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Wireless world

September 1984 85p

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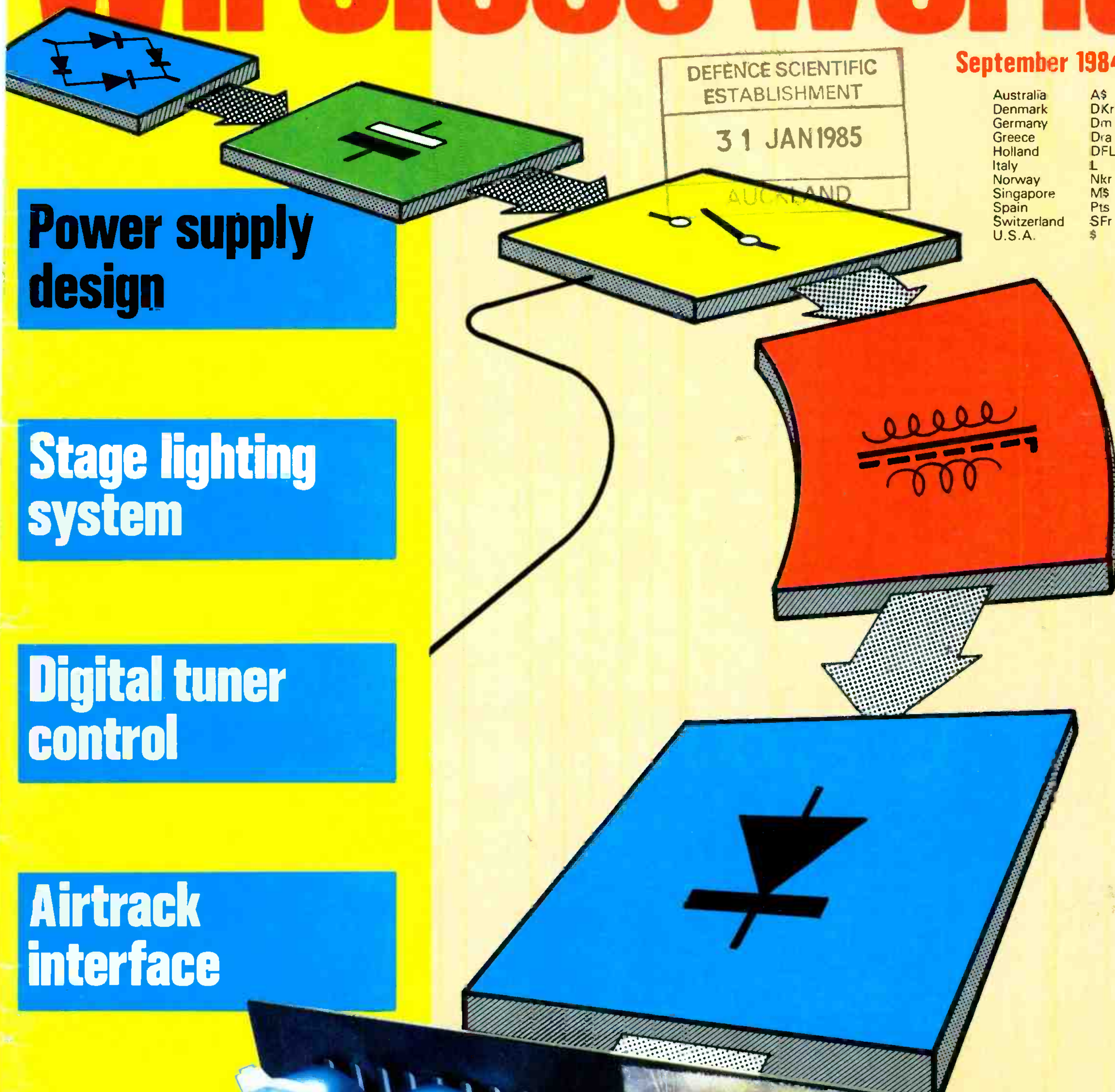

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CONTENTS

ELECTRONICS & Wireless world

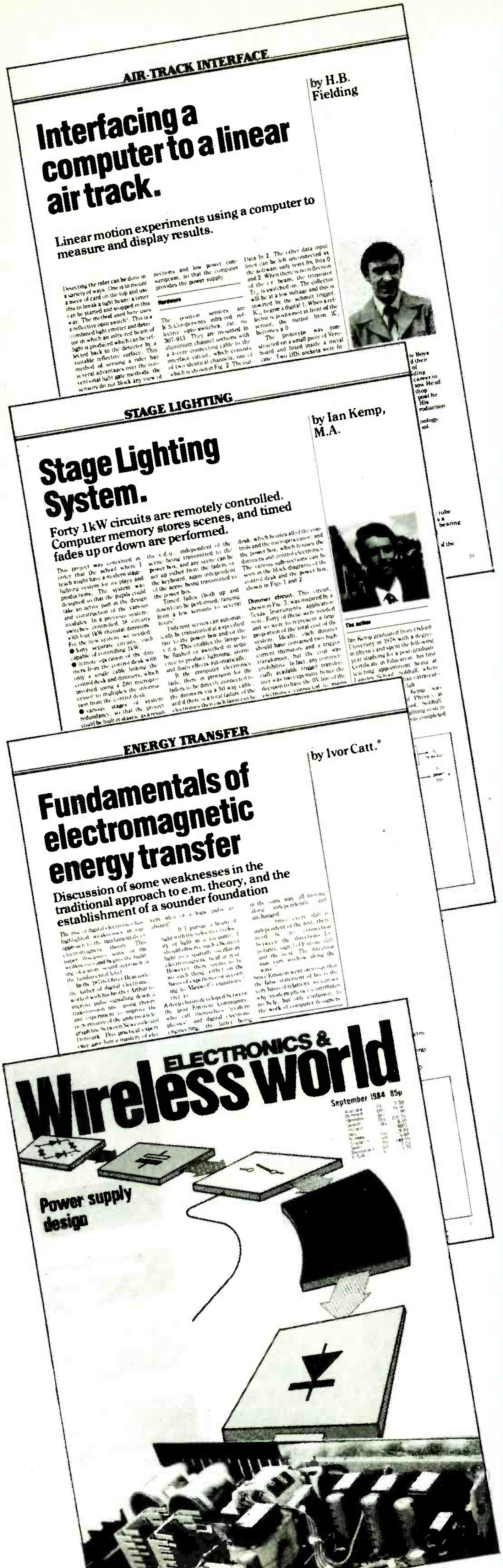
over 70 years in independent electronics publishing

September 1984 Volume 90 number 1583

FEATURES

REGULARS

The dispute between the Company and the National Union of Jounalists is settled and normal working has been resumed. The settlement came a little late to allow normal production of this issue, but the October edition will be well up to our usual standard. We apologize to readers and to advertisers for the enforced holding over of advertised features, notably the digital multimeter survey, which will appear next month.



front cover illustrates Ken Smith's series on the design of power supplies. Photograph by courtesy of Weir Electronics, design by Richard Newport.

NEXT MONTH

Following his recent modem design, Richard Lambley describes a software solution to the problem of autodialling.

John Wilson relates his experiences of lightning strike, which destroyed electronic equipment in a church, in spite of a 'good' lightning conductor.

A.E. Cawkell continues his appraisal of the Information Society and J.R. Watkinson's series on variable-speed video playback continues.

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Warfare hardware

An ex-civil servant who used to design weapon systems for the Ministry of Defence recently asserted that modern aircraft, ships and tanks are so stuffed with extremely complicated equipment that it is quite difficult to get them to work at all, even during exercises, let alone in circumstances for which they are intended — killing people. The electronics become more involved as new requirements are imposed on the designers, the natural result of overcomplexity, as always, being unreliability. Equipment is well hardened to magnetic pulse, but when a plug is dirty or a power supply designed ten years ago finds life too much for it when yet another micro is crammed into the last available corner, then the system will fail, probably when it is most needed.

All this runs completely contrary to the lessons learned years ago in industry, when it became clearer than ever before that one cannot continue to add bits of circuitry or even more units to a system without sacrifices in overall reliability. Not many electronic circuits or systems could, in truth, be called simple, but the simpler the better has always been the required attitude.

It may be that designers cannot keep up with Service requirements. It is unlikely that the electronic systems designed for a new aircraft will survive in their original form for long, since the users continually ask for more facilities. Modifications and extras pile up and the original, bird's-eye view of the system is obscured. There is no chance to call a halt and have a complete, integrated redesign because, even if the system were not needed urgently — and it always is — by the time the redesign was complete, another backlog of extras would have built up.

It is, of course, fairly harmless, except for the obscene cost of it all. There is not much chance of the weaponry being needed and, if it is, not much hope of its being effective in preventing total devastation, but at least it keeps a large number of people in employment. Of course, they would be far better occupied in using their skills to make something useful — medical, educational, industrial or purely scientific — or simply stop doing what they are doing and let us have the money for the railways or a new lot of sewers for London's crumbling drainage system.

Some apologists among us may have thought that 'defence' money was well spent if it would protect us from attack. Since it appears that it will probably be in the maintenance bay or have the engineers poking about inside it when the sirens sound, maybe the spending ought to be re-examined.

Free phones?

Much as we are opposed to the privatization of British Telecom, considering it to be a public resource and asset, there may be a way of capitalizing (pun intended) on the situation. Mr Norman Tebbit announced that individual subscribers will have special arrangements to enable them to acquire shares in BT plc. If every single individual subscriber were to buy shares then the whole system would remain 'public property'. If we look at the massive profits of BT, most of which come from the services to business and industry, then isn't it conceivable that there could be enough for us all to get a share of the profit, to about the value of our phone bills? At the same time we should not buy too many shares; don't forget that the Labour Party are committed to re-nationalizing at the first opportunity, whenever they may be returned to power.

Performing rights

A notice in the *London, Edinburgh* and *Belfast Gazettes* announces that, with effect from June 8, clause 1(1)(c) of the amateur radio licence has been replaced by the following verbal material:

> "To use the station as part of the self-training of the Licensee in communication by wireless telegraphy during disaster relief operations conducted by the British Red Cross Society, the St John Ambulance Brigade, the County Emergency Planning Officer, or any police force in the United Kingdom ('The user services'), or during any exercise relating to such disaster relief operations, or any other operation conducted by the said user services (provided that such other operations shall not exceed 4 in any one calendar month and not more than 12 in any one calendar year) for the purpose of sending to other licensed amateur radio station such messages as the Licensee may be requested by the user service concerned to send and of receiving from any other licensed amateur radio station such messages as the person licensed to use such other licensed amateur station may be requested by the user service concerned to send."

The *Wireless World* computer is now busy setting this to music. Something after the style of Mahler strikes us as appropriate, though some have argued forcefully for Havergal Brian. For the first performance, we hope to engage as tenor soloist the man responsible for the piece, Mr A. J. Nieduszynski of the Department of Trade and Industry.

A souvenir programme including the text in full will be available shortly from the DTI's usual agents, in exchange for an RAE pass slip and a fee of £12.

Sinclair's mighty chips

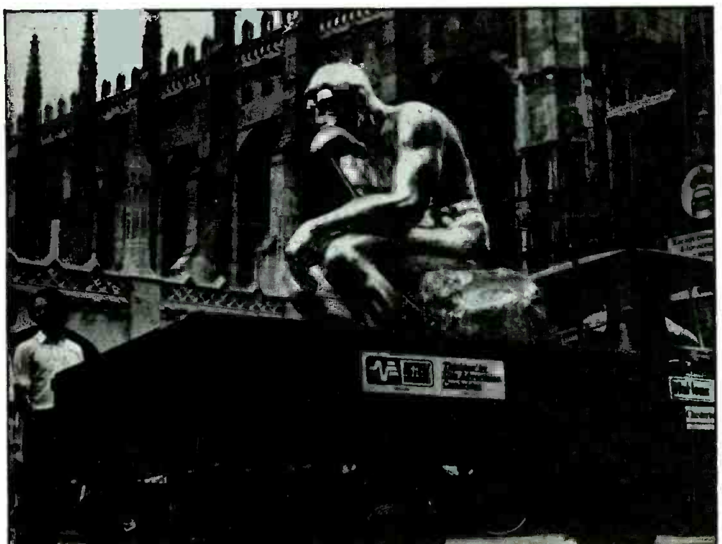
Metalab, The Sinclair Research think tank, is to develop a 'fifth generation' super-computer using wafer-scale integrated circuits. Such circuits, described in *Wireless World* in July 1981 by the inventor, Ivor Catt, involve using a whole slice of silicon to build a computer. Normally integrated circuits are produced on the slice, or wafer, which is then 'diced' into all the separate chips; the chips are encapsulated in plastic and then connected to each other on a p.c.b. Wafer-scale integation cuts out many of these processes and connects the circuits to each other actually on the wafer. Not only is there a saving in effort and space but clever use of the internal architecture of the circuitry can enable the computer to repair itself. For example, if a section of the memory is defective the circuit can re-route the incoming data to a new section. The system requires that memory is not at a fixed address; memory blocks are labelled and may be shunted about and called by their label. This in turn leads to the possibility of using parallel processing; working on different sections of data at the same time to speed up the process.

The particular architecture used in this approach still divides the slice into chip-sized sections and Sinclair Research thinks that there are several advantages to this compared with making a single wafer-sized circuit, the method being adopted in America by Trilogy, under the leadership of Gene Amdahl. Sir Clive Sinclair has said that wafer-scale integration is now a major research effort with which he believes will take his company ahead of the Japanese and American rivals in fifth-generation computer technology. He hopes to obtain funding from the Alvey Committee. Like so many of his products in the past, Sinclair will not be manufacturing the wafers; they are talking to manufacturers who may do it for them. The first wafer-scale memory chip should be produced 'by the end of 1985'.

Magnetic flip

According to Professor Bannerjee of Minnesota University, we might be about to undergo a reversal in the Earth's magnetic polarization. These things happen about every 100 000 years or so, says the Professor, who has examined the polarization of rock laid down in Lake Minnesota. Rocks retain the polarization prevalent at the time that they are laid. The imminance of the change is predicted by the current progressive weakness of the Earth's magnetic field which has reduced to a tenth of its power over the last 1000 years. What would happen is that the magnetic north and south poles would reverse but would not necessarily be in the same places (they tend to wander anyway). The implications of such a switch are of gigantic proportions. All the magnetically based navigation systems would be upset and not only human ones; birds and other migrating animals are thought to use magnetic guidance. Even bees have an internal magnetic compass. The magnetic field around the Earth; the Magnetosphere, protects us from a lot of solar radiation. If the magnetosphere were to collapse, even for a short period, the Earth would be subject to fierce radiation. One theory about the end of the age of dinosaurs is that it as caused by such a magnetic reversal. However the Professor cannot predict how soon this cataclysm will occur. Sometime in the next 1000 years is his estimate.

Musing its way past King's College Chapel, Cambridge is this giant silvery reproduction of Rodin's 'Thinker'. The Thinker has been adopted by Hi-Tek Electronics for their corporate symbol and they had the reproduction made for an exhibition stand. Unlike Rodin's original, which is only a third of the size, this Thinker is made from fireproof polystyrene, not cast bronze and is pasted all over with metallic foil.



Jobs to save energy

Seeking both to provide employment and to work towards methods of saving energy, The London Energy and Employment Network (LEEN) is offering workshop space and expertise for the development of new products in the field of energy efficiency.

Given that there is a great potential existing for methods of saving energy in homes, offices, factories and in transport, LEEN is inviting individual and small firms who have any original ideas to apply. They will be provided with machine-shop and electronic facilities for research and development which they could otherwise not afford. Technical assistance is available and on the development of a product help with marketing and financing is also at hand. LEEN was formed last year as a division of the Greater London Enterprise Board. It is based at 6 Avonmouth Street, London SE1 6NX.

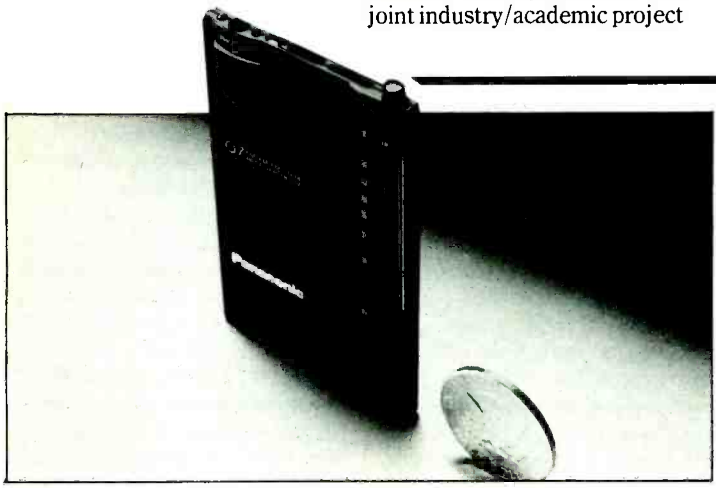
How big is your TV?

A new standard is to be adopted by tv manufacturers to describe the size of a tv picture. Up to now the phrase *22" tube* is often used to describe a tube where the diagonal of the visible part of the display can be less than 21 inches. As this can be misleading and may actually contravene the Trades Descriptions Act, the new method will be to give the length of the visible diagonal and as the method is to be adopted internationally, it will be in cm. The system is to be used on all the recently introduced 'flat square' tubes. Existing tubes may use such designation as *22" (53cm, V)* where the V stands for visible. *Visible* may also be spelled out.

Space network success

Project Universe was an attempt to provide a high-speed, high-reliability communications network to a wide area, via satellite. The experiment was a joint industry/academic project and included contributions from GEC, BT, Universities of Cambridge and Loughborough, University College London, and the Rutherford Appleton Laboratory as well as software contributions from Logica Ltd. Logica applied encryption to data transmission in a way that required no changes to user software. They did this by combining the key handling of Public Key cryptography with the higher speed of Data Encryption Standard.

They also managed to write the software for a Teletext system entirely in the C development language. Also successfully demonstrated over the satellite network was a distributed software development system which enabled any member of a development team from a remote site to use any other computer in the system as easily as their own.



This pocket radio from Panasonic is only 3.9mm thick and measures 91 by 55m, slightly larger than a credit card. It receives a.m. and f.m. stereo transmissions which it plays through miniature headphones. The built-in NiCd battery can last for about five hours of playing time but takes about the same time to re-charge, using the charger stand provided. The minuscule size has been made possible by the development of what Panasonic call radio high-density circuits (RHCs) four of which are used in the set. Many components have been redesigned including the variable tuning capacitor, volume potentiometer, tantalum capacitos i.f.t. and the a.m. aerial, each of these being less than 2.8mm thick. The printed wiring is incorporated into the back panel of the case. The sets are likely to be on sale in the UK at the end of the year.

Don't forget to enrol!

Readers are reminded that the season of mists and mellow fruitfulness is also the time for enrolling in evening classes. We have been sent reminders by a number of schools and colleges for enrolment in early September for students wishing to take the Radio Amateurs' Examination; however many adult education institutions do courses in all manner of subjects which can be work or hobby-related or just plain fun like flower arranging, or learning Early English or Icelandic, or playing a musical instrument. Now is the chance to bind all those back numbers of WW at a bookbinding class!

Engineers jamboree

The first ever national assembly of registered engineers will be held next year. Instigated by the Engineering Council, the assembly will provide a platform for 'grass roots' engineers to voice their views to the Engineering Council and also act as a forum to which the Council will report on its activities.

A detailed plan for the Engineering Assembly and a linked regional structure has been published by the Council. 300 000 engineers comprising chartered engineers, technican engineers and engineering technicians throughout the UK will have the chance to elect representatives to attend the annual assembly. The representatives will be grouped locally in some 20 'constituencies' throughout the country. They will also belong to regional committees established in each constituency, and the committees will initiate local activities which will slot together with the policies of the Council and include the co-ordination of information about the profession to schools together with the cultivation of links with local communities, employers, trades unions, industry academic institutions and local government.

Thorn buys Inmos

Thorn-EMI are to pay £95M in cash for a 76% share of Inmos, the British semiconductor manufacturer. Inmos was originally financed by public funds through the National Enterprise Board. It has developed a manufacturing facility for l.s.i. microcircuits, particularly c.mos memory circuits, and is working towards fifth-generation computers with the development of the Transputer, a microprocessor of advanced design. It has taken over £100M to get the company fully operative and into a position when it is actually profitable. It was perhaps the jewel in the NEB's crown, but has been made subject to the Government's policy of moving as many as possible publicly owned enterprises into the private sector.

The remaining 24% of the shares are all owned by Inmos staff and it is thought that Thorn-EMI are willing to make them 'offers that they cannot refuse'.

Inmos is to be given a degree of autonomy, being allowed to operate as a separate entity. Thorn-EMI will encourage the company to 'continue to fulfil its long term objective of developing a capability to produce standard memory and microprocessor devices and the v.l.s.i. silicon systems which will be a foundation of the electronics industry in the 1990s and beyond'.

Inmos have announced that they have come to an agreement with the Japanese MNB/Mineba to licence the production of the Inmos 256K dynamic ram. Up to now NMB have made miniature precision mechanical parts including instrument bearings. Because of the cleanliness required for such manufacture, NMB are familiar with clean-room working and are constructing a wafer fabrication plant. Both companies seem very pleased; NMB because the Inmos design and process technology are 'significantly in advance of the technology available in Japan and elsewhere' and Inmos because NMB can offer the manufacturing expertise and will provide a second source for their product.

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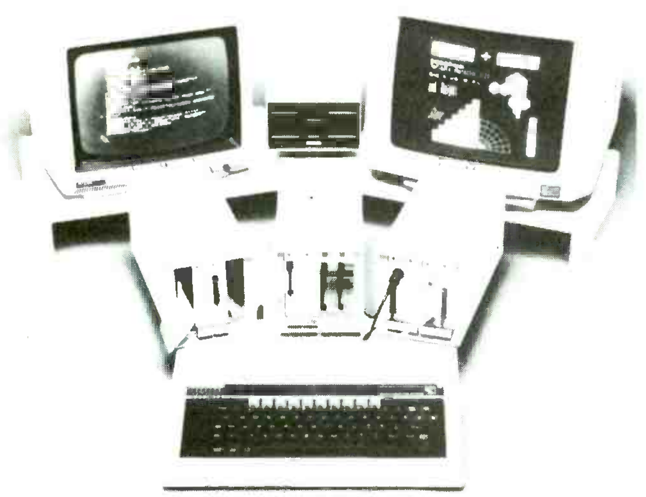

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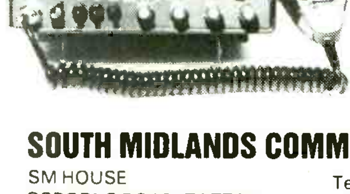

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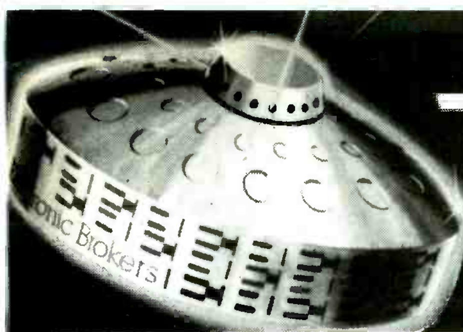

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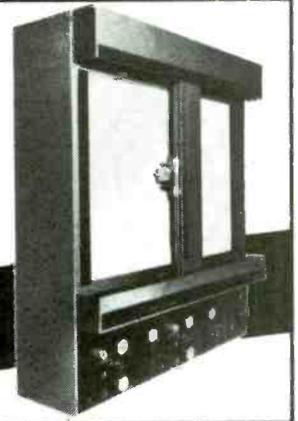

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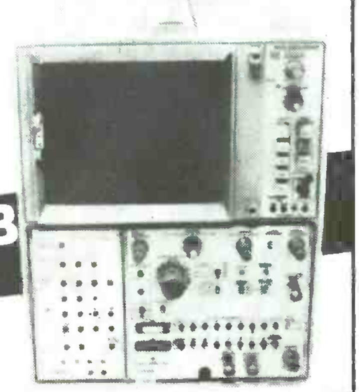

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CIRCLE 203 FOR FURTHER DETAILS.

DBS problems

Virtually every broadcaster is convinced that 12 GHz direct broadcasting from satellites to small home dish or planar aerials is technically feasible and will come into widespread use both for countries already well served by terrestrial v.h.f./u.h.f. transmitter networks and for those large Third World countries for which d.b.s. is particularly suited. The big question is how soon and how paid for — subscription pay channels are unlikely to be viable until homes with d.b.s. receivers reach a couple of million.

But it should not be forgotton that there are still technological problems that can be disregarded only at the risk of everyone concerned ending up with egg on their faces. The risk of an unsuccessful launch can be roughly quantifiable as around one in five though another NASA failure in early June for Intelsat again emphasises this risk. The risk of failures of the high-power transponders is perhaps even higher.

Japan successfully launched its Yuri 2A high-power broadcasting satellite on January 23 with the declared intention of providing the world's first true operational DBS service from May 12. Yuri 2A carries three 100-watt transponders and the intention was to put out two NHK programmes (carried also on their terrestrial network), one of them an educational channel, and having one transponder in reserve. The channels were planned as unencrypted 525-line NTSC with the stated intention of improving NHK coverage of the outer islands, etc. but undoubtedly also to stimulate the consumer industry into providing the electronic dish aerials and indoor converters needed for the f.m. type signals. I am told by Japanese visitors that a typical unit is retailing at 200,000 yen, or rather over £600, by no means a low cost.

Unfortunately by May 12 faults had occurred in two out of the three transponders. The educational channel has been dropped and NHK have re-classified the whole project as 'experimental'.

The Yuri transponders use travelling-wave tubes made by CSF Thomson in France and assembled by General Electric in the USA. Main contractors were Toshiba. The Japanese complained bitterly of the d.b.s. faults during a visit to Tokyo by the American vice-president George Bush. For several years the Japanese government have been pressurizing both NHK and the commercial broadcasters to plan for the extensive use of d.b.s. and so put their industry ahead of the world.

Tribroken-line dipoles

A few years ago F.M. Landstorfer of the Munich Technical University introduced the radical concept of a curved 1.5λ dipole element having a gain-optimized shape that causes radiation to increase significantly in a forward direction to about 7.5dBi (5-5.5dBd). Subsequently a number of people have developed his ideas, attracted by the unidirectivity of a non-terminated element. The front-back ratio is modest except when an array of gain-optimized elements is used.

The latest suggestion from Chinese workers (*Electronics Letters*, May 24, 1984, pp468-469) is that similar results can be achieved with a tribroken-line dipole with the curves replaced by six more convenient straight segments of roughly the same outline. Experimental results at 2000 MHz show a directivity of 6.6 dB. It is claimed that "this type of dipole with higher gain and simpler construction, which can even be folded up, is being used as a receiving antenna for u.h.f. and v.h.f. television channels".

Hand-held mikes

The UK is witnessing a tremendous build-up in the use of mobile radiotelephones, yet surprisingly little effort is being made to investigate road safety aspects of the use of telephone handsets by drivers. It is paradoxical that a driver risks prosecution by using an electric razor while a car is in motion but not from the use of a hand-held microphone unless other factors are involved.

It is now almost 20 years since in April 1965 the Ministry of Transport, in advance of the London Radiophone scheme announced that while Sections 2 and 3 of the Road Traffic Act 1960 already made it an offence to drive carelessly or dangerously it was intended to deal with the use of radio telephones with a new regulation that would insist that 'The driver of a motor vehicle shall not, while the vehicle is in motion on a road, speak into any radio transmitting equipment'.

The announcement provoked an immediate angry reaction from industry, following an emergency meeting of the Electronic Engineering Association which believed that the Ministry proposals threatened the whole concept of private and business two-way radio. Since no distinction was made between boom and hand-held microphones.

In the end the Ministry was prevailed upon to drop the proposed regulations. There apparently has been no research into the safety aspects of mobile radio in the UK since the 1960s, in spite of the tentative findings of investigations in 1965 and 1969 that suggested that while background music from entertainment radios or tape cassettes presents no problem, and can be beneficial, anything that requires mental effort or is distracting, including operation of knobs, switches and push buttons can impair safety. The UK, unlike some American States, does not even forbid the use by motorists, motor- or pedal-cyclists, of stereo headphones. Similarly some of the radio/cassette stereo models now marketed provide audio outputs of 2×20 watts despite recognition by the Medical Research Council's Applied Psychology Unit in Cambrige that overloud speech or music, or the use of stereo headphones, can impair the driver's monitoring of auditory information, for example from horns outside the vehicle or any warning signs from the engine.

For many years it has been recognized (for example in the RSGB safety recommendations for amateur radio mobile operation) that the use of boom-type microphones arranged not to impair vision is much to be preferred to hand-held microphones or telephone handsets; this practice is also followed, for example, in taxi installations yet is still widely ignored in p.m.r. and c.b. installations.

The subject of safety in respect of entertainment car radio/tape installations has been raised in an article "Facing the Music" by Lydia Taylor in the RoSPA publication *Care on the Road* (April 1984) but this does not cover the important question of two-way communications. It would seem that having over-shot the mark in 1965 by suggesting banning *all* use of transmitters while driving, the Ministry has left the subject severely alone. Yet the distinction between hand-held and boom-type microphones is surely a valid one.

More frequencies

May 23, 1984 saw the publication of an official DTI Consultative Document on the future use of Bands 1 and 111 for mobile radio following the final close-down of 405-line television in early January 1985, as a result of the 1982-83 'Independent Review of the Radio Spectrum', by the Merriman Advisory Committee which unmercifully clobbered British television viewers (a re-engineered v.h.f. tv network would have been far, far less costly or risky than d.b.s.) while concluding that Defence needed all of their generous allocations. While most observers agree that the p.m.r. services have long been starved of frequencies in the UK, the current recommendations largely ignore the expectation that the major growth area in the future will be 900 MHz cellular systems. Similarly the possibility of 5 kHz s.s.b. channels is covered only by suggesting that provision should be made in Band III for the introduction of new methods of modulation.

The DTI document identifies a dozen 'key issues' inviting comments by the end of July.

May 1984 also saw the issue of detailed information on the Racal 'Vodafone' cellular system with the forecast of trials over a 150 square-mile area of Central London starting next December, and with a typical cost for a standard saloon car of £63.50 per month (excluding v.a.t.).

Phase 1 of the Vodafone service is due to start in London and the major centres of population throughout the South, Midlands and Wales, and along several motorways. By late 1985 Phase 2 should extend the service to other main population centres.

The cellular system is claimed to be better and cheaper than

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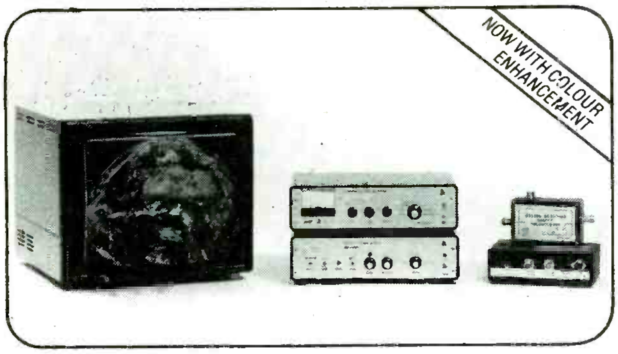

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6000	203.65	OA

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350	23.47	2.70
500	29.23	2.95
1000	52.98	4.00
2000	82.27	5.00
3000	115.37	OA
6000	228.75	OA

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2×12V Secs. Pri. 240V

12V		24V	Price	P&P
0.3A		.15	2.41	.90
1		.5	3.19	1.20
2		1	4.25	1.20
4		2	4.91	1.60
6		3	7.69	1.60
8	A	4	8.98	1.60
10	M	5	9.82	1.80
12	P	6	10.89	1.90
16	S	8	12.97	2.12
20		10	17.46	2.44
30		15	21.69	2.64
60		30	44.45	OA
83		41	51.20	4.50

96/48V. Pri 2×120V
Secs 2×36/48V

72/96-		36/48V	Price	P&P
0.5A		1	5.37	1.20
2	A	4	14.69	2.20
3	M	6	17.79	2.40
5	P	10	32.23	3.20
6	S	12	40.36	3.50
8		16	44.03	3.75

50/25V or 25-0-25V
2×25V Tap Secs. 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40, 20-0-20 or 25-0-25V

50V		25V	Price	P&P
0.5		1	4.13	1.40
1		2	5.03	1.50
2		4	8.69	1.84
3	A	6	10.36	1.90
4	M	8	14.10	2.12
6	P	12	18.01	2.20
8	S	16	24.52	2.70
10		20	30.23	3.00
12		24	36.18	3.20

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60V		30V	Price	P&P
0.5		1	4.70	1.50
1		2	7.15	1.50
2	A	4	9.20	1.90
3	M	6	13.31	2.00
4	P	8	15.15	2.20
5	S	10	19.16	2.20
6		12	21.86	2.65
8		16	30.72	3.00
10		20	35.76	3.30
12		24	41.22	3.50

MINIATURES

Sec V	Amp	Pri	P&P
3-0-3	.2A	3.11	.90
6×2	1A×2	3.45	1.20
9-0-9	.1	2.59	.90
9×2	.33×2	2.41	.90
8,9×2	.5×2	3.36	1.20
8,9×2	1A×2	4.27	1.40
15×2	.2A×2	2.41	.90
12-0-12	.05	3.11	.90
20×2	.3×2	3.39	1.20
20×2	.15×2	1.50	.50
20,12,0			
12,20	.9	4.13	1.30
15,20-2	1A×2	5.60	1.60
15,27×2	.5×2	4.83	1.40
15,27×2	1A×2	7.30	1.60

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1		2	4.32	1.40
2	A	4	6.99	1.60
3	M	6	8.10	1.85
4	P	8	9.67	1.90
5	S	10	11.95	2.00
6		12	13.52	2.00
8		16	18.10	2.26
10		20	20.88	2.26
12		24	23.20	2.50
15		30	26.60	3.00
20		40	35.64	4.83

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500	13.30	2.24
1000	24.14	2.80
1500	28.17	3.20
2000	42.14	4.00
3000	71.64	4.80
5000	108.30	OA

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150	12.10	1.90
250	14.73	2.00
500	24.14	2.20
1000	33.74	2.80
2000	60.47	4.50

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CIRCLE 204 FOR FURTHER DETAILS.

conventional area and trunking systems, such as the London Radiophone Service operated by BT, providing travellers with full access to the national and international public switched telephone network based on *handsets*. Here again one could note that telephone conversations can be more distracting and put more emotional strain on users than, for example, routine instructions from individual base stations in the private mobile service.

In the DTI rush to expand the mobile radio industry, road safety appears to have taken a back seat.

In from the cold?

The current proposal to transfer responsibility for the high-power FCO broadcast transmitters at Orfordness, Crowborough, Cyprus and Masirah Island to the BBC seems designed to produce 'paper cuts' rather than any genuine saving of taxpayers' money. Foreign Office mandarins have seized the opportunity to cut down the 'plebian' activities of its Communications and Broadcast department (formerly 'Diplomatic Wireless Service') and so finally rid itself of those embarrassing links with wartime 'black' broadcasting" from Milton Bryan, using transmitters supplid by the Intelligence-Service-linked Special Communications under Sir Richard Gambier-Parry and Harold Robin.

A similiar coyness can be seen currently at the Imperial War Museum where several rarely-seen examples of radio transmitters and receivers used for wartime clandestine communications links with France, Belgium, Denmark and Poland are among the fascinating collection of memorabilia in the special exhibition 'European Resistance to Nazi Germany, 1939-45' which runs to next April. The emphasis is firmly on SOE equipment and operations with a marked absence of any of the many equipments made by Special Communications at Whaddon (another notable omission is any reference to the Dutch Internal Radio Service of 1944-45). However the excellent Anglo-Polish AP4 and BP3 equipments can be seen as well as a very compact unit made in Denmark by Lorens Hansen when he became dissatisfied with equipments supplied from the UK. SOE equipments on display include the B2, S-phone, MCR-1, Type 53 Mk1 etc., although most of these can be seen in other collections in the UK. A home-built Belgian transmitter can also be seen.

Amateur Radio

Satellite to satellite

During the period when Oscar 7 and 8 were both fully operational it was possible for amateurs to establish contact 432 to 29 MHz by using both satellites simultaneously, with an intermediate satellite-to-satellite link on 146 MHz. Pat Gowen, G3IOR and David Rowan, G4CUO have now demonstrated that a similar path is possible using the Oscar 10 (mode B) transponder in conjunction with a mode A transponder on one of the current Russian satellites, such as RS4.

An interesting feature of this experiment with the higher orbit of Oscar 10 is that it would appear that, given the right combination of satellite positions, it should be possible to establish two-way communication between *any* two points on the globe.

The possibility of a successful outcome to the University of Surrey's UoSAT2 project, which went off the air shortly after being launched on March 1, is looking more hopeful, following restoration of the 145.825 MHz beacon.

Novice licence

Ian Abel, G3ZHI who has campaigned for the introduction of a 'novice licence' for amateur radio in the UK believes that there is now widespread misunderstanding of its aims and purposes. He believes, and there is evidence to support this, that many licensed amateurs have been led to believe that such a facility would serve only to permit c.b. operators who are unwilling to take, or have failed, the Radio Amateurs Examination to operate in the amateur bands. On the contrary, as administered over more than 30 years in the USA, 'novice' operation is restricted to A1A (morse) within small segments of h.f. bands. it is primarily a form of 'incentive' licensing, of limited duration, and designed to encourage interest in cw operation on the h.f. bands, and thus to some extent to counter the concentration on 144 MHz telephony that has resulted from the popularity of the Class B licence. Today Class B licences outnumber Class A by more than 2500 (over 25,000 Class A, almost 28,000 Class B) and undoubtedly the hobby now differs significantly from its counterpart in North America where the emphasis is still on h.f. operation.

Under a London Gazette notice of June 8 the various changes in the conditions of the UK amateur licence introduced in January 1983, affecting training exercises for Raynet emergency communications and operation of a station by a non-licensed person under direct supervision, have been formalised. It is perhaps surprising that it is now many years since individual British Amateurs have been issued with an up-dated licence document.

Mixed grill

Leave to appeal to the House of Lords against the recent Manchester Crown Court decision that proof of unlicensed use of a transmitter is not necessary to secure a conviction under the Wireless Telegraphy Acts has been refused. This decision suggests that an offence can be established by the fact that transmitting equipment has been 'available for immediate use at any time'. The Manchester ruling, before Part VI of the Telecommunications Act 1984 was on the Statute Book, appears to establish an entirely new precedent that runs contrary to the often-expressed view that to obtain a conviction a 'pirate' has to be caught using his equipment.

The RSGB has reminded its members that it is a breach of the Copyright Acts to transmit or receive commercially-produced computer software. There is nothing in the terms of the amateur licence to prohibit the exchange by data transmission of non-copyright material such as programs written by the amateur concerned. Commercial software includes computer games, educational programs and the software developed for small business computers, etc.

Italian amateurs have claimed a new distance record of 289 km on the 24 GHz band for a difficult contact last April between mountain-top stations I4BER/I4CHY in the province of Pescara and IW3EHQ/I3SDY in the province of Udine. Both used Gunn-oscillator transceivers with about 100 mW output. The RSGB is recommending for 10 GHz that as from January 1985 wideband equipment should use the section of the band between the 'narrowband' section (10.368 to 10.370 GHz) and the nominal beacon frequency of 10.4 GHz. Currently most wideband operation is below 10.1 GHz.

The DTI has indicated that it is willing to hand over responsibility for the Morse Test, currently administered by British Telecom, to either the RSGB or the City & Guilds of London Institute. RSGB Council is actively seeking to bring this about. When some years ago I suggested in *Wireless World* that it was time to make such a change I received a heated phone call from an indignant coast station radio operator who pointed out that giving tests to would-be amateurs represented a valued 'perk' since part of the fee came to the person giving the test!

The DTI-authorized extension of training facilities for the Raynet amateur radio emergency service appears to have had the unexpected effect of dragging this service into the political arena. This is because of the participation of Raynet in various civil defence training exercises. Objection has also been raised to the band-plan reservation of frequencies on the grounds that in other countries emergency services are allocated frequencies outside the amateur bands.

August mobile rallies include: August 5, RSGB national rally at Woburn. August 12, Derby rally at Lower Bemrose School, St Albans Road. August 19, RAIBC/Flight-Refuelling societies at the Flight Refuelling social club, Merley, Wimborne, Dorset. August 26, BARTG rally at Sandown Park Racecourse, Esher, Surrey; Preston rally at Lancaster University; and Torbay rally at STC Works, Old Brixham Road, Paignton.

PAT HAWKER, G3VA

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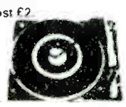

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6-0-6V. 1½ amp	£3.50	£1	15-0-15V. 2 amp	£5.00	£1
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9-0-9V. 50ma	£1.50	£1	0-12-27V. 2 amp	£4.00	£1
9-0-9V. 1 amp	£3.50	£1	20-40-60V. 1 amp	£3.50	£2
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.22MF 350V **12p**. 600V **20p**. 1000V **30p**. 1750V **60p**.
.47MF 150V **10p**. 400V **25p**. 630V **30p**.

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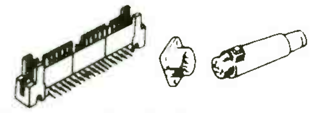

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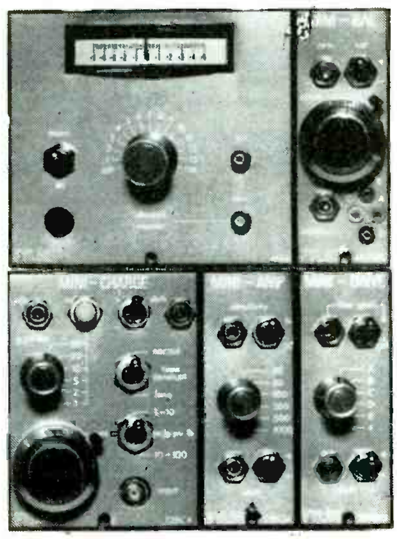

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CIRCLE 55 FOR FURTHER DETAILS.

Interfacing a computer to a linear air track.

by H.B. Fielding

Linear motion experiments using a computer to measure and display results.

Detecting the rider can be done in a variety of ways. One is to mount a piece of card on the top and use this to break a light beam: a timer can be started and stopped in this way. The method used here uses a reflective opto switch[2]. This is a combined light emitter and detector in which an infra-red beam of light is produced which can be reflected back to the detector by a suitable reflective surface. This method of sensing a rider has several advantages over the conventional light gate methods: the sensors do not block any view of the track and the movements of the rider — useful in demonstrations; they are not subject to interference from the ambient lighting; each sensor can detect a specific rider on the track; and the equipment has a minimum of connections and low power consumption, so that the computer provides the power supply.

Hardware

The position sensors are R.S.Components infra-red reflective opto-switches, cat. no 307-913. They are mounted in aluminium channel sections with a 4-core connecting cable to the interface circuit, which consists of two identical channels, one of which is shown in Fig. 2. The outputs go to the user port input of the computer, in this case a Research Machines 380Z; channel A is Data In 0 and channel B is Data In 2. The other data input lines can be left unconnected as the software only tests for Bits 0 and 2. When there is no reflection of the i.r. beam, the transistor Tr_1, is switched on. The collector will be at a low voltage and this is inverted by the schmitt trigger, IC_1, to give a digital 1. When a reflector is positioned in front of the sensor, the output from IC_1 becomes a 0.

The prototype was constructed on a small piece of Veroboard and fitted inside a metal case. Two DIN sockets were fitted for connecting the sensors, and a 25-way D plug providing the connection to the computer's user port.

A linear air track is a piece of laboratory equipment that allows experiments in linear motion under very low friction conditions. It is essentially a long length of square section tube with a series of fine holes drilled along its length. When air is fed under low pressure into the tube, jets of air are produced that lift a piece of aluminium angle, called a rider, clear of the track, see fig. 1. Experiments on the motion of this rider can be carried out using the very low friction conditions[3].

Any experiments will involve the detection of a rider as it moves past a sensor. Some will need to detect two riders, as in the cases of collisions.

The author

Educated at Rochdale Boys Grammar School and then Nottingham College of Education, H.B. Fielding started his teaching career in Birmingham and is now Head of Physics at Archbishop Masterson School, a post he has held since 1975. His activities include introduction of computer control, electronics and technology courses into the school.

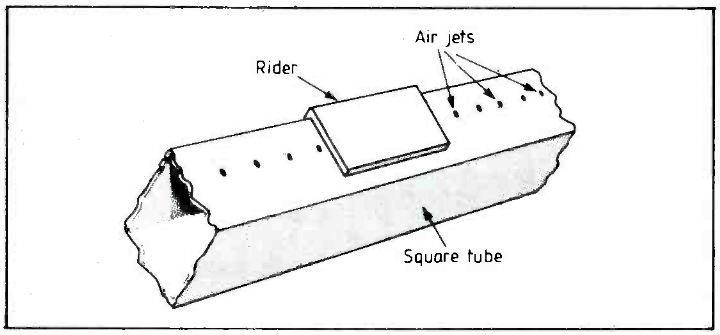

Fig. 1. **Hollow square tube with air outlets forms a virtually frictionless bearing for the 'rider'.**

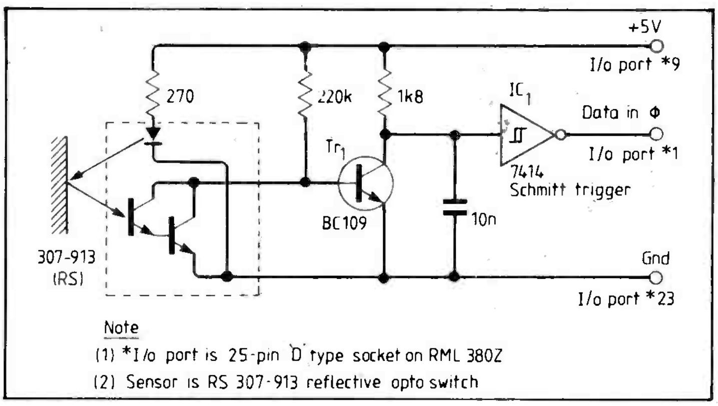

Fig. 2. **One channel of the interface amplifier.**

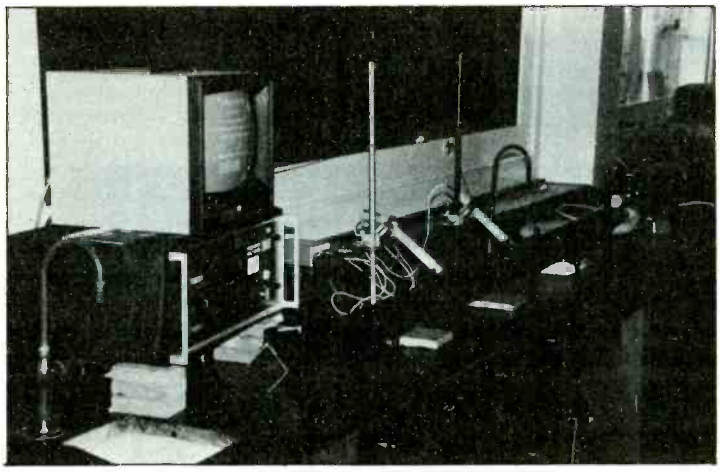

Photo 1 **Experimental assembly. Track is seen in position with the two sensors and an RML 380Z.**

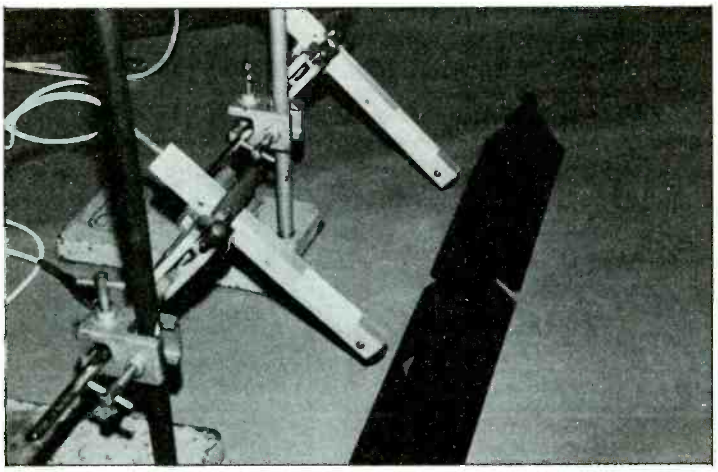

Photo 2 **Positioning of the two sensors.**

Riders

The original black anodized surface of the riders was found to be a good reflector of infra red and so had to be coated with a matt-black spray paint: the surface of the track was also treated in this way. Sensors can be mounted by the side of the track, pointing downward at an angle of 45 degrees. The riders have a set of reflectors fitted to them — the small, silver, self-adhesive labels used for Write protection on floppy discs. Side one of the rider has a reflector that can only be picked up by one sensor. Depending on the height of the sensor, it will only be sensed by the A or B sensor, as in Fig. 3. On side two, there are two reflectors so that the rider can be detected by both sensors. On this side there are two extra reflectors fitted in the top corners, used with another program[3] for measurement of velocities and accelerations of the rider.

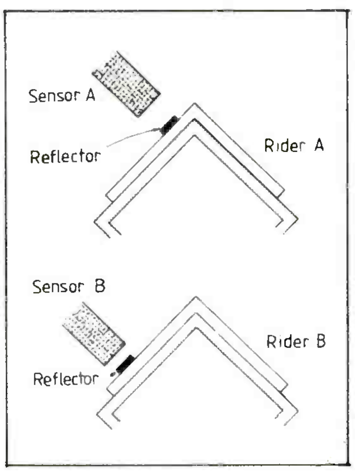

Fig. 3. **Setting the sensors and reflectors at different heights enables the sensors to differentiate between them.**

Demonstrations

Constant velocity. One rider is used with the two reflectors on the same side, separated by 40cm. One reflector is detected by sensor A, the other by sensor B. The rider can be given an initial velocity by hand. By measuring the velocity at the two places along the track, the idea of a constant velocity can be demonstrated.

Potential energy into kinetic energy. Using an elastic band, a rider can be catapulted along the track. A value for the kinetic energy that the moving rider possesses can be determined from the velocity and its mass. By using two elastic bands stretched by a similar amount, twice the energy can be given to the rider.

Elastic collisions. Using two riders, send rider A along the track to collide with the stationary rider B. Use rubber bands at the collision points on the riders. The rider B should move away at the same velocity of rider A before the collision, (assuming equal masses).

Inelastic collisions. Change the rubber bands at the collision points to adhesive pads or plasticine and repeat the previous procedure.

Software

This is designed to run on a Research Machines RML 380Z with 56K of memory. Most of the program is in Basic with a machine-code subroutine for the time-critical sections. It is loaded from the Basic program and could be relocated to allow for other memory configurations.

Using the two infra-red switches, the positions of riders on the track can be detected. An inbuilt clock provides the means of timing the riders. In this case it is on a PIA board type EA2380 made by Irwin-Desman Ltd, giving times in increments of 10 ms. If the length of the reflector on the detected rider is known then the velocity can be calculated and if the mass of the rider has been given, the momentum and the kinetic energy can also be calculated. The program is able to decide from the measured results if a collision between two riders was elastic or inelastic, by comparison of the momentum before and after the collision. Assuming the law of conservation of momentum, the value after the collision should be of the same order; if the difference is greater than an arbitrary value, (20%), the collision is deemed to be inelastic, the two riders having joined together to form one of larger mass. The new mass is calculated along with the new momentum and kinetic energy values.

The program is organized as a series of modules, some being used in the setting up of an experiment, others calling up values taken from running the experiement. All modules except the Run timing are in Basic and command is from the keyboard. Only certain keys are operated on; all others are ignored. The Run timing module cannot be interrupted; it will only return to the main program after all the riders have been detected and timed.

Option S

This section enables the two sensors to be set up in relation to the reflectors on the respective rider. The screen shows two areas marked A and B. When a reflector on the appropriate rider is in the view of its sensor, a white square appears. Each sensor can be set up individually. Exit from the module is by pressing any key except L. Pressing L enables the lengths of each reflector to be entered in the program, which is useful as the measured length of a reflector may not be the effective length that the sensor sees. The default value for the reflector length is set at 2.5 (cm).

Option D

This section enables details about the masses of the two riders to be entered into the program. There is no error checking on the values entered. If this module is not run, default mass values of 400g are assumed. A simple diagram is also displayed that may be useful in explanations about the experiments.

Option T

This draw a blank results table on the screen. Two columns are provided for values for the two riders A and B. Values for the masses of the riders are already shown. After a run, values for the velocity, momentum and kinetic energy for each rider can be called up onto the table. If a timing run has not been performed, there will be no valid values shown, 0 in fact. Values for velocity, momentum and kinetic energy must be prefixed by either A or B, e.g. momentum of B would be called up by BM.

Option R

This runs the timing routine. First the start of a reflector on rider A is detected and the clock started. When the end of this reflector is detected, the clock is stopped and the value stored. The routine now repeats this but for the other rider, B. The exit from this routine is automatic after the second rider has been detected. There is no other way out of this routine except by pressing the main reset button on the front panel!

Option H

Shows on the screen the complete list of options available. This clears any previous screen information but not stored values which can be called up once more onto the screen.

Option X

Not shown on the general option table. Allows exit from the program back to Basic command level.

Option V

With the prefix A or B, displays the calculated velocity value. The value is displayed as a whole

```
100 PUT 27,"=0J"
102 ?:?:?:?:?
104 GRAPH 1
106 REM************************
108 REM*                      *
110 REM* Air Track Collisions *
112 REM*        AIR.2         *
114 REM*    H.B.FIELDING.     *
116 REM*                      *
118 REM*        1/1984        *
120 REM*                      *
122 REM************************
124 D1=2.5:D2=2.5:                   REM *Initial values only*
126 MA=400:MB=400:                   REM *Initial mass values *
128 GOSUB 330:                       REM *M/C loader*
130 GOSUB 488:                       REM*Headings*
132 GOSUB 218:                       REM*Summary*
134 Q$=GET$()
136 PLOT 0,-12,Q$
138 GOTO 148
140 REM**
142 GOSUB 568
144 Q$=GET$()
146 PLOT 0,-12,Q$
148 IF Q$="X" THEN GRAPH 1:TEXT:PUT 27,"=1J":END
150 IF Q$="x" THEN GRAPH 1:TEXT:PUT 27,"=1J":END
152 IF Q$="S" THEN GOSUB 358:     REM *Sensor set up *
154 IF Q$="s" THEN GOSUB 358
156 IF Q$="D" THEN GOSUB 410:     REM *Collision details *
158 IF Q$="d" THEN GOSUB 410
160 IF Q$="T" THEN GOSUB 514:     REM *Blank table*
162 IF Q$="t" THEN GOSUB 514
164 IF Q$="R" THEN GOSUB 294:     REM *Run timing *
166 IF Q$="r" THEN GOSUB 294
168 IF Q$="A" THEN 182
170 IF Q$="a" THEN 182
172 IF Q$="B" THEN 200
174 IF Q$="b" THEN 200
176 IF Q$="H" THEN 132
178 IF Q$="h" THEN 132
180 GOTO 140
182 Q$=GET$()
184 PLOT 0,-12,Q$
186 IF Q$="V" THEN GOSUB 246:     REM *Velocity *
188 IF Q$="v" THEN GOSUB 246
190 IF Q$="M" THEN GOSUB 262:     REM *Momentum *
192 IF Q$="m" THEN GOSUB 262
194 IF Q$="K" THEN GOSUB 278:     REM *K.E.*
196 IF Q$="k" THEN GOSUB 278
198 GOTO 140
200 Q$=GET$()
202 PLOT 0,-12,Q$
204 IF Q$="V" THEN GOSUB 254:     REM *Velocity *
206 IF Q$="v" THEN GOSUB 254
208 IF Q$="M" THEN GOSUB 270:     REM *Momentum *
210 IF Q$="m" THEN GOSUB 270
212 IF Q$="K" THEN GOSUB 286:     REM *K.E.*
214 IF Q$="k" THEN GOSUB 286
216 GOTO 140
218 REM                     *Summary of options*
220 GRAPH 1
222 PLOT 22,55,"Summary of Options."
224 PLOT 22,52,"~~~~~~~~~~~~~~~~~~~"
226 PLOT 0,46,"S          Set up sensors."
228 PLOT 0,40,"D          Enter details of collision."
230 PLOT 0,34,"T          Display blank results table."
232 PLOT 0,28,"R          Run/Repeat timing section."
234 PLOT 0,22,"H          Help."
236 PLOT 0,13,"A/B        Prefix for next values."
238 PLOT 0,6,"V           Velocity value."
240 PLOT 0,3,"M           Momentum value."
242 PLOT 0,0,"K           Kinetic energy."
244 RETURN
246 REM*AV*
248 PLOT 58,33,"      "
250 PLOT 58,33,STR$(INT(AV+.5))
252 RETURN
254 REM*BV*
256 PLOT 36,33,"      "
258 PLOT 36,33,STR$(INT(BV+.5))
260 RETURN
262 REM*AM*
264 PLOT 58,24,"      "
266 PLOT 58,24,STR$(INT(AM+.5))
268 RETURN
270 REM*BM*
272 PLOT 36,24,"      "
274 PLOT 36,24,STR$(INT(BM+.5))
276 RETURN
278 REM*AK*
280 PLOT 58,15,"      "
282 PLOT 58,15,STR$(INT(AK+.5))
284 RETURN
286 REM*BK*
288 PLOT 36,15,"      "
290 PLOT 36,15,STR$(INT(BK+.5))
292 RETURN
294 REM*M/C Subroutine, Return with Times.*
296 CALL &A220:                    REM*M/C Start Address.*
298 M=&A200:                       REM*Start Address of Stored Times.*
300 S1=PEEK(M)
302 H1=PEEK(M+1)
304 K1=PEEK(M+2)
306 T2=S1+(H1*.01)+(K1*.0001)
308 S2=PEEK(M+3)
310 H2=PEEK(M+4)
312 K2=PEEK(M+5)
314 T3=S2+(H2*.01)+(K2*.0001)
316 AV=D1/T2:                      REM*velocity of A.*
318 BV=D2/T3:                      REM*velocity of B.*
320 AM=MA*AV:BM=MB*BV:             REM  *Momentums*
322 AK=(MA*AV*AV)/2:               REM    *K.E.*
324 BK=(MB*BV*BV)/2:               REM    *K.E.*
326 GOSUB 590:                    REM * Test for collision type *
328 RETURN
330 REM*Machine Code Loader.*
332 A=&A220
334 FOR J=0 TO 86
336 READ M
338 POKE(A+J),M
340 NEXT J
342 DATA &3E,&04,&D3,&00,&3A,&FF,&FB,&E6,&01,&C2,&24,&A2,&3E,&07
344 DATA &D3,&00,&3A,&FF,&FB,&E6,&01,&CA,&30,&A2,&3E,&06,&D3,&00
346 DATA &DB,&00,&32,&00,&A2,&DB,&01,&32,&01,&A2,&DB,&02,&32,&02
348 DATA &A2,&3E,&04,&D3,&00,&3A,&FF,&FB,&E6,&04,&C2,&4F,&A2,&3E
350 DATA &07,&D3,&00,&3A,&FF,&FB,&E6,&04,&CA,&5B,&A2,&3E,&06,&D3
352 DATA &00,&DB,&00,&32,&03,&A2,&DB,&01,&32,&04,&A2,&DB,&02,&32
354 DATA &05,&A2,&C9
356 RETURN
358 REM*dual sensor setup*
360 GRAPH 1
362 PLOT 16,31,"DUAL SENSOR SETUP."
364 PLOT 0,22,"PRESS L TO INPUT NEW REFLECTOR LENGTHS."
366 PLOT 4,16,"PRESS ANY OTHER KEY TO CONTINUE."
368 PLOT 10,56,"Sensor A"
370 PLOT 42,56,"Sensor B"
372 V=PEEK(64511)
374 IF V AND 1 THEN PLOT 17,46,128 ELSE PLOT 17,46,255
376 IF V AND 4 THEN PLOT 50,46,128 ELSE PLOT 50,46,255
378 L$=GET$(2)
380 PLOT 0,-12,L$
382 IF L$="" THEN 372
384 IF L$="l" THEN L$="L"
386 IF L$<>"L"THEN GRAPH 1:RETURN
388 PLOT 0,22,"                                        "
390 PLOT 0,22,"SET NEW LENGTHS FOR REFLECTORS. IN cm."
392 PLOT 30,19,"THEN"
394 PLOT 4,6,"NEW LENGTH FOR REFLECTOR A (cm)^"
396 X=70:Y=6:GOSUB 606
398 D1=D
400 PLOT 4,0,"NEW LENGTH FOR REFLECTOR B (cm)^"
402 X=70:Y=0:GOSUB 606
404 D2=D
406 L$=GET$(:500)
408 GRAPH 1:RETURN
410 REM*collision details*
412 REM*Returns riders Mass MA & MB*
414 GRAPH 1
416 PLOT 18,58,"Collision details."
418 PLOT 0,46,"Rider B ( Stationary )"
420 PLOT 0,40,"Rider A ( Moving toward B )"
422 PLOT 18,31,"B"
424 PLOT 52,31,"A"
```

number even though subsequent calculations use the complete number.

Option M

With the prefix A or B, displays the calculated momentum value.

Option K

With the prefix A or B, displays the calculated kinetic energy value.

Note

The keyboard can be set to upper or lower case.

When an option can be called up, the lower part of the screen shows the valid keys.

A complete listing of the program is given. The machine code subroutine assembly is also given, and it may be than an alternative timing routine could be developed here that could be used on a wider range of machines.

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1. Linear Air Track, Equipment Notes P10041, Philip Harris Ltd.
2. R.S.Components Ltd, Reflective & Slotted Opto Switches, Data Sheet R4276.
3. H.B.Fielding, Air Track Data Processing Program, **Electronics Systems News**, May 1983.


```
426 PLOT 10,10,"Sensor B"
428 PLOT 44,10,"Sensor A"
430 PLOT 12,18,254
432 PLOT 14,18,253
434 PLOT 12,17,255
436 PLOT 14,17,255
438 PLOT 46,18,254:PLOT 48,18,253
440 PLOT 46,17,255:PLOT 48,17,255
442 PLOT 16,17,2:LINE 28,17:LINE 28,4
444 PLOT 46,17,2:LINE 32,17:LINE 32,4
446 PLOT 22,2,"Computer"
448 PLOT 0,35,1:LINE 79,35
450 PLOT 0,27,1:LINE 79,27
452 GOSUB 578:                    REM* Clear lower screen*
454 PLOT 10,-6,"MASS OF RIDER A ":X=44:Y=-6:GOSUB 606
456 PLOT 68,53,"Mass"
458 PLOT 66,40,"        "
460 MA=Q
462 PLOT 66,40,STR$(MA)+" g"
464 PLOT 10,-9,"MASS OF RIDER B ":X=44:Y=-9:GOSUB 606
466 PLOT 66,46,"        "
468 MB=Q
470 PLOT 66,46,STR$(MB)+" g"
472 PLOT 10,-12,"Is this correct? ( Y/N )"
474 Q$=GET$()
476 PLOT 0,-12,Q$
478 IF Q$="N"THEN 452
480 IF Q$="n"THEN 452
482 IF Q$="Y"THEN RETURN
484 IF Q$="y"THEN RETURN
486 GOTO 474
488 REM*Headings*
490 GRAPH 1
492 PLOT 10,48,"COLLISIONS >   < COLLISIONS"
494 PLOT 10,36,"A program to measure times"
496 PLOT 10,30,"and velocities of air track"
498 PLOT 8,24,"riders involved in collisions."
500 PLOT 25,15,"H.B.Fielding."
502 PLOT 13,6,"Archbishop Masterson School"
504 PLOT 27,3,"Birmingham."
506 PLOT 20,0,"Version 1. 12/1983"
508 A$=GET$(1500)
510 GRAPH 1
512 RETURN
514 REM*blank display table*
516 GRAPH 1
518 PLOT 20,58,"TABLE of RESULTS"
520 PLOT 34,55,1:LINE 34,8
522 PLOT 79,55,1:LINE 79,8
524 PLOT 55,55,1:LINE 55,8
526 PLOT 34,55,1:LINE 79,55
528 PLOT 34,49,1:LINE 79,49
530 PLOT 34,8,1:LINE 79,8
532 PLOT 44,52,"B"
534 PLOT 66,52,"A"
536 PLOT 6,42,"Mass"
538 PLOT 6,33,"Velocity"
540 PLOT 6,24,"Momentum"
542 PLOT 6,15,"Kinetic"
544 PLOT 6,12,"Energy"
546 PLOT 26,42,"m"
548 PLOT 26,33,"v"
550 PLOT 26,24,"mv"
552 PLOT 32,16,4
554 PLOT 26,15,28
556 PLOT 28,15,"mv"
558 PLOT 0,33,"V"
560 PLOT 0,24,"M"
562 PLOT 0,15,"K"
564 PLOT 36,42,STR$(MB):PLOT 58,42,STR$(MA)
566 RETURN
568 REM*Help menu*
570 GOSUB 578
572 PLOT 32,-6,"OPTIONS"
574 PLOT 8,-12,"AV AM AK  D S T R H X  BV BM BK"
576 RETURN
578 REM*Clear lower screen*
580 PLOT 0,-3,"                                         "
582 PLOT 0,-6,"                                         "
584 PLOT 0,-9,"                                         "
586 PLOT 0,-12,"                                         "
588 RETURN
590 REM *Test for collision type/ adjust momentum & K.E. *
592 T=ABS(AM-BM)
594 IF T<(AM*.2) THEN RETURN:        REM * Elastic *
596 MB=MB+MA:                        REM * New mass of B *
598 BM=MB*BV:                        REM * New momentum of B *
600 BK=(MB*BV*BV)/2:                 REM * New K.E. of B *
602 PLOT 36,42,STR$(MB)
604 RETURN
606 REM *Build number*
608 N$=""
610 Q$=GET$()
612 IF Q$=CHR$(13) THEN 620
614 PLOT X,Y,Q$:X=X+2
616 N$=N$+Q$
618 GOTO 610
620 Q=VAL(N$):RETURN
```

```
                                    ;AIR.ZSM  - AIR TRACK SUBROUTINE
                                    ;H.B.FIELDING 2/1984

FBFF =          UPORT   EQU     0FBFFH          ;380Z USER PORT
A200 =          STORE   EQU     0A200H          ;STORED TIME AREA
A220                    ORG     0A220H          ;START OF PROGRAM

A220 3E04       START:  LD      A,04H           ;RESET & HOLD CLOCK
A222 D300               OUT     (0),A

A224 3AFFFB     START1: LD      A,(UPORT )      ;READ I/O PORT
A227 E601               AND     01H             ;TEST FOR BIT 0
A229 C224A2             JP      NZ,START1       ;JUMP BACK IF NOT
A22C 3E07               LD      A,07H           ;START CLOCK
A22E D300               OUT     (0),A

A230 3AFFFB     END1:   LD      A,(UPORT)       ;READ I/O PORT
A233 E601               AND     01H             ;TEST FOR BIT 0
A235 CA30A2             JP      Z,END1          ;JUMP BACK IF NOT

A238 3E06               LD      A,06H           ;HOLD CLOCK
A23A D300               OUT     (0),A
A23C DB00               IN      A,(0)           ;GET SECONDS
A23E 3200A2             LD      (STORE +0),A    ;STORE IT
A241 DB01               IN      A,(1)           ;GET 1/100 SEC
A243 3201A2             LD      (STORE +1),A    ;STORE IT
A246 DB02               IN      A,(2)           ;GET 1/10000 SEC
A248 3202A2             LD      (STORE +2),A    ;STORE IT

A24B 3E04               LD      A,04H           ;RESET CLOCK AND HOLD
A24D D300               OUT     (0),A

A24F 3AFFFB     START2: LD      A,(UPORT)       ;READ I/O PORT
A252 E604               AND     04H             ;TEST FOR BIT 2
A254 C24FA2             JP      NZ,START2       ;JUMP BACK IF NOT

A257 3E07               LD      A,07H           ;START CLOCK
A259 D300               OUT     (0),A

A25B 3AFFFB     END2:   LD      A,(UPORT)       ;READ I/O PORT
A25E E604               AND     04H             ;TEST FOR BIT 2
A260 CA5BA2             JP      Z,END2          ;JUMP BACK IF NOT

A263 3E06               LD      A,06H           ;HOLD CLOCK
A265 D300               OUT     (0),A
A267 DB00               IN      A,(0)           ;GET SECONDS
A269 3203A2             LD      (STORE +3),A    ;STORE IT
A26C DB01               IN      A,(1)           ;GET 1/100 SEC
A26E 3204A2             LD      (STORE +4),A    ;STORE IT
A271 DB02               IN      A,(2)           ;GET 1/10000 SEC
A273 3205A2             LD      (STORE +5),A    ;STORE IT

A276 C9                 RET                     ;RETURN TO MAIN
                                                ;PROGRAM


A230 END1   A25B END2   A220 START   A224 START1   A24F START2
A200 STORE  FBFF UPORT

No errors
```

TYPE 9051

TYPE 9046

VMOS WIDEBAND LINEAR POWER AMPLIFIERS. 4W/10W/20 watts RF output. Without tuning. Power gain 10dB. 24V. + supply.

TYPE 9046 100KHz.-100MHz. 4 watts	£84.50 + £3.50 p&p
TYPE 9051 15MHz.-200MHz. 4 watts	£84.50 + £3.50 p&p
TYPE 9171 15MHz.-200MHz. 10 watts	£140.00 + £8.00 p&p
TYPE 9172 As above with integral power supply unit	£200.00 + £15.00 p&p
TYPE 9174 15MHz.-200MHz. 20 watts	£180.00 + £8.00 p&p
TYPE 9175 As above with integral mains power supply unit	£240.00 + £15.00 p&p

TYPE 9152

TYPE 9159

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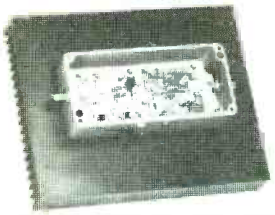
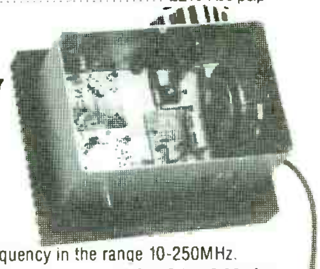
Type 9061	£140+£5 p&p
Type 9152	£180+£5 p&p
Type 9159	£210+£5 p&p



TYPE 9155



TYPE 9157

RF POWER AMPLIFIERS. Tuned to your specified frequency in the range 10-250MHz.

TYPE 9105 10 mW. input, 3 watts output	£160.00 + £10.00 p&p
TYPE 9155 3 watts input, 30 watts output	£240.00 + £10.00 p&p
TYPE 9156 As above with integral mains power supply unit	£320.00 + £15.00 p&p
TYPE 9106 100 mW. input, 10 watts output	£180.00 + £10.00 p&p
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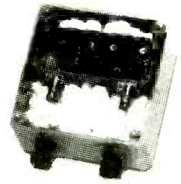
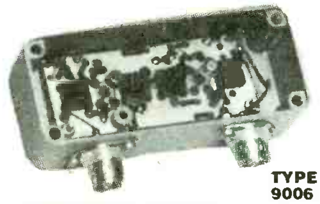
TYPE 9157 As above with integral mains power supply unit	£400.00 + £15 p&p



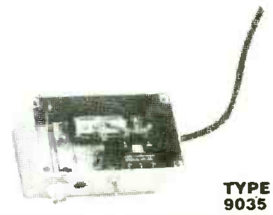
TYPE 9010

TWO STAGE GASFET STRIPLINE PREAMPLIFIERS
Tuned to your specified channels in bands IV or V

TYPE 9002 Two stage Gasfet preamplifier. N.F. 0.7dB. Gain 25dB. High Q filter	£85 + £2 p&p
TYPE 9004 UHF two stage Gasfet preamplifier. N.F. 0.6dB. Gain 25dB. Aligned to your specified frequency in the range 250-500MHz. High Q filter	£85 + £2 p&p
TYPE 9012 Gasfet preamplifier mains power supply unit	£24.50 + £3 p&p
TYPE 9010 Masthead weatherproof unit	£6.50 + £2 p&p



TYPE 9006



TYPE 9035

GASFET RF PREAMPLIFIERS. Aligned to your specified frequency in the range 30-250MHz. Masthead or local use.

TYPE 9006 N.F. 0.6dB. Gain 10-40dB. variable	£65.00 + £2 p&p
TYPE 9006FM As above. Band II 88-108MHz	£65.00 + £2 p&p
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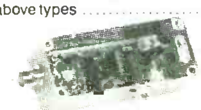

TYPE 8034

TYPE 8034 PHASE LOCKED SIGNAL SOURCE using low frequency reference crystal. Specify output in the range 1-600MHz. Output 10mW.+10dBm	£84.50+£2 p&p
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TYPE 9086 FM TRANSMITTER 88-108MHz. 50 watts RF output. 24V + supply. Complete modular system	£480+£30 p&p
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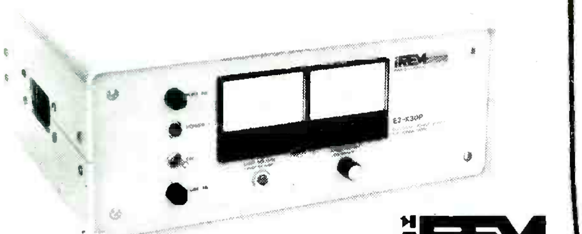

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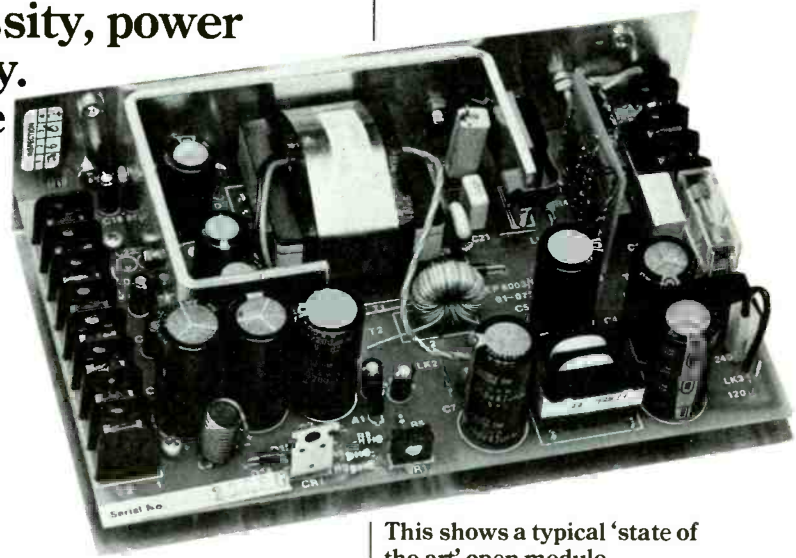
CIRCLE 29 FOR FURTHER DETAILS.

D.C. Supplies from A.C. Sources

by K. L. Smith Ph.D.*

Often regarded as a boring necessity, power supply design is changing rapidly. Rule-of-thumb design will not be enough for long.



This shows a typical 'state of the art' open module construction s.m.p.s. system. The EP6003 from Powerline Electronics Ltd is a 50 watt unit with multiple outputs which are futher regulated with linear circuits.

The universal mains distribution network of alternating current is rough stuff when considered as a power source for nearly all instrumentation, processing and communications equipment, the requirement for which is stable d.c. bias levels. Therefore all equipment entails a box (or corner of the rack, board, etc.) called 'the Power Pack', that changes the transformed a.c. to pulsating d.c., smooths and stabilizes it. The stabilization is against current or voltage variations to some degree or specification sufficient for the job in hand.

This Cinderella of all circuits is often bought-in, built up speedily from some standard design, or otherwise got out of the way as quickly as possible. Ubiquitous and important though it is if you want to run your apparatus from the a.c. mains, it nevertheless has a reputation of boring necessity.

* University of Kent at Canterbury

But a glance just under the surface of this boredom, reveals a slightly messy 'mystique' of poorly defined parameters such as *line regulation*, or rules of thumb and 'guesstimation' over things like the transformer design. On the other hand, judging from the number of power unit suppliers advertising, there is a good deal of bread and butter being earned in that industry.

The constructional magazines also carry articles on 'lab.' power supplies and so on, at regular intervals, so perhaps there exists a specialized band of power-pack enthusiasts — who, with an attitude like the 'Manhole-cover Collectors' don't find such things boring at all!

Two cultures

If you look a little closer, power supplies fall into two categories, (ignoring the very simple supplies like battery chargers, model-train controllers and similar). Firstly, the linear series or shunt stabilized supply is met, see Fig. 1. Secondly, the switched-mode power supply (s.m.p.s.) is seen, as in Fig. 2.

Linear supplies are notoriously inefficient — they get hot and tend to be bulky, especially at high powers. These supplies are geared to the technology of 50/60 Hz a.c. mains. Because of this, the need for bulky transformers and large CV products in the filtering capacitors is easily accounted for.

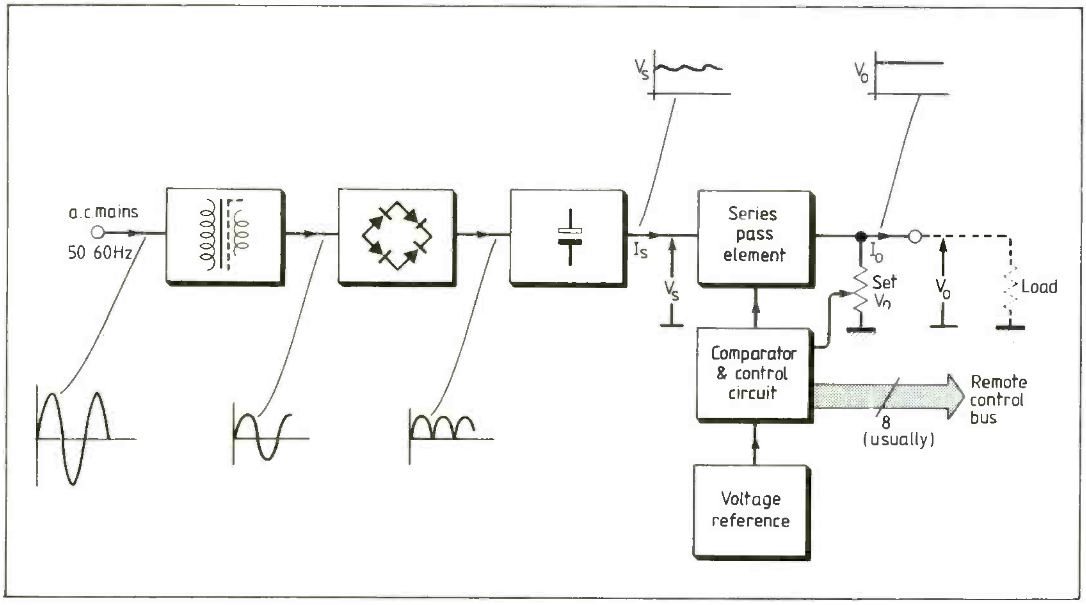


Fig. 1. The linearly stabilised d.c. power supply relies on the dissipation of excess power as heat, so that a constant output level can be maintained even if variations occur at the input. A typical design is schematically shown, including the growing use of a programming bus for automatic control and close-down.

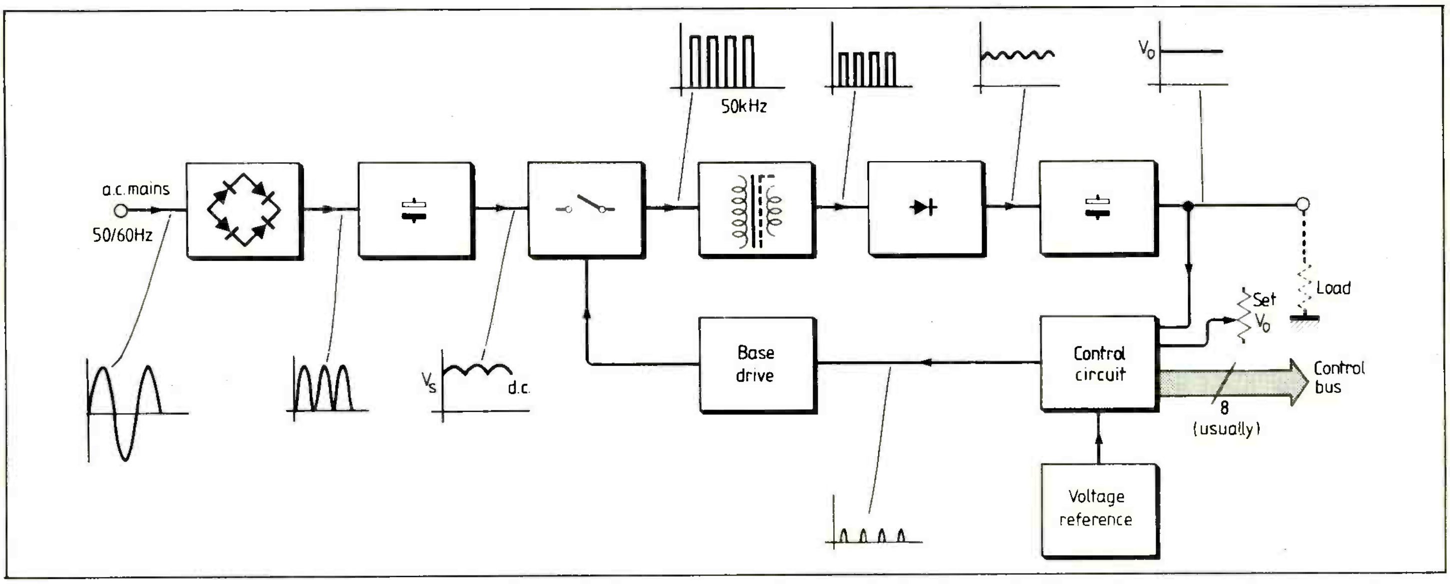


Fig. 2. **A switching system (s.m.p.s.) is shown here. Already it is obvious that greater complexity is likely in the design. Smaller components and much less heat dissipation is the trade-off. Again programming can be incorporated.**

Aircraft electrical designers opted for supply frequencies of 400 Hz, where the transformers are much smaller and lighter. However, in whatever environment these supplies are used, after all the energy has been handled and stored, a large part of it is thrown away in the series dissipator, so that the output voltage is kept constant in spite of changing levels at the power line input (line regulation). The same control circuit is used to sense load changes and by feedback, keeps the output voltage at the set level, (load regulation).

A series regulator device and its control circuit usually take very little of the current, so in Fig. 1, I_o is very nearly equal to I_s. You might want to set V_o anywhere between a low minimum to a fairly high maximum. V_s must be above this V_o(max). Therefore power into the regulator stage is V_sI_s which is very nearly equal to V_sI_o (being slightly greater if anything) and the power into the load is V_oI_o. The difference, $(V_s—V_o)I_o$ must be dissipated in the series element. So if you want a low output voltage at maximum current, your equipment is going to get a little warm...

Switchers, on the other hand, are potentially much more efficient. The principles are not new and many old time radiomen will recall the vibrator supplies used to convert the 12 or 24 volt d.c. lines available in vehicles, up to a few hundred volts. The mechanical vibrators that were used still operated at a low frequency, so the same arguments regarding transformers and capacitors still applied. But synchronous rectification on the vibrator eliminated hot and lossy valve rectifiers and the supplies ran relatively cool.

The growth of switchers had to wait until fast, bipolar, power transistors became available. Recently, even faster power mosfet devices have added new impetus — and s.m.p.s. technology appears to be sweeping the board. This seems to be relegating the linears to a shrinking market at the low-power (5 to 25 watt) end. Single-chip, monolithic, adjustable linear devices, such as the LM317, keep up the attraction for some turnover of designs at this low-power end, especially for experimenters and home constructors.

High frequencies reached in switchers mean that the inductive and capacitive components rapidly shrink in size for a given throughput of power. Significant power dissipation only occurs during the very short times at the edges of the rectangular switching waveform, where current flows in the switch at the same time as a high voltage appears across it.

Comparison of 'the two cultures' shows the effects of the principles involved.

	linear	switcher
output power	150 W	150 W
efficiency	30%	70%
power dissipated	350 W	64 W

The saving in space is equally impressive:

Volume	$26\,\mathrm{ml\,W^{-1}}$	$6.5\,\mathrm{ml\,W^{-1}}$
ratio of weights	5	1
ratio of area	3.5	1

Growth areas

Large inroads into the market by the s.m.p.s. people are occurring in the computer, telecommunications and data communications areas, especially in the new 32-bit micros, which overlap the old minicomputer systems. The new machines will hardly ever require more than 200 to 300 watts, even with power to Winchester disc drives, back-up cartridges, v.d.u. displays etc. Multi-output switchers can cope well at this power level.

Original-equipment manufacturers used to make 'in-house' p.s.us, but vast ranges of standard modules have appeared on the market and the attraction now is to buy-in. Some suppliers diversified into the market by developing their in-house supplies into a generalized range.

Rapid growth of local-area networks, word-processors, and the use of the Telex network — and all the growing awareness towards information technology in business networks and so on, have created this demand. By marketing a 'standard range', however, especially for business and office — to say nothing of home — environments, s.m.p.s. manufacturers have been pitchforked into meeting international standards requirements. S.m.p.s. are efficient, but the square waveforms necessarily employed in the high-frequency chopping circuits are especially rife with e.m.i. and r.f.i. problems from the harmonics generated. Typical requirements laid down for this appear in BS800, Part 3 (1972) and VDE0875, curve 'N', see Fig. 3. CISPR recommendation 43 (1970) and IEC478-3 is slightly more stringent, while FCC class 'A' is less so. Safety standards, set up generally before switchers came onto the scene, are particularly concerned with fire hazards (USA) and electric shock prevention (UK and Europe). The preoccu-

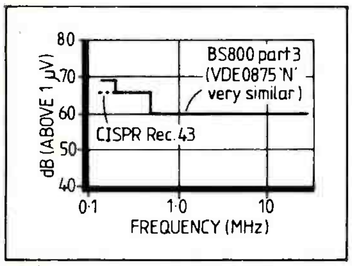


Fig. 3. **Limits to radio-frequency interference levels at the input to a power supply system, as laid down by the BSI and CISPR authorities.**

pation by us regarding shock is probably because of the use of 230 volts for the r.m.s. mains pressure used here.

These standards include ours, the British Standards Institute and the International Elektrotechnical Commission (IEC). Various BS specifications relate to transformers, BS2204 and BS5850, for example. Most vendors of s.m.p.s. modules find the user-market tied to demanding conformity to IEC380 and IEC435, where the 'creepage distance' of live conductors to dead metal and winding to windings must be at last 3mm. The insulation breakdown voltage (class 1) is 1250 V to earth and input-to-output isolation, 3750 V. Class 2 requires 3750 V to earth also. The Verband Deutscher Elektrotechniker (VDE) standards of West Germany are very similar to the IEC requirements and VDE0730 and 0840 apply to power supplies. Both IEC and VDE are advisory inasmuch as they carry no international legal weight, but manufacturers struggle to comply with them — and the competitive economic pressures accompanying the enterprise.

Andrew Smith of Weir Ltd told me that his firm's units are designed to meet the above specifications and he confirmed that the volume sales were in the data processing/microcomputing/telecommunications industries. Weir use linear post-regulation circuits (in which they have had a lot of experience with their well known 'mini...' and 'maxi-regs' and similar, lab. supplies) for switchers of less than 150 watts throughput, but they use switched post regulators in new designs above this rating. Bill Kerr (Power General Ltd) confirmed the market was now increasingly competitive and pointed out that in spite of the difficulties in meeting the safety specs. with the 'different' small components in s.m.ps, his company markets a 40 watt switcher on one Euroboard, a 47% reduction in size. He agreed that a blanket statement that power can be supplied at so much per watt, is not meaningful, since a 50 watt unit might cost \$27 to make, a 75 watt one \$30 and 100 watt \$34. The e.m.i. filters, transformer design, control circuit etc. would not differ much as the rating changes at this (low-end) region. Again, it was interesting to hear Alec Parsons of Amplicon Electronics more or less say the same thing.

The market

The figures given by forecasters Frost and Sullivan make interesting reading. The European market for s.m.ps in computer/peripheral applications is now 50% of the market at £500M with a mean annual growth expected to reach 23%. This means a turnover of £1.4 billion by 1988.

20% of the market is taken up by industry itself and is growing at about 21% per year. A rapid growth is appearing in the telecommunications field. 31% annual growth rate in this area is mentioned. The military market runs at 9% with a 21% growth rate, while the consumer end is only a small market at 3% (£30M) growing at 23% to reach a turnover of about £85M by 1988.

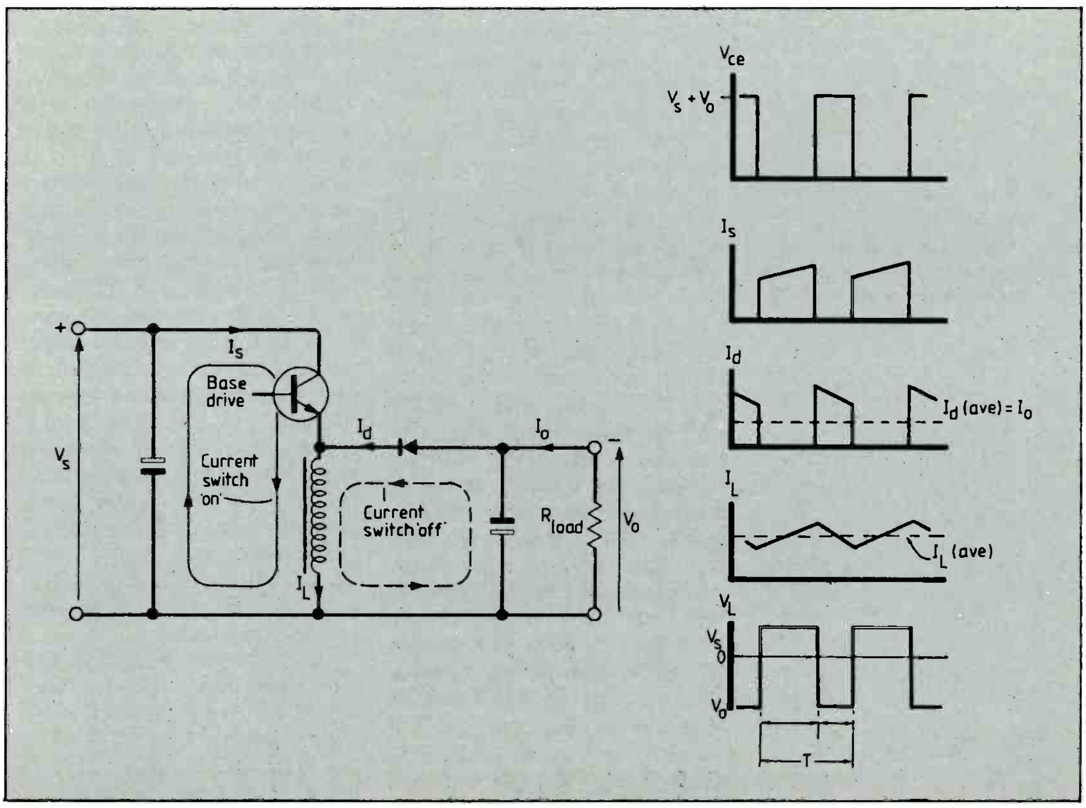
Options

Linear supplies operate on relatively simple principles, as I have outlined above. Switchers offer a number of options to the designer. Nearly all s.m.ps now employ a drive circuit, usually custom-designed integrated circuits such as the Mullard TDA2640 or the TDA2581, which offer slow start-up, over-voltage protection, off-load protection, short circuit protection as well as regulation and ripple cancellation. But in all s.m.ps designs, the fundamental choice is in how the stored energy is handled.

One approach is to use the so-called 'flyback' circuit. The energy is stored entirely in the magnetic field of a choke during the 'on' period of the switch and is emptied into the output reservoir capacitor (via the 'flywheel' diode) during the 'off' period. The pressure level reached by the quantity of electricity passed, is determined by the ratio of on to off periods. The output voltage V_o, can be greater than V_s, so some people have referred to the flyback circuit as a *boost regulator.* Further flexibility and multi-outputs can be obtained by making the choke into a transformer where turns ratios and a number of isolated windings can be used to generate separate voltages at convenient levels. This circuit is illustrated in Fig. 4.

Another circuit, see Fig. 5, known as the 'forward converter', passes energy directly to the output rails during the on period of the switch. Some energy is stored

Fig. 4. **The 'flyback' switching-mode circuit is shown in basic form. The energy stored in the choke is passed to the output while the bipolar switch is 'off'. The current paths shown this, and the associated waveforms highlight the current and voltage levels at various parts of the circuit.**



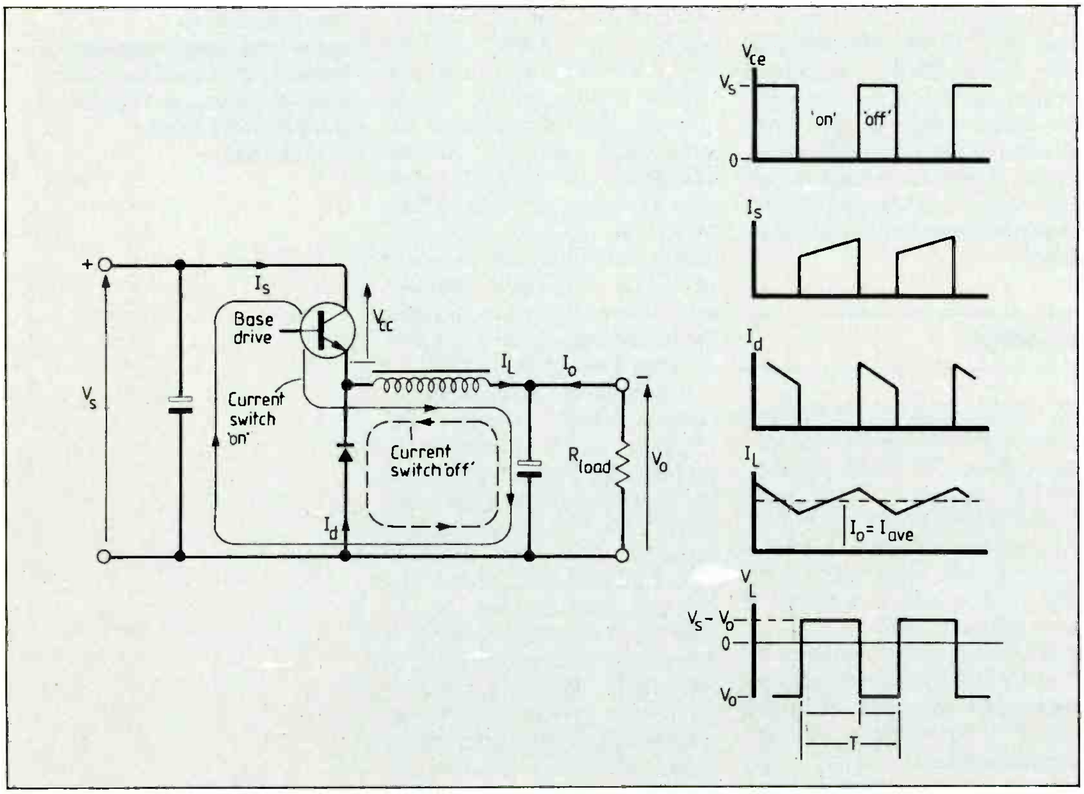


Fig. 5. **In the 'foward converter' switching circuit outlined, the current through the bipolar switch during the 'on' period is passed to the output in addition to storing energy in the choke. Current continues to flow (from the choke) while the switch is 'off'.**

in the choke to keep the output supplied during the off period via a steering diode. For the same throughput a smaller choke core is required for this circuit. The output voltage V_o, cannot exceed the input V_s. Some authors have called this circuit a *buck regulator.*

For large powers, energy is pumped into the transformer in both directions. In other words, true a.c. operation is used. Therefore, the largest flux swings from saturation to saturation* can be obtained by push-pull and bridge switching circuits.

In all the designs, minimum power dissipation is sought in the switches by tailoring the waveforms. Special low storage charge diodes are required for this, as well as correctly designed base-drive circuits for optimum switching in the bipolar devices. The problems of r.f.i. have already been mentioned and low-pass filters in the mains leads are vital to reduce conducted interference. Faraday screens between the transformer windings and around sensitive components, together with correct field cancelling layouts on the circuit board, are also required to reduce e.m.i. and r.f.i. The problems of smoothing of sawtooth current waveforms puts a strain on capacitor design. The series inductance and resistance of standard electrolytic capacitors has a large effect on residual ripple and noise voltages at the outputs. For low powers and very low ripple and noise levels at the outputs, linear supplies cannot be beaten. That is the main reason they hold their own there.

*The ferrite cored transformers in s.m.ps circuits could be 'loss-limited', rather than saturation limited in practice.

Specifications

Whatever the nature of the supply design, the user wants to know how it will perform. Specifications to be met may have been laid down beforehand: the power out is obvious and is given in terms of the regulated voltage range plus the maximum current drain. Supplies are designed to limit the current. The safest method is limiting by 'foldback: not only does the current limit, but it is 'turned down' to a low, safe level, as in Fig. 6. In switchers, you may find the 'hiccup' mode used if an overload occurs, the circuit turns off. After an interval it comes on — has a look, as it were; if the overload is still present, it immediately goes off again. The circuit might repeat this a few times, then go off permanently, until the fault is removed and the circuit reset.

The supply might be designed for a fairly long 'hold-up' time, where the energy stored is sufficient to keep up the output over a few cycles of lost mains input, (a common occurence, apparently).

There is always a requirement to know the quality of regulation obtainable. One of the most fundamental definitions of regulation can be seen as follows.

The output voltage V_o, is a function of the input voltage from the power line V_s, the output current demanded by the load I_o, and in many cases the temperature T.

$$\therefore \quad V_o = f(V_s, I_o, T)$$

$$\therefore \quad \Delta V_o = \frac{\delta V_o}{\delta V_s}\Delta V_s + \frac{\delta V_o}{\delta I_o}\Delta I_o + \frac{\delta V_o}{\delta T}\Delta T$$

You can read this as, 'The total change in V_o is the sum of how quickly V_0 changes with V_s, times the actual change in V_s; plus how quickly V_0 varies with load current I_o, times the amount the load changes; plus how quickly V_o varies with temperature, times the temperature change.' In the middle term on the right hand side, $\delta V_0/\delta I_0$ is a *load regulation factor.* You can see it can be thought of as the dynamic output impedance of the circuit. The first term factor is the output/input voltage change ratio, $\delta V_0/\delta V_s$, or *line regulation.* But defined in this simple way the value of the factor depends strongly on the levels of V_o and V_s. For example, if the mains voltage changes from 220 volts to 240 volts and V_o goes from 14.95 vols, then $\Delta V_0/\Delta V_s = 0.1/20 = 0.005$. But suppose the 'line' was the input to the actual regulator and this varied from 19.13 volts to 20.87 volts. Then $\Delta V_0/\Delta V_s = 0.1/1.74 = 0.057$... very different.

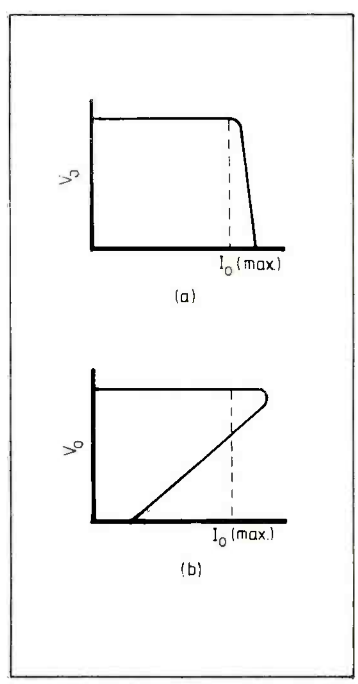


Fig. 6. **A simple current limit action is shown in (a), while that for 'foldback' action is illustrated in (b). In the foldback circuit, less power is dissipated during short circuit conditions.**

There are differences in agreement, but the industry broadly interprets and defines these regulation factors for its own use as follows:

Line regulation. This is the maximum change of output voltage in percent as the input voltage is varied from defined 'line high' to assumed 'line low' conditions. Output load and temperature are held constant.

This gives $[\frac{\Delta V_o}{V_o} \times 100] \div \frac{\Delta V_s}{V_s}$ for the line regulation. The earlier example now gives

$$\frac{0.1}{15} \times 100 \times \frac{230}{20} = 7.7\%$$

and $$\frac{0.1}{15} \times 100 \times \frac{20}{1.74} = 7.7\%$$

...a much more consistent, therefore useful result.

Load regulation is the maximum change of output voltage in percent as the load is changed from the maximum to minimum rated value. The input voltage is kept at the rated value, the temperature is constant.

This is given by $\Delta V_0/V_0 \Delta I_0 \times 100$, where ΔI_o is the maximum-to-minimum load current change.

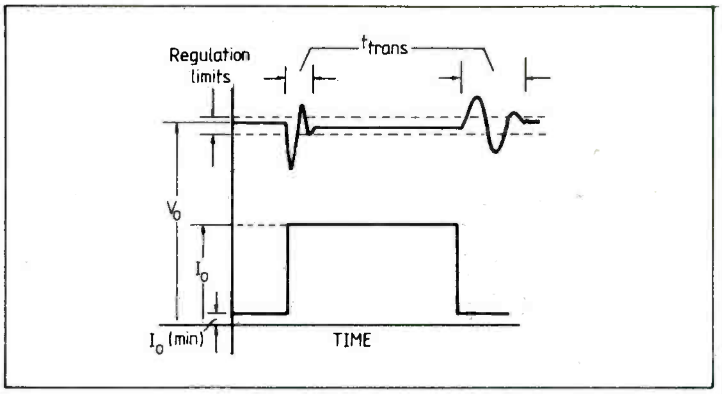


Fig. 7. **Controlled power sources cannot respond to rapid changes in load demand instantaneously. Like all servosystems there is an unstable — or settling — time required. The time required for an 'up' demand may differ from that necessary for a 'down' change.**

As an example, if V_o goes from 15 volts to 14.5 volts when ΔI_o is 10 amps, then

$$\frac{15 - 14.5}{15 \times 10} \times 100 = 0.33\%$$

which is the load regulation.

The temperature coefficient is the average change of output voltage per degree Centigrade, measured over the specified temperature range of the unit.

A parameter known as the *transient recovery time* is sometimes important, and is the required time for the output voltage to settle within the regulation limits after a sudden change in load is applied. Figure 7 shows the usual way this is portrayed. Linear supplies are much better in this respect than switchers. t_{trans} is some microseconds for linears, whereas it might be a few *milli*seconds for s.m.ps.

As in most situation where you rely on someone to supply something, 'you get what you pay for'. Of course, if you take mainstream economics out of it a little, you can custom a 'one off' for small expense, with a very good spec. I hope these articles therefore will not put off the home constructor, student — and engineer in her lunch hour... from having a go by direct construction.....

To be continued

R.S.C. r.f.i.

There has been a lot of fuss in the papers about the BBC's proposal to build a short-wave radio station near Stratford upon Avon. The locals seem largely to be against it; and had their objections been purely on aesthetic grounds, my sympathies would have been with them. But the debate seems to centre instead on the irretrievable damage the BBC's kilowatts may do to the Bard's reputation through disrupting the Royal Shakespeare Theatre's lighting and sound systems.

I can see that no-one would want Lillibullero bursting forth during the matinees there. However, as one who was brought up within sight of the BBC's Daventry station, and who now lives within a mile of the high-power television stations in south London (they keep our house wonderfully warm in winter), I'm finding it difficult to work up much sorrow for the thespians. They're lucky to have avoided r.f.i. troubles for so long: do they never get radio taxis outside?

But to free yourself of interference, you don't have to make your home on an uninhabited wasteland or in a Faraday cage. We veterans of the battle against video breakthrough known that it's largely a matter of wiring layout and filtering — in other words, of good design and construction practice.

Professionally-built theatre lighting and audio equipment should be capable of withstanding the sort of assault the BBC is likely to make on Stratford. And if the RST's stuff turns out not to be, then I may one day fill my pockets with disc ceramics and r.f.-stopping 1k resistors and wander up there to sort them out. In exchange for free seats, of course.

Multi-standard modem: correction

On page 46 of the July issue, Fig.1 shows two capacitors marked C_{36}. The one nearer transformer T_2 (2.2μF) should have been marked C_{35}.

Capacitor C_8 must be a class X mains-rated suppression type. C_{16} does not exist.

There is also a small mistake in the initial issues of the printed-circuit board for this project. The anode of D_5 has been wrongly linked to pin 10 of IC_{19} instead of to pin 11. This error, which would affect selection of the 75 baud loopback mode, can be easily corrected on side 1 of the board.

One of the telephone numbers given for STC Electronic Services' Estelle system, the number for the V.23 service is in any case not yet in operation. STC have said they will let us know the correct number as soon as it becomes available.

An autodialler program for the BBC Microcomputer, for use with the modem, will appear in next month's issue.

CIRCLE 15 FOR FURTHER DETAILS.

Stage Lighting System.

by Ian Kemp, M.A.

Forty 1kW circuits are remotely controlled. Computer memory stores scenes, and timed fades up or down are performed.

This project was conceived in order that the school where I teach might have a modern stage-lighting system for its plays and productions. The system was designed so that the pupils could take an active part in the design and construction of the various modules. In a previous system, switches controlled 18 circuits with four 1kW rheostat dimmers. For the new system, we needed:

- forty separate circuits, each capable of controlling 1kW;
- remote operation of the dimmers from the control desk with only a single cable linking the control desk and dimmers, which involved using a Z80 microprocessor to multiplex the information from the control desk;
- various stages of system redundancy, so that the project could be built in stages: as a result the lamps can still be operated even if there is a total failure of the electronics;
- scene storage and several other facilities. The whole thing was to cost no more than £1800, of which £1000 was for lamps and re-wiring.

The following terms are used in the article: *power box* refers to the enclosure containing all of the dimmers and the main a.c. supply; *scene* refers to a lighting arrangement; and *fader* refers to the variable controls on the control desk which determine the lamp brightness.

System functions

All the information for transmitting to the power box is stored in the computer memory as a scene. Each scene is numbered (with 2K of ram, 46 different scenes can be stored) and any scene can be transmitted to the power box. The master fader always controls the brightness of the lamps, whichever scene is being transmitted.

Any scene can be displayed on the v.d.u., independent of the scene being transmitted to the power box, and any scene can be set up either from the faders or the keyboard, again independent of the scene being transmitted to the power box.

Timed fades (both up and down) can be performed, ranging from a few seconds to several hours!

Different scenes can automatically be transmitted at a specified rate to the power box and/or the v.d.u. This enables the lamps to be flashed or switched in sequence to produce lightning, storm and disco effects automatically.

If the computer electronics fails, there is provision for the faders to be directly connected to the dimmers via a 50 way cable, and if there is a total failure of the electronics then each lamp can be controlled by switches on the power box.

The system is split into many sub-sections so that different pupils could be involved with the design and construction. There are two main sections: the control desk, which houses all of the controls and the microprocessor; and the power box, which houses the dimmers and control electronics. The various sub-sections can be seen in the block diagrams of the control desk and the power box, shown in Figs 1 and 2.

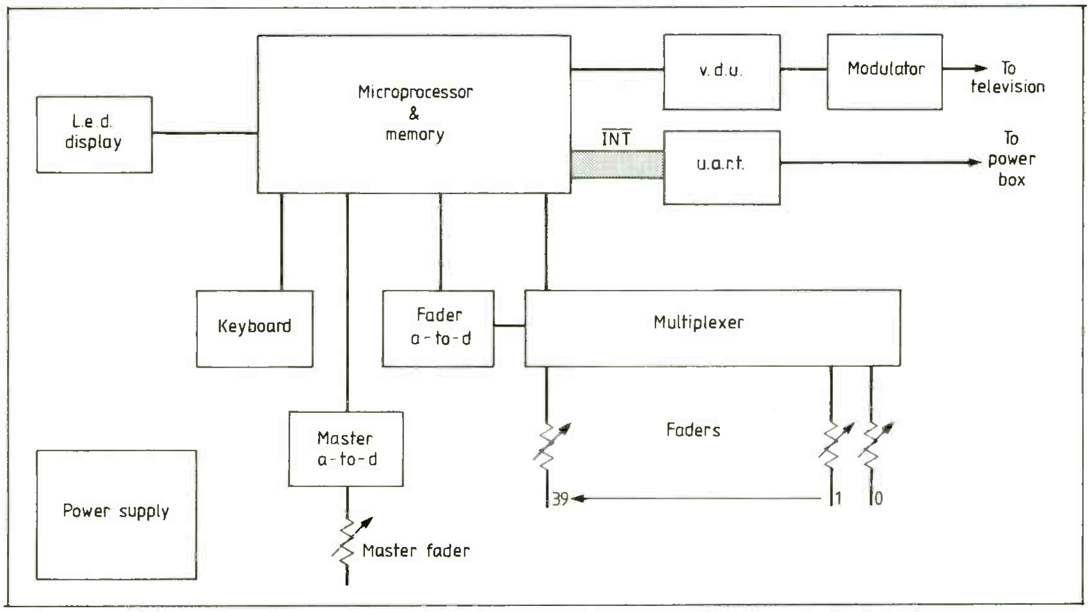
Dimmer circuit. This circuit, shown in Fig. 3, was inspired by a Texas Instruments application note. Forty of these were needed and so were to represent a large proportion of the total cost of the system. Ideally, each dimmer should have contained two high-current thyristors and a trigger transformer, but the cost was prohibitive. In fact, any commercially available trigger transformer was too expensive hence the decision to have the 0V line of the electronics connected to mains neutral. The triacs used were cheap, 400 volt, 8 amp. devices and none of these components have yet failed whilst in operation. Each triac is mounted on a heat sink of approximately 35cm^2 of aluminium fitted to a dimmer board.

The author

Ian Kemp graduated from Oxford University in 1976 with a degree in physics and spent the following year studying for a post-graduate Certificate in Education, his first teaching appointment being at Langley School, Solihull, where he formed a very active extra-curricular electronics club.

In 1980 Mr Kemp was appointed Head of Physics at Malvern Hall School, Solihull. The design of the lighting system began in 1981 and was completed in November 1983

Fig.1. **Control desk block diagram.**



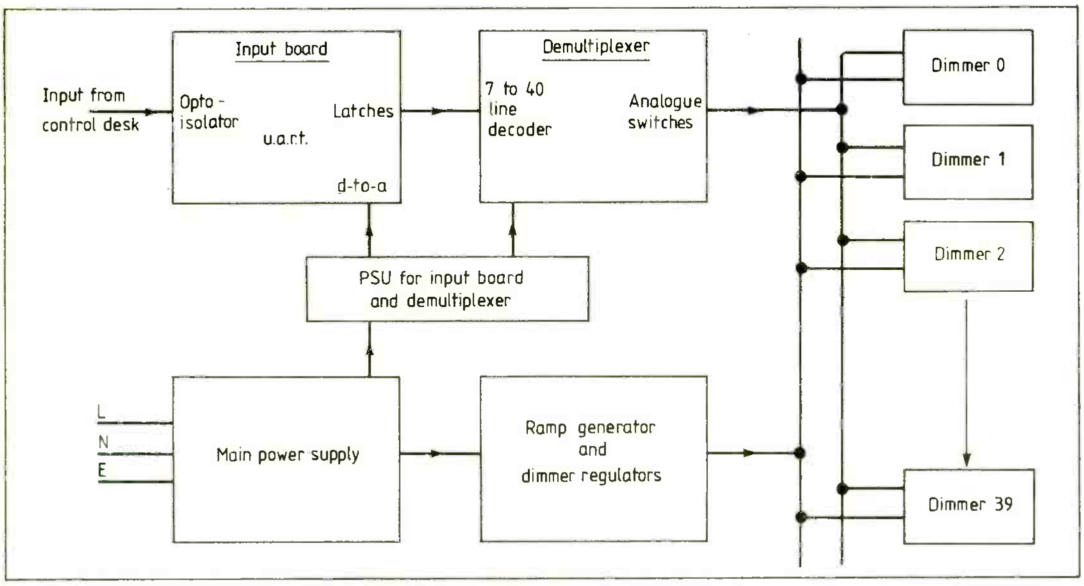


Fig. 2. **Block diagram of power box. Forty identical dimmer circuits are used.**

Fig. 3. **One of forty dimmers, based on a TI design.**

Each dimmer is updated with information approximately every 100ms. This meant that each dimmer needed a memory to retain the brightness information between refresh cycles, which is provided by a 0.1μF capacitor and a TL081 voltage follower. The associated resistors and 8V2 Zener diode provide protection to the TL081. Although only needed to retain information for 100ms, these analogue memories are quite stable for several minutes. The output from the voltage follower, 0 to +6V, is fed to a summing amplifier, the 741. The ramp input (see ramp generator description) varies linearly from —6 vols to 0 volts in 10ms (mains frequency synchronized) and then resets to —6 volts again. When the inverting input of the 741 is positive, the op-amp is free to oscillate, its output being amplified by the 2N3703 and fed to the gate of the triac via the 0.1μF capacitor. The continuous oscillations during the conduction time of the triac ensures that it reliably triggers and remains conducting.

Two power-supply lines, plus and minus 12 volts, are fed through 220Ω resistors, to ensure that if there is a fault on any dimmer board it should not disturb any of the other dimmers. The same also applies to the —20 volt supply line which passes through a 1KΩ resistor.

Radio-frequency interference suppression is aided by inductors in series with the lamps, which are 1¼in diameter toroids supplied by Telcom Metal Industries (code number CM630) for r.f.i. suppression in such circuits. Further suppression is obtained by the 0.01μF capacitors across the lamp circuit.

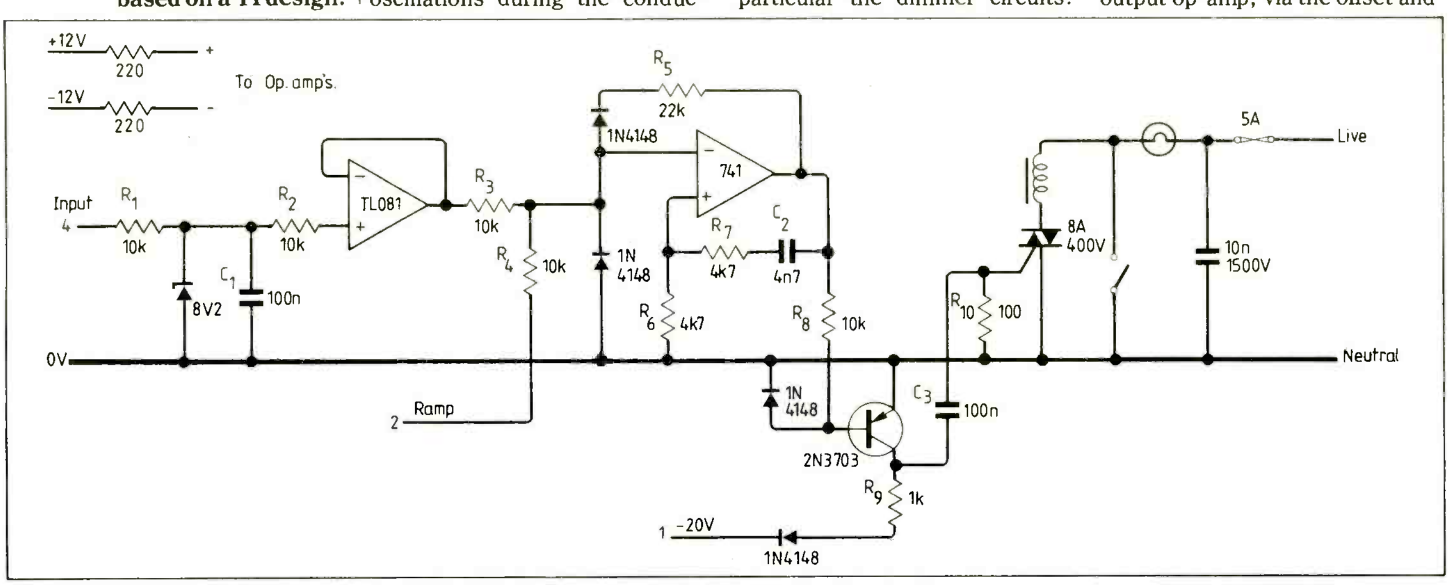
Power box power supply. During the development of the lighting system, a component failure in the power supply led to some damage to other sub-sections, in particular the dimmer circuits. The power supply was therefore redesigned and as many precautions as possible were taken to ensure that, if a similar fault developed, then any other damage caused would be minimized.

Each sub-section has its own regulators powered from the main power supply in Fig. 4, which provides plus and minus 20 volts. These supply lines are taken through 1N4002 diodes to further increase isolation for the various sub-sections.

The mains supply is taken directly from the 100A supply lines, via a switch and fuse. The filter, consisting of the inductor and two 0.01μF capacitors, was included to reduce noise on the mains due to the triacs. The inductor consists of 30 turns of 20 s.w.g. wire wound on a 1in diameter toroid.

Ramp generator and diameter regulators. The ramp generator provides an output waveform as shown in Fig. 6.

In Fig. 5, an a.c. from the power supply is full-wave rectified by the 1N4148 diodes and then fed to the first transistor, which conducts whenever the input voltage exceeds approximately 0.6V. The second transistor is switched off, enabling the integrator formed by the 741, 0.1μF capacitor and the 150k resistor to produce the ramp. When the input voltage to the first transistor falls below 0.6V, it switches off and makes the second transistor conduct, which short-circuits the integrating capacitor and so reduces the integrator output to zero. This process repeats every 10ms. The output goes to a 759, high-current-output op-amp, via the offset and



amplitude present potentiometer. Dimmer boards are mounted in two racks, each containing 20 circuits.

In the event of a dimmer-regulator failure forty dimmer circuits could suffer. The aim of the dimmer regulator circuit was to provide an 'indestructible' power supply: 500mA fuses protect the 1 amp regulators on the input and 3423 over-voltage i.cs on the output, feeding TIP3055s, which clamp the output. The use of the transistor rather than the usual arrangement of the thyristor is so that any voltage spikes are removed without the whole supply being terminated by the fuse blowing.

Power box input board. Since the 0V line of the power-box electronics is at mains neutral potential, the input from the control desk is fed via an opto-isolator, as in Fig7. The device used is rated at 2kV breakdown and so it does not matter if the control desk and power box are being operated from different mains supplies. Data is taken from the opto-isolator to the 6402 uart, which has a clock frequency of approximately 140kHz, and is crystal-controlled for stability (an ex-tv crystal being used and a divide-by-32 counter).

Master reset of the uart is provided at switch on by the 1MΩ resistor and 0.47μF capacitor connected to the MR terminal. The data outputs, D_0 to D_6, are connected to the lamp number latches, consisting of the first two 4042s, and also to the input buffer of the ZN428 d/a convertor. D_7 is used to determine whether a lamp number or a brightness has been received. Brightness is in the range 00H to 7FH and lamp numbers in the range 80H to FFH.

On receipt (DR=1) of a lamp number (D_7=1), a pulse is produced to store the number in the lamp number latch. The bistable, consisting of a 4011, is set and a pulse is generated which resets the uart (DRR=0). The next information to be received should be a brightness (D_7=0), and pulses are produced which store the brightness in the d/a convertor, the information in the lamp number latch is transferred to the output latch which consists of two more 4042s, the bistable is reset and the uart is reset.

The logic is such that whenever a lamp number is received it is stored in the lamp number latch. If a brightness is received and the previous data received was also a brightness (due to a received error) then the data is ignored and the uart is reset. The uart is also reset if any received errors (parity, overflow or framing) are detected.

All of these i.cs operate from +5V, but the demultiplexer operates from +12V, so that a control voltage of 0 to 6 volts can be used for the dimmers. It is therefore necessary to change the logic levels, by means of a ULN2003 Darlington driver i.c. The output from the d/a is amplified by the

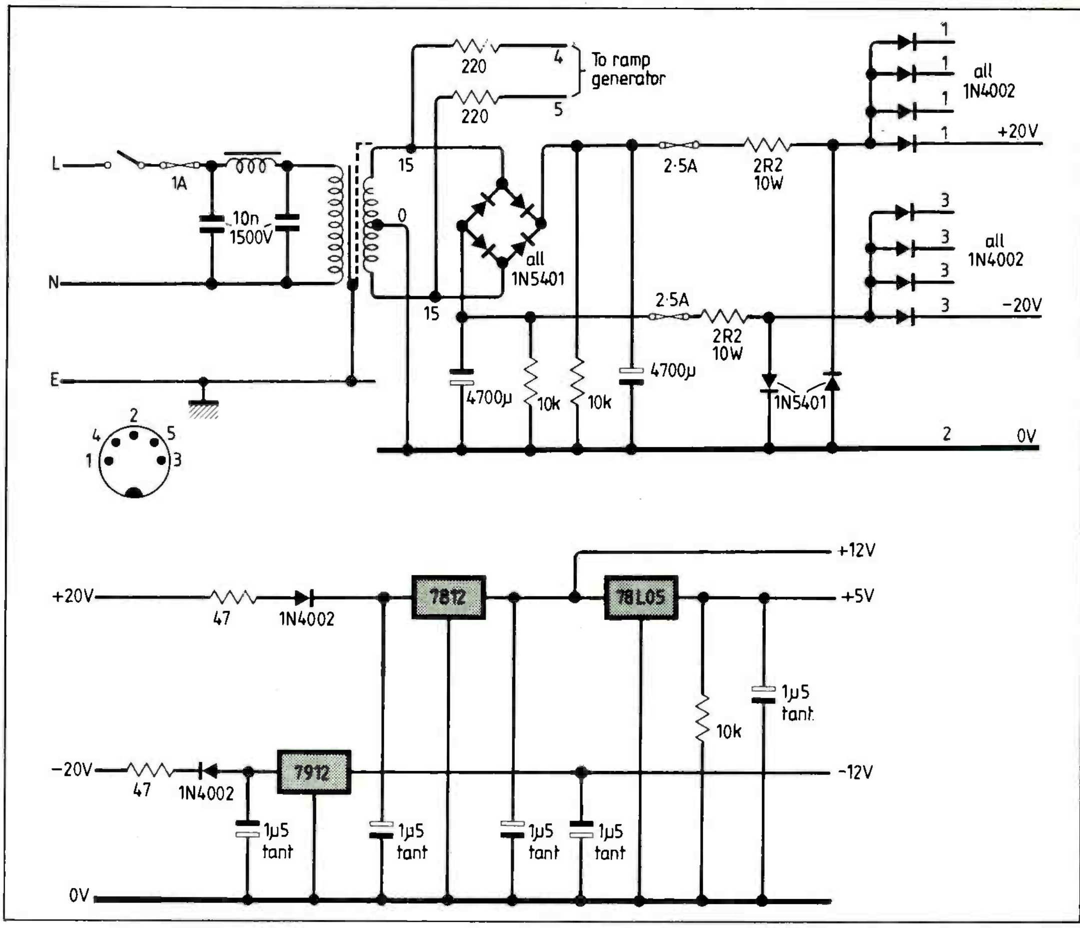


Fig.4. **Power box power supply, supplying voltage regulators in each sub-section.**

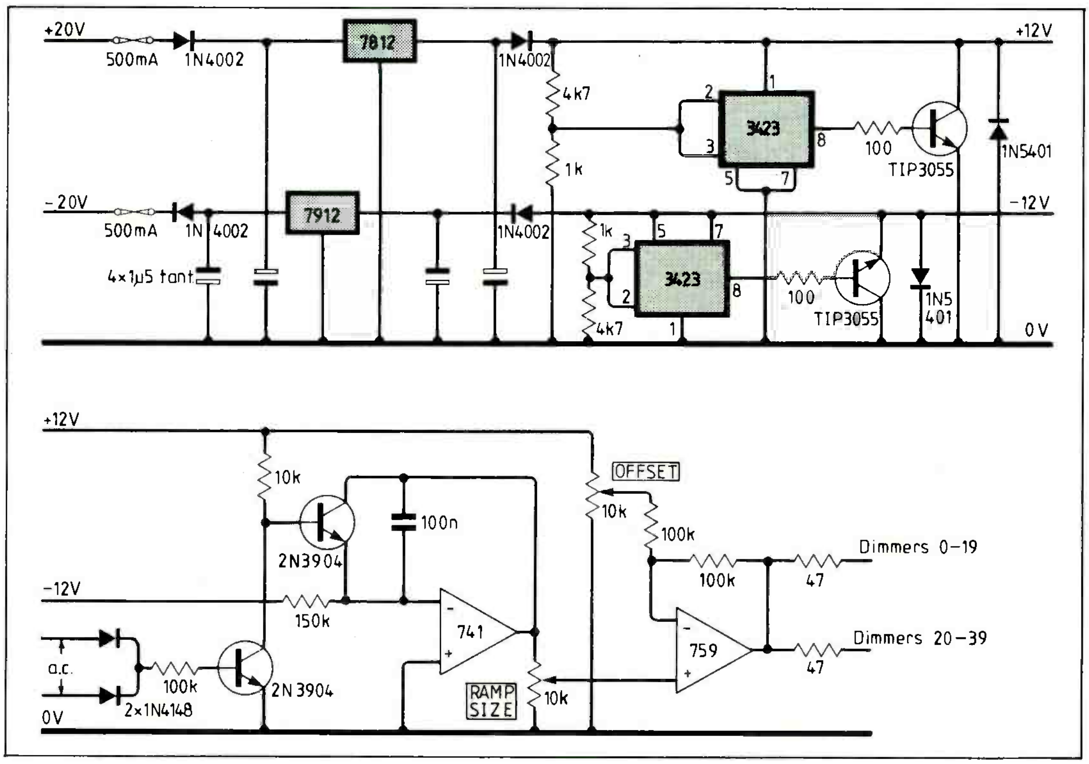


Fig.5. **Ramp generator and dimmer regulators, which feed all forty dimmers.**

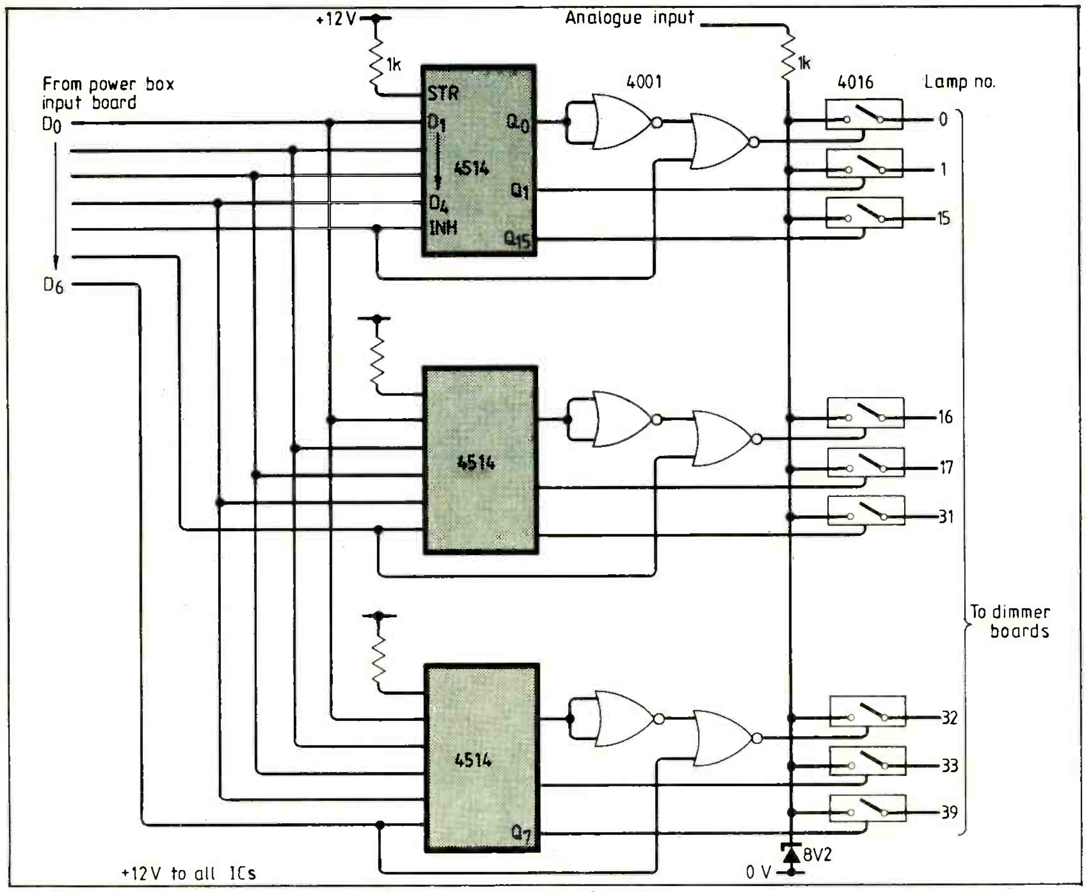


Fig.8. **Demultiplexer in power box.**

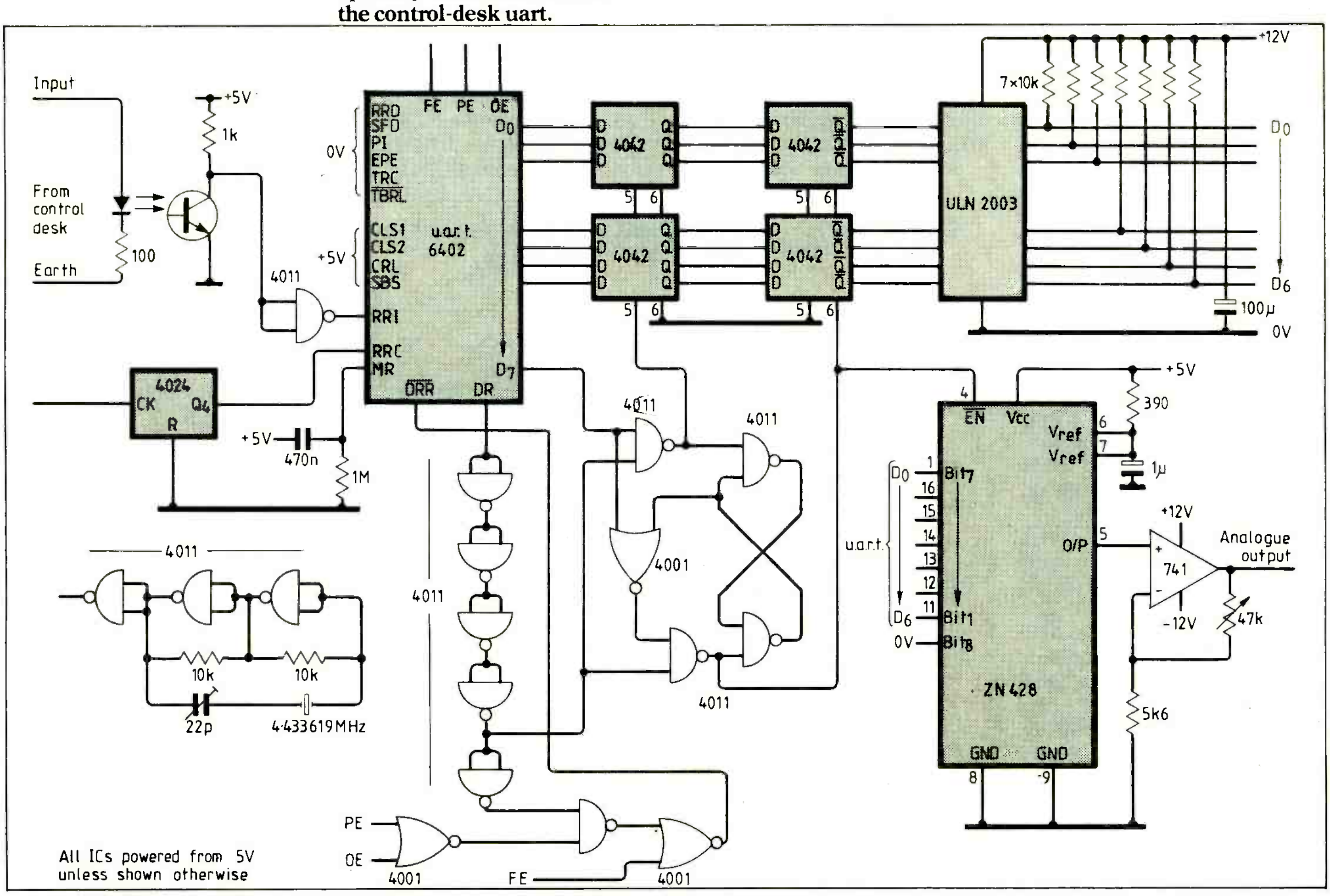
Fig.7. **Input board of power box, taking an optically-isolated feed from the control-desk uart.**

741 to give an output in the range 0 to 6V.

Power box demultiplexer. Demultiplexing is achieved by the circuit of Fig. 8, using a 7 line to 40 line decoder consisting of three 4514 i.cs and forty analogue switches (4016). Lamp numbers 0-15 are decoded by the first 4514, the numbers being transmitted as EOH-EFH. Lamp numbers 16-31 are decoded by the second 4514, the numbers being transmitted as DOH—DFH. Lamp numbers 32—39 are recorded by the third 4514, the numbers being transmitted as BOH—B7H.

The analogue input to the 4016s is fed via a 1k resistor and a 8V2 zener to ensure that the input will not cause any damage to the analogue switches if it deviates from its normal operating range. Each demultiplexed output is fed to the appropriate dimmer.

If it is requied to operate the dimmers directly from the faders then the demultiplexer is disconnected from the dimmers and the dimmer inputs are connected to a 50-way Type D connector for linking to the control desk.



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by J.H.Adams M.Sc.

Originally designed for SC84, but suitable for any application requiring a simple and economical power supply, this multi-rail switching unit is 90% efficient with high loads.

For computer use, the ideal power supply should have plenty of spare capacity for future expansion of the system, and run cool enough to be part of the general assembly. This unit was designed for the SC84 microcomputer but is suitable for any application where a high-efficiency fixed or variable-voltage p.s.u. is required. It provides plenty of spare capacity and runs cool, but it is also cheap and doesn't require a special transformer.

Ratings of the supply using components shown over and a 15-0-15V transformer are +5V at 5A, +12V at 2A and −12V at 750mA individually. It is designed to run from a standard transformer and is easily adapted to supply other voltages and currents (see SC84 application). At low loads, efficiency of the power regulators is 80%, rising to 90% at high loads.

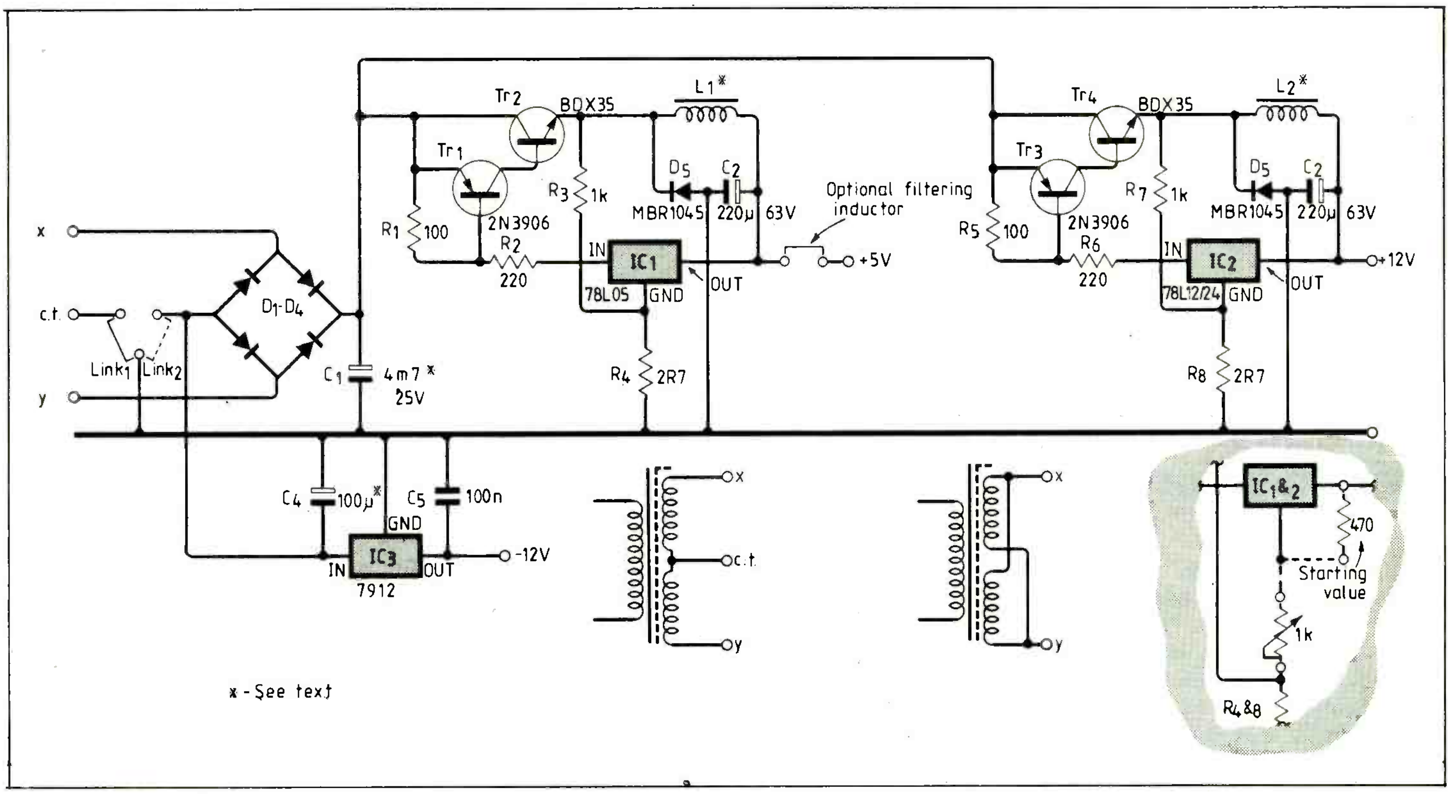
Supply design

One of the problems with conventional linear power regulators is that to cope with component tolerances, mains fluctuations, expansion needs, etc., while keeping the minimum input voltage to the regulator high enough for correct operation, mean input voltage to the regulator needs to be well above the minimum. This results in considerable heat dissipation in the regulator. A simplified design example for a linear regulator is shown separately. It is not difficult to see the problems associated with designing suitable circuits. What is more, to optimize performance a special mains transformer is needed to supply the right voltage from the right source impedance — a very special one if several voltages are required! My design consists of a rectifier, smoothing capacitor and two switching and one linear regulators. The linear regulator provides a low current negative supply but most of the regulation is done by the two switching circuits. Switching regulators do not provide such a smooth output, which is not very important in most computer circuits, but are very efficient regulators. They are more correctly called regulating power converters as their nature is to take in power and deliver it at alternative, regulated voltages and currents with efficiencies of up to 90%. They are cheaper than equivalent linear types, they do not require large heat sinks, fans and mounting paraphernalia, and allow a common supply with a single rectifier and smoothing capacitor to feed several regulators.

In a switching regulator, the transistor controlling load current operates in one of two highly efficient states — either fully on or fully off. Using the +5V section as an example, consider what happens when the circuit is switched on. Output capacitor C_2 is discharged so the linear regulator turns on and, as it draws current through R_2, turns Tr_1 and hence Tr_2 on. Voltage at the emitter of Tr_2 switches from zero to just less than the unregulated supply and so a steadily increasing current flows through the inductor, passing charge to output capacitor C_2 and the load, as well as storing magnetic energy in the inductor. When this voltage appears at the emitter of Tr_2, a small fraction of it appears at the common terminal of the regulator i.c. The regulator and pass transistor stay firmly on until the regulator is delivering 5V, i.e. load voltage reaches 5V plus this small fraction. At this point the regulator and pass transistor switch off — an act which is hastened by the positive feedback effect of the voltage at the common terminal falling to zero — and do not come back on again until output falls to +5V. At this point the regulator comes back on — speedily again, as its common terminal is pulled back up by the small fraction. During the off period, inductor flux collapses and the reverse e.m.f. generated biases the diode on so that even this energy is not wasted but is fed forward into the output capacitor and load.

Construction

One can see from this discussion that the ratio of R_3 to R_4 sets the amount of ripple on the 5V supply and that they, along with the values of the inductor and output capacitor, set the switching frequency. The frequency chosen is just supersonic so that magnetostriction effects in the inductor core are not heard. Inductors L_1 and L_2 are identical. Each consists of 18 turns of 1mm diameter polyurethane-coated copper wire wound as two layers on a Mullard RM10 core type LA4546, also available as RS Components part number 228-242. When winding the ends of the copper wire around the bobbin pins prior to soldering, take care not to flex the brittle bobbin. Leave between 5 and 10cm of wire free at each end of the coil so that when the wire is fed through the bobbin gap and wound around the pin, the length of wire between your finger and thumb and the point where the wire presses on the bobbin acts as a shock absorber. When you have half a turn wrapped around the base of a pin, cut away the rest and solder the wire directly. Do



The two switching sections of this regulated power supply are 90% efficient at high loads. Components shown and a 15-0-15V transformer provide +5V at 5A, +12V at 2A and −12V at 750mA but minor modifications give a wide range of output voltages and currents or variable output voltage. A Eurocard p.c.b. and kit of parts are available.

not attempt to strip the polyurethane prior to soldering, just keep the iron on the wire and pin and feed in solder. Surplus can be removed later and the bobbin itself appears to have a remarkably high melting point.

The transistor specified is a high-speed switching type selected for its transition frequency of about 50MHz, low collector-emitter saturation voltage and suitable current capability. The diode, a Schottky power type, is crucial to efficient operation of the regulator. An efficency figure of 90% is easily degraded to 70% or less (still better than the 30% for the linear version) by using an adequately rated conventional diode. Not only does the Schottky device offer a very low forward voltage drop when passing the very high currents which flow when the flux in the inductor collapses, but it switches off very quickly when the pass transistor comes on. This avoids the few microseconds of full conduction at full reverse applied voltage which would occur, degrading efficiency and the conventional diode's life expectancy.

There are, naturally, disadvantages to using switching regulators which tend to apply to their general use rather than to the SC84 power unit. It is difficult to protect this design against short-circuits. Fusing would not be fast enough to protect the circuits and, even if a circuit is added to shut down the regulator on a short, the regulator will be damaged when the short is removed due to the very high currents which would flow as the circuit attempts to build up the 5V supply again. This effect is due to saturation in the switching inductor. It does not occur at switch-on as supply to the regulator builds up relatively slowly; after a short circuit, the full voltage will already be present at the regulator input.

Circuits must be checked for shorts before being connected to the supply. Where short circuits might occur, connect a 1Ω power resistor in series with the supply. Failure in the power unit is less likely than with conventional circuits as its running temperature is lower and, should an external short circuit occur, the failure mode of the device tends to be to render the pass transistor or its driver open-circuit, switching off the supply.

There is a high frequency ripple at the regulator output due to the switching. Ripple magnitude is set by the ratio of two resistors and is at −40dB on the noisiest supply. Being at tens of kilohertz, what ripple remains is easily filtered should critical circuitry be added to the computer. Switching regulators radiate interference which can be significant if component layout is poor. In particular, as suggested in the way the circuit has been drawn, paths between the pass transistor emitter, the inductor, the Schottky diode and the output capacitor must be kept as short and as thick as possible. Careful selection of components is also necessary. Apart from those mentioned already, the capacitors should have as low an effective series resistance, (e.s.r.) as possible. Unfortunately, when manufacturers bother to quote e.s.r. they quote it at 100 or 120Hz. As e.s.r., as its name suggests, is not an actual resistance but an effect which can be modelled by a series resistance, this value is not a guide to the capacitor's performance at tens of kilohertz.

The design as shown uses a 15-0-15V transformer whose power rating will depend upon the load you intend to put on the power supply. An 80VA type is more than adequate for the SC84 computer. The linear regulator smoothing capacitor has an optimum value of 140μF per 100mA drawn, 100μF being a suitable initial value. Any higher value will just cost more and increase heat dissipation in the regulator. If the negative supply is not required, leave out the 79-series regulator and its associated capacitors and make link two instead of link one. Connect the two transformer windings in parallel to terminal x and y and leave c.t. unused to offer the maximum transformer power to the switchers. Different voltages may be obtained by simply changing the 78L-series regulator although an upper limit is set by the unsmoothed supply available to the regulator. A 15V transformer was chosen for this design as it allows a 25V smoothing capacitor to be used. If regulated outputs above 15V are required, as for an 8in drive, a 22-0-22V transformer will be suitable providing the smoothing capacitor is also uprated to at least 35V. When using a 78L24 with a 22-0-22V transformer, reduce R_6 to 10Ω. It is possible to make a variable voltage version of this supply, just as for the linear version, as shown in the inset diagram.

SC84 application

Power requirement for the basic SC84 computer, i.e. one using the three Eurocard modules described in the May, June and July issues of *E&WW*, is +5V at 1.5A for the logic i.cs and +12/-12V at 50mA for the RS232 interface and possibly a keyboard. One of these power units with a 15-0-15V, 80VA transformer could run the computer and a second one with an identical transformer could supply +5V at 4A and +12V at 3A for disc drives and a v.d.u. Alternatively, a 22-0-22V transformer and a different voltage regulator could supply +5V at 5A and 24V at 1.25A for an 8in disc drive. Efficiency of the unit is high. It runs cool enough to be built on Eurocard and mounted in a rack unit alongside the other computer boards without overheating risks.

Linear versus switching regulators

Take a linear 5V, 5A supply using a 78H05 regulator i.c. (minimum input 8V), a bridge rectifier and a 4700µF smoothing capacitor with a tolerance of —10 to +30%. The worst-case capacitor value is 4230µF from a smoothing point of view (maximum supply ripple) and 6110µF from a dissipation point of view (minimum supply ripple). Maximum peak-to-peak ripple voltage is 11.8V given by I/Cf where I is 5A, C is 4230µF and f is 100Hz. To maintain regulator voltage, peak unsmoothed voltage must be at last 19.8V (11.8V+8V). Allowing, optimistically, for mains fluctuations of 5%, the safe minimum is 20.8V.

If the capacitor is 6110µF, peak-to-peak ripple voltage is I/.611 so worst-case dissipation in the regulator, W, is given by multiplying current by peak supply minus mean ripple minus regulator output voltage.

$$W = I\times(20.8-(I/.611)/2-5).$$

So worst-case dissipation of 58W occurs when I is 5A, which means an efficiency of less than 30%.

The equivalent switching regulator dissipates only 4W. It draws approximately 1.5A from a 19V (mean) supply and so only requires a bridge circuit rated at 2A rather than 5A. The switching regulator requires a transformer rated at 32VA; volage is not too important. Assuming a 2V loss in the bridge rectifier, the linear regulator requires a 16.1V, 100VA transformer. Use an 18V one and worst-case regulator voltage rises to over 70W. Even with a nominal mains supply and smoothing capacitor, a perfect transformer and a load current of 2.5A, dissipation is over 30W and efficiency only 45%. No allowance has been made for transformer regulation or winding impedance. Non-ideal parameters will produce even more dissipation in the linear circuit.

Drilled and roller-tinned Eurocard form p.c.bs are £5 each including inland or overseas postage and v.a.t. from Combe Martin Electronics, King Street, Combe Martin, Devon EX4 0AD. A kit of parts (excluding transformer and p.c.b. but including terminal block) costs £20.50 including vat and UK postage from John Adams, 5 The Close, Radlett, Hertfordshire. Parts are available individually; send an s.a.e. and details of parts required to John Adams.

BOOKS

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Fundamentals of electromagnetic energy transfer

by Ivor Catt.*

Discussion of some weaknesses in the traditional approach to e.m. theory, and the establishment of a sounder foundation

The rise of digital electronics has highlighted weaknesses in our approach to the fundamentals of electromagnetic theory. This paper discusses some of the weaknesses and begins the building of a more sound approach at the fundamental level.

In the 1870s Oliver Heaviside, the father of digital electronics, worked with his brother Arthur to improve pulse signalling down a transmission line, using theory and experiment to improve the performance of the undersea telegraph line between Newcastle and Denmark. This practical experience gave him a mastery of electromagnetic theory which remained unequalled for a century. It led to his greatest achievement, the discovery of the concept of 'energy current'[1,2,3], which he himself undervalued, and never mentioned again after Hertz demonstrated the more glamourous wireless waves ten years later.

Ever since its advent in around 1900, wireless signalling has been regarded as a major advance. In fact, it stunted theoretical development. Wireless is a resonant, neo-steady state activity. It is far less central to the successful development of electromagnetic theory than its apparent primitive precursor, the TEM step or transient, travelling undistorted at the speed of light, guided by two conductors. The glamour, the magical nature of signalling without wires caused the suppression and then the loss of understanding of the mechanism by which a pulse travels at the speed of light from one logic gate to the next. In 1949, this suppression even made it possible for Albert Einstein to dismiss the very idea of a logic pulse as absurd!

> "...If I pursue a beam of light with the velocity c (velocity of light in a vacuum), I should observe such a beam of light as a spatially oscillatory electromagnetic field at rest. However, there seems to be no such thing, either on the basis of experience or according to Maxwell's equations." (ref.4)

A deep chasm developed between the post Einstein Community, who call themselves 'modern physics', and digital electronic engineering, the latter being based on the logic pulse which the former dismissed as absurd. (Within the 'modern physics' community, the only viable electromagnetic wave is the sine wave, whereas digital electronics is based on the pulse[3,5].

Einstein never read Heaviside, and Heaviside, although very interested in Einstein, lacked the information needed to grasp the nature of the gaffe Einstein had committed. Today, the chasm could be bridged if only professors of modern physics would look at high-speed logic pulse using a sampling oscilloscope[5]. They would then be forced to admit that, far from being absurd, Heaviside's slab of energy current exists.

> "Thus the whole slab moves bodily to the right at speed v, so that a moves to A and b moves to B in the time given by vt = aA or bB.
>
> "The disturbance transferred in this way constitutes a pure wave. It carries all its properties unchanged...
>
> "... For the slab may be of any depth and any strength, and there may be any number of slabs side by side behaving in the same way, all moving along independently and unchanged.
>
> "... Since every slab is independent of the rest, there need be no connection between the directions [= polarity, sign,] of E in one slab and the next. The direction may vary anyhow along the wave."[3]

Since Einstein went on to say that the false statement of his is the very basis of relativity, we can see why 'modern physics' contributes no help, but only confusion, to the work of computer designers.

Energy current

Whereas the conventional approach to electromagnetic theory is to concentrate on the electric current in wires, with some additional consideration of voltages between the wires, Heaviside concentrates primarily on what he calls 'energy current, this being the electromagnetic field which travels in the dielectric

Fig.1. **Theory N. Electric current is the cause.**

Fig.2. **Theory H. Energy current is the cause.**

Fig.3. **Trapped energy current.**

Fig.1.

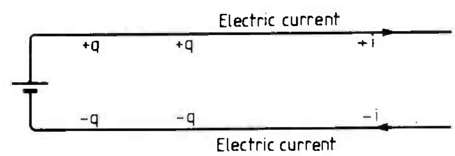
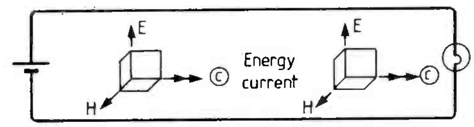


Fig.2.



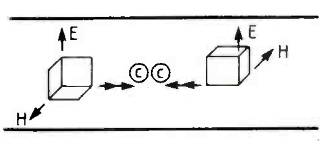


Fig.3.

*Watford College.

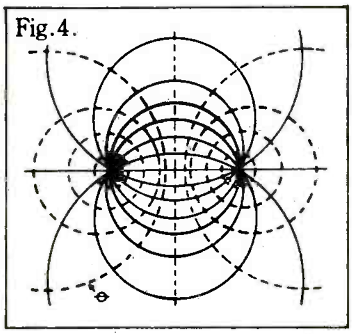


Fig.4. **Curvilinear squares.**

Fig.5. **The theories.**

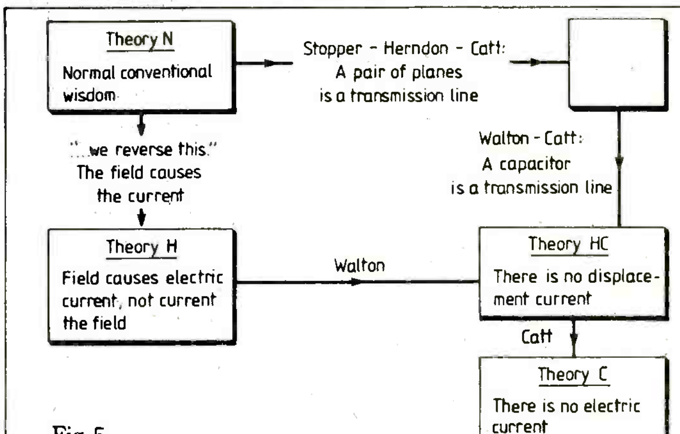


Fig.5.

between the wires. It has an amplitude equal to the Poynting Vector, E × H. Heaviside's phrase, "We reverse this"; points to the great watershed between the 'etherials' who with Heaviside believe that the signal is an 'energy current' which travels in the dielectric between the wires, and the 'practical electricians', who like Sprague believe that the signal is an electric current which travels down copper wires, and that if there is a 'field' in the space between the wires, this is only a result of what is happening in the conductors[1].

Oliver Heaviside announced Theory H a century ago[2].

> "Now in Maxwell's theory there is the potential energy of the displacement produced in the dielectric parts by the electric force, and there is a kinetic or magnetic energy of the magnetic induction due to the magnetic force in all parts of the field, including the conducting parts. They are supposed to be set up by the current in the wire. We reverse this; the current in the wire is set up by the energy transmitted through the medium around it..."

The importance of Heaviside's phrase, "We reverse this", cannot be overstated. (See Fig. 1, Fig. 2.) It points to the great watershed between the 'practical electricians'[7,8], who have held sway for the last half century, promulgating their theory — which we shall call 'Theory N', the Normal theory: that the cause is electric currents in wires and electromagnetic fields are merely an effect — and the 'etherials', who believe what we shall call 'Theory H': that the travelling field is the cause, and electric currents are merely an effect of this field.

The 'energy current' approach, Theory H, is much the more helpful approach for the digital designer. The car battery delivers energy which is guided between the 0V and +12V lines, to the car headlight. The electromagnetic energy travels down through the dielectric at the speed of light.* When the energy reaches the lamp, it penetrates into the filament, is absorbed and converted.

If the car lamp is removed, the energy current reflects at the resulting open circuit and returns back towards and into the battery, always travelling at the speed of light. This results in an endless dance of energy. The energy current continually flows from the battery at the speed of light; reflects at the open circuit to the right; and flows back into the battery, there to reflect back out again from the (left hand) far end of the battery plates and down between the wires for a second time.

In the resulting, apparently stationary, quiescent state, there is no mechanism for the energy current, which has been delivered into the dielectric between the wires at the speed of light, ever to slow down as it oscillates from end to end.

If the two wires are now suddenly cut at the middle, then energy current (conventionally thought to be electic charge) is trapped between the wires to the right. The energy is apparently stationary, but in fact is all moving at the speed of light. If these wires were very wide and close, we would have a conventional charged capacitor. At any moment, half of the energy trapped in a charged capacitor is moving to the right, and the other half if moving to the left. Using either theory N or H[8], the total current in each plate (or wire) is zero, so there are no i^2R losses, only dielectric leakage G losses, which would be zero in the case of a vacuum dielectric. Attempts to detect the magnetic field component of the energy current would be frustrated by the fact that the leftwards travelling energy current has a magnetic field component in the opposite direction to that of the rightwards travelling energy current[9,10] (Fig.3).

*The density of this energy at any point is equal to the product of the electric field D and the magnetic field B, which are always at right angles to each other and to the direction of energy flow. The flow rate of energy across unit area is E × H, which is called the Poynting Vector.

Nature of space and ether

A logic pulse is a TEM wave (Transverse Electromagnetic Wave), which means that both the electric field and the magnetic field are at right angles to the direction of propagation. Also, at every point, the electric field and the magnetic field are at right angles to each other. If the wires in Fig.2 are circular, the field pattern is as in Fig. 4.

The vertical E lines and the circular H lines divide the surface into what are called 'curvilinear squares' of equal width and height. Down one side of a square the electric potential drop is E and along the other side the magnetic potential drop is H. If the dielectric medium has permittivity and permeability μ then the ratio of E to H is $E/H = \sqrt{\mu/\epsilon}$, which in the case of a vacuum dielectric turns out to be 377 ohms. Further, the velocity of propagation of this energy current into the paper is equal to $1/\sqrt{\mu}$ which in the case of a vacuum turns out to be 300,000 km per second.

(It is noteworthy that Einstein himself and also the whole post-Einstein community who call themselves 'modern physics', never mention the impedance of free space $\sqrt{\mu/\epsilon}$, although it is one of the key primitives on which digital electronic engineering is based. The reader is encouraged to look for reference to it in the literature of modern physics.)

As energy current flows through one of the squares in the (vacuum) dielectric in Fig. 4, it is resisted in its attempt to proceed. This is necessary, because if energy is flowing through the square, work must be done. The $E \times H$ energy works against the impedance of the square surface, 377 ohms, as it passes through that surface. The resistance (impedance) of a square of vacuum is innate. Thus, empty space has the physical characteristic, impedance (resistance), a fact which has to be ignored in modern physics which conforms to the belief that empty space has no features. (It is remarkable that, while ignoring $\sqrt{\mu/\epsilon}$, modern physics can still make such play with velocity, $1/\sqrt{\mu\epsilon}$.)

In the world view of the digital electronic engineer, it is convenient to say that free space and the ether are synonymous. This includes the assertion that the ether exists; it is the something which resists the passage of energy and so, paradoxically, makes the passage of electromagnetic energy $E \times H$ possible. (It is impossible to give kinetic energy to a brick with zero mass. Similarly, it is impossible to deliver potential energy to a spring whose Young's Modulus is either zero or infinity. Energy may only enter a region when its entry is reasonably resisted — hence the need for free space to have an impedance (resistance),. if energy is to be able to enter it.)

Via a devious route, we have come to think that the fundamental primitives in a region of space are permittivity and permeability, ϵ and μ. However, when it comes to actually measuring anything, which mean measuring the impedance (of space) or the velocity (of space), we find that we always use ϵ and μ in combination in order to form velocity © or impedance Z_0. It seems clear that the latter two are more primitive, being more fundamental and also measureable, and ϵ and μ are merely subsidiary parameters lacking fundamental physical reality. To sum up; whereas it is usual to start with ϵ and μ and <u>derive</u> the impedance $Z = \sqrt{\mu/\epsilon}$ and velocity $\copyright = 1/\sqrt{\mu\epsilon}$, it is more correct to start with Z and ©, the directly measurable parameters of a region of space. Should we be so disposed, we could then derive ϵ and μ using the formulae $\epsilon = 1/Z\copyright$ and $\mu = Z/\copyright$. However, although being far divorced from physical reality, and μ remain useful instruments for use in calculation.

(A further advance which the reader might wisely ignore initially is made when we realise that length of a region of (single velocity) space and velocity of propagation through that region cannot be independently measured. All that we can measure is the <u>time delay</u> through that region. We should move to the idea of a segment of space being of length t, e.g. 1 n, rather than of length 1 foot[11].)

Theories

A number of different dualisms obtain within or in the vicinity of electromagnetic theory as it is developing. The student needs to be warned against thinking that only one dualism is involved, and that he is merely seeing different expressions of the same dualism. The mutually distinct dualisms include:

wave-particle dualism
Theory N — Theory H[8]
The Rolling Wave — The Heaviside signal[9]

It will be seen later that one of these is in fact a three-way split between Theory N, Theory H and Theory C.

Historical development. The transition from classical, wireless-based electromagnetic theory, loosely equivalent to Theory N[8], to one of the preferred theoretical positions for the digital electronic designer, Theory H or Theory C[8], is via a complex development shown in Fig. 5.

The capacitor

In the early 1960's I pioneered the inter-connection of high speed (1 ns) logic gates at Motorola, Phoenix, Arizona[12]. One of the problems to be solved was the nature of the voltage decoupling at a point given by two parallel voltage planes. I asked Bill Herndon about this problem, and he gave me the answer: "It's a transmission line"[13]. Bill learnt this from Stopper, whom I never met, who now works for Borroughs in Detroit.

The fact that parallel voltage planes, when entered at a point,

Fig.6.

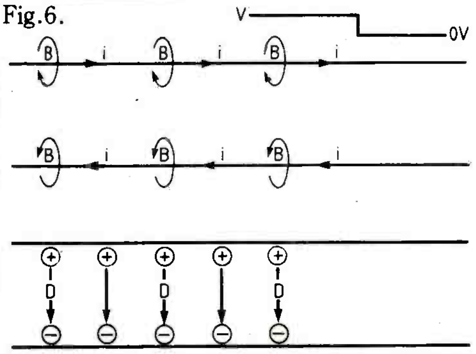


Fig.6. **Two voltage planes act as transmission line.**

Fig.7.

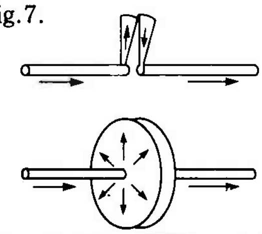


Fig.7. **Four factors in a TEM wave.**

present a resistive, not a reactive, impedance, was for me an important breakthrough. (It meant that as logic signal speeds increased, there would be no limitation presented by the problem of supplying +5V.). The reader should be able to grasp the reason why voltage plane decoupling is resistive by studying Fig. 6, which shows the effect of a segment only of two planes as they are seen from a point[14].

During the next ten years, with the help of Dr D.S. Walton, I gradually came to appreciate that, since a conventional capacitor was made up of two parallel voltage planes it also had a resistive, not a reactive (i.e. capacitive or inductive) source impedance when used to decouple the +5V supply to logic. Since the source impedance (= transmission line characteristic resistance) is well below one ohm, the transient current demand of logic gates approaching infinite speed can still be successfully satisfied with +5V from a standard capacitor of any type[15]. (The reason why the myth has developed that the worst (low capacitance, 'r.f.') capacitors are the best in this role is discussed elsewhere[16]).

The capacitor is an energy store, and when energy is injected, it enters the capacitor <u>sideways</u> at the point where the two leads are joined to the capacitor. Nothing ever traverses a capacitor from one plate to the other. This is clearly understood in the case of a transmission line. By definition, when a TEM wave travels down a transmission line,

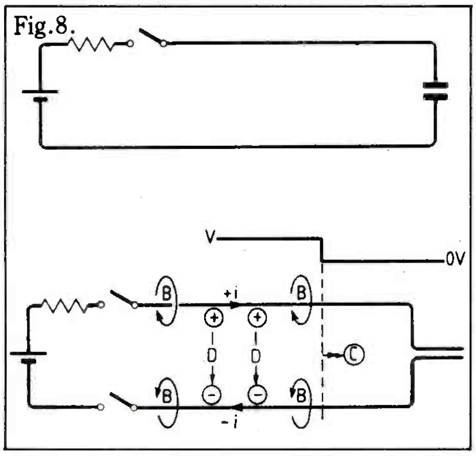


Fig.8. **The problem Maxwell faced.**

nothing travels sideways across the transmission line, or we would not have a transverse electromagetic wave.

Spring cleaning

"Then there were the remarkable researches of Faraday, the prince of experimentalists, on electrostatics and electrodynamics and the induction of currents ...The crowning achievement was reserved for the heaven-sent Maxwell, a man whose fame, great as it is now, has, comparatively speaking, yet to come"[17]

"Now, there are spots on the sun, and I see no good reason why the faults in Maxwell's treatise should be ignored. It is most objectionable to stereotype the work of a great man, apparently merely because of the great respect thereby induced..."[18]

"Heaviside, seventy years ago, missed the key point by a whisker. He failed, but he failed gloriously. He never discovered the flaw in the structure, displacement current."[19]

"Heaviside put together the main features of the new concept, but it took another century to put flesh on to the bare bones."[20]

"Closely related is Heaviside's concept of an electromagnetic wave, which in principle does not undulate, but only propagates itself. This concept leads to interesting insights which have not yet been fully realised. ...Many questions concerning this concept exist which, as Heaviside said, 'Have still to be worried about."[21]

The Catt anomaly

Until recently, the only flaws in classical electromagnetism were shown up by the new theoretical discoveries indicated in Fig.5. However, more recently, thanks to Dawe[22], I have been led to a flaw at a more simplistic level. We shall deal with this flaw, called the 'Catt Anomaly', first.

Traditionally, when a TEM step (i.e. a logic transition from low to high) travels through a vacuum from left to right, (Fig.7.), guided by two conductors (the signal line and the 0V lines), there are four factors which make up the wave:

electric current in the conductors;

magnetic field, or flux, surrounding the conductors;

electric charge on the surface of the conductors;

electric field, or flux, in the vacuum terminating on the charge.

The key to grasping the anomaly is to concentrate on the electric charge on the bottom conductor.

During the next 1 nanasecond, the step advances one foot to the right. During this time, extra negative change appears on the surface of the bottom conductor in the next one foot length, to terminate the lines (tubes) of electric flux which now exist between the top (signal) conductor and the bottom (0V) conductor.

Where does this new charge come from? Not from the upper conductor, because by definition, displacement current is not the flow of real charge. Not from somewhere to the left, because such charge would have to travel at the speed of light in a vacuum. (This last sentence is what those "disciplined in the art" cannot grasp, although, paradoxically, it is obvious to the untutored mind.) A central feature of conventional theory is that the drift velocity of electric current is slower than the speed of light.

Displacement current and the TEM wave. The concept of the transmission line and the TEM wave came after Maxwell's time, so he could not use it to resolve the anomaly which dogged electromagnetic theory in the mid-nineteenth century. This anomaly arose from consideration of the performance of the capacitor in a closed electric circuit, which upset the techniques which have been developed to relate electric current to nearby magnetic field. These were the Biot-Savart Law, $H = \frac{i\,dl\,\sin\theta}{4\pi r^2}$ and Ampere's Rule, $\oint H dl = i$. To resolve the anomaly, Maxwell proposed that the build-up of electric flux $\epsilon\, dE/dt$ (i.e. dD/dt) across the plates of a capacitor behaved just like real electric current in that it generated magnetic flux nearby as per the Biot-Savart Law. However, the assumption underlying the anomaly which he purported to solve was as follows. In a closed circuit (Fig.8) comprising battery, resistor and capacitor, at the moment the switch is closed, electric current instantaneously flows in all parts of the circuit, including the capacitor.

Since Maxwell's time, we have learnt that there is no instantaneous action at a distance, and part of that body of knowledge is the TEM wave which travels at the speed of light. We, who follow in the wake of the telegraph equations and the development of the TEM wave in a transmission line, known that when we close the switch(es), (Fig.9.) the current and field move across from left to right at the speed of light. We also know that the capacitor is merely a change in the characteristic impedance of the transmission line, and that the wave front enters it sideways.

To be concluded

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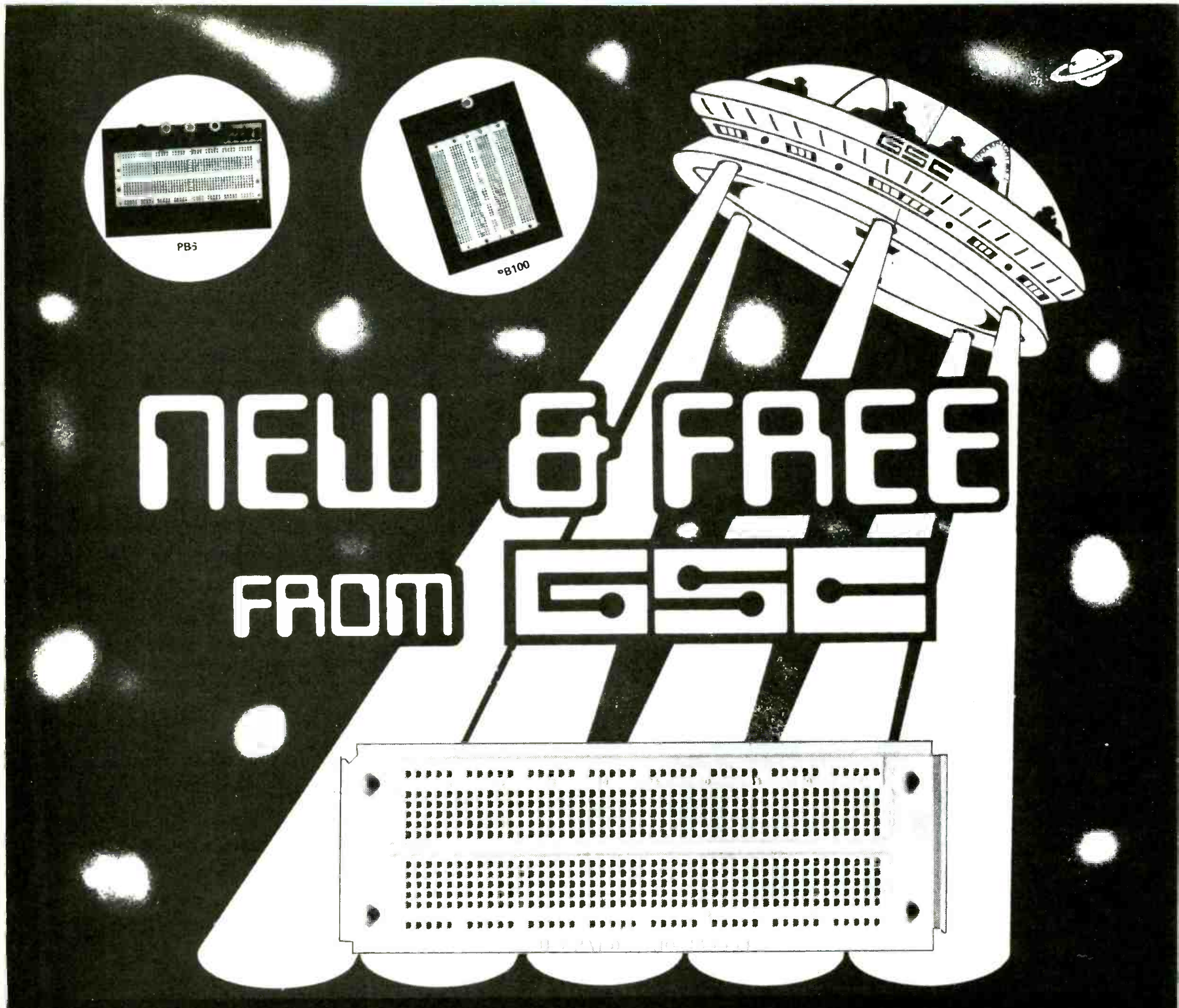

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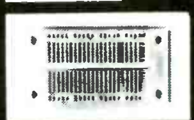

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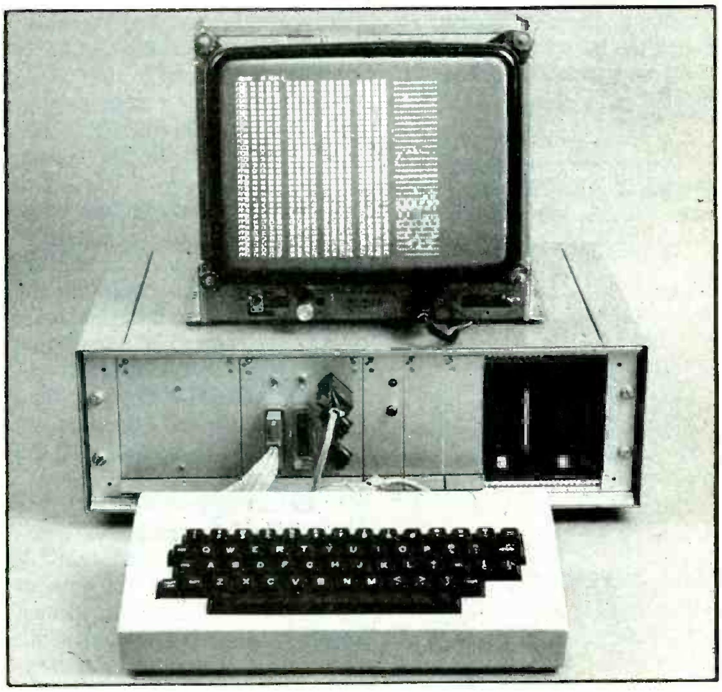
SC84 Micro–computer



These constructor's tips for SC84 — a professional Z80 microcomputer for engineers and enthusiasts described over the past three months — include notes on connecting various disc drives, and MCOS command syntax.

by J.H. Adams M.Sc.

The SC84 microcomputer has been designed as a series of Eurocards plugged into a common backplane and there are many suppliers of frames into which these cards may be fitted. The standard width for such frames is 19in with a capacity, to use the 'Euro measure', of 84E (1E is 0.2in). Vero produce narrower frames, down to 24E. ETL produce basic, but low-cost, 84E frames in plastic. For guidance, you should allow 6 or 7E for the power, v.d.u. and c.p.u. cards and from 12 to 24E for the i/o card, depending upon the number of connectors to be mounted on the front of the unit and assuming that recommended components are used. For a compact system, two 3.5in drives require 20E of space, two 5.25in drives 42E of space. I recommend wire-wrapping sockets together as a means of forming the backplane for the cards but, if the flexibility of wiring is not required — or for initial experimentation — long and short backplane p.c.bs are available from various sources.

To aid construction, a set of three printed-circuit boards and sets of components are available (details at end of article). I recommend use of these p.c.bs as the wiring can be critical — frequencies up to 36MHz being significant — and requires r.f. construction techniques.

With the exception of eproms, i.cs should not be socketed unless high quality sockets (e.g. turned-pin types) are used. By using cheap sockets you will be building in unreliability. In particular, dynamic memory i.cs $IC_{110-117}$ should be soldered in directly. Using sockets makes fault finding easier but may itself be the source of the trouble. General points to note are that 100nF decoupling capacitors should be mounted with as short leads as possible. Even a few extra millimetres of lead can lessen their decoupling efficiency — particularly with those between the dynamic memory i.cs. Crystals on the c.p.u. and i/o p.c.bs stand upright on the board and I recommend that a fillet of silicone rubber (not the acid-based type) is set around their bases to absorb vibration. The crystal on the v.d.u. board can be laid flat, a double-sided adhesive pad being a suitable anchoring device. Note that the crystal and e.p.r.o.m. on the board shown on the May issue front cover differ from those on the production processor board.

Since the processor board was designed, high-speed c.m.o.s. has become widely available and builders of the SC84, particularly those who intend using processors even faster than the Z80B, might like to use a 74HC04 for IC_{123}. The Z80 requires a clock signal which rises rapidly to at least 4.4V — it is not a normal t.t.l. signal. This is achieved in the original circuit by using a low-value pull-up resistor on the output of the 74S04 gate. This resistor, R_{103}, should be left out when using a 74HC04, as the cmos i.c. can more than meet the required signal specification, and R_{101} and R_{102} should be increased to 2.2kΩ. It may be necessary to connect a pull-up resistor to pin five of the 74HC04. The eprom supplied with the mos kit is a 2764. Although only 2Kbytes of the eprom are programmed, an 8Kbyte eprom is supplied to meet Z80B speed requirements. Theoretically, the eprom should be a 200ns device but the standard 250ns one will normally suffice. The philosophy behind this computer is that it is disc-based and as little rom software as possible should be used. Nevertheless, the 2764 gives scope for extra firmware and, as a 27128 may be used without any modifications — and a 27256 or 27512 with just a couple — the computer can easily be changed into a 'silicon system'.

It is only feasible to test individual boards by substitution in a working machine. The only reason for any of the protype units not working was that solder joints had been missed so it is worth inspecting the boards for unsoldered joints or solder bridges between adjacent points. The only shorts which are potentially dangerous are those to the supplies, so it is a good idea to check that supplies on the board only go where they should.

Power supply should be checked with a representative load to make sure that it performs correctly. Suitable loads are 47Ω, 4W resistors for the two 12V supplies and a 2.7Ω, 10W resistor for the +5V supply. It would be galling if a faulty power supply were to destroy working computer boards. To test the system, set

Table 1. Connections from i/o p.c.b. to female D-type connector for serial printer.

i/o p.c.b. pin	25-way D connector
1	7
2	5
3	3
4	2
5	20

SC84's processor, i/o and v.d.u. sections are described in the May, June and July issues of *E&WW* respectively. Addresses and prices for p.c.bs, the SciDOS CP/M compatible disc-operating system, Basic and the SC84 user group have been given. A power supply suitable for SC84 is described in this issue. John Adams, writer and supplier of SC84 software, can supply all parts for the three boards except t.t.l. i.cs, 64-way edge connectors and the disc-drive connector; John Hodson (SC84 User Group founder) can supply all t.t.l. parts and other hardware (excluding cases) at reasonable prices (stocks are limited). Their addresses are 5 The Close, Radlett, Hertfordshire and 12 Broughton Road, Basford, Newcastle-under-Lyme, Staffordshire ST5 0PQ, respectively. John Adams is also offering a repair service for SC84 modules built on p.c.bs from Combe Martin Electronics. Please send an s.a.e. and specify details required.

John Adams' next article describes SC84's machine-code operating system, MCOS.

Adresses of enclosure manufacturers mentioned are ETL Ltd, Unit G, Southhampton airport, Southampton SO2 2HG, and BICC-Vero Electonics Ltd, Unit 5, Industrial Estate, Flanders Rd, Head End, Southampton SO3 3LG.

the preset resistor on the processor board fully clockwise to its minimum, assemble the three boards and power supply, connect a monitor to the v.d.u. card and switch on. If the system works, the display will consist of 32 rows of 96 characters each. The lower 31 lines will consist of random characters and the top lines will be blank except for the word READY and a flashing cursor in the form of an underlining dash. If the screen is stable but there is no READY display, adjust the height control of the monitor, just in case the top line is off the top of the screen.

The display consists of 288 scan lines, each comprising a display period of 48μs, and should fit on a standard monitor without adjustment. If it doesn't, most displays have height and width controls (often on the tube neck) and horizontal shift may be achieved by adjusting the line hold. If the picture is rolling vertically or 'tearing' across the screen and cannot be held steady by adjustment of the hold controls, try altering S_{305} and/or S_{308} respectively as you may not be supplying correct sync. polarity. This should correct any synchronizing problems as the computer produces 625-line-compatible signals (624-line, actually). If the monitor is well out of adjustment it may be necessary to adjust both the vertical (frame) and horizontal (line) hold controls.

If nothing at all happens, try pressing and releasing the system reset button. If the system still doesn't work, check for unsoldered joints or a faulty backplane. Experience has shown that unsoldered joints are the prime cause of failure in these types of boards and that once these are rectified, it is very likely that the system will work first time. Apart from checking for the presence of supplies and short circuits there is little that can be done in the way of fault finding without an oscilloscope with a bandwidth of at least 10MHz.

A fault-finding service is available from me (only for systems built on E&WW p.c.bs) but for readers who can service the boards, first check the various oscillators and the devices they drive. After this, all bus signal should be inspected for signals not falling within the definitions of t.t.l. highs and lows, i.e. below 0.5V or above 2.4V. Note that this refers to signals; there will be periods when the data bus is in its third state and thus floating. Permanently floating lines may indicate an unsoldered joint. Lines sitting at the wrong levels will almost certainly be due to a short-circuit.

Readers who are new to microprocessor servicing should be wary of simple answers based on observations. If you have no screen display it doesn't necessarily mean that the fault is on the v.d.u. board. If the c.p.u. board is not working it will not load the c.r.t. controller with the information it needs to work properly. If the i/o board is faulty it may not be possible to access the v.d.u., access being controlled by a bit in the control port, IC_{205}. Do not waste too much time trying to define the fault from the current state of the system. If you know the system well you may get somewhere but it is more effective to work around the circuit repeatedly, accumulating evidence of simple, localized problems. Also note that low-capacity attenuating probes must be used with the oscilloscope and that what you see on the oscilloscope screen will not really be a true representation of the signals if their frequencies are more than one fifth of the oscilloscope bandwidth. Even then, the rise and fall times of the waves will be altered by the probe and the oscilloscope rise time. These points are not intended to be discouraging, merely to encourage realism. Experience has to be gained somewhere and if you have the time, fault finding is a good way of learning how the system works.

If the computer displays READY and the flashing cursor, the keyboard should be connected to the i/o board and the system switched on again. The keyboard strobe signal must be one that goes high when a key is pressed and stays there until it is released, and the 'echo' line must be connected or grounded. A sign of the strobe being wrong is that random characters will begin to fill the screen. If the echo line is high, only one character may be typed before the system freezes, waiting for the as yet non-existent printer to say that it is ready for an echoed character.

If it is possible to type in characters, press system reset and type LIST followed by a space and then 0000, i.e. the four letters, a space, then the four digits. The computer should now list an area of its memory, starting at address 0000, and then return to the READY state. If this occurs, connect a printer set for 9600 baud, eight-bit word, no parity and one stop-bit. The same listing operation may then be attempted with the echo line switched low. The printer should echo the listing which appears on the v.d.u. Note that the listing may not be as fast, or may pause before the screen is compeltely full as the computer paces the printer and its buffer capacity. Table 1 shows RS232C connections suitable for an Epson printer. These should suit other printers although it may be necessary to activate and/or interconnect other lines. For details refer to the printer manual.

All that remains is to connect the disc drives to the i/o board as described earlier. Many drives offer options. It would be impossible to describe all of the options available as they are different for each drive both in quantity and nature. Some drives (Canon, BASF) use jumpers to link pairs of pins, some (old DRE) use wire links that look like unmarked resistors. SC84 assumes what are generally the default settings of these links. The exception worth investigating is that most drives offer the option of loading the drive head whenever the drive is selected, or only when it is selected and another input line called Head Load, Radial Load or Option is active. Where possible, the second option should be used as although the system would work in the default mode, discs and the drive heads will last longer if the heads are loaded separately.

Some drives do not have a READY output, in which case wire the computer's READY input low. When using second-hand drives it is necessary to check the options with greater care as they may already have been altered for their original application. In particular, some 8in drives have an option link connected so that they use the two head-positioning control lines as 'step in' and 'step out' rather than as 'step' and 'direction'.

Many types of drive, new and second-hand, have been used with SC84 and with the Scientific Computer and the same problems have been faced and overcome due to the interface's inherent flexibility. Option details for various drives already used with SC84 appear in the users' group newsletter.

When more than one disc drive is used, the control cables are fed to one drive and then on to the next, all control and ground lines being wired in parallel. The drive will have some means of setting which drive-select signal it responds to. Once again, this varies from drive to drive but usually consists of an option area which connects one of the drive select pins on the drive interface connector to the drive electronics. Exceptions are Sony D31 and D32 drives where a four position slide switch does the selection. To use two drives set one switch to position two and the other to position three. A feature found on most drives (not Sony) is a pack of terminating resistors connected to the drive control lines. When more than one drive is to be used these resistor packs — usually in the form of a dil package — must be removed from all but the drive at the end of the interface cable.

When initially testing the disc drive(s) it is advisable to have the mechanism fully exposed so that its action can be observed. Apply power to the drive and computer. Set the switches on the i/o board for the type and density of disc used, insert a write-protected* SciDOS system disc in the drive selected by select-line one and type control S or control D (i.e. type S or D while holding down the key marked control or CTRL), depending on whether the disc is single or double density. Except for drives with mains motors — which should already be running — the drive motor should start. The head carriage in the drive should retract to the outermost position on the disc and the head should be loaded against the disc. In the mean time the computer will have cleared the display and should then load SciDOS from the disc and display '3.5in DOUBLE DENSITY DISC SYSTEM — Version 1.0A' or something similar on the top line of the v.d.u., followed by an 'A>' prompt. After about a second, the drive head is lifted from the disc and the drive stopped. If so, type the three letters DIR followed by the return key.

If the drive motors are running or the head is loaded before you type control S or D, press reset and try again. If you can, switch off the drive power and manually wind the head carriage towards the centre of the disc. This is quite simple with 8 and 5.25in drives and will ensure that you can observe any head motion. Apply power again, press reset and retype control D or S. If the head carriage doesn't move out as described earlier you may not be selecting the drive, either through an interface-wiring or option-selecting error. To force drive select, connect only one drive to the computer, temporarily ground all of its drive-select pins and repeat the operation. This will not harm the interface circuit as all its lines are open-collector types. With the drive forcibly selected thus, pressing system reset should make the head carriage move a short distance towards the outermost position, even if nothing else works. If not you should completely recheck the interface wiring for faults.

Use an oscilloscope to check that there is a short negative-going pulse on pin 19 of IC_{211} when system reset is pressed and released. If there isn't, trace this line to backplane line 16a. If the pulse is there, check IC_{211}, pin 21 for +5V, pin 24 for a 1 or 2MHz clock (depending upon the density, single or double, respectively) and then pin 15 and drive interface line 20 for up to 256 short pulses (positive going at the i.c., negative going on the interface) whenever system reset is operated. These pulses are part of IC_{211}'s reset procedure and should make the head of the selected drive step outward. The presence or absence of these pulses will give some guidance as to whether it is the i/o board, the interface cable or the drives which are not responding.

Once the disc reading function of the interface is confirmed by loading SciDOS, test disc writing by running the format program. To be on the safe side, when the program asks you on which drive code you want to format take out the system disc, even if it isn't the drive you intend using for the formatting operation, and insert a non write-protected blank disc in one of the drives then continue with the formatting operation (for fuller details, refer to the manual supplied with SciDOS). Once formatting is complete, press reset and type the three letters NEW followed by a space. This wipes the computer memory so that there is no chance of an undiscovered system bug reactivating the format program — which would otherwise still be in memory. Insert your system disc, load SciDOS as before, replace the system disc with the one you have just formatted and type the three letters DIR followed by the return key. If the message NOT FOUND appears within a second or two all is well as the system is reporting that it can read the disc directory but there is nothing in it — as one would expect with a newly formatted disc. If, after several seconds, a message beginning 'BDOS error' appears, you have a writing fault. To simulate the error message, try the DIR operation on an unformatted disc. Once you have a formatted disc, use the

Continued on page 63

MCOS operating syntax.

LIST <start address> lists 496 bytes of memory in hexadecimal form and in ascii starting from <start address>. Line format during list comprises the starting address of that line's code then the hexadecimal values of the contents of 16 consecutive memory locations starting at that address. At the end of the line the ascii representation of the 16 bytes is given, any bytes not in the normal ascii range (020 to 07E) being display as a period.

LOAD <start address> loads hexadecimal data into memory, starting at the specified address. LOAD formats the input code in the same way as that used during the LIST operation. If a mistake is made in entering a byte, the error may be corrected by completing the byte and then pressing DEL or DELETE. This decrements the memory pointer by one for each press as well as backspacing the cursor position to the peviously input data. Deletions attempting to place the cursor on a previous line of loaded code are processed by repeating that line's format on the current v.d.u. line. To exit from a LOAD, press the space bar.

ALT <address> <byte> alters the location specified to the given byte. After doing this it relists the memory area last listed. As you will have probably listed the area you are to alter before using ALT, the effect of this will be to re-display the same area with the alteration made. ALT re-enters itself to let you continue alterations. To terminate the ALT command use the soft reset or type any non-hexadecimal character — in which case MCOS will exit ALT and use this letter as the first of the next command.

FIND <bytes> searches the memory for the string of hex. bytes entered in the command line and lists the starting address of each occurrence. The maximum number of bytes is approximately 80, the string being terminated by pressing the ESC (or Control [) key.

MOD <start address> <end address> <to> <from> changes all occurrences of the byte <from> to the byte <to> over the memory range <start address> to <end address> —1.

FILL <address> fills memory from <address> to the end of the page in which <address> falls with the byte 0FF (a page being 256 locations sharing the same higher order address byte, e.g. 08900 to 089FF). FILL is usually used in clearing areas of memory to make code you are using stand out when listed or to prepare areas of memory which are not to be altered when you are preparing to partially program an eprom (programming 0FF into an eprom location has no effect upon that location).

NEW is an extension of FILL which fills the memory from address 00000 up to 0F7FF with byte 0FF and then rewrites the RST information. Used for similar purposes to FILL.

COMP <address 1> <address 2> compares on a byte-by-byte basis the two blocks of code starting at <address 1> and <address 2>. If any pair is found to differ, the address of the byte in block 1 is displayed. This command is terminated by a soft reset.

MOV <start address> <end address> <destination address> copies the block of code from <start address> up to <end address> —1 to the area of memory starting with <destination address>. Care must be taken in using MOV when the destination is within the block to be moved as this will result in replication rather than a clean block move as code is moved, moved again, moved again and so on. In fact this can be quite useful for creating large blocks of the same n bytes. If you need to move a block backwards, for example to insert an extra instruction, use BACK.

BACK <start address> <end address> <count byte> moves the block of code <start address> to <end address> —1 back <count byte> locations. A count of 00 corresponds to a move back of 256 locations which is the maximum possible in one BACK command.

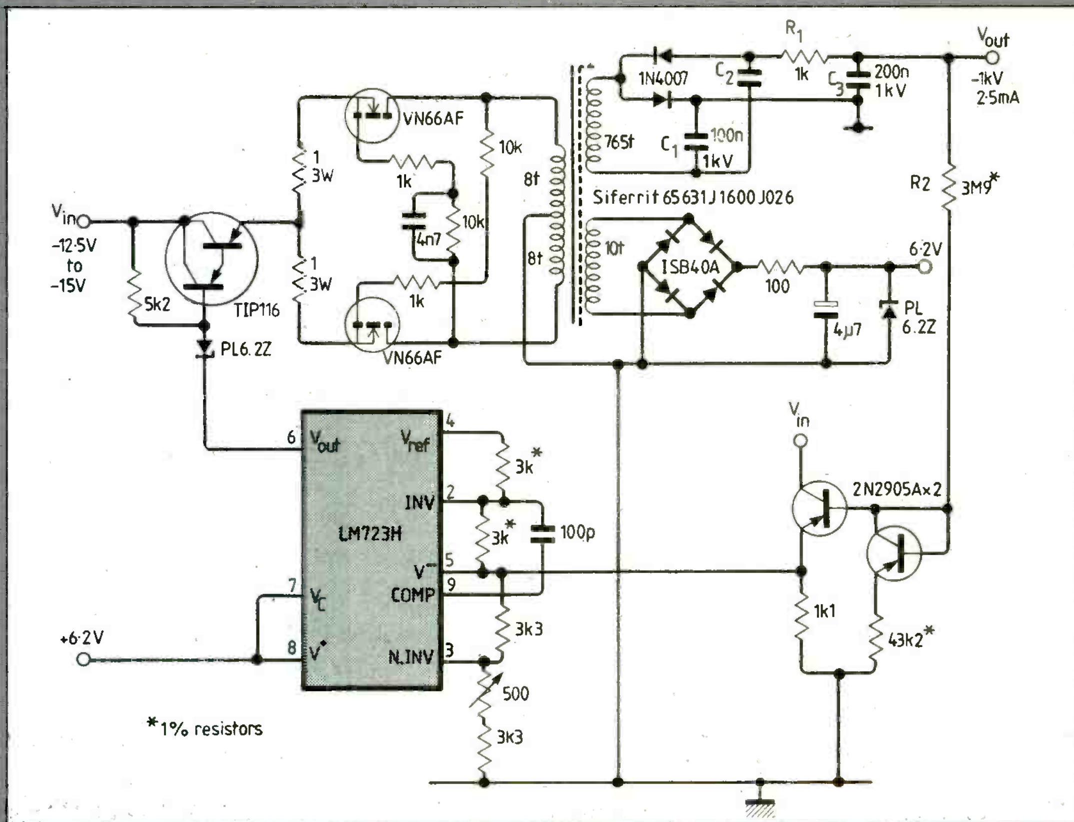
RUN <start address> begins execution at <start address>.

Press CTRL @ for soft reset.

Some readers have run into problems through using the wrong dynamic rams. These i.cs must be those specified on page 39 of the May issue. If in doubt, contact the author (address on previous page).

*Notch in the disc envelope covered for 5.25in, uncovered for 8in and window open on 3.5in discs.

DON'T WASTE GOOD IDEAS
We prefer circuit ideas with neat drawings and widely-spaced typescripts, but we would rather have scribbles on "the back of an envelope" than let good ideas be wasted. Submissions are judged on originality or usefulness — not excluding imaginative modifications to existing circuits so these points should be brought to the fore, preferably in the first sentence. Minimum payment of £30 is made for published circuits, normally early in the month following publication.



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Costing around £25, this high-voltage regulated power supply uses only low-voltage active components. We measured a 0.1% change in output voltage when varying output current between zero and 2.5mA. At full load (1000V, 2.5mA) with the Darlington and vmos transistors mounted on heat sinks, stability was better than 1% over a 10-hour period.

Buying a power supply for our vacuum photo-detector used in laser-experiments would have cost around £100.

Two vmos transistors and a pot-core transformer form an astable blocking oscillator operating at around 12kHz. The transformer's main secondary output voltage is doubled and then filtered by R_1 and C_3. A series-pass Darlington transistor controls supply to the oscillator. Its base is driven by an LM723H voltage-regulator i.c. connected in its negative-voltage configuration and fed by a 6.2V positive supply derived from a further secondary winding on the transformer. A potentiometer connected to this i.c. sets the output voltage.

Feedback from the high-impedance potential divider on the output is buffered by the left-hand 2N2905 transistor; the second 2905 compensates for temperature drift.

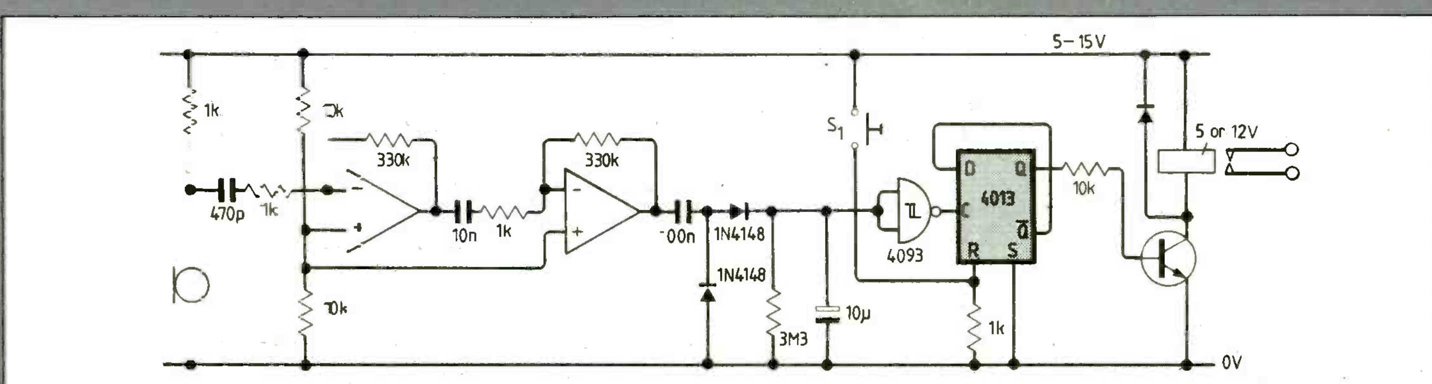
J.J. Meyer
ITODYS University
Paris
France

Cheap timing

Radios, tape recorders, heaters, etc., can be switched on at a precise time by the alarm output of cheap calculators and clocks with this acoustically coupled circuit. I have used the circuit for some time now to record BBC World Service programmes. Normally, the timer is used when the house is empty, but its filtering makes it tolerant of noise including background music and slamming doors.

A switch resets the D-type bistable i.c., the op-amps can be almost any type (if in doubt use the 741) and the microphone element is from Tandy.

Hans Wedemeyer
Vanse
Norway



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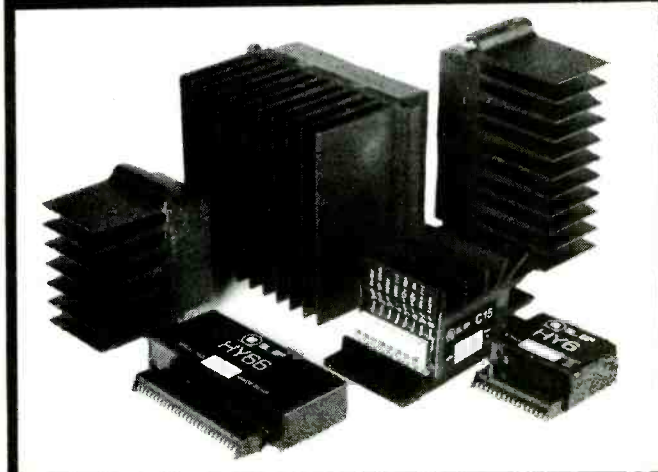

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HY128	60	8	£20.95
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Ideal for Disco's, public address and applications with complex loads (line transformers etc.). Integral Heatsink slew rate 20v/µs distortion less than 0.01%

Type	Output Power Watts (rms)	Load Impedance Ω	Price
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MOS248	120	4-8	£39.95
MOS364	180	4	£45.95

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PSU552	1 MOS248	£19.95
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The receiver is available in free standing or rack mounting form and all the original features are retained. The new am detector board achieves exceptionally low distortion: THD, 200Hz-6kHz at 90% modulation −44dB, 0.6% (originally −20dB, 10%). Reviewed Broadcast Sound, March/April 1984.

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CIRCLE 52 FOR FURTHER DETAILS.

Dynamic ram controller

Under normal conditions this high-speed dynamic-ram controller provides invisible refresh yet allows the rams to be used close to their minimum cycle time (320ns for 200ns devices). It does so by accessing and refreshing rams concurrently. Two 64Kbyte banks are shown but the circuit is expandable in 128Kbyte blocks. The controller works by dividing the memory into halves with separate refresh logic for even and odd memory locations (see p.58). When an even address is accessed by the processor, odd-address memory is refreshed, and vice versa.

Usually, the microprocessor accesses the memory almost sequentially and each memory driver executes refresh cycles for approximately 50% of the time. As long as 128 memory cycles are made for each memory driver in the time allowed for one complete refresh period of 1.536ms, extra refresh cycles are not required. This is so as long as a memory access is made once every 6µs on average, which most microprocessors are capable of, hence the microprocessor system normally sees the circuit as static memory; failing this, extra refresh cycles are requested.

Bus interfacing depends on the system used and details are not shown. Most of the signals used are common. At the beginning of a memory access ADDRESS STROBE goes low. This signal is given by the processor when the address is stable on the bus, and should be held low throughout the memory access (minimum 200ns). It should also be high for at least 120ns prior to each access. The controller sends out REFRESH REQUEST to halt the system while refresh cycles are carried out; normally, as mentioned, this should not happen. When the microprocessor is ready to allow these extra cycles it sends REFRESH GRANT to the controller. The 8MHz clock must be t.t.l. compatible but it need not be synchronous with the rest of the system.

Two inverters in the ADDRESS STROBE line, $IC_{4a,4b}$, cause a delay of about 30ns to form a select signal which multiplexes address lines A_{1-16} onto an eight-bit bus (M_{0-7}) through $IC_{6,7}$. Inverter IC_{4c} causes a further 15ns delay in the address strobe to produce a signal used by the memory drivers to form CAS. RAS is produced by $IC_{3b,4d,5c}$ either from the address strobe during a normal cycle or from the output of IC_1 during a refresh cycle.

The memory driver to be accessed is selected by $IC_{4e,4f,5a,5b}$ depending on the state of address line A_0. A normal memory access is executed by the selected memory driver, the multiplexed address M_{0-7} being applied to the dynamic rams through $IC_{13,14}$. During this period, the other memory driver executes a RAS-only refresh cycle, the refresh address being provided by IC_{12} and selected by $IC_{13,14}$.

If the memory driver has not executed 128 refresh cycles during the last 1.5ms, a refresh-request signal is produced by $IC_{9,10a,10b,11}$. Refresh request signals from the two drivers are combined in IC_{3a}. The incoming REFRESH GRANT signal is synchronized with the beginning of a refresh cycle by IC_{2a} then IC_1 provides a RAS signal while the memory drivers are not selected so that each executes refresh cycles until the memory driver requesting refresh is satisfied.

Memory capacity is increased in 128Kbyte blocks by decoding the CAS signal within each memory driver using the higher order address bits (A_{17} upwards).

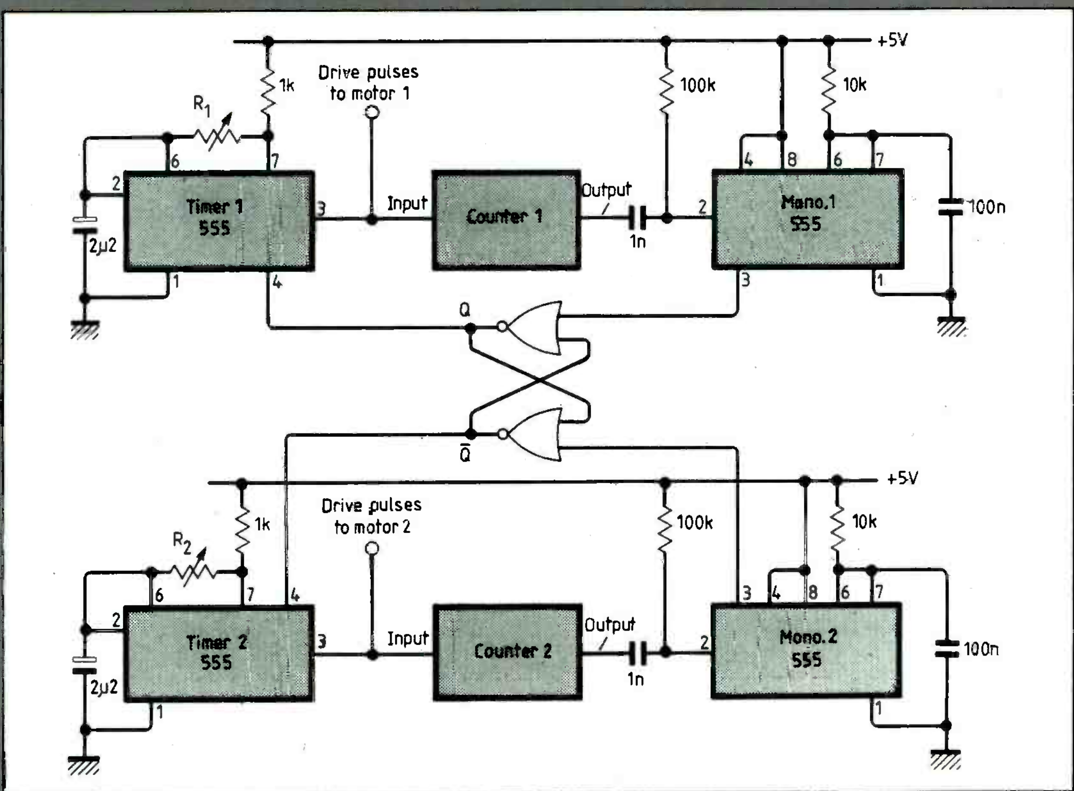
N.J.G. Brown
Jesus College
Cambridge

Complementary stepping-motor drive

Two stepping motors turning alternately through a given angle in a certain time were required for an instrument. In this solution, 555 i.cs in two identical sections determine how long each motor is on and counters fix the motor rotation angle. The two sections are linked by a bistable circuit.

At switch on, the first timer produces pulses at a rate depending on the setting of R_1. These pulses drive the first stepping motor until the counter reaches the end of its count and rests. Now, the first monostable i.c. gives a pulse which, with the aid of a bistable circuit, disables the first counter and enables the second to start the second motor and the process is repeated.

E. Olcayto
Helensburgh
Stathclyde



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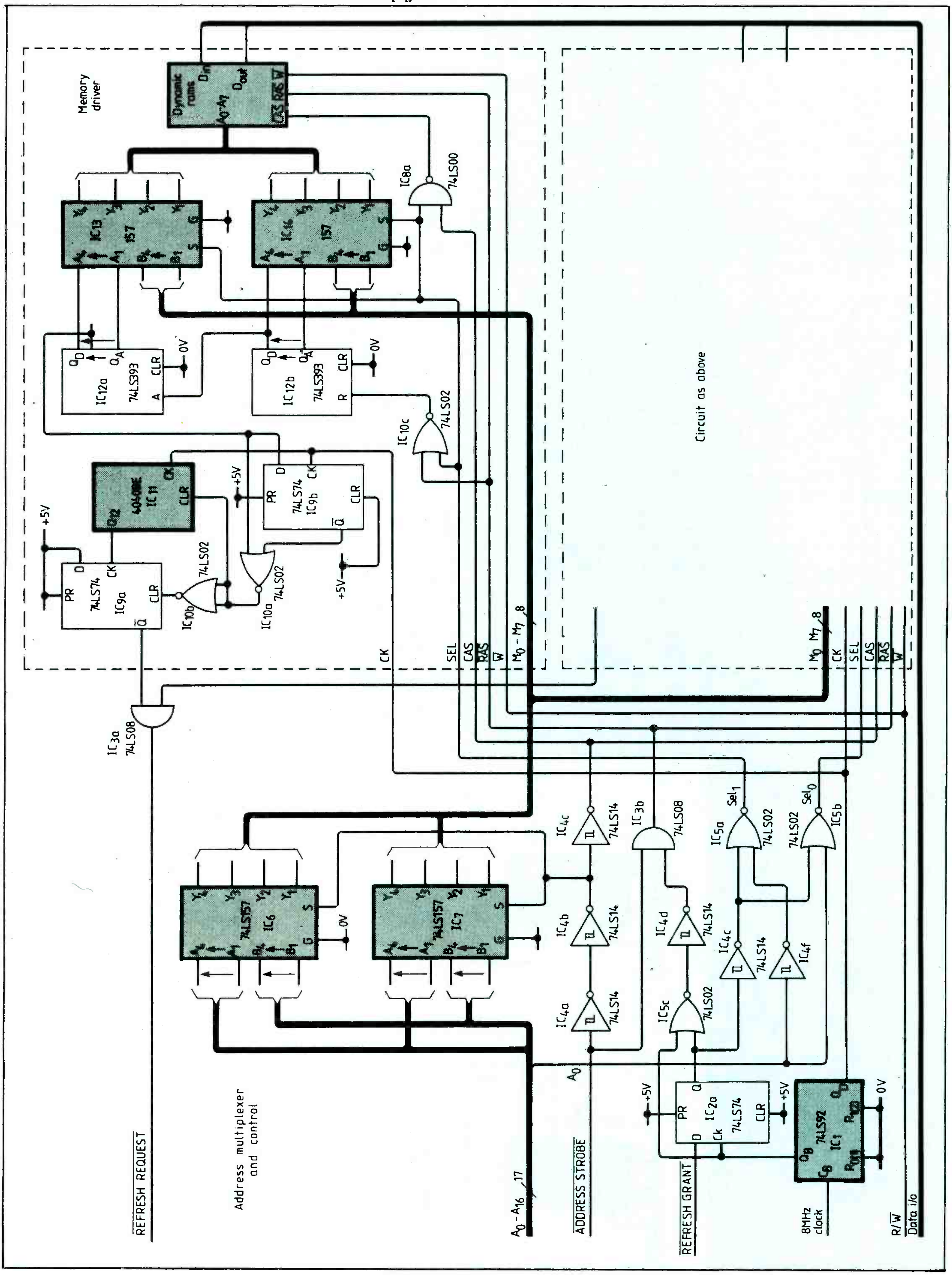


CIRCLE 12 FOR FURTHER DETAILS.

CIRCLE 38 FOR FURTHER DETAILS.

CIRCLE 16 FOR FURTHER DETAILS.

CIRCLE 72 FOR FURTHER DETAILS.

Microcomputer-controlled cassette recorder

An up/down counter determines tape position, and Linsley Hood's record/playback circuits are found suitable for this recorder.

Fig.9 shows the circuit of the electronic up/down counter used to determine the tape position. The counter consists of four t.t.l. decade up/down counter i.cs, type 74LS192. These are connected together as shown and controlled by logic signals from the control circuitry of Fig.2. The outputs from the four counters are selected for reading by four 4-to-1 multiplexer circuits contained in two, dual i.cs type 74LS153. The link between counter and microcomputer is thus by seven lines of an eight-bit i/o port. The outputs from the counter are on lines PA_0 (l.s.b.) to PA_3 (m.s.b.). Lines PA_4 & PA_5 are outputs from the microcomputer and determine which digit is selected. Line PA_7 is also an output from the microcomputer and provides an overall reset function to the counter. The link with the microcomputer and method of reading out the counter values via suitable software are described later.

Operation of the counter is controlled by signals from the control circuitry. The clock input comes from the motion sensor of the cassette deck, via the transistor interface, on the output to PB_6 (see Fig.2). The up/down control signal is derived from the rewind (R/W) l.e.d. output signal. This signal is low for forward motion of the cassette (play and fast-forward) and high for backward (rewind) motion. The up/down control signal combined with the clock signal, using the four, dual input nand gates (type 74LS00), produces the up-clock and down-clock signals required by the up/down counter. The clock input on PB_6 pf the control circuitry can be either at the logic high or low level when motion ceases. To prevent changes on the up/down input from clocking the counter, the clock signal should always return to logic low in the absence of tape motion. Consequently the monostable circuit, around the 74121 i.c. is introduced between the clock input and the input to the nand gates.

The reason for including the stop signal input is as follows.

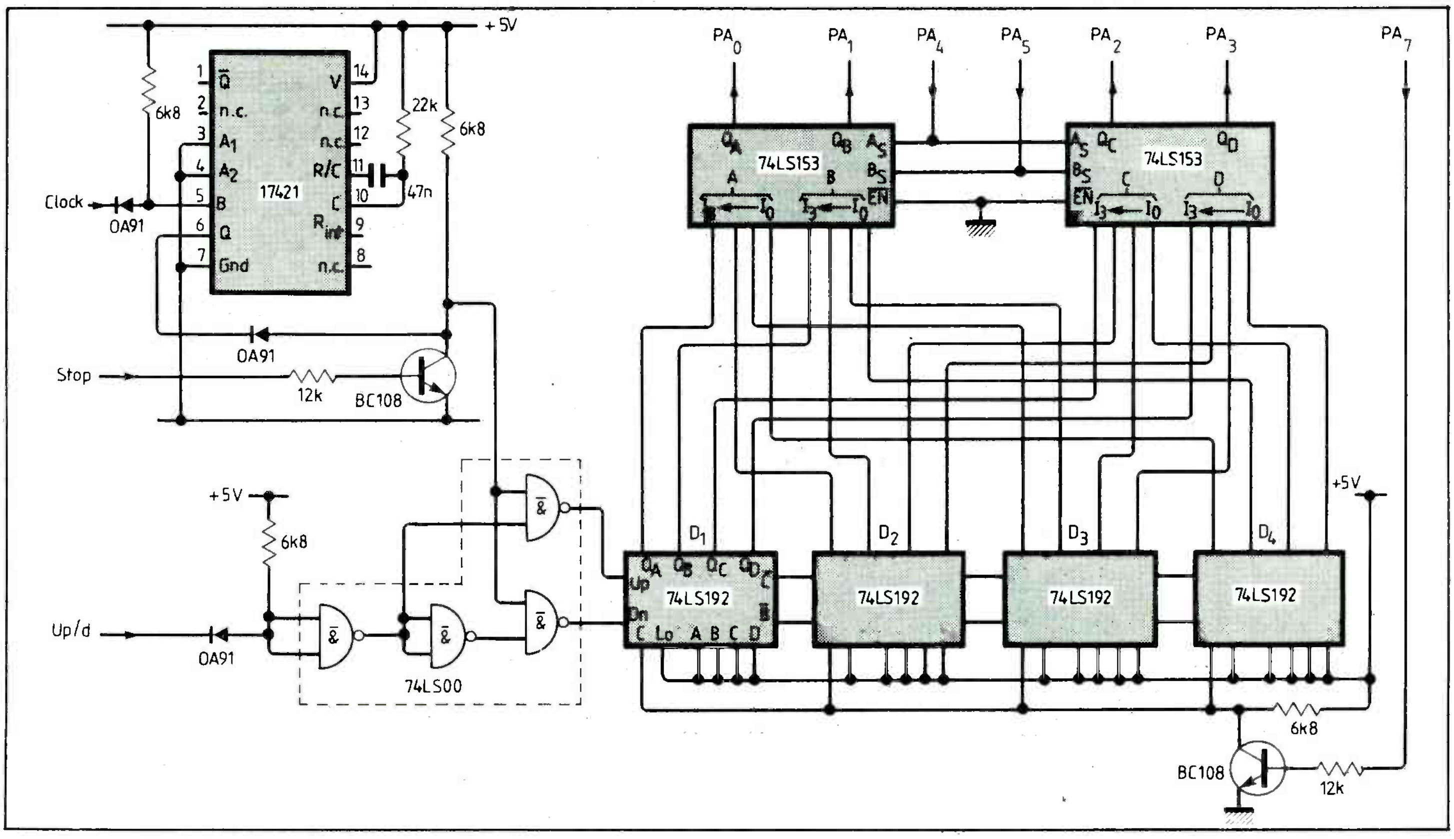


Fig.9. **Circuit of up/down counter.**

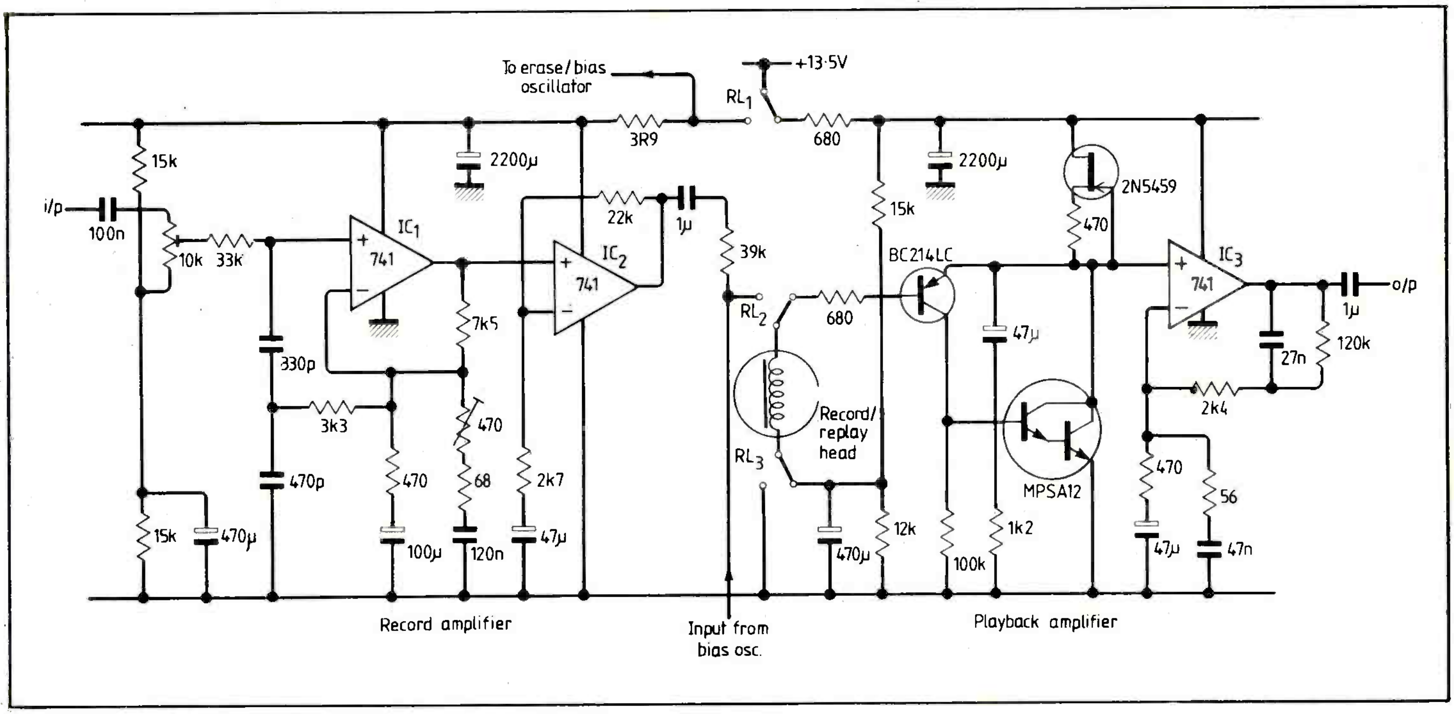


Fig.10. **Record and playback circuitry, based on a Linsley Hood design.**

Suppose that the cassette deck is operating in the rewind mode. In that case, the up/down line will be high and the counter will be counting down. Immediately the motion is stopped, the up/down line will go low. The motion of the cassette deck comes to an abrupt stop. However, the rotating magnet of the motion sensors oscillates mechanically, generating a number of false clock pulses. Because the up/down line is then low, the false pulses will clock the counter up. No matter in which direction the cassette deck is operated, the counter will always be incremented, at the instant motion ceases, by these false pulses. Such additional pulses quickly accumulate and offset the counter from its true reading. The stop signal thus prevents the clocking of the counter *immediately* the motion of the cassette deck is stopped. With this method some mechanical slippage between the tape motion and the counter is inevitable. However, it should occur in both forward and rewind directions and therefore, to some extent, cancel out. The stop signal is derived from the 'stop' l.e.d. signal output of the control circuitry (see Fig.2).

The circuitry of the up/down counter is powered from a 5 volt supply, but the inputs, CLOCK, STOP and UP/D are compatible with the higher 12 volt, logic signals from the control circuitry.

The four digits of the counter are selected for reading by the computer by logic levels on the lines PA_4 and PA_5. The truth table for digit selection is as shown below.

PA_5	PA_4	Digit	
0	0	D4	(m.s.)
0	1	D3	
1	0	D2	
1	1	D1	(l.s.)

Record/playback electronics

There have been a number of circuit designs for the record/playback electronics for cassette deck tape recorders in various magazines over the last eight years or so. Integrated circuits have been specially designed for this purpose. The potential constructor thus has a good choice of designs from which to make his selection. The main requirement of any design is that it should have an upper frequency response that extends to at least 12kHz. (If an attempt is to be made to increase the bit rate from 2400 to 4800 baud, then an upper frequency response in excess of 15kHz may well be desirable, so that the centre frequency of the f.s.k. system can be increased to about 12kHz.)

From my own experience of using a cassette tape recorder to record digital data*, I do not hesitate to recommend the Linsley Hood electronics described in this magazine back in 1976. For the benefit of readers who are not familiar with Linsley Hood's circuits, they are reproduced in Figs 10 and 11 in a simplified form for use with my f.s.k. circuits. The circuits have, in fact, been simplified very little, but I see little reason to include equalization for both 120μs and 70μs recording characteristics and therefore show the circuits with only the 70μs characteristic. (As good high frequency response is required for the f.s.k. circuits, the use of high-bias tapes and the 70μs characteristic is recommended.)

As no low frequency component is to be recorded, I have also removed the bass pre-emphasis components at 3180μs. The preset control of the record amplifier is retained so that the magnitude of the high-frequency pre-emphasis may be adjusted for a maximally flat frequency response; which seems to be the most logical response characteristic to choose for the f.s.k. circuitry. The rest of Linsley Hood's circuitry remains essentially unchanged.

The design of the bias/erase oscillator is that of the high efficiency circuit which Linsley Hood produced later as a postscript to his original articles. Component additions to the record/playback amplifiers, which were discussed in the postscript article, are not necessary in this undemanding application and have not been included. The requirements of the record/playback electronics in recording f.s.k. signals are not very critical (apart from good high-frequency response): audio signals are recorded at full recording level all the time and signal-to-noise ratio, for example, is not important. Distortion is also relatively unimportant, but as the frequency response is wider below the full recording level, it should not be exceeded.

There is no need for a VU or other level meter; once the output level from the f.s.k. modulator and the input level to the record amplifier have been set they do not need to be readjusted. In fact, one or other of the level controls can be removed. I suggest that the 10kΩ level control of the record amplifier be replaced with a fixed 10kΩ resistor. The input sensitivity of the record amplifier is about 50mV r.m.s., for a full recording level output of 2.25V r.m.s., at 660Hz, from IC_2. At higher frequencies the sensitivity will be even greater due to the high-frequency pre-emphasis circuit.

The record/playback electronics will operate very well with the record/playback and erase heads supplied with the solenoid-operated cassette deck. However, to get the best high-frequency response out of the system, it is recommended that the HS16 stereo record/play head is bought for use with the deck instead of that supplied. (No equivalent mono head as good as the HS16 is as yet available.) Stereo record/playback circuitry is, of course, not required in this application. There is, however, a good reason for recording the f.s.k. signals onto both halves of the tape. Both halves of the stereo head may be readily driven from the single output of IC_2 — simply provide an additional 1μF capacitor and 39kΩ resistor in series with the other half of the head. It is *not* recommended that the two halves of the stereo head should be paralleled for playback. Rather it should be possible to select which half is used for playback. The precise way by which this may be done is left to the constructor. If this technique is adopted, two recordings will always be made of the microcomputer programs or data. If one half is not recorded entirely correctly, there is a good chance that the other half will be.

To set the record/playback electronics to a satisfactory condition for recording the f.s.k. signals, three controls need to be adjusted. They are the signal level input, the magnitude of the high-frequency pre-emphasis (470Ω pre-set), and the bias level (100kΩ pre-set). To do this an a.c. voltmeter with a frequency response up to that of the bias oscillator's frequency is needed. Firstly, the bias voltage on the record head should be adjusted to

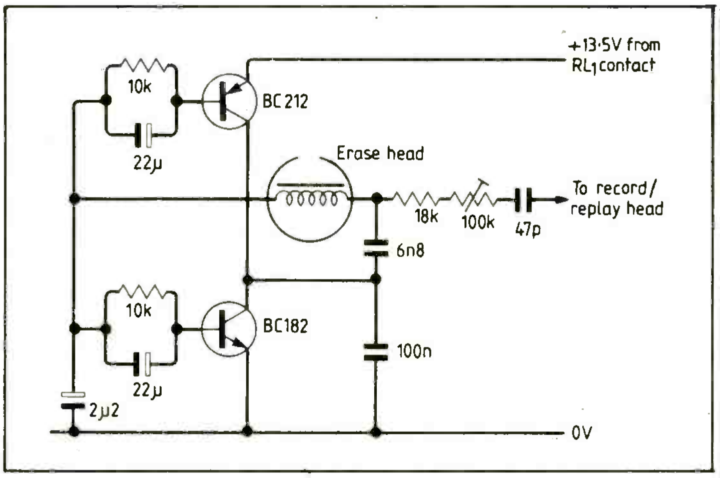


Fig.11. **Bias and erase oscillator.**

about 7V r.m.s. measured across the record head with a suitable low-capacitance h.f. probe. With the value of the 470Ω resistor adjusted for maximum resistance, adjust the input signal level from the f.s.k. modulator (at the higher frequency) for an output of 2.25V r.m.s. measured at the output of IC_2.

Applying logic 0 and 1 levels at the input of the modulator, record the resulting audio signals for a time sufficient for a subsequent analysis of the recorded signals. Rewind and replay the recorded signals. The amplitude of the replayed signals should be around 400mVs r.m.s. and there should be no significant difference in the amplitude of the two frequencies. If the amplitude of the higher frequency is more than 3dB below that of the lower frequency, repeat the recording process having first adjusted the 470Ω preset for a lower value of resistance. It should be possible to arrive at a setting that produces very little difference between the amplitudes of the two frequency signals.

If a large difference between the amplitude of the two frequency signals still exists after attempts at adjusting the preset, it may be worth altering the bias voltage setting, remembering that the higher the bias voltage, the greater the attentuation effect upon the higher frequency. When the best possible settings are found, do try the replayed signals on the demodulator; it is very non-critical of amplitude and amplitude differences.

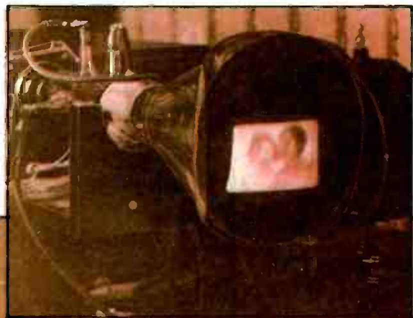
To be continued

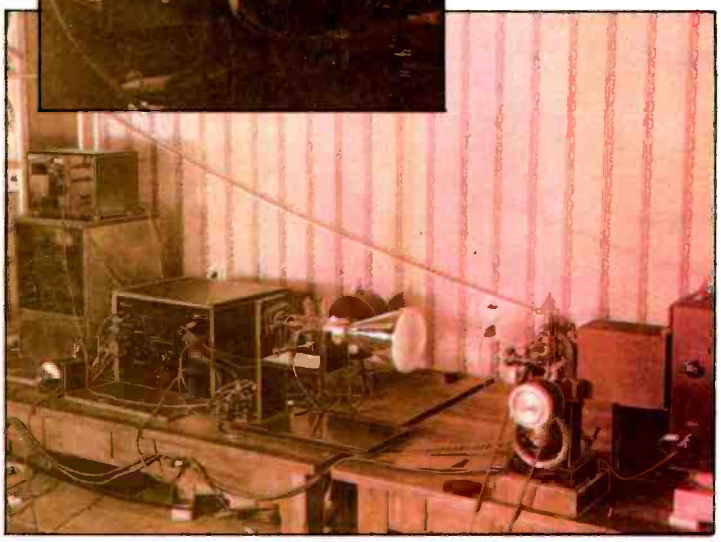
continued from page 53

COPY program to create a working copy of your master disc and then file the latter for safe keeping.

There are two preset adjustments in the computer, neither of which is critical. The potentiometer on the processor board adjusts the length of the RAS pulse applied to dynamic memory. By adjusting this potentiometer it is possible to use relatively low-speed dynamic memories in a high-speed system. With the high-speed memories supplied in the kits, the potentiometer can be set to its minimum. The trimming capacitor on the v.d.u. board, C_{301}, allows the crystal frequency to be trimmed to an exact value. The purpose of this is to allow the frame frequency generated by the c.r.t. controller to be set to exactly 50Hz.

Back in 1932, Baron von Ardenne was experimenting with variable-speed scanning tv. The theory was that if the scanning beam could travel slowly over the light areas of the subject and quickly over the dark, there would be no need to modulate the intensity of the beam. His experimental equipment used as a telecine to transmit films is shown in these pictures which are examples from the many historical photos held in the *E&WW* archives. These are available to outside users at a very moderate fee. Details from Quadrant Picture Library, Quadrant House, Sutton, Surrey. Telephone: 01-661 3427.





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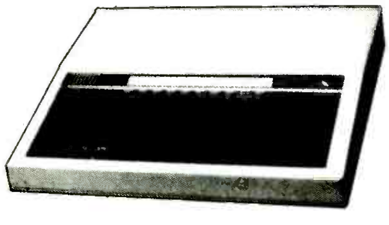

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2x25-way	225p	220p
2x28-way (Spectrum)	200p	—
2x36-way	250p	—
1x43-way	260p	—
2x22-way	190p	—
2x43 way	395p	—
1x77-way	400p	500p
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CIRCLE 24 FOR FURTHER DETAILS.

Variable-speed video

by J. R. Watkinson, M.Sc., B.Sc.

Part 3: C-format timebase correction

A video tape recorder cannot playback a C-format tape with sufficient precision to keep subcarrier phase within 5 degrees of reference, even at normal speed. By removing instabilities affecting line and position, a timebase corrector restores precise timing to the offtape signal.

The principle of sampling is almost universally used for the correction process. The continuous video waveform from the recorder is broken into discrete voltage samples which are stored for subsequent recreation of the waveform. The samples can be stored in analog form in charge-coupled devices, or quantized and stored as digital data in memories or shift registers. All these approaches will be found in current timebase correctors.

Fig.1 shows how the stored samples are treated to compensate for the instabilities encountered. In (a), a line played back at the wrong time can be shifted by changing the delay between storing and reading samples. To be able to advance or retard lines, all correctors introduce a nominal delay which can be changed as needed. The recorder is synchronized to signals which are in advance of reference video by the nominal delay period. To give a symmetrical advance and retard capability, the nominal delay should be one half of the storage capacity of the corrector.

In (b) a line is too short because the head to tape speed is higher than normal. The sample rate on writing the store is faster than on reading, and the line is expanded to the correct length. Clearly lines which are too long can be shortened by writing the store more slowly. In (c), the drum accelerates and time compresses the end of the line. The write sample rate is constant, but the read sample rate is decelerated as the line proceeds in order to time-linearize the waveform. This is known as velocity compensation.

In practice, all three processes will be contemporaneous. The structure of a simple timebase corrector is largely defined by the requirements of these processes, Fig.2. The essential components are:

- Off-tape sample rate locked to off-tape signals, starting in a repeatable place on each line and dividing the line into the same number of samples irrespective of line period.
- Sample store, an endless ring memory, where the instantaneous delay is determined by the difference between write and read timing.
- Read sample rate based on reference video, spacing out the samples to standard line length.
- Velocity compensation, dynamically changing the read sample rate according to velocity errors

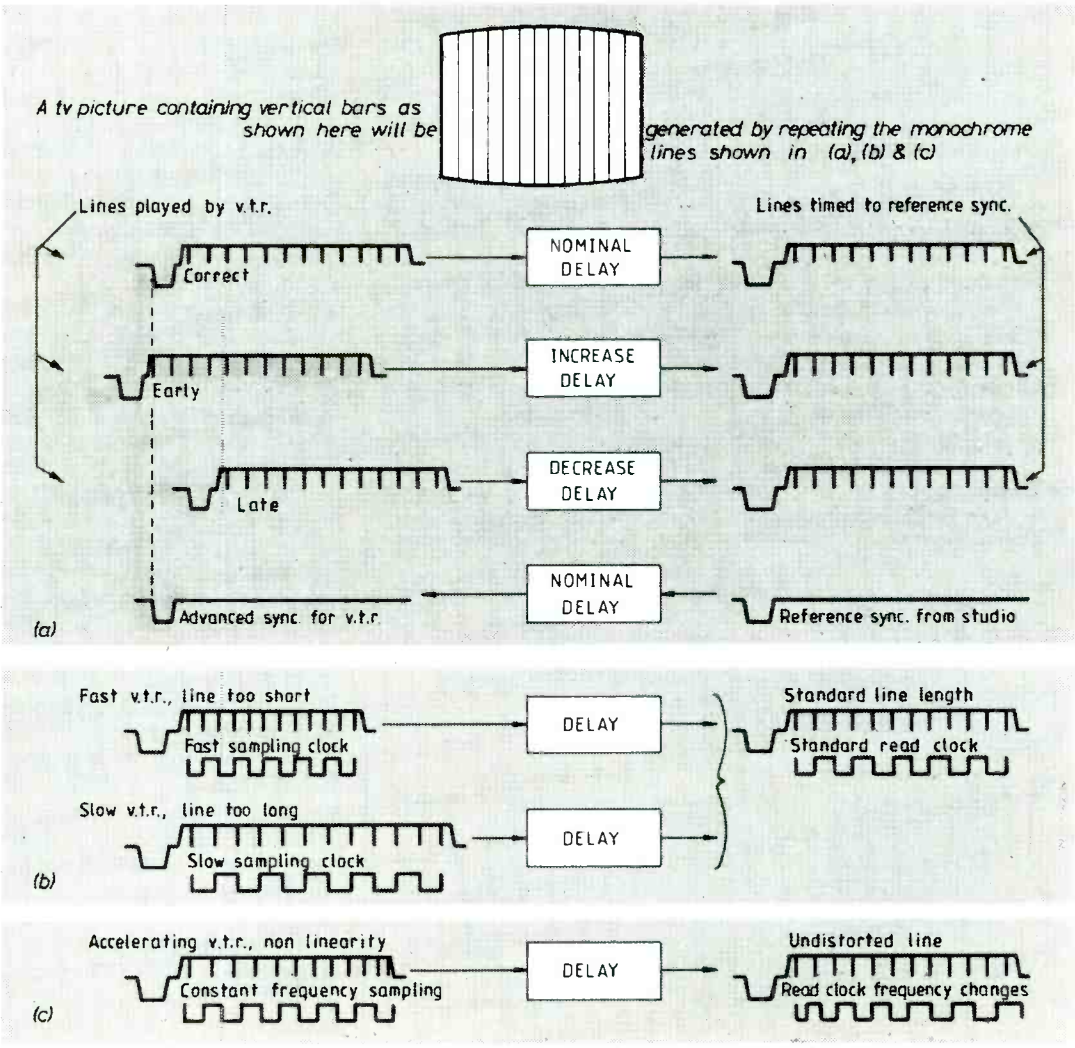


Fig.1. Three fundamental timebase corrections. At (a), the v.t.r. is advanced from reference, and correctly timed output lines are returned to reference timing by a delay equal to the advance. Early and late lines are compensated by changing the delay. At (b), off-tape lines are sampled by a clock which changes proportionally to off-tape line frequency. Line period errors are removed in this way. Shown at (c) is non-linearity due to tape acceleration which is removed by swinging the read clock in the same way. (Burst and chroma omitted for clarity.)

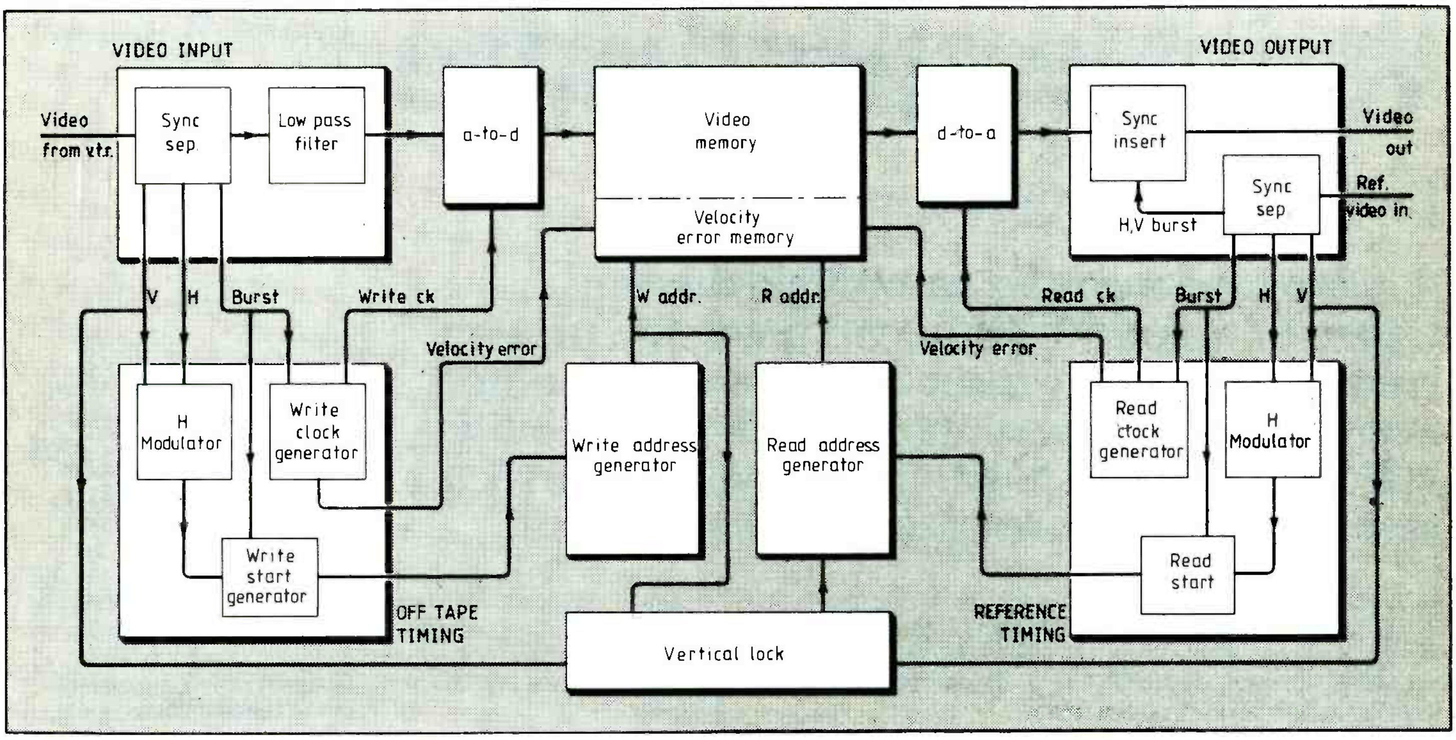


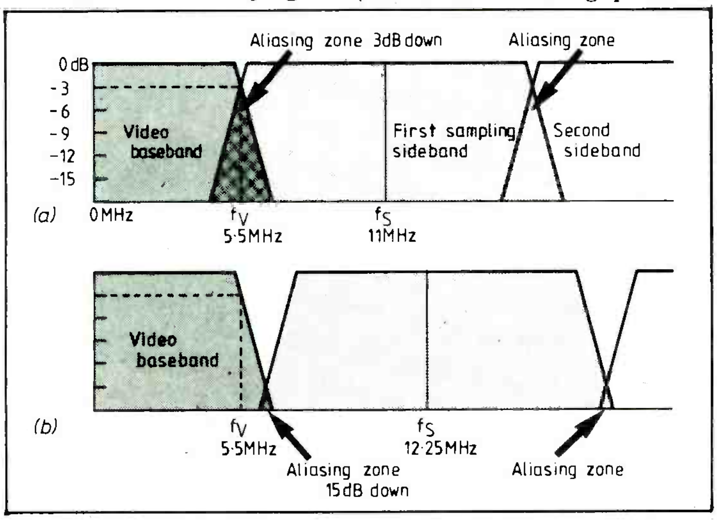
Fig.2. **Simplified t.b.c. block diagram, showing that the memory acts as a buffer between unstable off-tape timing and stable reference timing. Note that the dropout compensator and the varispeed colour processor have been ommitted as these functions can be performed at various different places.**

Fig.3. **When a finite filter slope is used, aliasing will always occur. In (a) the sampling rate is twice the —3dB frequency limit of the input spectrum, and accordingly aliasing products may only be 3dB below wanted signals. In (b) the sampling rate has been increased to 12.25MHz and aliasing products for the same filter are now 15dB below program.**

in the writing process.

• Vertical lock circuit, which ensures that the first line in an off-tape field entering the memory will become the first line in the reference field when the memory is read, irrespective of the relative timing of the two events, which can change due to inertial effects or the use of variable speed.

Sampling the off-tape video. As in all sampled systems, the sampling rate must satisfy the Nyquist criterion, which means that it must be at least twice the highest frequency in the input spectrum to avoid aliasing. It is standard practice to provide a steep cut filter immediately prior to the sampling circuit. Unfortunately all realisable filters have a finite slope, and this means that aliasing will always take place. The level of aliasing products



below program can be chosen by raising the sampling rate.

Fig.3(a) shows the aliasing area where the baseband spectrum overlaps the lower sideband of the sample spectrum. In (b) the aliasing products for the same filter slope have been reduced by raising the sampling rate.

For a video bandwidth of 5.5MHz a sampling frequency of 11MHz is adequate with a perfect filter, whereas perhaps 2MHz needs to be added to allow for finite filter slope, making 13MHz a working minimum.

The usual arbiter in choice of C-format correction sampling rate has less to do with Nyquist than with the difficulty of providing a sample clock which has the same number of samples in a line, whatever the line period may be. Some repetitive feature of the off-tape video signal must be multiplied up to provide the clock. It is a characteristic of phase-locked loops that those which display the least inertia are those which multiply by the smallest integer. It is far more practicable to track the offtape signal by phase locking to the burst than it is to rely on the much lower frequency H-pulses. For this reason, a sampling rate which is an integer multiple of subcarrier frequency is usually used. There is nothing in sampling theory to dictate such a choice.

The smallest integer multiple of subcarrier which exceeds the Nyquist criterion is 3, giving a sampling rate of 13.29MHz, but $4f_{sc}$ is also used giving a sampling rate of 17.72MHz.

The relative merits of $3f_{sc}$ and $4f_{sc}$ sampling can be assessed in a number of ways.

• Memory size and cost are proportional to sampling rate, all other things being equal.

• Where quantizing is used, the speed of the a-d converter will be determined by the sampling rate. In a varispeed system at +50 times normal speed, the line period falls to 41.3μs and a $4f_{sc}$ converter will be required to run at 27.5MHz, whereas a $3f_{sc}$ convertor will only be running at 20.6MHz.

• In a perfect sampling circuit, the sample gate is closed for an infinitely short time, and a truly instantaneous voltage is held. In practice the aperture must be finite, and the sample is not truly instantaneous. This so-called aperture effect causes a frequency response roll-off which is a sinx/x function of the aperture ratio. For a given aperture period, which is the usual design constraint, $3f_{sc}$ sampling gives an aperture ratio (aperture/sample period) which is 4/3 better than $4f_{sc}$ sampling, since the sample period is 4/3 as long. The result is that less equalization is necessary to compensate for aperture effect in a $3f_{sc}$ system.

• Four times f_{sc} sampling eases the design of the anti aliasing filter, but in timebase corrector applications such a filter is not a critical component, as there is very little energy in a v.t.r. output signal above the specified video bandwidth.

As there are points in favour of both frequencies, the choice of sampling rate is largley a matter for the designer's preference, and this view is reinforced by the fact that broadcast quality correctors are to be had using either sampling rate, and offering virtually identical specifications.

The sampling rate to be used on a given line of offtape video is determined by the frequency of the chroma burst at the beginning of that line. A phase-locked oscillator locks to the burst and runs at the same frequency for the duration of the line. The sampling clock is obtained from the p.l.l. divider chain. In this way every line is subdivided into an equal number of samples, irrespective of line period changes due to mechanical effects or the use of variable speed.

The precise point on a line where sampling begins is not as important as the stability of that point, as any variation in start point of write or read processes will result in horizontal picture movement.

It is neither necessary nor desirable to store the H-pulse at the start of the line, as it contains no information which cannot be obtained from reference video. There are, however, good reasons for sampling and storing the burst; following correction it can be phase compared with reference burst, and the error can be fed back to eliminate thermal drift.

A common write start point is just the burst on the back porch. As the back porch in this area is a constant voltage, there is nothing to trigger from, and the choice of such a point may appear to be a high-tech form of masochism. The problems to be overcome are

— centre crossings of the burst advance towards the H-pulses at one cycle per frame owing to the 25Hz component of subcarrier frequency
— burst inverts after every pair of lines due to the N/I sequence
— burst occurs after the desired write start point
— change in head-to-tape speed causes the time between the leading edge of H-pulses and the burst to change.

The 25Hz component of subcarrier, uncorrected, would cause ambiguity over which burst centre crossing to select, resulting in one cycle of subcarrier picture shifts. The solution is to apply an equal rate of advance to H-pulses as the frame progresses, which resets at the beginning of each

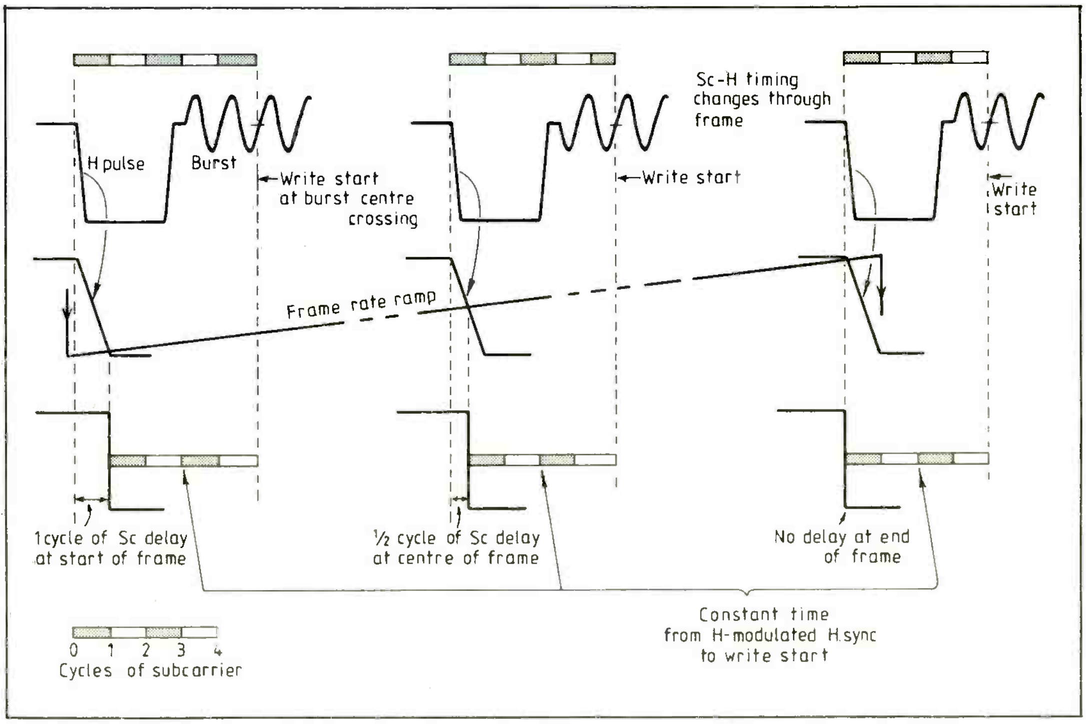


Fig.4. Since the 25Hz component of subcarrier causes burst centre crossings to advance towards H-sync at one cycle per frame, the write start point has to jump one cycle every frame to keep the horizontal position of the picture constant. The use of H-modulation converts the steady phase advance to a once-per-frame step of one cycle, which takes place during vertical blanking. The write start point will now be unambiguous through the frame. Note that burst inversion is neglected in the diagram, since the effect of this are removed by the t.b.c.

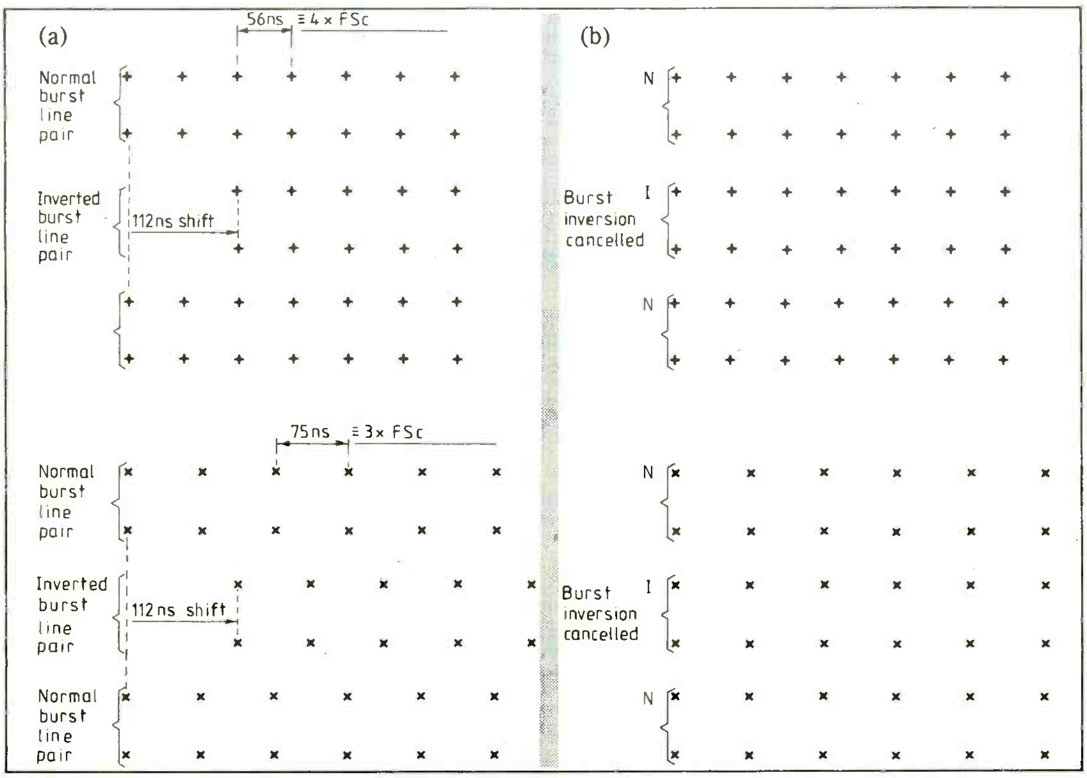


Fig.5. The burst swing of PAL causes burst inversion relative to H-sync every two lines. Uncompensated, this would cause ½ cycle (112s) shifts in the write start point, giving the sampling points shown in (a). By selectively re-inverting the burst, the write start points can be spatially aligned as shown in (b).

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frame. This process is known as H-modulation, and can be seen in Fig.4.

H-pulses are fed through an integrator which gives the leading edge a rise time of 225ns or one cycle of subcarrier. A second integrator produces a sawtooth of the same amplitude, but whose period is one frame. A comparator changes state when the H-pulse ramp crosses the frame rate ramp. The effect is to delay H-pulses by 225ns at the start of a frame, Fig.4, falling to zero delay at the end of a frame. Burst crossings now have a constant relationship to H-modulated sync. pulses, and there is no further ambiguity over the centre crossing to use as the start point.

The burst inversion every pair of lines would cause the half-cycle timing shifts shown in Fig.5 for both $3f_{sc}$ and $4f_{sc}$ sampling. In normal operation this is not important, but for drop-out compensation, where samples are taken from previous lines, the half-cycle shift causes problems for both sampling frequencies. The solution is to selectively invert the burst signal sent to the write (and read) start circuits, but to leave unchanged the burst signal sent to the a-d convertor. As the burst signal to the write start circuit is an e.c.l. level, it can be inverted with nothing more than an exclusive-or gate.

A consequence of this approach is that all lines in memory have the same relation to subcarrier, and can be interchanged for the purpose of dropout compensation and under certain other circumstamces due to varispeed operation which will be dealt with under memory control. The preference for constancy of subcarrier phase rather than H-pulse means that the start point moves along the line by one cycle as the frame progresses, causing the square frame to become slightly rhombic in the memory. As H modulation is also used to establish the read start point, the overall effect is cancelled.

The burst swing will also be discernible in the memorized bursts, because all lines in the memory now start at the same subcarrier phase. The readout burst can thus still be used for temperature compensation.

The write start point precedes the burst, but a burst crossing is necessary to define the start point. This problem is handled by inserting a delay in the video path to the sampling circuit, as in Fig.6. A phase-locked oscillator known as a burst stretcher, locks to the burst, and a centre crossing of the oscillator output, a fixed number of cycles after H-modulated H-sync, becomes the write start point which will be just before the burst on the output of the delay line. As the delay is not an integral number of cycles of subcarrier, the phase relationship between sampling points and off-tape burst is arbitrary but repeatable. As the sampling rate is only a multiple of subcarrier for convenience, no particular phase relationship is required.

The determination of the correct centre crossing of the burst stretcher output is complicated by the fact that the burst frequency changes as the head to tape speed changes. A simple time delay from H-modulated H-sync would only work at normal speed. One solution is to use an adaptive delay which adjusts itself every line by phase comparing the end of its own delay period with the nearest centre crossing of stretched burst. The process is shown in Fig.7.

If the v.t.r. accelerates, raising the burst frequency, the stretched burst will phase lead the delay output, and the phase error causes the delay to be shortened. If it decelerates, lowering the burst frequency. The stretched burst will phase lag the delay output, and the phase error will act to increase the delay. The delay adapts itself in this way to the speed of the v.t.r. and tracks the same cycle of subcarrier relative to H-modulated H-sync irrespective of the actual offtape subcarrier frequency.

A couple of refinements are necessary in practice. Firstly if the phase error exceeds 180 deg. it will be ignored, as such a gross error could only be conducive to picking the wrong cycle of burst. Secondly, there is no absolute standard for phase in PAL, and the relationship on a given tape will depend on the SPG used when it was recorded. A delay adjustment is usually provided to permit the write start phase error to be zeroed for a particular tape, which allows the adaptive delay to work in the centre of its range.

Reference timing. Accuracy of read timing must be no less than that of the write timing. The read sample rate is obtained by multiplying up reference video bursts. Read start timing is established by the same processes as write start, and sometimes identical circuitry will be used in order to cancel the effects of temperature change on overall timing. The read timing circuits contain in addition a manual adjustment to the read start point, which permits picture centering in the reference raster, and the read section of the velocity compensation system.

Velocity compensation. Frequency of the sampling clock is derived from the burst, and the remains constant for the duration of each line. However, the change of off-tape subcarrier from the v.t.r. is continuous, as it is proportional to head-to-tape speed. Fig.8(a) shows that if the v.t.r. accelerates, the subcarrier follows smoothly, but as the corrector can only lock to each burst, phase errors are caused between sampling rate and subcarrier which become worse as the line proceeds, Fig.8(a). The effect is an increasing chroma phase error along the line which gives rise to desaturation at the right hand side of the monitor screen.

Velocity compensation counteracts this error by changing the phase of the memory *read* clock after storage. The amount of phase swing necessary is exactly the same as the phase error between the stretched burst of the line concerned and the burst of the next line. When the memory is being written, the velocity error is not available until the end of the line, whereas when the memory is being read, the velocity error is needed throughout the line. The velocity error for each

Fig.6. **The insertion of a delay line in the signal path as shown permits the burst to be sampled at a rate determined by its own frequency.**

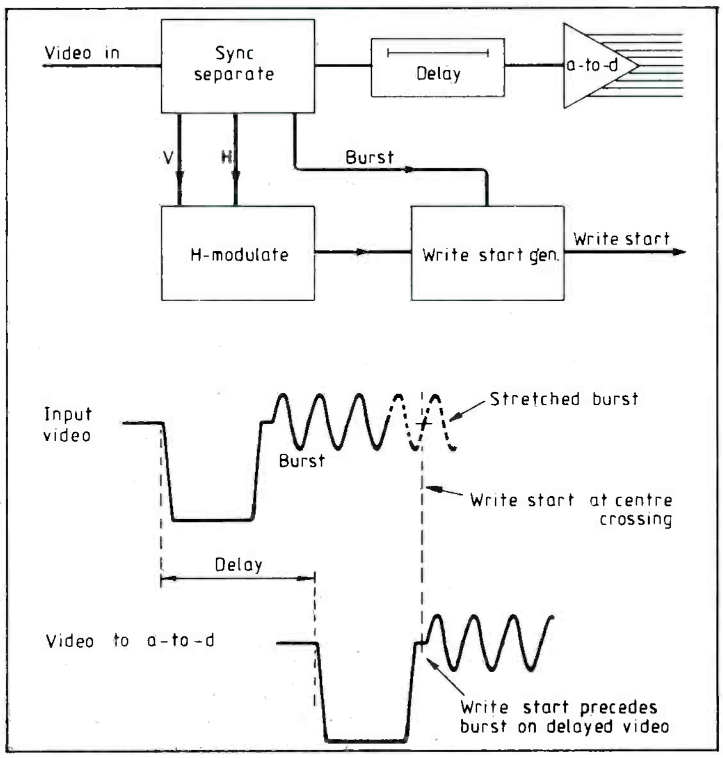
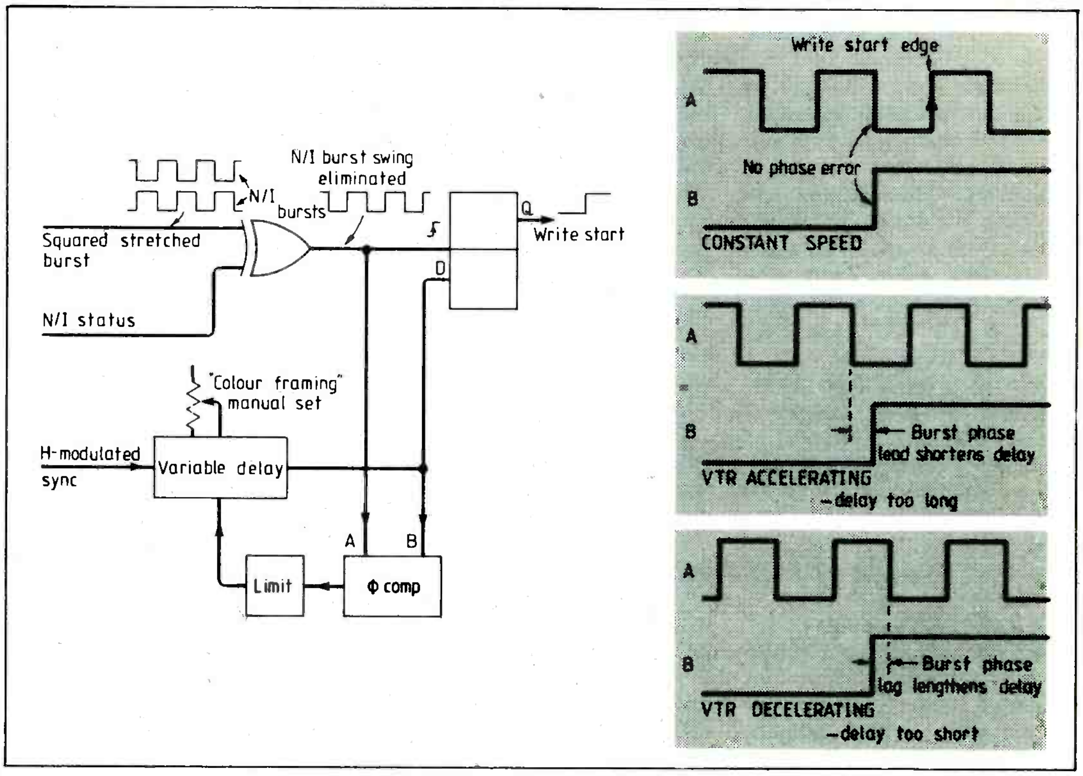


Fig.7. The use of an adaptive delay permits the write start point to track the same point on the line despite line period changes. The three timing diagrams shown how the delay period is changed to follow the input timing.

Part 4 continues with analogue-to-digital conversion, memory organization and sequencing, and the vertical lock system of vari-speed timebase correctors.

Fig.8. As burst phase can only be sampled at the beginning of each line, an acceleration or deceleration of head-type speed causes phase errors which worsen as the line proceeds (a). In first-order velocity compensation, the phase errors of (a) are used to determine the slope of a change of reed clock phase which is constant throughout the line (b). In second-order velocity compensation Successive velocity errors are used to fit a phase change curve to the points given by burst sampling (c). Read timing is phase wing ±180° of subcarrier by comparing the correction signal with a subcarrier rate sawtooth (d). The compensated signal will then be multipled by 3 or 4 to become the read clock proper.

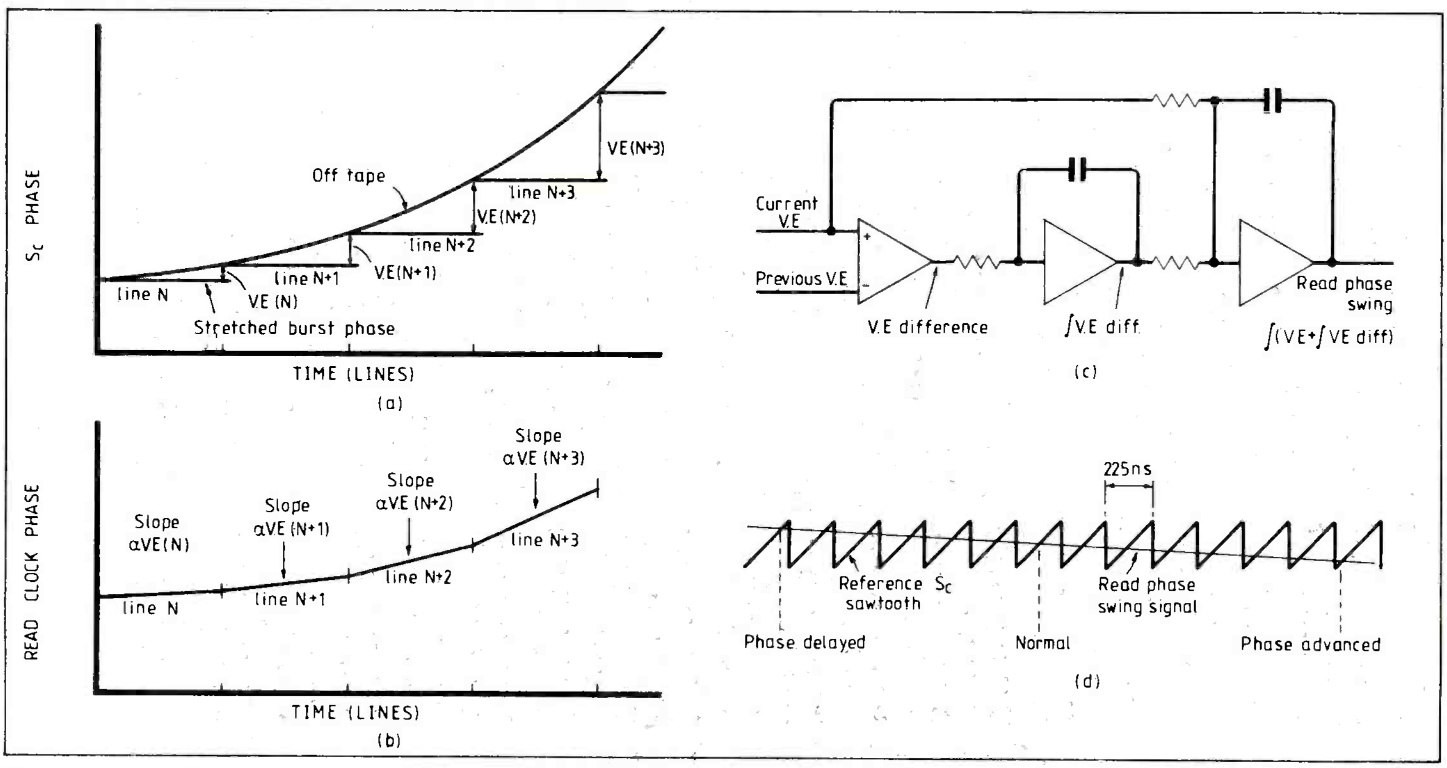


line is thus subject to one line less delay than the corresponding video. The error signal obtained by comparing successive bursts is an analog phase error, and can be stored either by quantizing or as the charge on a capacitor.

In first-order velocity compensation, used for example in the Sony BVT-2000, the velocity error determines the slope of a straight phase swing ramp, which gives a piecewise-linear approximation to the off-tape subcarrier phase change as shown in Fig.8(b). In second-order velocity compensation, used for example in the Ampex TBC-2, the difference between successive velocity errors is used in addition to the straight velocity error to give a curved phase swing signal from a double integrator as in (c).

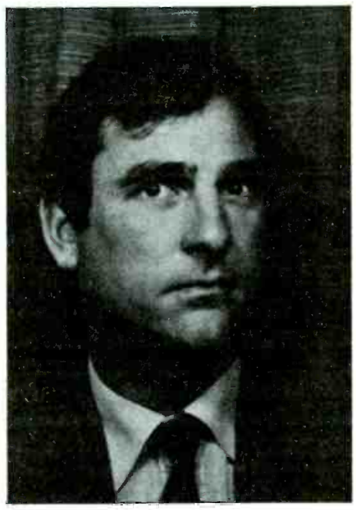
The phase swing signal is fed to a comparator along with a reference subcarrier rate sawtooth. The phase of the reference subcarrier is swung so that the memory read clock derived from it will cancel the velocity error for that line (d).

Velocity error is measured by sampling the phase of successive bursts, and an error of greater than plus or minus 180 deg. between samples will not be correctly measured. For example, an error of +225 deg. would be measured as —135 deg. It is the PAL system itself, rather than the corrector design, which determines this correction range. Fortunately, observed velocity errors are less than 180 degrees.



DIGITAL TUNER CONTROL

by J.N. Darlington



John Darlington joined the RAF in 1961 as a radio apprentice and trained for three years at RAF Locking, followed by a further ten years as a radar technician, during which time he obtained an HNC in electronics.

On leaving the RAF he joined Marconi Radar as a technical author attached to the Sea Wolf missile project. For the last eight years he has held production management posts, having gained a diploma in management studies at the Norwich Management Centre: first with Datron Instruments manufacturing precision digital voltmeters, and lately as works manager of Laserscan Laboratories in Cambridge.

Simple digital tuning, with readout, for Varicap-tuned f.m. modules.

Most f.m. tuner modules are Varicap-tuned and only require a tuning voltage, which can, of course, be derived from a stable source and potentiometer arrangement. This article describes a simple digital tuning arrangement providing up/down control, preset memory control and digital read out for less than a typical f.m. digital readout module.

Derivation of control voltage

Figure 1 is a block diagram of the principle used. The oscillator frequency is not critical and is chosen to provide an acceptable display count speed when either up or down is selected.

The fundamental frequency is divided by ten in the first half of a 14518 and by two in the second half, although the second division is a result of using this divider as a gate.

Two programmable up/down counters are used to provide an eight-bit input to the R-2R ladder network from which a sawtooth wave-form is obtained. The height of the ramp is about 4V for a frequency of 108MHz, so some modification is necessary to give a tuning voltage of 2-12 volts required by the tuner used. This is accomplished by use of a 3140 operational amplifier, where the output from the d-a section is applied to the 3140. The gain (adjusted by RV_1,) sets the range of the control voltage and the level shifting circuit (12k, 1k5, 500 R, 2k) enabling the start point of the ramp to be adjusted around 2V with RV_2. Figure 2 shows the overall linearity obtained from this circuit.

An 8-bit binary number will of course give 256 steps to the ramp, whereas only 200 are needed to step the frequency from 88.0 to 108.0 in 0.1MHz steps. This 'overrange' is compensated for in the calibration of the finished unit and is preferred to resetting the counter at the 200 count point because the large reset step in the ramp, which occurs at this point, may cause problems during calibration.

Preset stations

Figure 3 shows how the memory is added to the basic circuit to allow the selection of preset stations. Two 5101 rams are used because of their extremely low current consumption and low data-retention voltage, which is necessary when battery back-up is required. If ½A, 3.4 volt lithium batteries are used, data will be retained for up to five years.

The use of a 74922 keyboard encoder may be considered a luxury, but the prototype was built for use in a tuner/amplifer and by using a b.c.d.-decimal convertor (7445) up to sixteen key selections can be made available to cover f.m. stations and other inputs such as tape and pick-up etc. Additionally a clean pulse to enable the parallel inputs of the counters is obtained.

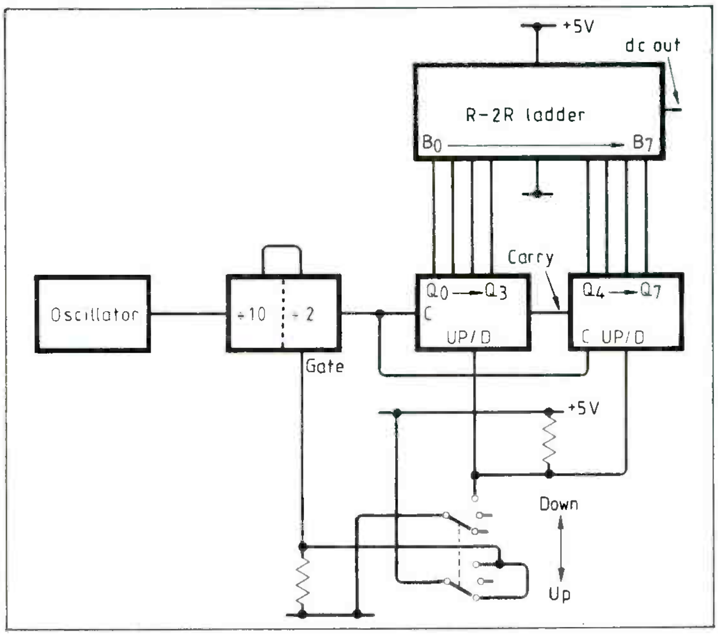


Fig.1. Principle of tuner control. R/2R ladder produces a stepped ramp.

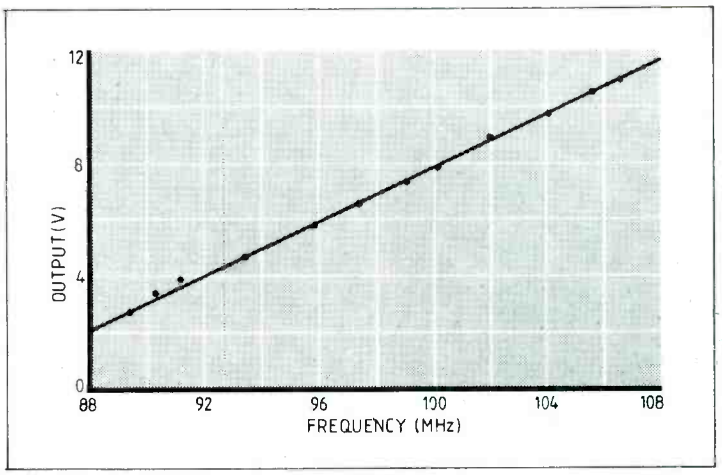
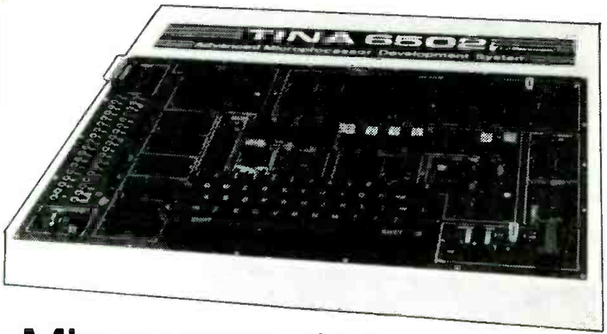


Fig.2. Linearity of ramp when amplified by 3140 op-amp.



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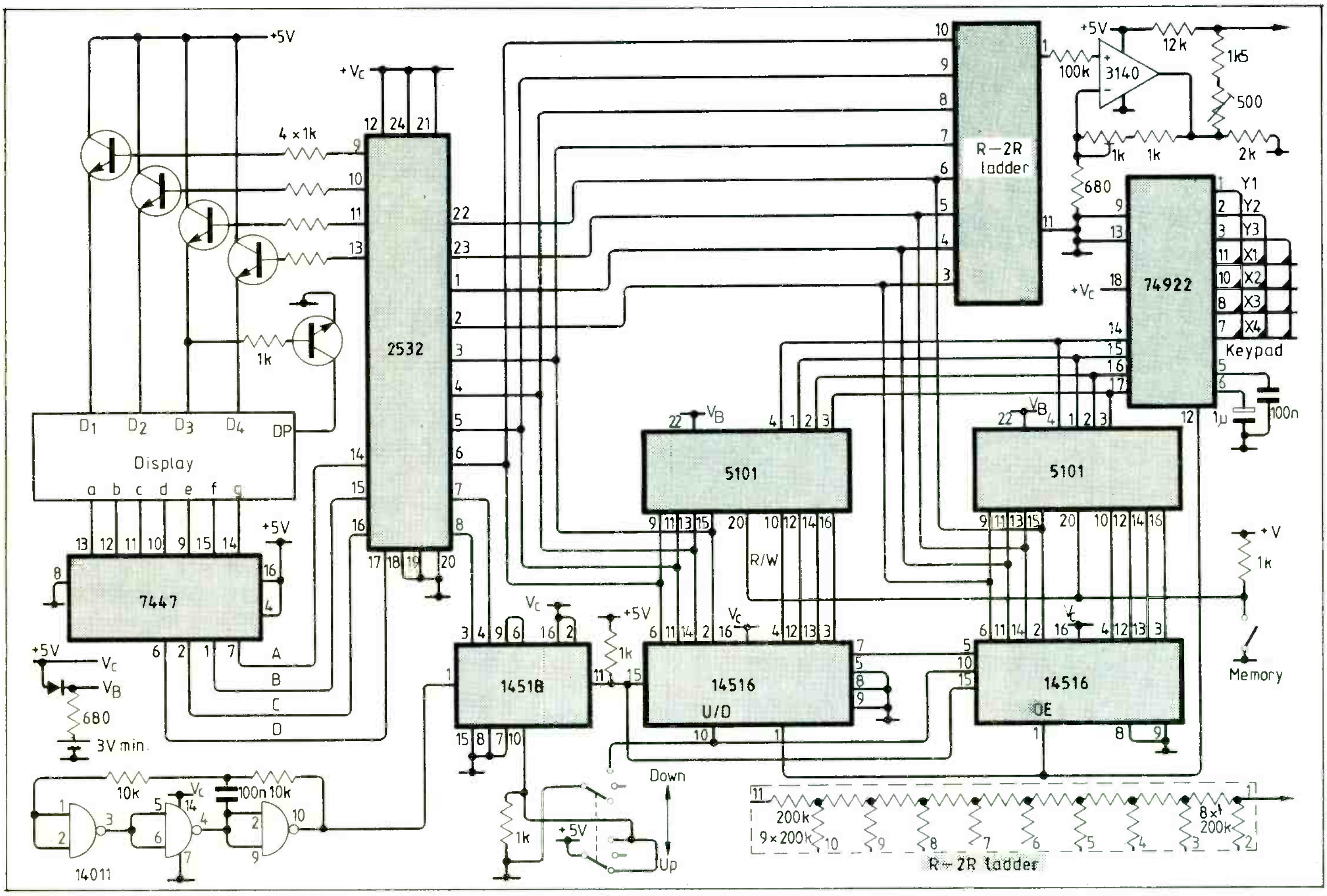


Complete circuit diagram of the digital tuner control.

Operation of memory

A pull up on the read/write lines of the memories forces the rams into a permanent Read mode: the output from the ram is therefore available at the program inputs of the binary counters. This information is ignored whilst PE is low, but on selection of a station, the contents of the associated memory location are present to the counter inputs and a positive pulse from the 94922 Data Available output sets the binary outputs to the inputs, thus setting a new d.c. bias condition.

Operation of the up/down control does not affect the stored information unless the memory key is pressed, whereupon the binary output is recorded in the present address position.

To be continued

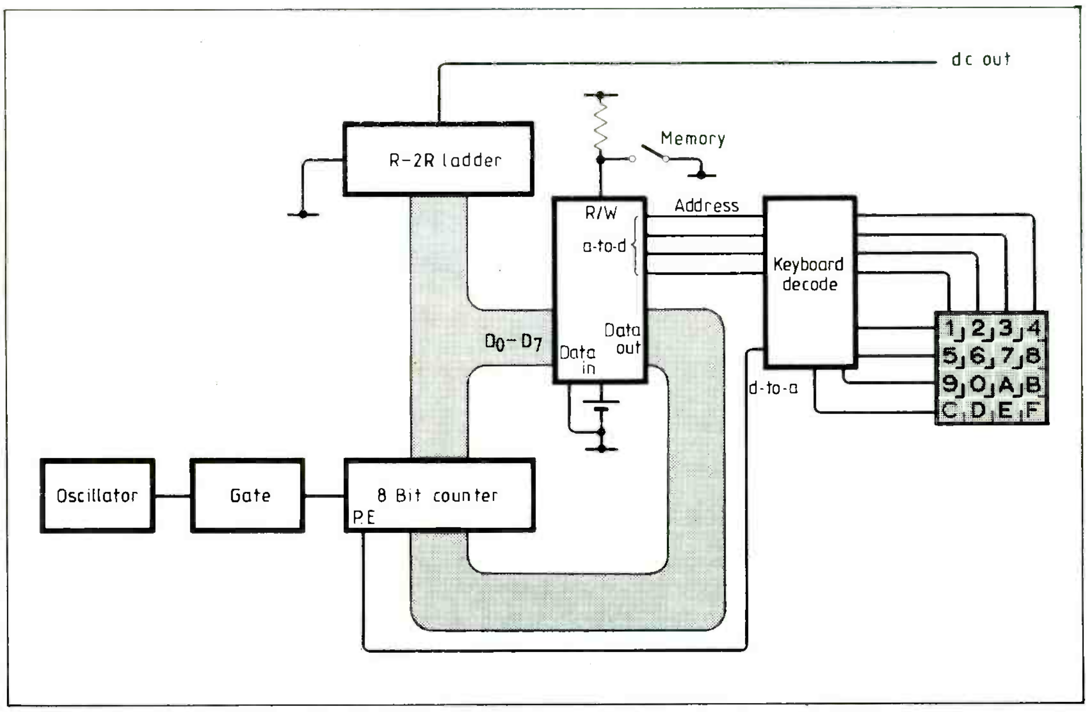
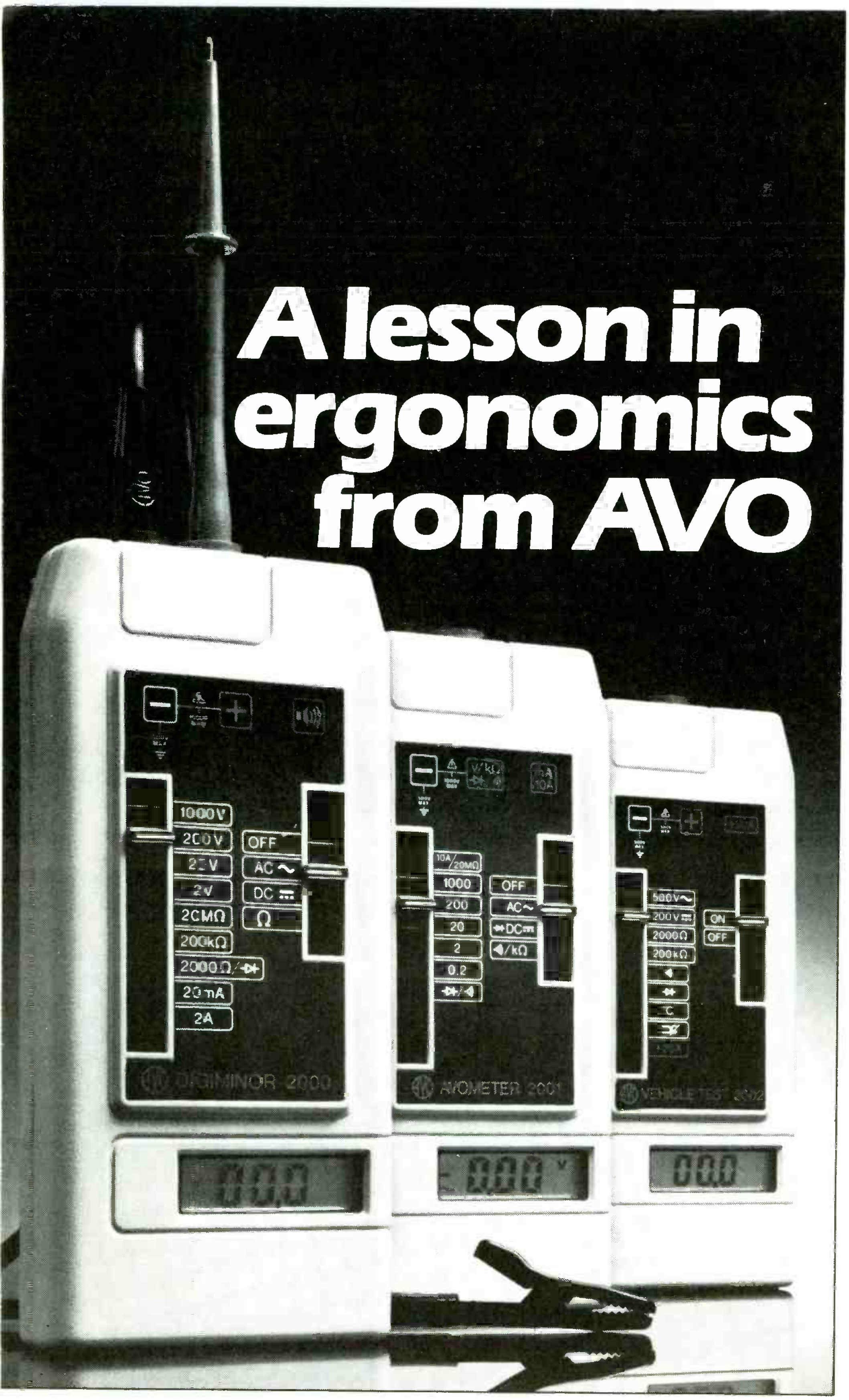


Fig.3. **Two 5101 rams are included to allow preset voltages to be stored.**



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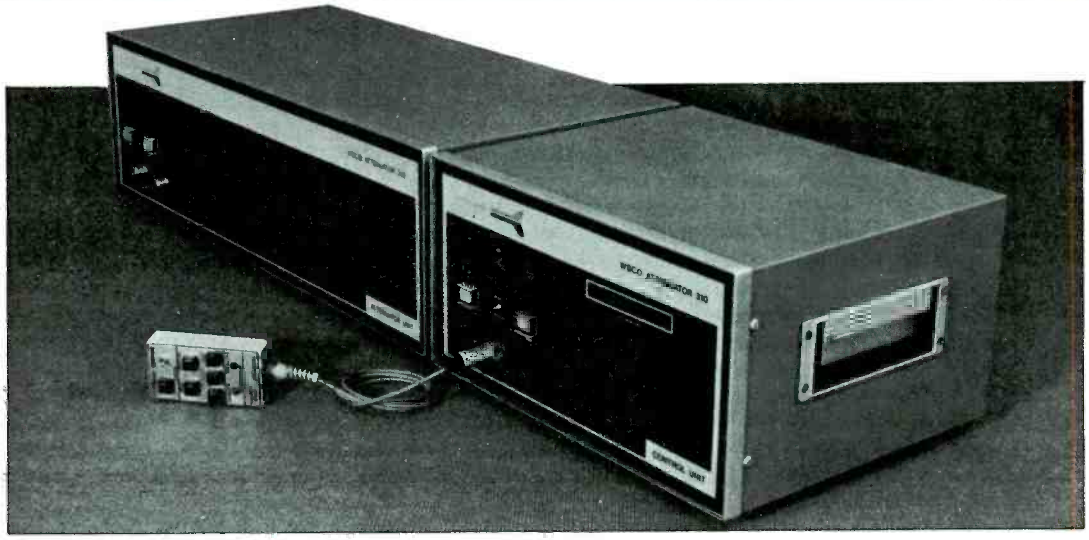
6-CHIP LED LAMP

Available in a choice of four colours, these new p.c.b. mounting lamps are 20mm (0.8in) diameter, low-power, dome-shaped lamps incorporating six chips per unit for high reliability and large area illumination. They are mounted on 15mm (0.6in) pitch d.i.p. bases with separate anodes and cathodes for each chip. The four colour options are: high efficiency red, orange, green and yellow.

Absolute maximum ratings are 500 milliwatts power dissipation; 30 milliamps average forward current per led; 200 milliamps pulse peak current per led and 5V reverse voltage per led. Storage and operating temperature range is —40°C to +85°C, and luminous intensity — with all six leds lit—varies from 20 mcd for the yellow version to 35 mcd for the green. Selectronic Ltd., The Old Stables, 46 Market Square, Witney, Oxon. EWW 210



PRIMARY STANDARD OF ATTENUATION

Based on a design by the National Physical Laboratory, the Techtest WBCO (piston) attenuator Model 310 is claimed to provide the most accurate standard of variable attenuation at present commercially available. It is intended for use in calibration laboratories requiring the precision of a national standard.

The Model 310 has a total dynamic range of 120 dB and an inherent accuracy, supported by NPL certification, of ±0.0002 dB/10 dB. It can be supplied to operate at discrete frequencies in the range 10 MHz to 500 MHz. Attenuation is adjusted at speeds up to 10 dB per second by means of an electronically controlled stepping motor and is displayed with a resolution of ±0.0001 dB on a 7 digit led display reading directly in dB.

The attenuator may be controlled manually by means of the hand-held controller supplied or it may be incorporated in a computer controlled system via the IEEE 488 GPIB interface fitted as standard. Techtest Limited, Street Court, Kingsland, Leominister, Herefordshire, HR6 9QA. EWW 211

PROGRAMMABLE CURRENT SOURCE

Model 224 programmable current source is the newest in Keithley Instruments' line of IEEE-488 instrumentation. Its output is settable from ±5nA to ±101mA d.c. in 6 ranges, while a separate voltage compliance limit is settable from 1 to 105V in 1V increments: the instrument is capable of 4-quadrant operation for full bipolar source and sink.

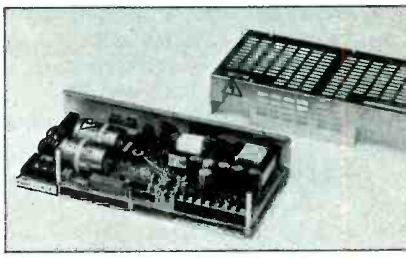
For manual testing, the data keyboard permits straightforward entry of output conditions, which can also be changed within the instrument's full-scale range by selecting a display digit and incrementing or decrementing from some preset value. A unique 'auto' capability generates a staircase ramp at a step size determind by the selected display digit. Time between steps, dwell time, and high/low current output limits are programmable from the front panel.

The optional IEEE interface, Model 2243, includes four input and four output t.t.l compatible I/0 lines which may be programmed and read through the interface. These may be used for monitoring external system events or controlling system activities.

External triggers provide easy synchronization with triggerable measurement instruments. Additionally, a 'dwell time' is programmable from 50ms to 999.9s and acts as a trigger delay to allow for external settling or other system timing.

In component testing on switches, relays, connector contacts and other low resistance applications, the low current and compliance settlings can assure no punch through on oxide layers.

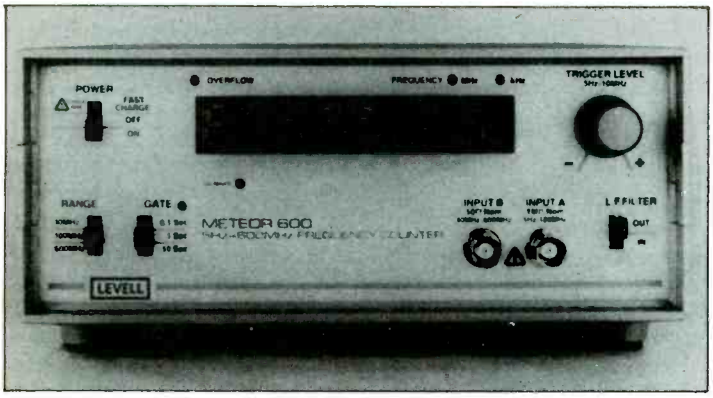
The low currents available from the model 224 can substantially reduce self-heating errors in precision thermometry using thermistors or PRTDs (platinum resistance temperature detectors). The guard output is useful in performing in-circuit measurements on resistance networks or reducing the effective capacitance in long runs of interconnect cabling. Keithley Instruments Limited, 1 Boulton Road, Reading, Berkshire RG2 0NL.
EWW 212



200 WATT SWITCHED P.S.U.

Powerline's F200 switched-mode power supply provides five outputs at 200W total, with pulse overload capability on all outputs. The main +5V output provides 25A with pulse load capability to 40A. Auxiliary outputs are +12V at 5A (10A pk), —12V at 5A (10A pk), —5V at 5A (10A pk) and +24V at 5A (10A pk).

The F200 has been designed to be mechanically similar to competitors' power units, but having the facility to trade power and allow for high peak currents to be taken from all the outputs. It has been designed in accordance with IEC 380 and IEC 435, VDE 0804 and VDE 0806, TG2 and TG26 and BS 5850 safety requirements. Powerline Electronics Ltd, 5 Nimrod Way, Elgar Road, Reading. EWW 213



FREQUENCY COUNTERS

The three versions of the Meteor range of frequency counters from Levell are for measurement of frequencies up to 100MHz, 600MHz and 1GHz: 'X' versions are also available fitted with temperature compensated crystal oscillators for improved accuracy. These counters have an 8 digit 0.5in led display with automatic decimal point and overflow warning. Sensitivity is 5mV up to 1MHz and 50mV at 1GHz with resolution down to 0.1Hz. Mains-input protection and a switched low-pass filter are included. A 10MHz crystal oscillator gives settability of $<\pm 0.5$p.p.m., temperature stability of $<\pm 2.5$p.p.m. 10°C to 40°C and ageing of $<\pm 5$p.p.m./year. The 'X' versions give improved settability of $<\pm 0.2$p.p.m., temperature stability of $<\pm 0.5$p.p.m. 0°C to 40°C and ageing of $<\pm 1$p.p.m./year.

Power is supplied by rechargeable batteries of a.c. mains supply via a mains adaptor/charger unit. A telescopic aerial is available to enable this portable instrument to be used for transmitter frequency measurement in the field. Levell Electronics Ltd, Moxon Street, Barnet, Herts, EN5 5SD. EWW 214

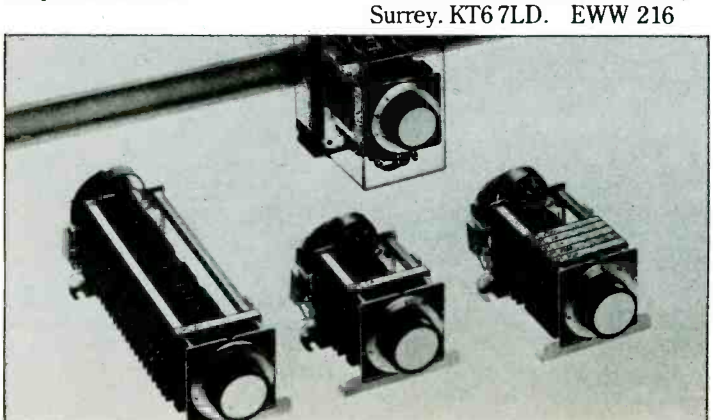
MOTORIZED POTENTIOMETERS

A range of motorized potentiometers with a 5W power rating, by Micro Electric Ltd of Switzerland, is Swissinco UK Ltd.

The Micromat[R] Series MPD 4000 potentiometers combine programmable cam-type timer units with a potentiometer drive. Features include high nominal resolution resistance tolerance of ±5%, excellent linearity (better than 0.25%), a friction drive which protects the unit when manually operated, solid mechanical stops, and two adjustable limit switches controlling the rotation angle of the potentiometer.

The standard units comprise a drive, cams and microswitches, potentiometer(s), and a frame with setting knob and scale. Drive unit options (24 to 220V a.c. or 24V d.c.) provide two directions of rotation and a broad range of cycle times from 3 to 36 hours.

All units have two cams fitted which allow an electrical limitation of the potentiometer's angle, and other cams are provided in accordance with each customer's requirements. The design permits easy programming adjustments by the user. Swissinco UK Ltd., Unit 2, 225 Hook Rise South, Surbiton, Surrey. KT6 7LD. EWW 216



ACTIVE A.M. ANTENNA

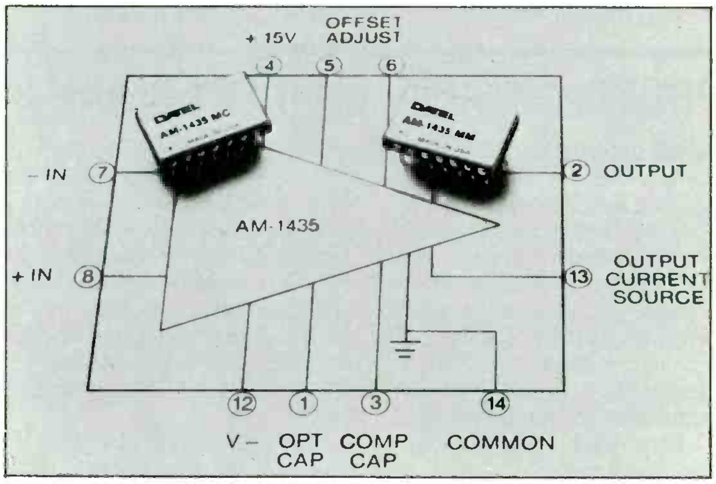
The Active AM Antenna 10 should get a warm reception from radio listeners whose 'tune in' preferences are the long and medium wavebands — audience figures indicate there are upwards of 10 million of them in the UK.

In a robust, 24.5 cm diameter, round plastic disc casing, the mains-powered Active Antenna from B and O is designed to enhance a.m. reception for all Bang & Olufsen Beomaster and Beocenter radios. It costs around £27.50, and can be used in conjunction with other radio receivers equipped with an a.m. antenna socket.

The antenna has a sensitivity which stands comparison with efficient roof aerials, say the manufacturers. It is directional and can be simply rotated to achieve optimum reception of desired stations, and to exclude interference from other stations or domestic electrical noise sources.

It employs the magnetic component of broadcast transmissions, by means of two ferrite rod aerials and an amplifier. The two aerials are precision-coupled to 'flatten out' the signal amplitude across the entire frequency range and eliminate the need for variable components which, in conventional designs, have to be manually adjusted when changing from one station to another.

The directional performance of the active antenna is claimed to be excellent, making it an extremely useful accessory in difficult reception areas. Installation requires connection to the radio's a.m. socket and to the mains supply. Bang & Olufen UK Limited, Eastbrook Road, Gloucester GL4 7DE. EWW 215



WIDEBAND OPERATIONAL AMPLIFIER

AM1435 from Datel is an ultra-fast-settling, wideband operational amplifier that is directly interchangable with devices having the same type number.

It provides high open-loop gain (100dB), flat frequency response beyond 10kHz and a 6dB/octave roll-off to beyond 100MHz, which suit the AM1435 for application in radar and sonar signal processing, video instrumentation and ultra-fast data-acquisition systems. Gain-bandwidth product is typically 1GHz and slew rate is 300 volts per microsecond.

D.c. characteristics include 1 megohm input impedance, initial offset voltage of only ±2 mV and an input offset voltage drift of ±5 microvolts/°C. Minimum common-mode rejection ratio is better than 80dB and full power frequency bandwidth is 8MHz minimum. Output voltage swing is ±5V minimum at 10mA load current and the AM1435 remains stable with capacitive loads up to 1000pF.

The AM-1435 is specified for operation over the commercial, industrial and military temperature ranges and is housed in a 14-pin, hermetically sealed, ceramic d.i.p. Datel Division, G.E. Intersil Datel (UK) Ltd., Belgrave House, Basing View, Basingstoke, Hants. EWW 217

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No. 4. Pri 220-240V Sec 6.3V 5ACT 6.3V 2ACT **£5.00**
No. 5. Pri 220-240V Sec 40V 3A **£6.25**

All prices inc. VAT and carriage

15AMP ISOLATION TRANSFORMERS BY FAMOUS MAKERS

These high grade transformers are as new and were manufactured for a top U.K. electronics company to extremely high standards. Each transformer has a large range of tappings for adjusting inputs and outputs.
Size approx 220mm×280mm×320mm Weight approx 37kgs. Our price **£95** inc. VAT Ring For Carriage Details

CONSTANT VOLTAGE TRANSFORMERS

Gould Advance
Typ 240V output ± 1%

150W .... **£15.00** carr £2.95
250W .... **£39.50** carr £3.75
500W .... **£85.00** carr £7.50
3000W .... **£295.00** carr £20.00

All prices inc. VAT

PAPER BLOCK CAPACITORS

8MFD 2500V WKG DC **£6.50**
10MFD 350V WKG DC **£15.00**
8 MFD 400V WKG DC **£2.50**
4 MFD 1000V WKG DC **£2.00**
1 MFD 1000V WKG DC **£1.25**

All prices inc. VAT and carriage

FANS

MUFFIN 4½" 110V **£4.00**
WOODS 6" and 8" 240V **£9.50**
Tangential Blowers 240V approx 3"x15" vent. Very powerful. **£11.**

All prices inc. VAT and carriage

AUTO STEPDOWN TRANSFORMERS FOR AMERICAN EQUIPMENT

240/110 Volts. 80-2250 watts. Regular stock line. Types 80-1500 watts are fully shrouded. Fitted with American two or three pin socket outlets and 3 core 240V mains lead. Types 1750 and 2250 watts are steel cased with two American socket outlets. Neon indicator, three core mains lead and carrying handle. Send SAE for price list and further details. American sockets, plugs, adaptors also available.

AVOMETERS

We have in stock a limited quantity of excellent quality AVOs.
AVO 8 **£59.95** inc. VAT. AVO 7 **£37.50** inc VAT. AVO MINOR **£20** inc. VAT. Callers only, or ring for special delivery.

MEGGERS

Special offer!! 250V and 500V metrohms at give-away prices. Buy now while stocks last. **£35** + VAT. Callers only or ring for special delivery.

DIGITAL CLOCK MOVEMENTS

A well made clock 'movement' fitted with timer mechanism and neon illumination. Size approx 110mm×50mm×50mm 240V a.c. operation. A Snip At **£3.95** inc VAT & Carraige

SWITCH MODE POWER SUPPLIES

By Gould Advance

5V 40 amp **£35.** 5V 20 amp **£25.** 10.5V 20 amp **£30.** Inc. VAT and carriage.

HIGH GRADE LT TRANSFORMERS

ALL PRIMARIES 240v
OPEN FRAME TOP PANEL CONNECTIONS

No 1 tapped 2-3-4-5-6-7-8-9-10-11-12-13-14-15v 8A **£10.** No 2 12v 8A **£7.50.** No 3 tapped 13-12-10-8v 8½A **£9.** No 4 Sec 6.3v 2A 6.3v 2A and 32-0-32v 280 m/a **£4.75.** No 5 Sec 37v 1.5A, 15v ½A, 9v 50 m/a **£3.95.** No 6 Sec 14v 2A **£3.95.** No 7 Sec 27.5-0-27.5v 1.2A and 7-0-7v 750 m/a **£3.50.** All prices include postage and VAT.

PARMEKO LT TRANSFORMERS

Open frame type top panel connections, prices include postage and VAT

No 1 12-18-32V 2A (DC rating) and 12-18-32V ½A (DC) **£9.** No 2 12-18-32V 1A (DC) and 12-18-32 ¼A **£5.** No 3 12-18-32V ½A (DC) and 12-18-32V 100 m/a **£3.95.** No 4 12-18-32V ¼A (DC) and 12-18-32V ¼A (DC) and 12-18-32V 50 m/a (DC) **£2.50.** No 5 32V 100 m/a (DC) and 32V 25 m/a DC **£2.50.**

HEAVY DUTY AMPLIFIER TRANSFORMERS MADE BY FAMOUS MAKER

These superbly constructed transformers have an output of 40V—0V—40V at a massive 2000 watts conservatively rated.
SPECIAL OFFER Price **£40** inc. VAT
Ring For Carriage.

GARDENERS 'C' CORE TRANSFORMERS

PRI+10V, 0V, 200V, 220V, 240V, (screen). Main outputs seperate windings 29V and 3V tappec at 1V will give 26V, 28V, 29V, 30V, 33V at 15amps. Size 150×133×170
Price **£18.00** inc. VAT & Carriage.

SPECIAL OFFER. CLAUDE LYONS VOLTAGE STABILISER. Input 210-270V a.c. Output 240V a.c. ± ·5%!!! Rated at 2.9kVA. Ideal for stabilising computer supplies
£195 inc. VAT. Carriage £12
Hurry – only a few left

GOULD ADVANCE P.S.U.s. 13.8V 30amp d.c. supplies. Great for linears!!! **ONLY £65** inc. VAT. Carriage £3. Limited offer

6000w CONSTANT VOLTAGE TRANSFORMER BY REGAVOLT

This high grade piece of equipment has inputs of either 220 or 240V a.c. — 20% + 12%
Output 220 or 240V + — 1% Please Note This C.V.T. Has Isolated Secondaries
Size 17.5"×11.5"×26" Weight 3cwt
Price **£550** inc VAT Ring for carriage details
Note: this transformer is ideal for computer P.S.U.s

E.H.T. DC SUPPLY

Mounted on P.C.B. with fuseholder and mains input block. Output 5KV at 20m/a.
Our Price **£5.50** inc. VAT & Carriage

E.H.T. TRANSFORMERS

High-grade E.H.T. Tranny, PRI 240V, sec. 10,000V, 18 M/A. Probably used for boiler ignition but with 101 other uses!!!
£5 inc. carr. & VAT.

PARMEKO OP TRANSFORMERS

Pri 6000 or 8000Ω or CT Sec 3.75 or 15Ω Ser/Par for EL84×2 12.5W **£4.50.** Pri 5000 for EL84 3W Sec **£3.75** or 15Ω Ser/Par **£2.50.** Pri 30-45-60-90 to 1 also 90TOI for push/pull Sec 3.75Ω **£2.** All prices include postage and VAT.

AC WKG CAPACITORS

MFD	AC wkg	Price	MFD	AC wkg	Price
0.25	1500v	£1.50	5	360v	£1.75
0.75	440v	£1.00	5	440v	£2.00
1	400v	£1.50	4	600v	£2.00
2.5	360v	£1.50	6	300v	£2.00
2.7	700v	£1.75	8.4	250v	£1.50

All prices include postage and VAT

ELECTROLYTIC CAPACITORS

22,000 63V DC wkg. 33,000 40V DC wkg. 3,000 50V DC wkg. 20,000 45V DC wkg. 6,500 50V DC wkg. All **£4 each** inc VAT and carr.

PARMEKO HT CHOKES

10H 250m/a	£5.95	20H 75m/a	£3.50
5H 250m/a	£5.50	10H 75m/a	£2.95
5H 180m/a	£4.75	7.5H 60m/a	£2.50
2.5H 500m/a	£5.95	15H 120m/a	£3.95
2.5H 250m/a	£5.50	50H 10m/a	£2.50
20H 120m/a	£4.75	25H 60m/a	£2.75

All prices include postage and VAT

HEAVY-DUTY L.T. CHOKES

C core type 10 m/h 25 amps **£10** carr. £3, VAT £1.95.

SPECIAL OFFER HIGH-GRADE ISOLATION TRANSFORMERS

Open frame terminal block connections **£29.50,** carr. £4, VAT £5.02. Pri 240V, Sec 240V, 250 watts, open frame type tag connections, **£10,** P&P £2, VAT £1.80. Pri 100-110-200-210-220-230-240-250V, Sec 220-230-240V 600W, can be used in reversed open frame type terminal block connections, **£15,** carr. £2.80, VAT £2.67.

PARMEKO NEON TRANSFORMERS

PRI tapped 200-220-230-240-250V. Size 7000V 55 M/A. Totally enclosed in wall mounting steel case. Size 9½x8½x4½in.
£17.50 inc. VAT and carriage
PRI tapped 200-220-230-240-250V. Size 5000V 20 M/A. Totally enclosed in wall mounting steel case. Size 7x6x5in.
£12.50 inc. VAT and carriage

COMPUTER GRADE LT TRANSFORMERS BY FAMOUS MAKERS ALL PRIMARIES 220-240V

PRICES INCLUDE POSTAGE AND VAT

No 1 Sec 43V 3A £6.95. No 2 Sec 40V 3A **£6.95.** No 3 Sec 65V 1A and 18-24V ½A **£5.95.** No 4 Sec 25V 2A **£4.50.** No 5 Sec 24V 2A **£4.50.** No 6 Sec 27.5-0-27.5V and 7-0-7V 0.75A **£5.25.** No 7 Sec 13-0-13 A and 12V A £ . No 8 Sec 60V 1½A **£4.95.** No 9 Sec 40V 1½A **£4.50.** No 10 Sec 10-7-0-7-10V ½A and 29-21-0-21-29V 370 m/a, c core **£4.25.** No 11 Sec 55V ½A **£3.75.** No 12 Sec 24V 3A and 110V ½A **£7.95.** No 13 Sec 28V 1½A and 24V 1½A **£5.50.** No 14 Sec 36V ½A **£3.50.** No 15 Sec 20V 2A **£3.75.** No 16 Sec 12-25V 2A **£3.75.** No 17 Sec 24-0-24V 1A and 6.3V 1A **£4.95.** No 18 Sec 24V 4A **£5.50.** No 19 Sec 12-15-20-24-30V 1A **£4.75.** No 20 Sec 4.5V 5A twice **£4.50.**

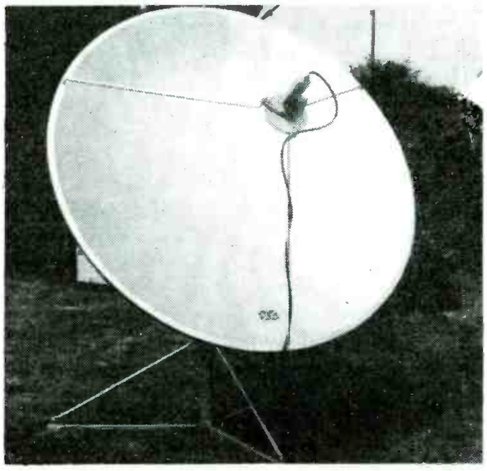
PARMEKO HT TRANSFORMERS

ALL PRIMARIES 220-240V
POTTED TYPES

No 1 Sec 500-0-500V 120 m/a 6.3V 5A 6.3V 3A 5V 3A **£8.50,** inc postage and VAT. No 2 Sec 300-0-300V 60 m/a 6.3V 2A CT 6.3V 1A **£6.50** inc postage and VAT. No 3 400-0-400V 180 m/a **£6.50** inc postage and VAT. No 4 Sec 400-0-400V 150 m/a and 150-0-150V 20 m/a **£6.50** inc postage and VAT. No 5 Sec 350-325-0-325-350V 120 m/a **£6.50** inc postage and VAT. Gresham Pri 220-240V, Sec 250V 80 m/a 6.3V 4.5A 15V 1.2A **£5.95** inc postage and VAT. Pri 230-250V, Sec tapped 190-210V 24 m/a 6V 1A **£3.95** inc postage and VAT. Pri 220-240V Sec 300V 200 m/a 30V 100 m/a 6.3V 5A half shrouded, sub chassis mounting **£6.50** inc postage and VAT. Pri 220-240V Sec 370-390-410V 6 m/a **£2.75** inc postage and VAT. WW-16

CIRCLE 84 FOR FURTHER DETAILS.

SATELLITE RECEIVING EQUIPMENT



1.9M, 2.5M and 5M Harrison Dishes. Sat-Tec R5000 4GHz Receivers. Avcom COM-2B 4GHz Receivers. California Amplifier 4GHz LNAs. Chaparral Horns. Harrison Feed Horns.

Demonstrations by appointment only.

Dealer enquiries welcome

For further details contact: Harrison Electronics, 22 Milton Road, Westcliff-on-Sea, Essex SS0 7JX. Telephone: Southend (0702) 332338.

CIRCLE 86 FOR FURTHER DETAILS.

JOYSTICKS CONTROLS

By specialisation, volume production and tightly-controlled overheads we are able to offer competitively-priced, well engineered, innovative and reliable joystick controls ranging from £1.50 each (for TV games units in quantity) to £2,000 for a one off triple axis force feedback system, including torque motor amplifiers. Our current ranges cover most combinations of:—

- 1, 2 or 3 axes, or up to 6 degrees of freedom.
- Potentiometer, wafer switch, microswitch and contactless sensing.
- Spring, friction or detent positioning, or force feedback systems.
- Press button switches in handles or handgrips.
- Miniature TV game units to heavy duty types for mobile and heavy engineering environments. In addition we can design and build special requirements into standard units within days.

OVERSEAS DISTRIBUTION

- **ITALY, FRANCE, GERMANY, SWITZERLAND, AUSTRIA:** Velco SRL, Contra Fransesco 75. 36100 Vicenza, Italy. 0444/36444. TX431075.
- **HOLLAND:** Silema, Wilhelmlaan 111 2182 CC, Hillegom, Holland.

AUSTRALIA: Tecnico Electronics. Lane Cove, Sydney, NSW Australia. Sydney 4273444
- **USA and CANADA:** P.Q.Controls Inc. 95 Dolphin Road, Bristol, Connecticut 06010 USA (203) 593 6994. TX 643127
- **SWEDEN:** Svensk Telindustri, Box 5024, 9162 05 vallingby, Sweden 8 380/320.

FLIGHT LINK CONTROL LTD.
UNIT 12 THE MALTINGS, PHONE 0420 87241 (24 HRS)
TURK STREET, ALTON, HANTS, TELEX 859623 TELBUR G

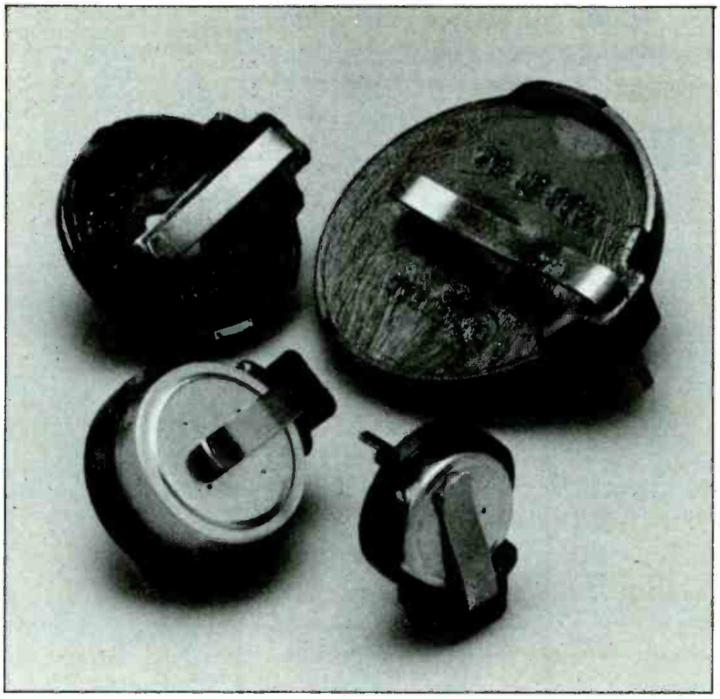
CIRCLE 91 FOR FURTHER DETAILS.

200NS EEPROM

Am9864, a 64-Kbit eeprom from Advanced Micro Devices, is a 200ns device that can be electrically altered in system. The Am9864 features a self-timed write cycle with a write time of 10 milliseconds, and uses a ready/busy pin to indicate the completion of the write cycle. It is pin-compatible with the AM2764 64Kbit eprom.

Three data-protection features prevent accidental writing into memory during transition states. Data is protected by inhibiting write-cycle initiation when the supply voltage is less than 3.8V; by preventing write-enable pulses or less than 20ns duration from initiating a write cycle and a feature that ensures a write cycle cannot be initiated when the output-enable control is in the enabled state.

Am9864 is offered in 200ns, 250ns, and 350ns versions, and is available in ceramic d.i.p. packages. The 200ns version is priced at £140.70 each and the 250ns version £108.24 each in 100-off quantities, in ceramic packages. Samples of the Am9864 are now available, with volume production planned for September. Advanced Micro Devices (UK) Ltd, AMD House, Goldsworth Road, Woking, Surrey GU21 1JT. EWW 218



P.C. BATTERY HOLDERS

Gould Micro Power Systems has introduced a range of plastic battery holders which allow zinc-air button cells to be mounted directly onto printed-circuit boards. They are produced in a heat-stable material, with a low-profile design and spacer feet allowing air flow. These holders, which cover all the standard sizes and ratings of zinc-air cells, enable equipment designers to exploit the energy-density benefits of zinc-air cells directly in memory-back-up or portable-equipment applications.

Typically, the Type 630EL zinc-air cell offers 950mAh with a maximum drain rate of 42μA. Gould Micro Power Products Division, 11 Ash Road, Wrexham Industrial Estate, Wrexham, Clwyd LL13 9UF. EWW 219

HIGH—PRESSURE PROXIMITY SENSORS

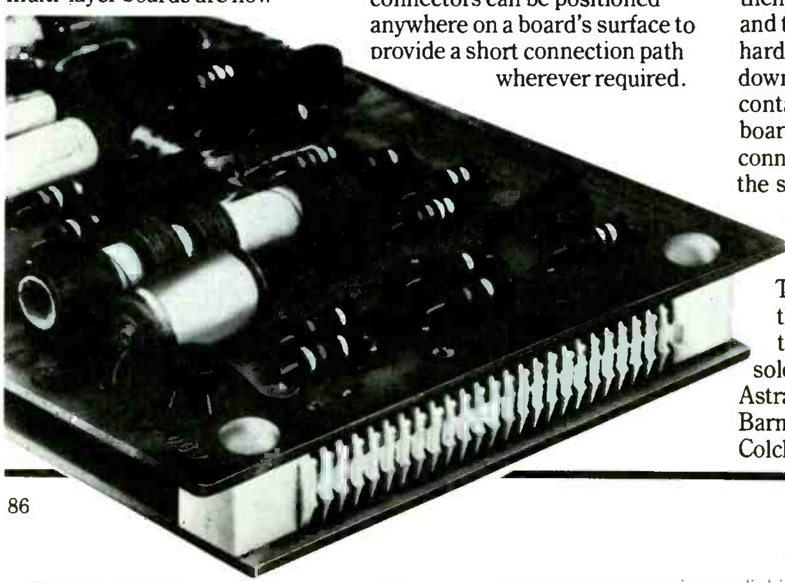
A series of inductive proximity sensors from Honeywell is capable of withstanding pressures up to 500 bar. These devices can be used for any applications where there is direct fluid pressure on the sensing face.

The front face of each device is made of ceramic and sealed to withstand pressures up to 500 bar, static and the sensor probe can vary in length as required by the application. Sealing of the stainless steel housing and factory-terminted cable is to protective class IP68, the standard cable length being 1.5 metres. The device will operate in a temperature of -25° to +85°C, requires between 5 and 55V d.c. and has overload and short circuit protection. Honeywell Control Systems Ltd., Honeywell House, Charles Square, Bracknell, Berkshire. RG12 1EB. EWW 220

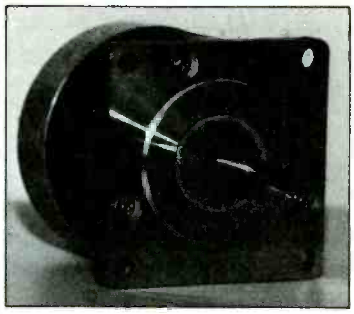
LOW-COST MULTI-LAYER BOARDS ALTERNATIVE

P.c.b. connectors which offer a low-cost alternative to multi-layer boards are now available from the Distribution Division of Astralux Dynamics Limited.

Called Burndy Qikstack connectors, they are 25-way surface-mounting devices which enable a number of boards to be stacked in parallel with each other to form a complete multi-board assembly. The connectors can be positioned anywhere on a board's surface to provide a short connection path wherever required.



Minimal board preparation is necessary: only the fitting of solder pads, and drilling of connector mounting holes; plus checks to ensure that the profile of components on each board is as low as possible. Connector contacts do not require soldering or welding. Boards are attached to each other by interspersing them with Qikstack connectors, and tightening the mounting hardware. This presses the boards down onto all the connector contacts simultaneously. As the boards bear down on each connector, its contacts penetrate the solder pads and form reliable gas-tight connections whose resistance is only 30 milliohms at 3A, 300 V.a.c. The mating forces are low, so that the possibility of damage to circuits, components and soldering joints is eliminated. Astralux Dynamics Limited, Red Barn Rod, Brightlingsea, Colchester, Essex. EWW 221



HIGH STEPPERS

A new range of SLO-SYN stepping motors from Micromech Ltd, the MA61 series, are claimed to have an extremely high torque and to set new standards in step angle and position accuracy. The MA61 can also produce up to twice the holding torque of conventionally constructed motors. Since they are capable of withstanding a load of five times the rated current, the makers claim that this new range of motors may be safely over-driven to produce high torque in a relatively small frame size.

A step accuracy of typically 98.7% makes them ideally suited for application in X-Y plotters, printing mechanisms and other computer peripheral equipment. Micromech Ltd, 12 Driberg Way, Braintree, Essex. EWW 222

Three new names from IQD- the leaders in DTMF equipment.

CODEPAD MICROPAD SELCALL

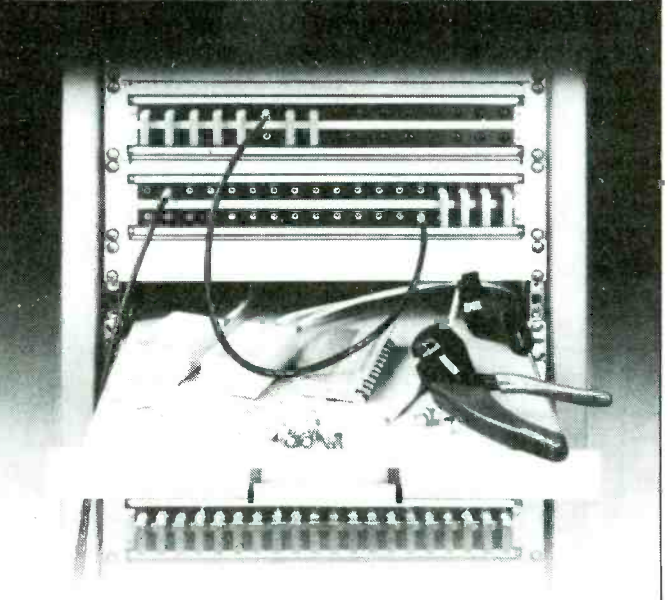
IQD offers the most advanced DTMF signalling equipment on the market.
IQD Codepad: the best in portable tone diallers, available in three models.
IQD Micropad: a microphone with not only the standard functions, but many additional features including an illuminated keyboard version.
IQD Selcall: a superior DTMF signalling unit with an extensive program facility giving you selective access to 99 sub-stations.

Telephone (0460) 74433 for further information.

IQD Ltd
North Street
Crewkerne
Somerset TA18 7AR
England
Facsimile (0460) 72578
Telex 46283

CIRCLE 75 FOR FURTHER DETAILS.

FFD Video Interconnections FFD



...listed in the 1984 FFD Catalogue.

FFD FUTURE FILM DEVELOPMENTS
P.O. Box 3DG, 114 Wardour Street, London W1A 3DG, England.
Telephone: 01-434 3344 & 01-437 1892. Telex: 21624 ALOFFD G.
Cables: Allotrope-London W1.

CIRCLE 79 FOR FURTHER DETAILS.

TIME WRONG?

MSF CLOCK is ALWAYS CORRECT — never gains or loses, SELF SETTING at switch-on, 8 digits shows Date, Hours, Minutes and Seconds, auto GMT/BST and leap year, can expand to years, Months, Weekday and Milliseconds, parallel BCD output for computer and audio to record and show time on playback, receives Rugby 60KHz atomic time signals, only 15×5×8 cm, built-in antenna, 1000Km range, £79-70, GET the TIME RIGHT.

60KHZ RUGBY RECEIVER, as in MSF Clock, serial data output for computer, decoding details, Basic listings, £25-80.

Each fun-to-build kit (ready made to order) includes all parts, case, by-return postage etc and list of other kits.

CAMBRIDGE KITS

45 (WJ) Old School Lane, Milton, Cambridge. Tel 860150

CIRCLE 28 FOR FURTHER DETAILS.

VIDEO TERMINAL BOARD

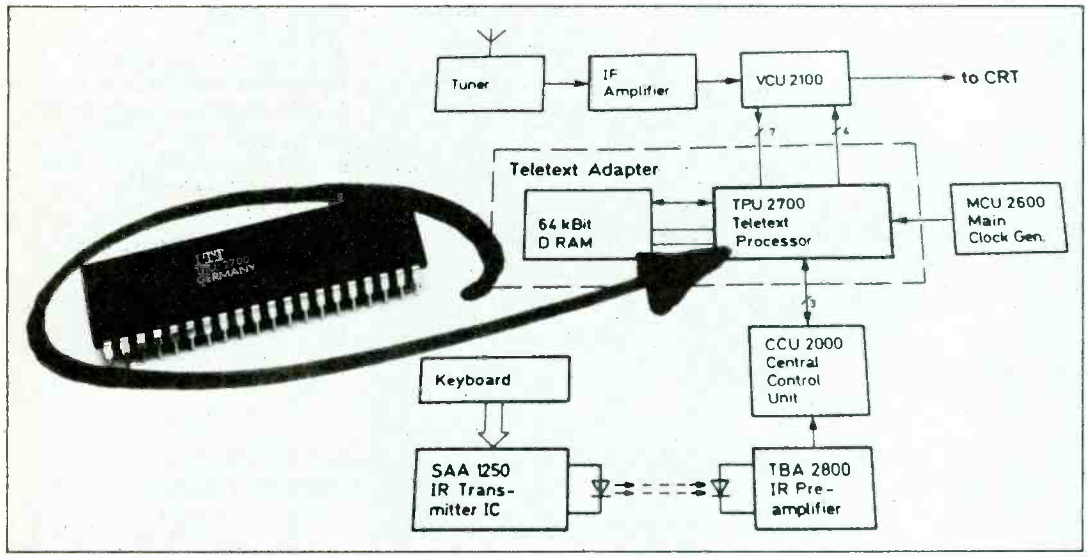
★ 80 characters × 24 lines ★

Requires ASCII encoded keyboard and monitor to make fully configurable intelligent terminal. Uses 6802 micro and 6845 controller. Program and character generator (7 × 9 matrix with descenders) in two 2716 EPROMs. Full scrolling at 9600 baud with 8 switch selectable rates. RS232 interface.

Bare board with 2 EPROMS and program listing — £48 plus VAT. Send for details or CWO to:

AM ELECTRONICS
A M Electronics
Wood Farm, Leiston, Suffolk IP16 4HT
Tel: 0728 831131

CIRCLE 44 FOR FURTHER DETAILS.



ONE-CHIP TELETEXT DECODER

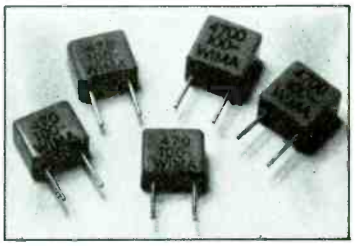
The TPU2700 from ITT Semiconductors provides a single chip solution to teletext decoding, with the capability of acquiring and storing eight pages simultaneously. It decodes the standard Level 1 teletext transmissions widely used in the UK and other European countries, and interfaces directly to the digital signal processing Digit-2000 v.l.s.i. circuit family.

Up to eight stored pages are controlled by the processor, giving a much reduced access time over current multi-chip decoder designs. A menu of the stored pages is also available to the user. The only external components necessary to build a decoder is some ram in the form of a single 64K × 1 device, or a number of 16K parts. Standard, low-cost dynamic ram can be used without speed problems by virture of an on-chip fifo buffer.

The processor will also underline and automatically select character sets. This single device will serve in receivers for eight different language teletext transmissions. Compensation for ghost pictures with delays up to 0.8 microseconds is automatically performed, and the device works on either PAL or NTSC standards.

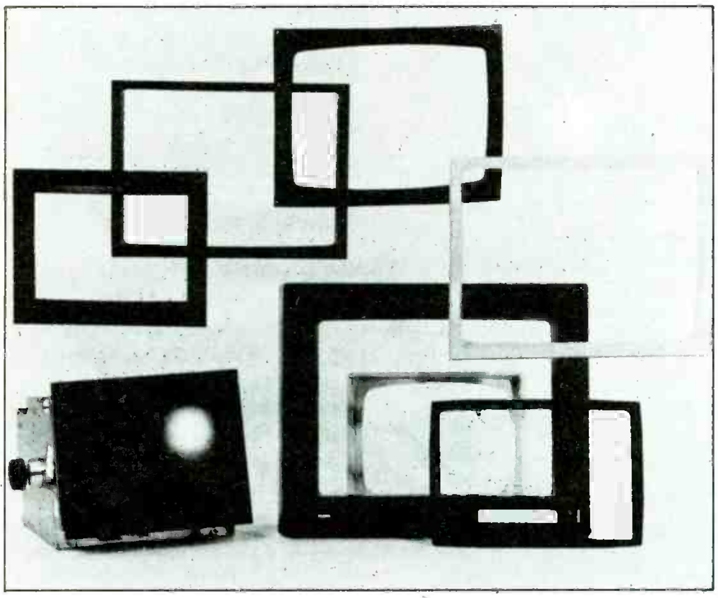
The TPU2700 comes in a 40-pin plastic d.i.p., requires a single 5V supply and consumes typically 1.25W.

ITT Semiconductors, 145-147 Ewell Road, Surbiton, Surrey, KT6 6AW. EWW 223



POLYSTYRENE REPLACEMENT CAPACITORS

The WIMA FKP2 series of polypropylene film/foil capacitors is now available in E48 capacitance values with 2.5% tolerance. These miniature, radial-leaded capacitors with 5mm pitch mounting are encapsulated in flame retardant cases. They are inherently resistant to cleaning solvents normally used in the electronics industry and thus they can be mounted on p.c.bs prior to normal board cleaning. The FKP2 series is available from 220pF to 0.01μF at 63V d.c. and is available loosely boxed or taped in either roll, reel or Ammo-packs. Waycom Ltd, Wokingham Road, Bracknell, Berks RG12 1ND. EWW 224



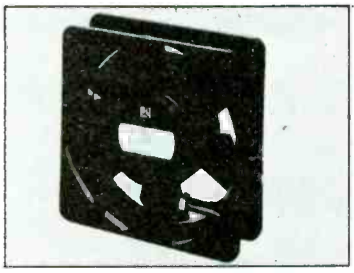
V.D.U. BEZELS

A range of v.d.u. bezels is available to accomodate all c.r.ts from 5in to 17in from G.A. Stanley Palmer Ltd. Bezels are available for both front and rear entry into the monitor housing. The standard colour is black, but other colours can be supplied to special order. Bezels can be fitted with moulded, anti-glare, contrast-enhancement filters using the 'Homalite' material already available from G.A. Stanley Palmer Ltd since 1980. G.A. Stanley Palmer Ltd, West Molesey Trading Estate, Surrey KT8 0UR. EWW 225

SUBMINIATURE TRIMMER POT

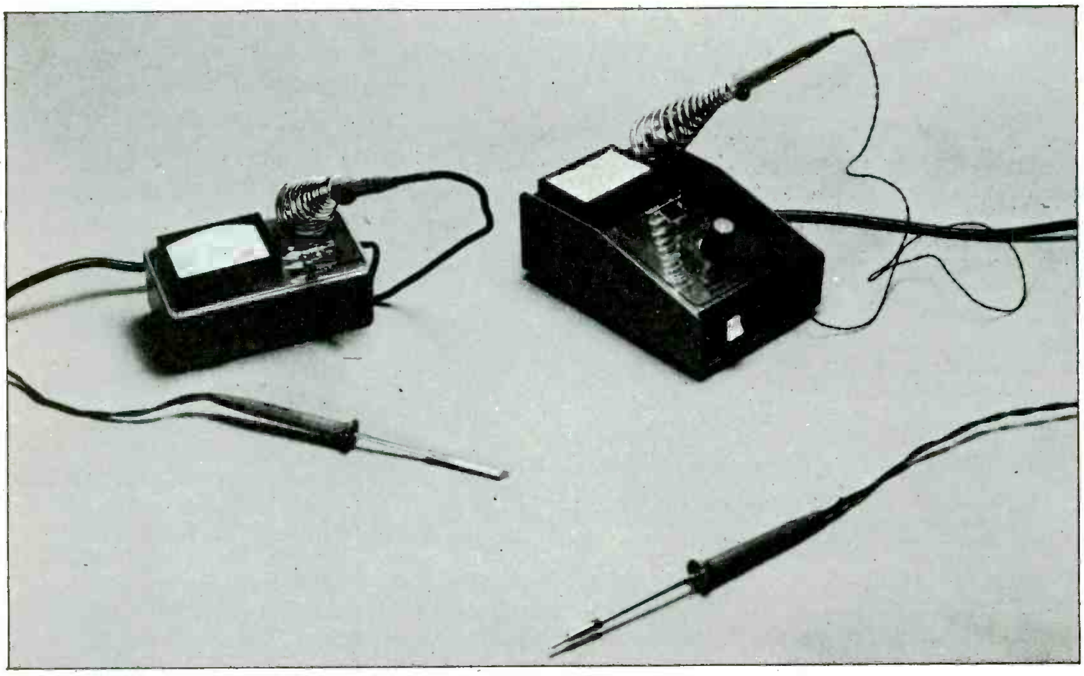
Murata have introduced a range of 1/10W subminiature trimmer potentiometers which use a moulded resin substrate with a carbon element fired to it and a single or double contact wiper, which is screwdriver adjustable. This simple two-part construction is claimed to give the RVF6 (single contact 6mm dia.) and RVF8 (double contact 9mm dia.) devices the advantage of outstanding reliability, and the makers say that the high-temperature fired carbon element provides stability in the most adverse environments and reduces resistance drift with temperature to less than half that of other similar devices.

A variety of pin configurations is available, and cartridge packing can be supplied. Both the RVF6 and RVF8 can be adjusted from front or back, have snap-in legs and are available with dust cover. Murata Erie Electronics UK Ltd., 100-102 Albert Street, Fleet, Hants. EWW 231



QUIET COOLING FAN

A range of cooling fans for quiet operation in office and domestic equipment is made by Papst. The latest is the 412GXL, which operates from a nominal 24V d.c. supply, produces an airflow of $85m^3/h$ at an operational noise level of only 28 dB(A). The airflow and noise level can be adjusted by operating within the permitted voltage range of 18 to 30 volts d.c. The low noise is attributed to a re-designed venturi and impeller shape. Dimensions are 119×119×38mm. At 24Vd.c., the motor uses 1.1W. Papst Motors Ltd, East Portway, Andover, Hants. EWW 226



MINATURE SOLDERING IRONS

The Oryx Micro Series of soldering irons, the smallest in the Greenwood 'Oryx' range, have been designed for intricate circuit work. They provide maximum heat in a concentrated area and offer typical tip temperatures of around 320°C. Typical unit weight is only 4 grams, The range includes 5, 6, 9, 11, 12, 18 and 25 watt models and operating voltages include 6, 12, 24, and 50 volts. A power-supply stand and cleaner, the Micro P.6.6, offers 115/240 V.a.c. mains operation and delivers a safe, isolated output for the 6V, 6W Micro iron. The Micro P.T.6.6 variable temperature unit is also available. With this, the tip temperature of the iron can be controlled between 120°C and 400°C via a control knob on the base stand. Greenwood Electronics, Portman Road, Reading, Berks. RG3 1NE. EWW 227

M.P.U.-BASED PANEL THERMOMETER

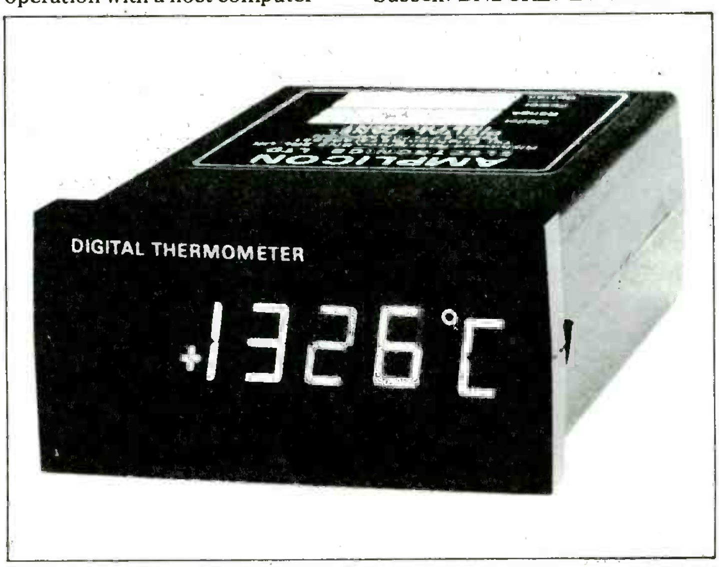
Amplicon Electronics Ltd announces a microprocessor-based, high performance 3½-digit thermocouple meter at £199.

The model 2051 digital panel thermometer measures temperatures in the range -256 to +1999°F or -165 to +1760°C. user-accessible switches are used to select thermocouple type and °C/°F scaling, whilst the meter is supplied with reversible bezel to show either °C or °F.

Gain, offset-error correction, cold-junction compensation and thermocouple linearization are supplied by the meter's internal microprocessor, which also provides 7 bit parallel ASCII characters in a nine-character serial sequence of polarity, temperature, space, C or F, carriage return and line feed. Digital outputs, with strobe, may be directly connected to the company's Model 24 digital panel printer to provide hard copy printout.

Additional circuitry is optionally available to provide a linearized 1mV/degree analogue output for chart recorders and an optically isolated serial 20mA current loop output, which may be used as four-wire, full-duplex operation with a host computer located up to 3km from the meter.

The 2051, which will operate from mains or d.c., is housed in a DIN or NEMA standard case. Amplicon Electronics Ltd, Richmond Road, Brighton, East Sussex. BN2 3RL. EWW 228



STE BUS BACKPLANES

Interconnection backplanes for the Eurocard-based STE bus market are available from Dage Systems. The ST14 range is in five sizes, offering either 7 or 14 slots using a 0.6in card pitch, or 5, 10 or 21 slots with 0.8in pitch. This choice provides designers with versions for quarter-, half- or full-width card frame systems using 19in standard packaging.

The p.c.bs are of four-layer construction, and are fully fitted with DIN 41612 connectors. Tracks are separated by 0.5mm, giving an unloaded characteristic impedance of typically 60 ohms. One, preferred, assembly option offers long connector pins protected by reverse DIN-style bridging shrouds at the end positions, allowing the use of pluggable termination-network modules. The rest of the DIN connectors in the backplane are standard short-terminal types.

The SYSCLK signal line has been sited as far away as possible from other lines to avoid crosstalk. Along with three other signals, SYSERR, SYSRST and ATNRQO, the SYSCLK line has been extended to additional pins at the end of the backplane for ease of system testing. Also, the power tracks have been made very wide, extending to within 8mm of the board edge, so that the backplanes easily deal with the maximum demands of the bus specification.

The backplane fully conforms to the IEEE P1000 committee specification for the bus, and remains fully compatible with the requirements of IEC 297 and DIN 41494 specifications. Standard FR4 epoxy material is used for p.c.b. construction. Dage Systems, Rabans Lane, Aylesbury, Bucks. EWW 229

FAST OP-AMP

With a slew rate of 600V/μs, settling time of 350ms to 0.1% and 600MHz gain/bandwidth, the TP1342 from Teledyne Philbrick should be well suited to video, c.r.t. graphics or fast track-and-hold work.

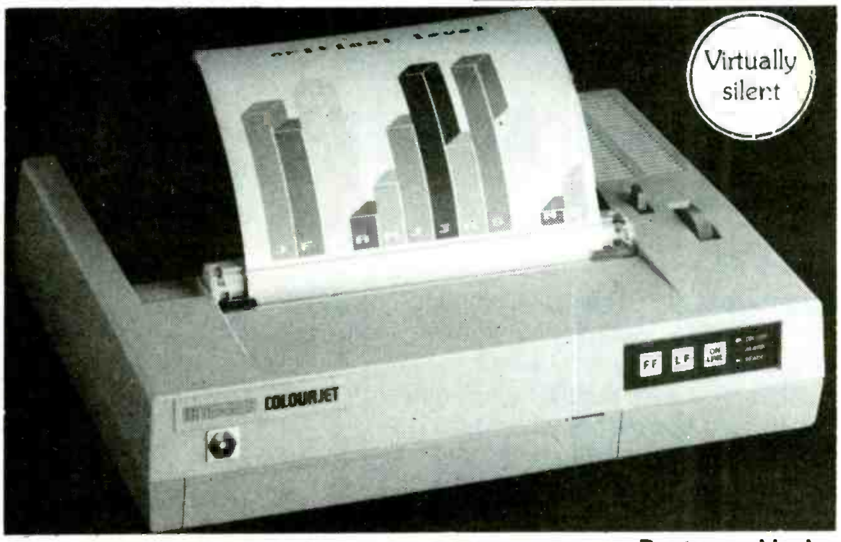
The standard version is in a 14-pin ceramic d.i.p. and works over the 0°—75°C temperature range(TP1342-01 from-55°-125°C).

MCP Electronics Ltd, 38 Rosemont Road, Alperton, Wembley, Middx. EWW 230

COLOURJET 132

7 COLOUR INK JET PRINTER

Logic seeking in dot address mode



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CIRCLE 68 FOR FURTHER DETAILS.

The way ahead for 8-bit computers

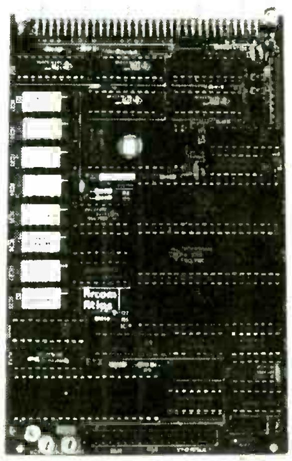
Arcom's new range of STE Eurocards point the way.

A compatible Eurocard standard is now available from Arcom that will make other Eurocards obsolete. A growing range of boards is now available which use the new STE bus interface (IEEE P1000).

The Z80A* based CPU board offers 64K DRAM, up to 32K EPROM and two RS 232 serial ports. Four extra I/O lines are provided plus a parallel keyboard port and the board can address 192K bytes of off board memory. The on board floppy disk controller can handle up to four drives from 3 inch to 8 inch in all formats, and the software package provided as standard is CP/M Plus* (version 3). A complete system on a single Eurocard, compatible with other STE bus systems, and **all for only £580**, including CP/M Plus*.

It has the all-new STE bus, easily expandable architecture, with a growing range of peripheral boards and full support from a young company which is rapidly establishing itself as one of Europe's leading innovators in control and processing.

It isn't just new, it's unique. Showing the way ahead for 8-bit computers.



- STE bus compatible board family.
- Fully asynchronous processor independent bus.
- Intermodule compatibility between manufacturers.
- The STE bus is multimaster, allowing up to three masters, CPU's or DMA's to use the same bus.
- 20 memory address lines allowing 1Mb of external addressing.
- 12 I/O address lines allowing up to 4096 I/O devices.
- Flexible scheme for interrupts.
- Single Eurocard mechanical format.

Get in touch for more details of the bus, the CPU and the I/O boards now available.

Arcom **Innovation under control.**

Arcom Control Systems Ltd., Unit 8, Clifton Road, Cambridge CB1 4BW Telephone: (0223) 242224.

DISTRIBUTORS:
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Dage Eurosem Limited, Rabans Lane, Aylesbury, Bucks HP19 3RG Telephone: (0296) 33200 Tlx: 83518.
Crellon Microsystems, 380 Bath Road, Slough, Berks SL1 6JE Telephone: (06286) 4300 Tlx: 847571.

CIRCLE 85 FOR FURTHER DETAILS.

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Required for work in the Broadcast Engineering and Production Departments of the SSVC which provides Radio, Television and Training Services for the British Forces and their dependents in the UK and abroad.
Candidates (preferably aged 22—35) should be educated to HND standard in electronic and electrical engineering and have work experience in broadcast or related industries.
The work, often overseas, includes the operation, maintenance and installation of the full range of professional radio and television studio equipments and, in some areas, medium wave and VHF transmitters.
The salary offered is in the range £7967—£10325, tax-free when on overseas service plus generous tax-free overseas allowances and other fringe benefits.
There are promotion prospects to higher grades and opportunities for training and transfer to other departments of the SSVC.
Write for application form to:

Mr E.G. Locke
Personnel Officer,
The Services Sound and Vision Corporation
Chalfont Grove,
Narcot Lane,
Gerrards Cross
Bucks SL9 8TN

(2659)

VIDEO ENGINEER (Service/Development)

Broadcast Developments Ltd. require an engineer aged 24/34 to service our specialist products. In addition he/she must have the ability to assist in the design and development of new products for the broadcast industry. A driving licence is essential. Salary negotiable (depending on experience). We are an equal opportunities employer.

Please write to: BDL, 16 Cannon Drive, West India Dock Road, Lime House, London E14 9SU

(2692)

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Applications are invited for the post of Service Manager. A sound electronic engineering background with several years experience of UHF/VHF land mobile systems is essential. Experience with HF/SSB, AM and FM broadcasting or small computer systems would be an advantage.

We are looking for a responsible, experienced engineer to take sole charge of a busy service department handling a wide variety of equipment and systems. The post is ideally suited to a single man wishing to broaden his experience whilst living in a pleasant Caribbean island.

The initial appointment would be for two years, with an option to extend for a further two years. Return passages will be paid, and a company car is provided. Salary commensurate with experience and ability in the range US dollar 25,000 to 35,000 per annum tax free.

Apply giving full details of qualifications and experience, together with a telephone number, to:—

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(Service Manager), P.O. BOX 1215, Grand Cayman,
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(2668)

TELECOMMUNICATIONS TECHNICIANS

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★ City and Guids Telecommunications Technicians Certificate Part II (Course No 271) or Part 1 plus maths 'B', Telecommunications Principles 'B' and one other subject
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Ex-Service personnel who have had suitable technical training, and with at least 3 years' in an approved senior technical capacity will also be considered.
Salary: £6262—£8580; London £1250 more, starting salary may be above minimum for those with additional relevant experience.
Promotion prospects are good.
Relocation assistance may be available.
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For an application form write to:
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required for expanding South London company in the amusement industry.

Applicants are expected to have the appropriate qualifications (minimum HNC) and have experience of electronic engineering.
The work is interesting and varied, involving repairs, fault-finding and some research and development.

Salary scale is currently £8,400-£9,000 per annum.

Applications giving full details of age, qualifications and experience.

Box No. 2615 (2615)

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Department of Bio-Medical Physics and Bio-Engineering

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Of practical bent required in department of international reputation, to care for electronic imaging equipment containing computers, particularly two X-ray CT Scanners in modern teaching hospital. Training will be provided.

Salary within Grade 1A Scale for other Related Staff, £7,190 — £11,615 per annum, depending on qualifications and experience (scale under review).

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(2678)

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(2684)

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We were one of the first companies in the U.K. to design and produce robots for educational and training purposes. Our products can now be seen in universities, colleges and other establishments throughout the world.
We need Electronic Engineers (Digital) for the design and development of new products in the cybernetics field. A familiarity with computers and a knowledge of mechanical principles are essential.
As well as the job itself, we are offering an excellent salary and the security and benefits of working for a publicly owned group. So, if you want to be involved in the development of brand new products and are prepared to roll up your sleeves and get the job done...
Ring for Application form or send C.V. to Managing Director. Powertran Cybernetics Limited, Portway Industrial Estate, Andover, Hampshire. Telephone Andover (0264) 62902

(2673)

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Ideally, applicants should have a thorough knowledge of techniques and have been employed for a minimum of 5 years' within the field of one or more of the following: mobile and static military radio systems, associated antennae and ancillary equipment; cryptographic and telegraphy equipment: weapons fire control systems and navigation aids used in air traffic control.

If you feel you are suitably qualified and interested in joining our Company, please write giving a brief summary of your qualifications and experience to: **The Company Personnel Manager, Airwork Limited, Bournemouth-Hurn Airport, Christchurch, Dorset BH23 6EB.**

(2640)

Airwork Limited

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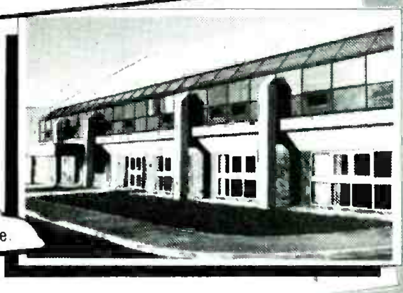

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For further details contact Mr D.W. Bailey (Principal Physicist) on 01.807 3071 Ext. 678.

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(2681)

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(2680)

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(2696)

Medical Physics Technicians

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Saudi Arabia

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The Hospital is managed by the International Hospitals Group in liaison with the British government and is staffed by IAL.

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The figure quoted is based on a salary of SR100,000 (c£21,700 pa), at a conversion rate of SR4.6=£1, plus a bonus of one month's salary for every 12 months satisfactory service which is paid as a tax-free lump sum at the end of your time with IAL in Saudi Arabia.

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Minimum qualifications are TEC/SCOTEC in Electronics/Telecommunications or a similar discipline or C & G Part II Telecommunications Technicians Certificate or Part I plus Maths B, Telecommunication Principles B and either Radio Line Transmission B or Computers B or equivalent: ONC in Electrical, Electronics or Telecommunications Engineering or a CIE Part I Pass, or formal approved Service technical training. Additionally, at least four years' (lower level) or seven years' (higher level) appropriate experience is essential in either radio communications or radar, data, computer or similar electronic systems. At the lower entry level first line technical/supervisory control of technicians involves "hands-on" participation and may involve individual work of a highly technical nature. The higher level involves application of technical knowledge and experience to work planning including implementation of medium to large scale projects.

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GCHQ

Recruitment Office, Government Communications Headquarters, Oakley, Priors Road, Cheltenham, Gloucestershire, GL52 5AJ.

(2452)

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Further details and application forms are available from The Clerk to the Governors at the College.

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(2676)

ELECTRONICS ENGINEER

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Experience within a recording studio or similar environment involving maintenance of electronic, electro-mechanical and digital systems would be an advantage.

The successful applicant must have a flexible approach and be able to fit into a busy working studio. There is a requirement for some overtime and weekend working to meet recording studio deadlines.

Applicants should have a degree or HNC in a relevant discipline.

Please send a detailed C.V. with covering letter to:

Veronica Spicer, Personnel Officer,
PolyGram Record Operations Ltd.,
54, Maddox St., London W1.
01 491 4600

(2691)

THE UNIVERSITY OF SUSSEX

ELECTRONICS TECHNICIAN

A vacancy exists for an electronics technician in the Psychology Laboratory, from as soon as possible. Applicants with at least seven years' experience in electronic work are sought. Someone with less experience will also be considered, especially if with an interest in the computer and/or audio/visual fields.

Salary in the Technician Grade 5 range, £6,279—£7,332 per annum, according to age and experience, but someone with less than seven years' experience would be appointed on a lower grade.

Send self-addressed envelope (9in×6in) for application form to Mrs. S. Cory-Wright, Personnel Office, Sussex House, University of Sussex, Falmer, Brighton BN1 9RH.

Applications must be received by 5th September 1984.

(2669)

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TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £5000-£15000.

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Tunbridge Wells,
Kent. TN4 8AS.

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TJB

Please send me a TJB Appointments Registration form:

Name . . . .

Address . . . .

. . . .

(861)

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We have vacancies for experienced and trainee technical authors, to write handbooks on some of the latest technology electronics equipment.

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Any Professional Membership: ....

CAREER HISTORY

From/To	Company	Job Title/Description	Salary

Please indicate any Companies you do not wish us to contact.

If you wish to detail further aspects of your experience or job requirements, please continue on a separate sheet.

(2450)

PORTSMOUTH POLYTECHNIC

Department of Electrical and Electronic Engineering (Electrical Standards Laboratory)

EXPERIMENTAL OFFICER — Post No. 254

Required for duties in the above laboratory, offering calibration of a wide range of electrical equipments. This laboratory has British Calibration Service approval and provides traceability to defence standards 05 for local industries. The postholder is responsible for the daily functioning of the laboratory and the ability to work unsupervised is essential.

Salary Scale: Up to a maximum of £8712.00 per annum

Application forms and further particulars can be obtained from the Personnel Office, Nuffield Centre, St. Michael's Road, Portsmouth, PO1 2ED, telephone (0705) 825451, and should be returned by 17 September 1984.

(2679)

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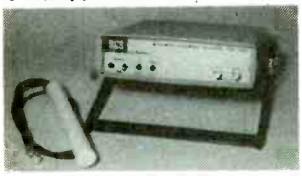

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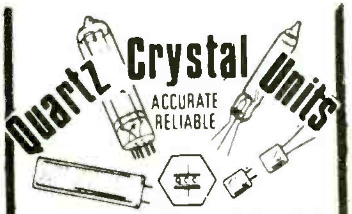

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C3JA	28.80	VR150	4.95	6CK6	6.00	150C2	3.10	6922	3.90
C3JL	30.00	XC12	1.30	6CL6	3.30	150C3	4.95	6939	19.50
C16J	120.00	XG1-2500	51.50	6CM5	2.30	150C4	4.50	6973	3.70
CK1907	17.70	XG2-500	36.00	6CN6	4.95	212E	170.00	6975	66.00
CK5687WA	4.10	XG2-6400	152.00	6CQ6	2.20	290A	1150.00	7014	44.50
DLS16	18.00	XG5-500	24.50	6CW4	6.50	350A	22.50	7015	50.00
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EB91	1.95	1B24A	100.00	6EV7	2.85	845	48.30	7322	604.00
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2N6080	6.00	2SC1311E	0.32	BLW60C	15.00	MRF517	3.50	SD1134-2	10.00
2N6081	8.75	2SC1314	25.00	BLW60CF	15.00	MRF620	18.00	SD1134-8	10.00
2N6082	9.00	2SC1318	0.40	BLW64C3	65.00	MRF644	27.50	SD1134-STUD	7.60
2N6083	12.00	2SC1368B	1.00	BLW78	61.80	MRF646	28.00	SD1135	10.25
2N6084	13.20	2SC1383B	0.50	BLW80	10.25	MRF648	33.00	SD1135-3	12.00
2N6094	8.00	2SC1424	1.35	BLW81	14.90	MRF750	6.50	SD1136	12.50
2N6095	8.50	2SC1509	6.00	BLW90	13.00	MRF846	46.00	SD1143	9.45
2N6255	3.45	2SC1546	0.45	BLW98	110.00	MRF901	2.75	SD1143-1	10.00
2SC382	0.65	2SC1568	0.45	BLX39	13.75	MRF904	2.95	SD1144-1	2.50
2SC458	0.22	2SC1589	5.00	BLX65	2.45	MRF911	2.50	SD1158	7.95
2SC458B	0.36	2SC1622	0.33	BLX67C	9.50	MRF5175	22.50	SD1201	7.35
2SC458C	0.22	2SC1623	0.30	BLX67CF	9.50	MRF5176	30.00	SD1202	7.50
2SC460	0.25	2SC1688	19.80	BLX68C3	10.00	MRF5177	43.00	SD1212-4	6.00
2SC460B	0.25	2SC1674	0.25	BLX68CF	10.50	MRF8004	2.00	SD1212-7	4.00
2SC461B	0.25	2SC1675	0.20	BLX69A	20.00	PT3134A	1.50	SD1214	8.70
2SC535	0.38	2SC1678	1.25	BLX94A	36.00	PT3134B	2.75	SD1216	11.00
2SC535A	0.38	2SC1729	18.00	BLX98	132.00	PT3134C	12.00	SD1219	18.00
2SC535B	0.38	2SC1730	0.25	BLY87C	7.50	PT3134D	12.50	SD1219-4	18.00
2SC535C	0.35	2SC1740Q	0.20	BLY88C	11.00	PT3134E	30.00	SD1220-1	9.50
2SC540	24.95	2SC1765	7.75	BLY88CF	11.00	PT3161A	1.75	SD1222-5	11.00
[illegible]	0.75	2SC1815Y	0.28	BLY89C	13.00	PT3161B	1.75	SD1222-STUD	11.00
2SC644	0.25	2SC1906	0.33	BLY90	45.00	PT3161C	8.50	SD1224-2	13.00
2SC684	0.28	2SC1907	0.30	BLY91CF	11.00	PT3161D	14.00	SD1229-F1	10.95
2SC703	36.00	2SC1945	3.50	BLY94	45.00	PT3161F	30.00	SD1229-STUD	10.95
2SC710	0.45	2SC1946	19.75	MRF208	12.00	PT3503	6.95	SD1244-6	12.75
2SC710D	0.28	2SC1946A	16.50	MRF212	12.00	PT4261A	16.00	SD1256	6.95
2SC715D	0.40	2SC1947	9.88	MRF221	12.05	PT4261B	24.00	SD1262	15.00
2SC715E	0.40	2SC1955	7.20	MRF229	3.50	PT4261C	60.00	SD1270	3.75
2SC717P	0.38	2SC1966	11.00	MRF231	12.36	PT4316C	12.00	SD1272	10.95
2SC730	4.10	2SC1967	15.00	MRF232	13.50	PT4316D	18.00	SD1272-2	10.95
2SC731	3.95	2SC1968	17.50	MRF233	14.30	PT4316E	25.00	SD1278	13.75
2SC732	0.25	2SC1968A	22.00	MRF234	16.00	PT4316F	30.00	SD1278-1	13.75
2SC741	2.50	2SC1969	3.05	MRF237	3.10	PT5661C	14.00	SD1285	12.75
2SC821	6.60	2SC1970	1.50	MRF238	12.60	PT8751	24.00	SD1300	1.25
2SC828B	0.30	2SC1971	4.00	MRF239	20.00	PT8820	15.00	SD1303	2.50
2SC829B	0.25	2SC1972	11.00	MRF240	24.50	PT8831	2.75	SD1316	2.10
2SC890	8.50	2SC1978	7.50	MRF243	35.00	PT8837	10.00	SD1317	8.00
2SC891	18.00	2SC2001	0.45	MRF245	30.00	PT8838	15.00	SD1405	21.00
2SC900	0.18	2SC2026	0.75	MRF247	30.10	PT8854B	18.00	SD1407	27.50
2SC900F	0.19	2SC2053	0.80	MRF260	5.00	PT8861A	15.00	SD1407MP	55.00
2SC908	4.50	2SC2097	36.00	MRF264	11.00	PT8864A	30.00	SD1410	21.06
2SC911A	18.00	2SC2099	15.00	MRF309	42.00	PT8874	18.00	SD1410-1	21.00
2SC945	0.21	2SC2100	24.00	MRF316	55.00	PT9795	12.50	SD1410-3	21.00
2SC945R	0.21	2SC2103	18.00	MRF317	73.00	PT9797	14.00	SD1412	36.00
2SC952	0.60	2SC2105	15.00	MRF321	35.00	PT9841	16.00	SD1412-3	24.00
2SC982	0.30	2SC2116	1.60	MRF323	35.00	PT9847	16.00	SD1413	18.00
2SC994	2.50	2SC2118	9.00	MRF326	63.00	SD1005	8.20	SD1414	36.00
2SC998	3.90	2SC2221	5.50	MRF327	70.00	SD1006	12.00	SD1416	33.00
2SC1001	9.90	2SC2233	0.90	MRF329	58.06	SD1012-3	10.00	SD1418	30.00
2SC1011	15.00	2SC2237	16.00	MRF412	18.51	SD1012-4	10.00	SD1421	36.00
2SC1070	1.15	2SC2281	13.00	MRF421	36.85	SD1013	10.00	SD1428	24.00
2SC1096L	0.90	2SC2283	9.00	MRF422	42.00	SD1014-6	10.50	SD1429	15.98
2SC1096M	0.90	2SC2287	11.00	MRF426	23.00	SD1015	17.50		
2SC1117	1.50	2SC2289	12.50	MRF427A	21.00	SD1018-6	13.00		

PRODUCTS

Backward Wave Oscillators	Magnetrons	Solid State Replacements
Camera Tubes	Microwave Tubes	Spark Gap Tubes
Cathode Ray Tubes	Microwave Semiconductors	Tetrodes
Cold Cathode Tubes	Photomultiplier Tubes	Thyratrons
Diodes	Phototubes	Transistors
Display Devices	Planar Triodes	Transmitting Tubes
Duplexers	RF Amplifiers	Travelling Wave Tubes
Electro-Optical Devices	RF Capacitors	Triodes
Gas Relays	RF Resistors, Terminations	Tube Sockets, Accessories
Glow Modulators	RF Transistors	Vacuum Capacitors
Ignitrons	Readout Tubes	Vacuum Interrupters
Image Intensifiers	Receiving Tubes	Vacuum Relays
Integrated Circuits	Rectifiers	Vibrators
Klystrons	Relays	Vidicons
Klystron Amplifiers	Silicon Controlled Rectifiers	X-Ray Tubes

ALSO AVAILABLE:

A replacement guide to dozens of Motorola Transistor part numbers.
Stocks of original RF Devices from such manufacturers as:
MOTOROLA, RCA, GE, TRW, MSC, ACRIAN, TOSHIBA, FUJITSU, NEC, MITSUBUSHI, PHILLIPS, AMPEREX and others

POWER TUBE ACCESSORIES

CHIMNEYS CONNECTORS FINGER STOCK SOCKETS

ENQUIRIES: Quotation for any types not listed S.A.E.

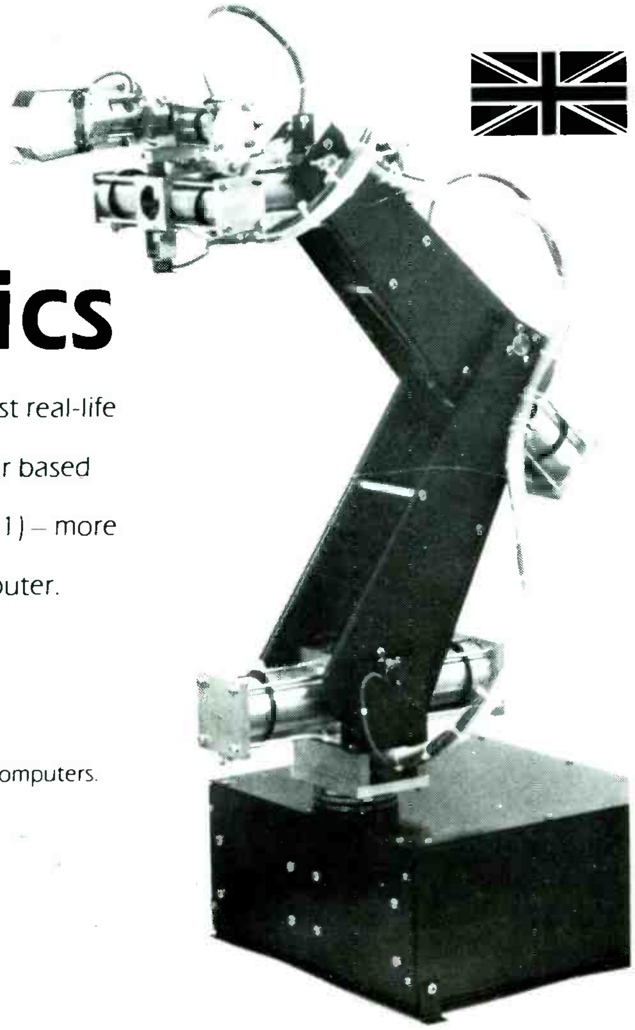
TERMS: Cash, Postal Order of Cheque with order
CREDIT: Accounts available subject to approved references
POSTAGE: Add £1.00 to order under £50 value
VAT: All prices are excluding VAT, please add 15% to order and postage
GUARANTEE: All goods are to specification and sold with manufacturers warranty

CIRCLE 002 FOR FURTHER INFORMATION

neptune

for low-cost training in

real-life robotics



The advanced design of the Neptune 2 makes it the lowest cost real-life industrial robot.
It is electro-hydraulically powered, using a revolutionary water based system (no messy hydraulic oil!)
It performs 7 servo-controlled axis movements (6 on Neptune 1) – more than any other robot under £10,000.
Its program length is limited only by the memory of your computer.
Think what that can do for your BASIC programming skills!

And it's British designed, British made.

Other features include:

- Leakproof, frictionless rolling diaphragm seals.
- Buffered and latched versatile interface for BBC VIC 20 and Spectrum computers.
- 12 bit control system (8 on Nuptune 1).
- Special circuitry for initial compensation.
- Rack and pinion cylinder couplings for wide angular movements.
- Automatic triple speed control on Neptune 2 for accurate 'homing in'.
- Easy access for servicing and viewing of working parts.
- Powerful – lifts 2.5 kg. with ease.
- Hand held simulator for processing (requires ADC option).

Neptune robots are sold in kit form as follows:

Neptune 1 robot kit (inc. power supply)	£1250.00
Neptune 1 control electronics (ready built)	£295.00
Neptune 1 simulator	£45.00
Neptune 2 robot kit (inc. power supply)	£1725.00
Neptune 2 control electronics (ready built)	£475.00
Neptune 2 simulator	£52.00

ADC option (components fit to main control board)	£95.00
Hydraulic power pack (ready assembled)	£435.00
Gripper sensor	£37.50
Optional extra three fingered gripper	£75.00
BBC connector lead	£12.50
Commodore VIC 20 connector lead and plug-in board	£14.50
Sinclair ZX Spectrum connector lead	£15.00

All prices exclusive of VAT and valid until the end of 1984.

mentor

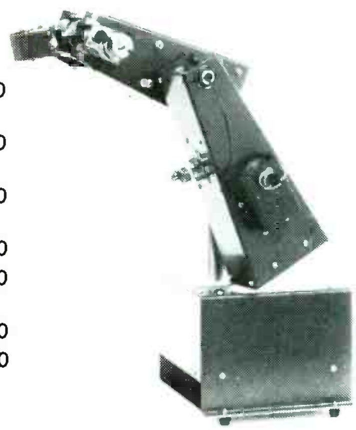
desk-top robot

This compact, electrically powered training robot has 6 axes of movement, simultaneously servo-controlled. It gives smooth operation, and its rugged construction makes it ideal for use in educational establishments. Other features include long-life bronze and nylon bearings, integral control electronics and power supply, special circuitry for inertial compensation, optional on-board ADC, and hand-held simulator as the teaching pendant. Like Neptune, Mentor's program length is limited only by your computer's memory. Programming is in BASIC.

Mentor is all-British in design and manufacture and comes in kit form at an astonishingly low price:

Mentor robot kit (inc. power supply)	£345.00
Mentor Control electronics (ready built)	£135.00
Mentor Simulator (requires ADC option)	£42.00
ADC option (Components fit to control electronics board)	£19.50
BBC connector lead	£12.50
Commodore VIC 20 connector lead and plug-in board	£14.50
Sinclar ZX Spectrum connector lead	£15.00

All prices exclusive of VAT and valid until the end of 1984.



Cybernetic Applications

CYBERNETIC APPLICATIONS LIMITED

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CIRCLE 003 FOR FURTHER INFORMATION