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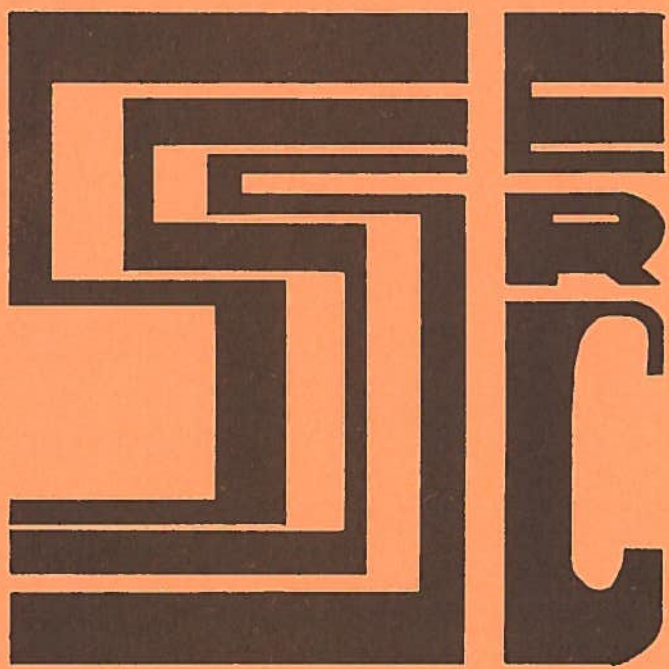
SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE



Bulletin No. 147 **September, 1985**

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Fenwick Electronics Limited, 295 Maxwell Road, Glasgow G41 1TD Tel. 041-429 7155.

Flamefast Technology Ltd., Pendlebury Industrial Estate, Swinton, Manchester M27 1FJ Tel. 061-793 9333 (Scottish Agents - Strathclyde Machine Tool Co.Ltd., Woodneuk Road, Darnley, Glasgow G53 7RF Tel.041-881 8131).

Griffin and George Ltd., Ealing Road, Alperton, Wembley, Middlesex HA0 1HJ Tel. 01-248 5680.

Philip Harris Ltd., Lynn Lane, Shenstone, Staffs. WS14 0EE Tel.(0543) 480077.

Heward & Dean Limited, 90-94 West Green Road, Tottenham, London N15 4SR Tel. 01-802 1731.

Jencons (Scientific) Limited, Cherrycourt Way Industrial Estate, Stanbridge Road, Leighton Buzzard, Bedfordshire LU7 8UA Tel. (0525) 372010.

Milton Bridge Ceramic Colours Ltd., Unit 9,Trent Trading Park, Botteslow Street, Hanley, Stoke-on-Trent ST4 3NA Tel. (0782) 274229.

(Cont.inside back cover.)

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INTRODUCTION

Saturday Opening

As this issue goes to press we are having, as the spokespersons would say, a full and frank exchange of views. The weighty matter on which discussion hinges - whose turn is it to do Saturday duty? (You guessed it, we mislaid the old rota notice. These are the things of which many a staff room drama are made). Assuming a favourable outcome, starting with September, we will again be open 9am to 1pm on the first two Saturdays of each month until further notice.

Arrangements for visitors

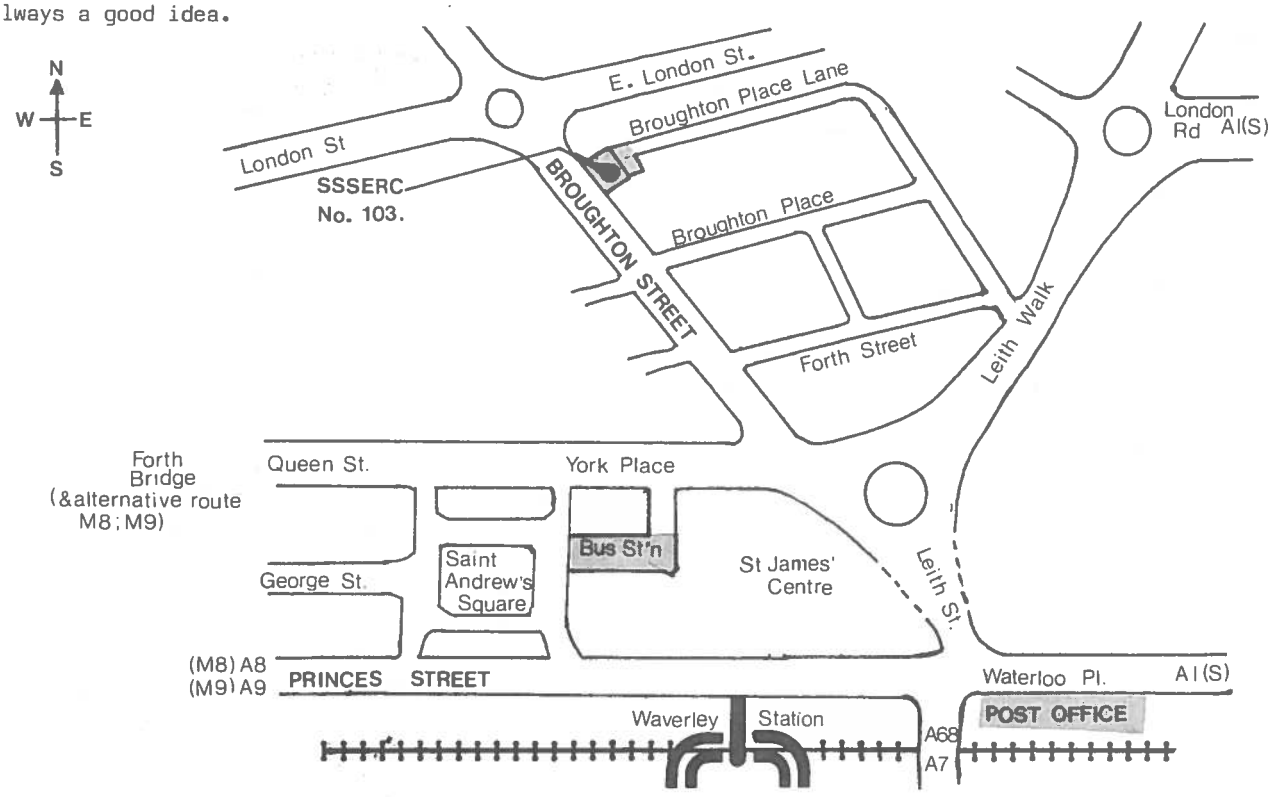
Many teachers it seems are not aware that we also welcome visitors on weekdays, when our office hours are (at least) 9am - 5pm. The surplus store and display laboratory are both open throughout that period. However if you wish to see a particular item of equipment, or seek specific technical assistance from a specialist member of staff, a telephone call in advance of your visit is always a good idea.

In order to assist erstwhile visitors we give below a, get yourself hopelessly lost in three easy moves, sketch map of our part of the east end of Edinburgh. As far as we are aware, there is no reason even in the current climate (nudge, nudge) for us to be deemed out of bounds.

Please note that limited parking is available in our backyard at the west end of Broughton Place Lane. The small step from our front to our rear is a great leap for the navigationally naive. If you call at the front we will tell you where to go.

Surplus Equipment Offer

This issue contains details of a number of offers for sale of equipment, publications or materials. Unless specific instructions to the contrary are given within this bulletin, then our general conditions of sale set out in Bulletin 116, will apply. We entreat prospective customers to read carefully those conditions as well as any further information given herein.



OPINION

"Domesday" Physics?

Every year it happens and not even the atrocious weather managed to dampen it down this year. I refer, of course, to the educational silly season. At a time of year when editors in the educational press are scratching around for stuff worth printing, it should no longer surprise me that the scribblings of the odd (in the quantitative sense) bampot should slip through the meshes of common-sense. Luckily only the hard done by like me (sigh!) in the educational world are at their desks to read the nonsense in the Summer issues. Usually little harm ensues but up with some things we should not put.

As I write this I am still recovering from one particularly loony article which appeared in the "Times Educational Supplement Scotland". In fact it wasn't so much just that article as it was its peculiar juxtaposition with other articles, events and pseudo-events (i.e. press releases). I became vaguely aware, through the roll of Summer thunder, of the faint and distant sound of bandwagons. As established readers will know, even such whispered alarums are to SSSERC as is an open china shop doorway to one of our bovine cousins. Let me, at last, reveal the plot (if plot there be).

I am worried, yet again, by the learned.

In this instance they come mainly from south of the border, I am relieved to write. These are folk in University Education Departments and some Colleges of Education, and they have done it again. They have researched in depth, using the seductive secrets of their black art to turn honest numbers into statistics, and told us, at length, what we already knew - wait for it!

> There is a growing shortage of suitably qualified physics and technology teachers.

And, there's more -

> There is a very great need to re-train teachers and technicians in new technologies and educational techniques.

No real need so far though for sarcasm nor serious satire? Certainly not as a response to this sort of harmless nonsense which, if nothing else, has given wider publicity to the problem. No, it's not their description of the obvious which worries me. Over the years I've got used to that as a sort of nagging toothache. At some times the pain is worse than at others. Nor is it their sudden discovery of the problem which frightens me. It's the panaceal solution put forward by some of them that scares the proverbial out of me.

You guessed - Open Learning!

It is simple. All we have to do is find the 'best' physics, electronics or whatever, teachers. We package them into an interactive video disc, wrap it all up in a few tree's-worth of paper and the problem is solved. I've obviously been worrying about nothing all these years. I should have known that eventually the philosopher's stone of training would be found.

When will folk get the message? There is no one universal instructional or learning technique. All techniques have to be looked upon as part only of a varied collection of educational weapons. All experienced, practising, professional teachers know this to be true. How is it then that, repeatedly, many are seduced by the siren voices of educational fashion?

Open, distance, and invidualised learning techniques all certainly have a role in training to meet skills shortages. It is however irresponsible to suggest that there is some magical educational technology switch we can throw and hey presto, no more teacher shortage problems. The causes of such shortages are longer term and deep-rooted. Solutions require radical re-structuring within systems for educational practice, management, resourcing and rewards.

No doubt open learning techniques will eventually take their proper place in the educational armoury. It would be nice though, just for once, before the bandwagon's inertia becomes too great; if we were to recognise at the outset that open learning has weaknesses as well as strengths. It can lack many of the advantages of the spontaneity which comes with direct access to (some?) teachers and one's fellow students. It is also a time-consuming, and potentially very expensive, business. Our greatest worry however is that it may lead to a creeping elitism. Schools able to attract, for whatever reason, effective teachers in shortage subjects may draw, where they have a choice, the abler pupils. The same could happen between subjects within schools. The rest are left with interactive video and other open learning techniques. What happens if those techniques then become devalued, as well they may, in the eyes of pupils and parents? Would we also, perpetuate and worsen the very supply problem we sought to alleviate?

For the occasion of our 100th Bulletin issue, we ran a competition for educational acronyms. The winner, I recall, was "FLOP" (Fulfillment of Learning through Open Plan). If we re-ran our competition now, I would have an entry. This would be - "Forging Open Learning Links with Youth". Certainly anyone suggesting a solution to the physics or technology teacher shortage through "Following Only Open Learning", would provide a fine example of just such a one.

Footnote

Is open learning, as the sole route to a science and technology education, invideous?

* * * * *

No Comment

On the air?

"The fourth estate responded well. Every local paper was represented as well as Radio Tay, and, of course, Jotter. The artisans of information got a little confused at one point with all the esotericism of educational jargon and clearly were under the impression that TVEI was a current affairs programme."

"Jotter", 'Times Educational Supplement, Scotland', 23rd August, 1985.

Comment

From the air

Many know of the unit the 'Henry' and hence of the millihenry. But, did you know that the **millihelen** is defined as the minimum unit of feminine beauty required to launch a single ship? SI of course! (from BBC radio 4)

We don't know how many topless towers are involved, nor whether a single kiss, a quantised concept if ever there was one, will bring immortality.

We are open to suggestions for similar definitions derived from the clytemnestra, or its multiples or sub-multiples - pico through to mega.

* * * * *

PUBLICATIONS LIST

For the convenience of teachers and subscribers we give below the titles of currently available SSSERC publications and related materials. Please note that Test Reports are only directly available to Scottish members and associates.

Bulletin Reprints

We have available back copies of most bulletins. A number of recent issues have been heavily in demand and are in short supply (e.g. 135; 140; 143). We may have to supply photocopies of relevant pages rather than a whole bulletin. Back numbers cost 65p per copy including postage and 50p to callers. Discounts may be available when ordering large numbers of copies or collections of issues.

Equipment Guides

a) pH meters

Copies of our comprehensive technical guide on pH meters:

> "School pH Meters & Probes - Advice on their use, maintenance and the diagnosis and remedying of faults".

are available at £1.20 per copy (inc.p&p.). We also have available individual test reports on some thirty or so models of pH meter.

b) Light meter guide

Just completed are our guide to light measurement and test reports on schools light meters (see also the "Biology Notes" section of this bulletin):

> Part A - "Environmental Light Measurement, the principles and practice"
>
> Part B - "Light Meter Test Reports"

Copies have been sent out to Science Centres, Science Advisers and nominated SSSERC/EA correspondents. Further copies can be made available at 30p.

Microelectronics Monographs (SSSERC Memos)

Extra copies of Memo 1 "Construction Techniques" and Memo 2 "Data Logger and Battery-backed Memory" are available at £1.50 per copy. Orders for over 20 copies of any "Memo", from any Scottish member institution, will be dealt with at £1 per copy.

Motor Control Notes

The availability of notes on servo-control, relevant at H grade to both analogue electronics in Physics and Engineering Science, was advertised in Bulletins 142 & 145. The precision motors advertised in the Surplus Equipment section of this bulletin lend themselves to the applications described.

1. "Servo mechanisms - angular position control" (major revision Dec.'84) 40p. per copy.

   Based on 741 op-amp wired as a high gain amplifier. Suitable for H grade courses.

2. "Servo mechanisms - speed control" (major revision Dec.'84) 40p. per copy.

3. "Servo motor control using ic ZN409" 40p. per copy.

The basic charges made for these notes are nominal and are to cover copying costs.

Joint CLEAPSE & SSSERC Publication

We still have a few sets of CLEAPSE/SSSERC "Hazcards" left at £5 per set.

Reprints from "The Physics Teacher"

A collection of reprints of 8 articles on the fine beam cathode ray tube, by permission of the author - John Le P. Webb. Available to interested teachers in Scotland at £1.50 per set to cover

copying costs. (For further details see "Physics Notes", Bulletin 146).

"Microelectronics Abstracts"

We have available a few copies only of issues of these abstracts (formerly "Interfacing Abstracts") which are prepared by SSSERC but printed and largely distributed by the Scottish Microelectronics Development Project (SMDP).

* *

Orders for under £2 should be accompanied by payment in favour of "SSSERC". It is uneconomic for us to raise invoices for small amounts (See "Surplus Equipment Offer" introductory section). Payments from overseas readers must be in Sterling and drawn on a UK bank branch.

* * * * *

Light Meter Summary

The following table is a summary of data obtained from the evaluations of five light meters. This forms part of a wider examination into the theory and techniques of environmental measurement.

Two guides are available on application to the Director, SSSERC. :-

Light meters, Part A - 'Environmental Light Measurement - the principles & practice' and

Part B - 'Test reports' giving fuller individual reports on all of the meters in the following table.

Model & Cat. No.	Supplier	Sensor	Scales (lux)	Chart output?	Battery reqd.?	Accuracy	Price (£)	Comments
Robin 520C Illumin-ometer YRC-510-W	Griff. & George	Selenium photo-voltaic	0-1k 0-5k x10 mask	no	no	±10%	73.50	well made easy to use
Light Unit 421.006+ 423.003	Unilab	Selenium photo-voltaic	0-100 0-1k 0-10k 0-100k	yes 100mV	yes PP3 (supplied)	±10%	23.90+ 24.20	separate amplifier & light unit
AVO LM4 P37620/1	Philip Harris	Selenium photo-voltaic	0-500 0-2k	no	no	±7%	89.21	limited scales
Lening-rad 7 exposure meter C58650/2	Philip Harris	Selenium photo-voltaic	1-18 stops equiv. to 1-250k arbitrary units	no	no	-	14.53	good value but awkward units
Light module C67710/6	Philip Harris	Cadmium sulphide photo-resistor	0-10k as 0-1 V output	yes 0-1 V ±0.25V	yes PP3 or 4xAA req.	±7%	34.93	requires separate meter or datalogger

CHEMISTRY NOTES

Corrosion

Abstract

Some background on the economic importance of corrosion prevention is outlined. Two further sources of educational ideas and information are given. Details are provided of procedures for examining two different aspects of corrosion and its prevention. The first describes an alternative way of demonstrating rapidly, corrosion sites on an iron nail and also sacrificial corrosion. The second gives some details of our experience in enamelling steel using industrial products rather than the types of enamel commonly found in jewellery kits.

Background

The total losses to industry, and hence to society, through corrosion are very high. A recent estimate by British Steel put the monetary equivalent of this loss, in the UK alone, at some £10,000 million per annum. That figure is equivalent to 3½% of the annual value of all goods and services produced in the UK. Another source [1] predicts that of all the cars bought new last year, about 50% will be on the scrap heap before 1996. This represents some £5000 million and the main cause of the eventual lack of roadworthiness will be rust. In addition to these more direct financial losses, most of the materials and energy consumed in the gaining of the metals from their ores and then in processing them into the final useful product are non-renewable.

For such reasons environmentalists, consumers and industrialists must all be concerned at the magnitude of such losses. It is important for courses on corrosion and on ways of reducing its effects to be included in our syllabuses.

The Scottish General Level, national examplar option on Corrosion is, in our independent opinion, an excellent set of materials. It has the merit, at least in our eyes, of including a deal of interesting practical work. Another source of ideas and information, which we would recommend as an excellent buy at £3, is a book produced by British Steel entitled "Corrosion, Attack and Defence" [2]. This makes an excellent resource with some 70, A4 pages well illustrated with photographs and details of a number of experiments.

Corrosion demonstration

For a rapid demonstration of corrosion this one is hard to beat, though the addition of a little hydrogen peroxide to hurry things along may seem a little like cheating. The peroxide oxidises the iron (II) ions thrown off the metal surface in the first stage of oxidation to iron (III). Ferroxyl indicator commonly used to detect corrosion sites is replaced by potassium thiocyanate. The original idea for this procedure came from a USA publication, the "Journal of Chemical Education" [3]. There it was described as an OHP demonstration but we found that it could easily be modified for pupil use. Two iron nails were taken and a small plate of zinc foil linked to one of them by copper wire and solder.

Both nails were prepared by soaking in 100 cm^3 of 0.25 M hydrochloric acid and 2 cm^3 of 3% hydrogen peroxide. The other three reagents,

200 cm^3 0.25 M hydrochloric acid,

7 cm^3 3% hydrogen peroxide

and 1 cm^3 4 M potassium thiocyanate

were mixed in a beaker and poured on top of the two nails placed in Petri dishes.(Fig.1)

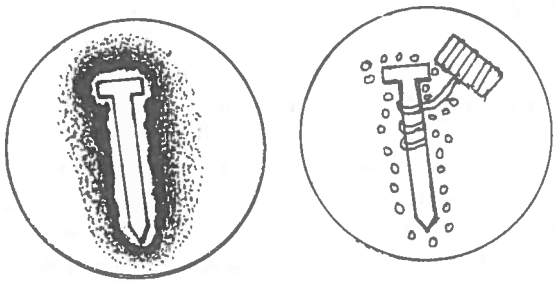


Fig.1

Within seconds an intense red colour was seen round the unprotected nail whereas that linked to the zinc slowly gave a very faint pinkish colour, hydrogen being evolved from the copper link and the nail.

On snipping the copper connector the formerly protected nail also rapidly oxidised.

If for some purposes the rapidity of the demonstration is a disadvantage, it is easy to slow it down. Replacing the aqueous medium by an agar or gelatine gel reduces the rate of diffusion. This has the additional advantage of preventing any pattern of corrosion products from being dispersed by accidental disturbance of the Petri dish. Wallpaper paste was found to provide a cheap, alternative gel medium. The other, simpler way to slow down this demonstration is by using less concentrated solutions of acid and peroxide.

One interesting, strange effect was seen when the demonstration experiment carried out in gelatine was neglected and left sitting for several days after the initial development. A train of banded layers of corrosion products vaguely resembling lines of force lying parallel to the body and head of the nail appeared. It looked like alternate zones of concentration and depletion - any suggestions?

Enamelling

The National Examplar, Standard Grade Science, option topic "Corrosion" includes several of the techniques for covering metal surfaces to demonstrate ways of reducing the rate of corrosion of metals. One of the methods described in the option is that of enamelling. Unfortunately the enamelling powders most readily available to schools are those sold as spares for jewellery enamelling kits. Such enamels are suitable only for applying to substrates such as copper, bronze or other gilding metals. They are completely unsuitable for steel. This is because the coefficients of expansion of enamel and substrate must be reasonably closely matched for the enamel to bond reliably to the metal surface. This we found out the hard way.

Those enamels which are suitable for coating steels are generally only available in very large quantities of a slurry. 50 kg is frequently the minimum quantity available. If you are lucky enough to have contacts, half a kilo begged will last a long time. We have however located one supplier who breaks enamel down into 1 kg lots. Milton Bridge Ceramic Colours Ltd. supply the groundcoat (Cat.No.GT972) 1 kg costing £3.99 and 1 kg of white topcoat (Cat.No.GT700) costing £3.59.

The process of enamelling consists broadly of 4 stages:

(i) preparation of the metal surfaces

(ii) coating with enamelling mixture

(iii) drying

(iv) firing

Stages (ii) - (iv) may be carried out twice, once with a ground coat and again with a finishing or topcoat.

A variety of colours for the topcoats is available. These we have purchased and tried out on both mild and bright steel. The ground coat,

usually dark purple/grey in colour, must first be applied to the treated steel and then the topcoat may be applied on top of that. As well as being more colourful than the ground layer the topcoat is tougher and more resistant to abrasion. For a simple demonstration the groundcoat alone is adequate especially if class practical time is short.

Preparation

The industrial firms we contacted take great care in the pre-treatment of surfaces in order to produce a smooth, durable finish. A typical commercial example of surface preparation had as many as fifteen stages including hot baths of sulphuric acid, borax neutraliser, nickel plating etc, the whole chain lasting well over an hour. We tried to find the minimum of pre-treatment needed to give a reasonably durable and smooth surface. Some pointers are given in the SSSERC insert sent out with the REFER examplar option "Corrosion" but details for two of the simpler methods are given here.

(i) thoroughly sanding mild steel plate (in our case a piece ca. 50 x 15 mm) followed immediately by enamelling gave a finish which adhered well but was a little lumpy. It was important to lift the plate with tongs or pliers to avoid adding any grease to the surface.

(ii) Alternatively bright steel could be simply dipped in 1,1,1-trichloroethane (avoid breathing the vapour and avoid skin contact) to de-grease it . The plate is allowed to dry and then coated. 'Bright' plate may be purchased locally or from Whistons, the price from the latter being £1.86 for a square foot 1.6mm thick (sic). This use of de-greased bright steel allows the enamel to take on a very smooth surface.

Coating

The enamels arrive in the form of a slurry and may need to stirred and/or possibly watered to the consistency of thick cream. The plate is dipped into this liquid and the surplus allowed to drain off.

Drying

The coating **must** be fully dried before firing. Air drying is slow and a few minutes in a laboratory oven at just over 100°C is more convenient. Incompletely dried enamels will suffer from steam blisters at the much higher firing temperatures in the furnace proper. A carrier to fit your particular oven is worth making from a heavier gauge of steel. On this a number of plates can be placed at the same time. The carrier (Fig.2.) can be used again at the next, firing, stage.

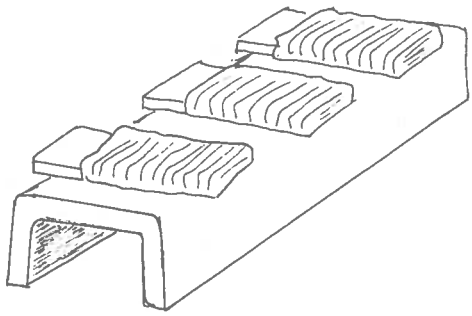


Fig.2

Firing

We found a firing temperature of about 840 °C for about 3 minutes to give a good glaze. Should the coating come out looking a bit 'flat' and not vitreous in appearance then the particles have sintered together but without sufficient fusing. As in baking some cakes, such a specimen can be popped back in the furnace for a little longer. We also found a longer time at a slightly lower temperature to be satisfactory. You may find your furnace has 'cold spots', for example near the door. It may then be necessary to lift out the rack and turn it the other way round.

Great care needs to be taken when handling these very hot objects. Heavy leather gloves are

recommended, but trying to wear a pair of the wrong size will pose a greater hazard. A pair of heavy pliers with insulated handles gave a more positive grip on both individual plates and the carrier than did tongs.

Cooling

One batch of our enamelled plates shattered and cracked on being left out on the bench overnight. This may have been due to strains being set up in the 'glass' caused by rapid cooling. Thereafter we allowed for slower initial cooling. After firing the enamelled plates were left in either the switched off furnace or in the oven.

Even thereafter the fired pieces take a long time out of the furnace or oven to cool down to safe-to-touch temperatures. A suitable area for cooling, clearly marked or even 'fenced off' is needed. Raising heat resistant mats or small sheets of scrap steel slightly off the bench will save the bench-top from scorching.

Suitable furnaces

For the few occasions when such a furnace is needed it seems best to come to an arrangement with the art or technical departments. However, suitable small furnaces are available at low prices from several suppliers. For example the Flamefast Minikiln at ca. £40 has internal dimensions of 65 X 45 X 85 mm, runs on gas and is claimed to reach the operating temperature of 900^{o}C in 6 minutes. It has no thermometer and the experts guage the temperature by colour.

The Vitreous Enamel Development Council (See Address List, inside cover) can supply several useful leaflets on enamelling. Their booklet, "Vitreous Enamel - a performance guide" [4] is an excellent resource, but seems a bit on the expensive side at £6. (An inspection copy is available at SSSERC).

Acknowledgements

We are grateful for the help received from the above body and from a number of firms, notably Bayer(UK), Carron Steelyne Ltd., and Ferro (GB) Ltd.

References

1. "Which?" Magazine, March 1985, Consumer Association.

2. "Corrosion, attack and defence", 1975, BSC and NCST Trent Polytechnic, ISBN 0 9500451 2 8.

(Other useful titles on metals include "Which Metals?" and "Crystal Structures of Metals" - all available at £3 each from BSC Special Steels at the address on the inside front cover of this bulletin).

3. Journal of Chemical Education, Vol.58, June 1981, Ward C.R. et.al. "Tested demonstrations - cathodic protection - an overhead projection demonstration".

4. "Vitreous Enamel - a performance guide", 1984, Vitreous Enamel Development Council Ltd., ISBN 0 9509849 0 6.

* * * * *

A.C. current measurement

Abstract

Technical difficulties are presented by the accurate measurement of a.c. current in the milliamp range. In general this is due to signal degradation caused by the rectifier diodes within the a.c. milliammeter.

Introduction

At the planning stage of any article, one is beset by conflict. On the one hand, one does not want to set about teaching grannie how to suck eggs, but on the other hand there is the peril of going over the top. Some sort of balance has to be struck that is useful to all; that provides help to those who need help; that provides stimulus to those who, we hope, look to the Bulletin for something new.

An innocuous looking request came in last session on a.c. measurement, a subject gey lang i' the tooth, as the linguistically fashion conscious might say. Nonetheless it exposed a number of points on experimental method and measurement which we think will be of use and interest to our readers. The letter requesting assistance is reproduced below by permission of our correspondent and serves to delineate the problem.

"Dear Sir,

Higher Syllabus Section 04.17

'Perform and describe an experiment using an alternating voltage supply of constant peak value to obtain a graph of current against frequency in a capacitative circuit.'

I enclose a typical set of results with a graph for this experiment for frequencies over 1 kHz. It appears that the current is constant and independent of frequency.

apparatus Advance signal generator
6.8 μF capacitor
0-10 mA a.c.ammeter

volts (V)	frequency (Hz)	current (mA)	'Xc' (Ω)
1.8	50	2.6	693
	100	4.6	392
	200	7.0	257
	300	8.1	222
	400	8.8	205
	500	9.15	197
	600	9.35	193
	800	9.6	187
	1000	9.72	185

The Unilab 'grey' meters are used with the 'Jardine' 10 mA/10 V a.c. shunt/multiplier. A range of capacitors, 1 to 10 μF is used to fit in with this shunt/multiplier.

Can you help us to obtain the requisite straight line graph as indicated in 'Higher Core Physics', p.92, figure 8.28? - or is it all connected with matching in the signal generator? Similar results are obtained on the high and low output impedances of the signal generator.

Yours faithfully"
etc.

Choice of capacitor

A first appraisal of the problem pointed to the reactance of the capacitor being swamped by the effect of other impedances in the circuit. In Table 1, values of reactance ($1/2\pi fC$) are listed against the calculated circuit impedance.

The circuit appears to have a hidden impedance which, at 50 Hz, is several hundred ohms in magnitude, but at 1 kHz is under 200 ohms.

Obviously, one must be careful in choosing a capacitor whose reactance, in the frequency range being covered, is at least two orders of magnitude greater than the impedance of other elements in the circuit.

frequency (Hz)	current (mA)	circuit impedance (Ω)	capacitative reactance (Ω)
50	2.6	693	468
100	4.6	392	234
200	7.0	257	117
300	8.1	222	78
400	8.8	205	59
500	9.15	197	47
600	9.35	193	39
800	9.6	187	29
1000	9.72	185	23

Table 1

Leaving aside, for the time being, the question of using an a.c. ammeter, one can recommend carrying out this experiment using an oscilloscope to measure current in the way outlined in S.C.D.S. Memorandum no.55 [1] (Fig.1).

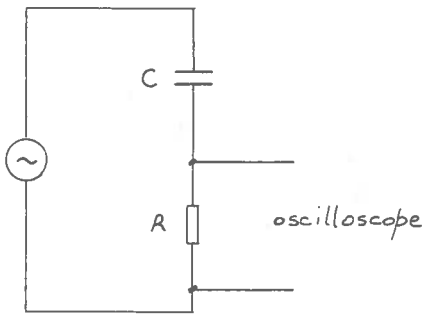


Fig.1

Suitable values for R and C are 330 ohms and 10 nanofarads polyester respectively and with these values a plot of current against frequency can be shown to be linear across the range 100 Hz up to 10 kHz. Note that at 10 kHz, the reactance of C is 1700 ohms, still well above the impedance of the series resistor.

Jardine Special

Unilab have kindly supplied us with a Jardine Special for investigation. This attachment to one of their basic meters consists of shunt and multiplier resistors, plus a bridge rectifier. The shunt has a resistance of 11.3 ohms. The bridge rectifier comprises four germanium OA91 diodes. From this we can unravel why the experimental results are not as expected.

First of all we can dismiss the shunt's resistance as being the prime reason. Even at the highest frequency used, the capacitative reactance, at 23 ohms, is sufficiently above the shunt's resistance that the effect of the latter would not throw the current out by as much as 10%.

What, then, about the resistance of diodes? From semiconductor theory, diodes have dynamic resistance, R (in ohms), where

$$R = 25/I$$

and I is the current in milliamps. Thus at one end of its range, with I = 1 mA, the bridge rectifier has a dynamic resistance of 50 ohms; at the other end with I = 10 mA, the resistance is down to 5 ohms. This, also, is not the prime reason.

The third factor to consider is the forward voltage dropped across a germanium diode. From the evidence given below this turns out to be the dominant reason for the experimental readings being what they are.

Averaged readings for this forward voltage drop across a pair of diodes in the Jardine Special are shown below.

current (mA)	forward voltage drop (V)
1.07	0.75
3.12	1.12
5.04	1.40
6.69	1.61
9.82	1.98

These readings should be regarded as typical, not absolute. From measurements made on a range of OA90 diodes, the distribution was up to 10% about the mean.

We hope this adequately explains the rather interesting results which we were asked to investigate.

It must be pointed out that Unilab state, in their catalogue, that the Jardine Special is **not for accurate work.** This article should not, therefore, be considered to be condemnatory of this meter. Whilst the meter does have its uses, clearly they do not stretch to the type of quantitative work to which our correspondent had applied it.

Readers are likely to experience similar problems in the accurate measurement of a.c. with many other models of meter, digital and analogue.

Other analogue meters

In "Higher Core Physics" [2], a Universal Avometer, on the 0-100 mA a.c. range, is recommended. This meter has been tried out by us. With the above range and a 1 μF polyester capacitor, the response is fairly linear between 1 kHz and 10 kHz. However severe difficulties were experienced on the 0-1 A a.c. range.

Digital multimeters

Difficulty will also be experienced over the use of a.c. current ranges in many models of digital multimeter. However, excellent results can be obtained by measuring the a.c. voltage which is dropped across a series resistor (Fig.2).

With a 330 ohm resistor and 10 nanofarad, polyester capacitor, the reactance of the capacitor will grossly exceed the impedance of the resistor at frequencies up to 10 kHz.

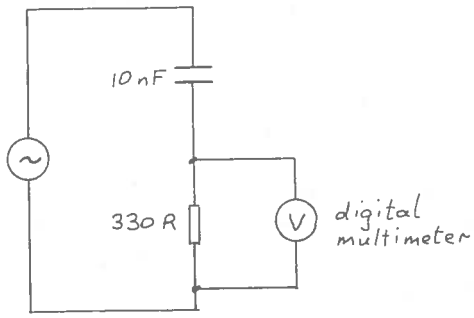


Fig.2

Most digital multimeters have a lowish frequency cut-off, up to which they are calibrated. However, in practice, one may find that the range over which a digital meter functions in linear fashion is broader than specified. For example, the specified range of the Fluke 75, not quite a bottom-of-the-market meter, is from 45 Hz to 1 kHz, but satisfactory results have been obtained between 10 Hz and 5 kHz. Likewise, the bottom-of-the-market Hung Chang 6010 is specified up to 400 Hz, but would appear to operate satisfactorily up to 1 kHz.

Textbooks

Our final point is to examine the helpfulness of textbooks in experimental work. We turn first to the outline of this experiment in "Higher Core Physics", page 92, to which reference was made by our correspondent.

Clearly from the circuit (Figure 8.27) in this book, the authors are advising, by means of this circuit, that one should measure current with an a.c. ammeter rather than with an oscilloscope. It would have been more helpful if a specific type of suitable meter was given, in particular because a suitable, a.c. milliammeter is an elusive instrument which the general reader is unlikely to have come across.

The following sample results are presented in the text.

frequency f (Hz)	1000	2000	3000
current Ic (A)	0.025	0.05	0.075

I do not like such a presentation. Firstly, there is the suspicion, with such perfect numbers, that the results are invented. If this were to be the case then it would be a dangerous ploy because it would give tacit sanction to fiddling and to the avoidance of facing facts. It would be anti-science. It would encourage one to believe that experimentation does not matter; an unnecessary adjunct in the study of science. Secondly it does give the impression that experimentation is a piece of duff. This is a misleading impression which, quite clearly in this instance, has led a number of teachers astray.

In that other textbook, "Higher Physics" [3], by himself, that is, the natural philosophy guru, himself, a fairly full technical description of how to conduct this experiment is given. This description is very helpful, though readers might have trouble finding a 30 μF paper capacitor, and is commended. (As suggested above, a 1 μF polyester, which is easier to come by, should be found suitable.)

References

1. Memorandum Number 55, "Electricity for Higher Grade Physics Section O", 1983, Dundee College of Education (for the Scottish Curriculum Development Service - Dundee Centre).

2. "Higher Core Physics", 1983, Cackett et.al., Oxford University Press, ISBN 0 19 914096 0.

3. "Higher Physics", 1983, J. Jardine, Heinemann Educational Books, ISBN 0 435 68221 0.

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SURPLUS EQUIPMENT OFFER

In general these offers are subject to the conditions laid down in Bulletin 116. We have of late experienced an increase in wrongly routed payments. In order to keep unnecessary paper and telephone work to a minimum, your attention is drawn to the following specific points:

(a) Items may be purchased on a cash or credit basis. We do not however issue invoices for transactions totalling less than £2.

(b) Unless specifically requested to despatch items to a school we will assume that they will be collected in due course. We are perfectly happy to hold items pending collection for a reasonable period.

(c) Payment for goods on collection will result in the issue of a SSSERC cash receipt. In all other cases an advice note will be issued which should be annotated to the effect that the goods have been received and then referred to the school or college adminstrators.

(d) Normally an advice note will trigger an invoice at the end of that month. Please note the instructions for payment given on our invoices. Remittances for credit transactions against such invoices should go to Lothian Regional Council Finance Department Collection Office, not to the Centre here in Broughton Street. We are a national centre working for all Scottish Regional and Islands Councils, but Lothian as host authority looks after our accounts.

(e) If for some reason you wish to pay a debt after the issue of an advice note but before the arrival of an invoice, you must do so in plenty of time to allow us to prevent the preparation of that invoice. Such payments therefore should come here to the Centre. Once an invoice has been prepared it enters the great Lothian financial computing mill and we lose direct control over the process. Direct payment to SSSERC after the issue of an invoice wastes everyone's time. All we can do is pass on your payment to the Lothian system.

Miscellaneous, ex-stock items

Many of the items on offer in this issue are replenished lines from bulletins 140 or 142. Item numbers greater than 418 are new lines.

Item 165	Bimetallic strip, 30cm	40p.
Item 313	Thermostat skeleton type	60p
Item 321	BC108 transistors	5p.
Item 323	Panel meters 1mA f.s.d. centre zero, circular case, 48 divisions.	£1
Item 328	15R pots. w.w. lin. 36mm	20p.
Item 329	33R pots. as above	20p
Item 330	as above,50R,40mm dia.	20p.
Item 331	" " ,100R,36mm "	20p.
Item 371	Ferrite rod aerial	40p
Item 382	6-pole, 8-way switch	65p
Item 402	Ilford PQ paper developer 5 litre bottle (for further dilution). Price in error in Bull.145.	£4.50
Item 419	Humidity switch, contacts rated at 240 V a.c., 3.75 A	75p
Item 420	5% carbon film, ¼ watt resistors values as follows: 10R; 15R; 22R; 33R; 47R; 68R; 100R; 120R; 150R; 180R; 220R; 270R; 330R; 390R; 470R; 560R; 680R; 820R; 1K0; 1K2; 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; 470K; 680K; 1M0; 2M2; 4M7 and 10M.	6p per 10

N.B. If anyone is interested in purchasing other 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.

Item 421	d.i.l. resistor networks, following values available: 62R; 100R; 1K0; 1K2; 6K8; 10K; 20K; 150K; 125/139R and 1M0/6K0	30p per 10
Item 422	Geared d.c. motor, 12 V 4 r.p.m.	40p
Item 423	Geared d.c. motor 6 V 4 r.p.m.	40p
Item 424	Solid-state timer, 5-60 minutes in 5 minute increments (ex-equipment).	40p
Item 425	Electric clock, 6 V d.c. with cam and microswitch	40p
Item 426	Steel equipment enclosures with lockable clasp, 50 x 26 x 24 cm	50p
Item 427	Proximity switch	10p
Item 428	Voltage regulated supply 240 V a.c. input 13 V, 500 mA d.c. output in black aluminium enclosure, ex-equipment, modified and safety tested by us.	£2.50
Item 429	Metallised polyester film one square metre 12 microns thick (see Bulletin 139 for applications)	£1

Motor control

See "Publications List" section of this bulletin for details of applications notes on motor control.

Item 373	Motor precision, 12 V d.c. (operating current 1 - 3mA).	£4.50

	by Portescap, suitable for servo mechanisms or being driven directly from a solar cell.	
Item 375	Gearbox for above motor,141:1 reduces to 0.5 rev. per second at 12 V.	£3
Item 376	Motor, precision 12 V, d.c., operating current 10-100mA, suitable for servo speed control.	£2.50
Item 377	Motor,precision, 12 V d.c with gearbox & helipot in one unit.	£3
Item 417	Motor,precision, 9 V d.c. Portescap with attached 6.3:1 gearbox	£5
Item 429	Stepper motor, ex-equipment (limited stock),4-phase, 62 mA, 195R, 40 steps per rev, max. stepping rate - 100 Hz at 5 V complete with SSSERC prepared technical notes.	£3
Item BP100	Precision Helipots,Beckman many values available please send for a complete stock list.	10p and up
Item 378	Encoder disk, 15 slots precision made, 30mm dia. with 4.5mm shaft dia.	50p.

Offers from third parties

We have been asked to notify readers of the availability of certain items which are surplus to requirements in Oban High School and Dundee College of Education. Please get in touch **directly** with the contacts named. You are particularly asked not to negotiate via SSSERC since that will merely make an extra link in the chain allowing Murphy's Law a freer rein.

Oban High

On offer are a number of items of monochrome video equipment. Please note that this equipment will only be open for offers until the end of October:

Sony video recorder, AV3670 CE (open reel)

Sony video recorder, AV3420 CE (open reel)

Sony video camera, AVC3420 CE

Camera adaptor

65,5" high density, open reel tapes.

Offers to:

Mr Elliot or Mr Mitchell, Oban High School, Soroba Road, Oban, Argyll PA34 4JB Tel.(0631) 64231

Dundee College

On offer from the Chemistry Department are:

1-off, Mettler top-pan balance P160 as new.

1-off, Mettler balance P1200 again as new.

1-off, Oertling, 'Releas-o-matic' single pan balance Model H05. 1000g capacity. Unused for many years but requires servicing.

2-off, Griffin Student Water Baths. Type S15-192, both as new, unused.

Offers to, and negotiations directly with:

Either, Mr J Auld or Dr R Partington, Chemistry Dept., Dundee College of Education, Gardyne Road, Broughty Ferry, Dundee DD5 1NY Tel.(0382) 453433.

* * * * *

Power Supplies Part 1
5 V regulated supply

This is the first of an occasional series of articles on the design and construction of voltage regulated power supplies. The aim of the series, as with most of our technical writing, is to inform teachers and technicians of design principles, in addition to providing a guide on the construction of a useful artefact.

Abstract

An outline is given of the design of a 5 volt regulated supply which is capable of delivering currents of up to 500 milliamps. The input can be either 9-12 volt a.c. or 12 volt d.c.

The supply is designed to be on an open board, thus saving costs and expenditure of labour. It is intrinsically, electrically safe since the entire circuit is at low voltages. The design ensures that burn injuries are unlikely through any component becoming exessively hot.

General description

Most electronic circuits require a stable source of d.c. voltage. Standard laboratory d.c. supplies do not meet this requirement. They normally supply a full-wave rectified, unsmoothed output, but even with smoothing this is sufficiently unstable to be considered unsuitable. Fortunately it is easy to construct a stable supply by means of a voltage regulator integrated circuit.

A block diagram of such a system is shown in Figure 1. The supply voltage is full-wave rectified (if necessary) by a bridge rectifier and smoothed by a filter capacitor. The signal is then regulated to provide a highly stable output voltage of +5 V d.c., suitable for powering TTL, and many CMOS family, digital circuits.

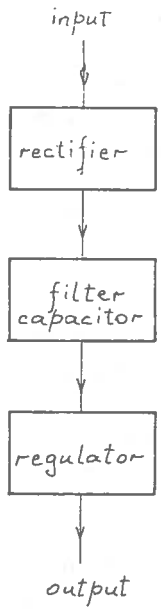


Fig.1 - Block diagram

Input supply

The input supply may be any, low voltage, a.c. or d.c., laboratory supply capable of delivering a current of at least 2.5 A. The voltage range of such an input is dependent on two factors.

1) **Minimum voltage constraint** - the input voltage must exceed the sum of the potential differences dropped across the elements within the system. The term 'dropout voltage' is described later in the text.

required output voltage	= 5.0 V
minimum dropout voltage	= 2.0 V
maximum tolerable smoother ripple	= 2.0 V
p.d. across bridge rectifier	= 1.7 V
- minimum supply voltage	= 10.7 V

2) **Maximum voltage constraint** - the supply voltage should be only a few volts in excess of 10.7 V since the excess voltage is dropped across the regulator causing heating.

e.g. if supply voltage = 16.0 V
p.d. across output = 5.0 V
p.d. across rectifiers = 1.7 V

- then p.d. across regulator = 9.3 V

if worst case current = 0.8 A
then worst case power
dissipated by regulator = 7 W

Therefore a suitable input voltage would lie in the range 9-12 V from an a.c. source or 12 V from a d.c. source.

Selection of components depends on worst case current analysis - the anticipated current under the severest overload. All components should be able to withstand such a condition for a reasonable period of time.

Note that in practice the worst case current is likely to be somewhat higher than the specified rating (500 mA) of the voltage regulator. Worst case currents can be obtained from manufacturers' data sheets for regulators and in this instance the anticipated worst case current is 800 mA, a figure which has been verified by experimentation.

Rectifier

A bridge rectifier should be used giving full-wave rectification. This way one is dealing with a not-so-big ripple current as compared with that from a half-wave rectifier.

The chosen rectifier, SKB202L5A, will conduct an average current of 1300 mA into a capacitive load, a sufficient margin above our worst case current of 800 mA. In addition, this rectifier can conduct a surge current of up to 50 A, which is very much higher than our worst case ripple current.

The rectifier should not require a heat sink. Its forward voltage is 2 V at 1 A and therefore its worst case power dissipation is only 2.0x0.8 = 1.6 W.

Smoothing capacitor

The choice of capacitor depends on three factors:

working voltage
ripple voltage
ripple current

The capacitor **working voltage** should be at least 50% in excess of the applied voltage. Thus, with an applied voltage of 12 V a.c., a capacitor working voltage of 25 V would be the minimum we could just about tolerate. In view of the nominal voltage specifications on many laboratory supplies, it would be preferable to opt for a working voltage at 63 V, the next rating up from 25 V.

The worst case **ripple voltage** should, as a rule of thumb, not exceed 2 V when the supply is delivering its maximum rated output of 500 mA. This figure is used to calculate capacitance.

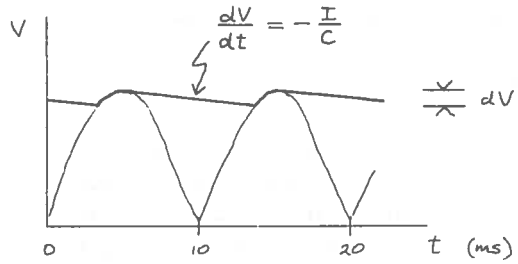


Fig.2 - Ripple waveform

The ripple voltage waveform is shown in Figure 2 and the parameters used are defined thus:

I = current drawn from capacitor
C = capacitance
dV = ripple voltage (= 2 V in worst case)
dt = ripple period

now ripple gradient $\frac{dV}{dt} = -\frac{I}{C}$

therefore $C = -I\,dt/dV$

$= 0.5 \times 0.01/2$

$= 0.0025$

This indicates that 2200 μF would be a suitable value of capacitance.

A factor that is perhaps less well known is **ripple current rating.** Ripple current is that current which flows into the capacitor as it charges. Another rule of thumb convention is that the worst case ripple current is about three times the average worst case current drawn from the capacitor. Therefore, in this instance, our capacitor should have a ripple current rating of at least 2400 mA.

The type should be electrolytic. 'Wire ended axial' is considered more robust than 'radial'. A bleeding resistor should be connected to discharge the capacitor after power-down.

We now have our capacitor specification and are in a position to search through the catalogues to find the cheapest, suitable supply.

Before leaving capacitors, we have noticed in our evaluation of power supplies, that it is common industrial practice to skimp on the ripple current rating of smoothing capacitors. Indeed, we do it ourselves with our home-built supplies for use within the Centre. The problem is entirely financial. One pays dearly for capacitors with high ripple currents.

Suppose for instance we up our specification to 5 V @ 1.5 A, we should therefore be looking for a 6800 μF capacitor @ 63 V and 4.5 A, costing somewhat over £3. Many designers take the view that since power supplies are normally operated at well under maximum output they can accept the risk of using components which are below par. Perhaps this is why a National Semiconductor Corporation handbook states: "Remember that capacitors are the number one cause of power supply failure. Don't let your supplies dominate the statistics column!"

Voltage regulator

Voltage regulators consist, primarily, of three elements, a reference voltage, error amplifier and power booster. The output is maintained at a fixed potential, in this instance, of +5 V, and is continuously monitored by the error amplifier. This difference between the output and internal voltage reference is called the error signal. Any change in output, caused by a change in load, say, generates an error signal and the error amplifier does whatever is necessary to return the output to +5 V.

Voltage regulators generally have three terminals. For the ones described below, they are known as input, output and ground (Fig.3).

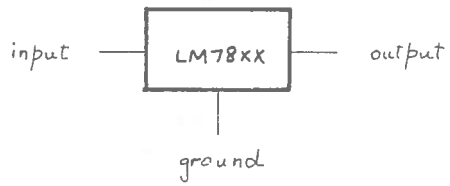


Fig.3 - Regulator terminals

The following comments on voltage regulator packages refer specifically to National Semiconductor series, perhaps the most extensively available.

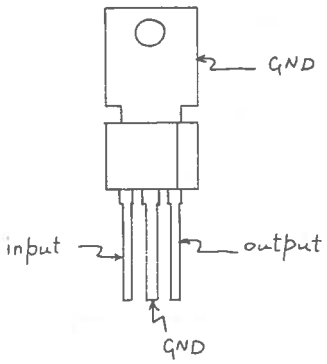
The 78 series is widely used. These are coded LM78XX where LM is the standard Nat. Semi. prefix and XX is coded 05, 12 or 15 for 5 V, 12 V or 15 V devices respectively. There is also sometimes a code letter inserted between 78 and XX which denotes the current output, e.g.

LM78XX	1.5 A output
LM78MXX	500 mA output
LM78LXX	100/200 mA output

The LM340 series of regulators has been designed to have a superior performance to the previously available LM78XX series regulator. From each of these series there is one device which meets the

specification of this supply, viz. LM341P-5 and LM78M05CT.

Both devices have three terminals and a TO-202 style, plastic package (Fig.4). The notes below refer specifically to the LM78M05CT regulator.



Front view - plastic package proud of tab

Fig.4 - TO-202 style regulator

There are a number of rules to observe about regulators. The **dropout voltage** is the p.d. dropped within the regulator necessary for the controlling function to operate. You must allow for a dropout voltage of at least 2.0 V. Note that the total voltage dropped across the regulator, between input and output pins, should be a volt or so above the dropout voltage giving leeway for input fluctations.

The regulator dissipates power as heat because of this p.d. dropped internally within itself. In consequence you should (1) take care not to let this p.d. between input and output become excessive and (2) mount the regulator package on a heatsink.

Calculation of heat sink size depends on our earlier analysis of worst case, power dissipation which we showed was 7 W. Since we are designing an open board supply, and we wish to avoid the risk of burns, it is undesirable to let the regulator heat up by as much as 40°C above room temperature. This indicates that a heatsink rated at 6°C/W is suitable.

If, like us, you never buy heatsinks, but cannibalize heatsinks off surplus equipment, the rough dimensions to choose are 30x60 mm main plate with lots of 20 mm fins. Some simple rules to observe are:

1) mount the cooling fins vertically for best convective airflow,

2) coat the surfaces with black oil paint or use anodized or oxidized metal and

3) use metal which is at least 1.5 mm thick.

The metal tag on the regulator package is connected to the ground pin and it is not necessary to insert an electrical insulator between this tag and the heatsink. It is advisable to mount the regulator at one edge of the heatsink letting its three terminal pins extrude into either stripboard or printed circuit board, whichever is used.

Like many other voltage regulators, the LM78M05 has on board current limiting to limit the output current to a safe level. The value of this output current limit depends primarily on the temperature of the regulator, the lower the temperature, the higher the current limit. To a large extent, the regulator temperature depends on the heatsink parameters. Using the specified heatsink, you are likely to find that the actual current limit is around 800 mA.

In the event of the output short circuiting, a thermal shutdown circuit takes over preventing the device from overheating. The life expectancy for such a plastic packaged device with its output continuously shorted is one hour. However the regulator will normally withstand such abuse as overloading and shorting, providing it is not prolonged for hours, and can be expected to operate satisfactorily afterwards.

Bypass capacitors (Fig.5) may require to be fitted. In particular, Cin is required if the smoothing filter capacitor is located more than 2 inches distant from the regulator. 2 μF solid

tantalum is recommended, but some experimentation of its effect on noise on the output signal might be undertaken. From our own experience, tantalum does seem the best type.

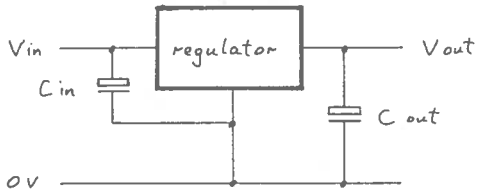


Fig.5 - Bypass capacitors

This input bypass capacitor, if fitted, should be mounted close to the regulator pins.

The output bypass capacitor, Cout, improves the transient response of the regulator. Transients are generated by the load changing, as will happen when logic arrays gate and flip-flops clock. As the regulator takes a certain settling time to respond to these changes in load, the effect generates high frequency noise on the output signal. Thus the reservoir effect of output bypassing tends to reduce output fluctuations. An electrolytic, 25 μF or larger, should be used and a bleeding resistor across this capacitor is recommended.

Open board construction

The complete circuit is shown in Figure 6.

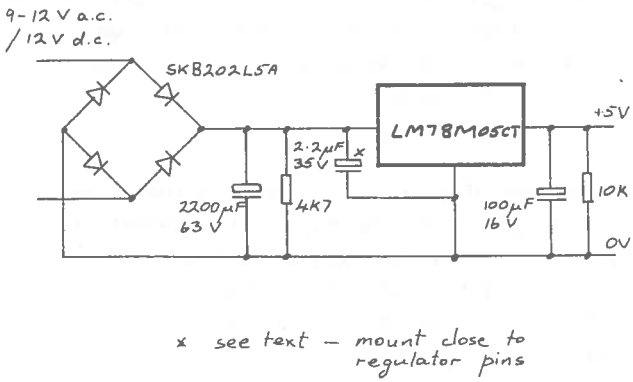


Fig.6 - Circuit

It seems unnecessary to go to the expense and effort of housing this supply. An open board with stick-on feet under each corner would seem sufficient.

We do have a printed circuit board master for this design at SSSERC and this can be obtained on application. Otherwise, the circuit can be assembled on stripboard.

Some thought should be given to input and output leads. Our own idea, about which we have no pretence that it is the best, is to fasten two pairs of flying leads, one on either side of the board. The input leads are coloured yellow and fasten to the left hand side of the board; the output leads are coloured black and red and come from the right hand of the board. Extra flexible wire, 55/0.1 mm, is used and 4 mm plugs are secured to the free ends.

Terminal blocks are not really required for attaching leads to stripboard. What we do is to drill a hole (3 mm diameter) which is 0.3 inches away from the slot into which the terminal of the lead is to be inserted. This hole should be between the solder point and edge of the board (Fig.7). The end of the lead is taken up through this hole before being fed down into the solder point, thereby making an adequate anchorage.

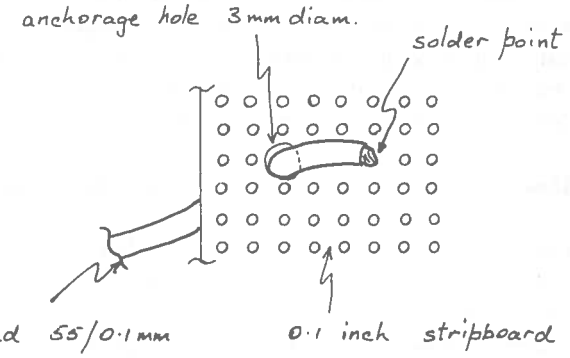


Fig.7 - Anchorage of lead

The terminals, of whatever sort used, should be clearly labelled.

Clearly any open board electronic circuit such as this design relies for safety on the integrity of the mains LT power unit from which it draws its supply. Such mains units must be regularly inspected and subjected to the appropriate tests.

Endpiece

Whilst open board regulators are easy to make and their components are inexpensive, they do tie up standard laboratory power supplies, occupy more bench space than a stand-alone, mains to 5 V supply, and can be wired up incorrectly. There is a strong case for having such a stand-alone, mains to 5 V supply and some teachers may be interested in constructing one. We have grave reservations on the propriety of teachers making their own mains equipment and in general we would recommend that such equipment be purchased from a reputable manufacturer. However, as we do get requests for advice on such manufacture, we are planning to issue our advice in a future article.

Before such advice is published, we strongly recommend that anyone about to embark on the making of mains equipment gets in touch with the Centre for our assistance.

Components

Standard components are used and these are available from a number of suppliers. In particular, all the components listed below can be obtained at competitive prices from Farnell whose reference numbers and prices are quoted.

item	cat.ref.	price
regulator 5V @ 500mA	LM78M05CT	0.78
rectifier	SKB202L5A	0.46
capacitor		
2200μF electrolytic 63V	143-673	0.956
100μF electrolytic 16V	100-814	0.09
2.2μF tantalum 35V	100-902	0.17

* * * * *

TRADE NEWS

Meters

Proops are retailing a series of student analogue meters which they import from Poland. The meters are priced at £3.25 each. There are six models in the series (each model having a single function):

50 V a.c.	250 V a.c.
500 mV d.c.	100 V d.c.
100 A d.c.	100 mA d.c.

The meters have a base area of 106 by 90 mm and are 100 mm high with a 45° sloping front and two 4 mm connectors.

In an entirely different league, the KED81 at £160, by WPA is a high input impedance digital meter with three functions:

1) coulombmeter based on the principle of measuring the voltage on a capacitor; single range 0-2000 nC;

2) voltmeter;
high input impedance (100 MΩ), 0-2000 mV;
not-so-high input impedance (1 MΩ),
3 ranges 0-200 mV, 0-20 mV, 0-2 mV;

3) nanoammeter/picoammeter;
input resistance 1 MΩ,
4 ranges 0-2000 nA, 200 nA, 20 nA and 2 nA.

This WPA meter is powered by mains and has a 3½ digit liquid crystal display. In addition there is an output which follows the display up to 2 V so that the device can be used as a high input impedance interface.

Hand held **digital capacitance meters** , selling at around £50, have been on the market for a number of years. But even at such a lowish price, they may well be that sort of unaffordable luxury which teachers and technicians have become thirled to discount.

However there is now an inexpensive, multiple function instrument which includes five capacitance ranges giving the user several instruments for the price of one. Other functions are current (a.c. and d.c.), voltage (a.c. and d.c.) and resistance. This meter is one of the new Circuitmate series by Beckman. The model number is DM25, it costs £58 and can be obtained from Beckman distributors such as Fenwick Electronics.

Also becoming available are hand held digital instruments which measure both **inductance and capacitance.** Decidedly up market is the Thorn EMI ('AVO') LCR meter distributed by RS Components at £197. Lower down the market we note the appearance, at £99, of the Lutron LC meter which has five inductance ranges (0-2 mH to 0-220 H) and six capacitance ranges (0-2 nF to 0-200 μF). The supplier of the Lutron LC meter is Centemp Ltd.

Tools and materials

The name Heward and Dean Ltd. is probably well known in the technical departments, but maybe not so well known to science teachers or technicians. They stock a comprehensive range of tools and materials, some a bit specialized, but have lots of useful bits and pieces. For example we have recently been looking for blacksmiths' close-mouth tongs which we found in their catalogue. Was this a "bits and pieces" or "specialized" item?

Thermometers

New to us, Vixen Hytech Ltd. supply a range of very low cost digital **thermocouple thermometers,** known as the LIN-1 seris. This range consists of four thermocouple types:

NiCr/NiAl	Fe/Con	Cu/Con	NiCr/Con
type K	type J	type T	type E
-120°C to	-120°C to	-120°C to	-120°C to
+820°C	+700°C	+350°C	+400°C

The basic instrument which has a 3½ digit liquid crystal display costs £29.85 and naked bead thermocouples complete with connector come at £3.18 to £3.49 dependent on type. In addition the firm can supply thermocouples which are sheathed for protection.

Also on the subject of **thermometers,** a new catalogue is available from the firm S. Brannan & Sons Ltd. In addition to the standard, mercury in glass, laboratory thermometer, this firm manufactures an extensive range of specialized items; there are thermometers for sugar, dough, freezers, ovens, concrete, soil, silage, incubators, The Factory Act, beer cellars and yoghurt making, to mention but some. So if anyone is off on a yort crawl around the aouls of Turkestan with the fourth year, Brannan may be worth contacting for that last mentioned item. But don't forget the spoons!

Other items from Brannan are a hand held digital thermometer with probe costing £28.50, weather instruments and soil testers.

Further catalogues

In the latest catalogue from C. P. Instrument Company Ltd. there are two items which we will bring to your attention. **Plasti-dip** is an air-dry plastic coating which is claimed to give a permanent, flexible and non-flammable finish. It covers metals, wood, rubber, polystyrene, rope, etc. and might be used for preventing rust, making a grip for tools or finishing off rope ends. It comes in two sizes, the smaller size costing £8.65 (CP8815-00H coloured red).

The second item is a **7 day time switch,** item no. SM8644-00H, which can be programmed to switch on/off up to 98 times per week. Programmes can be as short as 1 minute or as long as 7 days. It is suitable for operating any appliance up to a maximum of 3 kW and costs £34.95.

Jencons (Scientific) Ltd. have a number of new ideas. Their **Foldarack System,** cat. no. H200/20 at £5.75 each, is designed to store test tubes and sample bottles, but when not in use can be folded flat such that it takes up little storage space. Their **ampoule breakers,** cat. no. H122/19, seems an excellent idea. This useful aid provides a safety collar designed not only to break ampoules safely, but to retain the broken top for safe disposal thereby preventing the cuts and scratches so often associated with this job. Unfortunately the

minimum quantity is rather large, 1000 for a 1-4 ml size pack costing £50, 500 for a 5-10 ml size pack. Perhaps a pack could be bought on a regional basis for distribution around schools?

In the catalogue of Premier Select, a mail order firm, there is listed an electronic **blood pressure & pulse rate meter** with digital display. The product number is 00655 and it costs £47.50. This is somewhat cheaper than either of the models of this type of sphygmomanometer reviewed in Bulletin 145.

Castle Laboratory Systems is a newly established, local firm (local in the sense of being in Scotland, but it certainly won't be located near some of our Scottish readers). This firm specializes in laboratory disposables and retails instruments and meters for a number of manufacturers.

Does the identification of leads cause problems, with leads being taken out of one room and left in another? **Cable marking systems** may be the answer. These are available from such general electronics suppliers as Farnell Electronic Components and RS Components. However if a marking system within their catalogues is not suitable, it may be worth your while consulting the catalogue of a specialist supplier such as Cooper's Cable Accessories Ltd.

Herewith ends "Trade News" and Bulletin 147.

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Premier Select Limited, FREEPOST, Lambourn Woodlands, Newbury, Berkshire RG16 7BR Tel. (0488) 72666.

Proops Brothers, 52 Tottenham Court Road, London W1 Tel. 01-636 4420.

RS Components, PO Box 99, Corby, Northants. NN17 9RS Tel.(0536) 201201.

Unilab Ltd., Clarendon Road, Blackburn, Lancs. BB1 9TA Tel.(0254) 57643 or 57644.

The Vitreous Development Council Ltd., New House, High Street, Ticehurst, Wadhurst, Sussex TN5 7AL.

Vixen Hytech Limited, 17 Amberley Road, Bostal Heath, London SE2 0SG Tel. 01-310 4233.

WPA Limited, The Old Station, Linton, Cambridge CB1 6NW Tel. (0223) 892688.

K.R.Whiston Ltd., New Mills, Stockport SK12 4PT Tel.(0663) 42028.

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