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INTERNATIONAL SEPT 1987 VOL 16 No.9

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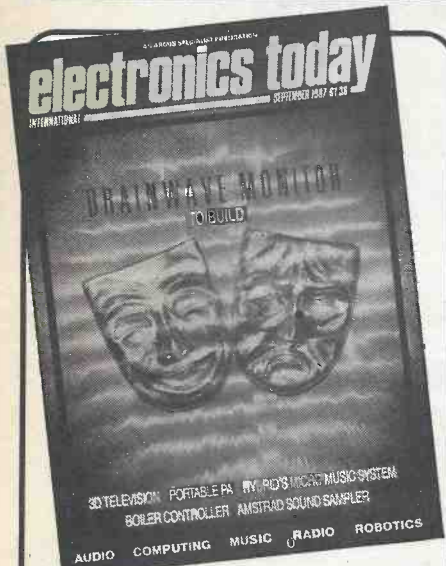

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FEATURES

PROJECTS

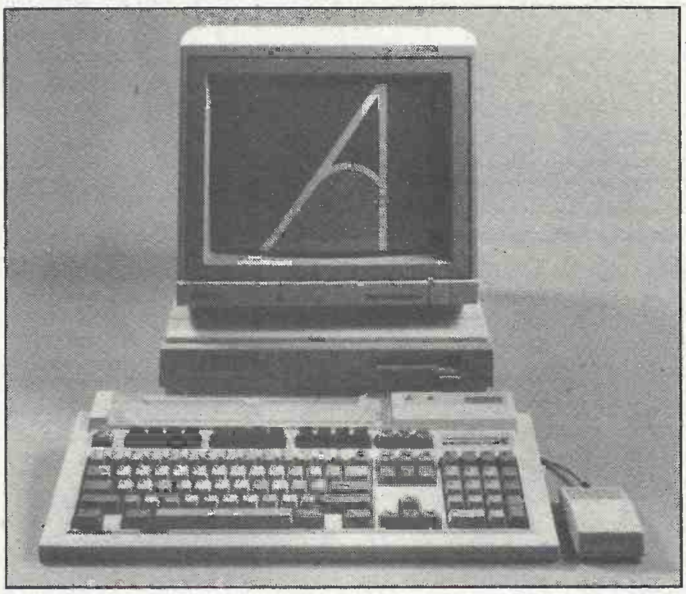
REGULARS

- **UK electronics companies are being encouraged to apply for licences which would allow them to manufacture and sell equipment designed by the BBC. The move follows the success of previous licences, notably the LS3/5a small monitor loudspeaker which was designed by the BBC and manufactured by several hi-fi companies. A new licensing initiative is now under way following a recent decision that the corporation should purchase more of its equipment from outside manufacturers. The BBC says it has over thirty designs on which it is willing to grant licences and has appointed a liaison officer, Peter Jefferson, to oversee the process. He can be contacted on 01-927 4345.**

- *Shortly after announcing the new marketing agreement which allows West German Metrawatt multimeters to be sold under the AVO brand name (see last month's News), Thorn EMI has revealed plans for a management buy-out of its Measurement Division. The newly-created independent company will take with it not only the AVO name but also such well-known British test instrument brands as Taylor, Megger and Foster. Thorn EMI says the move is in line with its policy of concentrating only on selected areas of technology.*

- It is often required to split a mono signal across the two channels of stereo system so as to position a sound within the stereo image. Unfortunately, it is difficult to do this and still maintain a constant total output power. A new 4-page application note from Analog Devices suggests the use of a dual CMOS multiplying DAC, a digital control signal being fed to one half while the twos-complement of that signal is fed to the other half. Circuits for both 8 and 12-bit arrangements are shown using AD7537 and AD7547 dual DACs. Copies of the application note are available from Analog Devices, Station Avenue, Walton-on-Thames, Surrey KT12 1PF. Tel: (0393) 232 222.

- **The 1987 Redpoint catalogue contains details of the company's extensive range of heatsinking products, from small thermal clips for individual semiconductors through to large extrusions, fans and liquid-cooled units. Performance graphs, photographs and sectional drawings are included and the product line is supported by a selection of accessories. Copies of the catalogue are available from Redpoint Ltd, Cheney Manor, Swindon, Wiltshire SN2 2PS. Tel: (0793) 37861.**



Archimedes — The Faster BBC Micro

Acorn Computers is billing its new Archimedes range as 'the fastest micros in the world.'

Based on Acorn's 32-bit RISC (reduced instruction set computer) chip, they offer speeds of up to four million instructions per second.

The Archimedes micros feature a built-in 3.5" disc drive, a separate enhanced-PC style keyboard with mouse and space for a second floppy disc or 20MB hard disc drive.

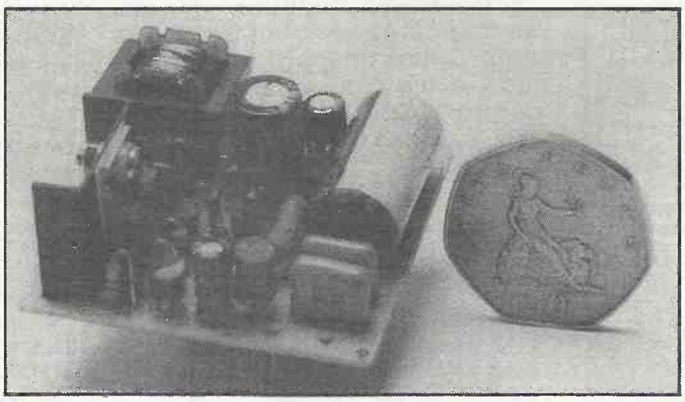
Eighteen graphics modes are included with up to 256 colours and the expansion facilities include Econet, MIDI and emulation of the 6502 processor and the 8088 which runs MS-DOS.

The two 300-series Archimedes machines will be sold as BBC microcomputers and will receive the same sort of television and educational backing given to earlier Acorn-BBC micros. The base model is the 305 which offers 0.5MB of RAM while the 310 has 1MB. Both models come with a range of software including a window-icon environment manager and BBC BASIC V.

The 400 series machines are intended for business and professional use. The 410 is fitted with 1MB of RAM while the 440 carries 4MB and comes with a 20MB hard disc.

Prices of the Archimedes range start at £799 plus VAT for the model 305 without monitor and extend up to £2,499 plus VAT for the model 440 with colour monitor.

Acorn Computers Ltd, Cambridge Technopark, 645 Newmarket Road, Cambridge CB5 8PB. Tel: (0223) 214 411.



A Switch In Time Saves Pounds

Greenweld are offering a neat little 5W switching regulator module for inclusive £5.

Made by Astec in Hong Kong, the AA7271 regulator provides up to 2A output and will operate with input voltages from 8-24V DC. Overcurrent and thermal protection are included and Greenweld say the output filtering is excellent.

The six-transistor circuit is built on a board just 50mm (2") square, allowing it to be used as a simple replacement for linear IC regulators in many applications.

The AA7271 is available from Greenweld Electronic Components, 443 Millbrook Road, Southampton S01 0HX. Tel: (0703) 772 501.

Job Prospects In Decline?

The percentage of electronics companies planning to take on more staff has declined over the past year.

Figures prepared by temporary staff specialist Manpower PLC show that 29% of employers in the electronics manufacturing industry plan to increase the size of their workforces during the third quarter of 1987. This is well down on the figure of 41% recorded last quarter and 37% this time last year.

The decline is partly offset by a reduction in the percentage of companies planning to reduce the size of their workforces. Only 7% of employers expect to lay off staff in the coming quarter compared with 12% last quarter. The figure for the same period last year was also 7%.

Manpower suggests there has been a general decline in job prospects in the electronics manufacturing industry over the last twelve months. The difference between the percentage of companies planning to take on staff and those planning to shed staff has fallen from 30% a year ago and 29% last quarter to just 22% in the coming quarter. However the authors of the survey point out that their research was carried out in the run-up to the general election and the political uncertainty may have made employers more than usually cautious.

Manpower Survey of Employment Prospects, Third Quarter 1987, Manpower House, 270-272 High Street, Slough SL1 1LJ.

New Course For Software Engineers

The IEE and the National Computing Centre have reached agreement on the format of a new software engineering course which will start at colleges around the UK this October.

The Software Engineering Certificate has been developed to counter the current shortage of high quality engineers in the new technology of software engineering. It is aimed at graduates in any discipline who have some working knowledge of computing and is structured so that it can be taken either full-time for nine weeks or part-time over a longer period.

The Certificate will be administered by a newly-created Software Engineering Certificate Examining Board (SECEB) which comprises representatives of the IEE, the NCC, the British Computer Society and industry, academic and government agencies. All enquiries should be addressed to the SECEB Secretariat c/o the IEE, Savoy Place, London WC2R 0BL. Tel: 01-240 1871.

Initial Distinction for CD Video

Philips and Sony have reached agreement on several new video disc formats following their recent decision to work together on laser disc technology (see ETI News, June 1987).

The expanded system will be called CD Video and will consist of the two existing laser disc formats (20cm/8" and 30cm/12") and a new video and audio version of the standard compact disc.

The new disc will be the same size as existing compact discs but will be coloured gold rather than silver. It will carry five minutes of combined video and digital stereo sound and will be identified by the initials CDV. The existing laser disc formats will now be known by the initials LD.

Philips and Sony plan to introduce a range of disc players handling some or all of these formats and identified by combinations of initials. For example, CD-CDV would indicate a machine capable of playing 12cm (5") audio-only or audio and video discs while CD-CDV-LD would indicate a player which could accept audio-only CDs plus all sizes of combined video and audio discs.

Surface Mount Or Bust

Adopting surface-mount technology can mean the difference between success and failure in the fast-changing electronics industry.

That is the conclusion of a recent report from the National Economic Development Office, and it laments the fact that far too few UK companies have switched over to the new technology.

Surface mounting is not just a new assembly technique, the report argues. It offers increased efficiency and flexibility and opens the way to affordable automation. It also provides access to the latest developments in components since many new devices are now available only in surface-mount form.

As well as providing an assessment of surface-mount usage in the UK, the report also sets out to educate those companies who have not yet taken the plunge. The technology is explained in straightforward terms and related matters like staff training, standards and component availability are all covered in depth. There are also some case studies of firms who have successfully made the transition to surface-mount.

The report is called Introducing Surface Mounting and it costs £10 from NEDO Books, Millbank Tower, Millbank, London SW1P 4QX. Tel: 01-211 3608.

Putting Radiation Into Perspective

Perspective (UK) Ltd believes that people would be less afraid of radiation if they had a greater understanding of the background levels we live in.

With this in mind, the company has launched a range of pocket radiation monitors designed to appeal to everyone.

The Radalert 1310 is intended for household use and detects gamma and X-radiation at dose rates from 15uS/hr (micro-Sieverts/hour) to 5S/hr. It provides either a frequently-updated indication of radiation intensity or long-term/continuous counting.

The Radalert 1313 operates over the same range and is intended for local authority, military or civil defence use while the Radalert 1201 is designed for use in the nuclear, medical and mining industries and provides indications over the range 0.5uS/hr to 10mS/hr.

The three models cost £86, £129 and £169 respectively (plus VAT) and come complete with a specially-written leaflet on radiation and testing. For further details contact Perspective (UK) Ltd, Freepost 1, London W1E 2EZ. Tel: 01-486 6837.

Flatter, Squarer And Slightly Larger

Flat screen televisions are nothing new but at present they are available only in small sizes, ususally two to three inches.

In spite of this, crystal-ball gazers have been predicting for some time that we will one day watch large-screen televisions which are flat and hang on the wall like pictures.

The Lohja Corporation of Finland claims to have moved a step closer to this ideal with the development of a seven-inch flat-screen television called the Finlux Face. Unlike most miniature flat screen TVs now available from Japan and elsewhere, the Face does not use liquid crystal techniques but relies instead on an electroluminsescent display.

At present the corporation has no plans to manufacture the flat-screen TV. Further development is required before the technique will yield sufficiently clear colours for general use and the price at present would also be prohibitive.

Lohja Corporation, PO Box 13, SF-20311 Turku, Finland.

- **Following the excellent response to our special offer on the Oryx Portasol (see page 17) we are pleased to be able to offer a range of alternative bits for this versatile soldering iron. The tip sizes available are 2.4mm (order code GCT 24), 3.2mm (GCT 32), 4.8mm (GCT 48) and there is also a 'hot knife' sealing bit (GCT 56). All types have a built-in catalytic converter and simply plug on in place of the standard bit supplied with the iron. The price is £6.50 inclusive for all sizes and orders should be sent to our Readers' Services division at 9 Hall Road, Maylands Wood Estate, Hemel Hempstead, Hertfordshire HP2 7BH. Please make cheques or postal orders payable to ASP Ltd and allow 28 days for delivery.**

- Alternative sources of electronic components are always welcome, even when they're as heavily-hyped and thoroughly OTT as the new Alternative Catalogue. Launched amid a wealth of snide remarks about the supposed shortcomings of longer-established catalogues, the new arrival runs to around 350 A4 pages and claims to have everything you're likely to want in an easy-to-find format. If you're into taking risks and can cope with the social stigma of using a catalogue which is printed on grey paper and reads sideways, contact The Alternative Catalogue Company Ltd, Jubilee House, Letchworth, Hertfordshire SG6 1TS. Tel: (0462) 481 122.

- **The IEE has issued a further set of amendments to the 15th edition of its Wiring Regulations. The amendments are contained in two A4 booklets, one of which describes changes to the main body of the regulations while the second contains a substantial revision of Appendix 9, the set of tables relating cable current carrying capacity and voltage drop. The complete set of amendments costs £4.00 inclusive from the Institution of Electrical Engineers, Publications Sales Department, PO Box 26, Hitchin, Hertfordshire.**

- *The patter of tiny Walkmans has long since become a stampede. Eight years after the first personal hi-fi was created for Sony Chairman Akio Morita, the thirty-millionth has just rolled off the company's production lines in Tokyo. Sony estimates that around 200 million personal hi-fi's are in use throughout the world when those produced by other manufacturers are taken into account. And if figures like that are difficult to imagine, just try working out how many AA-size batteries it takes to power 200 million personal hi-fi's throughout their working lives!*

Young Designers Show Their Skills

A robot arm to help disabled people, a meter to measure stress in sick animals and an electronic tyre pressure gauge were among the winning designs at this year's Young Electronic Designer Awards.

Jointly sponsored by Texas Instruments and Cirkit, the award scheme is now in its third year and is open to anyone under 25 who is in full-time education. The designs are judged not only on technical merit but also for originality, presentation, usefulness and commercial viability.

There were about 120 entrants for this years awards and 25 of them made it through to the finals, held on July 2nd at the Institute of Civil Engineers in London. There they were given an opportunity to show off their designs to visitors and the press before the final judging took place. The presentations were made by Sir John Egan.

In the senior category (19-25 years old) the first prize went to Douglas Mackay, a first-year student at Robert Gordon's Institute of Technology, Aberdeen. (Pictured at right with his prize-winning design and trophy alongside Cirkit's Richard Bulgin.) His Robotic functional Arm for the disabled won him a £500 prize, sponsorship of £450 per year for the rest of his course, a vacation job at Texas Instruments and a reserved place at TI upon completion of his degree.

Runners up in the Senior category were Stephen, Morrison, Carl Gibson and Paul Briggs of Brunel University who won £250 for their 'Project Goliath' wheelchair controller, and Morgan Metters and Tim Mottershead of Hatfield Polytechnic who won £100 with their speech synthesiser design for disabled people.

First prize in the intermediate category (15-18) went to Paul Dagley-Morris and Roger Lucas of Cheltenham College for their novel animal stress meter. Developed in conjunction with a local veterinary practice the meter is designed to give early warning of problems during animal surgery and works by comparing the external body temperature with the internal temperature (measured by means of an anal probe). The prize was £350.

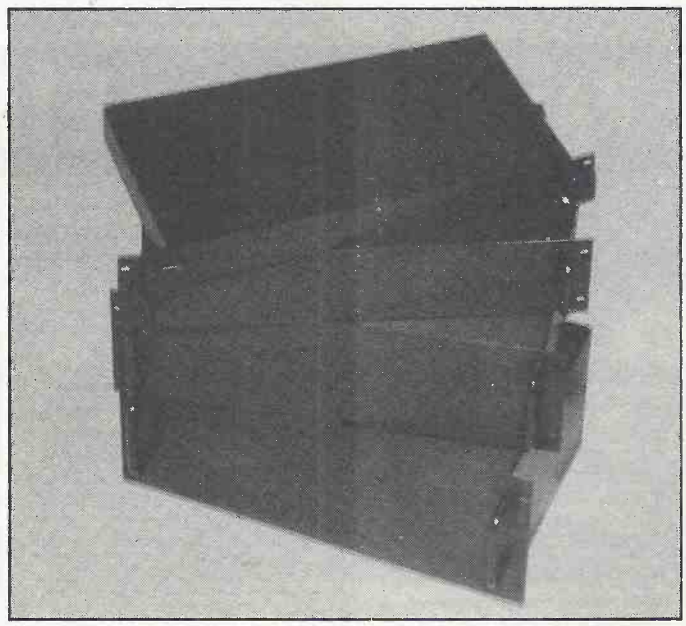
The runners up were Jonathan Ackland and William Mere, also from Cheltenham College, who won £200 for their temperature-sensing saucepan for blind people, and David Earle of Brentwood School who won £75 for his colour recognition system, a device designed to help people who suffer from colour blindness.

In the Junior category (under 15) first prize of £250 went to Neil Motson and Jonathan Cragg of Wilford Meadows School, Nottingham for their digital tyre pressure gauge. This design was also judged to have the most commercial potential of all the entries and won the major prize in the competition, a £10,000 Business-Pro computer from Texas Instruments which goes to the winners' school.

Runners up in the Junior category were Ian Karl Levy of Allerton High School, Leeds who won £150 for a safety device which indicates when a ladder is positioned at too critical an angle, and Sophia Ballarini who won £50 for a water level indicator and alarm.

• The Newnes Radio And Electronics Engineer's Handbook is described as an invaluable compendium of facts, figures and formulae for students, service engineers, electronics designers and anyone else interested in radio and electronics. The latest edition has been compiled by our very own Keith Brindley (he of Open Channel fame) and includes a considerable amount of new material relating recent developments plus new sections on batteries, cables and connectors and a complete update of the information on broadcasting. It fits in a (medium-sized) pocket and costs £6.95 from William Heinemann Ltd, 22 Bedford Square, London WC1B 3HH. Tel: 01-637 3311.

• Red Three is the latest addition to the range of Red Boxes manufactured by Chris Curry's new company, General Information Systems. It accepts signals from temperature sensors, light cells, etc, and converts them into ditital signals which can be transmitted through domestic mains wiring. Used in conjunction with other modules in the Red Box range, Red Three makes it possible for a home computer to provide sophisticated heating or energy management functions, all controlled from a central point and with no need for additional wiring. The Red Box system works with BBC, Commodore, Spectrum and Amstrad computers and is available from GIS, Croxton Park, Croxton, Cambridgeshire PE19 4SY.



19" Bockzes Supplied As Kitz

Rackz is the highly appropriate name given to a new range of 19" equipment cases.

They are available in four standard heights and come complete with feet and matching front-panel handles. The rear boxes are made from black PVC-coated steel while the front panels are ⅛" (3mm) thick aluminium with a black powder finish.

The cases are supplied in kit form, allowing each panel to be drilled and prepared before assembly. The manufacturers will also supply replacement panels individually, making it easy to change the function of a case or correct for mistakes!

All Rackz cases are 10" (245mm) deep and they come in standard heights of 1U (1¾"/44mm), 2U (3½"/88mm), 3U (5¼"/133mm) and 4U (7"/178mm). Prices start at £16 plus VAT.

The company also supply racking cabinets and blanking panels. For full details contact Rackz Products, PO Box 1402, Mangotsfield, Bristol BS17 3RY. Tel: (0275) 823 983. Trade enquiries welcome.

• Those of you who missed our 1972-1987 Project Index will be pleased to know that we can now supply photocopies of it. The reprint costs £3.00 and includes all four parts of the original index (as published in the April, May, June and July 1987 issues) with corrections where appropriate. Send your order to the ETI Photocopy Service, 1 Golden Square, London W1R 3AB, and make your cheque or postal order payable to ASP Limited.

• B & R manufactures and sells electro-mechanical and other components such as switches, connectors, relays, potentiometers, indicators and more. The complete range is described in an illustrated 205-page A4 catalogue which is available free on request. Contact B & R Components, Templefields, Harlow, Essex CM20 2BG. Tel: (0279) 443 351.

• They must be mad, but whatever the reason Kia Audio is still giving away free components to readers of ETI. Those who responded to Kia's classified advertisements in the last few issues will have received an IC preamplifier module, a pack of assorted resistors and several packs of assorted capacitors. This month's give-away is a pack of twelve full-spec transistors and for next month the company is planning a 555 timer IC with data and suggested circuits. After that the offers come to an end, so check out Kia's advert now and make the most of this opportunity.

NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

ETI ON THE BRAIN

The October issue sees the next part of the ETI EEG Monitor project. Learn how to connect up the EEG Monitor to control external equipment and computers and to play the world's first alpha wave controlled computer game!

CONTROL CONCEPTS

The ETI Concept is the ultimate mains controller. Not only will it switch on and off mains appliances at individual preset times, it will measure their power consumption, display how much it's costing you and forecast the cost for the future. It won't buy you a copy of the October ETI, though. That's up to you.

SWITCH ON

Switch mode power supply design is a bit of a black art but all is made clear in this illuminating article next month. Whether you just wonder how they work or want to design your own SMPS, you can't afford to miss the October ETI.

AND THERE'S MORE

The October ETI also has all your regular favourites — the news, reviews, diary, letters, free ads, special offers and more projects and features to make it the most essential electronics mag around.

THE OCTOBER ETI — OUT 4th SEPTEMBER

All the articles listed are in an advanced state of preparation but circumstances beyond our control may prevent publication.

DIARY: DIARY: DIARY: DIARY: DIARY: DIARY: DIARY: DIARY:

Electro-West — September 8-9th
Bristol Exhibition Centre, Bristol. Described by the organisers as a market place and meeting point for everyone involved in the electronics industry in the South West. Contact Electro Exhibitions on (0273) 675 131.

Television By Numbers — September 11th
The IBA, London. See August '87 ETI or contact the BKSTS at the address below.

Television By Numbers — September 11th
The IBA, London. Seminar on digital television techniques. Covers the subject from first principles for the benefit of managers, analogue engineers and others unfamiliar with the technology. Contact the BKSTS at the address below.

Designing For Electromagnetic Compatibility — September 13-18th
University of Sussex. Vacation school. Contact the IEE at the address below.

7th International Display Research Conference — September 15-17th
The IEE, London. See July '87 ETI or contact the Institute of Physics on 01-235 6111.

Electronics In Engineering Design — September 15-18th
NEC, Birmingham. Exhibition and conference on mechanical/electronic systems interfacing. Contact Cahners at the address below.

Design Engineering Show — September 15-18th
NEC, Birmingham. See July '87 ETI or contact Cahners at the address below.

IDEX '87 — September 21-23rd
Metropole Exhibition Halls, Brighton. See April '87 ETI or contact Nutwood Exhibitions on (04848) 25891.

Semiconductor International — September 29-October 1st
NEC, Birmingham. See July '87 ETI or contact Cahners at the address below.

Internepcon — October 6-8th
Metropole Convention Centre, Brighton. See July '87 ETI or contact Cahners at the address below.

Digital Audio Post Production — October 11th
BAFTA, London. Training seminar organised by the BKSTS. Contact them at the address below.

Automotive Electronics — October 12-15th
The IEE, London. See July '87 ETI or contact the IEE.

Computer Graphics Exhibition and Conference — October 13-15th
Wembley Conference Centre, London. For details contact Online on 01-868 4466.

Conference For Young Engineers — October 16-18th
Strand Palace Hotel, London. See July '87 ETI or contact the IEE at the address below.

International Video & Communications Exhibitions — October 18-21st
Metropole Exhibition Centre, Brighton. See July '87 ETI or contact Peter Peregrinus Ltd at the IEE address below.

Radar '87 — October 19-21st
Kensington & Chelsea Town Hall, London. See July '87 ETI or contact the IEE at the address below.

Testmex '87 — October 20-22nd
Business Design Centre, London. See July '87 ETI or contact Network Events at the address below.

Reproduced Sound Conference — November 5-8th
Hydro Hotel, Windermere. Topics covered include acoustics, digital techniques, measurements and electro-acoustic music. Contact the Institute of Acoustics on 031-225 2143.

Electronic Displays — November 17-19th
Kensington Exhibition Centre, London. Contact Network Events at the address below.

Interact '87 — November 17-19th
Kensington Exhibition Centre, London. See June '87 ETI or contact Network Events at the address below.

Addresses:
British Kinematograph Sound and Television Society, 547-549 Victoria House, Vernon Place, London WC1B 4DJ. Tel: 01-242 8400.

Cahners Exhibitions Ltd, Chatsworth House, 59 London Road, Twickenham TW1 3SZ. Tel: 01-891 5051.

Institution of Electrical Engineers, Savoy Place, London WC2 0BL. Tel: 01-240 1871.

Network Events Ltd, Printers Mews, Market Hill, Buckingham MK18 1JX. Tel: (0280) 815 226.

READ/WRITE

Not A Pun On PAL

Having been involved with PLDs for ten years (indeed I have built a business based on them) I feel qualified to take issue with some points Mike Barwise raised in his article in the July issue of ETI.

A £25 set up charge is not typical. My company charges just £9 to supply a programmed PAL to a set of logic equations.

He dismisses PLA design tools as 'expensive and flashy'. Signetics will *give away* the AMAZE software to serious users.

His advice regarding Pleasm is most misleading. This program will assemble logic equations to PROMs up to 32K at least by specifying a bipolar PROM as the target device. The idea of using an EPROM with 250ns delay is faintly ludicrous particularly as there are many small bipolar PROMs commonly used in applications similar to that he describes.

Geoff Bostock,
Programmed Logic Services.
Cheam, Surrey.

Mike Barwise assures us he is extremely pleased to hear of a cheaper service of PAL programming and will also attempt to extract the Amaze package from Signetics.

As to the suggested use of an EPROM, this was only a suggestion for experimentation, avoiding the need for readers to buy or hire expensive PROM programmers.

Equalised Quality

I read with interest Wilfred Harms' article on RIAA equalisation in the June ETI. I stand corrected on the precise values of EQ components but I take issue on the audible effects of the modified network.

Out of interest, I arranged my valve pre-amplifier (see August 1986 ETI) so I could switch between the original EQ network and the theoretically perfect network described by Mr. Harms.

So far 12 interested listeners have failed to detect any tonal differences between the networks. This is not surprising as a 1.5dB change in level is at the limits of the ear's discrimination.

Factors such as different input leads from the record deck to the pre-amplifier have far greater effect than the difference between the EQ networks.

Jeff Macaulay
Bognor Regis, Sussex.

Although the limitations of the human ear is something which (sadly) is rarely taken into account for discussions of the virtues of hi-fi, it must be said that if truly accurate RIAA equalisation can be achieved with such ease, it seems silly not to do so.

Hip Or Hype?

Although your recent coverage of musical electronics is most welcome, the Keynotes of the July issue was laughable. Vector Synthesis is new because waggling the joystick *programs* the synth. Your newly created combination of waveforms can then be played like a musical instrument without waggling the stick for every note.

I can honestly say that using the VS joystick makes the synth uniquely easy and versatile to play.

To call the Roland D50 linear arithmetic synth a rip-off is truly risible. The point of the Roland technique is that PCM sampled sounds are mixed with conventionally created sounds giving new powerful sounds. It could have been done before but only with a great deal more effort and lots of boxes connected via MIDI.

If you want technical innovation, how about the Simmons eight channel programmable mixer?

Grant Laurenson
Horsham, Sussex.

Bruno Hewitt replies: By 'new developements' I meant those pertinent to readers of an electronics magazine, not a buyer's guide. Keynotes is concerned with music technology and technology trends.

In the July column I said there is currently little momentum in this area. Although a few Western manufacturers are carrying technology forward, the Japanese have attained a position of market domination which allows them to take things easy.

This has nothing to do with the merits of the VS or D50 which are both good machines cited only as examples of what are basically old ideas doing the rounds.

Regarding the sound-mixing joystick, the July column stated clearly, 'To be fair, this is a very useful and ergonomic feature'. But with regard to *technological* innovation, Linear Arithmetic Synthesis is an old idea repackaged in new jargon.

Tact And Charm

You miserable scoundrels! I've just bought six JLH Audio Design Amplifier PCBs, six (yes, six) power supply PCBs, six toroidal transformers and so on. Now you have the nerve to tell me in the June issue that you are about to publish an improved version.

Before I utter a few incantations and cast a few spells turning you all into smelly frogs, I'll give you a couple of chances to save your worthless skins!

Could you please tell me if *any* of the kit I've just spent a life savings on will be compatible with the next design. When will you be publishing the new design?

Please answer carefully. I am also a black belt in Origami and Vogon Poetry.

Andy Goloskof ('The Wizard')
Tewkesbury, Gloucestershire.

It's a pity you practiced your martial arts on the April issue of ETI as you missed the original announcement of the new improved JLH amp.

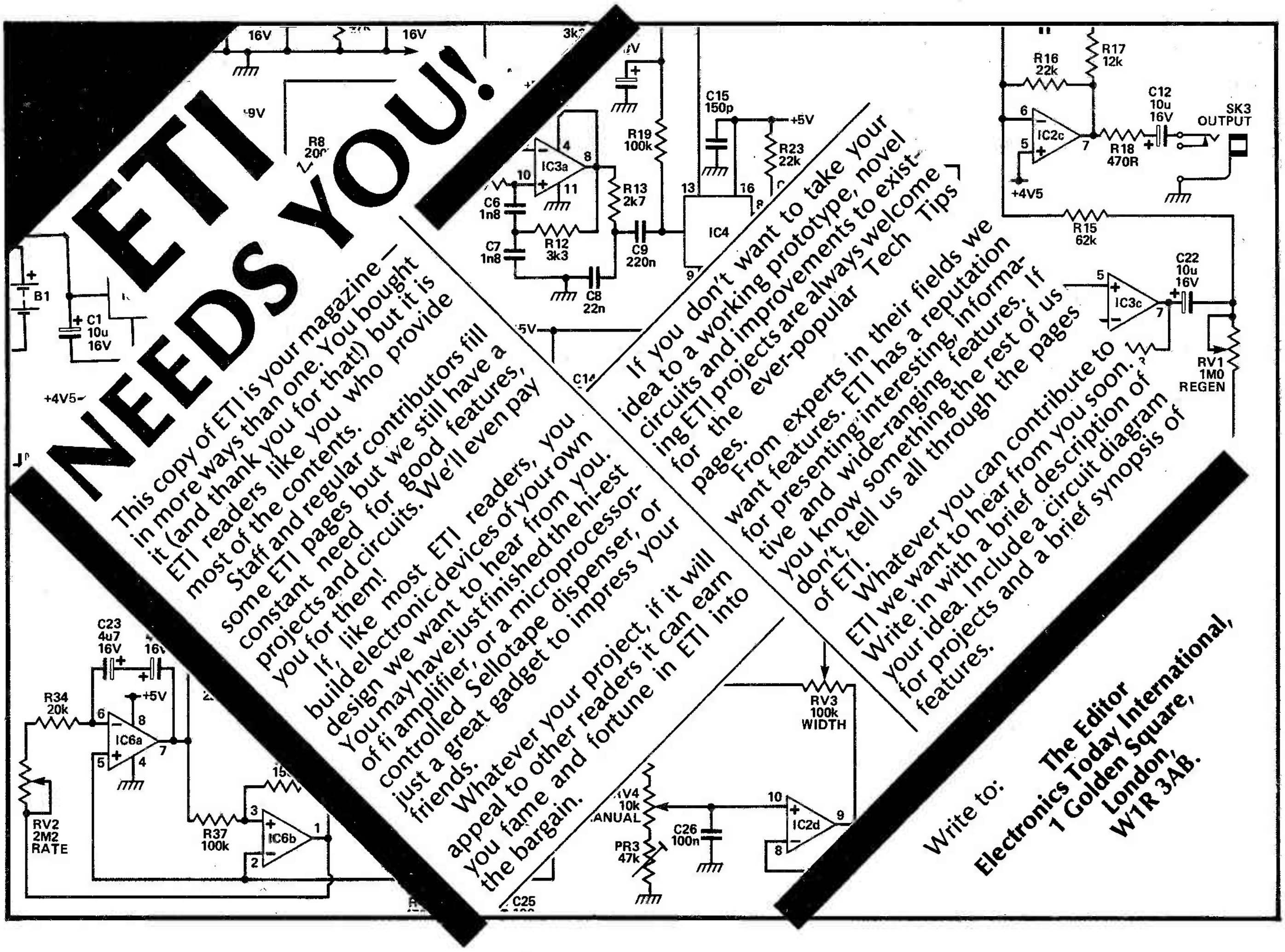
It is unlikely much of your purchases will be of use for the new amp (the transformers, maybe) as the PCBs are being redesigned but do not despair (or get violent). The original design is still an excellent one. The improvements are to the tone controls, power meters and the like so the new amp will not overshadow the old in terms of sound quality. The new design is still just a design and we shall bring you the final product as soon as it is finished.

Can we go back to the lillypad now please?

ETI

As you step onto the beach at Torremolinos on your summer hols this year spare a thought for those boys back at the ETI editorial office. A few well chosen lines scribbled on the back of a postcard depicting Mediterranean splendour could go a long way towards improving the lot of those of us stuck here in mother England. If you can manage some thoughts relevant to ETI or electronics in general you might even prevent a blank letters page in next month's mag. Write to:

Electronics Today International,
1 Golden Square,
London W1R 3AB.



3D TV

James Archer's crystal ball is in lifelike full colour 3D. He's been using it to look into the future of stereoscopic television.

As each new TV development comes along and is added to the signals we receive in our homes, it is soon taken for granted and everyone wonders how they ever managed without it. The addition of colour to the existing black and white pictures was probably the biggest single change that most of us have seen and although there were originally a few diehards who claimed that they still liked black and white best, there aren't many people these days who would deny that colour has added a whole new sense of realism to the pictures.

The same will no doubt be true for sound. Within the next year or so stereophonic sound signals will be added to the broadcast transmissions. Once viewers have experienced the improvement that stereo can bring, there will be no going back to mono sound, except for old films and repeats of course!

The next great step forward to bring television pictures closer to reality will be the introduction of true stereo television. That is stereoscopic or 3D television, in which the picture conveys a sense of depth.

System Requirements

Stereoscopic TV has been a gleam in the eye of researchers for many a long year and experiments have been carried out in various parts of the world with a great many different systems. So far there is no sign of a single standard method of transmitting these signals. The international body which looks after broadcasting standards, the CCIR, has got as far as laying down a list of requirements which any stereoscopic broadcast service should be able to satisfy. Although it has also taken note of various suggested methods of achieving 3D, as yet there is no suggestion that the time is right for a standard to be published.

The CCIR suggests that any practical 3D system should provide a three-dimensional display where the depth of the scene appears natural, without any discomfort to the viewer and that the display should be suitable for a group viewing so that almost any location in the room can provide good viewing of the stereoscopic effect.

As always in television, compatibility is important and this has two main requirements. In an ideal system stereoscopic receivers should display a 3D transmission in full depth and a standard 2D transmission (monoscopic) as a normal picture. In such a system any present day receiver should display the future 3D transmissions monoscopically, so that the viewer sees a normal and complete 'flat' picture.

It is also suggested that an ideal system would involve the minimum of modifications to the current television standards, that picture quality in terms of resolution and colour should be at least as high as that of today's pictures and that the cost and complexity of converting studio, transmission and receiving equipment should be as low as possible. This is quite a formidable list of requirements and it has to be said at the outset that although there are various working groups studying the subject throughout the world, none is yet claiming to have come anywhere near meeting all the CCIRs ideas.

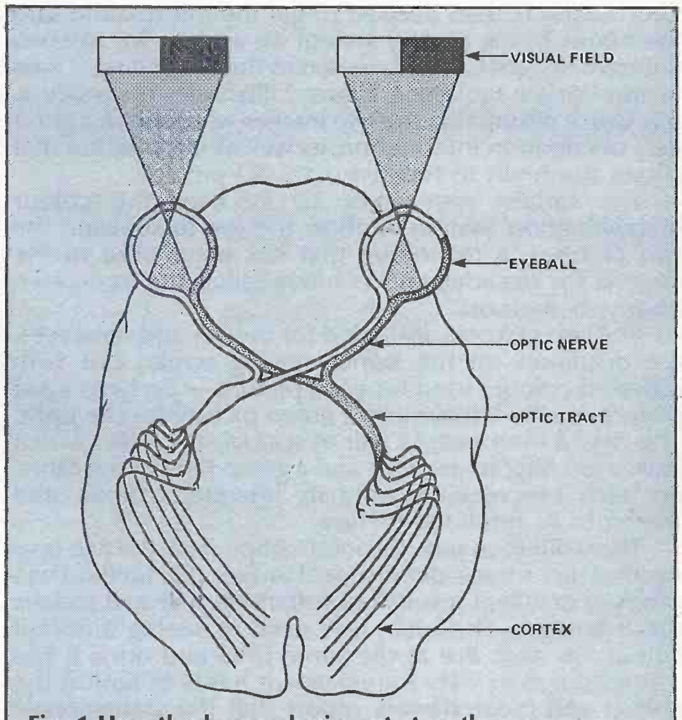


Fig. 1 How the human brain puts together a stereoscopic view of the world.

However, there are various systems which have been demonstrated and it is interesting to see how close each one comes to the ideal.

The Eyes Have It

The most important component of any television system is the human eye. Over the years television engineers have become experts at fooling the eye-brain combination into thinking the intermittent signals which are transmitted and the fast-moving scanning spot in the receiver actually form a moving colour picture.

The human brain 'sees' scenes in three dimensions because our two eyes each see any particular object from two slightly different viewpoints, or more accurately, from two slightly different angles. Figure 1 shows, in much simplified form, how the human brain copes with the signals from the two eyes.

Light falling on the retinas causes chemical changes to take place which give rise to electrical impulses. These travel along the optic nerve to the brain. At a sort of neural 'spaghetti-junction' known as the optic chiasma, some of the signals from the left eye are fed to the right hand side of the brain and some of those from the right eye to the left hand side of the brain. This combination of the two different sets of signals from the one image that is being looked at by the eye is then sent down the optic tract and processed by the brain so as to provide the sensation of stereoscopic vision.

It has been found that the stereoscopic effect is more marked for objects close to the eye than for those at a considerable distance. This is not really surprising, because the difference between the pictures seen by each eye becomes smaller as the object becomes further away.

Practical possibilities

Virtually all systems of 3D TV adopt a process based on an approximation of the method used by the human eye and brain. Each eye is supplied with a slightly different picture. At the transmitting end two cameras, separated from each other, provide two different images and some method of transmitting the two channels of information is then needed to get the information into the home. In the display system we arrange for the two different images to be presented to the left and right eyes in appropriate sequence. Figure 2 illustrates the process. It is worth noting that the two images will contain a good deal of common information, as well as information that allows the brain to reconstruct a 3D picture.

The earliest systems of 3D TV used the 'colour discrimination' system to allow the eye to separate the two pictures, a technique that has been used in the cinema for decades and is often called the 'red-green anaglyph' method.

The two pictures, intended for the left and right eyes, are displayed on the same viewing screen but with different colours used for each picture — perhaps a red picture for the left eye and a green picture for the right. The viewer then wears a pair of special spectacles which have a red filter in one lens and a green filter in the other. So each eye receives only its intended colour, and therefore its intended picture.

The brain then uses the information from the two eyes to construct a three-dimensional image. This method can produce excellent results but suffers from several serious disadvantages. The brain isn't used to seeing different colours in each eye at the same time and once it has settled down to view the images it tends to ignore the colour and most viewers report that the stereoscopic pictures they see are monochrome, grey and white pictures. This is obviously no use in the age when we are used to watching full colour pictures and neither is the fact that the system is in no way compatible with the existing transmissions — viewers who don't wear the spectacles see only blurred red and green images.

TVS, the ITV company which serves the south of England, actually carried live test transmissions as part of one of its popular science programmes a couple of years ago and cardboard spectacles with different coloured lenses were given away in the TV Times to allow viewers to participate. Many of the effects were very good, providing a true sense of depth and perspective, but some viewers felt that many of the pictures were out of focus and, of course, viewers not wearing the glasses complained they saw only a blurred mess.

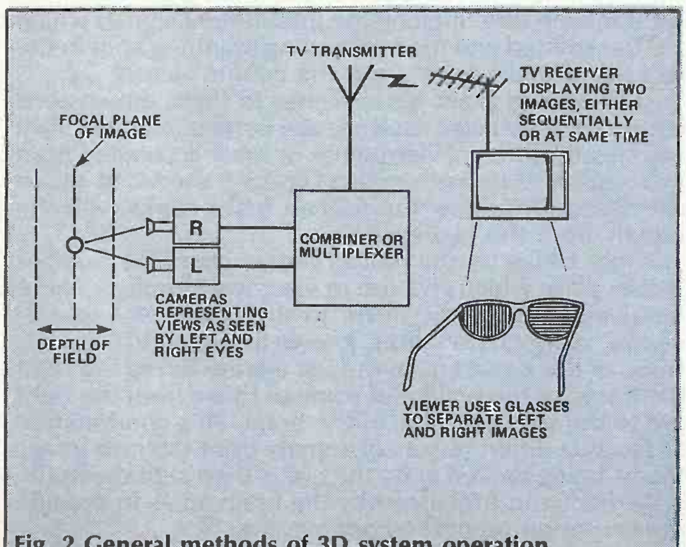
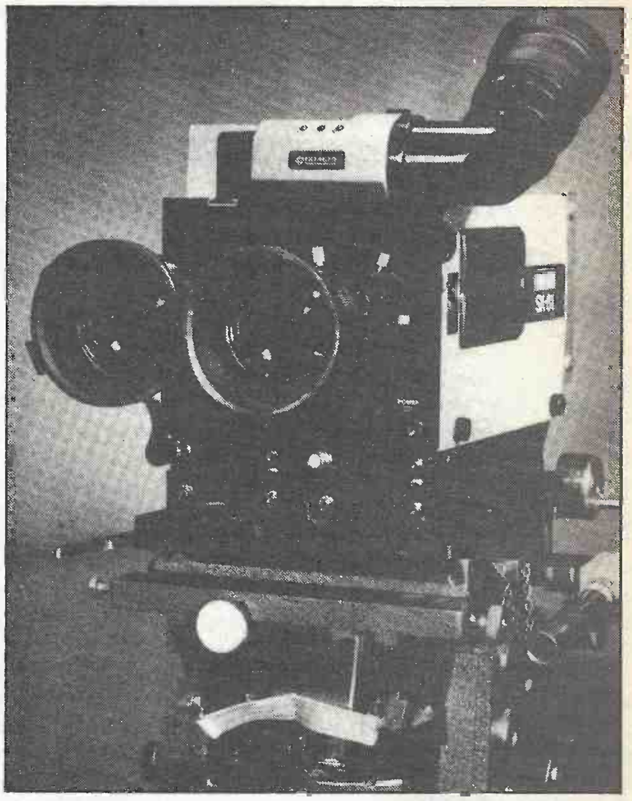


Fig. 2 General methods of 3D system operation.


An IRT 3D camera consisting of two Hitachi SK-81 cameras.

Polarisation

A better way of providing different signals for each eye is to use the 'polarisation plane' method. Again, the two pictures are displayed on the same screen but this time one picture has its light rays filtered in such a way that all the rays are aligned in the same direction (vertically polarised) and the other picture is filtered and displayed so that its light rays are horizontally polarised.

This polarisation technique is commonly used in sunglasses to prevent eyestrain caused by glare. It has been found that most of the glare of reflected sunlight is horizontally polarised and so vertically polarised lenses are used in the sunglasses to eliminate the offending horizontal rays whilst the vertically polarised rays still enable a clear sharp image to be seen. This means that if you have a pair of 'Polaroid' type glasses it is possible to use them for tests of 3D TV systems by rotating one lens through 90° so that you have a vertically polarised lens in one eye and a horizontally polarised lens in the other.

The polarisation plane method allows pictures to be seen in full colour and since the two pictures are displayed in exact physical alignment apart from the difference in polarisations, the viewer with a standard receiver can watch his two-dimensional pictures without any problems since the unaided eye cannot detect the polarity of light, so our compatibility requirements are met. Most serious researchers are currently using some variation of the polarisation plane technique.

Although many specialist members of the European Broadcasting Union are currently studying the topic, perhaps the keenest of the European broadcasting institutions as far as 3D TV is concerned is IRT, the West German institute for research into technical developments in radio and television. IRT has been researching 3D TV for over 17 years and as long ago as 1982 it broadcast a series of stereoscopic programmes, using the two-coloured anaglyphic technology and the accompanying two-coloured glasses. The IRT experimental broadcasts elicited a tremendous response from the German public but other work has shown that viewers are not prepared to accept a reduction in picture quality as the price for 3D television.

IRT's research engineers have found that the most satisfactory results are obtained by using the polarisation-plane method with polarising filters in front of the display tubes and corresponding filters in the spectacles worn by the viewer. The glass in the spectacles is a neutral grey colour and does not disturb normal vision any more than wearing a pair of sunglasses does. IRT has found that by far the most convincing 3D effects are obtained from projection televisions where the larger image seems to add to the stereoscopic effects. When stereoscopic pictures are shown on small screens many observers thought that although the 3D effect could be clearly seen, the overall impression was unreal and this has become known as the 'puppet theatre' effect.

IRT's most recent demonstrations have made use of the equipment shown in the photographs, which consists of two Barco projectors mounted vertically above each other, as closely as possible. Polarising filters in front of the lenses and corresponding filters in the spectacles allow the left eye to see only the beam produced by the upper projector and the right eye to see just the lower beam.

The type of polarisation currently used gives discrimination in the vertical direction but the researchers claim that it should eventually be possible to use bi-circular polarisation, which would permit more freedom of head movement. The red, green, and blue tubes of the two projectors are reversed on the two projectors, so that the left-right colour shading that is commonly found on single projection displays can be eliminated.

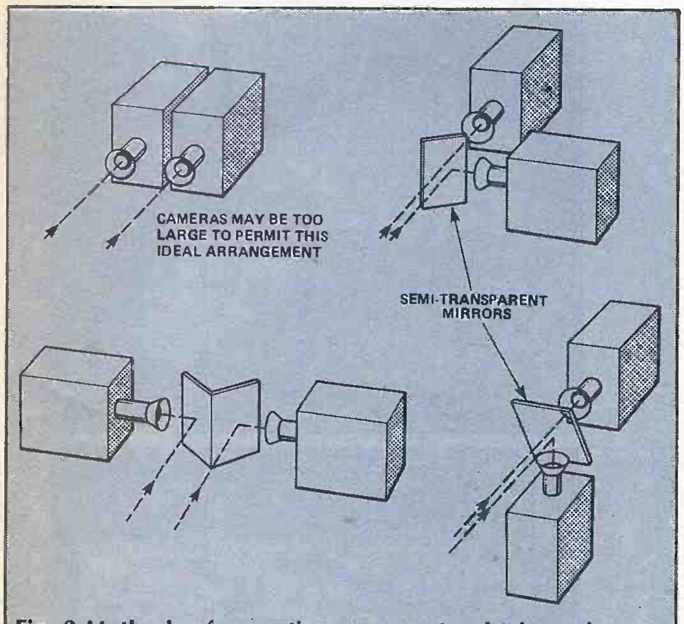


Fig. 3 Methods of mounting cameras to obtain optimum inter-eye spacing.

Programme production equipment included two standard cameras mounted side by side to simulate the two eyes. Although the ideal horizontal distance between the two lenses is 65-70mm (the average distance between human eyes) practical difficulties with the size of the cameras meant that the original interaxial distance was about 90mm. This exaggerates the perspective on some scenes and so later developments involved the cameras looking at the scene through an arrangement of mirrors and prisms (Fig. 3) which effectively allows the two image centres to be brought closer together. The focus and zoom controls on the two cameras are ganged together.

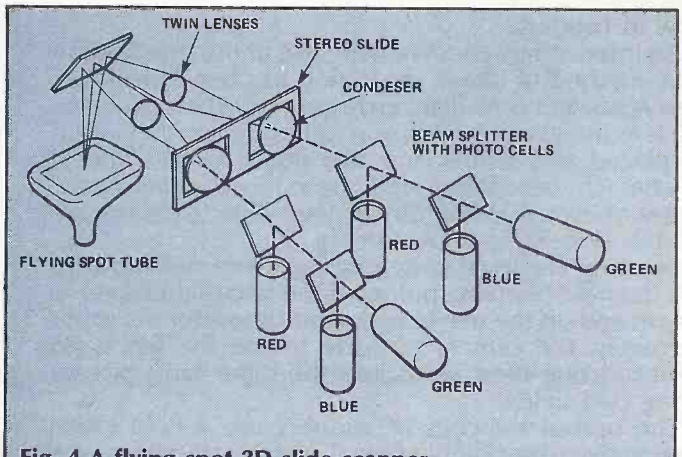


Fig. 4 A flying spot 3D slide scanner.

For still pictures IRT developed a slide scanner using the technique shown in Fig. 4 and two synchronised B-Format 1-inch professional tape machines were used to record and playback the pictures to be presented individually to each eye.

The demonstrations showed that three-dimensional television can be made to work with conventional studio equipment and most viewers reported that the 3D viewing also gave a subjective feeling of enhanced picture quality, as well as the sensation of depth, although the reasons for this have not yet been explained.

Engineers from many parts of the world conceded that the IRT pictures were clear, sharp and showed extremely good depth effects. However, some observers said that after watching the programmes for about twenty minutes they experienced feelings of nausea, perhaps caused by the fact that the eye is not normally used to having to continuously modify its focus and adjust its accommodation when watching television pictures.

To transmit such pictures would require the two signals to be carried on two separate television channels, which is not very realistic at the moment. However, it could be that the eventual introduction of wider bandwidth channels, perhaps on satellite or cable systems, which will be needed for many of the high-definition television services that are currently being examined, may well also open the door to this type of 3D transmission. Unfortunately, many practical problems of programme and receiver production at a reasonable cost still need to be overcome and even the most optimistic of the German engineers think regular broadcasts are still several years away.

Enter The Japanese

Some Japanese workers feel it would be better to replace the polaroid spectacles by a more sophisticated pair containing a liquid-crystal shutter for each eye. The LCD devices would work rather like those we see in watches and calculators, becoming transparent or opaque as appropriate voltages are applied.

Sharp and JVC have used a video-disc player to demonstrate that electronic switching of these glasses could be synchronised with the playback of individual pictures intended for the left and right eyes, giving stereoscopy without the need for either colour separation or polarisation discrimination and they claim to have plans to market this equipment. Indeed, Sharp demonstrated such a system at the recent Brown Goods

Show in London.

An interesting system making use of the polarisation plane method of image separation has been proposed by an Australian consultant engineer named Maxwell. His idea is to use just one television camera, in front of which are placed two lenses and two liquid crystal optical switches (shutters acting similarly to those in the special glasses above). A set of mirrors then directs the images into the camera, as shown in Fig. 5.

By using electrical switching signals in synchronism with the field blanking pulses of the television signal to turn on and off the two LCD shutters one after the other alternately, the camera is made to see the left hand picture during even fields and the right hand picture during odd fields.

The optical switches or shutters use a field effect transmissive type of liquid crystal, which naturally rotates the polarisation of any light passing through it by ninety degrees. Figure 6 shows how the system works.

A thin layer of the liquid crystal material is sandwiched between two glass or plastic sheets which are coated with a transparent electrically conducting material (usually tin-based) and the two sheets are coated with a polarising substance so that they only allow vertically polarised light to pass.

As unpolarised light passes through the first sheet of polarised glass the light rays coming out are vertically polarised. These vertically polarised rays then pass through the liquid crystal, which rotates the polarisation so that the rays are horizontally polarised. Since the second sheet of glass is vertically polarised, the horizontally polarised light from the liquid crystal will not pass through it and so the device prevents any light from passing.

If we now apply a voltage across the two conductive coatings the liquid crystals rotate and no longer cause the polarisation of light to be changed. The incoming vertically polarised light will still be vertically polarised when it has pased through the crystal layer and it will pass right through the vertically polarised glass on the output side of the device. The optical switch is 'on'.

The output signal from the camera can then be trasmitted in the normal way and the receiver uses a normal cathode ray-tube in front of which is placed a

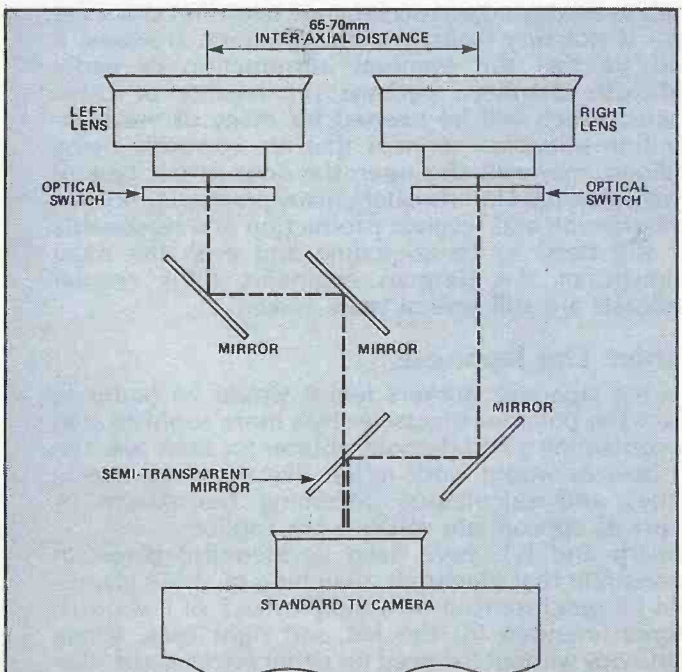


Fig. 5 The arrangement of mirrors and camera lenses for the Maxwell system.

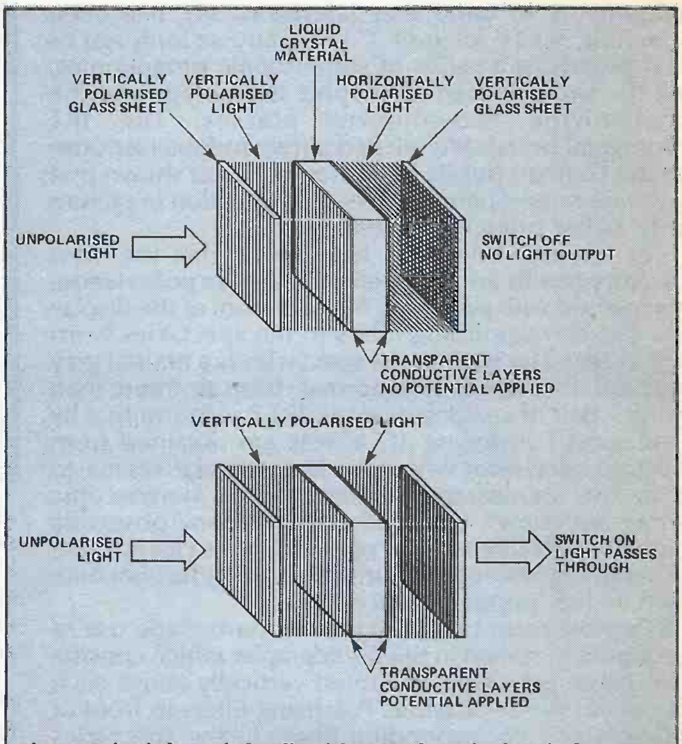
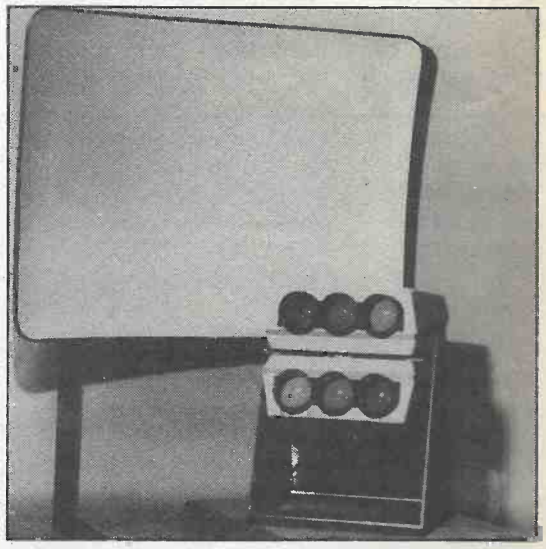
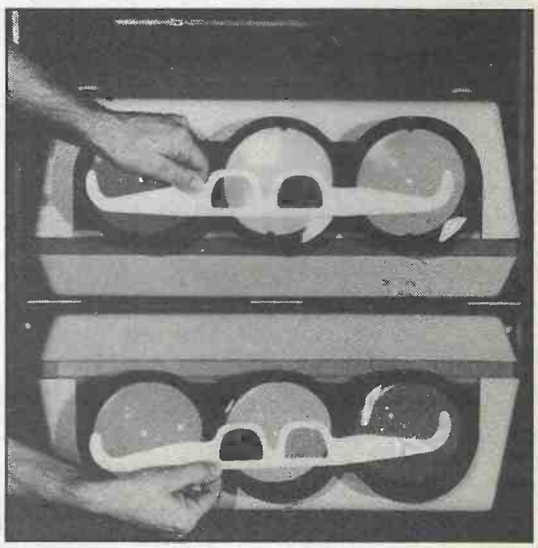


Fig. 6 Principles of the liquid crystal optical switch.





The IRT polarised projection system with viewer's glasses showing the different polarisation on each set of projectors.

special liquid crystal screen. By applying a potential across the liquid crystal layers the polarisation of the light from the screen can be rotated through ninety degrees, and the system is arranged so that a vertically polarised picture is provided during even fields and a horizontally polarised picture during odd fields. The viewer then wears simple glasses with polarised lenses, one vertically polarised, the other horizontally polarised, so that each eye sees only the image intended for it.

Nobody has yet managed to make this type of LCD screen filter of a large enough size to fit standard television receivers and this is the Achilles heel of what seems to be an otherwise excellent system. A similar system from India (Fig. 7) tries to overcome this problem by using a perfectly standard display tube but this time

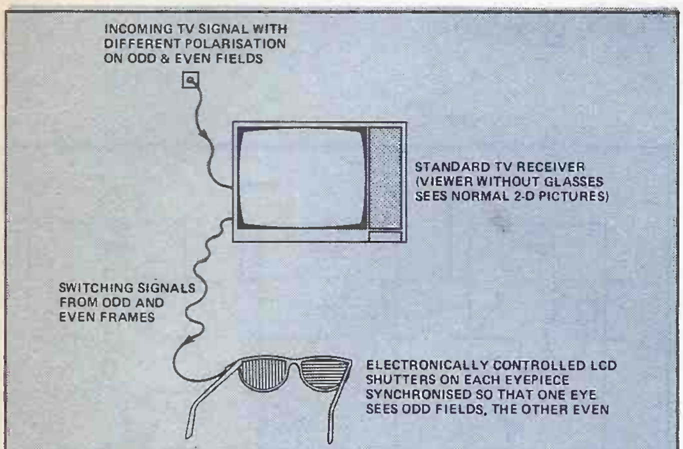


Fig. 7 The field-masking synchronous shutter system.

the viewer must wear special LCD-shuttered spectacles, similar to those mentioned earlier. Using what is known as a 'field-masking synchronous shutter', the light to each eye is switched on and off according to whether the odd or even field is being transmitted at any instant. Since the LCD screen is being switched in polarisation at a frequency of 25Hz, flicker might be expected to be annoying but tests have shown that since one eye or the other is seeing a picture during each field the brain seems to take account of the information seen by both eyes and the effective flicker rate becomes 50Hz and so no problems are encountered.

A Holographic Future?

All television engineers who have seen and marvelled at the 'true' stereoscopic effects that holograms can achieve, have a feeling that somewhere, somehow, there must be a way of adapting television to utilise holography.

We already know that the large amount of information contained in a hologram would require enormous bandwidths to transmit but this is far from being the only problem. Unfortunately it seems that holography is currently in the same state of development that photography was in the late 1890's and it looks as though we shall have to wait a lot longer before we see any real results from this work.

Perhaps the three-dimensional system of the future will have no display screen at all. My living room of the 2000's will contain three lasers, one each for red, green and blue, tucked away in the corners of the ceiling. The three beams will interact in the centre of the room and a full-bodied holographic image of my favourite film star will act out my fantasies on the fireside rug! If only I could live that long! **ETI**

CMOS OSCILLATORS

Neville Croucher explains how the whole world can be set oscillating with a few cheap CMOS gates.

Most electronics engineers have used CMOS logic gate ICs at some time or another. Whilst they are used as logic building blocks there are also a number of other uses to which they can be put. Two of these are astable and monostable multivibrators.

There are special devices designed for this purpose such as the 4047 but it is often cheaper and more convenient to use simple gates and inverters like the 4001, 4011, and 4069. The pinouts of these are shown in Fig. 1. For these circuits all we require is a single input inverter. The NAND and NOR gates of the 4001 and 4011 can be used with the inputs connected together.

To understand the operation of these circuits it is necessary to be aware of the transfer characteristics of the CMOS inverter as shown in Fig. 2. The operation is essentially that of a high gain inverting amplifier with its input biased at half the supply voltage. The bias point may be anywhere between 30% and 70% of the supply voltage although in practice it is usually quite close to 50%.

The simplest arrangement for an oscillator is shown in Fig. 3. This is a simple circuit requiring only two external components. When the output goes high the input (point 2) also goes high via the capacitor. At the same time the middle (point 3) goes low.

The effect is that the capacitor charges through the resistor as shown on the timing diagram. When the input voltage reaches the transfer voltage the two inverters change state and the output voltage goes low. At the same time the capacitor forces the input low. The whole sequence then repeats with the levels inverted. The frequency is approximately 1/(1.7CR)

Examination of the voltage waveforms will show an apparent error. When the output changes the input voltage only changes by half the output voltage swing. This is because the input protection diodes built into CMOS devices prevent the input going more than 0.7V outside of the supply rails. In normal CMOS use this would not be a problem but it does have an effect on this particular application. The main disadvantage is that the frequency becomes much more dependant upon the supply voltage. Fortunately there is an easy solution as shown in Fig. 4. With the addition of Rs the capacitor voltage is able to swing outside of the supply voltage as shown in the waveform diagrams. With this arrangement the frequency is approximately 1/(2.2CR)

The main factor affecting component values is the current which must be supplied from the gate output stage. For most practical purposes a minimum value for R of 2k2 is unlikely to cause any significant problems. Where possible a value of about 100k is a good starting point as it allows a large margin for adjustment in both

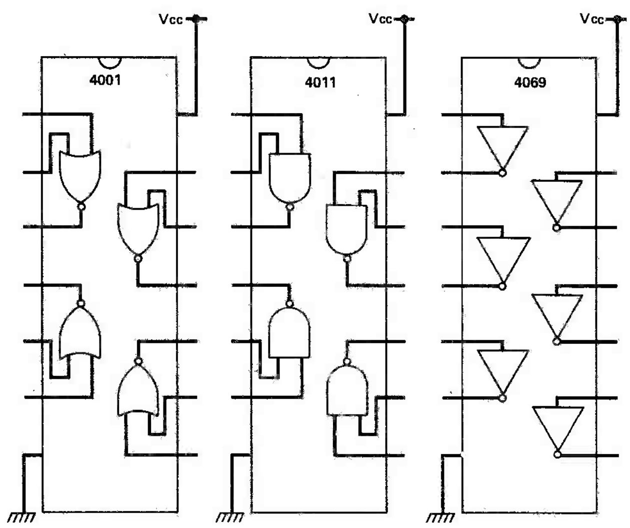


Fig. 1 The pinouts of the CMOS gate chips.

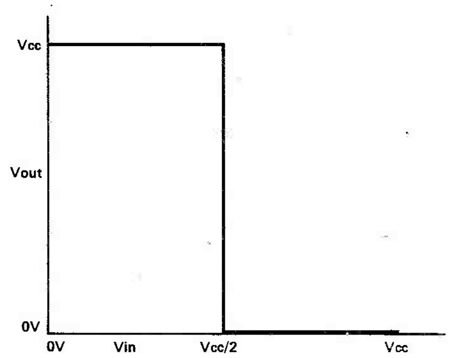


Fig. 2 The transfer characteristic of a CMOS inverter.

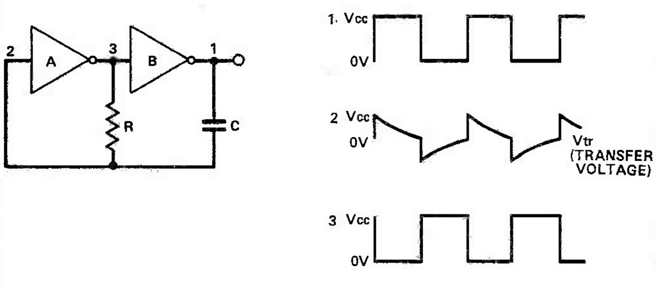


Fig. 3 The basic oscillator.

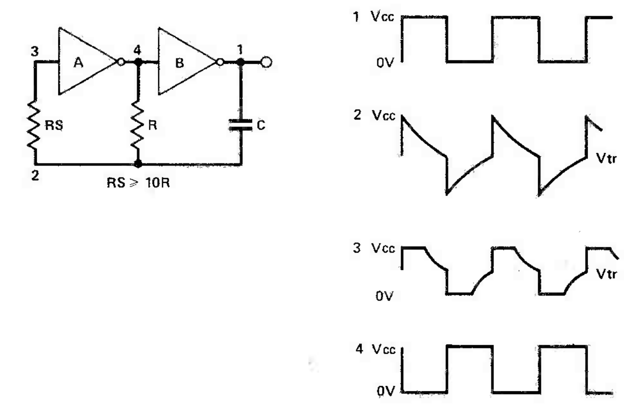


Fig. 4 The improved oscillator.

directions. The limiting factor for the capacitor is that there is an AC voltage across it and therefore an electrolytic must not be used. Despite this, using a 10M resistor and a 2μ2 capacitor it is possible to get down to 0.02Hz!

The upper frequency limit depends on a number of factors including supply voltage, component tolerances and component layout and stray capacitance. In practice a frequency of 5MHz should be easily obtainable.

It may be necessary to gate the oscillator using an external signal. Figure 5 shows how easy this is. When the control input is low the output of gate A is forced high and the output of the oscillator low. When the control input is high the oscillator runs normally.

Another possible requirement is a variable duty cycle. This can be achieved with the circuit of Fig. 6. Here the two diodes separate the capacitor charging cycles. The effect of this is that R1 determines the off period and R2 the on period. The overall frequency becomes 1/(1.1C(R1+R2))

It should be borne in mind that the non-linearity of the diodes will introduce some dependence on the supply voltage.

For applications requiring very accurate and stable frequencies the only real solution is to use a crystal. The circuit for this is very simple as Fig. 7 shows. Here the CMOS inverter is simply being used as a high gain inverting amplifier. The resistor forces the gate into linear operation and the crystal provides a 180° phase-shift at its resonant frequency. The resistor value should be as high as is practically possible to reduce loading effects on the crystal.

All the circuits shown so far have been for free running oscillators. There are also a large number of applications for monostable multivibrators or 'one shots'. Once again it is possible to use special devices but it can be simpler and cheaper to use individual gates. A basic positive edge triggered monostable is shown in Fig. 8. When the input goes high the output of gate A goes low which in turn operates gate B via the capacitor. The output of B going high also latches the other input of gate A. The output will now stay high until the input to gate B exceeds its transfer voltage. The width of the output is therefore entirely dependent on the timing components.

The only requirement for the input pulse is that its width exceeds the propagation delay of the two gates. For standard CMOS the circuit shown would require a minimum pulse width of about 70ns. For a negative input trigger the circuit of Fig. 9 is suitable. For all these applications the specialist chips have their own advantages but often the benefits of simplicity and cost which these circuits offer can be far more attractive.

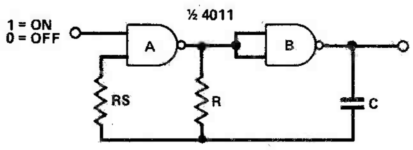


Fig. 5 A gated oscillator.

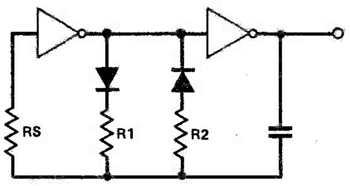


Fig. 6 A variable duty cycle oscillator.

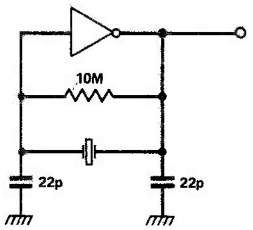


Fig. 7 A crystal controlled oscillator.

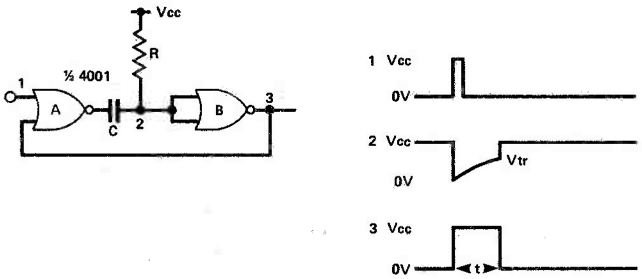


Fig. 8 A positive triggered one-shot.

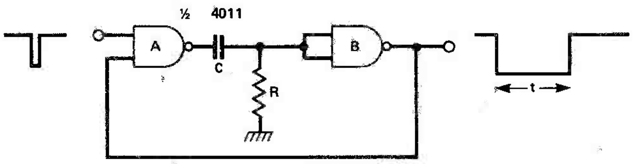


Fig. 9 A negative triggered one-shot.

ETI

HARDWARE DESIGN CONCEPTS

Mike Barwise is first in with a look at the latest developments in FIFO memories.

Since I last wrote about FIFO memories (ETI August, September 1986) technology has moved on a little and provided us with several types of large capacity devices. I shall take a look at one example and discuss some cunning implementations. First, though, a brief resumé of FIFO (First In, First Out) memories in general.

FIFO Memory Types

The earliest and still probably the fastest FIFOs are the small capacity ripple-through types such as the 74LS222/4/7/8 and the 40105. These are essentially parallel sets of shift registers in which the data entered at one end ripples through to the other by means of what would normally be considered an undesirable race condition. Such FIFOs are somewhat prone to corrupt date due to the dropping of bits in transit. This makes the technique unsuitable for use on FIFOs larger than about 32 words depth because the likelihood of dropped bits is roughly dependent on the FIFO depth and therefore on the number of stages the data word has to ripple through.

The second major type of FIFO is the ring counter FIFO which is the one I described in detail when I discussed multi-processor techniques. You may remember that it consists of a memory array and two address counters, one for input and the other for output. The data remains static with each item written only once into the memory. It is the address that changes as you write and read the device.

This allows much bigger memories to be used (typically 1K) and the resultant device is as reliable as any static RAM. A typical example is the Mostek 4501 (512 bytes), which has been second-sourced by several manufacturers. I use IDT parts myself (part numbers IDT720n) which come in single chip 512 and 1K byte devices and hybrids up to 4K.

This type of FIFO is currently a lot slower than the ripple-through devices because it contains CMOS RAM similar to ordinary static computer memory. The fastest IDT part that can be obtained has a cycle time of about 70ns, but things are getting faster all the time and some clever dodges can be used to improve this.

The IDT720n pinout is shown in Fig. 1. The input and output ports are separate, the inputs being labelled D and the outputs Q. There is a WRITE pin associated with the D inputs and a READ pin associated with the outputs. Up to this point, the device looks like a conventional RAM except for the absence of any address inputs and the less common nine bit wide data bus (mainly for parity storage).

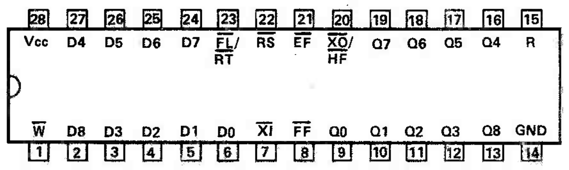


Fig. 1 Pin-out of the IDT720n FIFO.

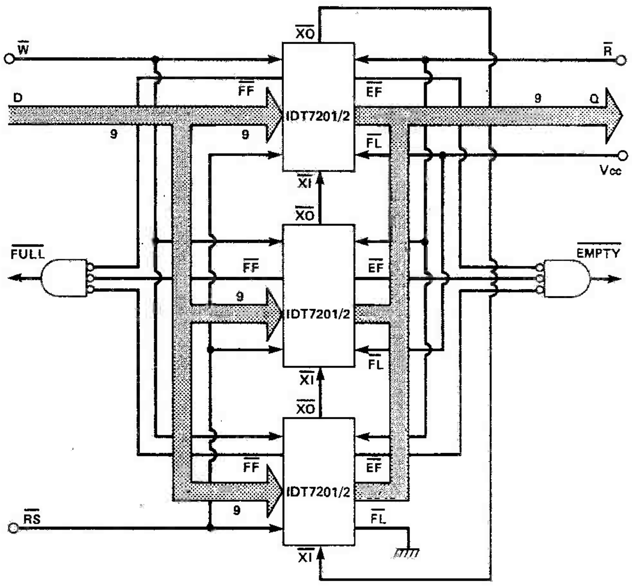


Fig. 2 Suggested depth expansion arrangement using the IDT 720n.

From here on, things start to get interesting. Pin 22 is a RESET. This zeroes both read and write address counters to initialise the device and has the effect of denying further access to any currently stored data. As far as I know data is not actually cleared from the memory element but this is not important because nothing can be read out after RESET.

In order to keep track of the availability of space within the FIFO, pins 8 and 21 serve as FULL and EMPTY flags respectively. The EMPTY flag is active until a byte is written to the FIFO after RESET and at any time when the same number of bytes has been read out as was written in. The FULL flag is active whenever N bytes more have been written in than read out (where N is the FIFO depth). Further attempts to write are ignored while the FULL flag is active, so it is the latest data which is lost.

These functions are common to the majority of FIFO memories, but the MK4501/IDT720n single chip FIFOs have some interesting additional features. First, they are expandable. Devices may be cascaded with minimal external support to provide FIFOs of almost unlimited capacity. This is accomplished by the provision of XI and XO (expansion in and expansion out) pins and a special FL (first load) status pin.

A suggested expansion configuration is shown in Fig. 2. Note that the only external support is the logical AND of the FULL flags and the EMPTY flags of all devices. IDT have taken advantage of the ease of expansion in the creation of 2K and 4K hybrid FIFOs with the same footprint as their smaller single chip brothers.

The three expansion pins are not used in single chip non-expanded mode so two of them have been given alternative functions which can be extremely useful. These are a HALF FULL flag and a RETRANSMIT request. The HF flag is available at the XO (expansion out) pin and the RETRANSMIT input is on the FIRST LOAD (FL) pin.

The first chip's FL pin is grounded and its XI pin is looped to the XO of the last device for expansion mode. Grounding the XI pin causes the FL pin to serve as RETRANSMIT in single device mode. When this pin is activated the READ address pointer is zeroed without loss of data access causing the previously stored data to be presented again during reading. There is a possibility of corruption if data is written into the device during a retransmit READ sequence.

Applications Of A Clever FIFO

OK, so what use is this clever little chip? The first and most obvious application is a straightforward inter-device data buffer such as a printer buffer. In this application only the most basic function using EMPTY and FULL is required, so cascading is perfectly possible, allowing incredibly easy creation of large printer buffers.

A printer buffer built around these FIFOs needs no software to drive it and can just be stuffed into the middle of the printer cable to upgrade elderly and slow printers. The device (or cascaded set of devices) is connected in the data path (D to the micro end and Q to the printer end). At the micro interface, the WRITE input is driven by the Centronics STROBE and the FULL flag is connected to BUSY.

This should provide an adequate interface (as used on the BBC micro) but where an ACKNOWLEDGE signal is required by the micro a dual monostable can be added. This will allow the micro to load the FIFO at its own speed until the FIFO is full. The printer interface will never supply data too fast for the FIFO because it is timed for the printer which is much slower.

On the printer side, the most convenient interface is a fixed rate STROBE generator which is gated by the FIFO EMPTY flag and by the printer BUSY flag. This will ensure that strobes are generated only while there is data available and the printer is ready to accept it. A typical block schematic is shown in Fig. 3

A more advanced application is the use of a retransmitting FIFO to implement a reliable communications protocol for data transfer. The system works by dividing the data stream into packets of N bytes for transmission. Typical packet lengths are 128 or 256 bytes. Parity is frequently used at byte level and a checksum or CRC is appended to each packet.

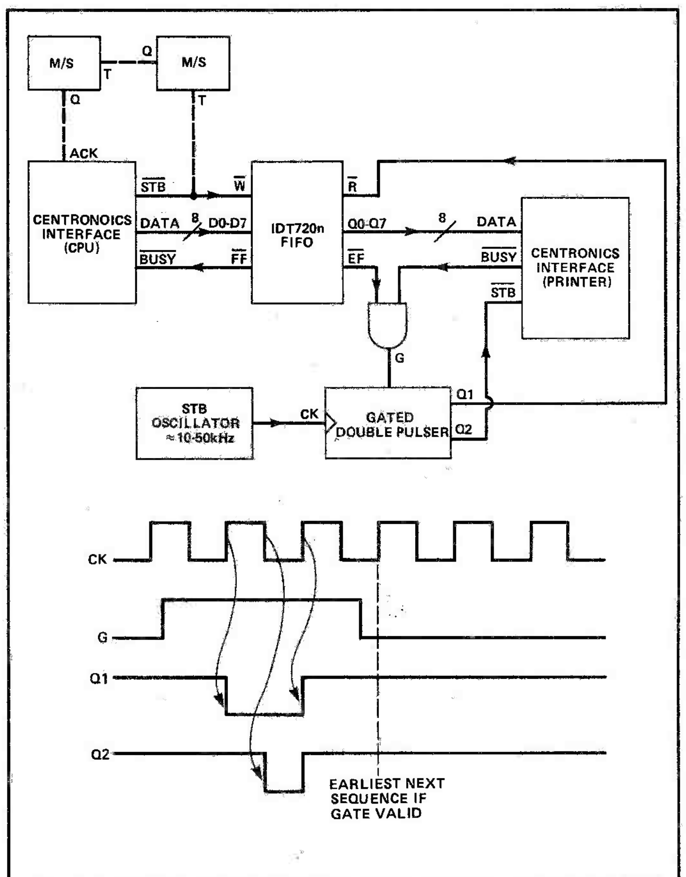


Fig. 3 A typical printer buffer arrangement using the IDT 720n FIFO.

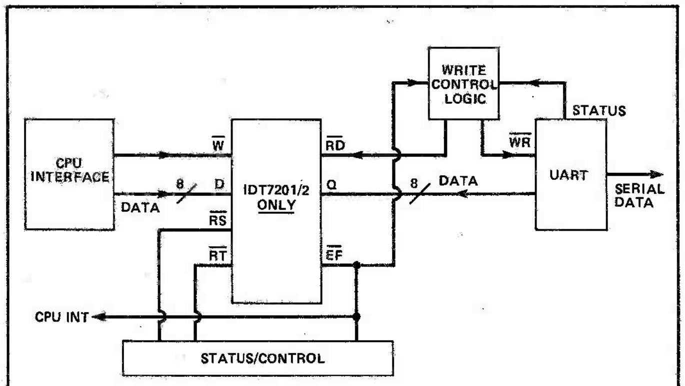


Fig. 4 An auto-retransmitting buffer for packet protocol communications.

As soon as a packet has been received, the checksum is verified and the next packet is requested only if there were no errors. If an error was found, the recipient requests retransmission of the whole packet.

This can, of course, be handled by a microprocessor but it is very time-intensive to retransmit the packet in this way. It would be much better to hold the packet in a private buffer at the transmitting station and automatically retransmit when necessary.

The mechanism using our FIFO is to wire it into the data stream to the communications controller (such as an RS232) so that all data into the controller is buffered. The FIFO EMPTY status, RETRANSMIT and RESET controls are wired to a control register mapped to the transmitting micro. A packet is loaded into the FIFO (a lot faster than it can be transmitted!) and the EMPTY flag (under interrupt) is waited for.

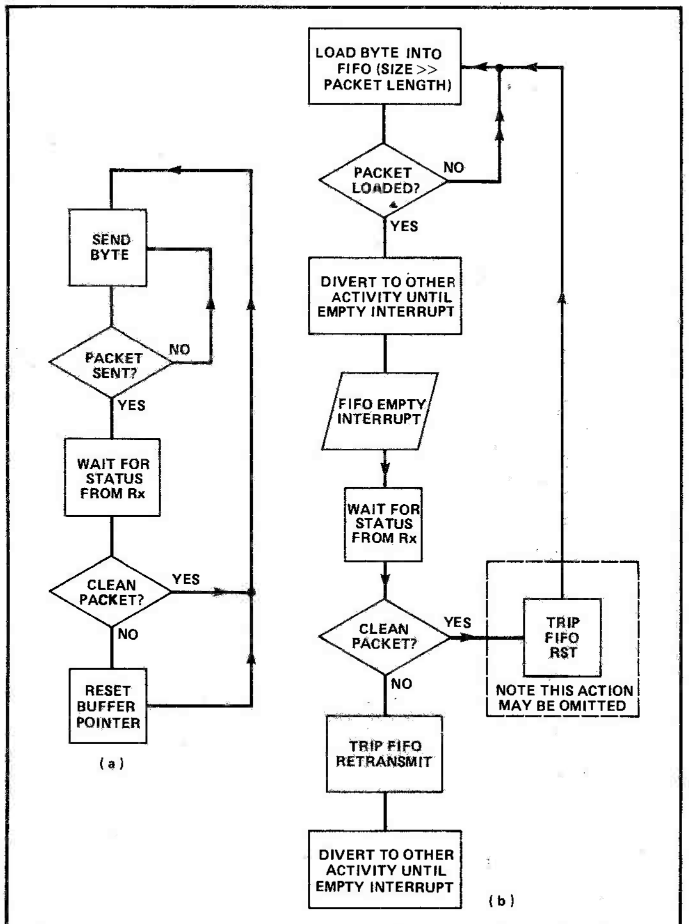


Fig. 5 Flowcharts demonstrating the benefits of buffered operation using auto-retransmission. The buffered approach (b) allows the CPU to spend a considerable amount of time on other tasks compared with the direct approach (a) which requires that the CPU be continuously involved in data transfer.

As soon as the FIFO goes EMPTY, the interrupt causes a wait for a status signal from the receiver (which can be a control line or a data byte) which indicates whether there was a transmission error. Either the RETRANSMIT (in case of error) or the RESET (if transmission was clean) is driven, then EMPTY is monitored until valid. When EMPTY is valid AND a clean packet status is current, the next packet may be sent.

The advantage of this technique is the time saving. The FIFO can be loaded very fast and is only reloaded when a new data packet is required. The status check and FIFO control take very little time. The transmitting micro can thus do a lot of useful work in the meantime. Figure 4 is a block diagram of the system and Fig. 5a and 5b are flowcharts of the direct and buffered approaches for comparison.

Gaining Speed by Cunning

Direct memory access (DMA) techniques such as those just discussed offer three significant benefits. First, they are very simple to implement. Second, the traditional RAM plus external counter approach is actually slightly lower than the speed of the RAM used (the counters use up some time) whereas the FIFO has a predictable performance. Finally, the FIFO is genuinely asynchronous, allowing you to read data out while writing data in without slowing down either process or causing conflicts.

There is, however, sometimes a need for even faster working, for example in fast digitisers. Superfast RAM is costly and its support circuitry is decidedly tricky to implement. The IDT720n FIFOs are available with cycle times of as little as 65ms (about 15MHz throughput), but by being crafty we can effectively reduce this by 50% and so create a 30MHz digital storage system.

The mechanism we use is called commutation and it is simple in principle. If we take two FIFOs with a storage cycle time of, say, 70ms and write data to them alternately, we should be able to perform a write every 35ns. It won't work, though, unless the writing device can reduce the duration of its own write cycle. If the writing device uses up all 70ns writing to the FIFO there is no gain by commutation (other than doubling the FIFO capacity, which could have been done by cascade expansion).

The answer is to provide a very fast holding register at each FIFO input, allowing a much shorter write time, and then time the write into the FIFO by means of additional logic. Figure 6 is a block schematic of such a system, including a simple commutator to control two FIFOs. There is no theoretical reason why you should not commutate across more than two FIFOs, except that the ultimate limiting factor is the sum of the holding register write times and the commutator settling time.

That's about it for this introduction to FIFOs. It's not possible to be exhaustive in these application suggestions because the possibilities are just too numerous. I hope this has got your grey matter in gear, though. Next month I will be looking at A/D and D/A implementations, so 'til then I'll leave you with the good news that the IDT FIFOs are sufficiently affordable for experimentation at around £14 for 512 bytes at 120ns speed from Microlog, The Cornerstone, The Broadway, Woking, Surrey. **ETI**

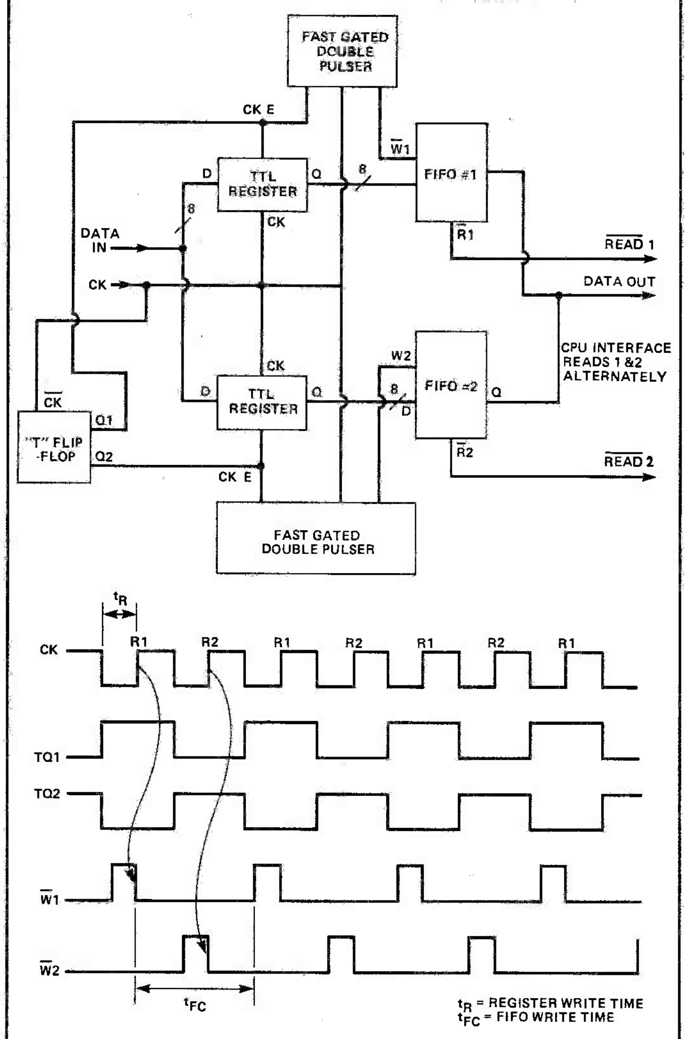


Fig. 6 Using two FIFOs in a commutator arrangement to achieve higher writing speeds.

THE HYBRID MUSIC SYSTEM

Malcolm Brown investigates the best thing to hit the computer music scene since sliced bread.

Now that music technology has risen to the lofty heights of custom LSI and other integrated high tech it is getting difficult to find much in the way of new equipment that can stimulate the electronics enthusiast as well as the musician.

So, it was with enormous enthusiam I greeted the Acorn Music 500 back in 1985. Here at last was a reasonably priced synthesiser capable of extracting a fair sized chunk of versatile, understandable music power from that most ubiquitous micro, the Beeb.

The Music 500 was sold by Acorn but designed by another Cambridge company, Hybrid Technology.

It was with an almost equal amount of apathy on the part of Acorn that the Music 500 faded into comparative obscurity without ever really making a splash.

The good news is that the Music 500 is back as the Music 5000. Just like Allied Carpets' sales, it's back bigger and better! The Hybrid Music System hardware is backed by tremendous software and a keyboard to enable just about anyone with a musical bent to make the most out of the BBC micro.

The Music 5000 package costs £161 — less than the 500 in its day. Alternatively, the new software only can be bought for £69 to upgrade an old 500. An even more attractive alternative is to buy a Music 500 — now reduced to £56 (or, just to confuse matters, £80 if adapted to work with the newer Acorn Compact) and then 'upgrade' it to a Music 5000. The Music 4000 keyboard add-on is another £161.

It doesn't matter how you buy a Music 5000. The important thing is to get out and buy one because this device is the biggest contribution to home computer music since the invention of MIDI.

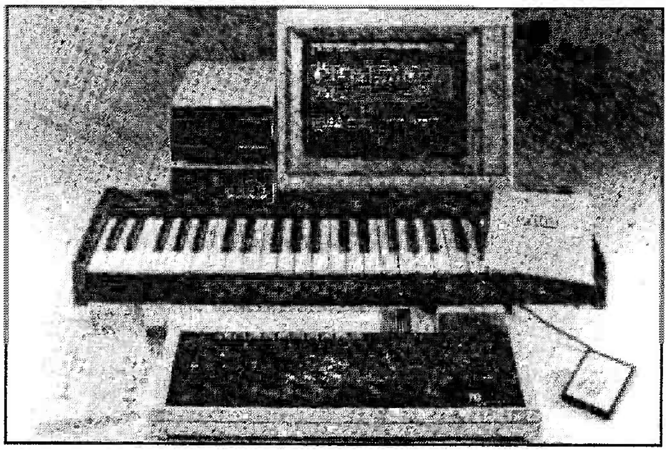
The Music 5000 looks uninspiring enough. It is a simple plain disk drive box which connects to the Beeb's 1MHz bus with a DIN connector to a hi-fi or studio amp.

Inside the box is a complete dedicated computer music system. The BBC micro provides few functions as regards the actual production of music. The micro just tells the synthesiser what sounds to play — the pitch, volume, stereo position (yes, it's stereo!) and pitch and volume envelopes.

Synthesis

The sounds are synthesised in 16 channels from waveshapes stored digitally in the unit's RAM and turned into sound by DACs working at breakneck speed (47kHz). The channels (or 'voices') are grouped together into 'instruments' and the instruments grouped as 'players'. Normally there are two voices per instrument but a very complex sound can use all 16.

This alone produces some pretty interesting noises but The Music 5000 can do more. The voices can modulate one another with amplitude, phase and, of course, frequency modulation, as used in Yamaha's DX and TX synthesiser range. Unlike the Yamaha machines,



however, the Hybrid synthesiser is not limited to modulating sine waves. The complexity and, if you want such things, the realism of the sounds produced is simply amazing.

Because this is a genuine *synthesiser* which builds up each waveform digitally the range of sounds is enormous. Fourteen preset waveshapes are provided and seventeen volume envelopes and seventeen pitch envelopes are pre-programmed. These can be combined in any way to produce your own sounds.

This *should* be a restriction over full waveform programmability. However, the presets provide all the sounds you are ever likely to need and they are all there without the trouble of programming them. In addition, combinations of waveshapes and envelopes are available already preset as a range of useful sounds. The 'Upright' piano sound is one of the best non-digitised I've heard.

The Music 5000 manual provides lots of useful information about the presets. This includes graphs of amplitude and harmonic content of the waveshapes and amplitude or pitch graphs for the envelopes. In addition, several type-in-and-try instrument example programs are provided to give you the idea.

Ample

Like all good computer products, the Hybrid Music System is a combination of hardware and software. The software to control the Hybrid hardware is a programming language called 'Ample' (Advanced Music Programming Language Environment).

Ample is not just a programming language (though it is that as well). It is a kind of music operating system. Under the control of Ample the BBC micro becomes a music processor with the capability of multi-tasking composition and music production.

Ample itself is supplied as a sideways ROM for the micro. This is just a nucleus with the potential of taking a variety of different music input or output devices along with suitable driver software. With the Music 5000 comes a separate disk containing the front end utilities which make up the drivers for the Music 5000 synthesiser and actually enable the system to be used.

The Music 4000 keyboard is also supplied with driver software to link it to the Ample nucleus and further units are planned — a MIDI interface and even a kind of vocal music recognition unit.

The Ample software is a word based language similar in many respects to Logo or Forth. A range of basic command words are provided to set up the hardware to produce sounds and these may be combined in short programs to form new words which can then be used as commands or in further words.

As a music composition language Ample is unusual. Notes are represented in a unique way. The letters A to G denote their respective notes with a capital letter representing a note higher than the last and a lower case letter a lower note. Note lengths are represented numerically and rests, ties and slurs indicated by symbols.

In this way every nuance of a piece of music can be transcribed. Ample notation is difficult to get to know at first but in fact more useful and accurate than the traditional sticks and blobs. Combined with the programming aspect of Ample, this system can be used to program the most complex musical pieces imaginable, with the greatest of ease.

A text editor makes programming easy. This section really proves the Music 5000's worth not as just a synthesiser but as a computer instrument. The flexibility is bounded only by your imagination. Provision is even made to program-in other parts of the computer, external devices or even your own homemade add-ons. A Music 5000 backing track could, for example, easily be synchronised to the press of a key on the micro's keyboard.

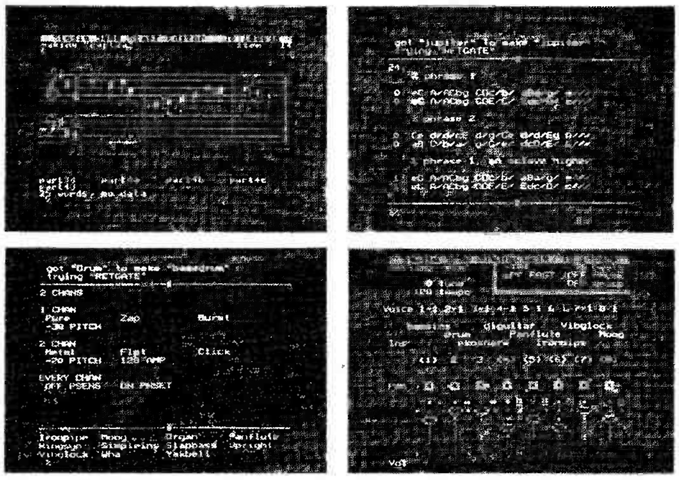
That's all very well for programmers. For hardened musicians who don't know one end of a keyword from another, the Hybrid Music System can operate on another level requiring no real computer knowledge at all.

A series of software 'modules' supplied on disk provide an easy software path all the way from the composer's manuscript to the recording studio.

Sticks And Blobs

The first on the musical road is the staff editor. This is to my mind the best of its type on any computer. Although it lacks some of the graphics frills of many systems, the notes are entered on the staff in a very natural way, each taking its value from the last one entered and then altered if necessary with the cursor keys.

Sections of the piece can be deleted or copied and



Top left: Writing a piece using the staff editor. Top right: Using the text editor and Ample notation. Bottom left: creating a new sound. Bottom right: The mixing desk.

time and key signatures added. If you choose to use bar lines these will be checked. Most importantly, once the whole section is written it is transformed into Ample's own notation providing a route into the intrinsically more powerful composition language.

If the keyboard package has been purchased, this can also be used for entry of notes either in the form of Ample notation or in traditional sticks and blobs.

The keyboard is a reasonable 'feel' four octave model. When the driver software for this is installed the keyboard is always 'live' and can be used alongside the micro's keyboard for music entry or real time playing.

Most impressive is the 'recorder' software which accompanies the keyboard. This enables sections of music to be played (at slow speed if you want) on the keyboard and recorded in memory. The piece can then be 'cleaned up', converted to Ample notation, stored and combined with other parts and sections to make a full piece.

It really is just like using a multi-track recorder. the section you are working on is recorded with the tracks already 'laid down' playing in the background for guidance.

The translation of the physical playing of a keyboard into computer musical notation seems a simple enough process. However, this is a startlingly complex process to get right.

Suffice it to say that Hybrid has got this right. Whether it's the music keyboard, the ASCII keyboard or the staff you are most at home with, the Hybrid Music System will cope well and give you more power to your elbow.

Once a song has been written in as many parts and sections as it requires, it is taken into the Ample 'studio' for a mix down. The mixing desk module enables pieces to be mixed as they play. Unlike a real desk, the sounds themselves can also be changed and the tempo altered. All the controls are pictured in fairly normal form on the screen but activated with the computer keyboard. This takes a while to get used to.

The software doesn't require you to be a computer programmer to produce some great sounds. Complex sounds and pieces can be created and altered easily by anyone unafraid of the computer equivalent of twiddling a few knobs. With the forthcoming MIDI interface and the like, the Hybrid Music System is a boon for home recording or studio backing tracks. If you have a BBC micro then this is a must. If you haven't, it's an excellent reason for getting one. **ETI**

In next month's ETI the designer of the Hybrid Music System explains how off-the-shelf components were used to design this synthesiser to rival custom chip instruments.

Specifications

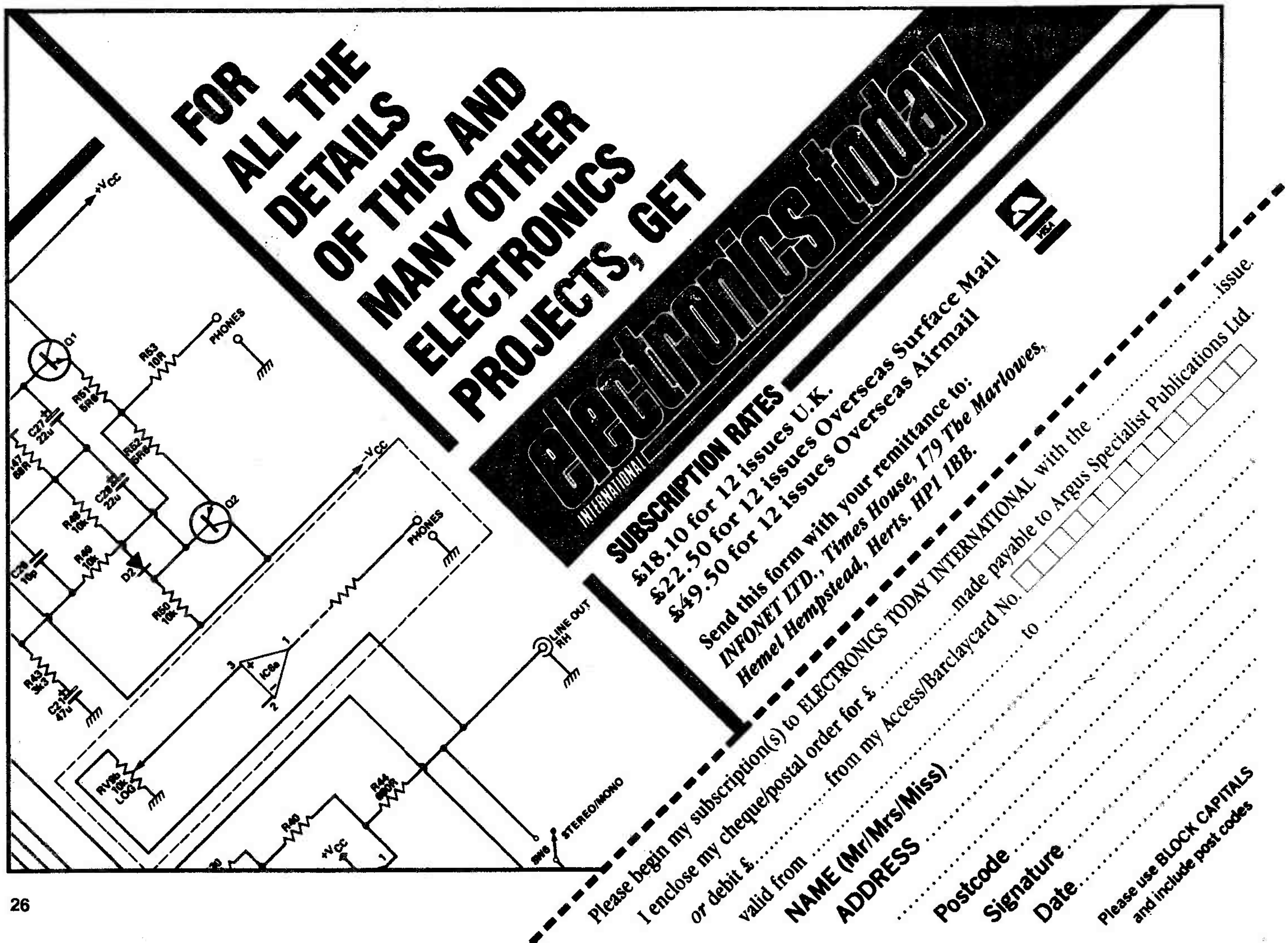
Music 5000	£140+VAT
Frequency range	0-20kHz
Pitch resolution	1/16th semitone
Frequency resolution	0.0056Hz
Sampling rate	46,875s^{-1}
Waveform precision	8-bit logarithmic
Output level	2V p-p
Stereo resolution	7 positions

ROM software providing 9 task concurrent Ample music environment and disk software providing master menu, Ample notepad, mixing desk and staff editor modules.

Music 4000	£141+VAT
Keyboard	49 keys/4 octaves
Footswitch	single sustain switch

Disk software providing keyboard drivers for Ample and recorder module.

Hybrid Technology, Unit 3, Robert Davies Court, Nuffield Road, Cambridge CB4 1TP. Tel: (0223) 316910.



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AVOIDING FEEDBACK

Vivian Capel gives an address and finds all the feedback comes from his audience and none from the PA.

Have you ever been to a meeting or function where the speeches were punctuated by hoots, howls and squeals? Maybe you have had to fix up sound yourself and found that as soon as the volume was turned up the howling started. If you turned it back there were complaints that the volume wasn't loud enough.

The problem is acoustic feedback. Sound from the loudspeakers is picked up by the microphones, re-amplified, emerges from the loudspeakers again at a higher level and re-enters the microphones to be further amplified. The slightest sound starts off the cycle which rapidly builds up to the familiar howl. How then can this be avoided?

The simple answer is that it cannot. Whenever a loudspeaker and a microphone occupy the same volume of air there will be a level of amplification at which feedback will take place. This is known as the *feedback level* or *feedback point*. The trick is to make that level as high as possible.

Microphone Choice

The single most important factor affecting feedback level is the type of microphone used. For best results the type chosen must satisfy certain requirements regarding directional characteristics and frequency response.

A directional microphone is one which is more sensitive to sounds arriving from some directions than from others. With a little care a directional microphone can be positioned so that its most sensitive face is directed towards the sound source while its least sensitive side faces the loudspeaker. This gives an enormous improvement compared with omnidirectional microphones.

One of the most common directional pick-up patterns is the cardioid response. As the name suggests, the response pattern is heart-shaped with a large bulge (maximum sensitivity) at the front gradually tailing off along the sides towards the back where there is minimum sensitivity. A variant of this is the hypercardioid which has a slimmer heart shape bought at the expense of a small response lobe at the back of the microphone. The slimmer pick-up pattern of the hypercardioid means that it is more directional than the cardioid and therefore better able to reject sound from the sides while picking up sound from the front.

The directional qualities of a microphone are sometimes expressed in terms of the ratio between the maximum and minimum sensitivities. The figure is usually known either as the *directivity factor*, the *rejection ratio* or the *front-to-back ratio* and typical values are around 15-20dB.

A more practical figure is one that gives the ratio of sound picked up from the forward direction compared with that picked up from all other directions, because reflections from the loudspeakers usually arrive from a variety of directions. This figure is obtained by comparing the acoustic power received by an omnidirectional microphone in a reverberant environment with that picked up by the directional microphone. The ratio is squared and the result is termed the *directivity index*. For a cardioid, the index is about 3 and for a hypercardioid it is 4.

Taking the square root of this index (which is the original acoustic power ratio) gives the distance from the source at which the same proportion of ambient sound compared to the omni will be received. For a cardioid the distance is about 1.75 times, and for the hypercardioid it is twice that of the omni. For public address work this means that for the same feedback level the cardioid can be positioned 1.75 times the distance from the user compared with an omni while the hypercardioid can be positioned twice as far away. Alternatively, the microphone could be used at the original distance from the user and the feedback point will be that much higher.

The rifle microphone is better still, having directivity indices of 6-10 depending on length. However, it is rather unwieldy to use on a microphone stand and the high directivity can be a two-edged sword. The user needs to stand right in front of it and not move more than an inch or so to either side or the volume will drop considerably at each deviation. The hypercardioid is thus the most practical choice for sound reinforcement purposes.

The other microphone parameter which considerably affects feedback is the frequency response. The important thing here is not an extended response but a flat one.

A glance at Fig. 2 will show the principle. The straight horizontal line represents the feedback point of the system while curve A is the frequency response of a microphone having a pronounced peak in its higher mid-range. Although the general level of the curve is below the feedback point, the peak exceeds it so feedback will occur.

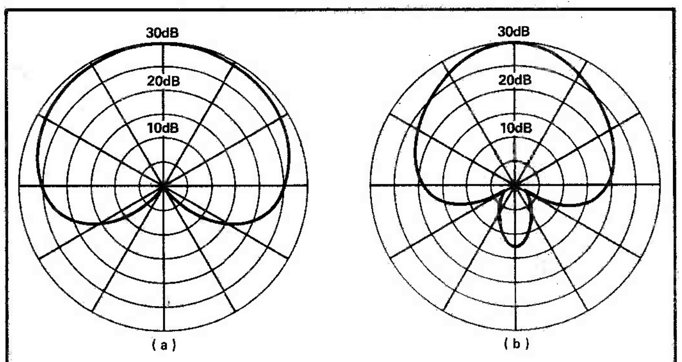

Fig 1 (a) Cardioid microphone polar diagram and (b) hypercardioid polar diagram. These show the response at 1kHz. Lower frequencies are less directional and higher ones more so.

Curve B is that of a flat response microphone and the whole curve remains below the feedback level, so it will operate at a higher volume and still not run into feedback. Even when it is operated on the feedback point it will not go suddenly and violently into feedback like the peaky microphone of curve A. Rather, it starts to give an echoing effect called *ringing* after each spoken sentence and so gives due warning that feedback is near.

A big problem here is that nearly all moving-coil microphones have a peak in their response from about 2-5kHz. This due to the mass of the resonance diaphragm and the coil. Some of the better instruments have the peak damped to a degree but the laws of physics cannot be circumvented and the peak is still there.

What is required is a microphone with a moving element that is very light and so has its resonance into or above the treble region where a little top-cut on the amplifier can tame it. Capacitor microphones of studio quality have this characteristic but they are expensive and need a polarising power supply. They are rather out of the class for sound reinforcement work.

Electret microphones are another possibility. These are cheap and have light diaphragms, working on a similar principle to the capacitor but with a built-in polarising charge. Unfortunately, their cheapness seems to preclude high-grade construction and there can be problems with the internal battery connections, the power switch and the adverse effect of atmospheric humidity on the stored charge. Furthermore, only a few exhibit the smooth response that in theory they should be capable of.

Another type of unit is the ribbon microphone. This has a low mass and is capable of a flat response but some models have peaks purposely introduced by the makers to give a brighter effect. Ribbons are generally more fragile than moving-coil units but a few are remarkably robust and prove themselves capable of standing up to quite rough usage.

Of all the hundreds of microphones that are now available, few have all the characteristics necessary for the inhibition of feedback. The author's own favourite is the Beyer M260 N80 ribbon, which has proved itself in many difficult acoustic conditions. The only snag is its high cost.

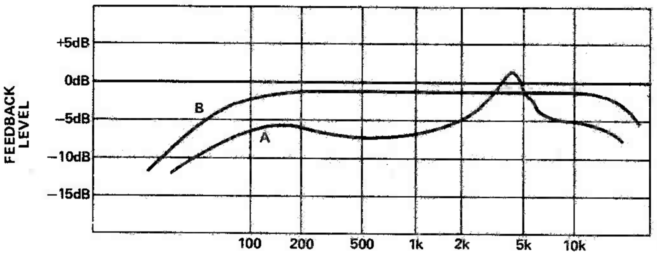

Fig 2. A peak in the response of microphone A exceeds the feedback level. With microphone B, the response is flat allowing operation at a higher level without crossing the feedback line.

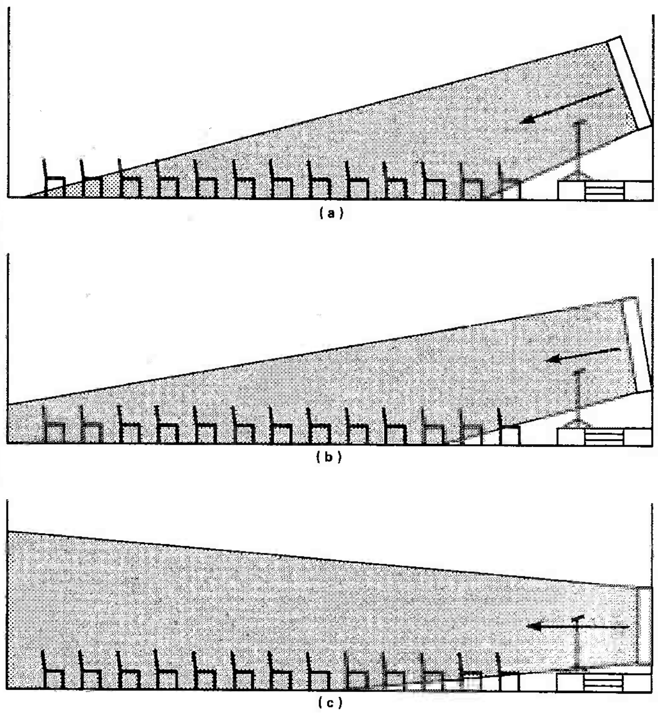

Fig 3 (a) A high mounted line-source speaker can be tilted to direct sound into the audience, but the angle of incidence limits the seating area covered. (b) A lower position requires less tilt and gives better coverage. With a lower position still (c), having the bottom of the column at audience shoulder height, no tilt is needed.

Loudspeakers

The type and positioning of the loudspeakers can play a major part in the avoidance of feedback.

Single-unit loudspeakers radiate sound in a wide cone-shaped pattern from the front and if the back of the cabinet is not fully blocked off they will radiate a similar though restricted pattern from the rear. Much of the sound energy is thereby directed toward the ceiling and the upper walls from where it is bounced about to be reflected back to the microphone and produce feedback. If the sound could be beamed into the audience these reflections would be avoided.

This can be achieved with a column or line-source loudspeaker. It consists of a number of units mounted vertically in a narrow cabinet, the sound distribution pattern produced being that of a wide-angled beam having a flat top and bottom. The beam diverges to a very limited extent and it can be considered for practical purposes to be of the same height as the column itself. Divergence is greater when there are fewer units in the column, making the device less effective. Five or six units give good results and four is the minimum to achieve line-source characteristics.

Another useful feature of the column loudspeaker is that the sound pressure produced at a single point actually increases as that point is moved away from the speaker up to a certain maximum distance. This means that the volume level is sufficiently high at a distance without being deafening at close quarters.

The important factor is the positioning of the columns. If mounted high, they must be angled forward so as to direct the sound into the audience. The higher the position, the greater the inclination, but this will cover only part of the audience effectively (see Fig. 3a).

A greater coverage will be obtained by a lower position and narrower angle (Fig. 3b). Often though it is more convenient to mount them vertically, in which case the bottom of the column should be at about the shoulder height of a seated audience (Fig. 3c).

Acoustics

One thing that can nullify much of the advantage obtained from applying the above information is the back wall of the platform. Sound from the auditorium is reflected from it right into the front of the microphones thus making them virtually omnidirectional.

The answer is to hang a heavy curtain in deep folds along the back platform wall. If possible it should go the whole length of the wall but if not it should extend at least six to eight feet either side of the microphone position.

Another major factor is the audience itself. The clothed human body is highly sound absorbent so nearly all of the sound directed into the audience by the column speakers will absorbed when there is a capacity crowd. Feedback problems are therefore few.

When attendance is poor and there are many empty seats, more sound is reflected back and feedback is greater. In an empty hall feedback is at a maximum and many an installer has sweated to improve it only to find the problems disappearing as the hall fills up. If the feedback level is reasonable when you install the equipment, it can only get better!

One useful tip is to try reversing the loudspeaker phasing. All the speakers should be connected in the same phase or there could be blind spots where the sound from two out-of-phase columns will overlap. However, the combined speaker wiring can be connected either way round and it may be found that feedback is less in one position than the other. There may be little difference but it is worth a try, especially if made convenient by using a double-pole switch for the reversal.

Frequency Shifting

Another solution to the feedback problem is provided by a device known as a frequency shifter. This is inserted somewhere in the amplifying chain (usually between the mixer and the power amplifiers) and raises all the signal frequencies passing through it by a few Hertz. This works well with speech and the slight difference between sound heard directly from the person speaking and sound heard through the loudspeakers is normally too small to be noticed.

Frequency shifting prevents feedback because there is no reinforcement of the original sound. Each signal from the microphone will emerge from the loudspeakers at a higher frequency. If it is picked up by the microphone again, it will then re-emerge from the loudspeakers at yet another frequency. The result is that potential feedback is rapidly swept upwards in frequency until is above the upper frequency limit of the system. This allows far more gain to be used before feedback becomes a problem and the effects are less obtrusive when feedback does occur.

The disadvantages are the cost and complexity of the hardware and the fact that it does not work well with music, particularly in the bass register. Because all signal frequencies are increased by a fixed amount (usually around 5Hz) the effect is to apply a larger proportional increase to lower frequencies than to higher ones. Adding 5Hz to signals of 100Hz or less will raise the note by a semi-tone or more while adding 5Hz to signals over the next octave will raise notes by around a quarter of a tone. This introduces a discordant relationship between fundamentals and harmonics.

Because of these drawbacks, frequency shifting should be looked upon as something of a last-ditch solution to be used when all else has failed. It should not be used as a substitute for good anti-feedback design in the choice and use of microphones, loudspeakers and stage furnishings as described here. Frequency shifters should always be fitted with a bypass switch so they can be removed from the signal path should problems develop. **ETI**

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PORTABLE PA

Alan Watling describes a pocket PA for low power sound reinforcement in small halls.

The problem of speech reinforcement in small halls, so frequently used for club and society meetings, has been a thorn in the side of many hard-worked secretaries. In rare cases a good system is provided as part of the hall fittings but all too often the organiser has to collect an amplifier, loudspeaker, mike and stand then struggle with the vagaries of remote mains sockets and inadequate speaker leads.

As a desperate solution some years ago I incorporated a line-source speaker, mains PA amplifier, mixer and stowage for mikes and leads into one custom-built box. Although heavy, it met with such acclaim that I developed a smaller, lighter, battery-operated version to operate from tie-clip electret mikes. The electronics are based on a simple mixer with four mike channels.

For simplicity a ready-built power amp unit is used. The original prototype used a Sinclair IC12 amp (those were the days!) which gave a 4W output.

Used in a hall with an audience of 200 it provided a natural speech level right to the back row and enabled lecturers to walk about within feet of the unit without howlback.

The choice of power amp is left largely to the reader. One suggestion is the TBA810P power amp IC. This provides about 4W output and a PCB is available from Maplin to build a complete power amp. This option would require a 12V battery supply, either from a car battery or even eight HP2 dry or rechargeable cells.

An alternative is the Matchbox Amplifiers featured in the April 1986 issue of ETI. These can operate with a wide range of supply voltages — about 10-30V. With a 12V supply you could expect around 3W from the single Matchbox amp and about 9W from the bridge version. If 16 HP2 cells or two car batteries are used for the power supply the increased voltage (24V) will give around 12W and 25W from the single and bridge versions respectively.

Loudspeakers

The electronics of the Portable PA is to say the least, simple. However, the strength of this design lies in the loudspeaker system. To avoid feedback with a portable PA system used by inexperienced speakers a line source loudspeaker arrangement is used.

The line-source loudspeaker concept depends for its operation on the additive output from several units arranged vertically in line to give a flat, fan-shaped beam of sound with very little radiation above and below the 'fan'. The cancellation occurring between the closely spaced units drastically reduces the output in other directions (to ceiling and floor in this case). Thus the sound goes where it is needed, to be absorbed by the audience and does not add to the unwanted reverberant sound which can cause howlback.

Additionally, an open assembly of such units will act as a dipole radiator with a figure-of-eight distribution in the horizontal plane creating 'dead' areas each side of the assembly which will again reduce the incidence of howlback.

A sophisticated ideal line source loudspeaker design would use a tapped transformer to taper

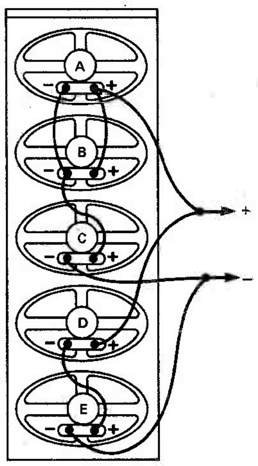


Fig. 1 The wiring arrangement for the five loudspeaker column.

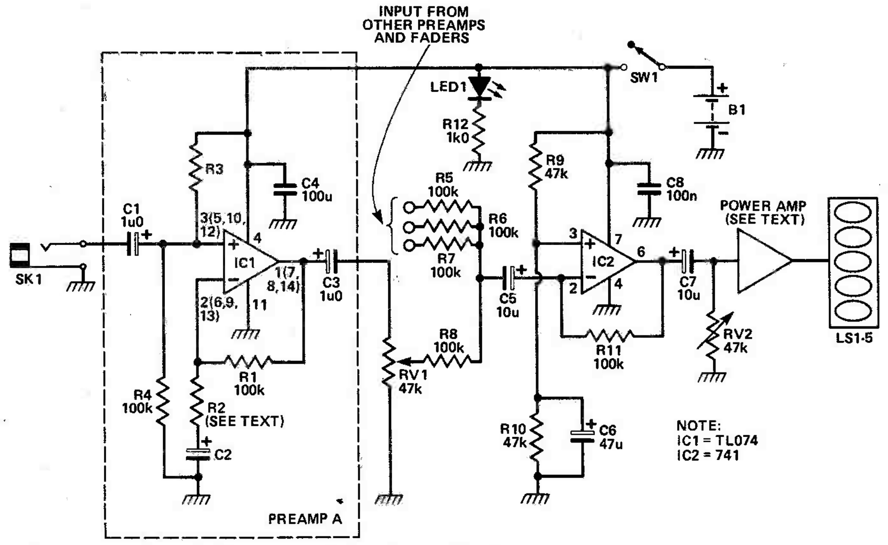


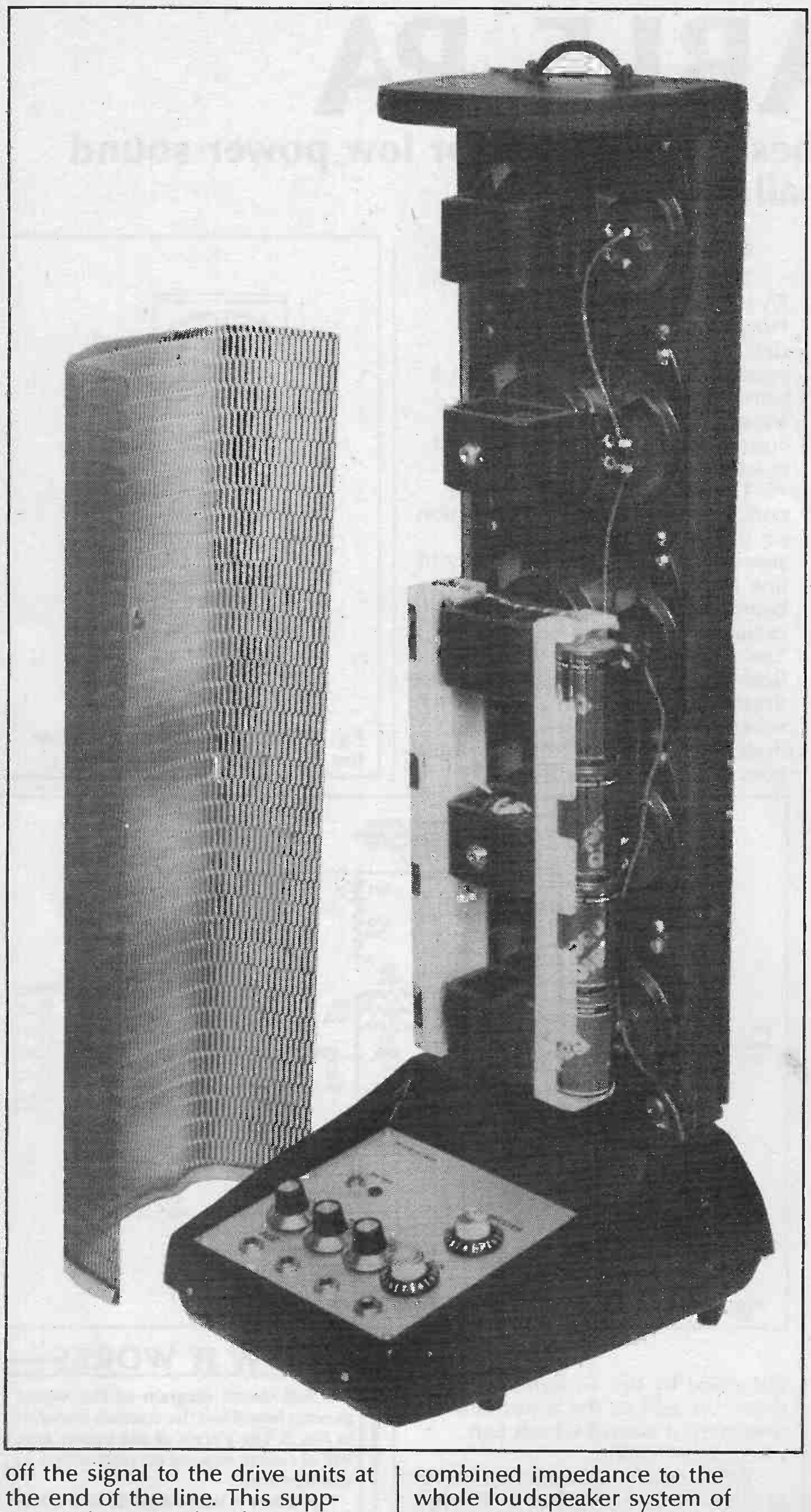
Fig. 2 The circuit diagram of the Portable PA.

HOW IT WORKS

The full circuit diagram of the mixer/preamp board and the controls is shown in Fig. 2. The circuit of the power amp will of course depend on your choice in this direction.

The mixer is based around IC1, a low noise, low distortion TL074 J-FET quad op-amp. The four mixer channels are identical (except for the value of R2 (102, 202, 302) chosen to suit the sensitivity required) and follow a fairly standard configuration.

The outputs from the four sliders are summed by IC2, a trusty 741 op-amp, again in standard guise.



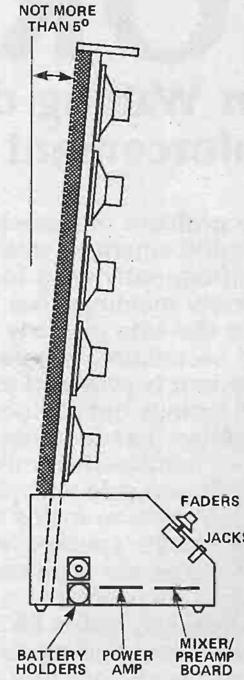
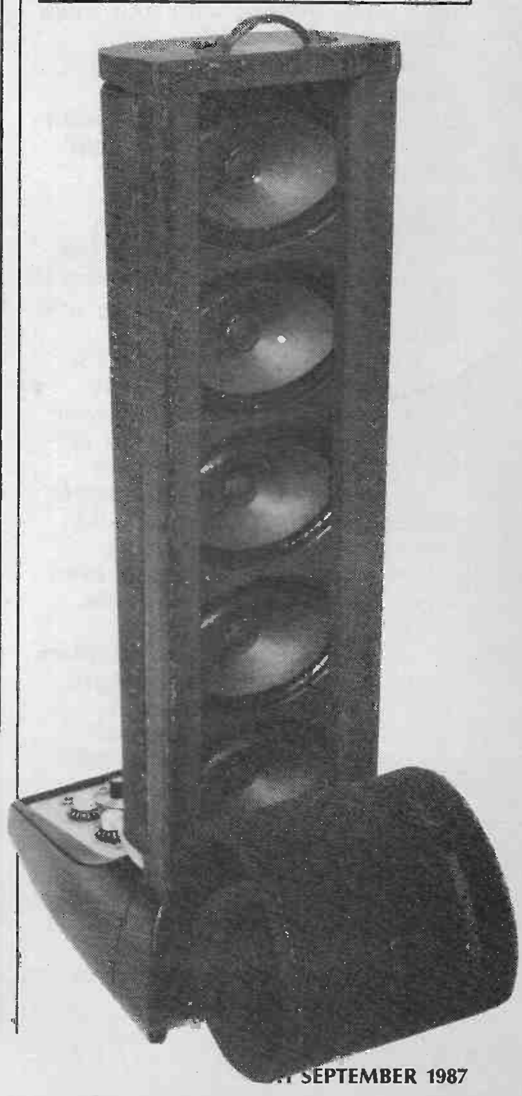


Fig. 3 The construction of the Portable PA.



off the signal to the drive units at the end of the line. This suppresses the secondary beams which otherwise occur.

In this 'poor man's' version the series-parallel arrangement of five 8R drive units results in a reasonable approximation to the ideal power distribution along the line (Fig. 1).

This arrangement also gives a combined impedance to the whole loudspeaker system of about 6R9 — ideal for both the Maplin TBA810P amp and the ETI Matchbox amps.

The practical result as measured in the open air is a flat, fan-shaped figure-of-eight beam with very useful dead areas where even a wandering mike can be used without howlback. Due to

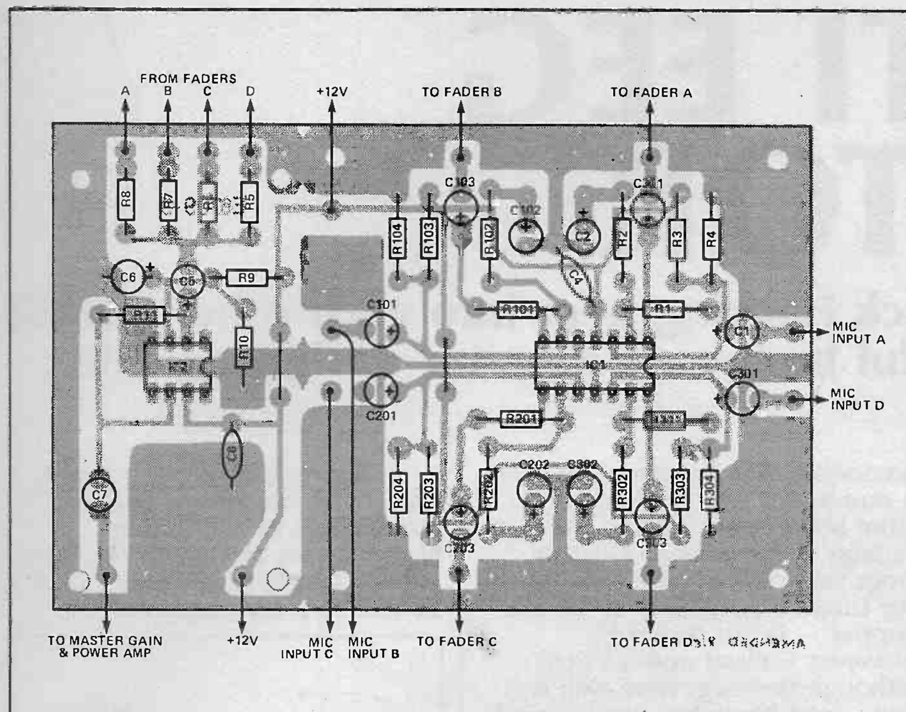


Fig. 4 The component overlay for the mixer/preamp board.

the dipole arrangement there is, of course, a rear radiation pattern, but this can usually be arranged to fire into stage curtains or at least avoid hard reflective surfaces. Attempts to absorb rear radiation at the speaker unit will usually modify the front radiation as well and lose all the benefits of a simple system.

Construction

The overall construction of the Portable PA is shown in Fig. 3. The prototype uses a Verocase which provides a neat exterior but is a little small and required strengthening to take the weight of the loudspeaker column. A larger, stronger box would be a good idea or even one custom built from wood or aluminium.

The loudspeaker column should be strong enough to take the weight of the five drive units (bearing in mind that the cheaper drive units usually have heavier and bulkier magnets).

The frame to hold the drive units can be made from 20mm softwood or 15mm aluminium angle. Either way it must be as open as possible. The front grille fabric and back protection must offer little resistance to maintain the correct polar response.

The prototype uses the gap beside the large drive magnets to mount the batteries. This is a neat enough solution but does make the complete unit a little unstable. Mounting the batteries in the base is a better move.

Figure 4 shows the overlay for the mixer/preamp board. This should provide few problems of construction. The two sections of the board (the mixer based around IC2 and the preamps based on IC1) can be easily separated for convenience of fitting into the case.

Screened leads should be used for all input and output connections to the board. Ferrite anti-parasitic beads can usefully be placed on the input (microphone) leads close to the board to prevent the local taxi service contributing to the audience's entertainment.

The gain of the microphone inputs can be varied from unity to several hundred by selection of the resistors R2 (102, 202, 302). The value chosen will depend on the sensitivity of your microphones. Select a value which gives adequate output with the volume slider at about half mast. The approximate gains are as follows:

R2 = 1k0 ×100
R2 = 2k2 ×50
R2 = 4k7 ×20
R2 = 47k ×2

In the prototype 270R was found to work well with the tie-clip electret microphones used on three channels and a 47k was used on the fourth channel for a cassette recorder input.

The Results

Carrying the completed system into the hall with one finger will repay all your hard work.

PARTS LIST

RESISTORS (all ¼W 1%)	
R1,3-8,11,101-103, 201-203,301-303	100k
R2	See text
R9,10	47k
R12	1k0
RV1,2,101,201,301	47k log rotary or slider
CAPACITORS	
C1,3,101,103,201, 203,301,303	1µ0 35V tantalum
C2,6,102,202,302	47µ 16V axial electrolytic
C4,8	100n ceramic
C5,7	10µ 16V tantalum
SEMICONDUCTORS	
IC1	TL074
IC2	741
LED1	Red LED
MISCELLANEOUS	
B1	Batteries to suit power amp (12-24V)
LS1-5	8R elliptical loudspeakers to suit power amp
SK1,101,201,301	¼in self-shorting jack sockets
SW1	SPST toggle switch

PCB; case and case materials; knobs for faders and master volume; battery holders; ferrite anti-parasitic beads; grille cloth and mesh protection; carrying handle.

BUYLINES

No particularly difficult components on this one. Suitable loudspeakers can be found in many 'junk' shops or they are obtainable from Maplin, Cirkit, Electromail and so on.

Site the unit to one side of the stage or lecturer's desk and aim it diagonally across the audience at head height.

Plug in the microphones after checking their batteries, if fitted. Advance the master gain to about half way and then each fader until howl level is reached. Then back off the faders a little.

Avoid clipping tie microphones near ladies' brooches or necklaces and try to anticipate the speakers' quirks — such as folding their arms or blowing their noses at 110dB.

Most important is not to forget the golden rule: a good PA system should not draw attention to itself. The aim should be natural support to the voice right to the back of the audience with clarity and consistency.

ETI

THE ETI EEG MONITOR

Paul Chappell and Nick Hacking peer into each others heads with the most powerful brainwave monitor design outside the laboratory.

Your brain is in a state of continuous oscillation! This remarkable observation was first reported by Hans Berger, an obscure German psychiatrist, almost fifty years ago. That the brain responds electrically to external stimuli comes as no surprise, but oscillation?

Berger's results were no accident, no fortuitous piece of serendipity. They were the result of many years of hard and painstaking work. Since 1902 he had been trying, with little success, to record electrical activity from the brains of animals. Considering that his measuring instruments at the time were crude string galvanometers, his difficulties are hardly surprising. What *is* surprising is that in 1929, using an improved galvanometer but without any kind of amplification, he succeeded in recording the first human Electroencephalogram, or EEG!

A Brief History

Research into electricity in the body began in the late 18th century with a chance observation by Luigi Galvani, an Italian anatomist, who happened to have a number of frog corpses hung from brass hooks around the iron railings in his garden. What the frogs were doing there — whether for Luigi's experiments or for his supper — is not recorded. However, Galvani noticed that, although the frogs were well and truly dead, their legs would twitch from time to time.

He was sufficiently intrigued to begin experimenting and, after causing a frog's legs to jerk by touching the crucal nerve with two metal probes, concluded that electricity was somehow involved in muscular activity.

Let's just spend a moment getting our bearings in time. It is 1791, two years after the beginning of the French Revolution (Marie Antoinette, storming of the Bastille, that kind of stuff) and two years since George Washington became first president of the USA.

It is almost forty years since Ben Franklin's famous kite-in-a-thunderstorm experiment but electrical research is still little more than a parlour game: causing sparks and explosions, killing small animals, melting metal. Equipment for generating electricity is crude in the extreme — a rotating ball of sulphur in a glass container, for instance. Instruments for measuring electricity are unknown. The basic relationship between voltage and current in a conductor (Ohm's Law) will not be known for another 35 years.

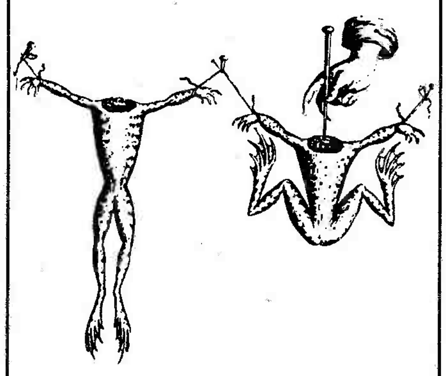
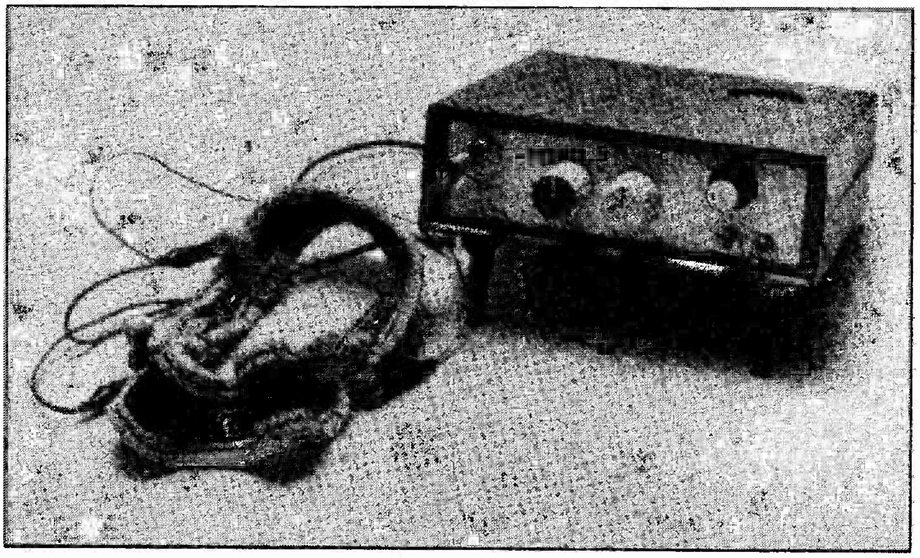


Fig. 1 Mental hydraulics. Early ideas on the workings of the brain.

The official doctrine of the time was that muscles are operated by hydraulics. In the centre of the brain are a number of interconnected, fluid filled cavities known as 'ventricles'. What was more natural than that control of muscles should be achieved by forcing this brain fluid along hollow nerves? The mechanism was easily demonstrated as an 18th century illustration (Fig. 1) shows.

Galvani's discoveries led to heated debates as to whether electricity could be totally or partially responsible for muscle control. Alessandro Volta, originally in favour of Galvani's ideas, changed his mind when he discovered that the twitching only occurred when the probes were of dissimilar metals. It was partly to settle the question of whether the frog or the probes were generating electricity that Volta made his 'voltaic cell', forerunner of the battery.



Interest in 'animal electricity' led to a rapid development of measuring instruments — Galvani's galvanometer and Volta's electrometer (much later called a voltmeter) and various improved and modified versions of these devices. It was not until 1827 that Nobili first managed to measure currents in a frog muscle.

Skipping rapidly over the next half century, the first recorded success at measuring electrical activity in the brain came in 1895 when Richard Caton reported 'feeble currents' from electrodes on the external surfaces of a rabbit's brain. Caton certainly didn't believe in making life easy for himself — he went on to take readings from the brains of conscious, unrestrained animals!

This may be why his experiments gave more convincing results than Berger's early attempts — the anaesthetics used by Berger would have suppressed the EEG activity to the point where it was almost unmeasurable with the instruments of the time.

Brainwaves

Berger identified two different types of waveform from the brain. The first were slow, regular, relatively high amplitude waves at around 10Hz which appeared when his subjects were relaxed. These he called *alpha* waves. The second type were smaller, faster waves ranging from about 18 to 50Hz, associated with alertness. Berger called them *beta* waves. Many more types have since been identified, some distinguished by their frequency range and some by their shape. Here are the main ones.

ALPHA These are waves in the region of 8 to 12Hz with amplitudes up to 100µV. The shape varies from person to person with some having almost sinusoidal waves and others very irregular ones. No two people have exactly the same alpha pattern! Alpha is associated with a calm, receptive state of mind and feelings of pleasant relaxation which is probably why there has been so much enthusiasm for alpha training in recent years. The waves can be blocked by anxiety and tension and by any kind of intellectual activity, although some people show spindle-shaped bursts of alpha at the temples when reading or problem solving.

BETA Beta waves are faster than alpha, ranging from 18 to 50Hz. They are also smaller in amplitude, rarely going above 20µV. They are associated with alertness and also with the motor (muscle control) areas of the brain. Being of a size and frequency where they are easily confused with muscle potentials, and since spectral analysis has not shown up much of interest, they have been given very little attention in comparison with other waves.

THETA This term was coined by W. G. Walter for waves in the region of 4 to 7Hz. Walter suggested that whereas beta waves scan for information, theta waves scan for pleasure! Theta occurs during the dreamlike state between wakefulness and sleep when you may experience images from childhood memories and all kinds of imaginitive scenes. The Menninger Foundation has been keen to encourage theta training since this state of reverie is seen by creative people as being the source of many of their best ideas.

DELTA These are still lower in frequency, from 3Hz down to 0.5Hz. In healthy adults they are only seen during sleep. Delta waves range in amplitude from twenty to several hundred µV.

Other common waves include Gamma, a name given by Jasper and Andrews to the top end of the beta range, 30 to 50Hz. These waves are present during wakefulness and appear to be fairly insensitive, unlike the lower beta range which can be disturbed by movement.

Lambda and K-complex waves occur in response to external stimuli and are distinguished by shape rather than frequency.

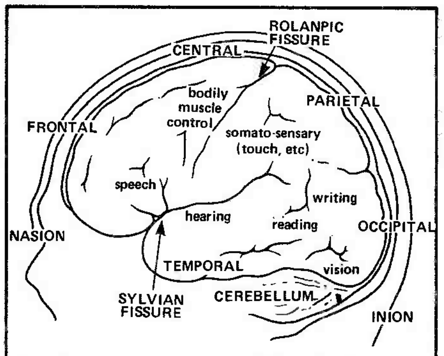
The Whereabouts

A rough guide to the main areas of your brain is shown in Fig. 2. In capitals are the names for the various regions and in lower case an indication of the general function of each area. Unless you intend to submit to major surgery you won't be able to see your brain when you put on the electrodes, so sooner or later you'll have to know the layout of your head from the outside.

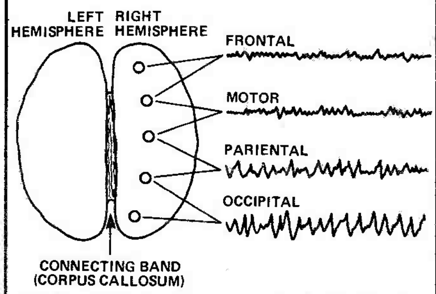
If you feel the top of your nose where it joins your forehead, you will notice a hollow. This is your *nasion*. Now run your fingers up the back of your neck. At a height level with your ears you will feel a distinct lump. This is your *inion*.

If you were to put a band around your head across these two points, your brain would be almost entirely in the region above the band. A line across the highest part of your head between these two points would mark the dividing line, as seen from above, between the left and right hemispheres.

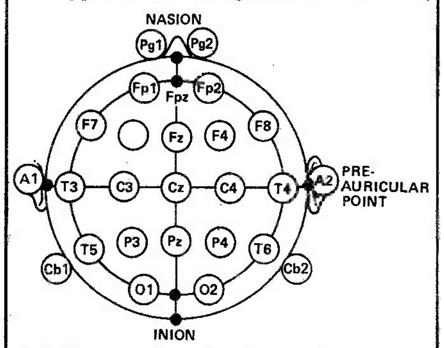
Just above the inion and a little to the left or right, depending on which hemisphere you're interested in, is the *occipital* area of your brain (or as close as you can get to it from outside). This area is concerned,



(a) The main areas of the brain and their general functions.



(b) Typical 'raw' outputs of the brain.



(c) The ten-twenty electrode positions.

Fig. 2

HOW IT WORKS

IC1, 2 and 3 form a differential amplifier designed to give better common mode rejection than a single op-amp. IC1, 2 amplify the differential signal by a factor of 2,000 whilst leaving the common mode signal substantially unchanged, so IC3's CMRR should appear to be improved by a factor of 2,000!

This huge increase in performance is never quite achieved in practise but the performance of this circuit is very much better than a single op-amp.

RV2 provides DC offset cancellation for the entire circuit and RV1 is the CMRR trim for low frequencies — it balances the combination of the outputs from IC1, 2 by IC3.

The filter block employs two second order sections, the first to peak the gain at the frequency band of interest and the second to remove 50Hz mains hum. This is followed by a standard inverting amplifier to bring the gain up to that required by the rest of the circuit.

The ubiquitous 4046 IC comes next, being the cheapest and most convenient way to build a VCO into the circuit. The remainder of the IC is unused. The VCO is driven either directly by the signal which varies the frequency about a mean level set by RV3 or from a peak detector circuit (strictly speaking a leaky-peak-to-peak-minus-a-bit circuit!) which provides a voltage dependent on the amplitude of the brainwave signal.

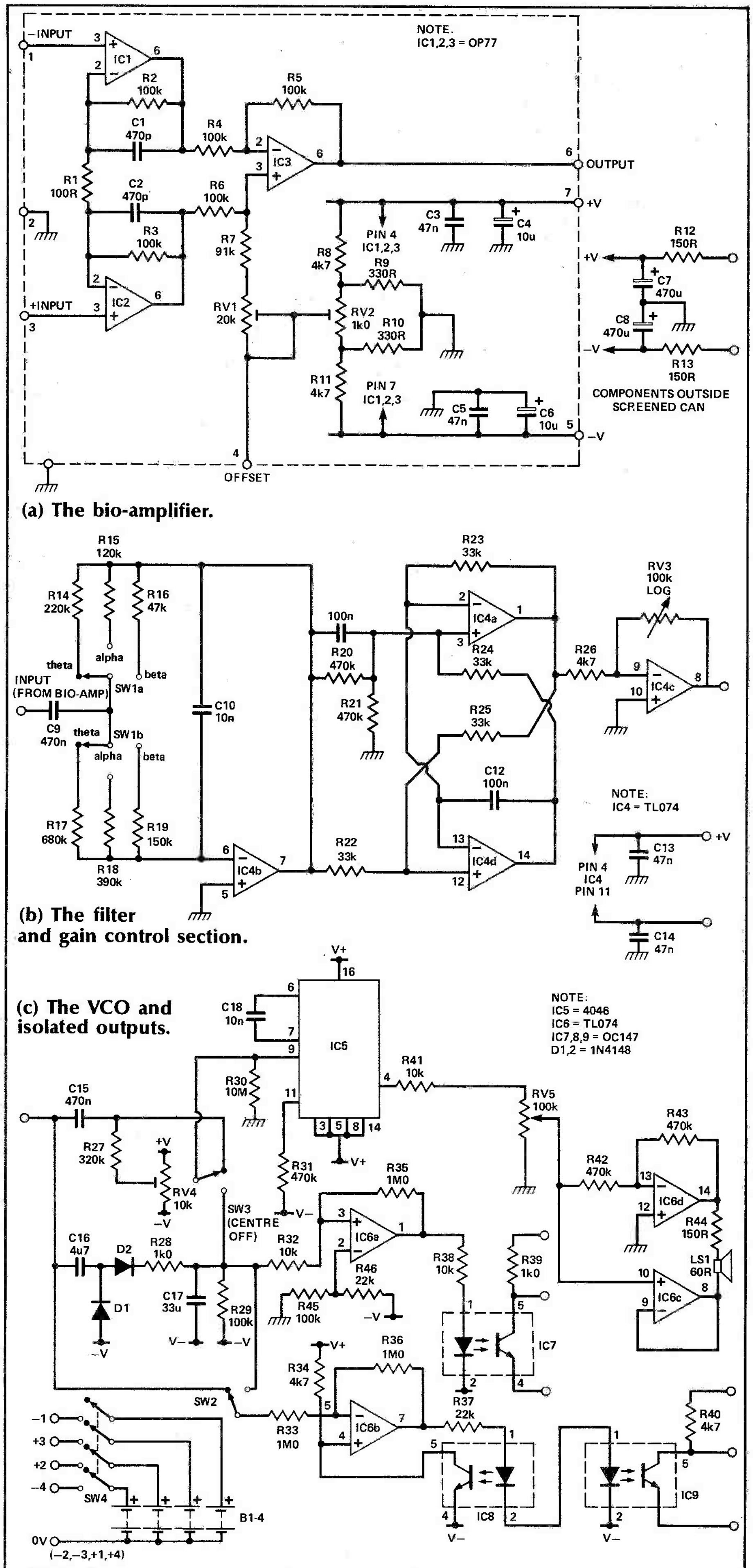
The output of the 4046 passes through volume and tone controls and is applied to the loudspeaker via IC4a, b. Two external outputs are provided by IC4c and d, isolated for safety. These will be discussed in the text next month.

broadly speaking, with vision and is also the site of the strongest alpha activity.

Carrying on around your head on the same level you come to the *temporal* region, above your ear and extending back towards the occipital area. Towards the front of your head you reach, naturally enough, the *frontal* regions where beta activity is at its peak, or at least relatively unmasked by alpha. Theta is mainly seen in the frontal and temporal regions.

Returning to the occipital region and moving upwards will take you through the *parietal* region (strong alpha) to the *central* region (beta, gamma and lower amplitude alpha) and then into the frontal region.

A diagram of the international 'ten-twenty' electrode positioning is shown in Fig. 2c. Early researchers used to put their electrodes wherever the fancy took them which made comparison of results and identification of the positions used somewhat difficult.



(a) The bio-amplifier.

(b) The filter and gain control section.

(c) The VCO and isolated outputs.

Fig. 3 The circuit diagram of the EEG monitor.

The system was introduced to overcome this problem, not because the marked positions are of any particular interest in their own right. The positions are based on the measured distance between the nasion and inion, with the frontal pole (Fp) and occipital (0) electrodes being 10% of this distance from the base line and the intermediate electrodes 20% of this distance apart — hence the name.

The resulting spacing on an 'average' head is about 5 to 6cm. For our purposes, the diagram gives a convenient map of the head which may help you to find suitable electrode positions for the waves you want to listen to.

Alpha Beta Theta Monitor

Hear your brainwaves? This month's project will allow you to do just that! Not directly, of course, since the frequencies are much too low, but by frequency modulating the monitor's oscillator. If you have an oscilloscope, a chart recorder or a computer with A to D converter, the project will also act as a single channel EEG recorder. Failing that, you can use it to play computer games, to switch lights on and off, to become powerful, rich and famous (maybe) ... but first you've got to build it!

The circuit of the monitor is shown in Fig. 3. The electrodes feed a high gain, low noise amplifier consisting of ICI-3 in a classic instrumentation amplifier configuration. The amplifier is built into its own screened box and provided with a clean power supply to prevent any unwanted noise from interfering with the tiny EEG signals.

By the time the signals emerge they are 2,000 times larger, at low impedance and strong enough to face the outside world.

The input amplifier is followed by a filter to select alpha, beta or theta waves for further amplification and a 50Hz notch filter to remove any remaining traces of mains hum. A gain block then amplifies the signals to a usable level.

The output of the signal processing stages can be directed along a number of different paths according to the switch settings. The 'direct' route allows the amplified brainwaves to modulate the frequency of an oscillator so they can be heard through the monitor's internal speaker.

The 'integrate' setting gives an indication of the amplitude of the waves and can be used for alpha or theta bio-feedback training. The other routes lead signals to the outside world via opto-isolators for safety. I'll tell you about these later.

Construction

A high standard of construction is needed for the bio-amplifier and a good deal of attention to detail over the electrodes, so take your time!

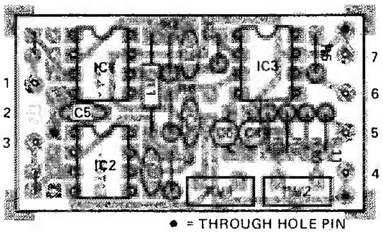
The bio-amplifier component overlay is shown in Fig. 4a. Most of the resistors are mounted vertically since there is very little space inside the screening can. Be careful not to miss any of the through links or top foil connections. When all the components are soldered in position, trim the leads so that they will not make contact with the base of the can.

The base must be drilled with 2.3mm holes as shown in Fig. 4b. The plastic sections of the feed-through insulators are pushed through the holes with the wide section beneath the can and the narrow section extending upwards. The pins can then be pushed through the plastic insulators with the aid of a pair of pliers. A short length of thin insulated wire is soldered to the base of the can close to the edge with the three pins. The solder will take a while to melt, so be patient.

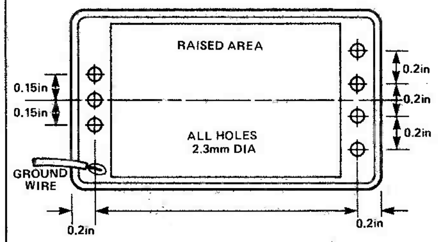
After testing the amplifier (see below) lower the PCB onto the pins and solder the ends to the *top* foil of the PCB. The bottom foil should not be soldered. When the PCB is in place, trim the can wire to length and solder the free end to the top of the central pin.

Place the top of the can upside down on a heat-proof surface and place the base on top of it with the PCB suspended inside the can. Make two small solder joints at opposite corners of the seam to tack the two halves of the can together. Starting at another corner, slowly make your way around the seam with the soldering iron using just enough solder to fill the crack. Solder will be drawn into the crack by capillary action and this is all that is needed to hold the case together.

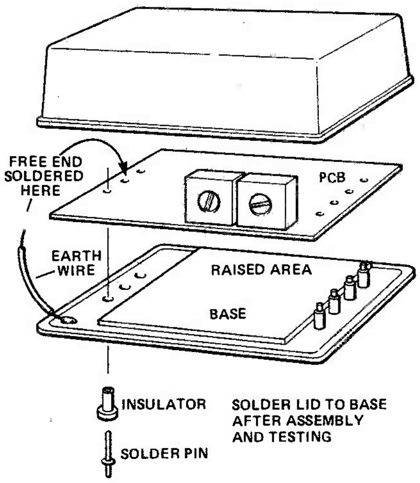
Solder on the outside of the can may make contact with components on the main PCB. Take it slowly and steadily, remembering that the can is conducting heat away at a high rate. If the can gets too hot, take a break for a few minutes and let it cool down again.



(a) The bio-amplifier overlay.



(b) Drilling in the screening can.



(c) Assembling the bio-amplifier.

Fig. 4

The soldering can be done with a 15W iron (I've tried it) but a 25W one will make it easier and quicker.

If you've made a good job of the bio-amplifier, the rest is plain sailing. The component overlay for the main PCB is shown in Fig. 5. The entire bio-amplifier assembly is mounted on the board by its pins in the position shown. All other components are mounted conventionally with resistors parallel to the PCB. Once again, don't forget the through links and top foil connections.

The front panel of the box can be drilled to suit your taste but it

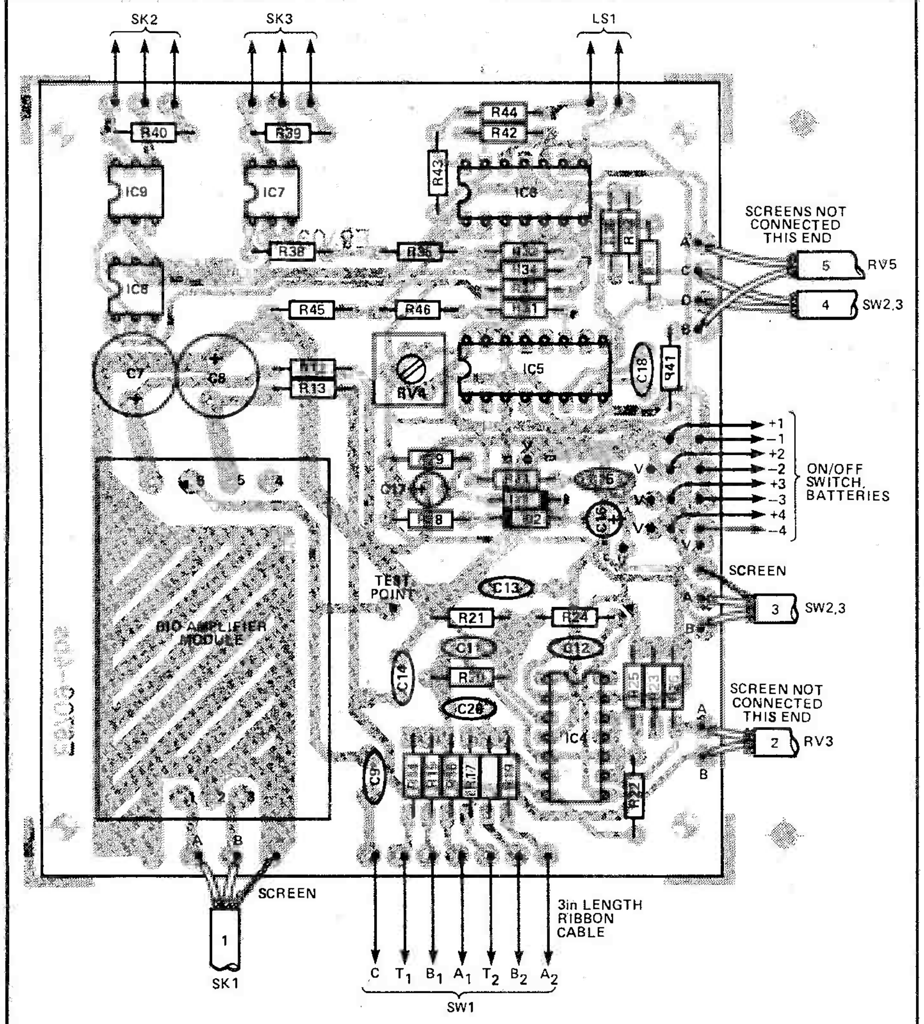
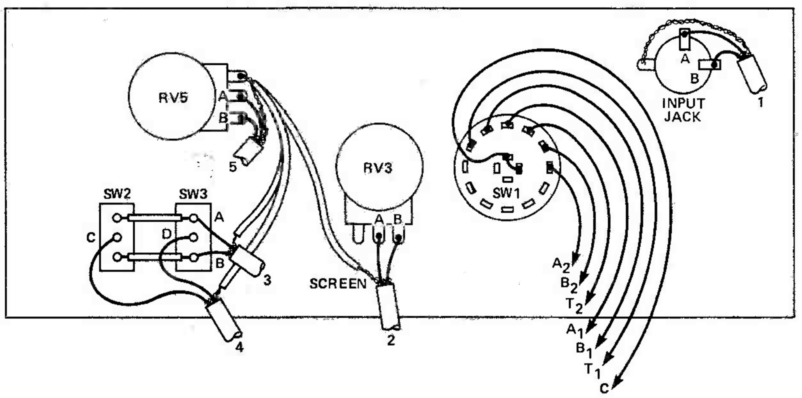


Fig. 5 The component overlay for the main board.



is advisable to follow the order of the socket and controls at least as far as the gain control and to keep the input socket, filter and gain controls fairly well spaced as shown in Fig. 6.

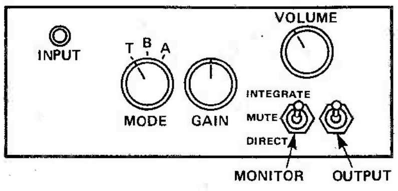


Fig. 6 The front panel.

Use screened wire for all control connections and earth and screens at the points shown.

Testing

The bio-amplifier is best tested before soldering it to its supporting pins and certainly before it is sealed into the screening can! Solder a 4k7 resistor to each input pin and a further 4k7 resistor to ground, then connect the free ends of all three resistors together. This is a rough simulation of a head with no brain! Power up the amplifier with a ±9V supply (two PP3 batteries will do).

Switch your test meter to the 20V range and connect its − lead to the amp's −V connection. Connect its + lead to the output terminal of the amp. Check that

PARTS LIST

RESISTORS (all ¼W 5% unless specified)	
R1	100R
R2,3,4,5,6,29,45	100k
R7	91k 1%
R8,11,26,34,40	4k7
R9,10	330R
R12,13,44	150R
R14	220k
R15	120k
R16	47k
R17	680k
R18,27	390k
R19	150k
R20,21,31,42,43	470k
R22,23,24,25	33k
R28,39	1k0
R30	10M
R32,38,41	10k
R33,35,36	1M0
R37,46	22k
RV1	20k vertical cermet
RV2	1k0 vertical cermet
RV3,5	100k log pot
RV4	10k horizontal cermet
CAPACITORS	
C1,2	470p ceramic
C3,5,13,14	47n ceramic
C4,6	10µ 16V radial electrolytic
C7,8	470µ 16V radial electrolytic
C9,15	470n ceramic
C10,18	10n ceramic
C11,12	100n
C16	4µ 16V radial electrolytic
C17	33µ 16V radial electrolytic
SEMICONDUCTORS	
IC1,2,3	0P77
IC4,6	TL074
IC5	4046
IC6,7,8	0C147
D1,2	1N4148
MISCELLANEOUS	
LS1	60R loudspeaker
PL1	¼in stereo jack plug
SK1	¼in stereo jack socket
SK2,3	3 pin DIN socket
SW1	4-pole 3-way rotary
SW2	SPDT toggle
SW3	SPDT centre-off toggle
SW4	4PST toggle or rotary

PCBs; case, speaker grille; knobs; stereo jack plug and socket; screening can; feed-through insulators; output socket; four PP3 batteries and connectors; connecting wire; screened cable; materials for electrodes (see text); head band; crocodile clips for electrode connection; nuts and bolts.

the output voltage is about 9V (it should certainly be within 1V either way). Now connect the meter between ground and the amp's output and adjust the preset RV2 until the meter reading is zero.

If you haven't got a scope, RV1 can be set with the aid of a crystal earpiece connected between the amp's output and ground. Leaving the resistors in place, short the two inputs together. Hold the common connection between your finger and thumb and adjust RV1 for the lowest sound output.

If you have a signal generator and scope, set the frequency of the signal generator to 100Hz and the output level to 1V p-p . Connect the ground of the generator to the amplifier ground and the output to the junction of the three resistors. With the scope connected between output and ground, adjust RV1 for minimum output.

If the amplifier output is hard up against one or other of the supply rails it's a sure sign that something has gone wrong. Check the PCB carefully for any solder bridges between tracks and search for any top foil connections that may have been missed. The outputs of all three op-amps should be at 0V, so if you check these you will at least know where to look for the fault.

The completed monitor is best tested functionally, after making the electrode assembly.

Electrodes

Getting a good, clean signal from your head to the monitor is the most critical part of the whole project. If you've got about £40 to spare for a set of chlorided silver electrodes it's no problem at all. If not, you'll have to make your own and the more care you take, the better the results will be.

Three M4 x 40mm pan-head bolts are the starting point. Your first task is to plate them with silver. This is most easily achieved using a widely advertised silver-plating compound which can be applied by rubbing it on with a cloth (see buylines). Follow the manufacturers instructions for applying the compound and check the coating carefully to make sure that no metal from the bolt is left exposed.

After plating, the next stage is to cover the the surface with a layer of silver chloride. Pour some undiluted household bleach over the bolts in a suitable container. After a while you will see the surface beginning to turn black. This is the silver chloride. Leave the screws in the bleach for two or three hours, then take them out and wash them thoroughly. The chloride coating is easily damaged, so take care not to scratch the surface.

For the next step, you will need three small pieces of sponge cut to ¼in cubes, three pieces of muslin about 1in square, some strong cotton or fine thread and three rubber bands. (Sounds a bit like Blue Peter, doesn't it!)

Place a cube of sponge in the centre of one of the pieces of muslin, then bring the head of one of the bolts down to compress the sponge slightly. Keeping the bolt in place, use your other hand to gather up the edges of the muslin around the threaded section of the bolt. Holding the muslin in place, lift up the bolt and wrap a rubber band several times around the muslin to hold it in place.

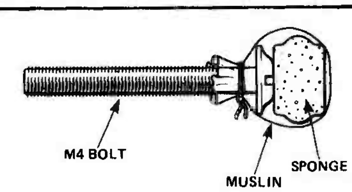
Twist several turns of thread around the muslin, tie it tightly, then remove the rubber band. Trim the edges of the muslin and you should be left with something looking much like Fig. 7a. Follow the same procedure for the other two electrodes.

The electrode support arrangement is a bit Heath Robinson but it works! Cut three 2in squares of any rigid material — PCB laminate, thin plywood, whatever you've got. Glue a 2in length of ½in baton parallel to one edge of the square and ¼in away from it. At the centre of the opposite edge and ¼in away from it, drill a hole big enough to clear the bolt. File or cut four deep notches as shown in Fig. 7b.

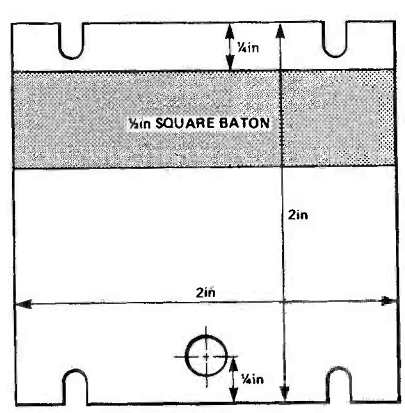
On the side opposite the baton, glue an M4 nut over the bolt hole, being careful not to get any glue in the thread. (Having the nut on the baton side is stronger but it will almost certainly get splashed with saline solution giving all kinds of horrible noise voltages from chemical action). Screw the bolt into the nut so that the muslin and sponge end is on the same side of the square as the baton. The tip of the muslin bag should be about ⅝in away from the surface of the square, but this can be adjusted later to suit the contours of your head! Prepare the other two supports in the same way.

Finally, we need something to hold the electrodes in place. A sweat band from your local sports shop will do admirably for the purpose. Rubber bands hold the electrode support to the sweat band so the electrode positions can be re-arranged without difficulty. When placed on your head, the baton should be below the electrode on each support so that the band can be worn lower down on your head where it will not be inclined to slip off.

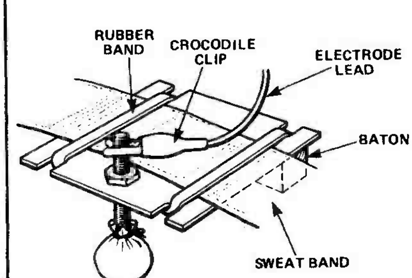
The electrode leads should be soldered to crocodile clips which can then be clipped to the electrodes. One or other of the screens should be soldered to a piece of wire terminated in a crocodile clip for the ground connection. This is better than using solder tags between two nuts since it allows the electrode pressure to be adjusted by twisting and makes the whole assembly easy to dismantle if the electrodes need re-chloriding or re-positioning.



(a) Making your own support.

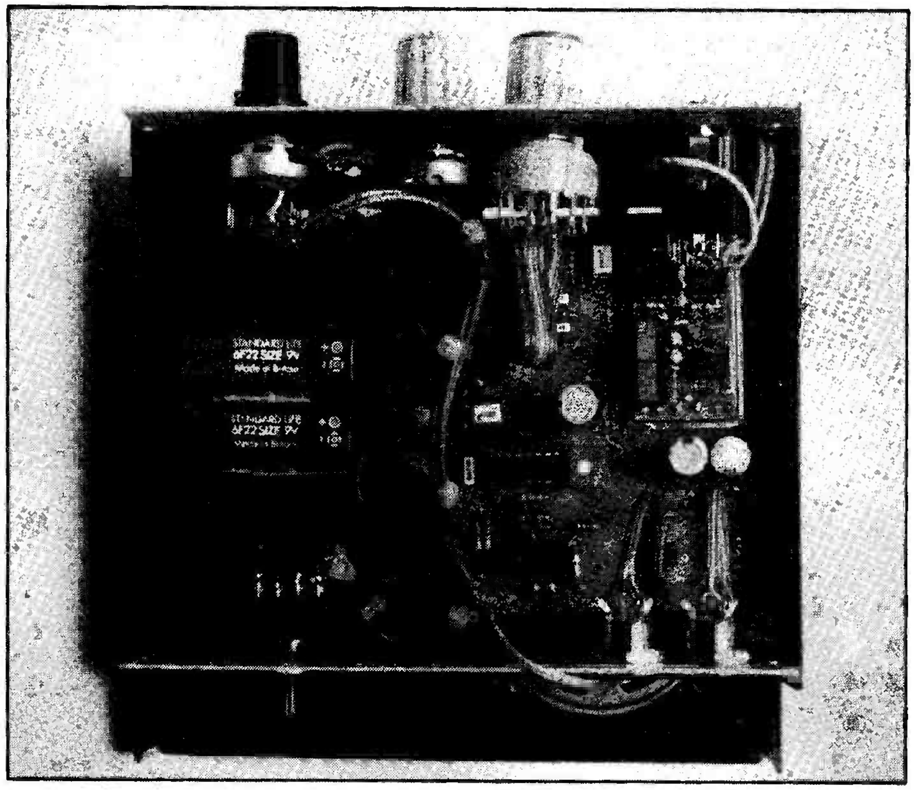


(b) The electrode.



(c) The complete electrode assembly.

Fig. 7 The electrode support.



BUYLINES

The silver plating compound (Sheffco Silver Solution) is available from many mail-order sources. You may be able to obtain it locally from shops stocking silver-plated tableware.

The OP77 precision op-amps are from Electromail, Tel: (0536) 204555. A complete parts set for the project is available from Specialist Semiconductors, Founders House, Redbrok, Monmouth, Gwent for £29.90+VAT, postage 60p.

Printed circuit boards will be available from the ETI PCB Service in due course.

Getting Started

Connect the three electrode crocodile clips together, set the gain control to minimum and the mode switch to 'direct'. Turn on the monitor and you should hear a continuous tone from the speaker. (If not, turn up the volume!)

Adjust RV3 until the speaker produces a sound you feel you could listen to for a fairly long period. Too high a pitch will probably get on your nerves after a while. Set the mode switch to 'integrate' and the sound should stop.

If all is well so far, set the mode switch to 'direct' and the range to 'theta'. Moisten your palms with salt solution, clip the ground lead to your watch strap (if it's metal) and hold one of the signal leads tightly against each palm. Advance the gain control and you should begin to hear a rythmic bleeping sound — your heart beat!

Make up a week salt solution with one teaspoon of salt to about ⅓ pint of water. When the salt has dissolved completely, dip each of the electrode pads in turn into the solution and shake off any drips. Adjust the electrode positions on the headband so that they lie with one roughly in position 0_1 (Fig. 2c) and one somewhere between T_5 and T_3. The ground electrode should be at the centre of your forehead. The positions are not critical.

When putting on the headband, be careful not to squeeze too much salt solution out of the electrode pads. Part your hair under the pads so that they make good contact with your scalp. Connect up the crocodile clips (the two signal leads can be either way around) and you're ready to go!

Turn on the monitor, set the range control to 'alpha', the mode control to 'direct' and the gain to about mid-position. Close your eyes and relax. After a while you will hear a rythmic modulation of the tone — alpha waves!

On your first session these may take some time to arrive. The reason is that you will probably be worrying about whether or not the project is working, wondering how much longer you've got to wait, maybe even *trying* to produce alpha. All this is guaranteed to kill it stone dead! Alpha will never come when you want it, it creeps up quietly when you're not looking.

When you forget for a moment that you're trying to hear your brainwaves, when your mind begins to freewheel — there it is! As soon as you pay attention to it — it's gone! After a while you'll get the hang of just letting it happen and you'll find it easy to produce alpha almost immediately.

Opening your eyes will also cut out alpha at first. When you've got used to letting it come with your eyes closed, try it with your eyes open. It's more difficult but it will come after a while. As Frankie and the Hollywoods used to sing, 'Relax, don't do it, when you want alpha to come'!

The reason for the electrode position towards the rear of the head, by the way, is partly because it's the site of the highest amplitude alpha but also to cut out the annoying eye-blink artefact. With electrodes towards the front of your head, relatively high voltages are picked up whenever you open and close your eyes.

If you want to try it, just swap the crocodile clips on the 'temporal' and ground electrodes so that one of the signal leads is connected to the electrode on your forehead. Now you'll hear a strong bleep every time you blink. If you can live with this, the new electrode position you've just made will pick up a bit of just about everything — alpha, beta, theta, you name it.

Theta is more tricky than alpha because it will only appear at first when you are on the point of drifting off to sleep. You'll need a very quiet place where you won't be disturbed and a comfortable chair to sit in. A reclining one is ideal but don't lie down — you'll have enough trouble preventing yourself from falling asleep as it is!

In a prolonged theta state, the images and associations you form can be quite spectacular. Research at the Menninger Foundation suggests that theta can be a powerful source of energy for creativity and personal development, so it's got to be worth a try.

Next month I'll be looking at more ways to use the monitor, talking about bio-feedback and explaining how to connect up the opto interfaces. In the meantime, you can familiarise yourself with the monitor and try out different electrode positions. Have fun!

ETI

AMSTRAD SAMPLER

John Jameson has made his Amstrad micro sound like Paul Hardcastle.

Over the last few years sampling keyboards have moved down market from machines like the Fairlight CMI, which costs roughly the same as a Ferrari, to the £100 Casio SK-1. However, if you have a home micro, it is possible to dabble with sampling for even less.

A sampler consists of an ADC, a DAC, some RAM and a controller. In this project, the control and RAM functions are provided by an Amstrad CPC micro. The hardware of the project incorporates the ADC, DAC, anti-alias filters and buffering/gain stages (Fig. 1).

As with all computer-based projects, some software is required. There is no provision in this project for a music keyboard (although one could be added as a separate project). Instead, the computer can, with the full software, be used as a 'step-time' sequencer. The other major function of the software is to allow editing — cut and splice of samples and also looping. Looping allows infinite sustain of notes although it can be tricky to get a good loop.

The cut-down version of the software presented here allows sounds to be captured, displayed and played back with full control over the sample rate and filter break frequency.

The complete system allows any line signal to be sampled and stored and played back with excellent fidelity and should find uses in the classroom and on stage as well as simply as an entertaining and enthralling home micro add-on.

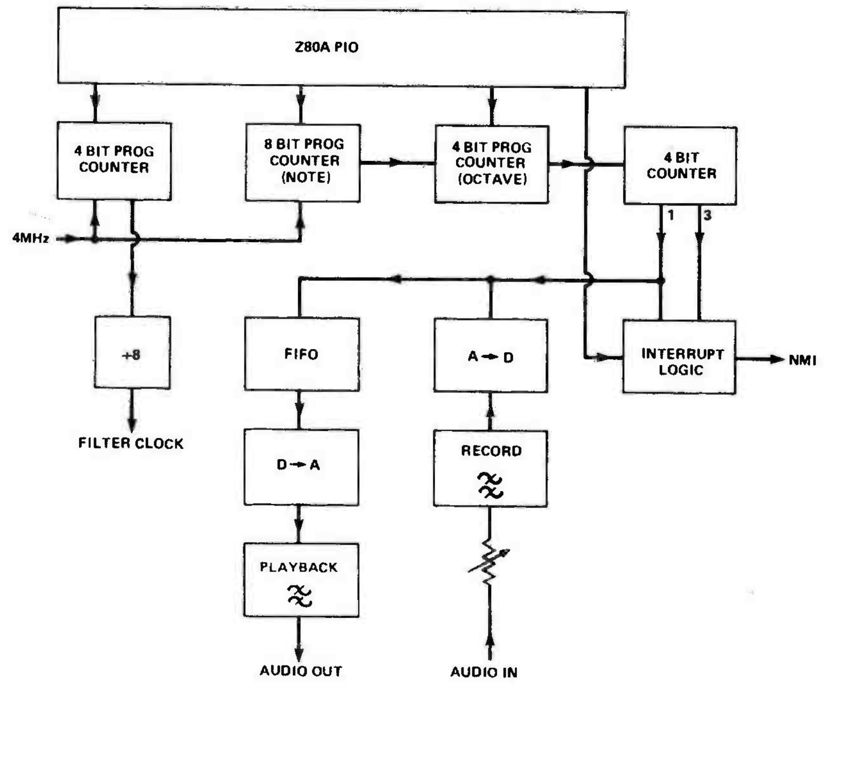


Fig. 1 The block diagram of the sampler.

Construction

There are two PCBs making up the project which roughly divide into an analogue board and a digital board.

The digital PCB (Fig. 4) is double sided but not through hole plated, so first of all you must make the through hole links with bits of wire or proper through hole pins if you have them. There is one under IC12 so *don't* solder the IC in and then realise...

Next job is to make up and solder in the computer ribbon. Making up IDC leads is tricky, especially 50-way leads such as this but Maplin operate a custom lead manufacture service.

At this stage it is worth plugging the board into the computer and switching on — just to check that nothing is shorted so far.

Now solder in the Veropins, resistors, capacitors and finally the ICs. Most of the ICs have some pads used as through holes, so using sockets is probably more trouble than it's worth. Remember to earth everything in sight including yourself when soldering in the CMOS devices.

Note that IC10, the ZN448 ADC is inserted the other way round from neighbouring devices.

Again try the board in the computer. If it won't wake up, switch off and check for mistakes. If the system comes up normally, it's a good sign but not conclusive. Try the following:

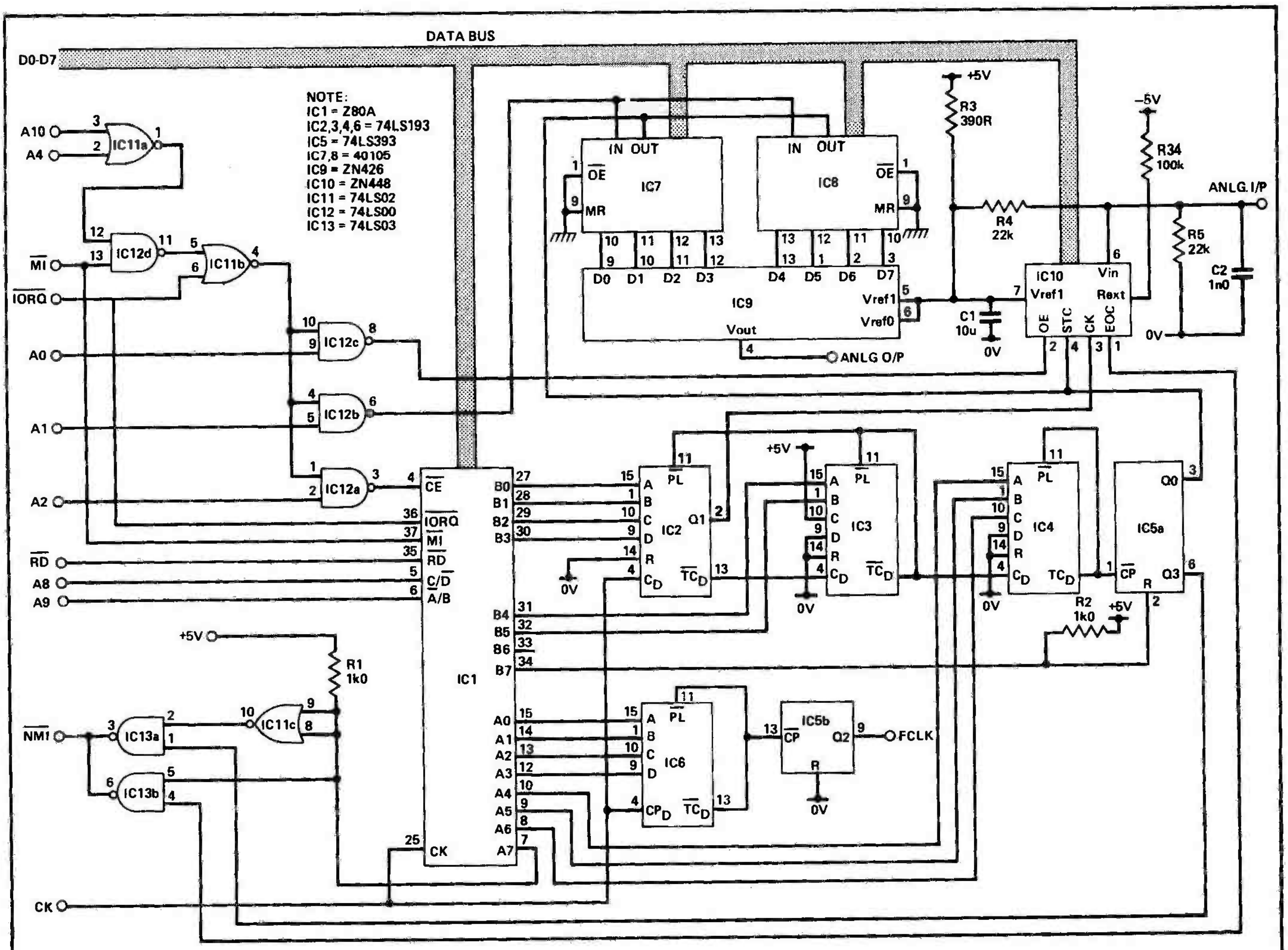


Fig. 2 The circuit diagram of the digital board.

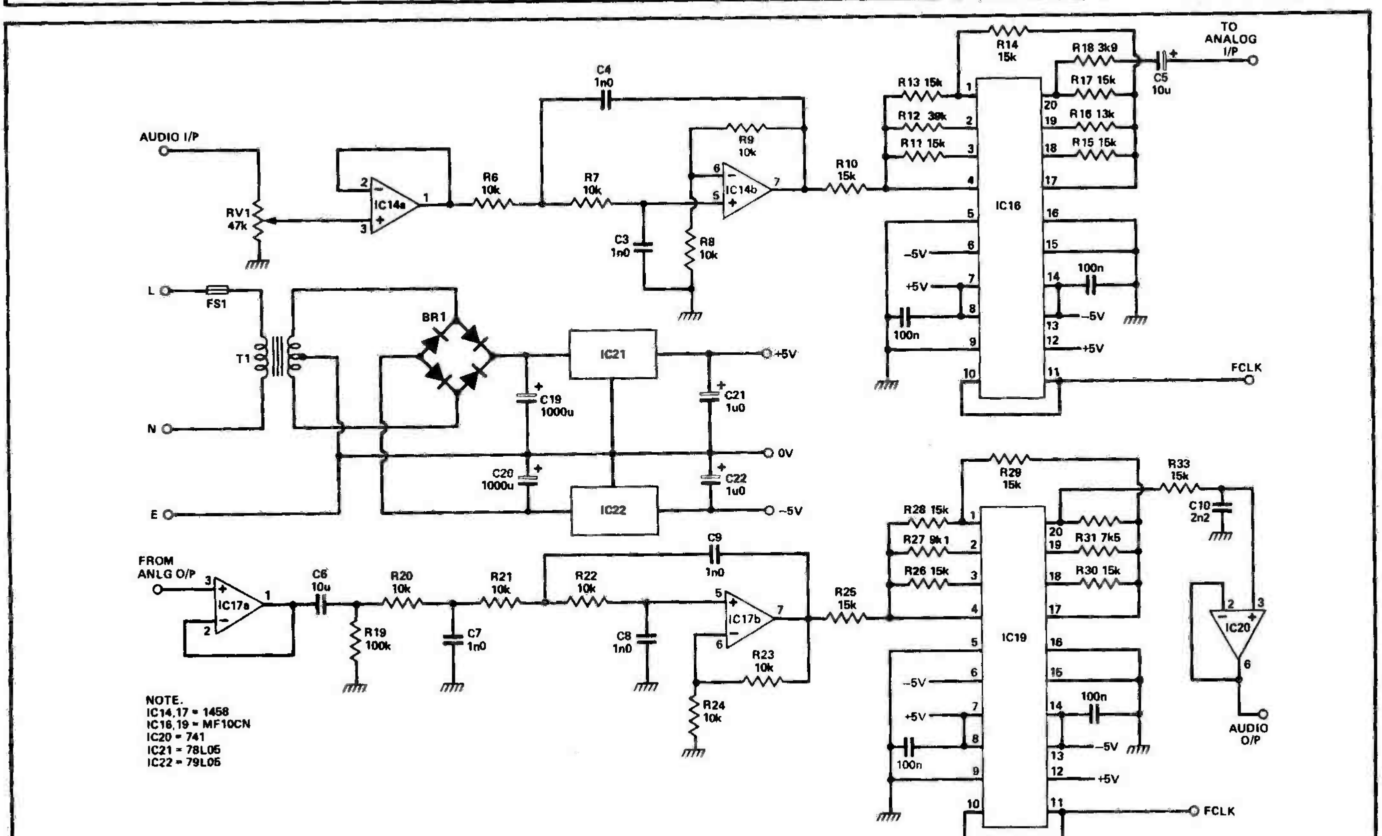


Fig. 3 The circuit diagram of the analogue and power supply board.

HOW IT WORKS

The hardware splits both logically and physically into two parts — analogue and digital (Fig. 2 and Fig. 3).

Digital

IC11, 12 decode the address bus of the computer such that the I/O map is:

& F8E4	PIOA data
& F9E4	PIOA control
& FAE4	PIOB data
& FBE4	PIOB control
& F8E2	Output Buffer
& F8E1	Converter

The two 8-bit ports of the PIO control the rate of sampling, the clock rate of the anti-alias filters and how the NMI requests to read/write data are generated. A PIO was used so that the spare bit (bit B6) could be used as input or output. Those of you who have other electronic music equipment could arrange the system to synchronise to a signal on this pin.

The two clock rates are generated by programmable divider chains which take their inputs from the PIO. Note that IC3 input C is connected high so the IC2,3 divider divides between 64 and 127 — one octave. IC5 is used to square the 'glitch' reload signals from IC3,6 and also generates a clock at ⅛ sample rate for mode 2 NMI generation.

Sample rate=2000/(PITCH+64)/(OCT+1) KHz
O<=PITCH<=63, OCT=0,1,3,7
Filter Clock=500/(FILTER)
FILTER=1,2,4,8

The sampler hardware can be set to request data transfer in one of two modes. In mode 1 an NMI is generated each time the ADC completes a conversion cycle. This mode is used when a sample is being captured.

Mode 2 generates an NMI after every 8 cycles to give the CPU time to perform a background task as well as feeding data to the DAC. In mode 1, the overheads of the NMI request, the subsequent pushing and popping of registers and the interrupt return leave precious little time out of 30µs to read or write a byte let alone do anything else. However, if 8 bytes are handled at a time the overheads are divided by 8 and a little background processing becomes possible. The 16x8 bit FIFO acts as a buffer, taking in bursts of 8 bytes from the CPU and clocking them out one by one to the DAC.

Note that if you write your own machine code for the system, the Amstrad's 300Hz interrupt normally causes the lower ROM to page in. If you have placed an NMI routine at & 0066 RAM, it will disappear, and as there is no NMI routine in the lower ROM, the machine will crash. To avoid this, either revector the 300Hz interrupt by changing the vector at & 0039 or simply disable maskable interrupts. This is handled correctly by both published and full software.

IC13 has open collector outputs and therefore does not affect the NMI line until one of the NAND gates goes low. PIO A7 enables one or the other of the gates. 0=Mode 2, 1=Mode 1. PIO B7 must be low before final divider of the sample rate generator (IC5a) will count.

When the circuit is powered up, the PIO ports configure as inputs. B7 is pulled high and there is therefore no sample clock. Hence no stray NMIs occur which is important since the Amstrad doesn't, by default, have an NMI routine!

Resistors R4, R5 bias the ADC to half full scale giving a reading of approximately 128 for no input. C2 eliminates any RF radiation picked up in the wiring between analogue and digital boards.

PIOA	bit 0-3	Filter
	bit 4-6	Octave (000,001,011 or 111 valid)
	bit 7	X — see below
PIOB	bit 0-5	Pitch
	bit 6	Unused — could use for sync input if needed. Not implemented in my s/w.
	bit 7	Y — see below

XY	Action	
00	Mode 2	NMI on SR/8
10	Mode 1	NMI on EOC
X1	No NMI	

Analogue

This section of the sampler is based on that used in the Spectrum Sampler (ETI November 85 to July 86). There are two separate channels — one for record, the other for replay. The MF10 switched capacitor filter ICs provide fourth order tunable filtering with pre-emphasis (record) and de-emphasis (playback). Without these, aliasing distortion would occur. For those of you that haven't read about sampling elsewhere, this is an interaction between the sample frequency (f) and the input signal that occurs if the frequency spectrum of the input signal exceeds f/2. By putting the input signal through a high order low pass filter, frequencies above f/2 can be removed (or at least severely attenuated) without affecting frequencies below f/2. Ideally a 'brick wall' filter is required but we live in an imperfect world and experience has shown that fourth order filters are adequate in this application.

The independence of filter clock and sample rate provided by the digital hardware allows you to optimise sound quality for a given sample. Some sounds contain more treble than others. If the result sounds dull then you can increase the filter break frequency. If you have the filter too high, aliasing will occur.

Switched capacitor filters are themselves sampling devices, all be it with higher clock rates. Analogue filters are employed to ensure the Nyquist criterion is met for the MF10s. This is especially important in the playback channel where the initial waveform from the DAC is quantised and therefore contains lots of harmonics.

The circuit as presented is designed for use at line level. If you wish to use a microphone directly you can easily increase the gain of the buffer stage of the record channel.

The signal from the DAC is at a fairly high impedance and has an offset of about 1.25V. IC17 buffers it and C3 removes the offset.

The analogue circuit requires a dual 5V PSU which is all constructed on the board except for the transformer.

```
10 OUT &F8E4,255
20 OUT &F9E4,255
30 OUT &F9E4,0
40 OUT &F8E4,254
50 OUT &F8E4,255
60 GOTO 50
```

This should generate a square wave on pin 15 of the PIO. Test it with a scope, or a crystal earpiece. If nothing happens switch off and check for mistakes. If you have a scope, you can check the other I/O devices by reading/writing to them and monitoring their enable pins. Don't enable the clock system unless you've provided an NMI routine!

The analogue board (Fig. 5) is a single sided board with three wire links. Insert these first, followed by the Veropins, resistors, capacitors and finally the semiconductors. Ensure that you get the regulator ICs in the right places and the right way round.

If you're not totally confident, then it's probably worth connecting the two boards together on the bench before building it into a box. Powering the analogue board off your bench supply is advisable — connect as though the PSU were the transformer. Don't forget to connect the pot to the input of the record channel which will otherwise not be pulled down to the ground.

Power up the computer and the analogue board. Check for zero volts output on the relay channel and about 1.25V on the record channel. Inject a signal into the record channel (touch the input with a finger) and check if it comes out OK. Disconnect the DAC from the replay channel and do the same. Don't forget to reconnect it.

If all the above tests go OK, there's a good chance that your sampler will work. Load up the software and off you g-g-g-go. The full software also includes a program called EKO. This is not a delay line but simply reads the ADC and feeds it out through the DAC — useful for testing.

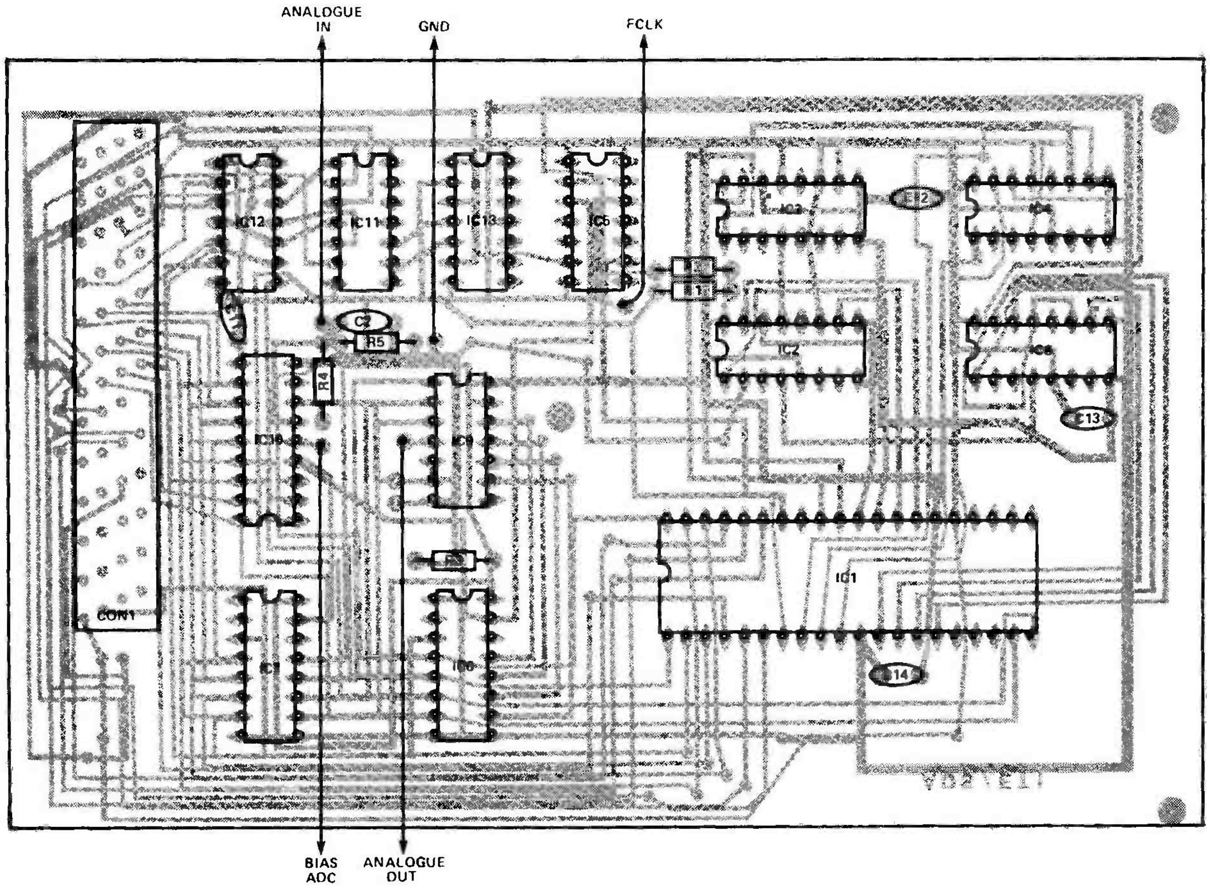


Fig. 4 The component overlay for the digital board.

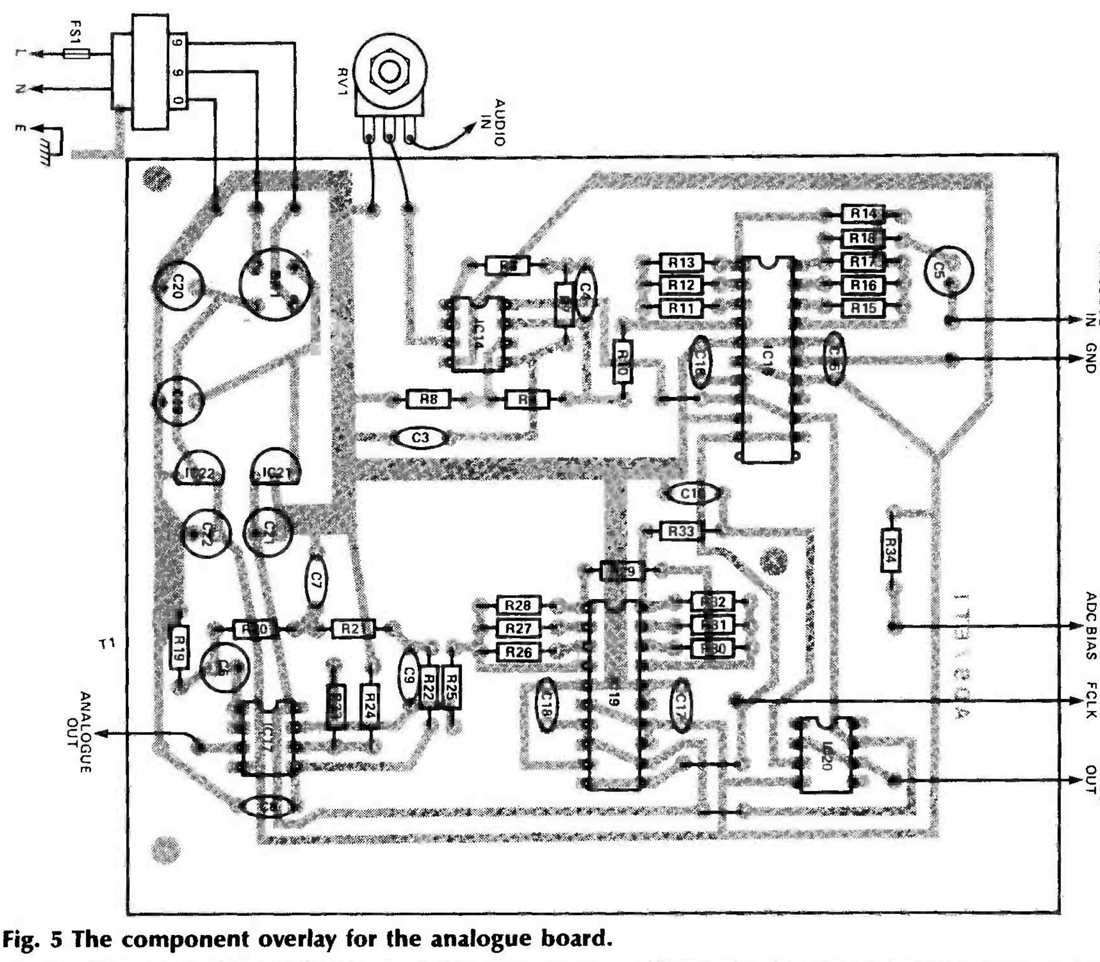


Fig. 5 The component overlay for the analogue board.

PARTS LIST

RESISTORS (all ¼W 5%)

R1,2	1k0
R3	390R
R4,5	22k
R6-9,20-24	10k
R10,11,13-15,17, 25,26,28-30,32	15k
R12	39k
R16	13k
R18	3k9
R19,34	100k
R27,31	7k5
R33	2k2
RV1	47k log rotary pot

CAPACITORS

C1,5,6	10µ 25V radial electrolytic
C2-4,7-9	1n0 polyester
C10	2n2 polyester
C11-18	100n ceramic
C19,20	1000µ 16V radial electrolytic
C21-22	1µ0 63V radial electrolytic

SEMICONDUCTORS

IC1	Z80A PIO
IC2-4,6	74LS193
IC5	74LS393
IC7,8	40105
IC9	ZN426
IC10	ZN448
IC11	74LS02
IC12	74LS00
IC13	74LS03
IC14,17	1458
IC16,19	MF10CN
IC20	741
IC21	78L05
IC22	79L05
BR1	W005

MISCELLANEOUS

CON1	50-way IDC ribbon header
FS1	500mA fuse
PL1	2x25-way IDC edge connector
SK1,2	phono socket
T1	mains transformer 9-0-9 3W

PCB; 50-way ribbon cable; case; knobs; nuts and bolts.

The case for the sampler is a matter of choice. The prototype was housed in a black ABS Verobox size 207x122x77mm. The pot, mains transformer, fuse and audio connectors were fastened to the case and hardwired to each other and the analogue board. Part of the tongue in the lid was removed to allow the ribbon through.

Software

For reasons of space it has not been possible to publish more than some primitive routines which allow you to capture, edit and replay a single sample. It is strongly recommended that you obtain the full software unless you are experienced in Z80 machine code and architecture.

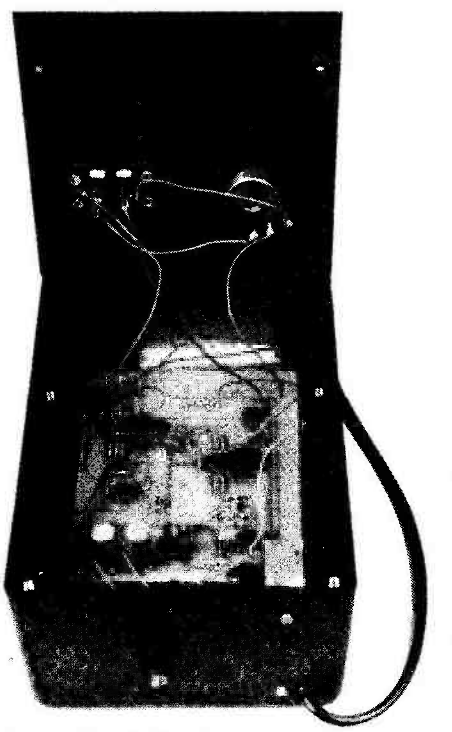
To enter the published software, type in the hex loader (Listing 1) and run it. Enter the hex dump (Listing 2) one line at a time. There are spaces between the bytes in the dump for the sake of readability but do *not* enter these

```
10 REM HEXLOAD
20 MEMORY &9FFF
30 x=&A000
40 FOR a=1 TO 41
50 INPUT h$
60 IF LEN(h$)<>36 THEN PRINT CHR$(7):GOTO 50
70 c=0
80 FOR b=0 TO 15
90 d=VAL(MID$(h$,b*2+1,2))
100 POKE x,d
110 x=x+1
120 c=c+d
130 NEXT
140 IF c<>VAL(MID$(h$,33,4)) THEN PRINT CHR$(7):GOTO 50
150 NEXT a
160 PRINT"OK"
170 SAVE "ADS.BIN",&A000,&300
180 NEW
```

Listing 1

```
A000 01 0E A0 21 0A A0 CD D1 BC C9 00 00 00 00 1C A0 0559
A010 C3 3F A0 C3 A7 A0 C3 E7 A0 C3 07 A1 43 41 50 54 0889
A020 55 52 C5 52 45 50 4C 41 D9 53 45 43 53 54 41 54 05D0
A030 D3 4D 45 54 45 D2 00 00 00 00 00 00 00 00 00 CD 039D
A040 CC A1 DD 7E 04 32 37 A0 DD 7E 02 32 38 A0 DD 7E 0797
A050 00 C6 7F 32 39 A0 DD 21 65 A0 CD 20 A2 AF 21 00 06B2
A060 20 CD 3E A2 C9 3D C0 DD 21 73 A0 3A 39 A0 57 01 070F
A070 E1 F8 C9 ED 78 01 E2 F8 ED 79 01 00 F4 ED 48 CB 0A3D
A080 51 CA 9E A0 01 E1 F8 BA D8 DD 21 8E A0 C9 ED 78 0A1F
A090 01 E2 F8 ED 79 01 E1 F8 77 23 7C FE A0 C0 DD 21 098D
A0A0 A5 A0 C3 41 A2 ED 45 CD CC A1 DD 7E 06 32 37 A0 08C1
A0B0 DD 7E 04 32 38 A0 DD 7E 02 C6 20 5F DD 7E 00 C6 072C
A0C0 20 32 3C A0 57 DD 21 D6 A0 63 2E 00 22 3D A0 CD 0656
A0D0 20 A2 CD 3E A2 C9 7E 01 E2 F8 ED 79 23 7C BA C0 0910
A0E0 DD 21 A5 A0 C3 41 A2 DD 7E 04 C6 20 67 2E 00 CD 0790
A0F0 55 A2 EB DD 6E 02 DD 66 03 77 23 36 00 DD 6E 00 0690
A100 DD 66 01 73 23 72 C9 21 00 00 22 AE A1 CD 16 A1 062B
A110 CD 1B BB 30 F8 C9 DD E5 CD CC A1 DD 21 B3 A1 3E 0A20
A120 48 32 38 A0 3E 42 32 37 A0 21 00 9F AF CD 20 A2 05D9
A130 CD 3E A2 21 00 9F CD 55 A2 DD E1 CD 19 BD CB 3F 089C
A140 6F 26 00 22 B0 A1 ED 5B AE A1 B7 ED 52 C8 38 2E 07C3
A150 7D 32 B2 A1 11 20 00 21 78 00 CD 1D BC ED 5B AE 0668
A160 A1 19 0E 14 E5 3A B2 A1 47 3E 70 B6 77 23 10 F9 069C
A170 E1 CD 29 BC 0D 20 ED 2A B0 A1 22 AE A1 C9 7D ED 08CC
A180 44 32 B2 A1 11 20 00 21 78 00 CD 1D BC ED 5B B0 0631
A190 A1 19 0E 14 E5 3A B2 A1 47 3E 0F A6 77 23 10 F9 062B
A1A0 E1 CD 29 BC 0D 20 ED 2A B0 A1 22 AE A1 C9 00 00 0762
A1B0 00 00 00 3D C0 DD 21 BD A1 01 E1 F8 C9 ED 78 77 07D8
A1C0 23 7C FE A0 C0 DD 21 A5 A0 C3 41 A2 F3 3E DD 32 0926
A1D0 66 00 3E E9 32 67 00 01 E4 F8 3E FF ED 79 01 E4 078B
A1E0 F9 ED 79 AF ED 79 3E 03 ED 79 01 E4 FA 3E FF ED 0A24
A1F0 79 01 E4 FB ED 79 AF ED 79 3E 03 ED 79 01 00 F6 0872
A200 ED 49 01 82 F7 ED 49 01 0E F4 ED 49 01 C0 F6 ED 08C3
A210 49 0E 00 ED 49 01 92 F7 ED 49 01 48 F6 ED 49 C9 0788
A220 01 E2 F8 3E 80 ED 79 ED 79 01 E4 F8 3A 37 A0 F6 0949
A230 80 ED 79 01 E4 FA 3A 38 A0 E6 7F ED 79 C9 76 18 08F9
A240 FD F1 76 76 76 76 01 E4 FA 3E FF ED 79 01 E4 F8 0A25
A250 ED 79 FB 76 C9 44 4D 21 00 00 11 7F 80 0A BA 38 065E
A260 01 57 BB 30 01 5F D6 80 D5 16 00 30 02 ED 44 5F 05A6
A270 19 D1 03 79 B7 20 E6 7B 2F BA 38 01 57 7A D6 80 06E7
A280 C9 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00C9
```

Listing 2



```
100 IF HIMEM=&1FFF THEN 200
110 MEMORY &1FFF
120 LOAD "ads.bin",&A000
130 CALL &A000
200 CLS
210 PRINT"AMSTRAD DIGITAL SAMPLER"
220 PRINT
230 PRINT"1 - Capture/Edit"
240 PRINT"2 - Meter"
250 k$="":WHILE k$="":k$=INKEY$:WEND
260 IF k$="1" THEN GOSUB 1000
270 IF k$="2" THEN GOSUB 3000
280 GOTO 200
1000 REM *** CAPTURE NEW SAMPLE ***
1010 CLS
1020 WINDOW#1,2,39,20,22
1030 PEN#1,2
1040 WINDOW#2,1,40,25,25
1050 WINDOW#3,1,40,4,25
1060 PEN#3,1
1070 PAPER 3:PEN 1
1080 PRINT"CAPTURE SAMPLE"
1090 PAPER 0
1100 INPUT#3,"Trigger:",T%
1110 IF T%<0 OR T%>99 THEN 1100
1120 INPUT#3,"Sample Rate:",SR%
1130 IF SR%<2000 OR SR%>25000 THEN 1120
1140 INPUT#3,"Filter Setting:",FS%
1150 IF FS%<1 OR FS%>4 THEN 1140
1160 CLS#3
1170 OB%=2^INT(LOG(31250/SR%)/LOG(2))
1180 PB%=INT(2000000/SR%/OB%)
1190 IF PB%=64 THEN PB%=65
1200 OB%=16*(OB%-1)+2^(4-FS%)
1210 LOCATE 9,12
1220 PRINT"Press any key to start"
1230 WHILE INKEY$="":WEND
1240 LOCATE 9,12:PEN 2
1250 PRINT"   Capturing Sample   "
1260 |CAPTURE,OB%,PB%,T%
1280 PFS%=FS%:PR%=SR%
1290 CLS#3
1300 SS%=0:ES%=127
1320 GRAPHICS PEN 1
1330 ORIGIN 16,232
1340 MOVE -16,-100,3
1350 DRAWR 639,0:DRAWR 0,200
1360 DRAWR -639,0:DRAWR 0,-200
1370 MOVE -16,-116
1380 DRAWR 639,0:DRAWR 0,-80
1390 DRAWR -639,0:DRAWR 0,80
1400 MOVE 0,0,1:DRAWR 576,0
1410 pk%=0:avg%=0
1420 FOR i%=0 TO ES%-1
1430 |SECSTATS,i%,@pk%,@avg%
1440 avg%=avg%/256
1450 MOVE i%*4.5,avg%:DRAWR 0,-2*avg%
1460 NEXT
1470 GOSUB 1920
1480 GOSUB 1960
1490 PEN 1
1500 K$=""
1510 WHILE k$="":k$=UPPER$(INKEY$):WEND
1520 IF k$="P"THEN GOSUB 1610
1530 IF k$="Q"THEN RETURN
1540 IF k$="X"THEN GOSUB 1630
1550 IF k$="F"THEN GOSUB 1680
1560 IF K$=CHR$(242)THEN GOSUB 1760
1570 IF K$=CHR$(243)THEN GOSUB 1800
1580 IF K$=CHR$(246)THEN GOSUB 1840
1590 IF K$=CHR$(247)THEN GOSUB 1880
1600 GOTO 1500
1610 |REPLAY,OB%,PB%,SS%,ES%
1620 RETURN
1630 INPUT#2,"Filter:",PFS%
1640 CLS#2
1650 IF PFS%<1 OR PFS%>4 THEN 1630
1660 OB%=(OB% AND &X11110000)+2^(4-PFS%)
1670 GOTO 1960
1680 INPUT#2,"Playback rate:",PR%
1690 CLS#2
1700 IF PR%<2000 OR PR%>30000 THEN 1680
1710 OB%=2^INT(LOG(31250/PR%)/LOG(2))
1720 PB%=INT(2000000/PR%/OB%)
1730 IF PB%=64 THEN PB%=65
1740 OB%=16*(OB%-1)+2^(4-PFS%)
1750 GOTO 1960
1760 GOSUB 1920
1770 IF SS%>0 THEN SS%=SS%-1
1780 GOSUB 1920
1790 RETURN
1800 GOSUB 1920
1810 IF SS%<ES% THEN SS%=SS%+1
1820 GOSUB 1920
1830 RETURN
1840 GOSUB 1920
1850 IF ES%>SS%THEN ES%=ES%-1
1860 GOSUB 1920
1870 RETURN
1880 GOSUB 1920
1890 IF ES%<127 THEN ES%=ES%+1
1900 GOSUB 1920
1910 RETURN
1920 MOVE SS%*4.5,64:DRAWR 0,-128,2,1
1930 MOVE ES%*4.5,64:DRAWR 0,-128,2,1
1940 LOCATE#1,9,2:PRINT#1,ES%-SS%;"  "
1950 RETURN
1960 CLS#1
1970 PRINT#1,"Filter :";PFS%;TAB(20);
1980 PRINT#1,"Freq.  :";PR%
1990 PRINT#1,"Length :";ES%-SS%
2000 RETURN
3000 REM *** LEVEL METER ***
3010 CLS
3060 ORIGIN 0,0
3070 PAPER 1:PEN 3
3080 PRINT"LEVEL METER"
3090 PAPER 0
3100 GRAPHICS PEN 3
3110 MOVE 44,220
3120 DRAWR 552,0:DRAWR 0,80
3130 DRAWR -552,0:DRAWR 0,-80
3140 FOR I=0 TO 39 STEP 2
3150 MOVE 64,240+I
3160 DRAWR 410,0,2
3170 NEXT I
3180 PEN 2
3190 LOCATE 8,18
3200 PRINT"Press any key to continue"
3210 |METER
3220 RETURN
```

Listing 3

or the four character address into the loader. The last four characters on each line are a checksum. Enter this as well. The machine will bleep if something is wrong — re-enter the whole line. The loader will save the code as 'ADS.BIN' and then clear the machine.

Then enter and save the Basic program (Listing 3) and run it.

The sound sampled by the device can be either captured or metered. In the meter mode a simple bar graph of the real time amplitude of the sound is displayed. In capture mode the program allows the sample rate, filter setting and trigger threshold level to be set. The allowable values are:

Capture Rate *2000-25000*
Filter *1-4*
Trigger Level *0-100*

The program will then wait for a sound above the trigger level and capture it. The sample is displayed as a plot of amplitude against time and the cursor keys can be used to select the part of the sample for playback. The playback rate and filter setting can also be altered using the following keys:

◆ ◆	: move start cursor
SHIFT (◆ ◆)	: move end cursor
P	: Play
F	: Set Playback Rate
X	: Set Filter
Q	: Quit

The machine code provides the following RSX routines which can be incorporated into your own programs.

CAPTURE,FO%,PT%,TR%
Capture Sample.
FO% — written to PIOA bits 0-6
PT% — written to PIOB bits 0-6
TR% — Trigger level

REPLAY,FO%,PT%,SS%,ES%,
Replay Sample.
SS% — Start Sector (0-ES%)
ES% — End Sector (SS%-127)

SECSTATS,S%,@PK%,@AVG%
Return Peak and Average Values for Sector S%.
S% — Sector (0-127)
PK% — Peak value
AVG% — Average value

METER Produce level meter display.

ETI

BUYLINES

The ribbon cable and edge connector are available ready assembled from Maplin

The software published here and the full software of sound capture, display, edit, storage, retrieval, playback, and sequence modules all together in a powerful composition package, along with a sample library, documentation, and the source code is available on cassette (£9.95) or disc (£13.95) from the author. Prices include post and packaging. Please address all enquiries and orders to Labcenter Electronics, 14 Marriner's Drive, Heaton, Bradford, BD9 4JT.

BOILER CONTROLLER

No need to keep the home fires burning with Tim Markham's comprehensive controller for your boiler, heating and hot water system.

This control unit is suitable for either gas or oil fired domestic central heating systems. It is designed for systems where the boiler is operated by a mains-powered motorised valve (or fuel pump) and the central heating is driven by a water pump (Fig. 1). If the system includes further pumps or motorised valves in the pipework or there is a hot water cylinder thermostat, this control unit may not be directly compatible.

In a standard heating system such as this, whenever the hot water or central heating is on, the boiler maintains itself at all times at a temperature set by the boiler thermostat. The hot water tank is gravity fed from the boiler and heated through the internal heat exchanger coil so the hot water temperature is close to the boiler temperature. Hot water is also pumped through the radiators under control of the room thermostat.

This control unit reduces the boiler fuel consumption in a number of ways. Note that the old timeswitch is still used. If the old system does not have a timeswitch then one should be installed.

- The boiler is only allowed to fire up if the hot water tank or room temperature is too low. If both are up to temperature the boiler cools down instead of firing to stay hot as happens with the old controls.

- When the room temperature reaches the set level and the boiler turns off, the water pump continues to run for a few minutes so that the remaining heat in the boiler is used to heat the house. If the hot water is below temperature, there is no saving as the boiler continues to fire but when the hot water is up to temperature then this is a very useful economy feature as the boiler is not left full of heat.

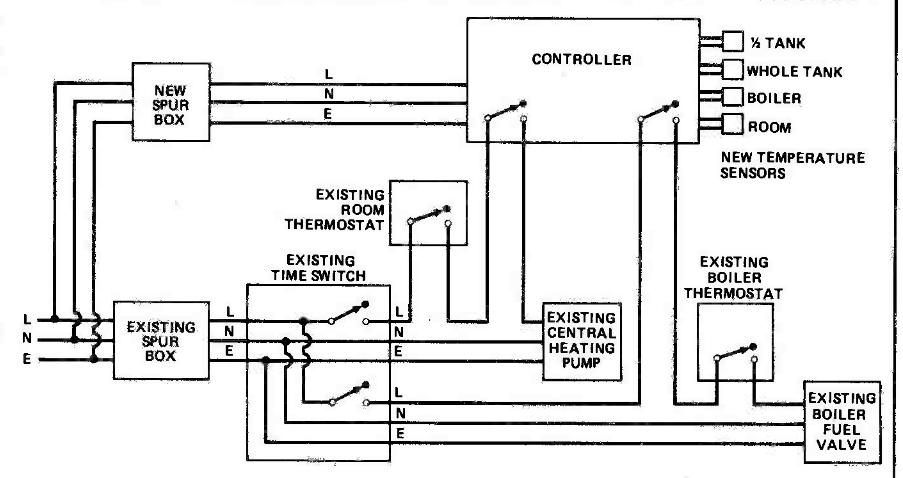
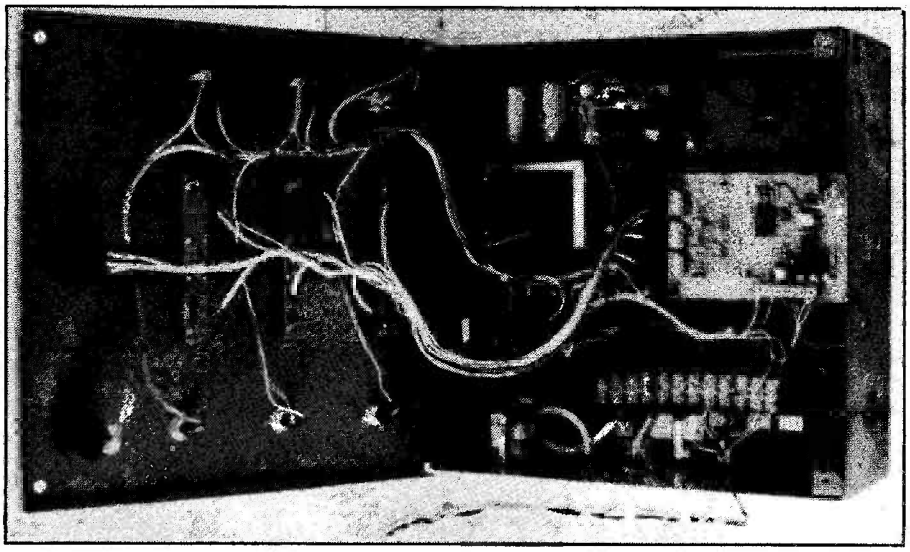


Fig. 1 How the ETI Boiler Controller fits in with an existing system.



- There is the option of heating either half or a whole tank of hot water at a temperature set independently of the boiler temperature.

- It is possible to request a single half or whole tank of hot water outside of the timeswitch setting. Once the water reaches the set temperature the complete system turns off and stays off. This can be more economical than over-riding the timeswitch, especially if you tend to forget to turn it off again.

- The new thermostats are more accurate than standard mechanical thermostats, so reducing the length of the heating cycle and keeping the room temperature more constant.

The control unit is based in a wall-mounting box which houses the electronics. The front panel includes three slider potentiometers which are used to

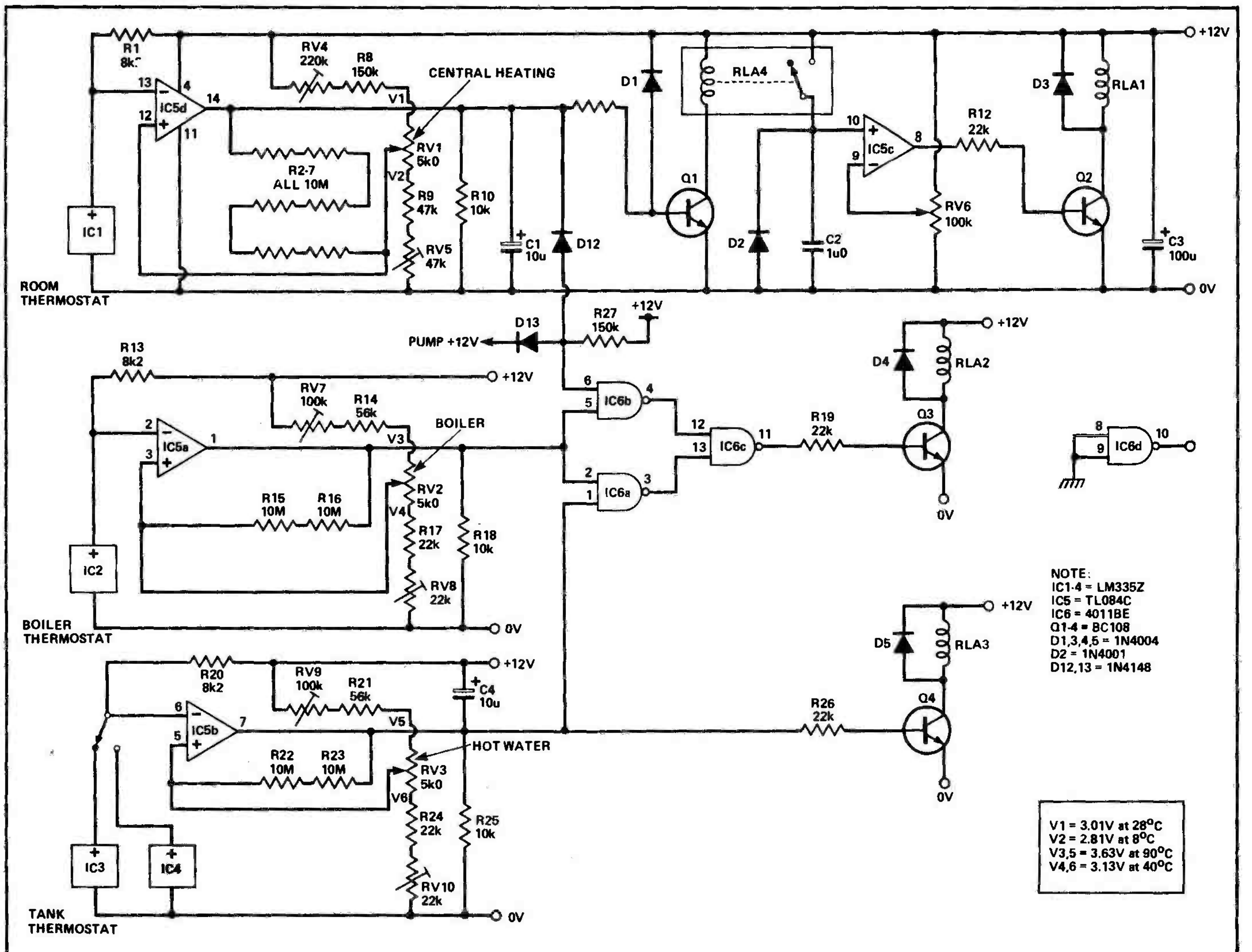


Fig. 2(a) The circuit diagram of the signal section of the boiler controller.

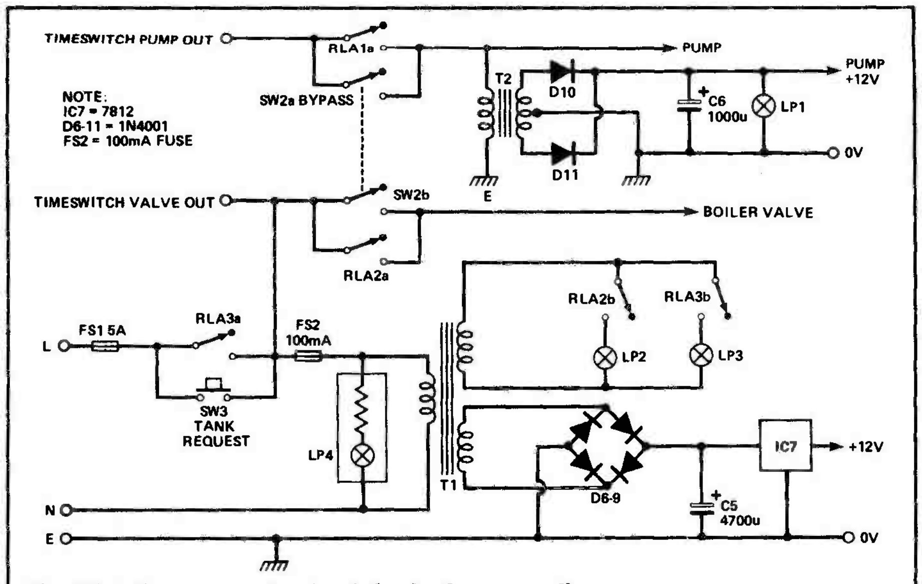


Fig. 2(b) The power circuit of the boiler controller.

set the boiler temperature, the room temperature and the hot water temperature. There are three indicator lamps, one paired with each slider.

The red lamp indicates when the boiler is burning, the green lamp indicates when the water pump is running and the yellow lamp paired with the hot water thermostat indicates a tank request. A tank request is generated whenever the hot water temperature is below the set temperature if the control unit is on. Either half or a whole tank of hot water is selected using the switch on the panel.

The neon indicator shows when the control unit is on, switched either by the timeswitch or manually using the tank request button in the opposite corner. When this is pressed the control unit fires up the boiler until the hot water is up to temperature and then switches itself off again completely.

Construction

The first stage is the drilling of the wallbox. The box used was the Maplin plain wallbox and this is recommended.

Holes must be cut for all parts fitting on the front panel, for cable grommets on the bottom and the voltage regulator and earthing bolts on the right hand side (Fig. 3).

The front panel components are then fitted in place. The slide potentiometers were held in position using countersunk bolts and spacers which were then covered with slider bezels. This also means the slots do not have

HOW IT WORKS

The control unit is based on three similar thermostats. Consider the room thermostat based on IC5d. IC1 is a zener diode whose voltage drop depends on absolute temperature. The voltage drop is 10mV per Kelvin. The calibration input of these sensors is not used.

The sensor voltage is compared in IC5d with that from a resistor chain with a small amount of hysteresis produced by R2-7 and the output used to drive a relay. The resistor chain includes a slide potentiometer which allows the temperature at which the thermostat operates to be altered.

The cicuitry around IC5c is used to generate time delays of several minutes before switching off the pump with RLA1. This is done by discharging C2 by the reverse leakage through D2. The voltage on C2 is compared with a fixed voltage set by RV6 and the pump relay is switched off when the C2 voltage falls to less than this.

IC6 ensures the boiler only fires up when it is really needed, and drives the boiler valve through RLA2.

RLA1 is connected into a break in the pump power line. RLA2 is similarly connected into the boiler valve (or fuel pump) power line. SW2 by-passes the whole unit in the event of failure.

The control unit can be powered up in two ways. When the timeswitch turns on, power is applied directly to the transformer from the boiler valve power line, powering up the control unit. Alternatively, to request a tank of hot water, depressing SW3 powers up the unit from the external mains supply, so pulling in RLA3 if the tank is below the set temperature. Once the tank is up to temperature RLA3 is released and the control unit is therefore turned off. A tank request is also generated when the timeswitch turns on if the water is cold but the control unit remains powered up after the tank reaches temperature and will generate another tank request if the tank temperature should fall again. If the timeswitch turns off while the hot water is below temperature then the tank request will keep the boiler firing until the hot water reaches the set temperature and then switch off.

The power supply is a standard circuit. The indicator lamps LP2 and LP3 are powered off a separate transformer winding for simplicity and to reduce interference on switching. LP1 is connected across the pump through a miniature transformer, so indicating when the pump is running.

C1 and C4 are to prevent glitches in the sensor signals upsetting the control outputs. If problems are still experienced a combination of reducing the value of the sensor resistors (R1,13,20) to a minimum of 2k2, increasing C1 and C4 and using screened wire to the sensors should eliminate them.

to be cut too neatly. Temperature markings are linearly spaced over the length of the potentiometer slide (8-28°C for the room control and 40-90°C for the tank and boiler controls).

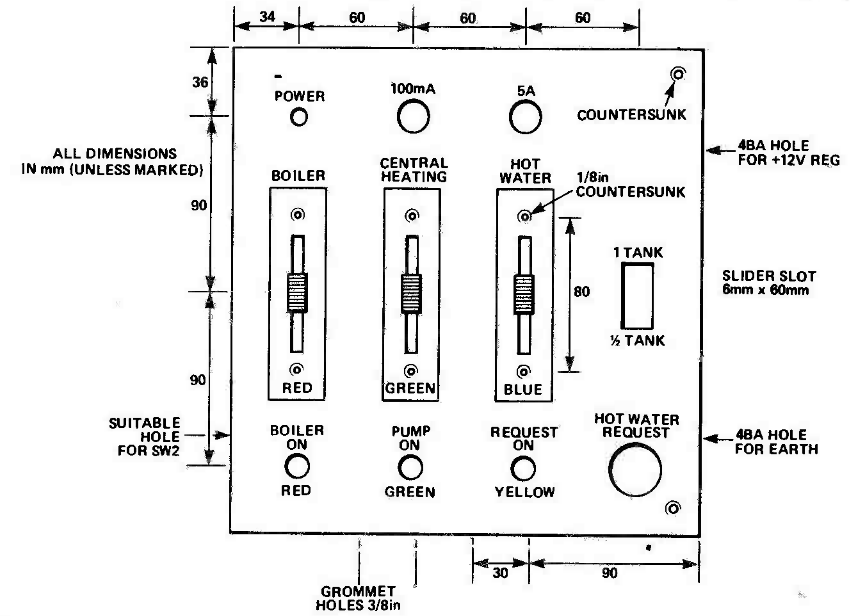
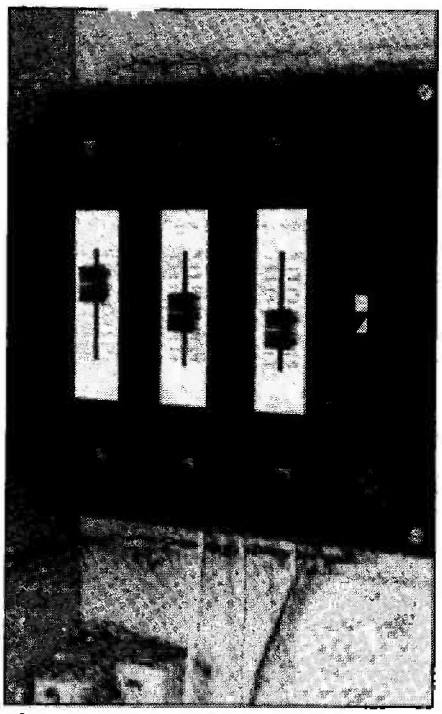


Fig. 3 The controller front panel.



The prototype installed in the author's airing cupboard.

The PCB is simple to construct (Fig. 4). It is strongly recommended that screw down terminal blocks are used as they make wiring easier and neater. Check that the semiconductors are correctly inserted. RLA4 is simply glued to the space on the board and wired to Veropins. This allows any relay pin configuration to be used.

The method of mounting the various parts on the back of the control box is left to individual preference. The prototype made extensive use of glue! Whatever method is used, make sure the PCB can be removed easily.

The first stage of the wiring of the circuit is the front panel. It is worth spending time doing a neat job here as any mistakes will be easier to trace. Mains connections and the power to the lamps are run off together at the top of the panel. Sensor signals and wires to the sliders are grouped together further down the panel. This helps keep mains and low voltage thermostat signals separate.

The wires to the slider potentiometers must be screened. The screens are soldered to the metal frames of the potentiometers and left unconnected at the PCB. Insulating sleeving is widely used throughout.

The rest of the internal wiring can now be completed. If the wiring is done methodically with a useful choice of coloured wires, there should be no problems. The 12V regulator is bolted to the right hand side of the box with an insulating kit. A bolt down connection to the box is also made on this side to allow for a reliable earth to be made.

Diodes D3-5 are soldered directly onto the relay coil terminals and the rectifier diodes D6-11 are soldered to the transformer terminals. It may be necessary to add an earthing wire from the box to the hinged front, although there was a satisfactory connection through the hinge on the prototype.

Calibration

Once the wiring of the control box is completed the thermostats can be calibrated. Connect up a mains power lead to the 5A

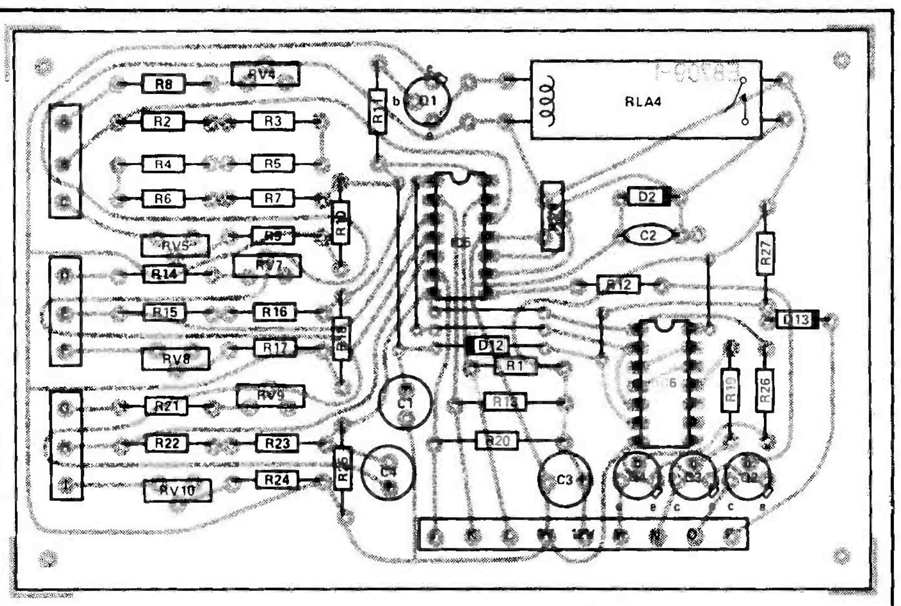


Fig. 4 The component overlay for the boiler controller PCB.

connector block and check that there is not a short circuit across it, with or without SW4 depressed. Disconnect the 12V supply lead from the PCB, apply power to the mains lead, hold down SW3 and check the 12V supply is correct. Then reconnect the 12V lead and set the voltages at each end of the slide potentiometers as shown in Fig. 2. A digital multimeter is useful here as it is necessary to measure to within 0.01V.

First measure the voltage at terminal A and adjust RV4 until it is close to that required. Now adjust RV5 until the voltage at terminal C is correct. This alters the voltage at terminal A, so the process must be repeated until the required voltages are set. Do this for the other two slider pots also.

Care must be taken throughout as there are mains voltages present in the box.

Installation

Installation should be possible to complete in a day. The wallbox should be mounted near to the old boiler controls. The wires to the water pump and the motorised valve (or fuel pump) are cut and rewired to connectors with the live lines passing to the control unit. If the two original wires run next to each other at some point then a single small wall-mounting junction box provides a neat solution.

The mains power to the control unit must be connected through a standard switched spur box and not to a plug and socket as the plug terminals could become live from the timeswitch power lines when unplugged.

The boiler temperature sensor should be fitted in close thermal contact with the boiler water. The exact position will vary with the boiler type but possible sites are close to the original boiler thermostat or on the outlet pipe. A touch of super-glue should hold it in place. If the sensor is likely to be cooled by air movement it should be covered with some insulating material.

The hot water tank sensors are simply glued onto the outside of the tank at approximately one third (whole tank) and two thirds (half tank) its height from the bottom and then covered by the tank insulating jacket.

The room temperature sensor should be situated away from outside doors, windows and radiators. It should also not be situated in the kitchen or anywhere else where extra heat is frequently used. It may be possible to use the corner of the existing room thermostat box.

If a new site is being used then any small box may be used to hide the sensor but ensure that slots or holes allow air movement. Leave the sensor hanging by its wires rather than glueing it to anything.

The wires to the sensors carry low current at an isolated low voltage so very thin plastic coated or enamelled wires can be used. The wires to the boiler and hot water tank can follow the water pipes, but all sensor wires should avoid mains cables as much as possible.

Operation

When the control unit is in operation, the old boiler thermostat should be turned up to about 90 degrees Centigrade so it will act only as an emergency cut-out to prevent the boiler boiling. The old room thermostat should be turned up to maximum.

The temperatures required may now be set on the new control unit. Normally the boiler temperature should be set to at least 60° C as this improves efficiency and prevents condensation which may cause

PARTS LIST

RESISTORS (all ¼W, 5%)	
R1,13,20	8k2
R2-7,15,16,22,23	10M
R8,27	150k
R9	47k
R10,18,25	10k
R11,12,17,19,24,26	22k
R14,21	56k
RV1-3	5k0 lin 60mm slider
RV4	220k vertical preset
RV5	47k vertical preset
RV6,7,9	100k vertical preset
RV8,10	22k vertical preset
CAPACITORS	
C1,4	10μ 25V radial electrolytic
C2	1μ0 polyester, low leakage
C3	100μ 25V radial electrolytic
C5	4700μ 25V radial electrolytic
C6	1000μ 25V radial electrolytic
SEMICONDUCTORS	
IC1-4	LM335Z
IC5	TL084C
IC6	4011BE
IC7	7812
Q1-4	BC108
D1,3-5	1N4004
D2,6-11	1N4001
D12,13	1N4148
MISCELLANEOUS	
FS1	5A anti-surge
FS2	100mA anti-surge
LP1-3	12V LES (red, green, yellow)
LP4	mains amber neon
RLA1-3	12V coil, DPST 3A 250V AC
RLA4	12V coil, SPST sub-miniature
SW1	SPDT rocker
SW2	DPST rocker (3A, 250V AC)
SW3	SPST push button (3A, 250V AC)
T1	12-0, 12-0, 12VA mains transformer
T2	12-0-12 100mA mains transformer

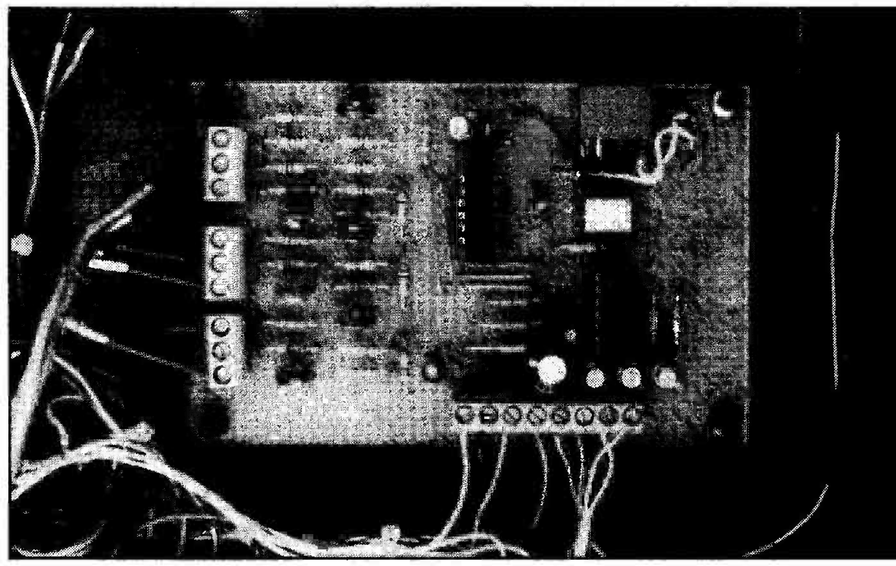
PCB; case; junction box; T066 insulating kit; PCB connectors; 5A connectors; bulb holders; fuse holders; slider knobs; connecting wire; nuts and bolts.

the boiler to corrode. This can be done without the normal increased fuel consumption as the hot water temperature is now independent of the boiler temperature.

Obviously the hot water temperature can never *exceed* the boiler temperature and generally the boiler should be 10° to 20° C hotter than the water temperature.

The pump time delay should be set to about three or four minutes. Switch on the central heating and turn up the room thermostat until the pump starts running. The thermostat is then turned right down and RLA4 should switch off. After three or four minutes turn RV6 until the pump just switches off. Start the pump running again and check the time delay making further adjustments as necessary.

It is worth checking the central heating system. When the radiators are hot, the boiler will switch off (assuming the hot water is up to temperature) and the pump over-run will continue the pump running for a few minutes. The boiler should then stay off for typically 10-15 minutes before the thermostat switches the heating on again. If the boiler tries to switch on and off every few



minutes, the room thermostat is too sensitive to air movements. A couple of turns of insulation tape around the sensor should cure this.

In the event of a control unit failure it can be completely by-passed using the switch inside the control box. As none of the old system is removed when this control unit is installed it will run as before if the old thermostats are reset.

The fuel savings with this system will depend on how well the control unit is used but there is a greater degree of control over the boiler with the control unit and so with intelligent setting a considerable saving and increase in convenience should be possible. **ETI**

BUYLINES

All the components for this project should be simple enough to obtain. The temperature sensors (IC1-4) are available from Maplin as is the wall-mounting box used for the prototype. The PCB is available from the ETI PCB Service.

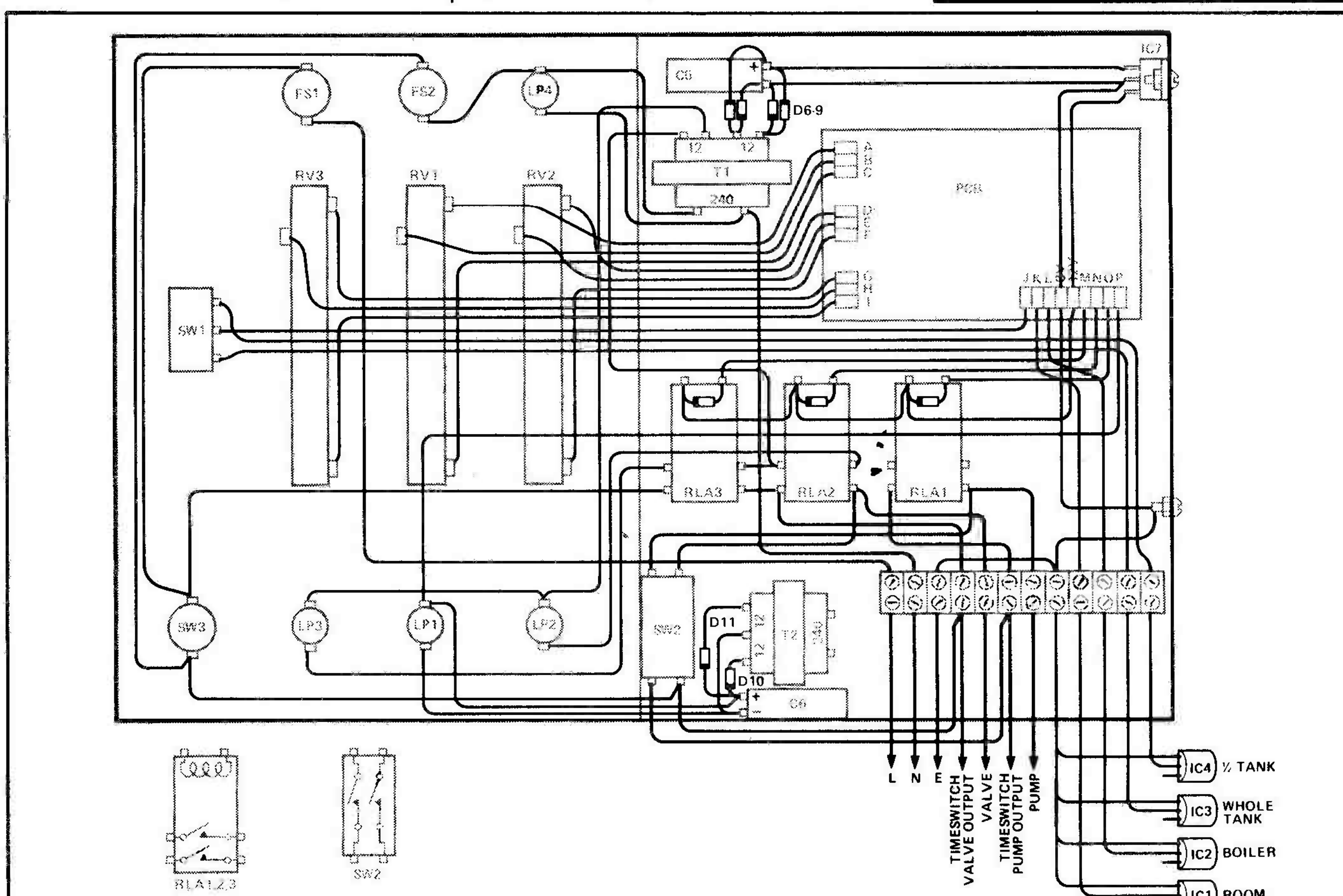
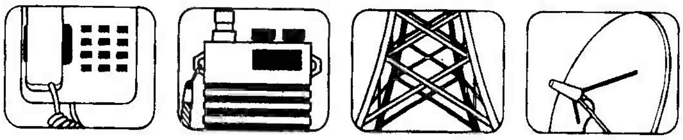


Fig. 5 Wiring up the boiler controller.

OPEN CHANNEL



Two things cause personal doubts regarding any possible direct broadcast by satellite television system in Britain. The first is simply that Alan Sugar (yes, he of Amstrad fame) has withdrawn his company's support from the British Satellite Broadcasting (BSB) consortium which is licensed to provide DBS services from 1989.

Now in fairness (and this is the line which BSB appears to be taking) Amstrad's financial support to the consortium was a small percentage anyway. In this respect, BSB's costings will be harmed relatively little and no doubt further backers can be approached to fill any financial gap.

However, the lack of Alan Sugar's company name on the list of backers must do more harm than any loss of money — particularly as Amstrad has actually *pulled out* of the consortium's affairs. If Amstrad had not been involved in the first place the situation might be more palatable.

Joe Public is well aware of Amstrad. Amstrad is the company which does for hi-fi what Henry Ford did for the motor car. Amstrad is the company (not the *only* company, mark you, but the company most people know about) which produces cheap yet reasonable quality goods which we can all afford.

Initially, the problem is one of PR. Mr Public will rightly think that for Alan Sugar to take his company out of BSB there must be a reason.

By playing it down and discretely dropping the Amstrad name from the credits, BSB will recover. However in the longer term Amstrad's experience in design, development and production along with its aggressive pricing and marketing policies, is bound to affect the product finally offered for sale.

With Amstrad's experience, the product could well have been as cheap as it will need to be to sell in huge quantities. Without Amstrad (or another company of its ilk), I can personally see no way in which product price can be low enough to attract high sales. Without high sales, the venture is doomed to failure.

All of this leads to my second doubt regarding DBS in Britain. Consider the product. DBS is to provide three, four, maybe five broadcast television channels for a price tag which will, without Amstrad I am sure, approach £1000. True, broadcasts will be near high-definition quality (using the proposed MAC standard) but high-definition reception will rely on a high-definition receiver. Users of existing receivers will be able to receive boardcasts in ordinary quality with a converter. All this for a maximum of five new channels!

Yet, satellite reception of over three times this number of channels (with many more to come) is *already* available with present price tags between £1000 to £2000. Given the choice, *will* the user who wants more television channels plump for a system which gives only five channels for around £1000 or for a system which gives many more for the same cost or perhaps just a little more? In my scenario, BSB cannot hope to persuade Joe Public that DBS is the one for him.

Centrex

British Telecom is timetabling the launch of its new centrex-style service, Centel 100, for about the time this edition of ETI is published. The chances are that Mercury's own version, although officially without a name or launch date at the time of writing, will be available at or before this time, too.

Centrex is the use of part of a central exchange to give branch exchange style services to customers without the incumbent costs of maintaining and keeping a branch exchange on the premises. Services are generally software-controlled and so can be changed rapidly and cheaply by the network provider without the necessity of access.

Signs are that both BT and Mercury are taking Centrex seriously and it'll be extremely interesting to watch the development of services on both systems, along with the accompanying publicity hype.

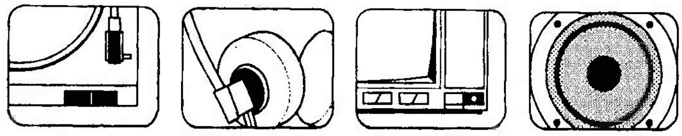
Cool, Real Cool

Superconducting cables, maintained at a temperature of -180°C could form the national power grid of the future. IBM has apparently found ways of maintaining this temperature and creating power lines of immense current carrying capacity, using the near-zero resistance of metal when cooled this far.

It is claimed the lower resistance of the cables will reduce electricity wastage (calculated as being up to 30% of the total electricity generated) so that electricity costs will be reduced accordingly. It all sounds too good to be true and I look forward to being convinced of its efficacy to my pocket.

Keith Brindley

PLAYBACK



I recently bought a number of hi-fi magazines in order to help my father-in-law choose some hi-fi equipment.

What I read set me to wondering why some equipment reviews get right up my nostrils. A correlation between adjectives such as 'depth', 'perspective' and 'seamless coherence' and a high irritation factor was soon apparent.

Surely the purpose of hi-fi is to provide, in front of the loudspeakers, the closest possible approach to the sound pressure wave at the microphones in the concert hall or studio.

Any deviation from this aim should be able to be measured and described in reasonably precise terms.

I accept that there are probably some aspects of sound reproduction as yet not understood but a great deal *is* known.

Musicality

When I read a reviewer saying that musicality, rather than technical specifications, is what matters, I picture the baby disappearing down the plug hole with the water.

If there is a clear difference between the sound of items of equipment then lab tests will unmask the reason. In the rare cases where this is not so, it is because the effect which the ears detect is not addressed by any of the standard lab tests.

There seems to be a marvellous opportunity in such cases to find out what is happening and devise a means of measuring it, not inventing vague terms to describe it.

Unless virtually perfect sound reproduction becomes available there will always be something for hi-fi gurus to pontificate about. The worst problems are rarely mentioned, perhaps because there isn't much to be done about them — such things as hiss, crackle and pop on records, which are still there even if you use a cartridge costing hundreds of pounds.

Still, subtle imperfections can be irritating even in the presence of more gross ones. A reviewer may well be influenced in judging between two good pieces of equipment by what aspect of the music he concentrates on or by the preferred position in the concert hall. An opera fan may be more concerned with the middle and high frequency response of a system while a rock fan might be interested in an extended bass response.

There is also a degree of fashion in the way in which subtle distortions are judged.

Differences

Where, then, does common sense break down? If you disregard the hype there are still cases of audible differences in equipment where you would not necessarily expect it.

For example, CD players are so much better than ordinary record players in so many respects that I would not expect to find a very noticeable difference between brands, unless one of them had a particular design fault such as a non-monotonic digital to analogue converter.

As I found with the CD player I reviewed last month this does not always hold in practice. Test discs, which I do not possess, would almost certainly have demonstrated a slight difference in frequency response between the two machines I was comparing.

Full time hi-fi reviewers for specialist magazines might be expected to have such discs available to enable them to quantify the differences.

Amplifiers are even more a case in point. At one time I thought that amplifier technology was well and truly sorted out. It was possible to obtain almost arbitrarily low harmonic distortion — far less than the best ears could detect.

Any amplifier which could do this was as useful as any other.

TIM

People still liked some amplifiers and not others and in due time transient intermodulation distortion was discovered. This obscure form of distortion would not show up on sinewave tests but could occur on some musical waveforms. This problem was tracked down and tests were devised to measure it.

So they should! If there is a genuine imperfection in the quality of one part of a hi-fi system, be the problem ever so slight, then it will be measurable. New tests may be needed but that's technological advance for you.

If an imperfection *cannot* be measured or detected except by panels of reviewers talking about the depth, width, height, and texture of the sound, one might be tempted to argue that it does not exist.

Andrew Armstrong

ONCE OVER

The biggest problem of installing a domestic intruder alarm system is wiring all the detectors to give protection over not only the access points (windows, doors, etc) but also the spaces in between — the rooms and corridors.

Short of covering your floor with pressure mats this means using some form of movement detector. The early such detectors were ultrasonic but these can be difficult to set up, they are easily triggered by inanimate moving objects (clock pendulums, fans and so forth) and they can drive pets wild!

So, more recent devices use infa-red light. Rather than use an emitter and detector arrangement (a broken beam detector) modern devices detect the heat (infa-red radiation) given off by a human body.

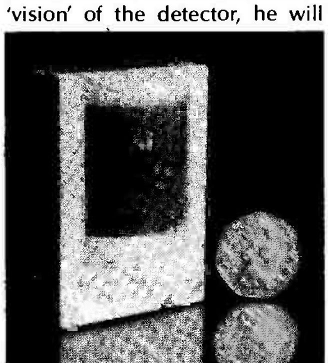
There are many of these 'passive' infa-red intruder detectors on the market. A recent addition to the range is the £30 RP33 from Riscomp.

The RP33 detector is tiny. With the exception of window switches, this is the smallest alarm system detector you could imagine. It measures only 80 x 60 x 40mm — about the size of a packet of 20 cigarettes.

This is not just a case of minaturisation for its own sake. The detector has to be mounted in direct line of sight with the area it is to protect so a small size makes it both easier and more discrete to mount on, say, a door frame.

The RP33 responds to *rapid changes* in the level of infa-red received and not absolute levels. This means your system won't be giving constant false alarms as the sun comes out.

To get the maximum use from this feature, a multi-facetted fresnel lens is mounted in the front of the unit. This splits the effective area covered into sectors. As an intruder crosses the field of 'vision' of the detector, he will move in and out of these sectors causing fluctuations in the infa-red radiation level received and triggering the unit.



The field of vision is also angled downwards by the fresnel lens. This means the unit can be usefully placed higher up on a wall — a more convenient position. The angle can be varied between 0 and 5 degrees by sliding the circuit board up or down inside the unit, changing the relative positions of the detector itself and the lens.

When an intruder is detected the unit switches an internal relay, opening a normally-closed contact. This is connected to your alarm control unit and triggers the alarm. A microswitch is also installed in the box which opens its contacts if the two halves of the case are separated — an excellent anti-tamper precaution.

The RP33 is powered by an external supply of anything between 9 and 15V and has its own on-board regulator. It draws only 14mA. A particularly useful function is a two minute delay after power-up during which the relay is kept firmly closed while the unit settles down.

To help you set up the RP33 a high brightness LED is mounted behind the lens which lights in sympathy with the operation of the relay. This can be switched off with a DIP switch inside the unit once correct operation has been confirmed.

Another switch puts the unit into a super sensitive mode for checking possible sources of false alarms during installation. To be honest, I couldn't get the unit to falsely trigger at all and so the extra sensitive mode just acted to extend the RP33's range.

This range is already impressive. Riscomp quotes 12m as the limit. It is difficult to find such distances in the average home but with a rather contrived arrangement of the RP33 at one side of my front room and myself busily 'intruding' at the far end of the corridor stretching opposite, I got reasonably reliable detection at a distance of about 48ft (14½m).

At £29.95+VAT the RP33 is not cheap. However, other makes of passive infa-red detectors also command this kind of price. The RRP33 has the advantage of a minute size and, by my experience, a very reliable unit.

Riscomp, 51 Poppy Road, Princes Risborough, HP17 9DB. Tel: (08444) 6326.

Malcolm Brown

KEYNOTES

Three months ago I said (somewhat jokingly) that MIDI retrofits for the piano are unavailable. I now have to eat my proverbial hat since Cristofori Ltd (an appendage of Syco Systems) offer just such a service.

Yamaha has also announced and demonstrated its MIDI Grand — a grand piano that has the operation performed at birth. Key sensing is performed electro-optically and provision is made to allow the keyboard to be split into two different MIDI outputs.

MIDI on a piano seems a strange concept at first but an immediate application lies in the generation of time code information for the purpose of editing within a recording context. Pressing a key gently will also allow MIDI data to be sent without the piano itself sounding which could be really useful for the MIDI control of outboard processing gear or to trigger the output of, say, a sampler.

Cost of the MIDI Grand is expected to be around £12,000 which is par for the course for an undoctored grand piano.

Computer Music

The concentrated media coverage of the proliferation of digital audio products has had the effect of eclipsing computer music. It is alive and well and staging a comeback.

Computer music means the generation or processing of sound (as opposed to MIDI control codes) using software running on a general purpose computer with a minimum of supplementary external hardware. The long history of CM has been blighted — by the phenomenally large ratio of computational time to sound time which results from the use of a common or garden computer. A time ratio of 1000:1 is typical for a university mainframe.

For this reason CM has been confined almost exclusively to research establishments, notably Bell Labs, Caltech, MIT, Stanford and UCSD in the US and IRCAM in Paris. Activity in this country has unfortunately been fairly low-key, due to scant funding.

The time ratio problem has two edges. First, the information flow rate of digital audio (44KHz or 48KHz) is high, especially when considerable signal manipulation is required. Secondly, there is a gaping chasm between the computational efficiency of a standard computer on the one hand and a dedicated hardware digital signal processor on the other.

Software simply cannot be traded for hardware if speed is of the essence. For example, an 8MHz 8086-based PC such as the Amstrad PC1512, fitted with an 8087 maths coprocessor will run an optimised machine code 1024-point FFT (fast Fourier transform) in 800ms. This compares with 11ms for a VME-bus board that is dedicated to performing FFTs and little else.

SPEED

The gap widens still further if the software is written in a compiled high level language (even the much vaunted C) rather than machine code.

Despite these problems, we are getting tantalisingly close to the computational speed required by a single processing channel or synth voice. There are now at least ten ranges of personal computers on the market based on Intel's 16MHz, 32 bit 80386 and supporting the addition of the matching 80387 coprocessor (not available yet but apparently near the end of the pipeline). Entry cost is under £3000 in the case of Apricot's Xeni-386.

Now, these machines are *fast*. Using machine code, you could implement a second order filter, or a simple flanging effect that handles the full audio bandwidth in real-time.

A second order filter for £3000 is no great shakes but if one can accept the concept of sub-real-time processing then the sky is the limit.

UNIX

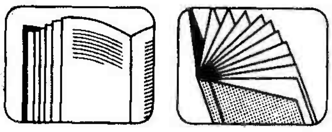
One of the exciting features of the new 80386 machines is that most of them will run various slimmed-down versions of the UNIX operating system which has hitherto been associated only with minis and mainframes.

In 1985 the University of California in San Diego (UCSD) made generally available a large collection of UNIX software from CARL, its Computer Audio Research Laboratory. This comprises over a hundred programs for sound synthesis, processing and editing written in C plus some FORTRAN programs for sound analysis.

The package is available for $100 from UCSD and comes on magtape complete with a manual. This software is public domain which means you can give (or sell) copies to anyone.

Bruno Hewitt

BOOKS



How To Use Special Purpose ICs by Delton T Horn (John Wiley & Son) £13.65.

There's definitely room for a good book to document the variety of 'general purpose' ICs but I wouldn't like to try to produce guidelines for what is a special purpose and what is general purpose.

There are two ways to work such a book. Either you look in detail at a relatively small number of ICs which between them give you a good diversity of function or you list a large range of devices.

In the former case, the aim is to make it possible to use the devices described without having to look at the manuafacturer's data sheet. In the later, the aim is to assist in the selection process, so that the book would limit the number of data sheets needed.

This book aims squarely for the middle ground and fails to do either job satisfactorily. Although it describes over 100 ICs in the first 12 chapters, it could hardly be described as comprehensive. At the same time there are few with enough information to allow you to start designing a circuit.

Indeed, there are so many errors in the text and circuit diagrams, I wouldn't rely on this book even if it did have sufficient information!

Another major problem with this book is due to its American origin. I found only 31 of these 100-plus devices available from my regular suppliers. So the books usefulness is severely limited.

Then there's the last six chapters. Here the author tries to cover digital devices, special purpose logic (tri-state gates and majority logic), multiplexers and demultiplexers and the like. This is a total waste of space — neither general nor specific enough to be of use.

What is the point in covering standard logic gates such as the 7413 and 7414 in a book on special purpose ICs? What earthly use are two paragraphs (and no more) on the Z80?

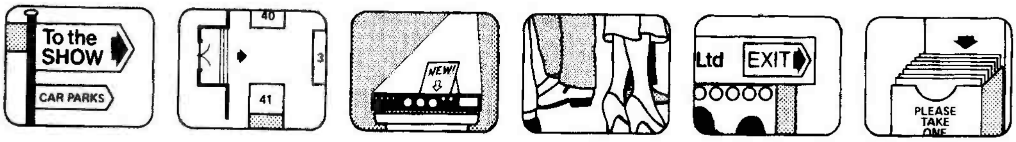
Really, the last chapters should have been left out and the space used to deepen the coverage elsewhere.

Finally, the book has an irritating habit of allowing diagrams to get out of step with the corresponding text.

Criticisms aside, this book does make an interesting read but it is ultimately frustrating because of the impossibility of using the information it gives.

Dave Bradshaw

BROWN GOODS SHOW



The Brown Goods Show, held at a number of hotels all over inner London, is primarily intended as an opportunity for trade buyers to see the current range of audio and TV equipment.

Inevitably there is a lot of the same old gear differently dressed but there are normally some genuinely interesting things as well.

This year, a sampling of a few of the stands (nobody could have the stamina to visit the lot) revealed a better crop than last year. Marantz was demonstrating a CDV (compact disc video) player by showing a disc of Star Wars. It was shown on an impressive large screen digital TV which, as far I could determine, contains a frame store to enable it to extract the full available definition from the PAL colour signal, as well as playing other tricks.

This answers my comment about last year's flatter squarer larger screens, that they did not address the real failing of current TV design. This technology doesn't come cheap though. The digital TV is a snip at £1200 and the CDV player is expected to sell at just under £500.

The watchword for Marantz midi systems is 'Audio Visual'. This means a compatible wiring system and a common remote control system for the traditional audio components plus CDV, videocassette recorder and television. The sound is intended to be good quality but not 'audiophile.' Many hi-fi buffs would scorn such fancy controls in any case.

I wonder how many people remember the old idea of sliding bias. This was intended to adjust the quiescent current of an audio amplifier to achieve virtually class A performance but with class B power consumption during the quiet bits. Marantz had on display a 'Quarter A' amplifier which I assume employs this concept. Perhaps it is coming back into fashion — the Sage Audio amplifier modules reviewed in ETI recently used a similar idea.

For the true hi-fi enthusiast one distributor was offering concrete loudspeakers, digital amplifiers and even amplifiers incorporating valves. the concrete loudspeakers, made by Avance, really did sound good. There was a noticeable lack of the resonance which is almost always present with wooden speaker cabinets.

The Luxman digital amplifier on show had three switched sampling rates, 32kHz for broadcast satellite programs, 44kHz for compact disc and 48kHz for DAT.

The idea is that if digital to analogue conversion is carried out inside the amplifier, the analogue signal is not disturbed by interference pickup or power supply noise generated by the motors in the CD player.

It is another amplifier from the Luxman range which features a triode valve in an intermediate amplifying position. I am inclined to think the valve has been put where it would be least nuisance, while providing a valuable sales gimmick!

For the delectation of all but the purest of audio purists, Sansui has produced a computer controlled graphic equaliser for about £450. This will automatically check the room response and set the graphic equaliser to compensate for it. Alternatively you can set the response, indicated on the fluorescent displays, with the use of a lightpen. This clever gadget can even measure the reverberation response of the room. If you have a small box of a room, not lined with acoustic tiles, this equaliser could be very useful.

Sansui was also showing a video mixer capable of insetting another picture on the monitor, or of different 'wipes' from scene to scene. To do this, the two video signals must be synchronised, so the mixer provides a sync output to genlock the video source to the main signal source, which may be a broadcast signal.

The mixer also has a switch position labelled 'digital art' which digitises the level of each colour giving some weird effects.

NEC showed 'the world's best CD player.' At a cost of almost £2000 it must be about the world's most expensive. They have taken the trouble to address technical problems which can subtly affect the sound.

To prevent electrical noise from the motors reaching the analogue output, the analogue circuits have a separate power supply and the digital signal is coupled to the four digital to analogue converters by optoisolators to prevent noise coupling via the earth.

So far as I can gather, the reasoning is that vibration of the chassis, caused by sound feedback from the loudspeakers, will force the tracking servos to compensate rapidly, which will load the power supply with audio frequency signals. If the analogue circuitry is operated from the same power supply as the servos and if this circuitry has less than perfect power supply rejection, a feedback loop is formed which can colour the sound slightly.

DAT was noticeable by its absence, but Tatung had a VHS recorder which can record four hours of video or eight hours of digital audio. As for DAT itself: 'Tatung is a reputable company and there are some legal questions about DAT, so we shall wait to introduce it here.'

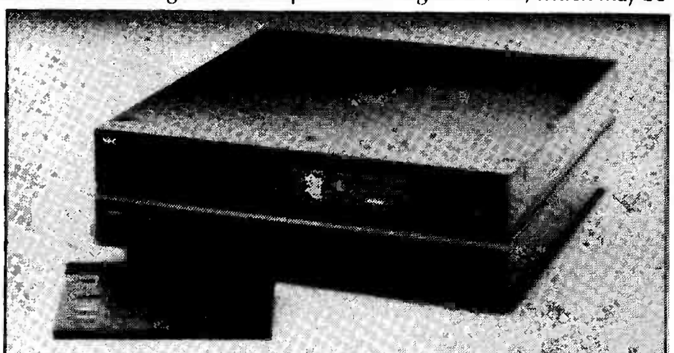
Tatung's television developments were for the most part logical steps forward rather than revolutionary improvements. Low reflectivity faceplates improve the contrast on new sets, teletext is enhanced by the addition of a page store and stereo sound is available.

One thing I noticed was that the television chassis was isolated from the mains, allowing connection to a stereo system. The isolation is accomplished not by a mains transformer but by a switched mode power supply with an isolated secondary winding.

Sharp had a couple of interesting televisions as well. A combined personal stereo and monochrome LCD television, the JC-AVIE, will almost certainly be in the shops when this is published, at a price of just under £200.

By the end of the year sharp plans to introduce a 3in colour LCD television at around £200. Will it have stereo sound and teletext?

Andrew Armstrong



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E8311-8	Moving Coil Pre-Preamp	F
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E8402-3	Modular Pre-amp Stereo Output	F
E8402-4	Modular Pre-amp Relay, PSU	F
E8402-5	Modular Pre-amp Tone Main Mono	F
E8402-6	Modular Pre-amp Tone Filter, Stereo	F
E8402-7	Modular Pre-amp Balanced Output	F
E8402-8	Modular Pre-amp Headphone Amp	F
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E8405-1	Auto Light Switch	F
E8405-2	ZX81 EPROM Programmer	N
E8405-3	Mains Remote Control Transmitter	H
E8405-4	Centronics Interface	F
E8405-6	Drum Synth	F
E8406-1	Oric EPROM Board	O
E8406-2	Spectrum Joystick	E
E8406-3	Audio Design RIAA Stage	G
E8406-4	AD Buffer/Filter/Tone	H
E8406-5	AD Headphone Amp	F
E8406-6	AD Preamp PSU	K
E8406-7	AD Power Amp	H
E8406-8	AD Power Amp PSU	J
E8406-9	AD Stereo Power Meter	F
E8406-10	AD Input Clamp	C
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E8408-2	EPROM Emulator	N
E8408-3	Infrared Alarm Transmitter	E
E8408-4	Infrared Alarm Receiver	F
E8409-1	EX42 Keyboard Interface	F
E8409-2	Banshee Siren Unit	F
E8410-1	Echo Unit	F

E8410-2	Digital Cassette Deck	N
E8410-3	Disco Party Strobe	H
E8411-5	Video Vandal (3boards)	N
E8411-6	Temperature Controller	D
E8411-7	Mains Failure Alarm	D
E8411-8	Knite Light	D
E8411-9	Stage Lighting Interface	F
E8411-10	Perpetual Pendulum	E
E8412-1	Spectrum Centronics Interface	F
E8412-4	Active - 8 Protection Unit	F
E8412-5	Active - 8 Crossover	F
E8412-6	Active - 8 LF EQ	F
E8412-7	Active - 8 Equaliser	F
E8501-3	Digital Delay (2 boards)	T
E8502-1	Digital Delay Expander	N
E8502-2	Data Logger	J
E8503-1	Combo Preamplifier	F
E8503-2	THD Meter mV & oscillator bds (2 boards)	K
E8503-3	THD Meter Mains PSU	F
E8504-1	Framestore Memory	M
E8504-3	Framestore Control	N
E8504-4	Buzby Meter	E
E8504-5	CCD Delay	F
E8505-5	Stereo Simulator	F
E8506-1	Audio Mixer Main	J
E8506-2	Audio Mixer PSU	F
E8506-3	Audio Mixer RIAA	D
E8506-4	Audio Mixer Tone Control	D
E8506-5	EPROM Prog MKII	O
E8508-1	RCL Bridge	N
E8508-2	EX42/BBC Interface	E
E8508-3	EPROM Emulator	L
E8509-1	Spectrum	F
E8509-2	Direct Injection Box	E
E8510-9	Sunrise Light Brightener	K
E8511-1	MTE Waveform Generator	H
E8511-2	Millifaradometer	H
E8511-3	Cymbal Synth	J
E8511-5	Chorus Effect	H
E8511-7	Enlarger Exposure Meter	F
E8511-8	Switching Regulator	E
E8511-9	Second Line of Defence	M
E8512-1	Specdrum connector	F
E8512-2	MTE Pulse Generator	H
E8511-3	Specdrum	L
E8601-2	Walkmate	L
E8601-3	MTE Counter-timer	M
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E8603-3	Sound Sampler Analogue Board	R
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E8604-2	Matchbox Amplifier	C
E8604-3	Matchbox Amp Bridging Version	C
E8604-4	MTE Analogue/Digital Probe	M
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E8605-3	Baud Rate Converter PSU Board	G
E8605-4	Portable PA	H
E8606-1	Midi-CV Converter Board	H
E8606-2	Midi-CV Converter PSU	D
E8606-3	Troglograph	F
E8606-4	80m Receiver	H
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E8610-3	Audio Analyser Display	H
E8610-4	Audio Analyser Power Supply	F
E8611-1	Audio Switcher (2 bds)	H
E8611-2	PLL Frequency meter (4 bds)	Q
E8611-3	Upgradeable Amp PSU	J
E8611-4	Call meter, main bd.	O
E8611-5	Call meter, interface bd	N
E8612-1	Bongo Box	J
E8612-2	Biofeedback monitor (Free PCB)	E
E8701-1	RGB Converter	F
E8701-2	Mains Controller	D
E8701-3	Flanger	H
E8701-4	Audio Selector main board	M
E8701-5	Audio Selector PSU	H
E8701-6	Tacho-Dwell	F
E8702-1	Ratemeter main board	K
E8702-2	Ratemeter ranging board	F
E8702-3	Photo Process Controller (3bds)	O
E8702-4	LEDline display board (2 off)	K
E8702-5	LEDline PSU and controller (2 bds)	G
E8703-1	Capacitometer	F
E8703-2	Geiger Counter	L
E8703-3	Credit Card Casino	E
E8704-1	BBC micro MIDI interface	L
E8704-2	ETIFaker patch box	H
E8704-3	24Hr. Sundial	E
E8705-3	MIDI Keyboard keyswitch boards (3 boards)	W
E8705-4	Batlite	C
E8705-5	Budget Power Meter	E
E8706-1	Hi-fi Power Meter	N
E8706-2	MIDI Keyboard CPU	U
E8706-3	MIDI Keyboard Front Panel	O
E8706-4	Flame Simulator	G
E8707-1	MIDI Keyboard PSU	H
E8707-2	Telephone Alarm	J
E8707-3	Nuclear Strategy Simulator	J
E8708-1	Remindalite	F
E8708-2	Rear Wiper Alarm	G
E8708-3	Rev Counter	F
E8708-4	Car alarm	F
E8708-5	Knight Raider	J
E8709-1	Boiler Controller	G
E8709-2	Amstrad Sampler (2 bds)	P
E8709-3	Portable PA	G
E8709-4	EEG Monitor (2 bds)	L

OOPS!

Capacitometer (March 1987)
The circuit diagram (Fig. 1) should show pin 1 of IC1 connected to 0V. The zener diode (ZD1) should be connected between the junction of R10/R11 and 0V. The PCB foil is correct.

BBC Micro MIDI Interface (April 1987)
IC7 and IC8 (the 6N139 opto-isolator ICs) are missing from the parts list. In the Buylines section it is incorrectly said that these are available from Electromail as part 302-126. The isolator is available from Maplin as part number RA59P. Resistors R8,9 are missing from the overlay diagram (Fig. 4). These are located in the two pairs of pads below IC6. There should also be no 0V connection to the MIDI IN sockets, only to the OUT sockets (pin 2) so as to prevent earth loops.

Power Meter (May 1987)
The foil for the budget power meter was given 50% full size on the foil pages. The correct size foil appeared in the June issue.

MIDI Master Keyboard (June 1987)
The foils for the CPU board were given 64% full size on the foil pages. Photocopies of the correct size foils can be obtained by sending a SAE to the Editorial address.

Flat Alarm (June 1987)
In the circuit diagram Q2 is shown as an NPN transistor. It should be a PNP device as given in the parts list. IC4 is given in Fig. 2 as a 74LS260 and C5 as 470n. They should be 74LS132 and 4μ7 as in the parts list. R13 is incorrectly given as 280R in the parts list instead of 270R.

Nuclear Strategy Simulator (July 1987)
The bridge rectifier (BR1) on the overlay diagram has no polarity markings. It should be positioned with the positive at bottom left, connected to the track which connects to IC8 IN and C4 positive.

Telephone Alarm (July 1987)
In the component overlay (Fig. 2) IC1 and IC2 should be swapped. In addition the capacitor to the right of IC1/2 is C1 and the inductor between them is L1. The unmarked resistor to the left of L1 should be a wire link.

Kappellmeisters (July 1987)
The position of the speaker port in the front panel was omitted from Fig.2. This should be a 7¼x4½in ellipse centred across the panel with its top edge 2½in below the panel top.

Knight Raider (August 1987)
In Fig.1(a) pins 4 and 5 of IC1 are swapped. IC2-3 show the correct pin-out.

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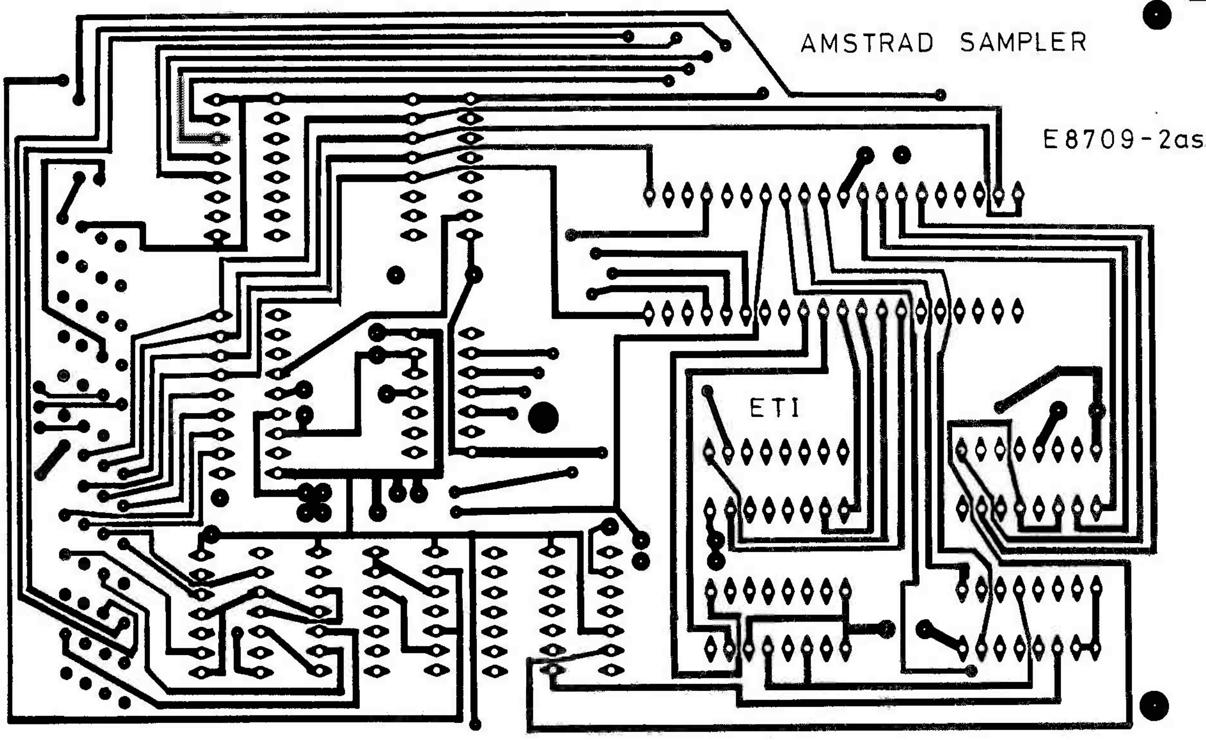
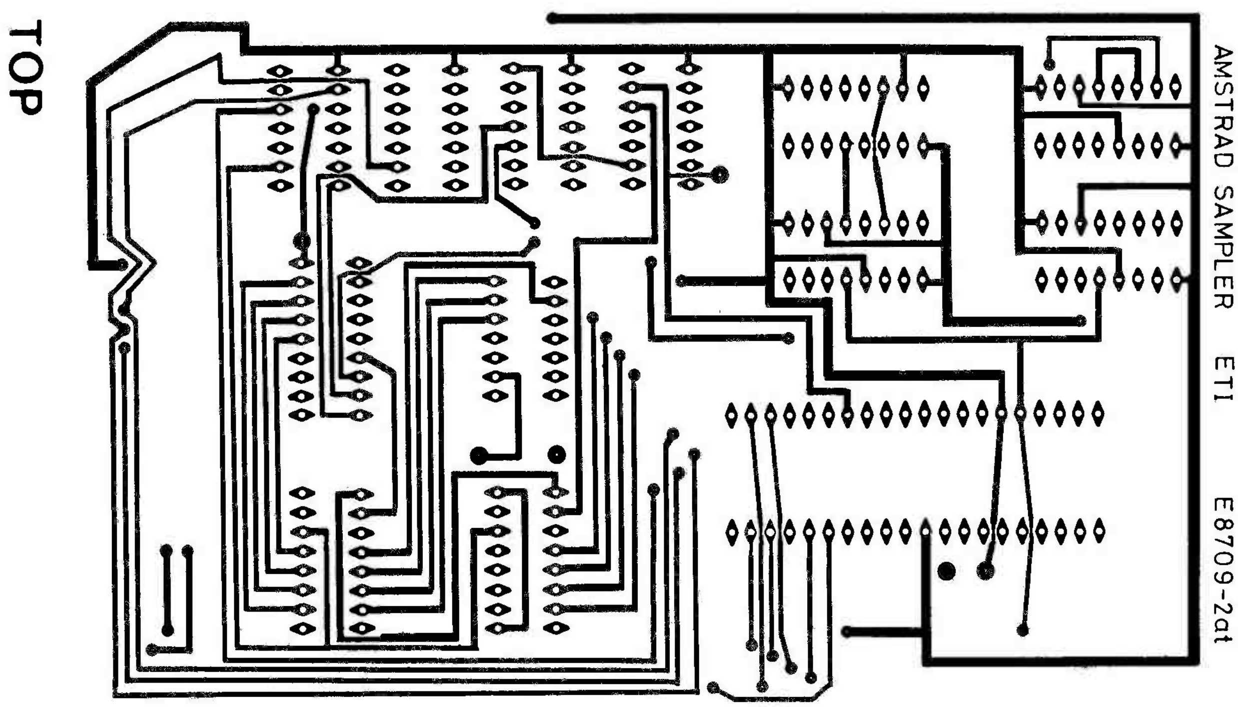
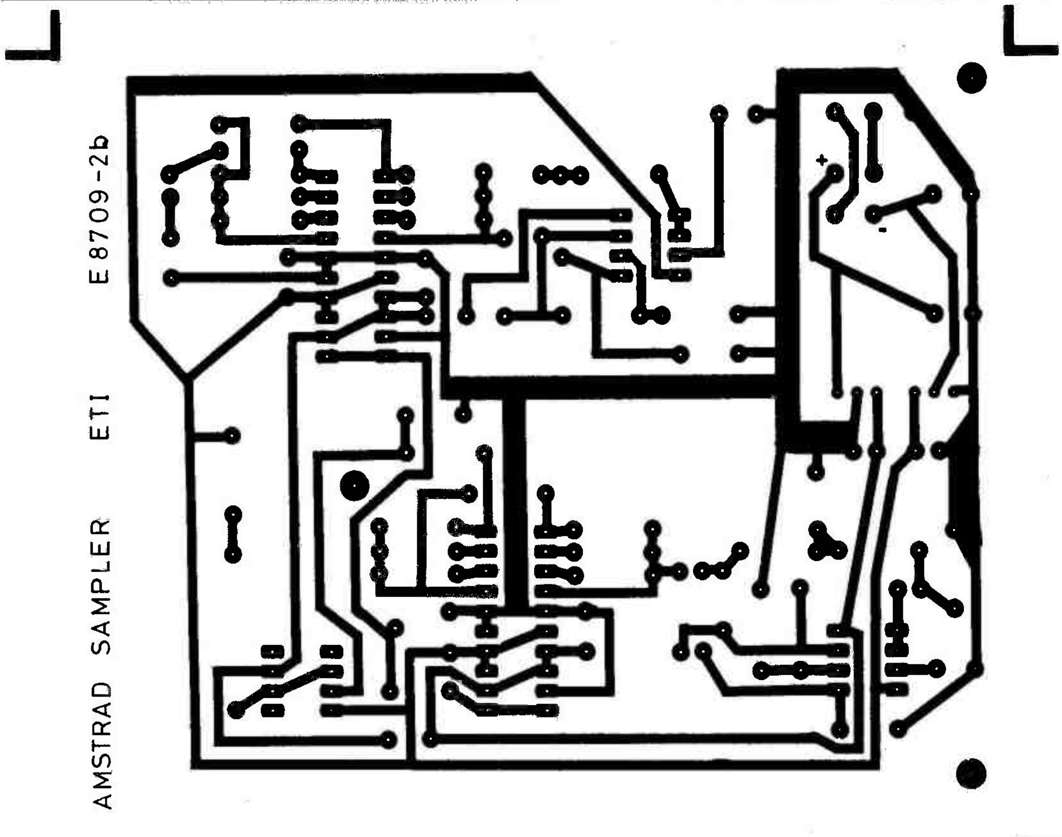


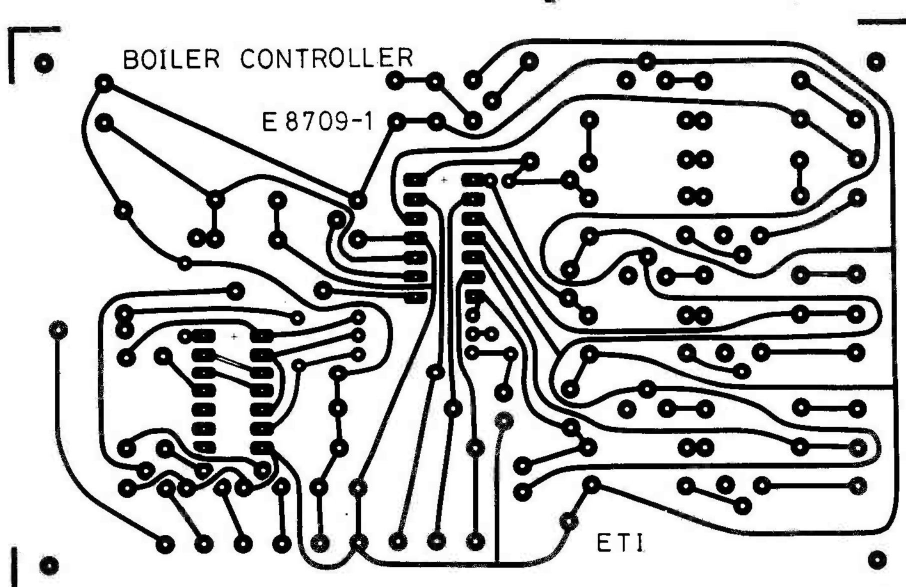
The sampler digital board solderside foil.

The Amstrad sampler digital board topside foil.

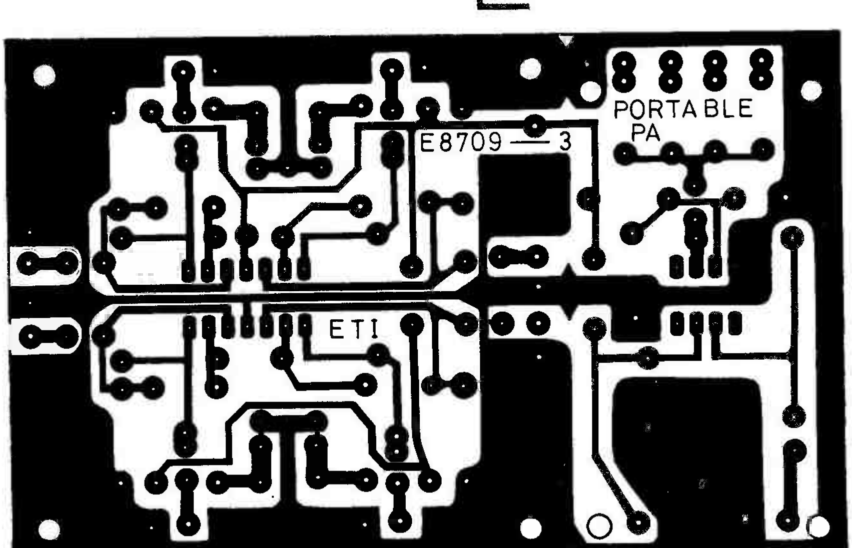




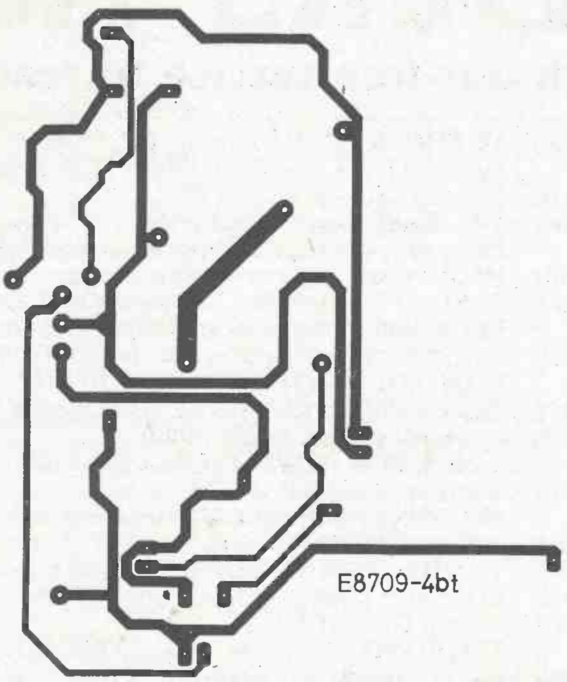
The Amstrad sampler analogue board.



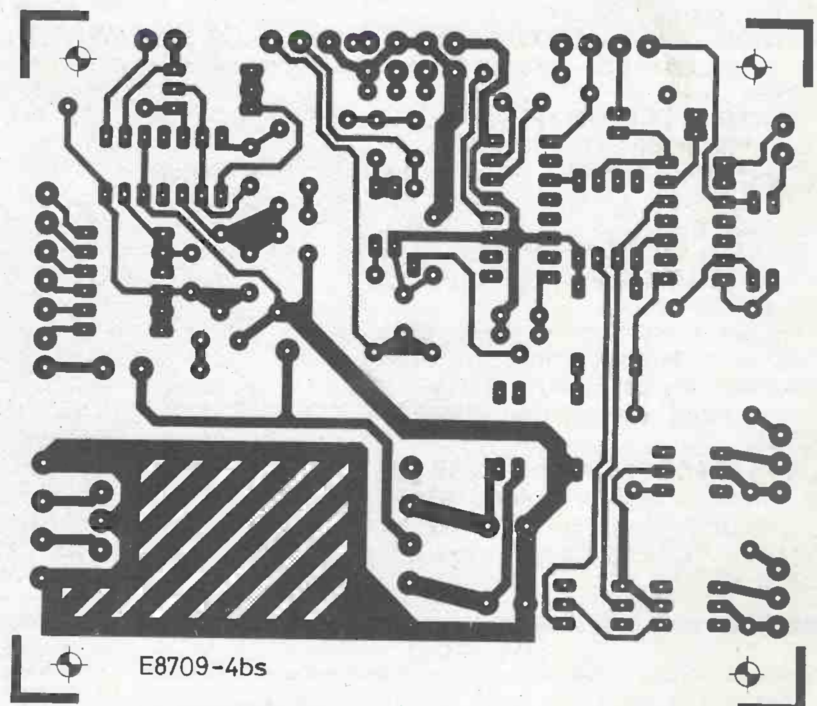
The foil for the boiler controller PCB.



The Portable PA foil.

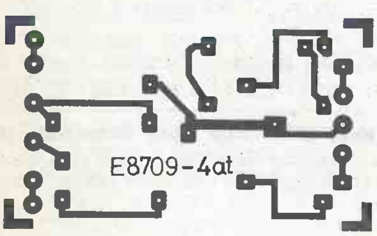


The EEG monitor main board topside foil.

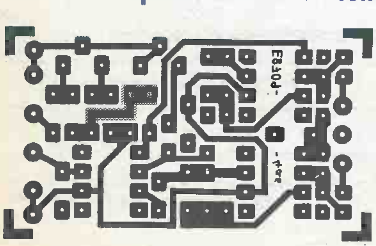


The EEG monitor main board solderside foil.

The EEG bio-amplifier topside foil.



The EEG bio-amplifier solderside foil.



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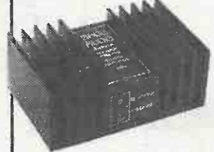

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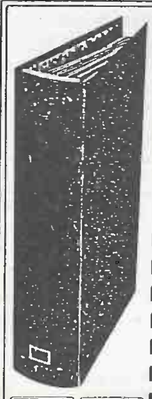

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