BRAINWAVE MONITOR TO BUILD

3D TELEVISION  PORTABLE PA  HYBRID'S MICRO MUSIC SYSTEM
BOILER CONTROLLER  AMSTRAD SOUND SAMPLER

AUDIO  COMPUTING  MUSIC  RADIO  ROBOTICS
**OMP POWER AMPLIFIER MODULES**

OMP POWER AMPLIFIER MODULES enjoy a world-wide reputation for quality, reliability and performance. Each module is made from high-grade alloy metal and includes a professional 300W stereo amplifier module, with low distortion, High and Hi-Fi, etc. Supplied ready built.

**OMP100 15W Bi-Polar Power output 110 vat R.M.S. into 4 ohms. Frequency Respon-
15Hz - 30KHz - 3dB, THD 0.01%. S.R. 118dB. Sens. for Max. output 500V/M, E/P 115 x 99 mm. PRICE £33.99 & £30.00 P&P.**

**OMP/MF100 Mos-Fet Power output 110 vat R.M.S. into 4 ohms. Frequency Respon-
15Hz - 100KHz - 3dB, Damping Factor 80, Slew Rate 450V/μS, T.H.D. Typical 0.002%, Input Sensitivity 500V/M. S.R. 120dB. Price £39.99 & £30.00 P&P.**

**OMP/MF200 Mos-Fet Power output 200 vat R.M.S. into 4 ohms. Frequency Respon-
15Hz - 100KHz - 3dB, Damping Factor 250, Slew Rate 50V/μS, T.H.D. Typical 0.002%, Input Sensitivity 500V/M. S.R. 130dB. Price £62.99 & £35.00 P&P.**

**OMP/MF300 Mos-Fet Power output 300 vat R.M.S. into 4 ohms. Frequency Respon-
15Hz - 100KHz - 3dB, Damping Factor 300, Slew Rate 50V/μS, T.H.D. Typical 0.002%, Input Sensitivity 500V/M. S.R. 130dB. Price £79.99 & £45.00 P&P.**

**NOTE:** Mos Fets supplied are standard 1000Vdc and 1000Vrms. Thermal performance is guaranteed.

VU METER: Available with built-in glass panel. Price £29.99 & £20.00 P&P.

**LOUDSPEAKERS 5" to 15" up to 400 WATTS R.M.S. Cabinet Fixing in stock. Huge selection of McKenzie Loudspeakers available including Cabinet Plans. Large S.A.E. (29p) for details.**

- **15" 80 VATTS R.M.S. Hi-Fi/Disco.**
  - 15" voltage drive. Res. Free £32.99 & £25.00 P&P.
  - 15" 80 VATTS R.M.S. Hi-Fi/Disco.**
  - 15" voltage drive. Res. Free £32.99 & £25.00 P&P.

- **18" 120 VATTS R.M.S. C15200 High Power Subwoofer.**
  - 18" voice coil. Grilled bidirectional horn. Res. Free 45kHz. Real 1.5kHz. Sens. 98dB. Price £60.00 & £40.00 P&P.

- **20" 120 VATTS R.M.S. C15200 High Power Subwoofer.**
  - 20" voice coil. Grilled bidirectional horn. Res. Free 45kHz. Real 1.5kHz. Sens. 98dB. Price £60.00 & £40.00 P&P.

**BURGLAR ALARM**

Better to be "Alarmed" then tired. Thandar's famous "Bur2" Alarm System. Superior microphone control. Suited for all windows, doors with interconnection between modules. SUPPLIED FULLY GUARANTEED.

Control Unit - houses microphone radio, range up to 12 metres adjustable by sensitivity control. Three position key operated 15A circuit breaker - armed 30 second exit and entry delay

Indoor siren - Electronic 85dB Siren. Freq. 100dB output.

Outdoor Alarm - Electronic swept freq. 95dB output. Ideal for a tamper-proof hard metal device.

Both the control unit and outdoor alarm contain rechargeable batteries which provide a minimum of 6 months protection during mains failure. Power requirement 200/500 Volt AC 60Hz. Expandable for multiple windows, patio doors etc. Complete with instructions.

SAVE £139.00 Ideal price £229.89

**BKE PRICE LIST**

- **120 VATTS 1/0db. Price £149.99 per pair.**
- **120-200 VATTS 102db. Price £199.99 per pair.**

**OVP 19" STEREO RACK AMPS**

Professional 19" cased Mos-Fet stereo amps. Used the World over in clubs, pubs, disco, etc. With twin toroidal power supplies. XLR connections.

- **MF60 Fan cooled.**
  - Three models (R.M.S. into 4 ohms). Input Sensitivity 75mV. S.R. 110dB. Price £169.00 Securicon £228.85 Delivery £322.00 (100 + 300W). 300 110 + 300W. £322.00

**BPB295 ELECTRONIC TURNTABLE**

- Electronic speed control. 45-33-15. Sens. 84dB, 86dB.
- Stereo phono stage.
- Minus variable pitch control. Bidirectional. All models include Toroidal power supply.
- MF60 100 + 100W. £169.00 Securicon £228.85 Delivery £322.00
- MF400 200 + 200W. £228.85 Delivery £322.00
- MF400 300 + 300W. £322.00

- **PIEZO ELECTRIC TWEETERS - MOTOROLA**

Join the Piezo revolution. The low dynamic mass (voice coil) of a Piezo tweeter produces a much more consistent response with a lower distortion level than cones. The Piezo tweeter is constructed of high grade materials and is designed to function as a high audio frequency source with a wide range of applications. The Piezo tweeter is ideal for use in stereo systems, Home Theatre, etc.

- **TYPE A (KSN2036A) 13" round with protective wire mesh, ideal for bookshelf and medium sized Hi-Fi speakers. Price £48.50 each."**
- **TYPE B (KSN1005A) 1" super horn: For general public address use or for medium size loudspeakers. Price £69.99 each."**
- **TYPE C (KSN1005A) 1-1/4" 4" wide dispersion horn. For use with medium sized loudspeakers. Price £99.99 each."**
- **TYPE D (KSN1205A) 2" 6" wide dispersion horn. For use with larger loudspeakers. Price £129.99 each."**
- **TYPE E (KSN1308A) 3" horn-tweeter with built-in crossover. Price £199.99 each."**

**STEREO DISCO MIXER**

STEREO DISCO MIXER with 2 x 5 band's A graphic equalizers and twin 10 segment dual 40 watts. 300 turntables. Many different outputs. Includes 5 inputs with individual faders providing a precise combination of the full range. 3 Turntables (Mag), 3 Miic. 4 Line plus Ja. With talk over switch. Headphone Monitor, Pan, L & R Master Control Outputs. Outputs 750W S. 360 x 360, 360 x 360, £134.99 & £90.00 P&P.

**B. K. ELECTRONICS DEPT**

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR Tel: 0702-527572
3D TV .......................... 13
James Archer finds developments in stereoscopic TV are hotting up and looks forward to the day when all TV is in lifelike 3D.

CMOS OSCILLATORS .......... 18
Neville Croucher explains how a few cheap CMOS logic gates can be used to make a basic electronics building block.

SOFTWARE DESIGN  .......... 20
Mike Barwise is first in with a look at designing hardware with single chip FIFO memories and it's first out in ETI.

THE HYBRID MUSIC SYSTEM .24
Malcolm Brown serenades a music synthesiser add-on for the BBC micro which rivals the big boys' custom chip, state-of-the-art instruments in all but price.

AVOIDING FEEDBACK .......... 27
Vivian Capel can be heard loud and clear right to the back of the magazine thanks to the application of a few simple ideas on PA equipment and installation.

PORTABLE PA .................. 31
Alan Watling is not Mr. Universe but he can carry his cheap effective sound reinforcement system into the hall using just one finger.

THE ETI EEG MONITOR ...... 34
Electroencephalograph is an extremely long word but that hasn't stopped Paul Chappell from developing a most powerful brainwave monitor. Develop you mental powers and become rich and famous with ETI.

AMSTRAD SAMPLER .......... 41
You'll have n-n-no end of fun with this sophisticated sound sampler from John Jameson for the Amstrad CPC range of micros.

BOILER CONTROLLER ......... 47
There's no need to blow hot and cold with ETI. Build this controller for your heating system and you need only be in hot water when you want it.
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 LSI/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 Metaltratt multimeter manufacturers to use 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 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 two's complement of that signal is fed to the other half. Circuits for both 8 and 12-bit arrangements are shown using AD7533 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 to large cabinets for VRs and IGBTs, 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 8888 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 drive.

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

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

Made by Astec in Hong Kong, the AA271 regulator provides up to 2A output and will operate with input voltages from 8-24V DC. Overcurrent and thermal protection are included and Greenwell 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 AA271 is available from Greenwell Electronic Components, 443 Millbrook Road, Southampton SO1 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 compared with 57% 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 recruit new 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 the number of jobs advertised in the run-up to the general election and the political uncertainty may have made employers more reluctant than usual to advertise.

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

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 Sub-Board of the Society for the Electrotechnical and Environmental 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 at the IEE, Savoy Place, London WC2R OBL. 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 standard 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 identify them by combinations of initials. For example, CD-CDV would indicate a machine capable of playing 12cm LD 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.

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 15μS/hr (micro- Sieverts/hour) to 6.6Sr. 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 0.5μS/hr to 18mS/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 2ZE. Tel: 01-486 6837.

Surface Mount Or Bust

A doping 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 SW1 5QQ. Tel: 01-211 3608.

Flatter, Squarer And Slightly Larger

Flat screen televisions are nothing new but at present they are available only in small sizes, usually 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 electroluminescent 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.

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

following the excellent response to our special offer on the Oryx Portaso (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 247) or 2.6mm (GCT 48) and there is also a 'hot knife' sealing bit (GCT 56). All types have a built-in catalytic converter and simply plug 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 Park, 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 as COTS as the new Alternative Catalogue. Launched amid a wealth of snide remarks about the supposed shortcomings of longer-established company's products, this 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 TTS. Tel: (0462) 401 122.

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 5, the set of tables relating cable current carrying capacity, 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 pater 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-fis throughout their working lives!
**TEST INSTRUMENTS**

UK's LARGEST IN-STOCK RANGE

DIGITAL MULTIMETERS

- **KT8905 (3) 1000V/AC 600V/DC 60kΩ 200mA**
  - £175.00
- **KT8905 (3) 1000V/AC 600V/DC 60kΩ 200mA**
  - £175.00
- **KT8905 (3) 1000V/AC 600V/DC 60kΩ 200mA**
  - £175.00

SCOPES

- **HAMEG** - all with optional testers
  - £432.00

POCKET INSTRUMENTS

- **KT8905 (3) 7 Range Digital Cap Meter**
  - £119.00
- **KT8905 (3) 7 Range Digital Cap Meter**
  - £119.00
- **KT8905 (3) 7 Range Digital Cap Meter**
  - £119.00

BENCH DIGITAL MULTIMETERS

- **Test Digital Multimeter 100V/AC 100V/DC 20mA**
  - £29.95
- **Test Digital Multimeter 100V/AC 100V/DC 20mA**
  - £29.95
- **Test Digital Multimeter 100V/AC 100V/DC 20mA**
  - £29.95

COUNTERS & TIMERS

- **All Bench Models**
  - £99.00
- **MM540**
  - £29.95
- **MM540**
  - £29.95

SIGNAL GENERATORS

- **200 MHz generator**
  - £285.00
- **200 MHz generator**
  - £285.00
- **200 MHz generator**
  - £285.00

**MAKE YOUR INTERESTS PAY!**

More than 6,000 students, throughout the world, have found it worth while to attend an ICS study course! Many students have more fun out of their ICS than in 600 hours experience in home study courses and are the largest correspondence school in the world. You may stay at your own pace, and where you choose. Why not ask us about the study course in the guidance of expert personalities. Find out how we can help you. Visit the ICS website today for your FREE INFORMATION PACK on the course of your choice. (Tick one box only!)

- **Electronics**
  - Radio, Audio and Video
- **Engineering**
  - Basic Engineering (City & Guilds)
- **Electrical Engineering**
  - Car Mechanics
- **Electrical Contracting**
  - Computer Programming
- **GCE** over 40 O' and A' level subjects

**ORDER BY POST OR PHONE • OPEN 6 DAYS A WEEK FOR CALLERS**

**HENRY'S**

404 Edgeware Road
London W2 1ED
01-724 0323

**AUDIOKITS PRECISION COMPONENTS**

The ETI VIRTUOSO PREAMP (featured ETI July–Sept & Nov 86)

**THE TRUE ENTHUSIASTS PREAMP**

- Supertative sonic performance
- Versatile case with space for mods, other circuit designs etc.
- MC stage, upgraded, uses transistors of lowest noise currently available.
- Two MM stage circuit with passive RIAA equalisation.
- High performance optional tone stage.
- Circuits and PCBs can be adapted for other audio uses, low noise mic preamps, active crossovers, filters, balanced/unbalanced amps, mixers etc.
- High performance power supply board with up to 4 positive and 4 negative regulated outputs - ideal for many other audio projects.
- All components incl. case & PCBs available separately.

- Complete kits cost a fraction of similar quality ready built preamps, saving hundreds of pounds.

Visit the Audiokit stand at THE HIFI SHOW
HEATHROW Penta Hotel September 19-20 '87

For details, please send 9" x 4" SAE ( oversees 3 IRCs) to:

**AUDIOKITS**
6, Mill Close, Borrowash, Derby DE7 3GU

**RACKZ 19" RACK MOUNTING EQUIPMENT CASES**

This new range of 19" rack mount equipment cases have been designed with economy and versatility in the mind.

- All cases are made from a black powder coated steel and are supplied with a built-in rack case, and are engineered to handle 19" rack units.

The equipment cases feature a front panel with a 19" rack case, and are engineered to handle 19" rack units.

**ORDER CODE**
- **H1**
- **H2**
- **H3**
- **H4**

**PRICE**
- £175.00
- £199.00
- £199.00
- £199.00

**MAKE YOUR INTERESTS PAY!**

More than 6,000 students, throughout the world, have found it worth while to attend an ICS study course! Many students have more fun out of their ICS than in 600 hours experience in home study courses and are the largest correspondence school in the world. You may stay at your own pace, and where you choose. Why not ask us about the study course in the guidance of expert personalities. Find out how we can help you. Visit the ICS website today for your FREE INFORMATION PACK on the course of your choice. (Tick one box only!)

- **Electronics**
  - Radio, Audio and Video
- **Basic Electronic Engineering (City & Guilds**
  - Exam (City & Guilds)
- **Electrical Engineering**
  - Car Mechanics
- **Electrical Contracting**
  - Computer Programming
- **GCE** over 40 O' and A' level subjects

**ICS**

International Correspondence Schools, 322/324 High St, Sutton
Surrey SM1 3PB, Telephone: 01-769 2984 (24 hours)

**AUDIOKITS PRECISION COMPONENTS**

The ETI VIRTUOSO PREAMP (featured ETI July–Sept & Nov 86)

**THE TRUE ENTHUSIASTS PREAMP**

- Supertative sonic performance
- Versatile case with space for mods, other circuit designs etc.
- MC stage, upgraded, uses transistors of lowest noise currently available.
- Two MM stage circuit with passive RIAA equalisation.
- High performance optional tone stage.
- Circuits and PCBs can be adapted for other audio uses, low noise mic preamps, active crossovers, filters, balanced/unbalanced amps, mixers etc.
- High performance power supply board with up to 4 positive and 4 negative regulated outputs - ideal for many other audio projects.
- All components incl. case & PCBs available separately.

- Complete kits cost a fraction of similar quality ready built preamps, saving hundreds of pounds.

Visit the Audiokit stand at THE HIFI SHOW
HEATHROW Penta Hotel September 19-20 '87

For details, please send 9" x 4" SAE ( oversees 3 IRCs) to:

**AUDIOKITS**
6, Mill Close, Borrowash, Derby DE7 3GU

**RACKZ 19" RACK MOUNTING EQUIPMENT CASES**

This new range of 19" rack mount equipment cases have been designed with economy and versatility in the mind.

- All cases are made from a black powder coated steel and are supplied with a built-in rack case, and are engineered to handle 19" rack units.

The equipment cases feature a front panel with a 19" rack case, and are engineered to handle 19" rack units.

**ORDER CODE**
- **H1**
- **H2**
- **H3**
- **H4**

**PRICE**
- £175.00
- £199.00
- £199.00
- £199.00
Show Their Skills

Young Designers

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 year's 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 Golliath wheel chair 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 greatest 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 winning 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 if a person 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 (the of Open Channell 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 3317.

- 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 digital 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 4SV.

- 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 WIR 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, Temperfields, 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 giveaway is a pack of twelve full-spec transistors and for next month the company is planning a SSS 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.

- 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 ½" (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 RU (1½"/44mm), 2U (3½"/88mm), 3U (5¼"/133mm) and 4U (7¾/178mm). 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 BS7 3RY. Tel: (0275) 823 963. Trade enquiries welcome.
Are we about to create a race of Superman?

The ETI Brainwave Monitor must be the most astonishing project ever to appear in the pages of an electronics magazine. It will allow you to hear your brainwaves and judge the relative levels of various activities. It will also help you to control your mind more effectively, to be at peak performance in all situations.

Don't my mind work perfectly well when left to its own devices?

If you've ever been confused, unsure of yourself, unable to make a decision or to impress people at interviews, you know perfectly well that it doesn't. Your mind (and everybody else's) is full of bad habits, inappropriate responses, feelings of inadequacy... all pulling you down. Why should you put up with it?

Mind training sounds like hard work!

It can be. If you want to do it the hard way, go and study under a Zen master for fifty years or so, and you'll get there in the end! With the brainwave monitor it takes no effort at all. Just the opposite in fact—trying is the one thing you mustn't do!

How do I start?

At first you use the monitor's internal indicator to exercise your mind. In direct mode you improve the time percentage; in integrate mode you concentrate on the amplitude. After that, the choice of direction is yours. With the Alpha Plan you can reach the core of your personality to root out the weaknesses and replace it with inner strength. Otherwise you can just enjoy the feelings of pleasure and clear headedness that alpha training brings, or the creativity and imagery of the beta state.

A friend told me I can use brain power to control lights and things. I can't believe it!

As a matter of fact, you can do more than that! The interface sockets on the monitor allow you to turn lights on and off, control toys and electrical gadgets, play computer games... all with your mind! Are we about to create a race of Supermen? Only time will tell.

The Brainwave Monitor is featured in the September, October and November 1987 issues of ETI. The approved parts set contains: two PCBs, all components including three PMI precision amplifiers, shielded box for screening the bi-amplifier, attractive instrument case with tilt feet, controls, switches, knobs, plugs and sockets, leads and materials for electronics, full instructions for assembly and use.

Parts are available separately. We also have a range of accessories, professional electrodes, boxes, etc. Please send a stamped, self-addressed envelope if you want the article. Otherwise, an SAE + £2 will bring you lists, construction details and further information.

---

**Complete Parts Sets for ETI Projects**

**Mains Conditioner**

**FEATURED IN ETI, SEPTEMBER 1986**

It is astonishing how many people buy a Bush telephone, and then a second Bush telephone, and then buy another Bush telephone. This is the largest set upgrade you will ever, and probably the most effective.

Our approved parts set consists of PCBs, all components, crystal, enters wire, fixing led, test response VFD, and full instructions.

**KNIGHT RAIDER**

**FEATURED IN ETI, JULY 1987**

The ultimate boxing effect for your living room! Designed for the user who is looking for the maximum amount of experience, without any pressure or compromise. Featuring a powerful dual channel audio system and the ability to be used with a variety of sources. A definite must for the enthusiast who wants to experience the full impact of boxing. The Knight Raider can be fitted to any car. It makes an excellent=form all parts and instructions.

**MATCHBOX AMPLIFIER**

**FEATURED IN ETI, APRIL 1986**

The ultimate amplifier for your home entertainment system. The Knight Raiden can be fitted to any car. It makes an excellent to-ge for the tester.

**POWERFUL AIR IONISER**

**FEATURED IN ETI, JULY 1986**

Have you ever considered the possibility of improving your concentration and putting an end to your mind 'fog'? Although some of the claims may be exaggerated, there is increasing evidence of the benefits that can be gained from using air ionisers. Although some of the claims may be exaggerated, there is increasing evidence of the benefits that can be gained from using air ionisers.

**PROJECT BOX**

**PROJECT CASE WITH POR BATTERY COMPARTMENT**

**LM2917 EXPERIMENTER SET**

**RUGGED PLASTIC CASE**

**SILVER SOLUTION**

This powerful silver plating compound must be the greatest revolution in electronics since the IC. Just wipe on with a cloth to plate PCB tracks, connectors, wire, component leads, etc. with a layer of pure silver. Essential for RF circuits.

Large bottle (150ml) Silver Solution £11.20 + VAT

Small bottle (50ml) Silver Solution £4.80 + VAT

---

**PROJECT BOX**

**PROJECT CASE WITH POR BATTERY COMPARTMENT**

**LM2917 EXPERIMENTER SET**

**RUGGED PLASTIC CASE**

---

Prices shown are exclusive of VAT, so please add 15% to the order total. UK postage is £1.60 on any order. Carriage and insurance for overseas orders £5.50. Please allow up to 14 days for delivery.
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: 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 (0275) 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 (0484) 25091.

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

Interelec — 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.

Testex '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: 0286 815 226.
These kits are designed to produce a high intensity light pulse at a variable frequency of 1.1 Hz. This kit also includes a trigger circuit to trigger the light from an external voltage source (if a loudspeaker is an opto-isolated). Instructions are also supplied on timing the light on a manual sequence. This is a useful tool in photographic applications or when a warning signal is needed. The kit includes all necessary components, an IR receiver, a transistor, and a relay. It is easy to assemble and can be used in a variety of applications, such as a warning signal or a security application. The kit requires only a little work to assemble, and can be used as a trigger for a more realistic effect.

**DELIVERY POLICY**
- Domestic orders over £20 delivered free of charge to any address in the U.K.
- Domestic orders over £50 delivered free of charge to addresses outside the U.K.
- International orders are charged at current rate.
- Orders placed by 5:00 PM UK time are despatched the same day, with no exceptions.
- Orders despatched to Europe arrive within 2-3 days, while orders despatched to the rest of the world arrive within 4-5 days.

**ORDERING INFORMATION**
- ELCAM LTD 15 BOSTON RD LONDON W7 2SJ
- Tel: 01-567 8910
- **FREE BPP on orders over £20 (UK only), otherwise add 75p + VAT. Overseas orders (Europe £2.75, Elsewhere £6.50). Send cheque to BPP Box 112, Access No. 0243 001708.**
- Local authority and export orders welcome. Goods by return subject to availability.
Hearing has 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 Plesam 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 to which 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.

Equallised 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 synths. 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 developments’ 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 yourselves.

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 practised 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 lilypad now please?

ETI

As you step onto the beach at Torremolinos on your summer holidays 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.
THE SPECIAL DISTRIBUTOR FOR SPECIAL AMPLIFIERS

ILP have long been recognised as manufacturers of top quality amplifiers. All ILP products are built to extremely high specification for the ultimate in hi-fi performance. They're unique in being completely encapsulated with integral heat sinks, and can bolt straight onto the chassis. They're also extremely robust, ensuring high levels of reliability as well as performance.

ILP Amplifiers are now available through Jaytee. The UK Distributor with the availability and service to match the quality of the amplifiers.

POWER BOOSTER AMPLIFIERS

The C15 and C1515 are power booster amplifiers designed to increase the output of your existing car radio or cassette player to 15 watt rms. C15...15 watt rms...£10.85 C1515...10 + 15 watt...£10.85

ILP LOUDSPEAKER

Power...350 watt rms. Size...12 inches. Impedance...8 ohms. Range...20 Hz to 5 kHz. NEW £78.61

FOR FREE DATA PACK PLEASE WRITE TO OUR SALES DEPT.
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.

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 composes 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 five 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.

**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.

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 local 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.

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 demonstration 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 has 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 passed 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 transmitted in the normal way and the receiver uses a normal cathode ray-tube in front of which is placed a
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 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 than photography was in the late 1890's and it looks as though we shall have to wait a long time 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!

---

**Back Again!**

**ONYX PORTASOL**

**Available From ETI Readers’ Services**

**Portable Gas Soldering Iron**

**Finitely Controlled Soldering Anywhere! Completely Self-Contained Gas Powered Soldering Iron**

**Features**

- Totally portable
- Powered by ordinary lighter fuel
- Up to 60 minutes continuous use
- Adjustable temperature equivalent to 10-60 watts
- Top temperatures to max. of 400°C
- Refill in seconds
- High performance — small size 173mm x 99mm
- Meets all safety standards

**Offer Price**

- Only £15.35
- £17.50 + P&P

**Order Code ROSL 1**

**Also Available at Special Prices to ETI Readers**

- ROSL 2 Onyx 15 — Electronic assembly iron £6.95 + 60p P&P
- ROSL 3 Onyx 30 — General purpose iron £12.50 + 60p P&P
- YMR 47 Onyx TC 15 — 35 watt iron £17.50 + £1 P&P
- YMR 100 Onyx TC 100 — 100 watt iron £26.50 + £1 P&P
- ROSL 4 Soldering iron stand £4.95 + 50p P&P

ETI Readers Services, 9 Hall Road, Maylands Wood Estate, Hemel Hempstead, Herts, HP2 7BH.

---

**Fig. 7 The field-masking synchronous shutter system.**
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 \(1/(1.2CR)\).

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 \(R_s\) 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 \(R_s\) of 2k\(\Omega\) 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.
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.
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 résumé 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 data 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).

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 MK450/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 on is 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 and can be retransmitted 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 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 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.

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 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 (at a lot faster than it can be transmitted) and the EMPTY flag (under interrupt) is waited for.
FEATURE: Hardware Design

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, 70ns 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 commute 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 SEPTEMBER 1987

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.

Fig. 6 Using two FIFOs in a commutator arrangement to achieve higher writing speeds.
Optional disassemblers for 68000, 8086/8088, Z80, 8085, 6502, 6809.

- Pitch Control
- Rewind/forward
- 12V DC Operation
- Fits standard BSR unit
- High quality ceramic cartridge supplied
- Grounding for added safety

£29.97 (plus p&p)
Magnetic cartridge: £19.96

**All the above units are "O" model event & are designed to be reliable under the most rigorous & testing sound system, disco & PA situations.**

**HIGH QUALITY TEST EQUIPMENT.**

**Audio Generator.**
- Output: ±2000 in 8 ranges
- 10kHz frequency
- 200kHz max
- Source: Audio
- Variable output 0-20V
- 10kHz square wave
- Suitable for testing all types of audio units

£199.97 (plus p&p)

**Toshiba XT 446SK**
- Personal Cassette Radio
- Wooden case
- "High" & "Low" volume control
- English & Japanese manual
- 1-year warranty

£239.97 (plus p&p)

**Vestax Engine 352**
- 3-channel engine
- 80W/90W/100W output
- Multi-level EQ
- 1-screen display
- 2-second delay

£199.97 (plus p&p)

**Atlantic VNE 605**
- 10 Band Graphic
- 3 Deck Inputs
- 2 Tape Inputs
- 20 watts peak
- Strobe

£199.97 (plus p&p)

**Phone MX 7700**
- Digital mixe
- 16 channels
- 16 inputs
- 16 outputs
- Digital dimmer

£199.97 (plus p&p)

**Digital Meter**
- Model: No. KD0038
- 30 Band Multi meter
- Side switch for single range use
- 9999 counts

£199.97 (plus p&p)

**Radio MX 7700**
- Telex
- Telegraph
- FM
- AM

£199.97 (plus p&p)

**Graphic Equalizer**
- 10 Band Graphic
- 200 watts
- 200MHz
- 200kHz
- 20kHz

£199.97 (plus p&p)

**Crosstalk Tester**
- Complete range
- 10MHz
- 1MHz
- 100kHz

£199.97 (plus p&p)

**Digtal Delay Generator**
- Delay range
- 10ms/20ms/50ms/100ms
- Multilevel delay
- Delay range
- 1000ns

£199.97 (plus p&p)

**Band Equalizer**
- 10 Band Graphic
- 200 watts
- 200MHz
- 200kHz
- 20kHz

£199.97 (plus p&p)

**Microphone Override**
- 10-Band Graphic
- 200 watts
- 200MHz
- 200kHz
- 20kHz

£199.97 (plus p&p)

**27 Band Mono Graphic**
- 200 watts
- 200MHz
- 200kHz
- 20kHz

£199.97 (plus p&p)

**10 Band Stereo Graphic**
- 200 watts
- 200MHz
- 200kHz
- 20kHz

£199.97 (plus p&p)

**Power Amp**
- 150Watt
- 600Watt
- 900Watt

£199.97 (plus p&p)

**Stereo Power Amp**
- 150Watt
- 300Watt
- 600Watt

£199.97 (plus p&p)

**Monophonic Power Amp**
- 150Watt
- 300Watt
- 600Watt

£199.97 (plus p&p)

**Graphic Equalizers**
- 4 Band Graphic
- 10 Band Graphic
- 20 Band Graphic

£199.97 (plus p&p)

**Cross-overs & Crossovers**
- 2 Way Crossover
- 3 Way Crossover

£199.97 (plus p&p)

**Graphic Analyzers**
- 32 data channels
- 100MHz maximum sampling rate
- 5ns glitch capture
- 4 level trigger sequencer with event count and delay
- Non-Volatile memory for data and set-ups

£2950 + VAT

**Logic Analyzers**
- TA3000
- TA2000

£4795 + VAT

Up to 112 channels.
100MHz Timing; 20MHz State.
Multilevel conditional triggering.
State/Timing cross-triggering and correlation.
Easy to use soft-key control.
Optional disassemblers for 68000, 8086/8088, Z80, 8085, 6502, 6809.

**Etan Electronics Limited**
- London Road, St. Ives, Huntingdon, Cambridgeshire PE17 4JL, England.
- Telephone (0480) 64646 Telex 32250 Test.

**The Logical Choice**

**Thandar Electronics Limited**
- Huntingdon Road, Huntingdon, Cambridgeshire PE17 4JL, England.
- Telephone (0480) 64646 Telex 32250 Test.

**Etan September 1987**
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 enthusiasm I greeted the Acorn Music 500 back in 1985. Here at last was a reasonably priced synthesiser capable of extracting a fairly 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 proved 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 keyboard 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...
**LINSLEY-HOOD SUPER HIGH QUALITY AM/FM TUNER SYSTEM**

Our very latest kit for the discriminating enthusiast of quality sound and an aesthetic feel for lovers of design by John Linsley-Hood. A combination of ultra high quality components, best tested circuitry described as "Electronics World's best!" and easy assembly described in "Wireless World". This complete unit is said to match our 300 Series amplifiers. Novel circuit features in the FM section include fully built pre-amp and trimmer followed by a response down to DC and advanced sample and hold stereo decoder together make a tuner which sounds better than the rest of the high-priced excels but, thanks to Linsley-Hood, runs easy to build. The simple circuitry and with it's selectable bandwidths provides the best possible results from Long and Medium wave input, so necessary in these days of split programming. If you want the very best in real hi-fi listening then this is the tuner for you. Since all components are selected by the designer to give the very best sound this tuner is not cheap, but in terms of it's sound it is incredible value for money. For all needs, four versions are available with variations up to the full AM/FM model, with any unit being upgradable at any time. Send for our fully illustrated details.

**STUART TAPE RECORDER CIRCUITS**

Complete stereo record, replay and bias system for real hi-fi recorders. These circuits will give studio quality with a good tape deck. Separate sections for record and replay give optimum performance and allow a third head monitoring circuits giving very low noise and drift. Full 250mV input and output levels. These circuits are ideal for bringing that old reel-to-reel recorder back to life. VFL600 Vertical front loading cassette deck, £13.95 each. Reprints of original Articles £1.10 no VAT.

**LINSLEY-HOOD 300 SERIES AMPLIFIER KITS**

Superb integrated amplifiers kits derived from John Linsley-Hood's article in "HiFi News" Ultra easy assembly and set-up with sound quality to please the most discerning listener. Ideal basis for any domestic sound system if quality matters to you. Buy the kit complete and save pounds off the individual component prices.

K300-35, 35 Watt. Discount price for Complete Kit £38.70 K300-45, 45 Watt. Discount price for Complete Kit £42.36 RH4AS. Reprints of Original Articles from 10th June News £1.05 no VAT.

**HIGH QUALITY REPLACEMENT CASSETTE HEADS**

Do your tapes lack brilliance? A worn head could be the problem. Fixing one of our replacement heads could restore performance to better than new! Standard mountings make fitting easy and our T1C Test Cassette helps you set the azimuth spot-on. We are the actual importers which means you get the benefit of lower prices on prime parts. Compare us with other importers and see! The following is a list of our most popular heads, all are suitable for use on Odyssey machines and are ex-stock.

H616 Sendalloy Super Head. This is the standard head fitted as standard equipment on most decks... £6.60 H616 Sendalloy Super Head. This head offer can be fitted. Longer life than Permalloy, higher output but flat to 20kHz, flat to 20kHz. £14.60 H616 Sendalloy Super Head. This head offer can be fitted. Longer life than Permalloy, higher output but flat to 20kHz, flat to 20kHz. £14.60 H616 Sendalloy Super Head. This head offer can be fitted. Longer life than Permalloy, higher output but flat to 20kHz, flat to 20kHz. £14.60

**HART METAL TAPE ERASE HEAD. Full double gap. £2.25**

For all the details of this and many other Electronics Projects, get in touch with us.

---

**FOR ALL THE DETAILS OF THIS MANY OTHER ELECTRONICS PROJECTS, GET IN TOUCH WITH US.**

---

**49 TUNER**

- **SUPER HIGH QUALITY AM/FM TUNER SYSTEM**
- **STUART TAPE RECORDER CIRCUITS**
- **LINSLEY-HOOD 300 SERIES AMPLIFIER KITS**
- **HIGH QUALITY REPLACEMENT CASSETTE HEADS**

---

**FOR ALL THE DETAILS OF THIS MANY OTHER ELECTRONICS PROJECTS, GET IN TOUCH WITH US.**
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 high level now 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 face 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 125 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 175 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.](image)
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.

**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 pattern 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
FEATrUE: Feedback

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 with 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 it 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 large 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.

Zenith Electronics

Kits — Modules — Hardware

The following are examples of our proven product designs in kit form:

- Miniature FM Transmitter; 60—145Mhz. Kit £6.95, R/Built £8.95.
- 10 Channel Variable Speed Running Light; Drives LEDs or mains lamps. Kit £14.97.
- 3 Note Electronic Door Chime unit: 9 volt operation; 3 melodious tones; variable frequency. Kit £9.93.
- 300 Watt Light Dimmer unit for 240 volt mains lights. Kit £6.95.
- 4 Code Digital Code unit plus Key Pad—select own code; 9 volt. Kit £15.95.
- VU Meter 10 LED indicator; —5 to +12dB range. Kit £12.59.
- Automatic light controller; automatically turns on and off lights at pre-set times and triggered by darkness. Kit £25.08.
- Mains Wiring and Metal Detector; complete with case. £11.00.
- Digital Clock module, 12—24 hour timing, LED type—£17.49, or LCD type—£22.80.
- Amplifier Power Meter; 10 LED indicator from 0-25—100 Watt input—9 volt operation. Kit £9.52.
- Light sensitive relay unit: variable sensitivity trigger control; senses light or dark.—selectable. Kit £8.45.

ALL KITS CONTAIN FULL INSTRUCTIONS: P.C.B.s AND COMPONENTS.
ALL PRICES INCLUDE VAT AND POSTAGE & PACKING.
OVERSEAS ORDERS ADD 10% TO ABOVE PRICES.
PLEASE SEND CHEQUE OR POSTAL ORDERS WITH ORDER.
S.A.E. For FREE Data Pack.

Zenith Electronics, 4 Cortlandt Business Centre, Hailsham, E. Sussex, U.K. BN27 1AE.
Tel: 0323 847973 Dept 2.

TRNAE TRANSFER OFFICERS

Are you looking for a secure shore-based job which offers a rewarding career in the forefront of modern telecommunications technology, then consider joining GCHQ as a Transfer Radio Officer. Training involves a 32 week residential course, (plus 6 weeks extra if you cannot touch type) after which you will be appointed RADIO OFFICER and undertake a variety of specialist duties covering the whole spectrum from planning to operation.

We offer you: Job Security — Good Career Prospects — Opportunities for Overseas Service — Attractive Salaries... and much more.

To be eligible you must hold or hope to obtain an HNC/G/M in a telecommunications subject with an ability to read more than 20wpm.

Anyone with previous relevant radio operating experience is also eligible.
The Civil Service is an equal opportunities employer.

Salaries: Starting pay for trainees is age related to 21 years. For those aged 21 or over entry will be at £6,072. After training an RO will start at £7,756 rising by 5% annual increments to £12,376 inclusive of shift and weekend working allowance.

Write or telephone for an application form to—

GCHQ
THE RECRUITMENT OFFICE, GCHQ, BROOM 4/106 BLACKBURN, PRIONS ROAD, CHELTENHAM, GLOSSOP, OR TELPHONE (0242) 721329/3

ETI SEPTEMBER 1987

29
FINDING LOVE

through Dateline

When you join Dateline you meet so many people that if you choose to stay on your own, you know it's not through lack of opportunity. The problem is, of course, that faced with that special person you've always hoped to meet, the joys of the single life fade fast.

Dateline arranges over half a million introductions each year — people of all ages, all walks of life, and from all over the country join Dateline and are matched specifically to the type of person they want to meet in the area they choose.

WHY DATELINE?

○ Dateline has operated a computer dating service in this country since 1966, many years longer than any other company, and is now the largest and MOST SUCCESSFUL computer dating service in the world.

○ Our experience over more than 20 YEARS has created a professional, reliable and confidential service which we are proud to offer our clients.

○ We want Dateline to be successful for you so take great CARE that your requirements are met.

○ Dateline is the only national computer dating company to allow you to choose the area you would like your dates to come from.

○ Dateline provides the BEST VALUE FOR MONEY service, with more people to meet than any other agency.

○ Despite having the LARGEST membership, Dateline is not just a box number service. You can call at our offices to discuss your membership and to read the thousands of letters from happily married Dateline members; or telephone us on 01-938 1011. We are always happy to help.

Dateline is a member of the Association of British Introduction Agencies
29 Manchester St., London W1.

Over the years Dateline has been featured many times by press, radio and television and has been acclaimed by many thousands of clients who have found happiness through our services. If you are interested in learning what Britain's largest, longest-established and most successful computer dating service can do for you, complete this coupon and post it today to: Dateline, 23 Abingdon Rd., London W8 6AH.

FREE Computer Test to Find Your Ideal Partner

1. Do you consider yourself...
   - Shy...
   - Extrovert
   - Adventurous
   - Family type
   - Clothes-conscious

2. Indicate which activities and interests you enjoy by placing a 'Y' (yes) or 'N' (no) in the appropriate box. If you have no preference, leave the column blank.
   - Pop music
   - Fashion
   - Pubs
   - Pets
   - Folk music
   - Traveling
   - Cinema
   - Good food
   - Politics
   - Classical music
   - Art/Literature
   - Sport
   - Science or technology
   - Creative writing/painting
   - Poetry
   - History/Archaeology
   - Conversation

3. Your sex...
   - put M or F
   - Your height...
   - Your weight...
   - Your age...
   - Your occupation...

4. Your address...

5. Your name...

Send today to: Dateline, Dept ETE
23-25 Abingdon Rd.
London W8
01-938 1011
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 around 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

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.
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. 3 The construction of the Portable PA.
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 Verobase 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 IC3) 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 from 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.
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.

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.

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

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 1877 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 must 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 \textit{alpha} waves. The second type were smaller, faster waves ranging from about 18 to 50Hz, associated with alertness. Berger called them \textit{beta} waves. More many types have since been identified, some distinguished by their frequency range and some by their shape. Here are the main ones.

\textbf{ALPHA} These are waves in the region of 8 to 12Hz with amplitudes up to 100µV. The shape varies from person to person, 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.

\textbf{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.

\textbf{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 imaginative 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.

\textbf{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 \textit{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 \textit{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 \textit{occipital} area of your brain (or as close as you can get to it from outside). This area is concerned,
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 practice 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.

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 (O) 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 output 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 to 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.

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...
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.

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

**Testing**

The bio-amplifier is best tested before soldering to its supporting pins and certainly before it is sealed into the screening case! 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
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 manufacturer's 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 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 1in 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 1/4in baton parallel to one edge of the square and 1/4in away from it. At the centre of the opposite edge and 1/4in 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 1/4in 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-chloridizing or re-positioning.
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 rhythmic bleeping sound — your heart beat.

Make up a week salt solution with one teaspoon of salt to about ½ 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 O, (Fig. 2c) and one somewhere between T₁ and T₂. 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 rhythmic 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!
PROJECT

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.

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

IC1, 12 decode the address bus of the computer such that the I/O map is as follows:

& F8E4 PIO data
& F8E0 PIO control
& FAE4 PIO data
& FBE4 PIO control
& FBE2 Output Buffer
& FBE1 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 86) 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 and also generates a clock at 1/4 sample rate for mode 2 NMI generation.

Sample rate = 2000/(PITCH+64)/(OCT+1) KHz
C = PITCH<15, OCT=0,1,3,7
Filter = Clock<300/(FILTER)
FILTER = 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 25us 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 16x8bit FIFO acts as a buffer, taking in bursts of 8 bytes from the CPU and giving them out one byte at a time to the DAC.

Note that if you write your own machine code for the system, the Amstrad's 300ohm interrupt normally causes the lower ROM to page in. If you have placed an interrupt routine at &0039 or simply disable maskable interrupts. This is handled correctly by both published and full software.

IC3 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 (IC5s) 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 NMI's 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.

POA bit 0-3 Filter
bit 4-6 Octave (000,001,011 or 111 valid)
bit 7 X — see below

POB 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/B
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 the other for playback. 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 (i) and the input signal that occurs if the frequency spectrum of the input signal exceeds 1/2. By putting the input signal through a high order low pass filter, frequencies above 1/2 can be removed (or at least severely attenuated) without affecting frequencies below 1/2. 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 the quality and 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 &F8E4,255
30 OUT &F8E4,0
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 ear-piece. 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 Vero pins, 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 welding into a box. Powering the analogue board on your bench supply is advisable — connect as though the PSU were the transformer.

Do not 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 relay 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.
ETI strongly recommended which allow than other audio connectors housed to remove to the edge of Verobox size 207x122x77mm. The pot, mains transformer, fuse and audio connectors were fastened to the case and hardwired to each other. 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.
PROJECT: Amstrad Sampler

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)

**SECCSTATS,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.

---

**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 (£3.95) 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.

- 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...
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 IC5. 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 circuitry around IC5c is used to generate time delays of several minutes before switching off the pump with RL1. 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 bypasses 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. If problems are still experienced a combination of reducing the value of the sensor resistors (R1,13,20) to a minimum of 2kΩ, increasing C1 and C4 and using screened wire to the sensors should eliminate them.

The prototype installed in the author's airing cupboard.

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 slider 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 five lines passing to the control unit. If the two original wires run next to each other at some point, use 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 which 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 gluing 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
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 bypassed 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.

**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.
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, 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 the gap. However, the lack of Alan Sugar's company name on the list of backers must do more harm than any cost 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. You will recall Mr. Public's interest in Amstrad, Amstrad is the company which does for hi-fi what Henry Ford did for the motor car. Amstrad licensed 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 may rightly think that for Alan Sugar to take his company out of BSB there must be a reason. Initially, the problem is one of PR. Mr. Public may rightly think that for Alan Sugar to take his company out of BSB there must be a reason.

Two things cause personal doubts regarding any possible direct broadcast by satellite television system in Britain. The first is simply that Alan Sugar, 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 the gap. However, the lack of Alan Sugar's company name on the list of backers must do more harm than any cost 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. You will recall Mr. Public's interest in Amstrad, Amstrad is the company which does for hi-fi what Henry Ford did for the motor car. Amstrad licensed 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 may rightly think that for Alan Sugar to take his company out of BSB there must be a reason.

Two things cause personal doubts regarding any possible direct broadcast by satellite television system in Britain. The first is simply that Alan Sugar, 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 the gap. However, the lack of Alan Sugar's company name on the list of backers must do more harm than any cost 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. You will recall Mr. Public's interest in Amstrad, Amstrad is the company which does for hi-fi what Henry Ford did for the motor car. Amstrad licensed 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 may rightly think that for Alan Sugar to take his company out of BSB there must be a reason.
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 but also 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 infra-red light. Rather than use an emitter and detector arrangement (a broken beam detector) modern devices detect the heat (infra-red radiation) given off by a human body.

There are many of these ‘passive’ infra-red intruder detectors on the market. A recent addition to the range is the E30 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 miniaturisation 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 infra-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, the large 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 infra-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 angle the fresnel lens makes with the detector itself and the lens.

When an intruder is detected the unit switches an internal relay, opening a normally-closed contact. This is then connected to the 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/off switch. It has only a 14mA current which is a useful unit which will keep a battery powered system running for a long time.

To help you set up the RP33 a bright green 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. However, other makes of passive infra-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, Princess Risborough, HP17 9DE. 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 a MIDI Grand — a grand piano that has the operation performed at birth. Key pressing is performed optically and provision is made to plug a keyboard to the piano to split into two different MIDI outputs.

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

The cost of the MIDI Grand is expected to be around £12,000 which is par for the course for an underdressed 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 held promise of CM has been fulfilled — 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 machine.

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 IBM 3886-based PC, such as the Amstrad PC152, 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 (such as C) rather than machine code.

Despite these problems, we are getting tantalisingly close to the computational speed required by a single processing channel per 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 pipe line). Entry cost is under £3000 in the case of Apricot’s Xenon 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 £300 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 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 magnetic tape complete with a manual. This software is public domain which means you can give (or sell) copies to anyone.

Bruno Hewitt
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 devices in which there are three or four 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 manufacturer's data sheet. In the latter, the aim is to assist in the selection process, so that the book would look like 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 1000 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 1000-plus devices available from my regular suppliers. So the book's 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 743 and 7414 in a book on special purpose ICs? What earthly use are two paragraphs (and no more) on the 740?

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.

Criticism 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

The Brown Goods Show, held at...
The initial development system has 64K of RAM, a 4 MHz 286A CPU, parallel AS/400 keyboard interface, VDU interface (TV set or monitor), and a floppy drive interface for up to 4 drives. Any size (including 8 double density) can be used, but our 1 Megabyte 8" drives are proving very popular because they can fit into the system rack, and (they only cost £94.00 each + VAT). CAP Plus is available, giving access to thousands of "public domain" programs.

The system can be described as "future proof" because it uses plug in 4.5" and 8" cards in an "industrial quality" 19" SU rack. We have been established since 1970, and this system was first made in 1977 so (unlike almost all other computers) it has stood the test of time.

Send two second class stamps, or telephone for a detailed descriptive leaflet, specification, prices, etc.

Greenbank
Greenbank Electronics (Dept T9E), 460 New Chester Road, Rock Ferry, Birkenhead, Merseyside L42 2AE.
Tel 051-645 3391

SPECIAL OFFER
FOR SPECTRUM AND BBC MICRO OWNERS

Now your computer can take control for an affordable price. These tried and trusted interfaces from DCP Micro developments are offered at £29.95 off the normal price.

Both units are extremely easy to use from both Basic and assembler/machine code and are supplied ready built and complete with all the documentation you need.

To order by post fill in the form below (or a copy) and send it with your remittance to ASP READERS SERVICES (RO ETS/6) 9 Hall Road, Maylands Wood Estate, Hemel Hempstead, HP2 7BH

Please make cheques payable to ASP Ltd. Overseas orders add £5 (Interspec) or £10 (Interbee) for airpost. Access and Visa card holders can also place their order by phone on (0442) 42121 Allow 28 days for delivery.

Please supply..... Interspecs (RO ETS) at £29.95 plus £1.95 p&p per order.
Please supply..... Interbees (RO ETS) at £49.95 plus £1.95 p&p per order.

Name
Address

Please debit my ACCESS/VISA card No.

To the sum of

£

Signed:

__________________________

ETI SEPTEMBER 1987 55
ETI PCB SERVICE

Build your projects in style with a properly designed PCB.

Use the form below (or a photocopy) for your order. Please fill in all parts of the form. The board reference number tells you when the PCB foil was published. The first two numbers are the year, and the next two the month. The number after the dash indicates the particular project in that issue. The terms are strictly cash with order. Make cheques payable to ASP Ltd. We cannot accept official or company cheques. We can supply a pro-forma invoice if required. Such an order will not be processed until payment is received. Orders can also be made by telephone on (0442) 41221 for Access and Visa card holders. Please allow 28 days for delivery.

TO: ETI READERS' SERVICES DEPARTMENT
Argus Specialist Publications Ltd,
9 Hall Road, Hemel Hempstead,
Herts HP2 7BH

Please supply:

<table>
<thead>
<tr>
<th>No. required</th>
<th>Board reference number</th>
<th>Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td></td>
<td>C</td>
<td>£1.80</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>D</td>
<td>£2.50</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>E</td>
<td>£3.23</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>F</td>
<td>£4.00</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>G</td>
<td>£4.75</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>H</td>
<td>£5.50</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>I</td>
<td>£6.62</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>J</td>
<td>£7.20</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>K</td>
<td>£8.00</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>L</td>
<td>£10.00</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>M</td>
<td>£13.10</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>N</td>
<td>£15.80</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>O</td>
<td>£17.90</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>P</td>
<td>£20.00</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>Q</td>
<td>£23.00</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>R</td>
<td>£25.90</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>S</td>
<td>£29.00</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>T</td>
<td>£32.20</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>U</td>
<td>£35.80</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>V</td>
<td>£38.50</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>W</td>
<td>£40.70</td>
</tr>
</tbody>
</table>

Price (inc VAT) £

POSTAGE & PACKING £ 0.75p

TOTAL ENCLOSED £ . p

ORDER TO BE SENT TO: (BLOCK CAPS PLEASE)

Name ...........................................
Address ........................................
...............................................
...............................................
Postcode ......................................

(Make cheques payable to ASP Ltd)
ACCESS and VISA credit card orders can be taken on (0442) 41221 (office hours only).

EB107-1 System A Disc Input bd .......................... F
EB107-2 System A Preamp Main ......................... K
EB108-1 System A Power Amp .......................... L
EB109-2 System A PSU .................................. F
EB201-2 Infat Guard .................................. C
EB202-5 MM Stage Disc Preamp .......................... (Tilsbrook) G
EB206-5 Logic Lock .................................. F
EB208-1 Playmate Practice Amp 3bds ..................... SA1 K
EB212-1 ELCB ........................................ F
EB301-2 Analogue to digital conv (ZXB1) .......... Spectrum E
EB305-3 Dual Audio Power Supply,....................... Linsley Hood G
EB305-5 Balanced Input Preamplifier ................. F
EB307-2 Flash Trigger-sound or FR ..................... F
EB308-1 Graphic Equaliser ....................... V/ Oct/Chnl M
EB308-2 Servo Fail-safe ......................... NICAD Charged/Regenerator F
EB310-3 Typewriter Interface-EX42 ...................... F
EB311-1 Mini Drum Synth .............................. F
EB311-8 Moving Coil Pre-Pream ......................... F
EB312-3 Light Chaser EPROM Controlled .. Spectrum K
EB402-1 Speech Board ................................ M
EB402-2 Modular Preamp Disc Input....... Mono ............... F
EB402-3 Modular Preamp Stereo ... Output ............... F
EB402-4 Modular Preamp Relay, ... PSU ............... F
EB402-5 Modular Preamp Tone Main ... Mono ............... F
EB402-6 Modular Preamp Tone Filter, ... Stereo ............... F
EB402-7 Modular Preamp Balanced .... Output ............... F
EB402-8 Modular Preamp Headphone .... Amp ............... F
EB404-2 Mains Remote control Receiver .......... F
EB404-1 Auto Light Switch ......................... F
EB405-2 ZXB1 EPROM Programmer ................. N
EB405-3 Mains Remote Control ... Transmitter .......... H
EB405-4 Centronics Interface ......................... F
EB405-6 Drum Synth .................................. F
EB406-1 Onic EPROM Board ......................... O
EB406-2 Spectrum Joystick ......................... E
EB406-3 Audio Design RIAA Stage ................. G
EB406-4 AD Buffer/Filter/Tone ..................... H
EB406-5 AD Headphone Amp ......................... F
EB406-6 AD Preamp PSU ......................... K
EB406-7 AD Power Amp .............................. H
EB406-8 AD Power Amp PSU ......................... J
EB406-9 AD Stereo Power Meter ..................... F
EB406-10 AD Input Clamp ......................... C
EB407-1 Warlock Alarm ............................... M
EB408-2 EPROM Emulator ......................... N
EB408-3 Infrared Alarm Transmitter ..... E
EB408-4 Infrared Alarm Receiver ................. L
EB409-1 EX42 Keyboard Interface .......... F
EB409-2 Banshee Siren Unit ......................... F
EB410-1 Echo Unit ................................ F
Please supply the following backnumbers of ETI.

Note: Backnumbers are held for 12 months only (complete in block capitals).

Month ....... Year ....... Month ....... Year .......
Month ....... Year ....... Month ....... Year .......
Month ....... Year ....... Month ....... Year .......
Month ....... Year ....... Month ....... Year .......

I enclose a cheque/postal order made out to ASP Ltd. to the value of £1.80 per issue ordered.

Total remittance £ ....... Date ...................................
Name ....................................................................
Address ..................................................................
...........................................................................
Postcode ................................................................

Send the completed form and your remittance to:
ETI Backnumbers Department
Infonet Ltd.
Times House
179 The Marlowes
Hemel Hempstead HP1 1BB

ETI has been published for over 13 years and in this time, many interesting articles and valuable backnumbers have appeared.

Photocopies are available for only the first 12 months issues of any individual article ever published in ETI.

Photocopies cost £1.50 per article regardless of their length. Please note that projects published over several issues must be ordered as a series of individual articles and are subject to the applicable fees.

Please supply photocopies of the following articles from ETI (complete in block capitals):

Month ....... Year ....... Page (if known) .......
Title ....................................................................

Month ....... Year ....... Page (if known) .......
Title ....................................................................

Month ....... Year ....... Page (if known) .......
Title ....................................................................

Month ....... Year ....... Page (if known) .......
Title ....................................................................

I enclose a cheque/postal order made out to ASP Ltd. to the value of £150 per photocopy ordered.

Total remittance £ ....... Date ...................................
Name ....................................................................
Address ..................................................................
...........................................................................
Postcode ................................................................

Send the completed form and your remittance to:
ETI Photocopy Service
Argus Specialist Publications
1 Golden Square
London W1R 3AB
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 bio-amplifier topside foil.

The EEG monitor main board solderside foil.

The EEG bio-amplifier solderside foil.
FREE READERS' ADS
Buy, sell or exchange through our free service to readers

TV VALVES WANTED: PCL 805, DY 802, PY 81, etc. Contact Yusuf, PO Box 36114, Lusaka, Zambia.
G E TERMIPRINTER. £80. Spectrum Interface 1. £24. P. H. Green, 5 Forted Penrith, Mold, Clwyd, CH7 1RP. Tel: (0352) 56481.
WANTED. Software and hardware technical details for Tatung Einstein computer. D. Titcombe, 18 Radway Road, Shirley, Southampton, SO1 2PW.
WANTED: Laservision video disc player. Working or not. Video discs also wanted. Tel: (0452) 417697.
WANTED: MAINS TRANSFORMER SOLARTRON SCOPE CD1400. Parmeica 0-1000-100X, 0-155V, 0-46V, 14-0-14V 3X 6.3V. M. L. Neal. Tel: (0342) 822189.
WANTED: BBC MICRO MODEL B computer and/or peripherals. Please ring (0903) 814809.
POWERTRAN CORTEX computer R5232, disk interface, C.DOS, etc. Twin 8in disk drives. £15. Tel: (0992) 468067.
WANTED: USED PRINTER for ZX Spectrum 128K. Write with postal charges for overseas to: M. But, PO Box 20, Power Complex, Abu Dhabi, U A E.
WANTED: CIRCUIT DIAGRAM for Texas Instruments terminal type 743KSR. Write: D. J. L., 202 Farmers Close, Winkton, Oxon, OX8 6NS.
WANTED: TANDY HARD DISK DRIVE. 5-meg 261130. Not working preferred — cheap! Phone Nottingham (0662) 783939.
WANTED: ELECTRON SPEECH BOARD. Kit form or ready built. Phone Blyth (0670) 367429.
END-OF-EARA, PRE-PC Collectors opportunity! Genuine VHF ROAMER TEN waves. Nine pages circuits only £45. Tel: (08894) 2516.
CORTEX. Most chips fitted, plus chip and disc for DOS2. Offers. Tel: High Wycombe (0494) 35659.
WANTED: 4½ DIGIT BENCH DMM. Batt/main. Zagorski, 7 Reid Road, Invergordon, Ross-shire IV18 0QF. (0349) 853817.
OSCILLOSCOPE. Tektronix $45B £50. Power supply +5V @ 7 amps £5. Stepper motor, 5 wires £2. Tel: (0344) 776894.
CLEAROUT. Newbrain AD, disks, CP/M components, monitors, PCBs, PSU, audio, manuals etc. Call Faruk (days) (0203) 329787.

MAPLINS KITS. Hexadrum £12, Syntax (built) £750, Synwave £750, Synchime (built) £750, Synclip £12. Tel: Polegate, Sussex (03212) 7577.
THE BEAST train control system. ETI Nov/Dec '79, set of PCBs, foil patterns or ETI prints wanted. Tel: (0247) 457270.
HELP. I need any information on the circuit of the Atari 800XL. A. Coulson, 196 Ladybank Road, Derby, DE3 5EE.
VIC 20 home computer starter pack, almost as new, plus one joystick and games. £50. Tel: (0493) 70032.
WANTED: INSTRUCTION MANUAL for Hitachi TRK8600E/2 portable stereo radio cassette recorder. Cash or exchange. Tel: (0246) 758811.
8 INCH DISK DRIVE £25 ONO. Used disks 50p each. Tel: Medway (0634) 353880.
48K SPECTRUM £30 ONO or swap for CB + PSU + antenna. Tel: 01-318 6930.
TANDBERG 4041X TAPE RECORDER integral amplifiers, monitor speakers, remote control, A-B monitoring, excellent condition. £95. Tel: (0642) 723204.
WANTED: service info for Sanyo answering machine, TAS-1G or diags. if possible. Tel: (0271) 80979 after 6 pm.
WANTED: PEN PAL: Own a ZX Spectrum and like electronics? Send to: Waleed Hasann, 23 Shifty Beck St., Saraya PO, Alexandria, Egypt.
CLEF ELECTRONIC PIANO six octave, fully touch sensitive, complete with integral amplifier. £495. Tel: (0785) 661391.
WANTED: ETI SOUND PRESSURE LEVEL METER (Feb, 81). Kit or built, or M81 microphone only. Tel: (0227) 362559.
TBA651 RADIO RECEIVER. Does anybody know of a supplier? Tel: (0698) 853787. Required urgently.
SORD COLOUR MONITOR needs attention. Swop for musical effects, Sinclair stuff or WHY. Tel: Al 01-451 5787.

CONDITIONS
• These ads are only for ETI readers not engaged in buying or selling the same items or services on a commercial basis.
• Ads will be inserted as and when space permits. Insertion in a specific issue cannot be guaranteed.
• ETI reserves the right to alter or refuse ads whenever this is judged necessary.
• All ads are accepted in good faith. Neither the magazine nor its publishers can be held responsible for any errors in the reproduction of ads, nor for truths or misrepresentations, nor for the activities of advertisers or respondents.
• Advertisers submitting ads for this section shall be deemed to have accepted these conditions.

Ads should be 20 words or less including the address and/or telephone number. Please write in black block capitals or type in the grid provided on this form or a photocopy.

Send the form to:
FREE READERS'ADS
Electronics Today International
1 Golden Square
London W1 3AB

Enter your advertisement below
COURSES

ELECTRONICS TECHNICIAN FULL-TIME TRAINING
(FULL TIME COURSES APPROVED BY THE BUSINESS & TECHNICIAN EDUCATION COUNCIL)

2 YEAR
BTEC National Diploma (OND) ELECTRONIC & COMMUNICATIONS ENGINEERING
(Electronics, Computing, Televisions, Video, Testing & Fault Diagnosis)

1 YEAR
BTEC National Certificate (ONC) INFORMATION TECHNOLOGY
(Electronics, Spreadsheets, TV, CD, Networks, Telecommunications)

ELECTRONIC EQUIPMENT SERVICING
(Electronics, Television, Video Cassette Records, CCTV, Testing & Fault Diagnosis)

SOFTWARE ENGINEERING
(Electronics, Assembly, BASIC, PASCAL, CAD/CAM)

COMPUTING TECHNOLOGY
(Electronics, Computing, Software/ Hardware, Microelectronic Testing Methods)

10 MONTHS
BTEC Higher National Certificate (HNC) COMPUTER TECHNOLOGY & ROBOTICS
(Microprocessor Design Systems, Fault Diagnosis, ATE, Robotics)

These Courses Include a High Percentage of College Based Practical Work to Enhance Future Employment Prospects. No Additional Fees for Overseas Students. Shortened Courses of from 3 to 6 Months Can Be Arranged for Applicants with Previous Electronics Experience.

O.N.C. 21st September 1987
FULL PROSPECTUS FROM
London Electronics College
292 Grand Ave., Lancing, Sussex, BN15 9PZ.

RAEVNSBOURNE COLLEGE OF DESIGN & COMMUNICATION
A Course in Applied Electronics B-TEC HND in Communications Engineering.

Applications are invited for places on a 2-year full-time course. The course is approved by the B-TEC, HND in Television and Broadcast Engineering. Applicants should have studied at least 2.5 years at GCSE level or have undertaken a B-TEC ONC in Electronic Engineering and be at least 18 years old. Full details are available from the course manager. The course is widely recognised by the Televison Companies and excellent employment prospects exist for the successful diplomates. Further particulars about the course and application forms are available from the Admissions Office.

RAEVNSBOURNE COLLEGE OF DESIGN & COMMUNICATION, WALDON ROAD, CHISLEHURST, KENT. BR7 5SN.

ADVANCED EDUCATIONAL OPPORTUNITY IN THE LONDON BOROUGH OF BROMLEY.

EDUCATIONAL SOFTWARE

LEARN ELECTRONICS
To use on Spectrum 48K and other Analogue Electronics Groups 1-2-3. For transistors and their circuits. 3 courses on cassette, £3.50.

DIGITAL ELECTRONICS Parts 1 to 6. For computer circuitry. 6 programs on cassette, £6.50.

POST FREE THROUGHOUT EUROPE. WORLDWIDE £2 FOR AIRMAIL.

LANCING TECHNICAL SERVICES LTD, DEPT T, 54 GRAND AVENUE, LANCING, WEST SUSSEX. BN15 9ZP.

SPECIAL OFFERS

FREE MEMBERSHIP to a new NATIONAL ELECTRONICS CLUB.
For details and a free gift of components worth over £10 send only £1.00 to Woodside, Dowsett Lane, Ramsden Heath, Essex CM11 1JL.

SWITCHES

VOICE/SOUND ACTIVATED SWITCHES easy to follow diagrams and uses only £1.00. Components and P.C.B's available.

Herrington, Soar Woodside, Dowsett Lane, Ramsden Heath, Essex CM11 1JL.

BOOKS


12 FREE full spec transistors for your E.T.I. projects. ITT BC012 (PNP), BC108 (PNP), BC182 (PNP). 2X500 (PNP) etc. Return ad + 50p coin (P&P) to: K.G. - 8 Culliford Road. Ilkeston TS29 0DZ.
ALARMS
FREE BOOKLET on BURGLAR ALARMS with LOWEST U.K. DIY PUBLISHED PRICES
PHONE OR WRITE FOR YOUR COPY
051-523 8440
AD ELECTRONICS
217 WARBRECK MOOR AINTREE, LIVERPOOL L9 0HU

SECURITY ALARMS - comprehensive, professional training courses for those wishing to further their career in the Alarm Industry. Send or phone for full prospectus. Castle Alarms & Electronics, North Street, Winkfield. Nr. Windsor, Berks. 0344 8866446.

LOUDSPEAKERS
UK MADE HIGH QUALITY LOUDSPEAKERS AVAILABLE. Dome Tweeters. Dome Mid-Range. Woofers and Sub-Woofer. UNIQUELY ENGINEERED. ALUMINIUM VOICE COILS.
For further information please phone: 0473-710212

PLANS & DESIGNS
ELECTRONIC PLANS, laser designs, solar and wind generators, high voltage teles, surveillance devices, Pyrotechnics and computer graphics table, 150 projects. For catalogue, SAE to Plancentre Publications, String Works, Byre St., Ledbury HR8 2AA.

FOR SALE
KIT OF PARTS - circuit for 12V-1A P.S.U no P.C.B. £80.00 + £1.00 P&P. I.E. PO Box 1, Broxburn, West Lothian.

COLOUR RIBBON CABLE 20, 34 way, 30 metre reels £10.00, £15.00 P&P. £15.00. Raitcliffe, 91 Ryhall Road, Stamford, Lincs. 0780 64052

KITS AND READY BUILT
ETI KITS assembled and tested by electronic trainees under supervision within a purpose built electronic workshop for as little as £10* (depending on type of kit and complexity). Contact: A.J. Smith, Dept K.A. Electronics Workshop, Lincoln I.T.E.C. Dean Road, Lincoln LN2 4JZ. Tel. 0522 43532.

BUG TRANSMITTER Kit £6.00, circuit diagram £2.00. Cheque payable: Craig Foulkes, 28 Down Green Road, Bolton, BL2 3GO.

WANTED
We purchase for cash or immediate settlement surplus stocks of L.C's, Memories, Transistors, etc. Please contact P.C.S. (Marketing) LTD FAX:0767 318200 TEL:0767 317388 TELEX NO:825616

CLASSIFIED ADVERTISING TERMS & CONDITIONS
Our terms for new advertisers (semi-display and line entries) are strictly pro-forma payments until satisfactory reference can be taken up, including recognized advertising agencies. Cheques and P.O.'s should be crossed and made payable to ARGUS SPECIALIST PUBLICATIONS LTD and sent together with the advertisement copy to:
"The Classified Dept L/P., No. 1 Golden Square, London W1B 2AT."

There are no reimbursements for cancellations. Advertisements arriving too late for a particular issue will be inserted in the following issue unless accompanied by an instruction to the contrary.

All advertising sales are subject to Government Regulations concerning VAT. Advertisers are responsible for ensuring that the legal requirements are met in force eg; The Trade Descriptions Act, sex discrimination act & the business advertisements (disclosures) order 1977. Full Terms & Conditions of Advertising are available on request.

ALARM SD 34
COLOUR RIBBON CABLE
Ledbury For devices, Winkfield, Electronics, prospectus. Castle Industry. Send or phone comprehensive, professional

SUPERMOS (MOSTET) E6, SUPERRAMP (bipolar) E5 total inc. Full PSU details supplied with modules, available separately £2.50, refunded on purchase.

To order send a cheque payable to SAGE AUDIO, export orders please draw cheque in STERLING & add appropriate postage, weight 80grams/mod. inc.
For further information on these and our other products send SAE or IRC's to Construction House, Whitley St, Bingley, Yorks BD16 4JD TEL. (0274) 588647 TELEX: 517783 Becton Group

PLANS & DESIGNS
ELECTRONIC PLANS, laser designs, solar and wind generators, high voltage teles, surveillance devices, Pyrotechnics and computer graphics table, 150 projects. For catalogue, SAE to Plancentre Publications, String Works, Byre St., Ledbury HR8 2AA.

FOR SALE
KIT OF PARTS - circuit for 12V-1A P.S.U no P.C.B. £80.00 + £1.00 P&P. I.E. PO Box 1, Broxburn, West Lothian.

COLOUR RIBBON CABLE 20, 34 way, 30 metre reels £10.00, £15.00 P&P. £15.00. Raitcliffe, 91 Ryhall Road, Stamford, Lincs. 0780 64052

KITS AND READY BUILT
ETI KITS assembled and tested by electronic trainees under supervision within a purpose built electronic workshop for as little as £10* (depending on type of kit and complexity). Contact: A.J. Smith, Dept K.A. Electronics Workshop, Lincoln I.T.E.C. Dean Road, Lincoln LN2 4JZ. Tel. 0522 43532.

BUG TRANSMITTER Kit £6.00, circuit diagram £2.00. Cheque payable: Craig Foulkes, 28 Down Green Road, Bolton, BL2 3GO.

WANTED
We purchase for cash or immediate settlement surplus stocks of L.C's, Memories, Transistors, etc. Please contact P.C.S. (Marketing) LTD FAX:0767 318200 TEL:0767 317388 TELEX NO:825616

CLASSIFIED ADVERTISING TERMS & CONDITIONS
Our terms for new advertisers (semi-display and line entries) are strictly pro-forma payments until satisfactory reference can be taken up, including recognized advertising agencies. Cheques and P.O.'s should be crossed and made payable to ARGUS SPECIALIST PUBLICATIONS LTD and sent together with the advertisement copy to:
"The Classified Dept L/P., No. 1 Golden Square, London W1B 2AT."

There are no reimbursements for cancellations. Advertisements arriving too late for a particular issue will be inserted in the following issue unless accompanied by an instruction to the contrary.

All advertising sales are subject to Government Regulations concerning VAT. Advertisers are responsible for ensuring that the legal requirements are met in force eg; The Trade Descriptions Act, sex discrimination act & the business advertisements (disclosures) order 1977. Full Terms & Conditions of Advertising are available on request.

ALARM SD 34
COLOUR RIBBON CABLE
Ledbury For devices, Winkfield, Electronics, prospectus. Castle Industry. Send or phone comprehensive, professional

SUPERMOS (MOSTET) E6, SUPERRAMP (bipolar) E5 total inc. Full PSU details supplied with modules, available separately £2.50, refunded on purchase.

To order send a cheque payable to SAGE AUDIO, export orders please draw cheque in STERLING & add appropriate postage, weight 80grams/mod. inc.
For further information on these and our other products send SAE or IRC's to Construction House, Whitley St, Bingley, Yorks BD16 4JD TEL. (0274) 588647 TELEX: 517783 Becton Group

WE ARE A REFRESHMENT: A YOU THE TALKON, AGAIN TALK?
ALARM SD 34
COLOUR RIBBON CABLE
Ledbury For devices, Winkfield, Electronics, prospectus. Castle Industry. Send or phone comprehensive, professional

SUPERMOS (MOSTET) E6, SUPERRAMP (bipolar) E5 total inc. Full PSU details supplied with modules, available separately £2.50, refunded on purchase.

To order send a cheque payable to SAGE AUDIO, export orders please draw cheque in STERLING & add appropriate postage, weight 80grams/mod. inc.
For further information on these and our other products send SAE or IRC's to Construction House, Whitley St, Bingley, Yorks BD16 4JD TEL. (0274) 588647 TELEX: 517783 Becton Group

PLANS & DESIGNS
ELECTRONIC PLANS, laser designs, solar and wind generators, high voltage teles, surveillance devices, Pyrotechnics and computer graphics table, 150 projects. For catalogue, SAE to Plancentre Publications, String Works, Byre St., Ledbury HR8 2AA.

FOR SALE
KIT OF PARTS - circuit for 12V-1A P.S.U no P.C.B. £80.00 + £1.00 P&P. I.E. PO Box 1, Broxburn, West Lothian.

COLOUR RIBBON CABLE 20, 34 way, 30 metre reels £10.00, £15.00 P&P. £15.00. Raitcliffe, 91 Ryhall Road, Stamford, Lincs. 0780 64052

KITS AND READY BUILT
ETI KITS assembled and tested by electronic trainees under supervision within a purpose built electronic workshop for as little as £10* (depending on type of kit and complexity). Contact: A.J. Smith, Dept K.A. Electronics Workshop, Lincoln I.T.E.C. Dean Road, Lincoln LN2 4JZ. Tel. 0522 43532.

BUG TRANSMITTER Kit £6.00, circuit diagram £2.00. Cheque payable: Craig Foulkes, 28 Down Green Road, Bolton, BL2 3GO.

WANTED
We purchase for cash or immediate settlement surplus stocks of L.C's, Memories, Transistors, etc. Please contact P.C.S. (Marketing) LTD FAX:0767 318200 TEL:0767 317388 TELEX NO:825616

CLASSIFIED ADVERTISING TERMS & CONDITIONS
Our terms for new advertisers (semi-display and line entries) are strictly pro-forma payments until satisfactory reference can be taken up, including recognized advertising agencies. Cheques and P.O.'s should be crossed and made payable to ARGUS SPECIALIST PUBLICATIONS LTD and sent together with the advertisement copy to:
"The Classified Dept L/P., No. 1 Golden Square, London W1B 2AT."

There are no reimbursements for cancellations. Advertisements arriving too late for a particular issue will be inserted in the following issue unless accompanied by an instruction to the contrary.

All advertising sales are subject to Government Regulations concerning VAT. Advertisers are responsible for ensuring that the legal requirements are met in force eg; The Trade Descriptions Act, sex discrimination act & the business advertisements (disclosures) order 1977. Full Terms & Conditions of Advertising are available on request.
EDINBURGH
OMNI ELECTRONICS
stock a wide range of electronic components at
174 Dalkeith Road
Edinburgh EH16 5DX
Tel: 031 667 2611
situated midway between Commonweal Pool and Cameron Toll

LIVERPOOL
PROGRESSIVE RADIO
87/93 Dale Street Tel: 051 236 0154
47 Whitechapel Tel: 051 236 5489
Liverpool 2
'THE ELECTRONICS SPECIALISTS'
Open: Tues-Sat 9:30-5:30

ENGINEERING
DESIGNERS
Making Your Own Software/Hardware?
Need special Standoffs.
For FREE estimate contact!
ANDREWS ENGINEERING
Unit 42, Middlefield Industrial Est., Sandy, Bedford.
Tel: 0767-81515

MISCELLANEOUS
HEATHKIT U.K. Spares and service centre Cedar Electronics, Unit 12, Station Drive, Breton, Tewkesbury, Glos. Tel: 0684 73127.

EDUCATION
BOOKS
WORKSHOP SERVICE MANUALS:
Thousands stocked. Most makes.
Types Audio, TV, Video, Test, Amateur etc.
Contact your nearest stockist.

RING NICOLA BATY FOR
ADVERTISING
DETAILS
01-437 0699

ADVERTISER'S INDEX
Audiokits ........................................ 6
BK Electronics ................................... IFC
Cricklewood Electronics ....................... 10
Dateline .......................................... 30
Display Electronics ........................... IBC
GCHQ ............................................. 29
Greenbank Electronics ......................... 55
Hart Electronics ................................ 26
Henry's Audio Electronics ..................... 6
HyTek Electronics .............................. 23
ICS ................................................ 6
Jaytee Electronics Services ................... 12
Maplin Electronic Supplies ................. 0BC
Rackz Mounting Products ................. 6
Specialist Semi Conductors ............... 8
Stewarts of Reading ......................... 55
Super Alpha Electronics ................. 10
Thandar Electronics ......................... 23
TJA Development ............................. 66
TK Electronics ................................ 10
Velleman kits .................................. 63
Zenith Electronics ........................... 29

RACK STYLE CABINET
' Suitable for instruments, high quality amplifiers and many other purposes.'
Top, side and rear covers removable for access.
Black anodised aluminium front panel.
Separate front mounting plate.
Heavy gauge front panel in brushed aluminium finish enhanced with two professional handles.
With ventilation slits and plastic feet.
Rear box manufactured from steel painted in black.
Rack mounting or free standing. Comes in quick assembly flat pack.

RACK STYLE CABINET

<table>
<thead>
<tr>
<th>Order Code</th>
<th>Panel Size</th>
<th>Rear Box</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>NME19/101</td>
<td>19 x 2.5</td>
<td>W x H x D</td>
<td>£24.50</td>
</tr>
<tr>
<td>NME19/102</td>
<td>19 x 2.5</td>
<td>W x H x D</td>
<td>£26.50</td>
</tr>
<tr>
<td>NME19/103</td>
<td>19 x 2.5</td>
<td>W x H x D</td>
<td>£28.50</td>
</tr>
<tr>
<td>NME19/104</td>
<td>19 x 2.5</td>
<td>W x H x D</td>
<td>£30.50</td>
</tr>
<tr>
<td>NME19/105</td>
<td>19 x 2.5</td>
<td>W x H x D</td>
<td>£32.50</td>
</tr>
<tr>
<td>NME19/106</td>
<td>19 x 2.5</td>
<td>W x H x D</td>
<td>£34.50</td>
</tr>
<tr>
<td>NME19/107</td>
<td>19 x 2.5</td>
<td>W x H x D</td>
<td>£36.50</td>
</tr>
</tbody>
</table>

Please add £3.00 P&P for the first item and £1.50 for each additional item. To order send cheque or postal order - please allow up to 7 days despatch for cheque clearance.

T.J.A. DEVELOPMENTS
Dept. ETI, 53 Hartington Road,
London E17 8AS.

BINDERS
FOR YOUR VALUABLE COLLECTION
OF ELECTRONICS TODAY
INTERNATIONAL MAGAZINES
- SMART - EASY TO USE - TOP QUALITY
To ASP Readers Services, PO Box 35,
Wolsey House, Wolsey Road, Hemel Hempstead, Herts HP2 4SS (0442-41221)

Please supply . . . Electronics Today International Binders £5.95 inc. P&P

Total £ . . . (Please make cheques payable to ASP Ltd.)
Yrs Required 100, 198, 198, 198, 198

Name ____________________________________________
Address __________________________________________

Please allow 21 days for delivery.

ETI SEPTEMBER 1987
YOUR COMPUTER WAREHOUSE

The ORIGINAL FREE OF CHARGE dial up data base.
Buy, browse or place your OWN AD for
goods or services to sell. 1000's of stock items,
used COMPUTER, ELECTRICAL, ELECTRONICS. Updated
ON LINE NOW. Call 01-679 1888
For 300 baud modem call 01-679 183

NO MINIMUM ORDER
1000's OF BARGAINS FOR CALLERS

DON'T MISS THE CPM Deal
FOR THE FABULOUS CPM TATUNG PC2000
Professional Business System

A cancelled exchange offer and months of negotiation enables us to offer this professional
PC/computer system, recently on sale at £1400, at a SCAFF price just over the cost of
the two internal disk drives.

Not a toy, the BIG BROTHER OF THE ENSTEIN computer, the DUAL PROCESSOR
PC2000 combines a modern central processor (CPU) and two of the
SMALL BUSINESS, INDUSTRIAL, EDUCATIONAL or NOBILITY USER with
the KNOWLEDGE of proven tested and available CPM software packages such as
WORDSTAR, FAST, DBASE II, etc. And, of course, the PC2000
UPGRADE feature makes it the most affordable of all.

The PC2000 is a complete CPM system
for up to 64K memory and includes
one 100K disk drive and one 40K disk drive (plug in)
plus two full size terminals.

The CPU has been designed and engineered for
advanced computer performance for
businesses, government or educational
institutions. Its features include
- 16-bit processing
- Four I/O ports
- Multitasking
- 16-bit addressing

The PC2000 is a complete system that
is designed to meet the needs of
businesses, government or educational
institutions. It is a powerful computer
that can handle a variety of tasks,
including word processing, database
management, and spreadsheet
applications.

In addition to the CPU, the PC2000
includes two full size terminals
and two full size disk drives.

The PC2000 is a high-performance
system that is well suited for a variety
of applications.

The PC2000 is a high-performance
system that is well suited for a variety
of applications.

For more information contact us.

Your monitor from its computer! For
only £29.95 it becomes a SUPER
QUALITY TV SET.

All for SCHOOLS, SHOPS, VCR or AUDIO
TEAK CASE, plug and play.

TELEX consists of a compact, stylish unit, two
tones, hardwired, designed with the
functions of a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,
which is used in conjunction
with a telephone and
computer. It has a large speaker,