24 V a.c. coil. This is a normally closed, direct controlled, two-way solenoid valve for water.	£7.90
371	Ferrite rod aerial, two coils MW and LW, dimensions 140 mm x 10 mm dia.	85p
511	Loudspeaker, 8 Ω, 2 W, 75 mm dia., resonant frequency 250 Hz.	50p
745	Sub-miniature microphone insert, (ex-James Bond?), dia. 9 mm, overall depth 5 mm, connection by solder pads.	40p
700	Microswitch, miniature, SPST, push to make.	25p
723	Microswitch, miniature, SPDT, lever operated.	40p
740	Microswitch, miniature, SPDT, button operated.	25p
354	Reed switch, SPST, 46 mm long.	10p
645	Ceramic magnets, assorted shapes and sizes.	7p
738	Relay, 6 V coil, DTDP, contacts rated 3 A at 24 V d.c. or 110 V a.c.	75p
742	Key switch, 8 pole changeover.	40p
382	Wafer switch, rotary, 6 pole, 8 way.	70p
688	Croc clip, miniature, insulated, colours - red and black.	5p
741	LES lamp, 6 V.	15p
690	MES lamp, 6 V, 150 mA.	9p
691	MES battenholder.	20p
347	SBC lampholder.	20p
692	Battery holder, C-type cell, holds 4 cells, PP3 type outlet.	20p
730	Battery holder, AA-type cell, holds 4 cells, PP3 type outlet.	20p
729	Battery connector, PP3 type, snap-on press-stud, also suitable for items 692 and 730.	5p
724	Dual in line (DIL) sockets - 8 way - 14 way	5p 7p
693	Power supply, switched mode, input: LT d.c., output: 5 V regulated.	£2.00
716	3-core cable with heat-resisting silicone rubber insulation, 0.75 mm^2 conductors, can be used to re-wire soldering irons as per Safety Notes, Bulletin 166. per metre	£1.35
714	Sign "Radioactive substance" to BSI spec., ca. 145 x 105 mm, semi-rigid plastic material. Suitable for labelling a radioactive materials store. With pictogram and legend.	£2.30
727	Hose clamp, clamping diameter from 8 mm to 90 mm, 101 uses - securing hose to metal pipe, tree to stake, joining wooden battens for glueing, etc.	30p
731	Re-usable cable ties, length 90 mm, width 2 mm, 50 per pack.	12p
612	Beaker tongs, metal, not crucible type, but kind which grasps the beaker edge with formed jaws.	£1.20
659	Assorted rubber bungs, one or two hole, per pack.	50p
743	Aluminium evaporating basin, 100 ml.	60p
744	Aluminium evaporating basin, 100 ml, disposable.	30p
728	Pipette pump, should be less messy and more controlable than rubber bulb types, one handed operation, easily disassembled for cleaning. Available in two sizes: 2 ml and 10 ml.	£5.00

Components - resistors

327	Potentiometer, wire wound, 8 Ω, 25 W, 63 mm dia.	60p
328	Potentiometer, wire wound, 15 Ω, linear, 36 mm dia.	30p
737	Potentiometer, wire wound, 22 Ω, linear, 36 mm dia.	30p
329	Potentiometer, wire wound, 33 Ω, linear, 36 mm dia.	30p
330	Potentiometer, wire wound, 50 Ω, linear, 40 mm dia.	30p
331	Potentiometer, wire wound, 100 Ω, linear, 36 mm dia.	30p
421	DIL resistor networks, following values available: 62R, 100R, 1K0, 1K2, 6K8, 10K, 20K, 150K, 125R/139R and 1M0/6K0. Price per 10:	30p
420	5% carbon film, $^1/_4$ W resistor values as follows: 1R5, 10R, 15R, 22R, 33R, 47R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K0, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 150K, 220K, 330K, 390K, 470K, 680K, 1M0, 1M5, 2M2, 4M7, 10M. Price per 10: NB If schools are interested in purchasing values in the E12 range between 1R0 and 10M which are not listed above please let us know so that we can consider extending our stock list.	6p
BP100	Precision Helipots, Beckman, mainly 10 turn, many values available. Please send for a complete stock list.	10p to 50p

Components - capacitors

695	Capacitors, tantalum, 4.7 µF 35 V, 15 µF 10 V, 47 µF 6.3 V.	1p
696	Capacitors, polycarbonate, 10 nF, 47 nF, 220 nF, 470 nF, 1 µF, 2.2 µF.	2p
697	Capacitor, polyester, 15 nF 63 V.	1p
698	Capacitors, electrolytic, 1 µF 25 V, 2.2 µF 63 V, 10 µF 35 V, 33 µF 10 V.	1p
358	Capacitor, electrolytic, 28 µF, 400 V.	£1.00

Components - semiconductors

322	Germanium diodes	8p
701	Transistor, BC184, NPN Si, low power.	4p
702	Transistor, BC214, PNP Si, low power.	4p
717	Triac, Z0105DT, 0.8 A, low power.	5p
726	MC74HC02N quad 2-input NOR gates.	5p
725	MC74HC139N dual 2 to 4 line decoders/ multiplexers.	5p
699	MC14015BCP dual 4-stage shift register.	5p
711	Voltage regulator, 6.2 V, 100 mA, pre-cut leads.	10p

Sensors

615	Thermocouple wire, type K, 0.5 mm dia., 1 m of each type supplied: Chromel (Ni Cr) and Alumel (Ni Al); makes d.i.y. thermocouple, described in Bulletins 158 and 165.	£2.00
640	Disk thermistor, resistance of 15 kΩ at 25°C, β = 4200 K. Means of accurate usage described in Bulletin 162.	30p
641	Precision R-T curve matched thermistor, resistance of 3000 Ω at 25°C, tolerance ±0.2°C, R-T characteristics supplied. Means of accurate usage described in Bulletin 162.	£2.60
718	Pyroelectric infrared sensor, single element, Philips RPY101, spectral response 6.5 μm to >14 μm, recommended blanking frequency range of 0.1 Hz to 20 Hz. The sensor is sealed in a low profile TO39 can with a window optically coated to filter out wavelengths below 6.5 μm. Data sheet supplied.	50p

Kynar film items

See Bulletin 155 for details of applications such as force/time plots and detection of long wave infrared radiation.

502	Kynar film, screened, 28 μm thick, surface area 18 x 100 mm, with co-axial lead and either BNC or 4 mm connectors (please specify type).	£20
503	Kynar film, unscreened, 28 μm thick, surface area 12 x 30 mm, no connecting leads.	55p
504	Copper foil with conductive adhesive backing, makes pads for Kynar film to which connecting leads may be soldered. Priced per inch.	10p
506	Resistor, 1 gigohm, $^1/_4$ W.	£1.25

Opto-electronics devices

507	Optical fibre, plastic, single strand, 1 mm dia. Applications described in Bulletin 140 and SG Physics Technical Guide Vol.1. Price per metre	40p
713	Solar cell and motor assembly.	£3.75
508	LEDs, 3 mm, red, yellow and green. Price per 10	50p
719	LED, HMLP 3850, 5 mm, yellow. Package untinted and non-diffused.	5p
720	LED, HMLP 3401, 5 mm, yellow. Package coloured and diffused.	5p
721	LED, red, rectangular 5 x 3 mm.	5p

Other components

We also hold in stock a quantity of other electronic components. If you require items not listed above please let us know and we will do our best to meet your needs, or to direct you to other sources of supply.

Items not for posting

The following items, numbered 657 to 686 inclusive, and 712, are only available to callers. You will appreciate our difficulties in packing and posting glassware and chemicals. We will of course hold items for a reasonable period of time to enable you to arrange an uplift.

Glassware

657	Screw cap storage jar, plastic cap, 4 oz, wide neck.	10p
660	Test-tubes, 75 x 12 mm, rimmed, 144 per box.	£1.00
661	Pyrex side arm flask, 1 litre.	£1.00
662	Dessicator.	£2.00
663	Flat bottom round flask, 250 ml.	50p
664	Flat bottom round flask, 500 ml.	50p
665	Flat bottom round flask, 800 ml.	50p
745	Quickfit vented receiver, 10 ml.	20p

Chemicals

NB: chemicals are named here as described on the supplier's labels.

667	250 ml N.H carbamide (Urea).	25p
668	500 ml dodecan-1-ol.	50p
670	500 g Keiselguhr acid, washed.	25p
671	25 g L-Leucine.	25p
672	500 g Magnesite native lump.	25p
673	250 g manganese metal flake, 99.9%.	50p
676	500 g quartz, native lump.	25p
677	100 g sodium butanoate.	25p
679	500 g strontium nitrate AR.	25p
680	500 g tin metal foil alloy, wrapping quality, 50% lead.	50p
681	zinc acetate AR.	25p
682	2.25 litre ammonia solution.	50p
683	500 g carborundum powder, 180 - 620 mesh.	25p
684	100 g cobalt sulphate AR.	25p
685	500 ml N-decanoic Acid.	25p
712	Smoke pellets by Brocks. For testing local exhaust ventilation (LEV) - fume cupboards and extractor fans, etc.	
	Large (each)	50p
	Small (each)	40p

Publications

SSERC Publications

Serial publication ISSN 0267 - 7474:

"SSERC Science and Technology Bulletin"
back numbers £1.50 to callers else £2

Health and Safety

COSHH Seminar Proceedings 1989 £4

Fume Cupboards in Schools £3

Preparing COSHH Risk Assessments etc.
£4 to members £7.50 to others.

Protection Against Ionising Radiation in Science Teaching - Explanatory Notes; to members £2
to non-subscribing Scottish H.E. establishments £10
all others £40

Transport of Chemicals £2

Equipment and applications etc.

pH Meters & Probes £3

Light Meters Parts A & B (incl. test reports - members and associates in Scotland only) £2

Technical Notes:

(Notes with hand sketches etc. but all good technical stuff!)

Motor Control: £1 per title £3 per set:
Servo Motor - Angular Position Control
Servo Motor - Speed Control
Servo Motor - ZN409 i.c.
Controller Stepper Motor - National Course Notes

A-D and D-A Conversion Notes £0.50

Curriculum support materials:

Standard Grade : Chemistry Practical Guides:
Vol.1 £4; Vols. 2 or 3 £5

Physics Technical Guide Vol.1 (Units 1 and 2) £4
other volumes available in provisional form with final publication during 1991; each volume: £5

(Equipment lists for all three sciences - please enquire)

Revised Higher Grade: Physics - hints and suggestions for experiments and practical activities. £2

Occasional papers

The School Technology Room: Design Brief Basics - A Discussion Paper £2

Standard Grade Biology New Technologies & Training £3

Computers in Chemistry £3

Information Technology Applications

New SSERC "Interfacing in....." series of booklets for each of biology, chemistry and physics. Each set consists of "Background Information"; "Techniques Sheets" and "Task Sheets", per set: £5

The materials are suitable for staff development through flexible learning since they can be used for formal INSET, supported self-study etc. SSERC offers practical courses based on these materials and can also train tutors to support their use - enquiries welcomed.

DIY Interfacing with the BBC Micro £3

Standard Grade Chemistry Equipment and Chemicals Database on disc. Runs under "MasterfileII" on Beeb/Arc
Site licences: £6 per school or £50 per EA
(members only - others on application).

SSERC Graphics Library - see separate advert opposite.

Other publications

The following titles are joint publications or documents where SSERC originated material is incorporated or where the Centre was otherwise involved and is thus acting as agent or publisher.

Interfacing with Datadisc (Phil Strange then of Argyll & Bute TVEI) £2

Microcomputers in the Science Laboratory (reproduced from Lothian TRIST material) £2

Simple BBC Interfacing Experiments (G.Macnaught Montrose Academy) £3

Unilab Interfacing Workshop (SSERC reset by Lothian TRIST) £4

Microelectronics Monographs:

Funded by IDS, BP and Britoil as was and originally distributed through SCCC. Subsidised cover price originally £1-50 now £1 to clear.

Memo 1 - Construction Techniques
Memo 2 - Data Logger & Battery Backed Memory
Memo 3 - now out of print
Memo 4 - Making a Start in Teaching Electronics
Memo 5 - Industrial Control: Programmable Sequence Controller.

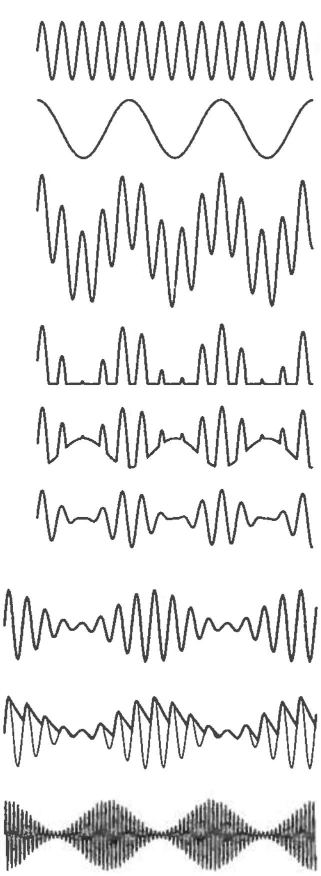
ASE and CLEAPSS publications (mostly Health and Safety) and all plus postage :

ASE:

Topics in Safety, £4
Microscope Care & Maintenance
(A.S.E. Technician Guide, SSERC as author) £2

CLEAPSS (prices per set):

Physics Safety Notes £1
Recipe Cards £2
Hazcards (revised chemistry cards only) £4



The waveform graphics shown (from 'An Ultrasound Project') were produced in DTPable form using our own general purpose graph-drawing program on the Arc. This program is now included on the SSERC Graphics Library disc.

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