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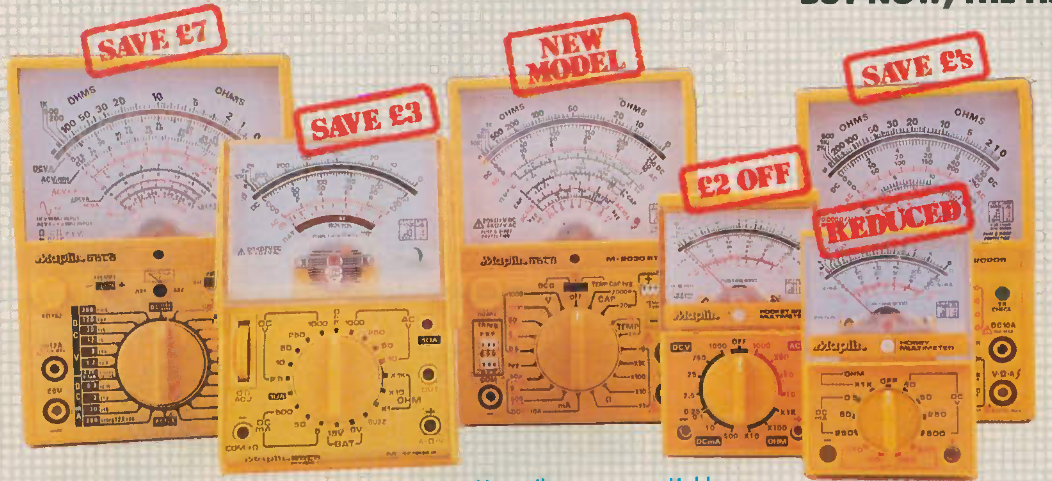

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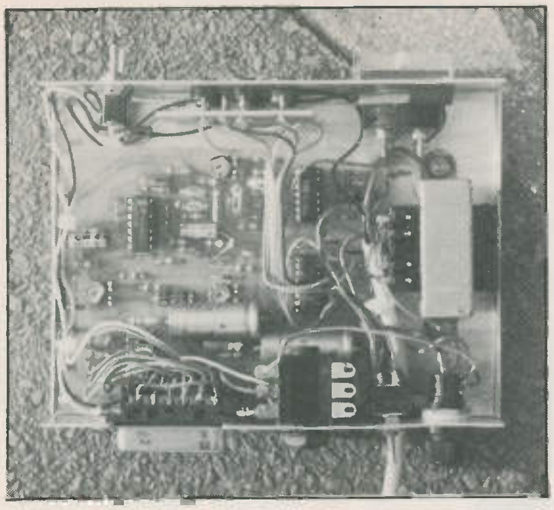
PRACTICAL ELECTRONICS

PE VOL 24 NO 3 MARCH 1988



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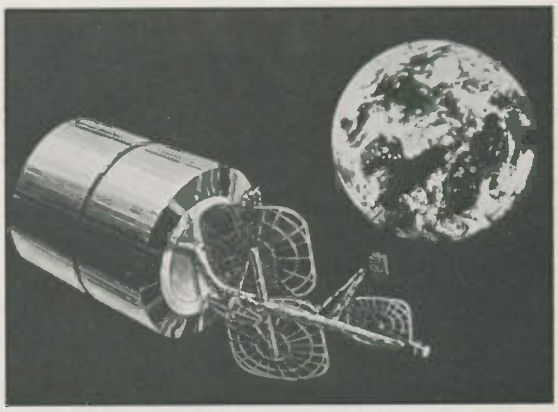

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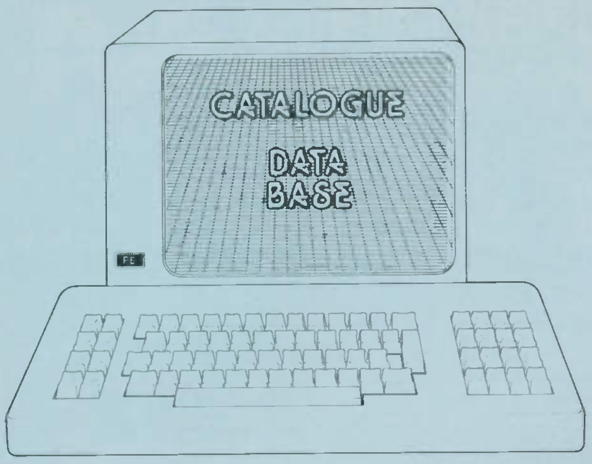


We have recently received the following catalogues and literature:

C-TEC have published their latest 48 page mail order **security equipment** and accessories catalogue. It is believed to be the most comprehensive of its type in the UK. **C-TEC are at Stephen's Way,** Goose Green, Wigan, Lancs, WN3 9PH. 0942 42444.

Eagle have announced their new colour catalogue of **PA, video door entry,** and test equipment. **Trade enquiries only to Eagle International,** Unit 5, Royal London Estate, 29–35 North Acton Road, London NW10 8PE. 01-965 3222.

Briticent have informed us of their new full colour brochure covering the **IP67-rated range of enclosures** which ensure total electrical isolation from weather, dust and chemicals. **Briticent International** may be contacted through Dryden Brown Ltd, Building 2, Shamrock Quay, Southampton, SO1 1QL. 0703 229041.

Thandar's 1988 catalogue is designated Issue Six, and includes their complete range of **electronic test and measurement** equipment. **Thandar Electronics Ltd,** London Road, St Ives, Huntingdon, Cambs, PE17 4HJ. 0480 64646.

West Hyde's catalogue of enclosures for practically every purpose is well illustrated and very informative. Apart from boxes, cases and the like, their **range of hardware items** is also covered. **West Hyde Developments Ltd,** 9–10 Park Street Industrial Estate, Aylesbury, Bucks, HP20 1YA. 0296 20441.

Barry's Award

We told you last month how proud we were to learn that in the fourth UK Technology Press Awards sponsored by *The Times* and Hewlett-Packard, Barry Fox had won the features journalist category award for his contributions to *Practical Electronics* and *New Scientist*. The photograph of Barry receiving the award from tv presenter Cliff Michelmore arrived too late to meet last month's printing date, but we are delighted to show it to you now. **Ed.**

WHAT'S NEW

Low Cost Fungen

A brand new all British instrument at a price to rival Far East imports is the claim made by Waugh Instruments for their new 2MHz Function Generator.

The new instrument is not based on a single chip function generator and does not suffer from many of the problems associated with such designs. A novel feature is the direct reading frequency dials which minimise reading errors over the wide frequency range of 100mHz to 20MHz. A vco input is provided to turn the instrument into a sweep generator with up to a 1,000 to 1 frequency sweep ratio. A 10% to 90% variable duty cycle control allows the triangle and square wave waveforms to be turned into ramp and pulse. The variable offset control allows the output to be biased positive or negative to ground. The maximum output is 20V peak to peak or 10V peak to peak into 50 ohms with sine wave distortion less than 0.5% and square wave rise time less than 60ns.

The unit is housed in an attractive, tough two tone case and is supplied with mains lead and comprehensive handbook, all at £169 plus VAT.

Contact: Waugh Instruments Ltd, Camhelyg Isaf, Glyn Ceiriog, Llangollen, Clwyd, LL20 7PB. Tel: 069 172 597.

Bright Scope

The Kenwood CS1025 dual-trace 20MHz oscilloscope is now available ex-stock from Thurlby Electronics. Unlike most 20MHz scopes the CS1025 uses a high brightness, domed mesh, post-accelerator tube with 6kV acceleration potential, which enables easy viewing of difficult waveforms, such as short duration pulses, even with ×10 magnification.

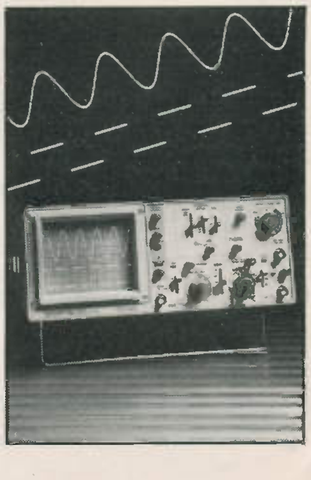
The vertical axis sensitivity is continuously variable between 1mV/div and 5V/div. The 1mV/div range provides a particularly powerful tool to observe complex, low level waveforms when combined with the extra brightness available.

A maximum speed of 20ns/div and variable screen illumination are combined with a full trigger capability which includes tv line and tv frame modes. The trace rotation control, situated conveniently on the front panel, allows for variations due to the earth's magnetic field.

Both horizontal and vertical amplifiers are specified at 3% accuracy. Other facilities available include X-Y mode, intensity modulation and vertical-axis signal output. Two PC-30 probes (switchable ×1, /10) are provided as standard, and modern slimline styling is combined with the usual Trio-Kenwood high standards of construction and reliability.

The CS1025 costs £425 + vat and Thurlby offers full sales and service support and a comprehensive guarantee.

Contact: Thurlby Electronics Ltd, New Road, St. Ives, Huntingdon, Cambs. PE17 4BG. Tel: 0480 63570.



Safely Disruptive

BRITICENT'S comprehensive range of Disruptor circuit breakers is presented in a new brochure from which potential users can choose the right device for their needs by using a simple reference chart.

The four-page brochure has photographs that depict all the different body types. It is further sectioned into five main areas of actuation characteristics: thermal, thermal magnetic, magnetic only, earth leakage, and special. The number of poles, between one and four, is listed for each type with additional information on voltage and current ratings. Accessory information includes options such as bases, weatherproof cases, and din rail adaptors. All standard models have an easily accessible reset button on the front panel.

Applications potential includes all areas requiring safe and efficient automatic isolation against overload. Tripping currents can be selected from 40mA to 70A.

Contact:
Briticent International Limited, Crow Arch Lane, Ringwood, Hampshire BH24 1NZ.
Tel: (0425) 474617.

Macro Cop-Coms

SYSTEMS Designers Scientific have been selected by the Metropolitan Police to act as prime contractor in a £17 million project to provide the Met's computerised Crime Report Information System. CRIS will replace the Met's current paper-based and time consuming crime report system with a force-wide integrated computer network.

The new system will allow for complex searches through databases and provide each division with instant access to crime reports throughout the Metropolitan Police Area. Over the last two years crime reports from previous four years held in archives will be obtainable within four hours.

Nearly 2000 computer workstations will be placed in all Metropolitan Police Divisions, Sub-Divisions, Areas, Enquiry Centres and in various Headquarters branches to access a network of divisional and central databases.

Contact:
Systems Designers plc, Centrum House, 101/103 Fleet Road, Fleet, Hampshire, GU13 8PD.

Speeding Tickets

NEW 'Quickfare' automatic ticket machines from Westinghouse Cubic, now undergoing trials at London Bridge Station, are speeding passengers to 40 British Rail destinations in South and South-East London as well as stations in Kent and Surrey.

A variety of ticket combinations, including adults single and return, children's tickets, cheap day, Network and Capital Cards are available to travellers from the automatic machines, each of which has an electronic clock mechanism capable of calculating off-peak periods, weekends, bank holidays and even leap years.

Since their installation in June 1987, the new, push-button operated 'Quickfare' machines have been smoothing passenger flow through this main line terminal. More than 100,000 commuters use London Bridge station every working day throughout the year, with destinations to and from some 380 stations throughout the network.

Contact: Westinghouse Cubic Ltd, 15-17 Long Acre, London WC2E 9LH Tel: 01-240 9821.

Appalling Calling

A recent survey confirms what many have known for a long time – that too many public call boxes are defective and the quantity is rising. OFTEL, the Office of Telecommunications, has released information that shows that around 23% of call boxes nationwide were defective during 1987, compared with 17% during 1986.

Although vandalism significantly contributed to failures, other faults were all too common and in some cases repairs were taking in excess of three weeks. Even Phonecard boxes fared only slightly better than coin boxes.

OFTEL state that two lines of action will be considered – the introduction of competition, and increased regulatory action to monitor BT's performance and bring further pressures for inprovements. A national call box survey is to be introduced on a monthly basis, from which the number of out-of-order boxes and fault repair times will be assessed.

As an aside, your Editor regrets that call boxes are no longer painted red – the new ones are far less visible from a distance. Since they are less numerous than they used to be, they should be made MORE visible to ease the search in unfamiliar areas. Perhaps sign-posting them would help, in the same way that toilets and car park facilities are indicated.

If you are organising any event to do with electronics, big or small, drop us a line – we shall be glad to include it here.

NOTE: Some events listed here may be trade or restricted category only, Also, we cannot guarantee information accuracy, so check details with the organisers before setting out.

Feb 24-25. Instrumentation Bristol. Trade only. Bristol Crest Hotel, Bristol. 0822 4671.

Feb 29 – Mar 4. Electrex 88. International electrical and electronics exhibition. National Exhibition Centre, Birmingham. 0483 222888.

Mar 20. Pontefract and District Amateur Radio Society annual components fair and boot sale. Carlton Community Centre, Carleton, Pontefract. 0977 43101. *(Good luck you enterprising lads! Ed.)*

Mar 22-24. Internepcon Production Show and Conference, plus Electro Optics and Laser UK. National Exhibition Centre, Birmingham, 0483 222888.

Mar 29-30. Instrumentation Harrogate. Trade only. Harrogate Exhibition Centre, Harrogate, N. Yorks. 0822 4671.

Apr 12-14. Scottish Computing Show. Scottish Exhibition Centre. Glasgow.

Videostar

THE new Ferguson Videostar CCR FC05 is a small, lightweight record/playback camcorder which gives highly professional results within reach of the keen amateur.

It offers 400 line picture resolution, giving even better performance than its highly acclaimed predecessor, the Videostar 3C03. Size and weight are kept to a minimum, yet the FC05 has a host of useful features including long play facility; two-speed 6x electronic zoom magnification; auto focus as well as variable shutter speed, tailor made for shooting moving objects clearly. It also offers high quality picture enhancement; an indoor light switch, allowing use under fluorescent lighting; automatic fader control; backlight control; date and time insertion facility; and rewind at tape-end.

The £1,100 retail price includes a two part soft carry case, and EC30 cassette, battery and new compact ac adaptor/battery charger, rf unit and audio/video out cable.

Contact: Ferguson, Cambridge House, Great Cambridge Raod, Enfield, Middlesex EN1 1UL Tel: 01 363 5353.

CHIP COUNT!

This month's list of new component details received — mainly chips, but other items may be included.

DM77-87SR191-87SR193. 16K-bit registered TTL PROM featuring synchronous and asynchronous outputs. **(NS)**

HD1801. CMOS ADPCM speech encoder-decoder chip that greatly simplifies the design of voice-data multiplexers, answerphones, voice mail systems etc. **(HT)**.

INTEL 8096. 8-bit external bus proliferation version of the 16-bit 8096 for real-time control applications. **(IT)**.

TP1465. High speed, high power, FET input, VMOS output opamp operating from supplies up to ±40V, with output voltages up to ±34V, and output currents up to ±750mA. **(MC)**

TP4192. 10-bit video analogue to digital converter optimised for arbitrary sampling rates frm dc to 30MHz. **(MC)**.

TP4951. Single mode laser diode module having enhanced stability and suitable for both analogue and digital applications. **(MC)**.

Manufacturers, and contact telephone numbers for further details:

(HT) Hitachi. 0923 246488. (IT) Intel. 0793 696204. (MC) MCP Electronics. 01 902 6146. (NS) National Semiconductor, only a West German number quoted — 08141 103376.

Hearing Help

LENGTHY mention of the problems related to hearing tv and film sound tracks has been made in the Letters pages recently. It was thus with interest that we recently received a document relating to other hearing problems from OFTEL, the Office of Telecommunications. They have published a Guide to the Requirements for Text Communication Equipment for Use by Hearing Impaired People and Others.

Hearing impaired people who are unable to use the telephone can communicate over the public switched network using suitable keyboards, modems and receiving equipment. The guide defines the preferred transmission standards, the character set and protocol to which keyboards and receiving equipment should conform. It is intended to encourage the supply or adaption of equipment for the technically inexperienced to make best use of text communication. Its content is not exhaustive but describes a common denominator to provide the widest compatibility and inter-working of systems used by hearing-impaired people.

OFTEL are at Atlantic House, Holborn Viaduct, London EC1N 2HQ. Tel: 01-353 4020.

Super Snags?

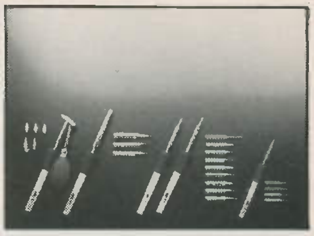
A lecture held by the IEEIE recently provided interesting insights into 'room temperature' superconductors, (SCs). The lecturer expressed his opinion that electricity generator efficiency was already so high at around 98.5% that the use of SCs would be of only marginal benefit. He also believed that replacing copper conductors with SCs would result in shrinking the financial size of the cable making industry. Additionally, since half the world production of copper was for electrical applications, extensive use of SCs would have serious consequences for the copper industry and those countries whose economy largely depends on it. As many are Third World countries, the financial institutions of developed nations could also be in for a tough time.

On the more optimistic side, he believed that data processing and communications would benefit from superconducting digital electronic components, which are capable of operating at several orders of magnitude faster than conventional ones. This could have a dramatic impact on the possible complexity and power of microprocessors.

Hot Lead

A new series of JBC soldering irons from Engineering and Electronic Supplies Ltd (EES), is ideal for a wide range of applications including pcb, circuit repair, laboratory, production and precision diy applications.

There is a choice of various tips and accessories and the heating system of the Pencil Line series offers high thermal efficiency since the insertion of the resistor in the tip makes total use of generated heat. The smallest iron in the series is the 14N with a power rating of 11W, a maximum temperature of 340°C and weighing only 18.5g. The 30N, weighing 40g, is a middle range 'versatile' tool suitable for all electronic applications. Power rating is 24W with a maximum temperature of 380°C. There is a choice of long life and copper tips. The most powerful model in the series is the 65N, designed for soldering jobs requiring higher temperatures and power for such applications as frame



connections and larger radio and general soldering with a power rating of 36W and maximum temperature of 440°C.

To complete the series there is a Model DS power desoldering tool that can be operated with only one hand and works in any position. The unit comes complete with its own heating element and includes a choice of six tips and an integral desoldering body replacement part.

All Pencil Line soldering irons can be supplied for 120V, 220V, 240V or 24V with triple pole cable.

Contact: EES Ltd, Seaway Parade, Baglan Bay, Port Talbot, West Glamorgan, SA12 7BR. Tel: 0639 813663.

Long Distance Lasers

MITSUBISHI Electric Corporation have recently developed distributed feedback (dfb) lasers with wavelengths of 1.3 and 1.55 microns.

These lasers are capable of maintaining a stable single-spectrum even at high-speed modulation of 2 gigabits/second, and can transmit a massive amount of information for over 100 kilometres.

Such light sources are required for the trunk lines of optical communication systems. At present, the Fabry-Perot semiconductor laser is used for this purpose. However, the Fabry-Perot laser generates a beam in many wavelengths and in transmissions at a speed of several hundred megabits/second, mode partition noise limits the distance to 30-40 kilometres. Long-distance transmissions of more than 100 kilometres at a speed of greater than several hundred megabits/second requires a semiconductor laser that can generate a single-spectrum output which is stable even at high-speed modulation.

Currently, the dfb laser excels in this application.

Telecom Transputer

The central role played by very large scale integration (vlsi) technology in powering rapid advances in telecommunications technology is underlined by the introduction of a high-speed, high-complexity digital switch on a single silicon chip by Inmos International at Telecom 87. The new IMSC004 shown working at Geneva, where it was used to configure a network of Inmos transputers and digital signal processors.

Distributed control in digital exchanges is an ideal application for the transputer. Alone among modern microprocessor systems it incorporates hardware and software features to support efficient inter-processor communication.

The IMSC004 can handle data traffic at up to 20 Mbits/sec and connects 32 inputs to 32 outputs in any order, by means of a separate serial control link. It can be cascaded to any depth.

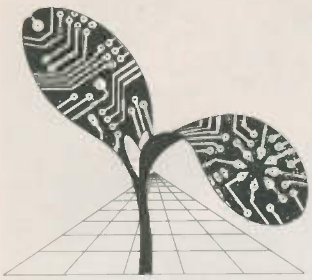
Contact: Inmos, 1000 Aztec West, Almondsbury, Bristol, BS12 4SQ. Tel: 0454 616616.

Footbridge

MCP Electronics informs us that heatsink specialist Thermalloy has come up with yet another new products, a bridge rectifier heatsink designed to duplicate the rectifier top, so that no extra board space is used and a really small footprint is thus assured.

Mounted by a choice of threaded studs or nuts, swaged on for easy assembly, there are three mounting hole sizes available. Heat dissipation from the bridge rectifier is optimised by slotted vertical pins to provide thermal resistance of 9.4°C per watt at 75°C temperature rise.

Contact: MCP Electronics Ltd, 26–32 Rosemont Road, Alperton, Wembley, Middx HA0 4QY. Tel: 01 902 1191.



YEDA 1988

The 1988 Young Electronics Designer Awards Scheme has been launched with renewed sponsorship from electronics distribution company Cirkit Holdings plc and leading semiconductor and computer manufacturersTexas Instruments Ltd.

Governed by the YEDATrust, a registered charity, and organised under the chairmanship of John Eggleston, Professor of Education at Warwick University and a member of the Council of Europe, the Awards Scheme offers exciting prospects for young people in the junior (under 15), intermediate (15–18) and senior (19–25) age groups, who attend educational institutions in the UK.

To enter the Scheme, students must produce an electronic device of their own which is original, effective and has a useful application in everyday life. A prestigious trophy and valuable cash prizes are presented to the winners in each category and in the senior age group there are the prospects of a job in electronics and course sponsorship.

Each secondary school or college with one or more entrants reaching the regional judging stages in May qualifies for a special award of useful electronic equipment from Cirkit, for example multimeters, furthermore the finalist whose project is adjudged to have the most commercial potential will win a sophisticted computer system and software valued at around £10,000 from Texas Instruments for his or her educational institution. Every finalist wins a personal prize, as does their teacher, and there are many more attractions for the successful entrant.

The YEDA Scheme was launched four years ago with the objective of encouraging the development of practical electronics at the educational level. It was devised in response to repeated criticism by industry that school leavers were not adequately prepared for the commercial world. It was also designed to create an increased awareness in the critical need for Britain to produce more world beating products using electronics, if the country is once again to become a major force in international markets.

Announcing the new scheme, Professor John Eggleston said, "YEDA has undoubtedly become one of the most important technological incentive schemes in education. It is an illuminating and highly encouraging indicator of progress being made in schools, colleges and universities.

"Since the commencement of the scheme in 1983 we have noticed not only a steady increase in the level of entries, but also dramatic improvements in standards and in the understanding of the nature of electronics and its importance to the modern world. I am more optimistic than ever about the outcome of this year's contest."

For further information and entry forms contact: The YEDA Trust, 24 London Road, Horsham, West Sussex RH12 1AY. Tel: 0403 211048.
The closing date is March 31st 1988.

Salford Robots

The UK Centre for Advanced Robotics Research is to be based at the University of Salford.

Robert Atkins, Parliamentary Under Secretary of State for Industry, recently announced the Government's decision at a Press Conference held at Salford University Business Services Ltd (SUBSL). SUBSL was selected to host the ARRC in the face of fierce competition from a shortlist of five organisations which included Harwell Laboratory and the Ministry of Defence.

The structure and method of operation for the new Advanced Robotics Research Centre is novel. ARRC researchers will be industrial staff seconded from their own companies to work together in teams with university academics. Up to 15 companies will be involved, including CAMPUS members British Nuclear Fuels plc. As Robert Atkins commented "Each of these leading-edge companies has recognised the importance of working together to integrate technologies such as artificial intelligence, sensors and vision, navigational and transport systems. Salford University Business Services Limited was selected from a variety of sites and proposals; and very influential in our decision was the fact that Salford was where industry *wanted* to go".

The Centre will be supported jointly by the DTI and industry for up to five years after which it is expected to be self financing. Annual running costs will be in the region of £2 million.

The Centre is the result of a Government initiative on advanced robotics launched in 1985, and the siting of the Centre at Salford is "exceptionally good news for the North West and the North of England" said Mr Atkins. Although the Centre has a national role, industrial leaders expect that its location in the heart of the North West will encourage new investment in what could become a whole new industry in the area.

Salford University is well known for its unique style of collaboration with industry. Through CAMPUS and Salford University Business Services Ltd, it has built up a reputation for delivering what industry wants.

Salford University Business Services Ltd already has a strong technical consultancy group with skills in engineering design, process control, electronics, manufacturing systems, automation and quality assurance and this existing group will work alongside university academics and industrial staff in the ARRC on robotic applications, for example in hostile environments such as undersea rescue and firefighting. Research areas will include advanced control applications, vision systems, gripper technology, tactile sensors, image processing, artificial intelligence and object-orientated software development. A national technical network is to be established which will involve many other institutions and research centred within the UK.

More information about the ARRC can be obtained from Derek Palethorpe or Diane Joines, Salford University Business Services Ltd. Tel: 061 745 7384.

Acadhomey

A low cost artwork design utility is available from CADsoft, to allow electronics enthusiasts to design professional quality single or double sided pcbs on a home computer. The utility is availble for all Amstrad CPC machines, and will operate with most Epson compatible dot matrix printers including theAmstrad DMP2000, Brother M1009, Cannon 1080A, Citizen 102A, Epson MX80, FX80, FX100, LX86 and many others. (Printers that will not work with this utility include the Amstrad DMPI, Shinwa CPA80).

Powerful on-screen editing makes layout design quick and simple, and the mutli-colour display (multi-shade on monochrome screens) allows both sides of double sided layouts to be viewed simultaneously. Boards of up to 25 inches square containing up to 4000 structures can be accommodated with memory expansion.

The artwork is printed out twice full size to ensure accurate scaling and high resolution, and draft or final quality printouts may be chosen.

The utility is available on tape or disk for £17.99 and £19.99 respectively, which includes a 16 page instruction booklet, postage and package.

Anyone wishing to confirm compatibility with their printer should write to **CADsoft Systems, 18 Ley Crescent, Tyldesley, Manchester M27 7BD,** enclosing detailed specifications of the printer and an sae.

Decade Capacitance

Levell Electronics have added to their range of instruments a new decade capacitance box type CB610 at only £79 + VAT.

The CB610 has 6 decades of capacitance from 10pF to 11.11111μF with an accuracy of $\pm$1%$\pm$2pF. Drift is $<\pm$3%$\pm$1pF in 1 year below 50nF and $<\pm$1% above 50nF. The dissipation factor is <0.002 at 1MHz from 30pF to 1nF, <0.001 at 1kHz on 1nF to 50nF and <0.01 on 50nF to 11μF. Maximum input is 250Vdc, 160Vac and 1A at hf. The compact box has dimensions of 190 × 110 × 90mm and weighs 550g. Also available is a 4 decade capacitance box type CB410.

The decade capacitors are selected from components with stable dielectrics and the switches have silver plated self-wiping contacts with low losses up to 1MHz. The minimum control setting of 10pF includes the residual capacitance so the controls indicate total capacitance at all settings. The capacitors are isolated from the case and an rfi screen is joined to a separate terminal that is linked to the adjacent capacitor terminal during calibration.

Contact: Levell Electronics Ltd, Moxon Street, Barnet, Herts. Tel: 01-499 5028.

THE LEADING EDGE

By Barry Fox—Winner of the 1987 UK Technology Press Award

A FIFTH TV CHANNEL

The choice of an extra channel for viewing entertainment now seems possible, but will radio astronomers suffer yet more interference?

Britain now looks likely to get a fifth TV channel, by the early 1990s. The programmes could well be premium entertainment which is scrambled and thus available only to subscribers equipped with decoders.

None of this bodes well for direct broadcasting by satellite. Premium entertainment, like first run feature films, pop concerts or big fights, is expensive for the broadcaster – regardless of whether it is broadcast from terrestrial or satellite transmitters. And clearly it is cheaper to transmit from existing aerials than launch a satellite into orbit. It is cheaper and easier, too, to receive programmes from existing transmitters on existing sets than install a dish and associated electronics.

In October 1987 the Department of Trade and Industry and Home Office asked the BBC and IBA to carry out a technical study and see whether there were enough frequencies available in UHF Bands IV and V for a 5th tv network, in addition to BBC1 and 2, ITV and Channel 4. A total of 48 frequencies in the UHF band are allocated to entertainment tv, but in the middle of the band four frequencies (numbered channels 35, 36, 37 and 38) are set aside for radio navigation at airports and radio astronomy.

The BBC and IBA currently reach 99.3% of British homes with their four programmes. They do this by sharing the 44 available frequencies between 50 large transmitters and 750 small relay stations spaced round the country. The same frequencies are reused by transmitters which are far enough apart not to interfere with each other.

The BBC and IBA did some tests and calculations which showed that there was no hope of providing a 5th service by tighter re-use of the existing 44 frequencies. Transmitters currently rated at up to a megawatt would only be able to radiate around 10 watts on the 5th channel. Even with the careful use of directional aerials, aimed to transmit signals only in directions where there would be no risk of interference, power levels would only be around 1 kilowatt. And the directional patterning would inevitably create blind spots for 5th channel reception. Only around 20% of the population would get a useable signal.

So the DTI, Home Office, BBC and IBA starting looking at the four "spare" frequencies.

Channel 35 should by now be free, with airport radars on this frequency already shifted out by the broadcast band or to Channel 36. The radars on Channel 37 are due to shift by 1994. Channel 38 is the most contentious; it is used by radio astronomers.

By international agreement, 26 frequencies between 37.75 and MHz and 49 GHz can be used by British radio telescopes. But astronomers have first call on only 14 of these. They are "secondary users" on the rest. Broadcasters leave them clear only as a favour.

Dr Jim Cohen, Senior Lecturer in Radio Astronomy at the University of Manchester and Jodrell Bank told me how he has been fighting over frequencies for 20 years. He says things are getting "steadily worse" and astronomers are not being told what is happening through official channels. "We read about it in the newspapers" says Dr Cohen. He fears that the astronomy channel will be lost because "radio astronomy is a softer target than radio navigation."

The threatened Channel 38 at 610MHz is allocated to Cambridge and Jodrell Bank, and used for observing pulsars. The allocation is secondary. So it is one which the government can commandeer for tv. Faced with a choice between more feature films and research into pulsars, it is not hard to guess what the great British public would choose.

Fortunately, the BBC and IBA engineers have found that although 800 transmitters are needed to cover 99.3% of the population, the law of diminishing returns works in their favour. Just 14 transmitters can reach around 70% of the population with just two frequencies.

The BBC and IBA have now told the Home Office and DTI that the answer is to stop airports using channel 37 for radar. This way there could be a 5th entertainment channel for two-thirds of the population by 1991. It would use channels 35 and 37, leaving astronomy channel 38 unaffected.

The people most likely to suffer are those investing money in direct broadcasting by satellite. The British consortium, British Satellite Broadcasting, is spending £200 million just to launch a satellite service which is scheduled to start beaming three new tv programmes into British homes in two years time. Viewers will have to pay several hundred pounds each for reception equipment. By comparison it will cost the BBC and IBA only a few million pounds to install 14 new transmitters at existing sites. Viewers will be able to receive the new programme on existing sets at little or no extra cost. They will only need to re-tune their existing receiver and in some cases modify their existing aerial to capture signals which are currently out of its band.

This ties in neatly with quite separate work done by the BBC on "downloading", or broadcasting scrambled tv programmes during the dead night hours. The scrambled programmes trigger a video recorder which has a decoder to de-scramble the programme for later viewing.

Shortly before Christmas the BBC tried several scrambling systems, to see whether the doctored signal could pass through the national distribution network to main transmitters and relay stations. Scrambled test programmes were broadcast at night after ordinary programmes had finished. Engineers toured Britain with de-scramblers to check picture quality.

The BBC chose Discret 12, a system developed by Philips and already being used in Switzerland and in France for the Canal Plus terrestrial subscription channel. Every tv picture is made up from 625 horizontal lines and Discret 12 randomly delays some lines, but not others, by a few microseconds. The effect on screen is a sideways jutter effect, which leaves the picture recognisable but unwatchable.

The sound is also scrambled by inversion. Because most music and speech contains mainly low frequency energy, the decoded result is a very high pitched tizzy sound. PE

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TIMELY EGGS

Following publication of the Christmas issue I received a letter from a reader who was dismayed that we had published 'another egg timer'. His letter is on the letters page. At first sight, some might consider it to be unworthy of comment. In fact it raises questions more serious than perhaps the writer realised.

It is true that over the years many egg timers have been published in electronics magazines. This certainly does not preclude them from being repeated occasionally.

Although magazines have a hard core of regular long term readers there is inevitably 'natural wastage'. People change, their hobbies change, they find that job or family commitments override other interests, and sadly they even die. This does not spell doom for magazines since others of all ages come to discover an interest in electronics and the constant flow of newcomers replenishes the ebb of departure. These new readers may never have seen an electronic egg timer, or whatever circuit it may be, and it could be just what they have always needed, but did not know it until seeing one in the latest magazine. For those folk such a circuit is not dried egg on an ancient plate, it's exciting new sunny side-up material.

This is not to say that magazines should reprint old articles, even for the sake of cost cutting. A thriving magazine does not need to resort to such tactics. There is, however, justification for reprinting some features in book form. In this way exceptionally high quality material is given a longer life and made available to a wider readership. PE has reprinted material in bookform several times, and will do so again in the future.

Normally, though, when a basic idea needs to be repeated it should be put forward in a different form so that even readers who have seen it before should benefit. Electronics changes rapidly, making available different techniques for achieving the same ends. Even if the cost and chip count does not decrease, the alternative thinking may be of interest in its own right.

One of the roles of a magazine like PE is to teach. Projects, therefore, are published not only as interesting things to build, but also as vehicles for illustrating particular aspects of design. Any teacher knows that learning can be made easier if a hands-on approach can be taken. Consequently, many projects have this dual role. Although a useful working model is one end product, another equally important function is to show techniques that may be applied to other situations.

In the Christmas egg timer, for example, various functions are shown that can be taken separately and used elsewhere. There is a 555 variable timer, decade and bcd counters, biasing levels for leds, multiplexed diode gating, and transistors used as switches, just to mention a few.

Be pleased when a magazine caters for new readers as well as regular ones. Only magazines destined for oblivion ignore the interests and importance of newcomers.

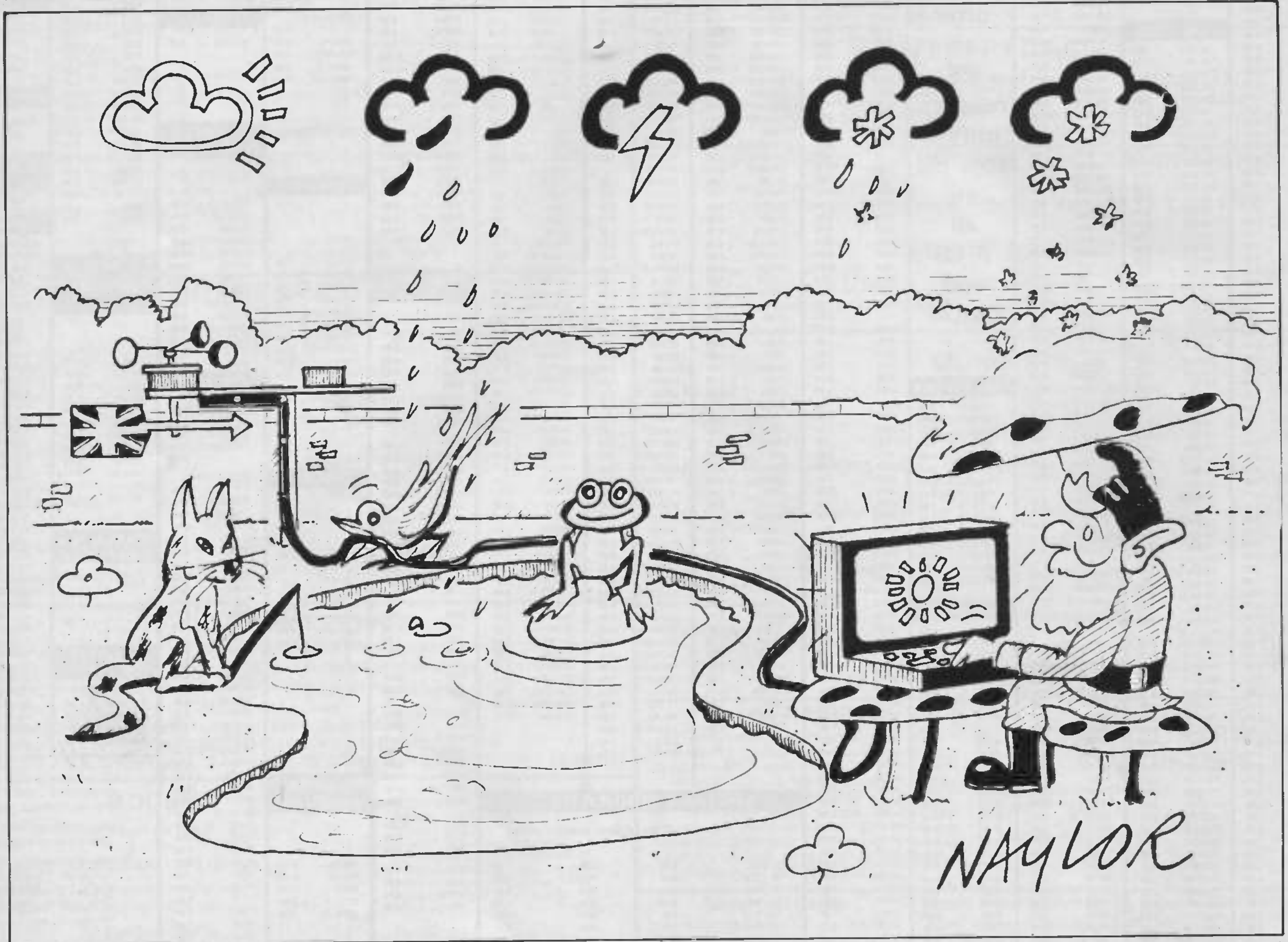
THE EDITOR

OUR APRIL 1988 ISSUE WILL BE ON SALE FRIDAY, MARCH 4th 1988 (see page 2)

Weathermen a wind-up? Is meteorology mud in your eyes? Atmosphere getting a bit heavy? With the PE wind speed, wind direction, soil moisture, temperature and light meters, you can measure your own microclimate.

EXPERIMENTAL WEATHER CENTRE

BY JOHN BECKER



ENGLAND has an international reputation as a country where it's always raining. Probably Hollywood is much to blame for this stock image; a favourite scene for many movies portraying an opening shot of England is a view of some well known landmark, usually around London, partly obscured by a downfall. If it's on film it must be true! What slander and libel — we all know that it only rains when we want to do something interesting outside.

Still, it's said there's no smoke without fire, so presumably there's no flood without rain, and our image must have a root cause somewhere. Let's face it, Britain as a whole does seem to be a nation obsessed with the weather. In any conversation the first remark is probably to do with health — 'How are you?', but the next is likely to be a reference to the weather — we all know the vast vocabulary of phrases available. We wouldn't have this vocab if the variety of situations didn't exist. Didn't the storms of October 87 give us something to talk about?

HOME TRUTHS

Being equally guilty of meteorological inquisitiveness, I decided to satisfy curiosity about relative climatic conditions in my back garden. This is not entirely because the back garden appears to have a meteorology dissimilar to that shown on the tv weather summaries. It's as much to quantitively answer such profound questions as "is it *really* cold/hot, or am I sickening?", or "surely it's not raining again?" or "has the wind dropped enough for me to risk realigning the roof aerial?". And so began the project that I am about to describe.

DESIGN WRITES

The design was actually created and put into periodic service during 1986, but it's taken the October 'hurricane' to get me down at the keyboard to write a few words about it. First, let me tell you briefly what it does, then I'll go into more detail about how it does it (Fig.1).

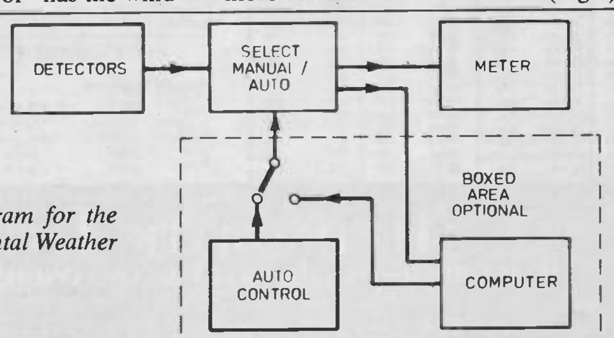


Fig 1. *Block Diagram for the complete experimental Weather Centre*

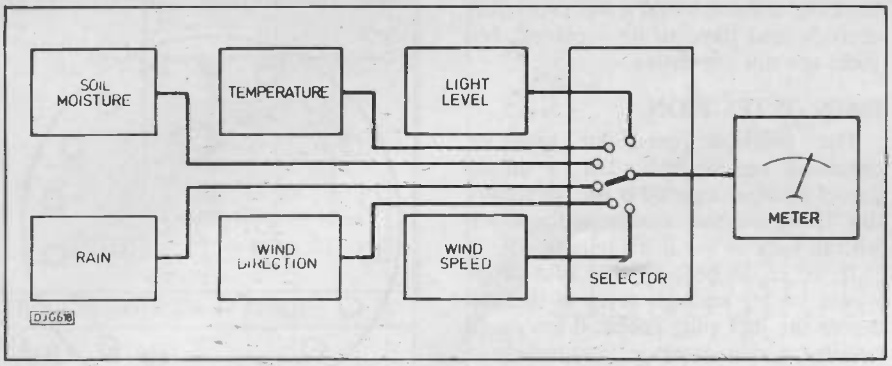


Fig 2. *Block Diagram of the Detector Circuits*

The project is split into two main sections, one for various detectors, and the other for selecting and monitoring them. The latter may be by a voltmeter, either manually switched or under automatic multiplexed control. Additionally, the complete unit can also be put under computer control. Although it's not a precision instrument, extra parameters may be incorporated into the computer program to compensate for non-linearity.

There are six detectors (Fig.2), covering temperature, light level, rain detection, soil moisture, wind speed and wind direction. They are suitable circuits for anyone to build, however limited their electronics experience. The first four are the simplest and basically only involve pcb assembly. These are probably suitable circuits for anyone still looking for a GCSE project. The other two need the construction of some mechanical hardware, but this too is largely derived from electronic parts.

If the six circuits are to be used with a manually switched meter as the monitor, a dc power line level of between 5V and 12V may be used; a 9V battery is obviously satisfactory. Fig.3 shows the circuit diagram for all six detectors.

LIGHT DETECTOR

The daylight level detector is probably the simplest of the circuits to put together and check. The latter can be done just by switching a light on and off. The detector itself is a light dependent resistor, LDR1. This has a resistance across it that varies with the level of light reaching its sensitive surface. In total darkness it has a resistance of around 10M, but under extremely bright conditions this can drop to only a few tens of ohms.

Since it it to be used to monitor daylight brightness, we are really only interested in the lower resistance values. The ldr is therefore put into series with a low value presetable resistance, VR1, and the two are used as a potential divider across the dc power lines. The voltage seen at the junction of VR1 and the ldr will vary with the light level. It is fed into the inverting unity-gain buffer IC2d, and the output voltage at G6 will rise as the light level increases. The output can be monitored by connecting a voltmeter directly between G6 and the 0V line.

VR1 should be set for the widest meter-scale swing between full brightness and darkness. Note that the characteristics of IC2 will never allow the output voltage to reach zero or full PSU level voltages.

This circuit, and the next three also depend on a split level reference voltage for their operation. This is provided by R21, R23 and C3, at the junction of which the reference will be approximately half the battery voltage level.

TEMPERATURE

One of the characteristics of a transistor is that its gain is dependent upon its temperature. Normally this is an unwanted characteristic around which one probably has to design and compensate. Here it can be put to good use by making the transistor a temperature detector.

TR1 is biased by R27, VR4 and R28 all in series. R29 is the collector load and VR4 is used to set the best bias level so that temperature changes will cause the voltage at the collector to swing within a reasonable range. The collector voltage change is detected by IC2c, in an inverting mode set for unity gain.

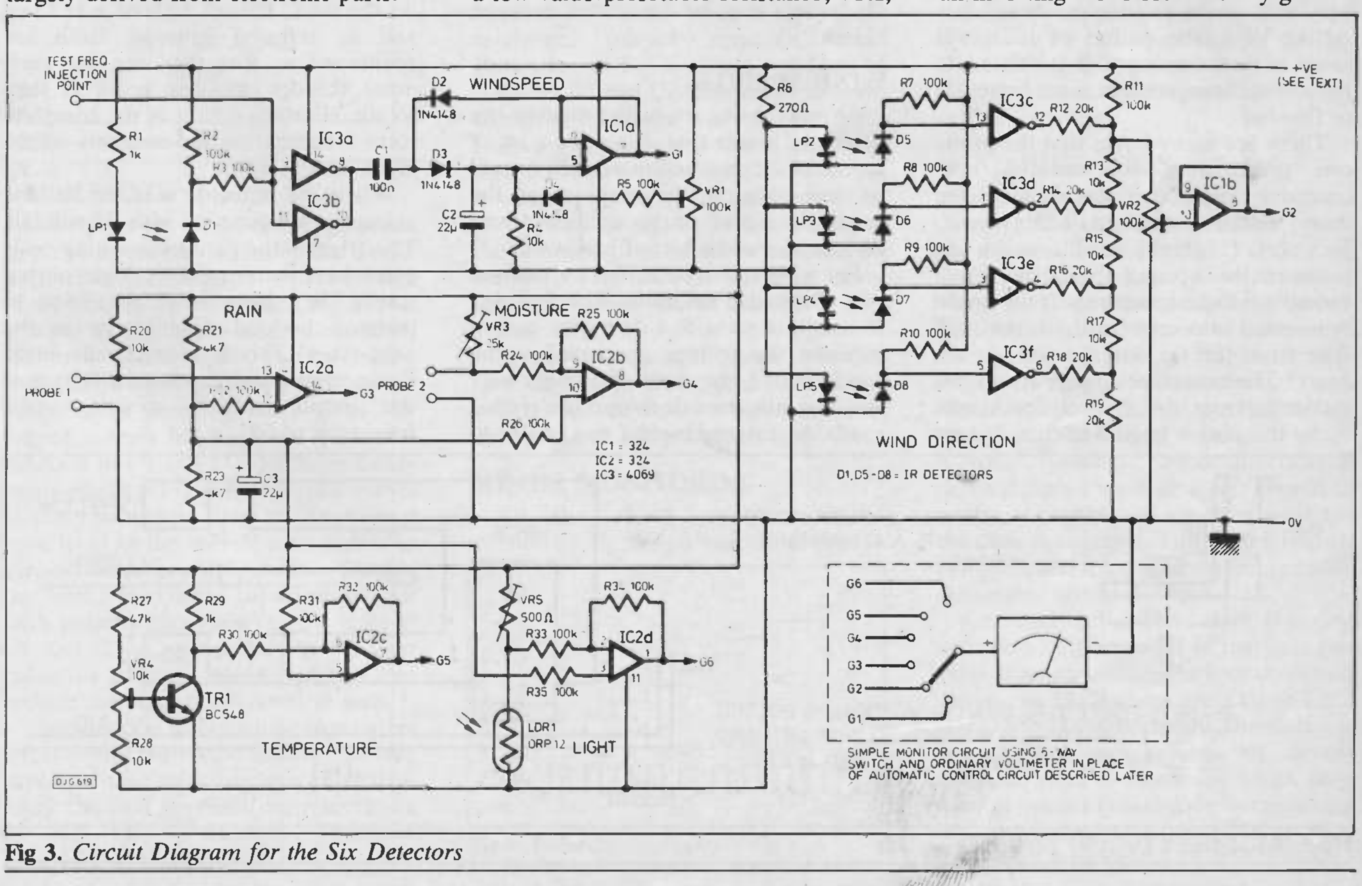


Fig 3. *Circuit Diagram for the Six Detectors*

As the temperature at TR1 rises, so its gain will increase, causing a voltage drop at the collector. Since IC2c inverts, the output of IC2c will rise correspondingly. Downward drops of temperature will reverse the gain factor and consequent level change direction. A voltmeter can again be used to read the voltage, at G5.

MOISTURE DETECTION

Most of you should know that water can conduct electricity. It's not a very good conductor, but it can do so readily enough to make the presence of mains operated equipment in its vicinity potentially hazardous. Low level dc voltages present no such danger and can safely be used to monitor wetness conditions. This next circuit for measuring soil moisture will show just how conductive even damp materials can be at low voltage levels.

IC2b is another inverting unity gain buffer, the output of which can be read on a voltmeter placed at G4. A two-pole probe is connected between VR3 and ground. Under dry conditions, there will be no conduction between the two sides of the probe. Consequently, the input to IC2 via R24 will be at a high level, and the output held equivalently low. If the probe is inserted into any damp substance, the dampness will conduct current across the probe. The current level will depend on the dampness level, in other words, on the resistance across it. This resistance forms a potential divider in series with VR3. The voltage at the junction of the two will of course vary with probe resistance. By suitably setting VR3, the output of IC2b will cause a meter swing that is related to the soil moisture content, from bone-dry to flooded.

There are many forms that the probe can take, from sophisticated non-corrosive conductive materials, to the item I used — a standard (0.25in) stereo jack plug. Under dry conditions the gap between the tip and the barrel has a virtually infinite resistance. If the probe is inserted into moist soil, current will flow from the tip, via the soil, to the barrel. The resistance change across this distance, from dry to wet conditions, make the plug a good detector. It does have the drawback that it will eventually corrode and have to be replaced, but jacks are not expensive.

RAIN DETECTION

The principle used for moisture detection can be extended to simply detect whether a probe is wet, or totally dry. Those are the conditions for which we can look to see if it's raining.

If we could be sure that rain drops would be big enough to cross the gap across the jack plug probe, it too could become a rain detector. Fortunately in Britain such conditions are rare (not so in the Tropics though, as I have first hand painful reason to know!). For normal rain drops or drizzle detection we need a probe that has a narrower gap between the two halves. Also, since the landing point for any rain drop may not correspond with the probe gap, a wider area of gaps and conducting tracks is preferable.

Veroboard, or a section of suitably designed pcb tracking can become an ideal wide area rain detector. A suggested pcb section is included on the board for these detector circuits.

The rain probe is connected via R20 across the PSU lines and fed to IC2a. This is coupled as a comparator, with its output at G3. If the probe is dry, R20 will hold the input of IC2a high, and its output will be low. If rain shorts across the probe tracks, R20 will then effectively be grounded, and the output of IC2a will go high. These two states will of course readily show up on a voltmeter. Alternatively a led in series with (say) a 1k resistor can be connected between G3 and 0V.

WIND SPEED

We now move on to the first of the detector circuits that also need a bit of mechanical construction as well. As will be seen though, the majority of the materials are all to be obtained from various electronic bits of hardware.

For wind speed detection I visualised two alternative solutions. The first was to couple a rotor to a dc motor, and to measure the voltage generated as the wind rotated the rotor. Although very low cost miniature dc motors are readily available, astonishingly, I was unable to find sources for the necessary couplings. You may have better luck in your area and be able to use a motor in this fashion.

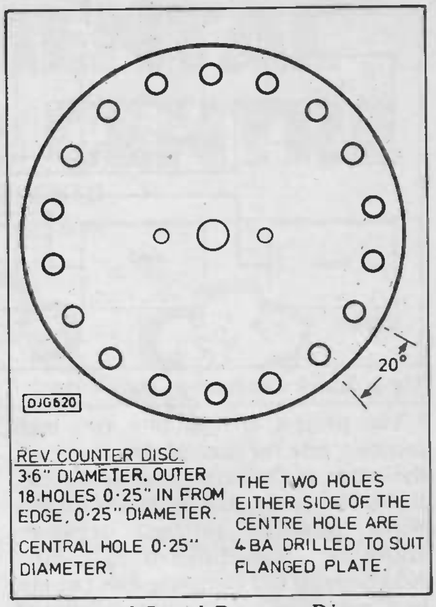


Fig 4. *Wind Speed Detector Disc*

I was not so lucky and instead had to use a rotatable punched disc to generate a series of pulses as it revolves, Fig.4. The number of pulses generated per given period of time can readily be translated into a speed equivalent. It is after all, only a question of simple frequency to voltage conversion.

On one side of the punched disc is a led, LP1, and opposite it there is a light detecting diode, D1. (Fig.5). Probably any sort of led and detecting diode will do the trick, though I chose a red led, and an infrared detector. Both are positioned so that they can see each other through the disc holes as they rotate. (Further details of the complete rotor construc-tion and assembly will be given next month).

When the detector sees the led the voltage at the junction with R2 will fall. This triggers the parallel inverting cmos gates into their opposite logic output stage. They have been paralleled to increase the load capability to suit the next stage. This is a practically-linear diode pump which produces a voltage at the output relative to the pulse frequency to C1.

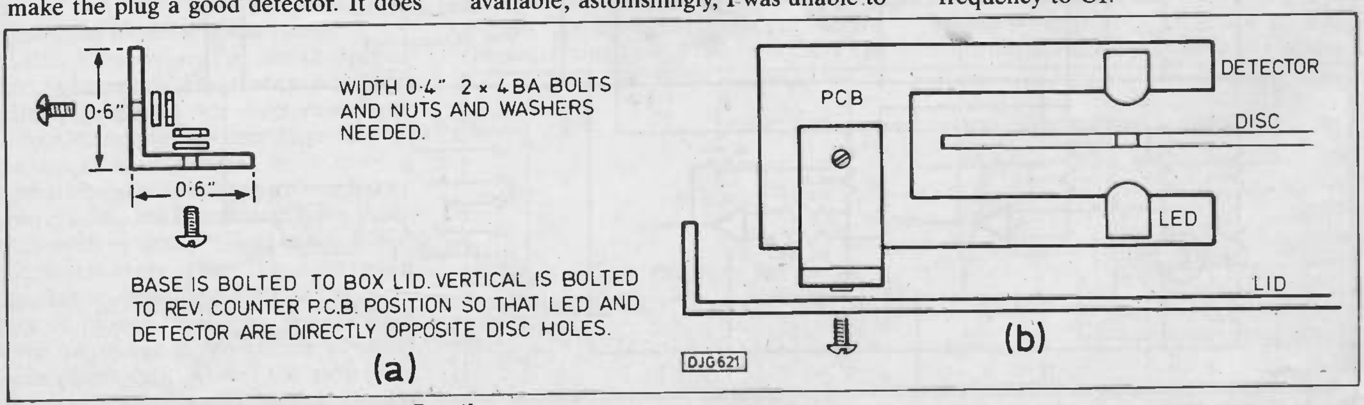


Fig 5. *Wind Speed Detector Mounting Details*

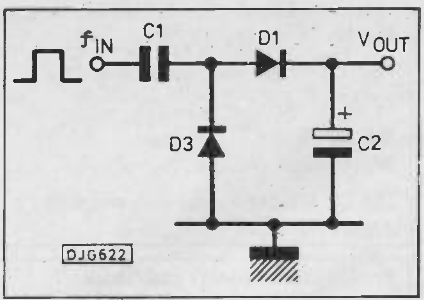


Fig 6. *Standard Diode Pump*

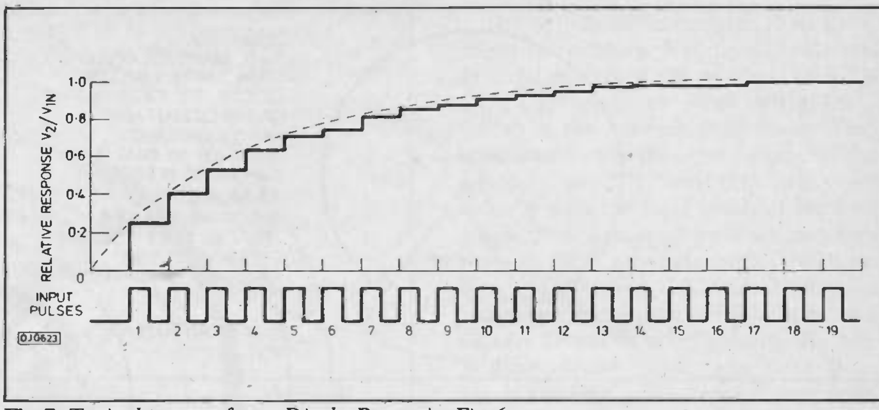


Fig 7. *Typical output from Diode Pump in Fig 6*

DIODE PUMP

It is quite an interesting circuit in its own right. In a conventional diode pump circuit, such as in Fig.6, pulses come from capacitor C1, through diode D1, to storage capacitor C2 which charges up a little more with each pulse. Useful though this circuit can be in rough frequency to voltage conversions, it is inherently non-linear. Tim Pike described the characteristics of capacitor charging in his Teacher Timer article in September 1987. In essence, the rate of charge of a capacitor will slow down the higher its charge level becomes. In a frequency to voltage application, this means that each consecutive pulse will add progressively less additional charge to the capacitor. Fig.7.

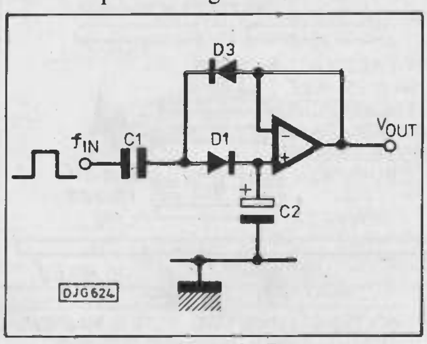


Fig 8. *Linearised Diode Pump*

IMPROVEMENT

With a simple bit of bodgery we can improve considerably on this and devise a circuit that adds similar steps of voltage to the capacitor at each pulse. Fig.8. This is done by taking the storage capacitor C2 to a non-inverting opamp buffer stage. The output and inverting input are coupled, so ensuring unity gain. The output is then fed back via D2 to the junction of C1 and D3. In the ordinary pump circuit in Fig.6, D2 causes the level at this junction to drop to the original base level at the end of each pulse. In this alternative configuration though, the level added to the capacitor store at each pulse is also added to the level at C1 and D3. Consequently at the next pulse the extra charge added will also include the previous dc level as well.

This situation will continue to progress linearly with each pulse until the storage capacitor reaches its maximum charge. Fig.9 shows a graphical representation of the linear staircase waveform generated in this fashion.

PUMP BIAS

Two problems arise from this method. First, once the capacitor has reached its maximum level, it can increase no further. This means that either it must be rapidly discharged periodically by a regular data pulse, or constantly have some of its level leaked away so that it can vary its response with frequency changes. The latter approach is simpler and although it introduces an element of non-linear charge and discharge, it is still a good solution in a wind speed detection application.

The second problem is that the opamp used can never allow its output to fall to zero volts in this configuration. Consequently, when the storage capacitor first starts charging from zero level, there will be no change on the opamp output until the charge level reaches the equivalent minimum inherent value. To overcome this, a small bias level is needed on C2 to bring it up to the minimum output response level. Returning to Fig.3, this is provided by VR1 via R5 and D4. The latter prevents capacitor discharge back through VR1. Failure to prevent this would affect the timing factor set by C2 and R4.

When monitoring the voltage output of G1, VR1 should be adjusted until, in the absence of a frequency input, the meter needle is just seen to move upwards. Then back off VR1 very slightly.

A test frequency injection point has been allowed at the input of IC3a-b, and enables the meter or other monitor to be calibrated. More on this later.

METER MONITORING

All the above circuits can be monitored by an ordinary multimeter.

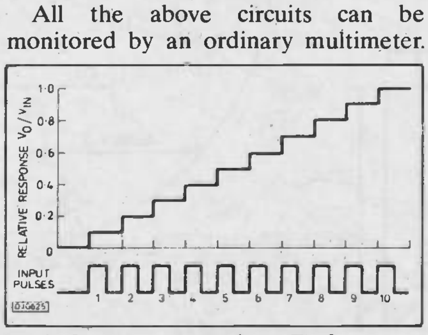


Fig 9. *Staircase output from Fig 8*

The dc volts range chosen should be the one suited to the battery or PSU level voltage. A 6-way switch may be inserted between each detector output and the meter so that monitoring may be manually switched from one circuit to another. Instead of a multimeter, a panel meter, preferably with a large scale, could be used. This then could be calibrated for each circuit so that an instant readout of weather conditions can be made. Alternatively, charts converting voltage to ambient conditions could be drawn up.

Such a set up would of course require that eight leads go from the unit, presumably in the garden, to the meter, presumably in the house. Two leads would supply the power, and six carry the detection voltages back to the switch.

WIND SPEED MECHANICS

It's said that pictures paint a thousand words, so I'll refer you directly to Figs. 10 to 12 for the remaining wind speed assembly drawings. Hopefully, these are self explanatory.

WIND DIRECTION

Before embarking on the original design I had expected to find a rotary pot that could turn through 360 degrees, and then more precise wind directions could have been detected. Regretably I could not find any. Rotary switches were discounted because of their friction. However, the method chosen has been found to be sufficiently reliable for simple purposes.

Not surprisingly, wind direction is derived from a weather vane. Digital to analogue techniques are then used for the data conversion. The vane is shown in Fig.13, and it too is made from readily obtainable bits and pieces.

Attached to the vane shaft is a disc with slots in it arranged so that leds can shine through and trigger light detecting diodes. In Fig.3 these are LP2 to LP5, and D5 to D8 respectively. The slots are cut so that the number of diodes activated, and the order in which they turn on forms a binary code by triggering the corresponding gates IC3c to IC3f from logic 0 to logic 1.

Fig 10.

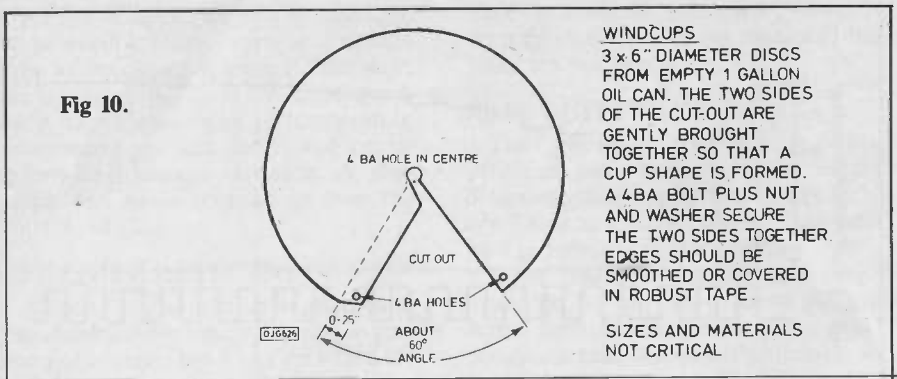


Fig 10. *Wind cup details*

Fig 11. *Wind cup mounting and rotor*

Fig 12. *Rotor Mounting Mechanical Details*

Fig 13. *Weather vane construction details*

Printed circuit boards and circuit components are available from Phonosonics

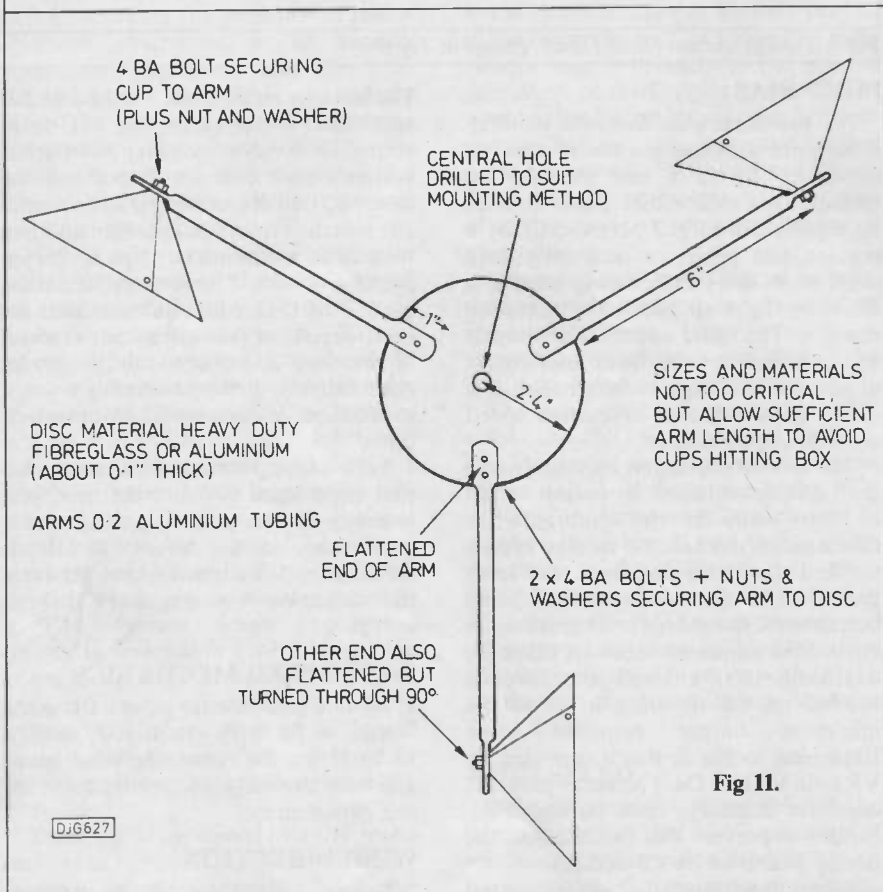
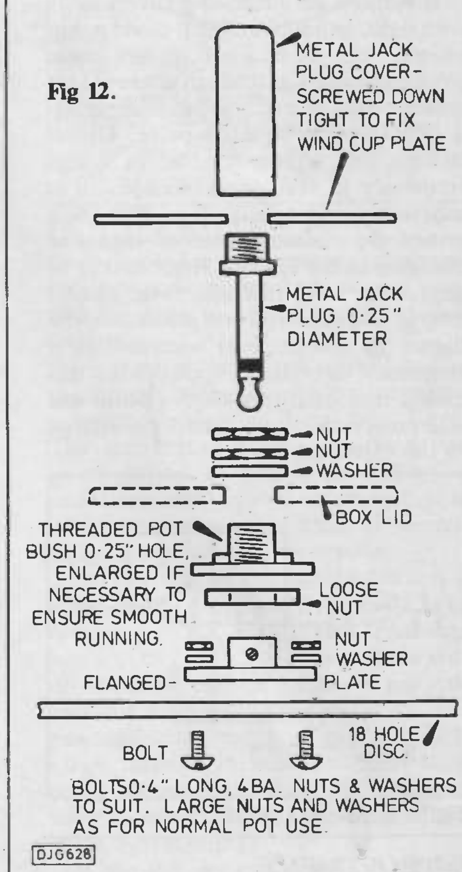


Fig 11.

Fig 12.



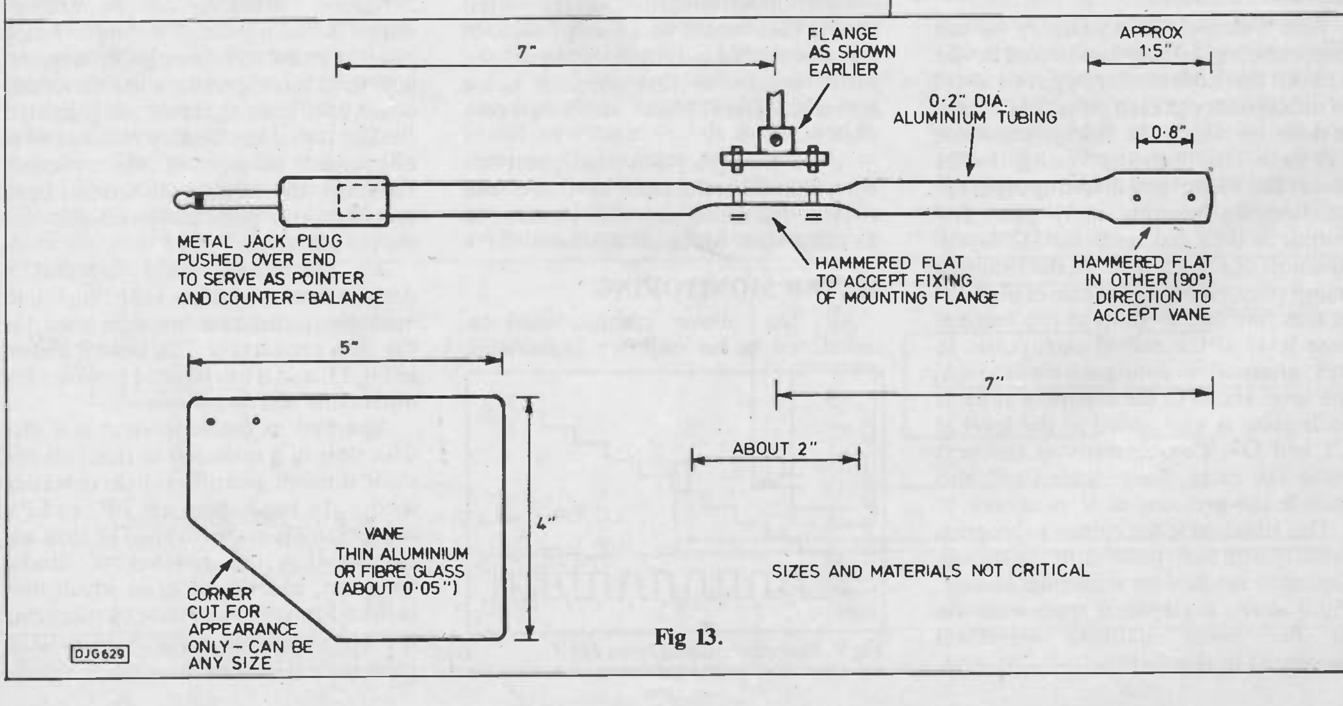


Fig 13.

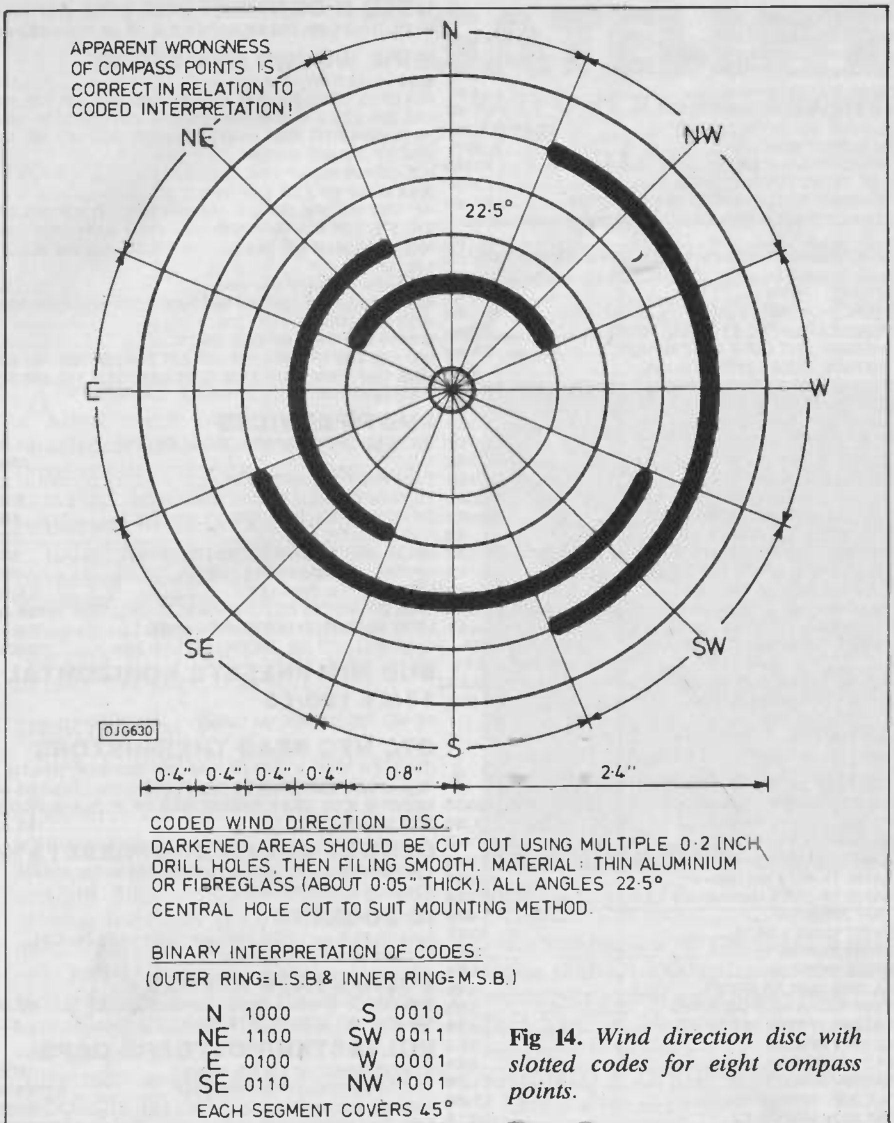


Fig 14. *Wind direction disc with slotted codes for eight compass points.*

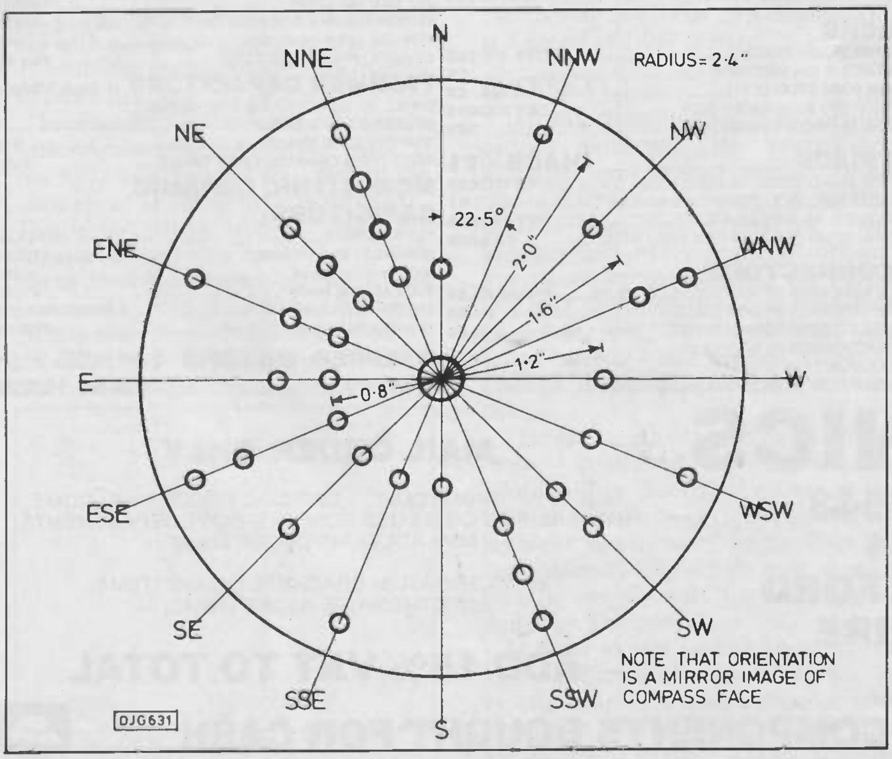


Fig 15. *Alternative coded wind direction disc with 16 compass points.*

The outputs are connected to an R-2R chain of resistors, R11 to R19. Robert Penfold described the principle of R-2R D-A conversion in Real World Interfacing in the January 1988 issue. What it amounts to is that the voltage at the junction of R11 and R13 will vary linearly with the logic levels of the four gates. This is tapped by VR2 and sent through the unity gain buffer IC1b, to appear at output G2. Sure enough, a meter can be coupled to this output, and voltage levels read off directly. By calibration of the meter, specific voltage levels can be related to the binary code, and thus to the weather vane orientation.

COMPASS SETTING

The details for one possible compass direction disc are shown in Fig.14. The slots are arranged so that the binary code produced by the leds and infrared detectors are –

N 1000, NE 1100, E 0100, SE 0110,
S 0010, SW 0011, W 0001, NW 1001.

In decimal these numbers are 8, 12, 4, 6, 2, 3, 1, 9. This is not the easiest of sequences to display linearly on a meter, though a computer program could cope with them quife readily. If we don't mind dispensing with the intermediate compass points, and end each slot immediately before the next one starts, a better sequence of 8, 4, 2, 1 can represent N, E, S, W respectively. There could, however, be a slight blind spot between each slot interchange.

An alternative disc is shown in Fig.15. This though, is only for computer use since there are many blind spots, between each compass point, and it isunsuited to meter monitoring. A computer is quite capable of memorising the previous hole detected and only updating the display when a fresh hole is encountered. With this disc the binary codes translate linearly from 15 to 1. The equivalent compass points are NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, NNW. Ideally for this disc a fifth led detector is needed to get the 16th point. Instead, I have put a number '8' hole at the North point. The computer can decide whether '8' should represent North or South by knowledge of the previous point detected.

The full assembly and mounting of the vane and its disc will be shown in greater detail next month.

FORECAST

In part two next month, I'll describe circuitry that will enable automatic monitoring of all the detectors, and require the use of only three wires, two for power, and one for a multiplexed analogue signal.

Have a nice day!

PE

SATELLITES

PART ONE BY MIKE SANDERS

FROM TELSTAR TO INMARSAT

The use of satellites in geostationary orbits has revolutionised global communications. PE looks at the early development and the modern day technology of the satellites and their ground stations.

ARTHUR C. Clarke, the science fiction writer envisaged world wide satellite communications with the use of three satellites place in stationary orbit as in Fig.1. He described this in an article in *Wireless World* in October 1945.

Today there are 500 million telephones worldwide and two thirds of international traffic is via satellites, the other third being over submarine cables. Not only do satellites carry telephone circuits, but telex, data and television.

ORBITAL FACTS

The Russian Sputniks and other experimental space flights of the mid 1950s were the forerunners of the first communications satellite, Telstar, in 1962. Telstar was not a stationary satellite like modern satellites but orbiting the earth at an altitude of 250 miles. And as the satellite was visible for only half an hour, the communications time was very limited but the excitement at receiving those first flickering pictures was unlimited.

By 1965 technology had progressed sufficiently for NASA (National Aeronautic and Space Administration) to try for geostationary orbit, that is, stationary with respect to a point on the earth. The satellite traces a small figure of eight in order to correct its position.

In order for a satellite to be stationary with respect to a point on the earth, it has to revolve around the earth at the same speed as the earth turns on its axis. This is not strictly true. Although the angular velocity is the same, that is, each has to cover 360 degrees in 24 hours, the linear velocity of the satellite has to be greater than the corresponding point on the earth. This is because the satellite is much further out.

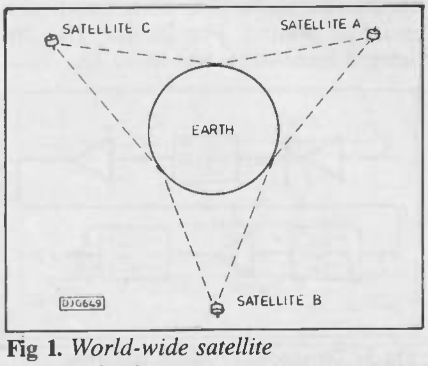


Fig 1. *World-wide satellite communication*

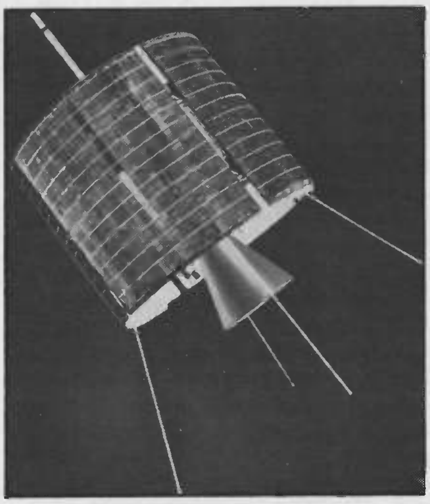


Photo 1. *Intelsat I*

With reference to Fig.2, the earth's radius is about 4000 miles and satellites are usually 22,500 miles above the earth. Therefore in 24 hours, the satellite travels:

$2\pi(4,000 + 22,500) = 166,571)$ miles

This is a speed of 6,940 mph.

By contrast, the point on the earth travels only $2\pi 4,000 = 25,142$ miles. This is a speed of 1,047 mph.

INTELSAT I

Intelsat (International Telecommunications Satellites), the organisation which manages most of the communications satellites, took charge of Early Bird in June 1965. This satellite went into geostationary orbit over the Atlantic and was joined by another over the Pacific Ocean in 1967 and a third over the Indian Ocean in 1969. These satellites were called Intelsat I and realised Arthur C. Clarke's dream of global communications.

The first earth stations operating to these satellites were Goonhilly (Cornwall) in the UK, Andover in the USA and Raisting in Germany. Receiving weak signals from the satellites has been likened to feeling the heat on earth from a one kilowatt bar heater positioned on the moon.

In order to pick up such weak signals in the presence of noise (sky noise as well as equipment noise), the receiv-ing amplifiers, called cryogenic ampli-fiers, are cooled to nearly −273°C (absolute zero) using helium as a coolant.

Each satellite in the Intelsat I network could handle 240 telephone circuits, but the big disadvantage was that a satellite could communicate with only one ground station at any given time. But by the time the Intelsat II range of satellites was launched, this problem was overcome and each satellite could communicate with more than one earth station simultaneously. Intelsat II also had a capacity of 240 circuits or one television channel.

In 1968, Intelsat III was launched with a much larger capacity: 1500 circuits or four television channels, or some of each. It was nearly ten years (1977) before there was any further demand for satellite capacity and Intelsat IV was launched with a capacity of 4000 circuits.

That was the heyday of satellite communications. There was suddenly a need for instant worldwide communications and small countries in particular could not justify submarine cables to every other country. Demand soon outstripped supply and an upgraded version of Intelsat IV, Intelsat IVA was launched with a capacity of 6000 circuits, several aerials and new technology, like "demand assignment" which will be described later.

DELAY FACTORS

Because of the distance that the signal has to travel to the satellite, considerable delay is introduced in receiving the signal. Although this is not such a big problem for speech, it can be more serious in transmitting data, particularly if real time processors are operating on the data. Suitable buffers and delay lines must be incorporated to ensure that no data is lost.

With reference to Fig.2, the total

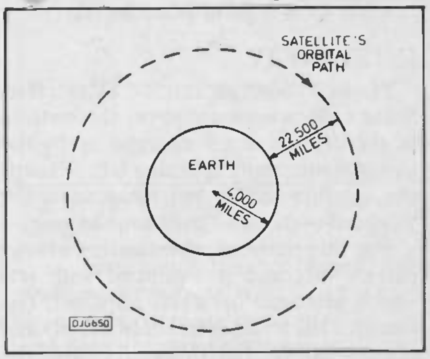


Fig 2. *Geostationary orbit*

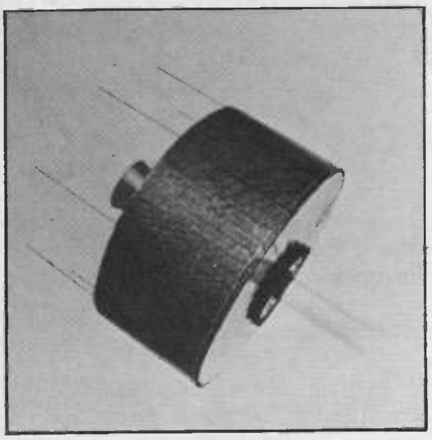


Photo 2. *Intelsat II*

distance to the satellite and back is about 45,000 miles. The speed of light is 186,000 miles per second. Therefore the time taken is:

$$\frac{45{,}000}{186{,}000} = 240\text{ms}$$

By comparison, a transatlantic cable from the UK to New York is about 5,000 miles. The time taken to travel this distance is:

$$\frac{5{,}000}{186{,}000} = 26\text{ms}$$

The satellite link is 9 times longer.

Photo 3. *Intelsat III*

Photos 1 to 3 shows the shape of the satellites used in Intelsat I, II and III. These were all drum-shaped and carried solar cells to power the equipment. The aerial on Intelsat III changed to a horn and this basic design (cylindrical body and horn plus dish aerials) has remained functional to the present time.

Although the physical shape change had been small, the technological and operational changes have been large. Intelsat IV is a good place to start.

INTELSAT IV

Photo 4 shows an Intelsat IV satellite. Solar cells are mounted on the outside of the drum and are charged up by the sun. An internally spinning wheel keeps the satellite steady but corrections are required to the orbit from time to time.

For this purpose, the satellite always carries fuel and is equipped with jets which are fired up when required. The satellite has an assortment of aerials and housekeeping functions are via the telemetry aerial.

When satellites are launched from Cape Canaveral, they are not in the correct position for an equatorial orbit, therefore they need to be placed in an elliptical orbit first, Fig.3. This is a temporary orbit and the satellite is moved to an equatorial position using its apogee motor. The name of the motor is derived from the highest point of the ellipse, the apogee. The perigee or lowest point is only 179km above earth.

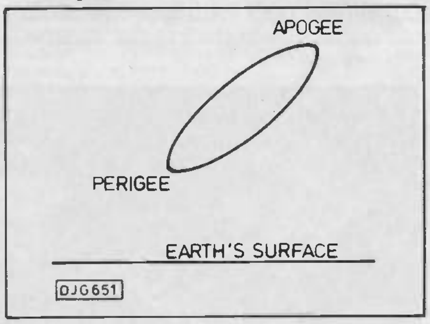


Fig 3. *Transfer orbit*

The European Space Agency (ESA) launch their satellites from Kourou in French Guiana, using their Ariane rocket. Since Kourou in South America is on the equator, the elliptical orbit, also called a transfer orbit is not required.

To assist in placing the satellite, it is equipped with a sun sensor and also an earth sensor. The earth sensor is an infra red sensor and senses heat from the earth against the cold of space. Gravitational forces in space, particularly the pull from the sun and moon, alter the position of the satellite gradually. This needs to be corrected at regular intervals.

Intelsat IV satellites carry horn aerials as well as paraboloids. The latter produce a narrower beam because of their focusing effect, only 4.5 degrees compared to 17 degrees from the horn

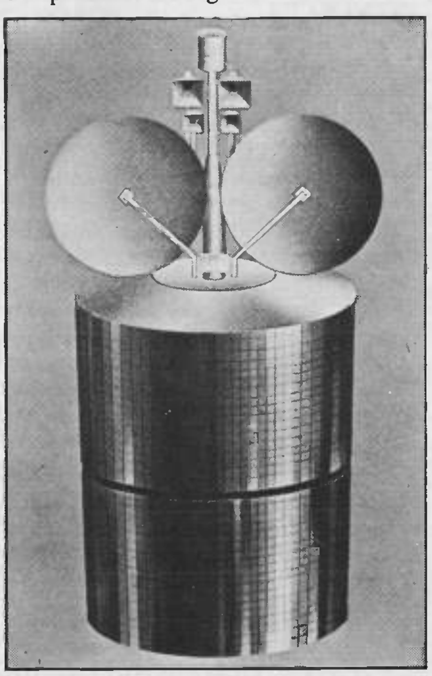


Photo 4. *Intelsat IV*

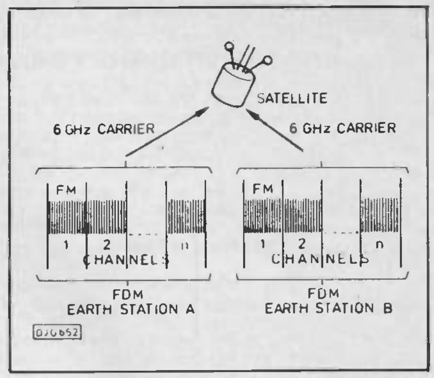


Fig 4. *FM/FDM/FDMA*

aerials. Therefore the paraboloids radiate a spot beam of 35dBW (relative to 1W) and carry East-West traffic. This traffic is double the capacity of the global beams radiated by the horn aerials which output 23dBW.

CHANNEL MODES

Intelsat IV operated in the fm/fdm/fdma mode. This means that each basic channel, whether for speech or data, was frequency modulated (fm). Then the channels were frequency division multiplexed (fdm) by each station within its allocated bandwidth on the satellite, Fig.4. Frequency division multiple access (fdma) means that more than one earth station can transmit to the satellite, provided each keeps to its allocated bandwidth in the frequency spectrum. Intelsat IV had 500MHz of bandwidth.

The 4kHz channels are assembled in blocks of 12 and up to a maximum of 960 for transmission to the satellite. Since the satellite receives signals on a 6GHz carrier and retransmits on a 4GHz carrier to prevent interference between the two signals, a frequency changer is required within the satellite.

The path through the satellite is shown in Fig.5. The part of the satellite that deals with signal reception, amplification and frequency changing is called a transponder. Each transponder has 36MHz of bandwidth with a 4MHz guard band between transponders. Therefore twelve transponders will cover the satellite bandwith of 500MHz, Fig.6.

A big improvement of Intelsat IV over Intelsat III was in the reduction of this guard band. For Intelsat IV, a 4MHz guard band for a 36MHz transponder means that about 10% of the bandwidth must be wasted. For Intelsat III, this wasted bandwidth was more like 70%.

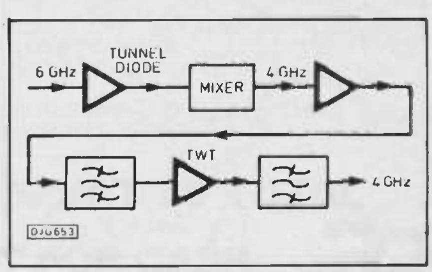


Fig 5. *Transponder block diagram*

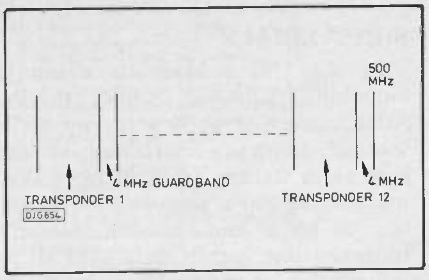


Fig 6. *Transponder coverage*

Also, the deviation of the frequency modulated carriers was greater for Intelsat III, which means that more bandwidth was used up.

POWER BUDGET

In designing a satellite link, the power budget is always worked out first.

Let P_e be the power launched by the earth station
P_t be the total noise in equipment and atmosphere
P_s be the signal power required by the satellite
Then $P_e - P_t = P_s$

Any of these factors can be altered. For instance if low noise equipment can be designed, then a satellite with lower signal power will suffice. The foregoing which applies to the up link (earth to satellite) can equally be applied to the down link. Because of power requirements and physical size, most of the burden of multiplexing and launched power is borne by the earth station or the earth segment as planners call it. Future satellites will bear a greater burden in terms of multiplexing and power.

With the signal to noise ratio at the satellite being only 10dB, expensive demodulators are required to recover the signal. These demodulators are called threshold extension demodulators because they effectively extend the threshold at which a normal demodulator would be able to detect a signal.

This is achieved by accurately locating the centre frequency of the received band. If a portion of the output from the demodulator is fed back to a voltage controlled oscillator and the oscillator in turn controlled by a phase comparator, then the centre frequency is effectively controlled, Fig.7.

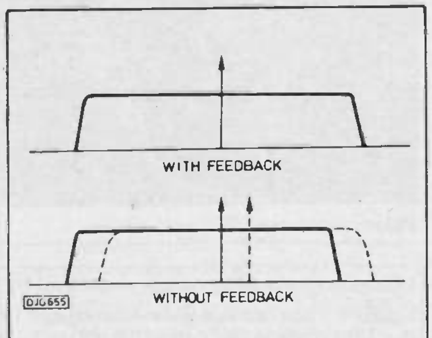


Fig 7. *Controlling the centre frequency*

This type of demodulator is of the frequency modulated feedback type and the semiconductors used in the circuits have special 'reach through' capabilities because of the manner in which the junctions are doped.

The ground station uses nine different carriers, each carrying a different number of 4kHz voice circuits or equivalent bandwidths for other purposes, eg data, tv etc. Operating more than nine carriers would increase the cost of the earth station. Reducing the number of available carriers much below nine would not give the range of transmitted bandwidths required by big countries in contrast with small countries.

If more than one carrier is transmitted, the power is distributed across the bandwidth allocated to that particular earth station and only 1kW may be beamed up to the satellite. On the other hand if only one carrier is transmitted, as much as 5kW may be concentrated in the one carrier.

TRAVELLING WAVE TUBES

Earth stations operate at an intermediate frequency (if) of 70MHz and this is converted up to 6GHz in two stages. There are also two stages of power amplifier employing travelling wave tubes (twt). These give a total of about 70dB of gain over 500MHz. The special feature of twts is that they have this wide bandwidth, so the valve era is not quite dead yet.

A travelling wave tube is shown in Fig.8. A mode converter is required to couple the waveguide (or coaxial cable) to the helical wire. An absorber is also used to stop reflections at the output. The helical wire is the all important part of this device since the speed of the wave depends on the pitch of the windings.

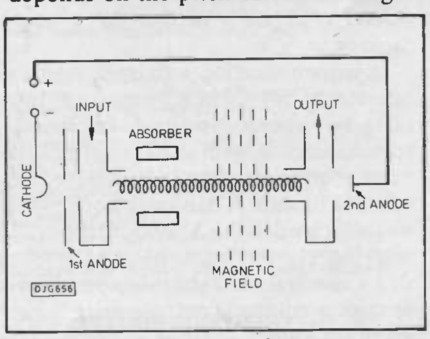


Fig 8. *Travelling wave tube*

A beam travelling down the helix energises the electromagnetic component, amplifying the latter, provided both are travelling at the same velocity. A magnetic field applied parallel to the axis of the helix stops the electron beam from spreading.

Klystrons are also used as power amplifiers in the microwave region and are capable of greater power outputs than twts but the klystron cavities require tuning. When equipment is required to be taken out of service, switching to a standby twt can be immediate since tuning is not required. But to avoid intermodulation products, twts are operated at 10dB below maximum power.

BAND GROUPING

At an international transmission centre, usually located in a city, 4kHz speech circuits are assembled in blocks of 12 called a group, occupying a bandwidth 60kHz to 108kHz. Other groups are then multiplexed to occupy slots in the 500MHz of satellite bandwidth. A further group is tagged onto the bottom and called group A, Fig.9.

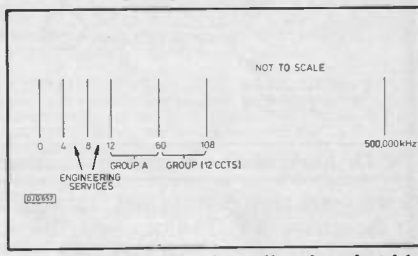


Fig 9. *Utilisation of satellite bandwidth*

This leaves 12kHz of bandwidth at the bottom of the spectrum. There are two 4kHz slots for engineering purposes and each 4kHz slot carries a speech circuit and five telegraph circuits. The band below 4kHz is left free and when traffic is light, a triangular waveform is applied here to balance the energy across the whole band.

By 1975 the number of different carriers had increased from 9 to 20 and to separate these, circulators were used. Today stripline couplers are used, Fig.10. In the circulator, a ferrite rod is placed along the axis of the waveform. Now, if a magnetic field is applied, the wave is rotated so that a wave perpendicular to port 4 will exit at port 2 and so on.

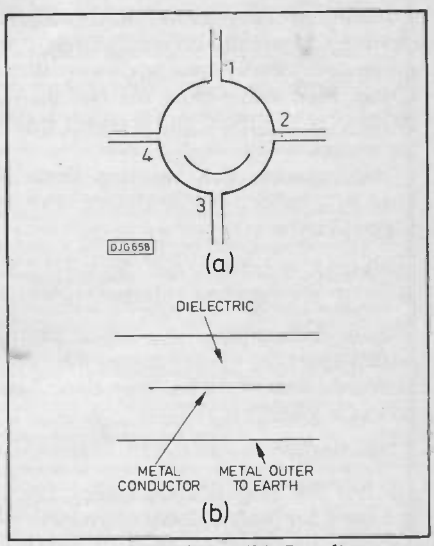


Fig 10. *(a) Circulator (b) Stripline Coupler*

Stripline couplers cannot handle large powers, as can circulators, but are useful for small power applications.

A figure of merit often quoted in radio applications is G/T for aerials, where T

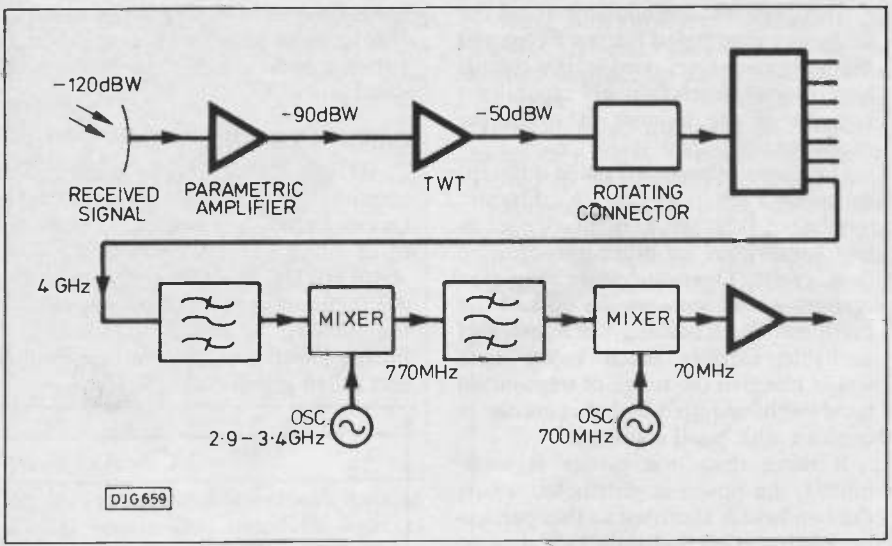


Fig 11. *Earth station receiving equipment flow path*

is the noise temperature and G the gain of the aerial. A G/T value of 40 dB/k is required for good signal pick up.

If a noise budget of 10,000pW is used for the round trip, ie up to the satellite and down again and including equipment noise, then it has been found that the aerial itself and first amplifier use up a part of this noise budget.

AMPLIFICATION

Fig.11 shows the earth station receiving equipment flow path. The signal goes through three stages of amplification using parametric amplifiers. The −120dBW signal is amplified by 30dB and by another 40dB at the twt. The parametric amplifiers are cooled to 16°K but for general applications parametric amplifiers do not require cooling since the circuit is usually associated with resistive components.

Parametric amplifiers are broadband devices and usually driven by Impatt or Gunn oscillators. Parametric amplifiers obtain their name from the fact that a parameter is altered and a power transfer occurs.

For instance, if a varactor diode is used as a capacitor, the charge is Q = CV coulombs

Where C = capacitance
V = applied voltage

Now if the plates of a capacitor are pulled apart the energy stored has been increased since work has been done. The power is given by:

$W = \frac{1}{2}CV^2$

After the amplification stages, there is a need for double down converters to convert the signal to an if of 70MHz. For this purpose a first if of 770MHz is used. Since the large carriers carry as many as 900 speech channels there is a requirement for standby amplifiers, demodulators etc. For such large carriers this is provided on a one for one basis, but for small carriers, ie 24 channels, there is one lot of standby for every five carriers.

MARITIME COMMUNICATIONS

In the mid 1970s it was decided to extend satellite communications to shipping, mainly because the radio frequency bands were getting crowded and were prone to fading.

The International Maritime satellite (Inmarsat) organisation was set up in 1982 with headquarters in London. A network co-ordination centre exists for each region and these are in Iberaki, Japan for the Pacific Ocean, Southbury, USA for the Atlantic Ocean and Yamaguchi, Japan for the Indian Ocean. Each centre co-ordinates the activities of all coastal earth stations in its region.

Inmarsat expects to own satellites soon, but at present leases transponder capacity on Intelsat. Today 6000 ships communicate with land via two satellites placed over each of the three ocean regions.

In communicating with land, satellites operate at 6/4 GHz (C band) or 14/11 GHz but operate in the L band when communicating with ships, ie at 1.6GHz from ship to satellite and 1.5GHz from satellite to ship. A bandwidth of 7.5MHz was allocated in the Atlantic Ocean, and working on the basis of 50kHz for a ship's channel, 150 ships would be able to communicate simultaneously with a given satellite.

However, the satellite cannot cope with the power demand, but future satellites are planned with increased transponder power. In some instances it is proposed to replace 8.5W twts with 20W and even 40W ones. Ships will then have access to greater services: higher data speeds, weather maps and pictures, navigation, shipping and information, and above all, search and rescue.

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SHIP AERIALS

In the UK a 14 metre aerial in Goonhilly, Cornwall works to the Atlantic satellite. A 3kW transmitter is associated with this aerial. We have seen how earth stations transmit more than one carrier, but a ship with its limited size of aerial and quantity of traffic transmits one carrier only with all its information modulated onto the one carrier. This is called single channel per carrier (scpc). Narrow band fm and phase shift keying are used to modulate the carrier and of the two, narrow band fm gives a better carrier to noise ratio.

The small aerials on ships, typically 5m diameter, have a limited signal capture capability. Therefore the onus is on the satellite to provide sufficient signal strength. The figure of merit G/T for a ship's aerial is around −4dB/k.

To make matters worse, the ship is pitching and rolling. In high seas, a pitch of 10 degrees and a roll of 30 degrees is quite common. Using a gyroscope and step tracking, a pointing accuracy of ±1 degree is achieved. Step tracking works in the horizontal and vertical planes, turning the aerial a small step at a time until the aerial finds a maximum signal. For this purpose, voltage samples are taken from the demodulator output and fed to a comparator to decide whether the signal strength had increased compared to the previous sample. PE

Part two next month will look at further aspects of orbiting satellites, including a discussion about Telsat V.

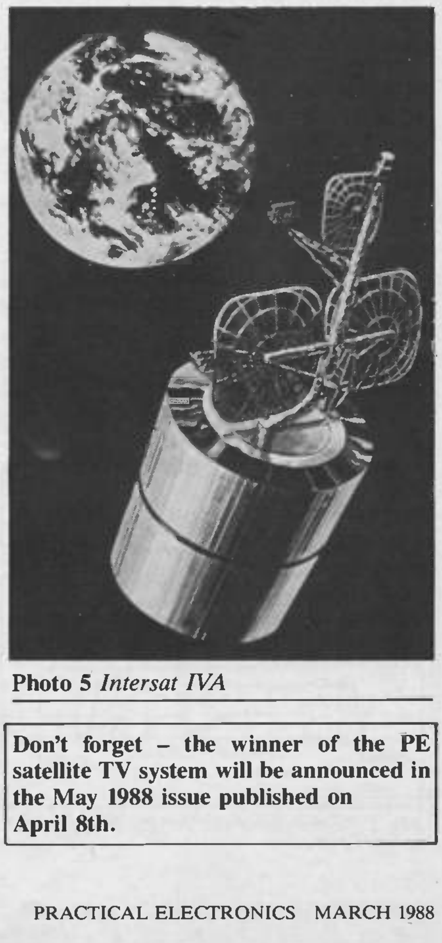

Photo 5 *Intersat IVA*

Don't forget – the winner of the PE satellite TV system will be announced in the May 1988 issue published on April 8th.

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12 – 5 octal bases for relays or valves
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14 – 4 OCP 70 photo transistors
16 – 4 tape heads, 2 record, 2 erase
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50 – 2 x 12V DC or 24V AC, 4 CO relays
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56 – Miniature Uniselector with circuit for electric jigsaw
57 – 5 Dolls' House switches
60 – 5 ferrite rods 4" x 5/16" diameter aerials
61 – 4 ferrite slab aerials with L & M wave coils
62 – 4 200 ohm earpieces
63 – 1 Mullard thyristor trigger module
64 – 10 assorted knobs ¼ spindles
65 – 5 different themostats, mainly bi metal
66 – Magnetic brake – stops rotation instantly
67 – Low pressure 3 level switch
69 – 2 25 watt pots 8 ohm
70 – 2 25 watt pots 1000 ohm
71 – 4 wire wound pots – 18, 33, 50 and 100 ohm
73 – 4 3 watt wire wound pots 50 ohm
77 – 1 time reminder adjustable 1-60 mins
78 – 5.5 amp stud rectifiers 400V
85 – 1 mains shaded pole motor ¾" stack – ¼ shaft
86 – 2 5" ali fan blades fit ¼" shaft
87 – 2 3" plastic fan blades fit ¼" shaft
88 – Mains motor suitable for above blades
89 – 1 mains motor with gearbox 1 rev per 24 hours
91 – 2 mains motors with gearbox 16 rpm
93 – 4 11 pin moulded bases for relays
94 – 5 B7G valve bases
95 – 4 skirted B9A valve bases
96 – 1 thermostat for fridge
98 – 1 motorised switch (s.h.)
101 – 1 2½ hours delay switch
103 – 1 6v mains power supply unit
104 – 1 4½ V mains power supply unit
105 – 1 5 pin flex plug and panel socket
107 – 1 5" speaker size radio cabinet with handle
109 – 10 ¼" spindle type volume controls
110 – 10 slider type volume controls
112 – 1 heating pad 200 watts mains
114 – 1 1W amplifier Mullard 1172
115 – 1 Wall mounting thermostat 24V
118 – 1 Teak effect extension 5" speaker cabinet
120 – 2 p.c.b. with 2 amp full wave and 17 other recs
122 – 10 mtrs twin screened flex white p.v.c. outer
132 – 2 plastic boxes with windows, ideal for interrupted beam switch etc
155 – 3 varicap push button tuners with knobs
188 – 1 plastic box, sloping metal front, 16 x 95mm, average depth 45mm
241 – 1 car door speaker (very flat) 6½" 15 ohm made for Radiomobile
243 – 2 speakers' 6" x 4" 15 ohm 5 watt made for Radiomobile
266 – 2 mains transformer 9V ½ A secondary split primary so OK also for 115V
267 – 1 mains transformers 15V 1A secondary p.c.b. mounting
330 – 2 6V 0.6V mains transformer .3a p.c.b. mounting
350 – 40 double pole leaf switches
365 – 1 7uf 660V 50hz metal cased condenser
453 – 2 2¼in 60 ohm loudspeakers
454 – 2 2¼in 8 ohm loudspeakers
463 – 1 mains operated relay with 2 sets c/o contacts
464 – 2 packets resin filler/sealer with cures
465 – 3 5A round 3 pin plugs will fit item 193
466 – 4 7 segment l.e.d. displays
470 – 4 pc boards for stripping, lots of valuable parts
480 – 1 3A double pole magnetic trip, saves repairing fuses
498 – 4 1000uf 25V axial electrolytic capacitors
504 – 1 Audax PM 8" speaker 15 ohm 5 watt rating
515 – 100 4BA 1½" cheesehead plated screws and 100 4BA nuts
541 – 1 pair stereo tape head as in cassette recorder/players
546 – 1 bridge rectifier 600V international rectifier ref 3SB100
548 – 2 battery operated relays (3-6v) each with 5A c/o contacts 2 pairs
553 – 2 lithium 3V batteries (everlasting shelf life)

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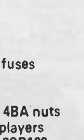

THIS MONTHS SNIP

3½ floppy Disk Drive, made by the Chinon Company of Japan. Beautifully made and probably the most compact device of its kind as it weighs only 600g and measures only 104mm wide, 162mm deep and has a height of only 32mm, other features are high precision head positioning – single push loading and eject – direct drive brushless motor – 500K per disc – Shugart compatible interface – standard connections – interchangeable with most other 3½ and 5¼ drives. Brand new with copy of makers manual. Offered this month at £28.50 post and VAT included.

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POWER SUPPLY FOR FDD – 5V and 12V voltage regulated outputs, complete kit of parts will fit into case 4P8 price £8 or with case £11.

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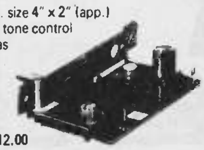
We are probably the only firm in the country with these now in stock. Although only four watts per channel, these give superb reproduction. We now offer the 4 Mullard modules – i.e. Mains power unit (EP9002) Pre amp module (EP9001) and two amplifier modules (EP9000) all for £6.00 plus £2 postage. For prices of modules bought separately see TWO POUNDERS.

CAR STARTER/CHARGER KIT

Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data case £17.50 post £2.

MINI MONO AMP on p.c.b. size 4" x 2" (app.)

Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or £13 for £12.00



LIGHT BOX

This when completed measures approximately 15" x 14". The light source is the Philips fluorescent 'W' tube. Above the light a sheet of fibreglass and through this should be sufficient light to enable you to follow the circuit on fibreglass PCBs. Price for the complete kit, that is the box, choke, starter, tube and switch, and fibreglass is £5 plus £2 post, order ref 5P69.

TANGENTIAL HEATERS

We again have very good stocks of these quiet runnng instant heat units. They require only a simple case, or could easily be fitted into the bottom of a kitchen unit or book case etc. At present we have stocks of 1.2kw, 2kw, 2.5kw, and 3kw. Prices are £5 each for the first 3, and £6.95 for the 3k. Add post £1.50 per heater if not collecting.
CONTROL SWITCH enabling full heat, half heat or cold blow, with connection diagram, 50p for 2kw, 75p for 3kw.

FANS & BLOWERS

5" £5 + £1.25 post. 6" £6 + £1.50 post
4" x 4" Muffin equipment cooling fan 115V £2.00
4" x 4" Muffin equipment cooling fan 230/240V £5.00
9" Extractor or blower 115V supplied with 230 to 115V adaptor £9.50 + £2 post.
All above are ex computers but guaranteed 12 months.
10" x 3" Tangential Blower. New. Very quiet – supplied with 230 to 115V adaptor on use two in series to give long blow £2.00 + £1.50 post or £4.00 + £2.00 post for two

9" MONITOR

Ideal to work with computer or video camera uses Philips black and white tube ref M24/306W. Which tube is implosion and X-Ray radiation protected. VDU is brand new and has a time base and EHT circuitry. Requires only a 16V dc supply to set it going. It's made up in a lacquered metal framework but has open sides so should be cased. The VDU comes complete with circuit diagram and has been line tested and has our six months guarantee. Offered at a lot less than some firms are asking for the tube alone, only £16 plus £5 post.

LOW COST OSCILLOSCOPE – kit to convert our 9" monitor into an oscilloscope with switched time bases to allow very high and very low frequency waveforms to be observed and measured. Signal amplitudes from as low as 10mV and as high as 1kV can easily be observed and measured. Ideal for servicing, also for investigating TV, radio and audio circuits.
Kit containing all the parts for the conversion and the power supply to operate from mains £25 our ref 25P3.

TELEPHONE LEAD

3 mtrs long terminating one end with new BT, flat plug and the other end with 4 correctly coloured coded wires to fit to phone or appliance. Replaces the lead on old phone making it suitable for new BT socket. Price £1 ref BD552 or 3 for £2 ref 2P164.

COMPACT FLOPPY DISC DRIVE EME-101

The EME-101 drives a 3" disc of the new standard which despite its small size provides a capacity of 500k per disc, which is equivalent to the 3½" and 5¼" discs. We supply the Operators Manual and other information showing how to use this with popular computers: BBC, Spectrum, Amstrad etc. All at a special snip price of £27.50 including post and VAT. Data available separately £2, refundable if you purchase the drive.

POWERFUL IONISER

Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, shop, work room etc. Makes you feel better and work harder – a complete mains operated kit, case included. £11.50 + £3 P&P.

J & N BULL ELECTRICAL

Dept. E.E., 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £20 add £1 service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted. Brighton (0273) 734648 or 203500.

NEW ITEMS

Some of the many described in our current list which you will receive with your parcel.

ASTEC T.S.U. Switch mode type so very compact. Normal 230V input. Has 3 outputs:– +5V at 3.5 amps, +12V at 1.5 amps and –5V at 0.3 amps. Should be ideal to drive floppy disc units. Regular price around £30, our price only £10 although brand new and unused. Order our ref 10P34.

SUPER WATER PUMP – Approx ⅓hp mains operated originally intended to operate a £300 shower unit at a controlled pressure – but of course suitable for many other water or liquid moving operations – where a good flow at a constant pressure is required – Price £25 each V.A.T. and Post Paid. Our Ref. 25P2.

VERY USEFUL MULTI TESTERS – These have all usual ranges AC & DC volts – DC MA and OHMS etc but an unusual and very useful feature is a "low OHMS" range. Very useful for checking dry joints etc. They are ex G.P.O., and may have faults but we test and guarantee the movement to be O.K. Price £3 each. Ref. 3P30.

AGAIN AVAILABLE – 12" mini fluorescent tubes – Price £1 each. Ref. BD314.

POWER PACK OR AMPLIFIER CASE – Size approx 10" x 8¼" x 4¾" plated steel – with ample perforations for cooling. Front panel has on/off switch and E.E.C. mains inlet plug with built in RF filter – undoubtedly a very fine case which would cost at least £50 from regular sources, our price is £5 each and £3 post. Ref. 5P111.

MINIATURE BCD THUMB WHEEL SWITCH – Matt black edge switch engraved white on black – gold plated, make before break contats – size approx. 25mm high 8mm wide 20mm deep – made by the famous Cherry Company and designed for easy stacking – Price £1 each. Ref. BD601.

EDGE METER – miniature, whole size approx 37mm x 13mm 100 ua fsd – centre zero scaled 0 to – 10 and 0 to + 10. Price £1 each. Ref. BD602.

LARGE 2 SPEED MOTOR – 1 hp at 2500 rpm and ¼hp at 200rpm – continental make, intended originally to power an industrial machine – regular price over £60, our Price £15 plus £5 carriage. Ref 15P5.

RUBBER FEET – Stick on – ideal for small instruments and cabinets – pack of 56 for £1. Ref. BD603.

CLEANING FLUID – Extra good quality – intended for video and tape heads – regular price £1.50 per spray can – our Price – 2 cans for £1. Ref. BD 604.

DON'T FREEZE UP! – We have had the strongest winds for over 200 years and who knows we may be in for the coldest winter, so if you have not already protected your water pipes you should do so now – our heating wire wound around the pipes will do this and will cost only about 50p per week to run – 15 metres (minimum length to connect to 230/240 v mains). Price £5. Our Ref. 5P 109.

PIEZO ELECTRIC FAN an unusual fan, more like the one used by Madame Butterfly, than the conventional type, it does not rotate. The air movement is caused by two vibrating arms. It is American made, mains operated, very economical and causes no interference. So it is ideal for computer and instrument cooling. Price is only £1 each. Ref BD605.

SPRING LOADED TEST PRODS – heavy duty, made by the famous Bulgin company. Very good quality. Price four for £1. Ref. BD599.

CURLY LEAD four core, standard replacement for telephone handset, extends to nearly two metres. Price £1 each. Ref. BD599.

TELEPHONE BELLS – these will work off our standard mains through a transformer, but to sound exactly like a telephone, they then must be fed with 25 hz 50v. So with these bells we give a circuit for a suitable power supply. Price 2 bells for £1. Ref. BD600.

ULTRA SENSITIVE POCKET MULTIMETER – 4k ohms per volt – 11 ranges – carry one of these and so be always ready to test ac/dc volts to 1000, DC milliams and have an ohms range for circuit testing – will earn its cost in no time. Price only £7. Ref. 7P2.

BLOW YOUR ROOF OFF 140 watt speaker systems – new type you must not hide! they have golden cones and golden surrounds and look really "Bootiful" 12" Woofer, Midrange and Tweeter and comes with a crossover at a special introductory price of £49, carriage paid. Two sets for £95 carriage paid. 140w Woofer only £35 carriage paid.

APPLIANCE THERMOSTATS – spindle adjust type suitable for convector heaters or similar price 2 for £1. Ref. BD582.

COMPUTERS

Big consignment of computers expected in mid Jan, various makes and numbers, write or phone for details.

NOVEL NIGHT LIGHT – plugs into a 13A socket. Gives out a surprising amount of light, certainly enough to navigate along passages at night or to keep a nervous child happy. Very low consumption, probably not enough to move the meter. Price £1. Ref. BD563.

CASE WITH 13A PRONGS – to go into 13A socket, nice size and suitable for plenty of projects such as car battery trickle charger, speed controller, time switch, night light, noise suppressor, dimmers etc. Price – 2 for £1. Ref. BD565

SPEAKER EXTENSION CABLE – twin 0.7mm conductors so you can have long runs with minimum sound loss and for telephone extensions or burglar alarms, bells, intercoms etc. 250m coil only £3 plus £1 post. Ref. 3P28.

ALPHA-NUMERIC KEYBOARD – this keyboard has 73 keys with contactless capacitance switches giving long trouble free life and no contact bounce. The keys are arranged in two groups, the main area field is a QWERTY array and on the right is a 15 key number pad, board size is approx. 13" x 4" – brand new but offered at only a fraction of its cost namely £3, plus £1 post. Ref. 3P27.

TELEPHONE EXTENSIONS – it is now legal for you to undertake the wiring of telephone extensions. For this we can supply 4 core telephone cable, 100m coil £8.50. Extension BT sockets £2.95. Packet of 500 plastic headed staples £2. Dual adaptor for taking two appliances from one socket £3.95. Leads with B.T. plug for changing old phones. 3 for £2.

MODULAR SWITCH – Panel mounting highest quality and ideal where extra special front panel appearance is required, can be illuminated if required d.p.d.t. and latching. Price – 2 for £1. Ref. BD607.

WIRE BARGAIN – 500 metres 0.7mm solid copper tinned and p.v.c. covered. Only £3 + £1 post. Ref. 3P31 – that's well under 1p per metre, and this wire is ideal for push on connections.

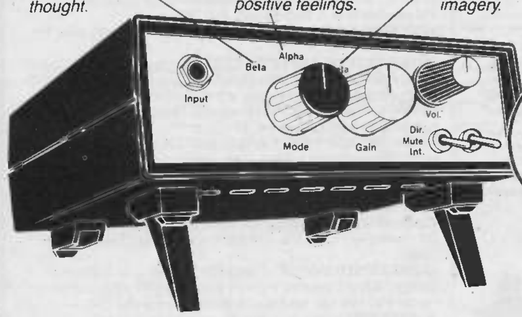
INTERRUPTED BEAM KIT – this kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components – relay, photo transistor, resistors and caps etc. Circuit diagram but no case. Price £2. Ref. 2P15.

3-30V VARIABLE VOLTAGE POWER SUPPLY UNIT – with 1 amp DC output. Intended for use on the bench for experimenters, students, inventors, service engineers etc. This is probably the most important piece of equipment you can own. (After a multi range test meter). It gives a variable output from 3-30 volts and has an automatic short circuit and overload protection, which operates at 1.1 amp approximately. Other features are very low ripple output, a typical ripple is 3mV pk-pk, 1mV rms. Mounted in a metal fronted plastic case, this has a voltmeter on the front panel in addition to the output control knob and the output terminals. Price for complete kit with full instructions is £15. Ref. 15P7.

TRANSMITTER SURVEILLANCE (BUG) – tiny, easily hidden, but which will enable conversation to be picked up with FM radio. Can be housed in a matchbox, all electronic parts and circuit. Price £2. Ref. 2P52.

Brainwave monitor

β BETA – *Concentration, problem solving, active thought.*
α ALPHA – *Relaxation, pleasure, tranquility, positive feelings.*
θ THETA – *Imagination, creativity, hynagogic imagery.*



BRAINWAVE MONITOR PARTS SET ONLY **£36.90** + VAT

This unique project will allow you to hear your own brainwaves! Through a simple training program you can learn to control them and achieve peak performance in all situations. It will revolutionise your life!

The approved parts set contains: two PCBs; all components, including three PMI precision amplifiers; shielded box for screening the bio-amplifier; attractive instrument case with tilting feet; controls, switches, knobs, plugs, sockets; leads and brass electrodes, full instructions for assembly and use.

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

THE ALPHA PLAN

Can you really train your mind to think more effectively? Can you really excel at things you're 'no good at'? The Alpha Plan has all the answers!
£2.50 (no VAT)

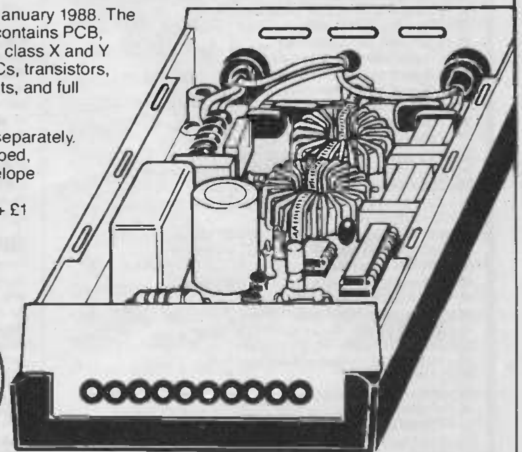
SILVER SOLUTION

Just wipe on with a cloth to plate PCB tracks, connectors, wire, component leads, coins or hosehold ornaments with a layer of **pure silver**. It must be magic!
LARGE BOTTLE (150ml)
SILVER SOLUTION **£11.20** + VAT!

POWER CONDITIONER

As featured in ETI, January 1988. The approved parts set contains PCB, case, toroidal cores, class X and Y capacitors, VDRs, ICs, transistors, LEDs, all components, and full instructions.

Parts are available separately. Please send a stamped, self-addressed envelope if you want the lists. Otherwise, an SAE + £1 will bring you lists, construction details and further information.



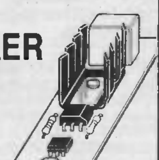
POWER CONDITIONER PARTS SET ONLY **£28.50** + VAT

- For those who will only be satisfied with the best
- Use with Hi-Fi, computers, radios, TV sets to eliminate mains-borne interference
- 10 LED logarithmic display shows the amount of interference removed
- Massive filter section with thirteen capacitors and two current-balanced inductors
- Bank of six VDRs to remove transients and spikes
- Suppresses common mode and differential mode interference

Complete Parts Sets for ETI Projects

MAINS CONTROLLER

FEATURED IN ETI, JANUARY 1987



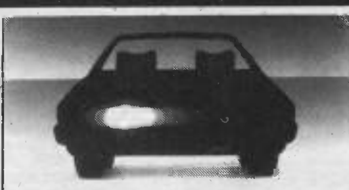
Have you ever wondered what people *do* with all those computer interfaces? 'Put your computer in control,' say the ads. 'The Spectrabeeb has eight TTL outputs.' What on earth can you control with a TTL output? A torch bulb?

The ETI Mains Controller is a logic to mains interface which allows you to control loads of up to 500W from your computer or logic circuits. An opto-coupler gives isolation of at least 2,500V, so the controller can be connected to experimental circuits, computers and control projects in complete safety. Follow your computer interface with a mains controller and you're *really* in business with automatic control!

The mains controller connects directly to most TTL families without external components, and can be driven by CMOS with the addition of a transistor and two resistors (supplied).

Your mains controller parts set contains: high quality roller tinned PCB; MOC3021 opto-coupler; power triac with heatsink, mounting hardware and heatsink compound; all components, including snubber components for switching inductive loads; transistor and resistors for CMOS interface; full instructions.

MAINS CONTROLLER PARTS SET £6.20 + VAT!



KNIGHT RAIDER

FEATURED IN ETI, JULY 1987

The ultimate in lighting effects for your Lamborghini, Maserati, BMW (or any other car, for that matter). Picture this: eight powerful lights in line along the front and eight along the rear. You flick a switch on the dashboard control box and a point of light moves lazily from left to right leaving a comet's tail behind it. Flip the switch again and the point of light becomes a bar, bouncing backwards and forwards along the row. Press again and try one of the other six patterns . . . An LED display on the control box let's you see what the main lights are doing.

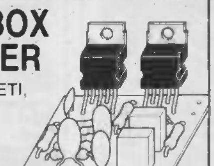
The Knight Raider can be fitted to any car (it makes an excellent fog light!) or with low powered bulbs it can turn any child's pedal car or bicycle into a spectacular TV-age toy!

The control box parts set consists of case, switches, LEDs, PCB, components, hardware and instructions. The sequence board includes PCB, ICs, power FETs; components, hardware and instructions.

KNIGHT RAIDER CONTROL BOX ONLY £6.90 + VAT!
KNIGHT RAIDER SEQUENCE BOARD ONLY £13.90 + VAT!

MATCHBOX AMPLIFIER

FEATURED IN ETI, APRIL 1986



No ordinary amplifiers, these. When our first customers took an interest, it was for the diminutive size (both modules will fit in a matchbox!), the total disregard for power supplies and speaker impedances, and the impressive power output from these little amplifiers. When they re-ordered, it was for the sound quality.

Two amplifier modules were described, both based on the powerful L165V IC. The single IC version will deliver over 20 Watts with a suitable speaker and power supply. The bridge version can provide up to 50W! Although the specified supply voltage and speaker impedance must be used to achieve maximum power, both modules are quite happy to work from any voltage between 12V and 32V, and will accommodate any type of speaker. The bridge version is ideal for giving a boost to car Hi-Fi systems, driving two 4 Ohm speakers in parallel on each channel for best effect.

Both designer-approved parts sets consist of a roller tinned printed circuit board and all components. The L165V ICs are also available individually, with a free mini data sheet giving specifications and suggested circuits.

SINGLE IC 'MATCHBOX AMPLIFIER' SET (20W into 4 Ohms)	BRIDGE AMPLIFIER SET (50W into 8 Ohms)	L165V IC, with data,
£6.50 + VAT	**£8.90** + VAT	**£3.90** + VAT

POWERFUL AIR IONISER

FEATURED IN ETI, JULY 1986

Ions have been described as 'vitamins of the air' by the health magazines, and have been credited with everything from curing hay fever and asthma to improving concentration and putting an end to insomnia. Although some of the claims may be exaggerated, there is no doubt that ionised air is much cleaner and purer, and seems much more invigorating than 'dead' air.

The DIRECT ION ioniser caused a great deal of excitement when it appeared as a constructional project in ETI. At last, an ioniser that was comparable with (better than?) commercial products, was reliable, good to build . . . and fun! Apart from the serious applications, some of the suggested experiments were outrageous!

We can supply a matched set of parts, fully approved by the designer, to build this unique project. The set includes a roller tinned printed circuit board, 66 components, case, mains lead, and even the parts for the tester. According to one customer, the set costs 'about a third of the price of the individual components'. What more can we say?

DIRECT ION PARTS SET
WITH BLACK CASE £11.50 + VAT
WITH WHITE CASE £11.80 + VAT

Instructions are included

SPECIAL OFFERS

AD7541 Precision 12-bit multiplying DAC	£1.20 + VAT
LM3524 Switch mode regulator IC	£0.80 + VAT
CF585 Calculator IC	£1.00 + VAT
LM339 Quad comparator IC	3 for £1.00 + VAT
MC1458 Dual op-amp	3 for £1.00 + VAT

All ICs supplied with **FREE DATA**.
Prices apply only while stocks last.

LM2917 EXPERIMENTER SET

Consists of LM2917 IC, special printed circuit board and detailed instructions with data and circuits for eight different projects to build. Can be used to experiment with the circuits in the 'Next Great Little IC' feature (ETI, December 1986).

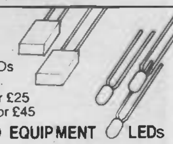
LM2917 Experimenter Set £5.80 + VAT

RUGGED PLASTIC CASE

suitable for mains conditioner and mains controller.

ONLY £1.65 + VAT

LEDs



Green rectangular LEDs for bar-graph displays.
50 for £3.50 500 for £25
100 for £6 1000 for £45

DIGITAL AND AUDIO EQUIPMENT LEDs
Assorted 3mm LEDs: red, green, yellow and orange. 25 of each (100 LEDs) for **£6.80**

Prices shown are exclusive of VAT, so please add 15% to the order total. UK postage is 70p on any order. Carriage and insurance for overseas orders £4.50. Please allow up to 14 days for delivery.

Specialist SEMICONDUCTORS LIMITED

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GWENT

REAL WORLD INTERFACING

PART TWO BY ROBERT PENFOLD

MEASUREMENT AND CONTROL

This article looks at ways of achieving real world control with feedback from real world measurements, with techniques including digital to analogue flash conversion and successive approximation, mains switching with zero crossing, and proportional feedback control.

WHILE there may seem to be little link between the subjects of electronic measurement and control (which are more or less the opposite of each other), these two types of circuit are frequently used together. For example, in something like an automated photographic darkroom there would be sensors to measure light and temperature, and control circuits to switch the enlarging lamp on and off, control heating elements, etc. Much microprocessor and general digital electronics is concerned with controlling something, and taking measurements which are used as feedback for decision making software. In our darkroom example a sensor could monitor the temperature of a photographic solution. Via some form of power controller interface, the program could increase the power to the dish warmer if the temperature was found to have fallen below a particular level, or decrease it if the temperature exceeded a certain level.

This is much like a conventional electronic thermostat based on analogue circuits, but with digital control there are a number of potential advantages. Any desired temperature within the range of the system can be set easily and accurately. The set temperature should be maintained with great precision. In a simple switching system problems with switching "jitter" can easily be avoided, using a software solution if necessary. The more sophisticated proportional method of control is easily implemented in a microprocessor based system, and usually gives much more stable and accurate control. Last, but by no means least, microprocessor based control systems give great versatility. New features can sometimes be implemented simply by improving the software, rather than by adding more hardware. Similarly, changed circumstances can often be accommodated by software updates instead of having to undertake extensive hardware modifications. These advantages apply generally, and are not just applicable to temperature control.

There is only one major drawback to digital measurement and control systems, and this is that they are still relatively expensive. Systems of this type are most cost effective when applied to fairly large tasks, and are not usually worthwhile for something simple like controlling the temperature of a single room.

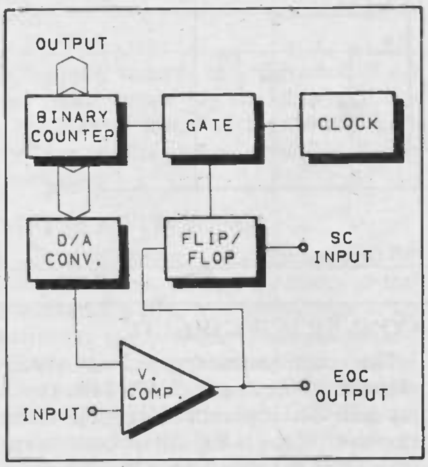

Fig 1. *Block diagram showing the arrangement used in a counter type A-D converter*

A/D CONVERSIONS

Digital to analogue conversion was covered in part one of this article, but only low power circuits were discussed. The Ferranti based converter circuits are suitable as the basis of power controller circuits, but some additional circuits are needed in order to control things such as dc electric motors and ac mains heating elements. Also, for measurement purposes it is analogue to digital conversion that is required.

Taking analogue to digital conversion first: this is something that is a bit more complex than a conversion in the opposite direction. I suppose that the nearest thing to an a/d converter which operates like a d/a type in reverse is a "flash" converter. This consists basically of a long potential divider chain that provides reference voltages to a large number of voltage comparators. The other inputs of the comparators are fed with the input signal, and their outputs are taken to a logic decoder circuit. The latter converts the output levels from the comparators into a corresponding binary output.

Flash converters have the advantage of being very fast, but despite advances in integrated circuit technology they are still horrendously expensive. An 8 bit type requires 256 high speed comparators and 256 accurate reference voltages, plus the decoder circuit! Some converters use a mixture of flash and successive approximation conversion, but even these tend to be sufficiently expensive to deter all but the most ardent amateur user.

Successive approximation converters now seem to be the most popular form of a/d converter, having largely ousted the basic counter type at the low cost end of the market. The counter type is based on arrangement of the type shown in Fig.1. A binary counter drives a d/a converter, and a comparator is used to equate the input voltage with the output from the d/a converter. When a "start conversion" pulse sets the flip/flop, the clock signal passes through the gate and increments the binary counter. The value fed to the converter is then gradually increased until the voltage comparator detects that it is providing an output voltage which is higher than the input voltage. At this point the voltage comparator resets the flip/flop and blocks the clock signal from the counter. The higher the input voltage, the higher the count goes before the point is reached. A simple but accurate analogue to digital conversion is produced with the binary counter providing the converted value. The output of the comparator provides a status output that indicates when a valid reading is availble from the counter.

Some converters of this type operate by having output pulses sent from the computer to increment the counter, and a ram location is used to keep track of the number of pulses sent. These serial type a/d converters are usually quite cheap, and require relatively few connecting lines to the microprocessor system. Their disadvantage is that they are not applicable to most non-microprocessor based systems, and they tend to be very slow in operation. In fact the ordinary counter type converters are not particularly fast, which is probably why they have not achieved great popularity.

Successive approximation converters achieve a reasonable compromise between cost and complexity on the one hand, and operating speed on the other.

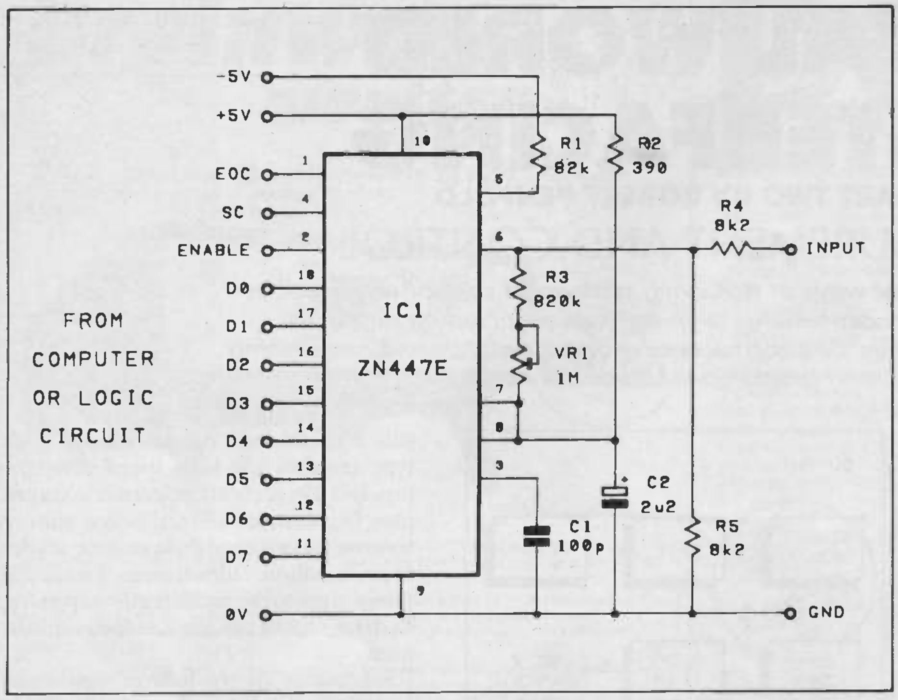

Fig 2. *The ZN447E A-D converter circuit*

Although they tend to be regarded as totally different from counter type converters, they are really just a development from these. The basic setup used is very similar to that for a counter type converter, but the clock and control logic circuits are somewhat different. Initially the most significant bit of the counter is set to 1, but the other bits are all set at 0. The comparison process then takes place, and if the input voltage is at the higher voltage then the most significant bit is left at 1. If not, it is reset to 0.

This procedure is then repeated with the other bits of the counter, working in sequence through to the least significant bit. As each bit is set on successive clock pulses, the value held in the counter becomes a better approximation of the correct value, until the least significant bit has been set and the reading is a valid one. It is presumably from this that the "successive approximation" name is derived.

Counter type converters are inconsistent in the time taken for a valid reading to be achieved. With low input voltages it takes only a few clock cycles to complete each conversion, but with high readings (and an 8 bit conversion) over two hundred clock cycles are required for each reading. With higher resolution converters thousands of clock cycles per reading may be required. The successive approximation approach gives much more consistent conversion times, and guaranteed fast times. The number of clock cycles per conversion depends on the exact form of control circuit used, but for an 8 bit type it can take as few as nine clock cycles per conversion. This permits tens of thousands of conversions per second, which is adequate for most applications, including audio digitising.

CONVERTER CIRCUIT

The complementary a/d converter chip for the Ferranti ZN426/8 d/a types (as described in part one) is the ZN427E. However, there is a more recent version (the ZN447E) which has a built-in clock generator and is generally more convenient to use. In addition to the ZN447E there are two cheaper devices, the ZN448E and the ZN449E. Really these three converters are the same, but the guaranteed level of accuracy is different. The ZN447E is the superior (and relatively expensive) version with its accuracy of 0.25 lsb. This compares with 0.50 and 1 lsb respectively for the ZN448E and ZN449E. Although the ZN449E offers something less than optimum accuracy, it is still adequate for most purposes as it gives a maximum error of less than 1% of the full scale value. In applications where its performance is adequate it represents what has to be regarded as a "bargain basement" solution to a/d interfacing.

Fig.2 shows the basic circuit for a ZN447E series converter. Starting with the connections to the microprocessor or other logic circuit, D0 to D7 are 8 bit output. These are tristate outputs that can be directly interfaced to the data bus of many microprocessors. They are activated by taking the ENABLE input to logic 0. In common with most a/d converters, the ZN447E does not automatically run in a continuous conversion mode. Each conversion must be initiated by a brief (as little as 200ns) low pulse at the start conversion (SC) input. The conversion will be completed in nine clock cycles, and a timing loop or circuit can be used to prevent premature reading of the converter. Alternatively, the end of conversion, (EOC) output can be brought into service. This goes to logic 0 when a conversion is in progress, and its return to logic 1 therefore indicates that a conversion has just been completed.

The circuit can be made to provide continuous conversions, and it is basically just a matter of inverting the EOC output and using it to drive the SC input. The only slight complication is that in order to ensure correct operation this circuit must be designed to provide an initial SC pulse at power-up. In most cases a delay circuit would also be needed so as to give sufficient time for each conversion to be read. Note that a valid reading is only present when the EOC output is high, and that the previous conversion can not be read once a fresh one has been commenced.

An external clock signal of up to 1MHz in frequency can be applied to pin 3 of the device, but in most cases it is easier to use the built-in clock oscillator. This requires only a single discrete component, which is a timing capacitor connected from pin 3 to ground. The value of 100p shown in Fig.2 gives a clock frequency of just under 1MHz, and a conversion time of around 10μs. An 82p timing capacitor represents about the lowest value that is guaranteed to give reliable operation, and the conversion time is then about 9μs. Most ZN447Es will actually operate with lower values, and conversion times as low as 5μs are often possible. Even the guaranteed 9μs conversion time represents about 110000 conversions per second, which is adequate for all but a few highly specialised applications.

The d/a converter section of the ZN447E has a built-in 2.55 volt reference source, but an external reference voltage of between 1.5 and 3 volts can be connected to pin 7 if desired. There would not normally be any point in doing so however, and in most cases the built-in reference will suffice. In Fig.2 the internal voltage source is used, and this requires discrete components R2 and C2.

A resistor network at the input of the device sets the full scale voltage and provides zero adjustment. VR1 is the zero adjustment control, and with an input voltage equal to 0.5 lsb (ie 5 millivolts at pin 6 of ICI) VR1 is adjusted to a point where readings fluctuate between 0 and 1. R4 and R5 form a potential divider that reduces the basic 2.55 volt full scale voltage of the converter to a sensitivity of approximately 5 volts full scale. Obviously any full scale voltage of more than 2.55 volts can be obtained using a suitable potential divider circuit, but a preset potentiometer to permit accurate adjustment of the sensitivity is essential where high accuracy is required. For optimum results the potential divider should have an output impedance of approximately 4 kilohms. The zero adjustment circuit can be omitted if marginally less than

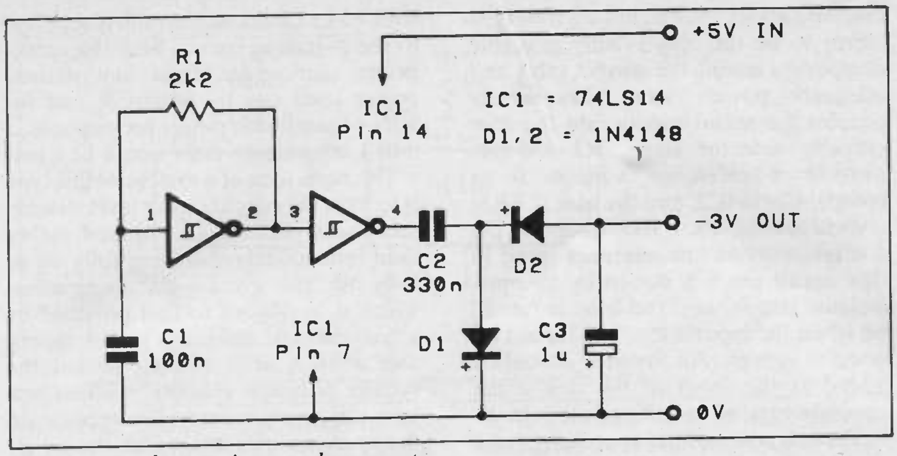

Fig 3. *A simple negative supply generator*

optimum accuracy is sufficient.

The −5V supply has to provide a current of only about 65 microamps, and this can usually be derived from the +5V supply via a simple oscillator and rectifier circuit. As little as −3V will suffice, but with this lower supply voltage the value of R1 should be reduced to 47k. Fig.3 shows the circuit for a simple negative supply generator circuit. The current consumption from the +5V supply for the converter circuit as a whole is typically 25 milliamps (40 milliamps maximum).

While the ZN447E series represents what is often the most convenient a lowest cost solution to a/d conversion, there are of course many other worthwhile devices available. There is insufficient space available for these to be considered in detail here, but the ADC0844 four channel type is worthy of mention. This device will readily interface to 8080 style microprocessor buses, and it includes a four channel multiplexer at the input. Apart from straightforward four channel operation, this also provides some useful differential operating modes. The cmos AD7581 is also a very useful type. It includes an eight channel multiplexer and an 8 × 8 ram to store the readings taken on each channel. It appears to as eight ram addresses to the micro-processor system, and reading one of these addresses gives the most recent reading for the relevant channel. A top quality product that is well worth using if you can arrange a mortgage to buy one!

Sensor circuits to drive the converter go beyond the scope of this article, but conventional sensor circuits are all that are needed. One point to bear in mind is that the scaling should be something sensible, with (say) 0.5 degrees per lsb rather than some odd figure such as 0.478 degrees per lsb. Also, for optimum accuracy the circuit driving the converter should provide an output volt-age range which is almost as wide as the input voltage range of the converter. For example, if the converter has a 0 to 5 volt input range, but the sensor circuit only provides a 0 to 1.25 volt swing, this gives a resolution of just 64 levels, and effectively reduces the converter to a 6 bit type. Amplifying the output of the sensor by a factor of four would give better results with genuine 8 bit resolution.

MAINS SWITCHING

Although relays are considered to be completely out of date by many in the electronics world, they still represent an attractive method of switching the mains supply. Isolation between the control circuit and the mains supply is usually vital. Apart from the danger of damage to the control circuit if effective isolation is absent, it could also be extremely dangerous for anyone using the equipment. A relay intended for switching 240V ac should give reliable isolation between the control circuit and the mains supply, and these days there are physically small relays that are capable of handling quite large mains loads. There is no significant voltage drop through the relay contacts, and hence no significant heat generated.

Presumably most PE readers can handle relay driving without too much difficulty, and this subject will not be pursued further here. Solid-state control of mains loads is a somewhat more tricky affair, since the standard ac power switching device (the triac) does not have any inherent isolation between its input and output circuits. This isolation must therefore be provided in the driver circuit. There are various ways of providing this isolation, but an opto-isolator is the most popular approach these days. A normal opto-isolator consists of an infra-red led driving a photo-transistor. When the led is activated, its light output causes strong leakage currents through the transistor, effectively switching it on. With this arrangement there is no direct electrical connection between the input (led) circuit and the output (triac) circuit. Opto-isolators are generally guaranteed to withstand input to output voltages of 2500 volts or more. Therefore, even high voltage noise spikes on the mains supply should not cause the insulation to break down.

For ac power control there are now special "triac-isolators", which consist of an infra-red led driving a photo-sensitive triac. This enables ac mains loads to be controlled directly by the triac section of the device, but the present types only seem to be able to handle currents of up to 100 milliamps. This represent just 24 watts with the 240V ac mains supply, which is obviously inadequate for most applications. However, the triac in the isolator can easily be used to control a larger triac so that higher currents can be controlled. Fig.4 shows how this can be achieved.

(Observant readers will notice that this is practically identical to the isolation circuit that I used in the Santalite in Jan '88. Ed).

On the input side of the circuit the logic output drives the led via current limiting resistor R1. At the output side the triac section of the isolator, when switched on, biases CSR1 into conduction. Power is then fed through to the load. R2 has a compromise value. It is low enough to ensure that CSR1 is triggered early in each mains half cycle, but it is high enough to prevent a massive current flow if the circuit is activated when the mains voltage is close to its peak level. Once CSR1 has switched on

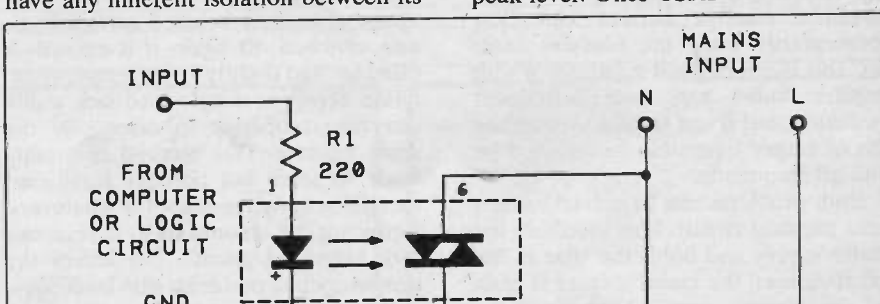

Fig 4. *Using a Triac Isolator to drive an ordinary Triac*

it virtually cuts off the current through R2, and the dissipation in R2 is very low.

Although CSR1 is shown as switching the "N" side of the mains, it could be used in the "L" lead if preferred. Opinion seems to be divided about which is the correct method. Switching the "N" side of the supply leaves the "L" wired through to the controlled equipment even when it is turned off. On the other hand, switching the "L" side of the mains means that the output side of the controller circuit is live. You have to accept one drawback or the other. What is not a matter of opinion is that the mains earth lead should be carried through to the controlled equipment if it has a three core mains lead.

The C206D triac specified for CSR1 can handle loads of up to about 200 watts or so without the aid of a heatsink, or about 700 watts if it is fitted with a suitable heatsink. There should be no problem in controlling higher power loads if a higher power triac plus a suitable heatsink are used.

ZERO CROSSING

A basic switching circuit of the type shown in Fig.4 can produce strong radio frequency interference. This happens when the triac fires while the mains voltage is close to its peak value, and the output voltage almost instantly jumps to a high voltage. This fast rising edge generates high frequency harmonics, and the high voltage ensures that even the higher frequency harmonics are quite strong. This is not too much of a problem when the circuit will only be turned on and off infrequently, but it can produce severe interference in applications where continuous and frequent switching are involved.

There can also be problems with this basic form of switching when the load is a filament bulb. The "cold" resistance of a lamp filament is only a small fraction of its resistance at the normal operating temperature. If the triac switches on while the mains voltage is near its peak level, a massive current can flow momentarily while the filament heats up. This is not of great significance with smaller bulbs and very infrequent switching, but it can greatly shorten the life of larger types that are flashed on and off frequently.

Both problems can be solved using a zero crossing circuit. This monitors the mains supply and holds the triac in the off state until the mains voltage is zero, or close to zero anyway. Fig.5 shows the circuit for a mains controller which incorporates opto-isolation and a zero crossing circuit.

The zero crossing circuit is based on a TDA1024 integrated circuit (IC2) which is specifically designed for this task. It has a built-in power supply circuit that requires discrete components R5, D1, and C1. Note that R5 has to dissipate about 4 watts, but a 7 watt type seems to be the only readily available component having the correct value and adequate power rating. R6 loosely couples the mains supply into the zero crossing detector stage. R3 and R4 provide a reference voltage to a comparator in IC2, and the triac (CSR1) is switched on when the voltage at pin 5 is taken above this reference level. In this circuit pin 5 is driven by an opto-isolator circuit, and the triac is turned on when the input is low, and turned off when it is high. An inverter should be added at the input of the unit if the opposite type of switching is required.

There is now another approach to zero crossing switching, and this is to use a special type of triac-isolator which incorporates a zero crossing detector circuit. These are used in the same way as a conventional triac-isolator (ie as shown in Fig.3), and require no additional circuitry at all. The only drawbacks of these components are that they are relatively difficult to obtain at present, and are not necessarily the most economic solution to the problem.

(The MCP3041 and OPI3041 are two such devices, also available as RS components number 301-628. Ed).

with a 1 to 1 mark-space ratio is supplied to the switching circuit. With the appropriate mark-space ratio any desired power level can be obtained, and for 90% of maximum power for example, a 9 to 1 mark-space ratio would be used.

The basic idea of a system of this type is to have the output power level steadily increase or decrease, as required, rather than immediately switching fully on or fully off. This gives a stabilising effect which is analogous to that provided by a conventional stabilised power supply, and after a brief settling period the system provides accurate stabilisation. In a temperature controller application the system settles down with the power fed to the heating element exactly compensating for heat losses. Of course, if the level of heat loss changes for some reason, then the feedback automatically adjusts the output power to compensate for this.

When applied to ac mains equipment this system of power control must have a low pulse frequency of a few hertz or less. To give low levels of radio frequency interference this type of control must be provided by way of zero crossing circuits, and the output therefore consists of complete half cycles. In order to permit

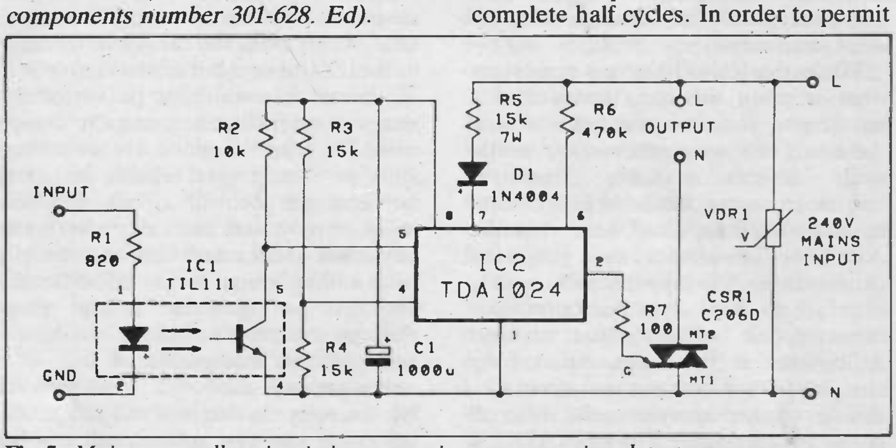

Fig 5. *Mains controller circuit incorporating zero crossing detector*

accurate control the pulse frequency must be substantially lower than the 50Hz mains frequency. This is not purely of academic importance, and although the output from this type of controller is perfectly suitable for heating elements, it will not give the desired result with lamps and certain other types of load. Lamps would visibly flash on and off rather than dimming, and most motors would be rather jerky in operation.

Fig.6 shows the circuit diagram for a simple pulse width modulator that can be used to drive the switching circuit of Fig.5. IC1 is a CMOS 4046BE low power phase locked loop, but in this circuit only the voltage controlled oscillator section of the device is used. This has the input voltage fed to its control voltage terminal, and the circuit is designed to be driven direct from a ZN426E or ZN428E d/a converter. IC2 is a 4047BE astable/monostable which is connected here to operate as a positive edge

IN PROPORTION

Simple thermostats use a system where the power is switched on if the temperature falls below a certain level, and switched off again if it exceeds a different and slightly lower temperature. Other forms of simple feedback stabiliser circuit operate in essentially the same manner. This method inevitably leads to small but possibly significant variations in temperature (or whatever). Reducing the amount of hysteresis can give improved results, but leaves the system open to problems with instability.

Proportional control can give much better results, but this requires some means of varying the power fed to the load. The most simple means of achieving this is to have what is basically just an on/off control system, but to feed this with a low frequency pulse width modulation signal. This operates very much like a pulse type dc motor controller, and at half power for instance, a signal

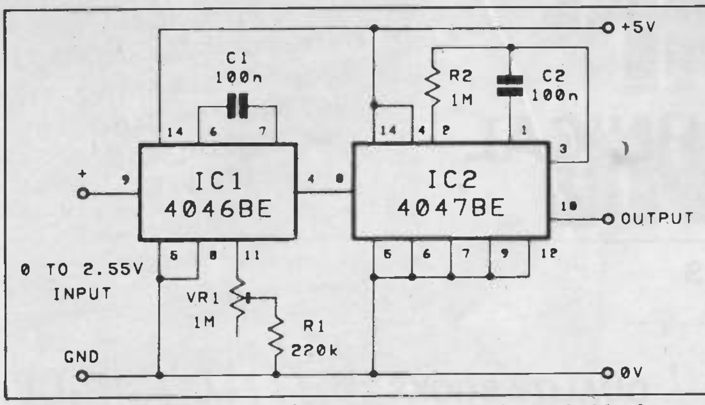

Fig 6. *Adding variable power control to the circuit of Fig 5.*

triggered (non-retriggerable) monostable. This is triggered by the output from IC1. With a low frequency input signal the pulses from IC2 are well spread out, and the mark-space ratio is quite low. As the input voltage is raised and the output frequency from IC1 increases, the pulses from IC2 become bunched together and the mark-space ratio increases as well. This gives a simple but effective method of pulse width modulation.

It is important that the output frequency of IC1 does not become slightly excessive, as this would result in IC2 only triggering on alternate output half cycles, and the output power dropping to about half the correct level. VR1 is adjusted to give maximum output power with the input voltage at 2.55 volts, but it is probably best to settle for just marginally less than maximum power to allow for possible drift in components values, the supply voltage, etc.

DC CONTROL

As mentioned previously, this method of pulse control is a standard method of speed control with dc electric motors (such as those used in model trains, etc.). It also works well with filament bulbs and many other small dc loads. For this type of application a higher pulse frequency generally gives better results, and a system that provides a constant output frequency is likely to be more consistent and reliable in use.

The circuit diagram of Fig.7 is for a simple dc pulse type power controller having a constant output frequency of just under 200Hz. This frequency gives excellent results with most electric motors, as well as lamps and other types of load. However, if necessary the output frequency can be altered by changing the value of C2. Changes in value have an inversely proportional affect on the output frequency. The circuit utilises the standard approach to pulse width modulation with IC1 providing a triangular clock signal and IC2 acting as the comparator. The circuit is designed to have a 0 to 2.55 volt input voltage range, but VR1 can be adjusted to accommodate maximum input voltages from about 1 to 5 volts. With the input voltage at maximum, VR1 is advanced just far enough to give maximum output from the controller.

TR1 is a darlington power transistor which enables output currents of up to about 2 amps or so to be provided. The pulsed nature of the output signal means that TR1 does not have to dissipate high power levels, but with output currents of about 1 amp or more it should be fitted with a small heatsink. Note that a 15 volt input supply is needed in order to give a 12 volt output due to losses through the circuit. No output current limiting circuit is included, and this should be incorporated in the supply which provides the 15 volt dc input. A supply based on a 15 volt monolithic voltage regulator will suffice. PE

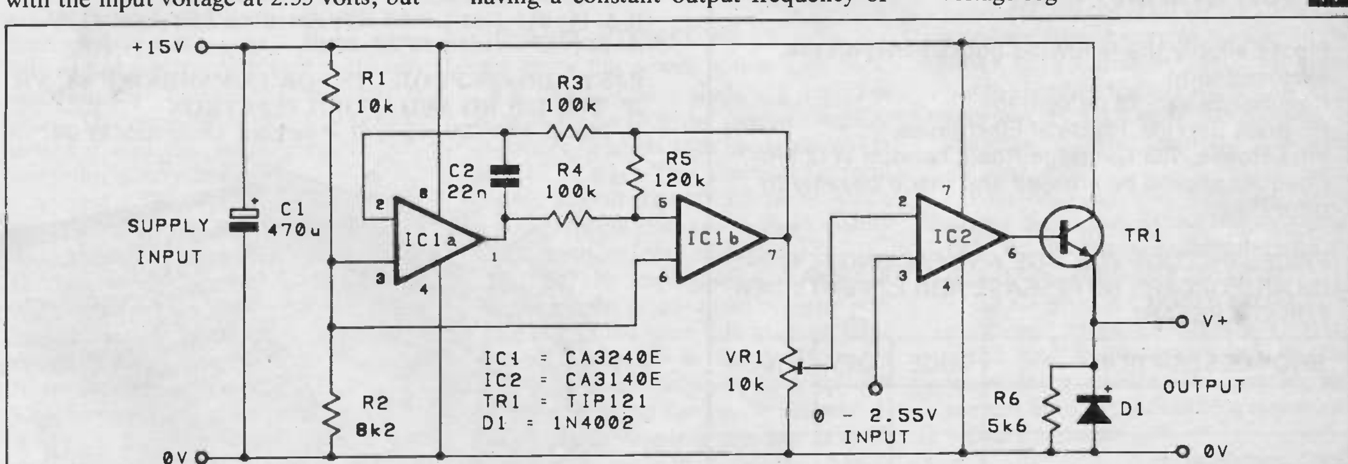

Fig 7. *A DC motor speed control interface*

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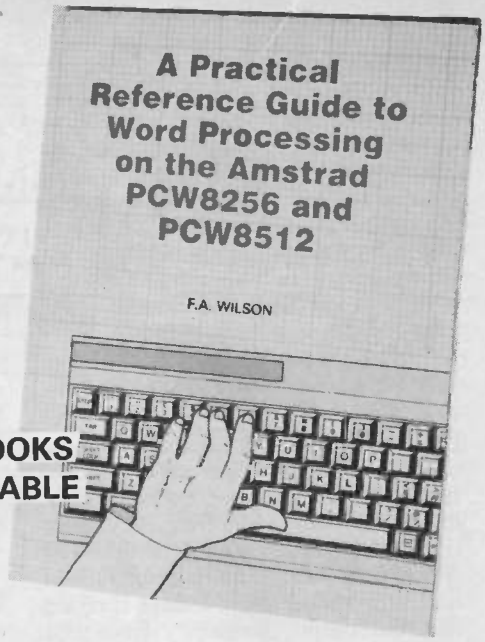

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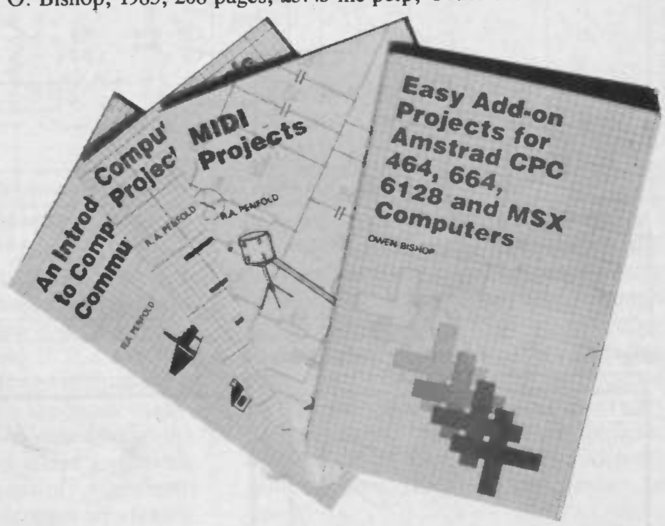

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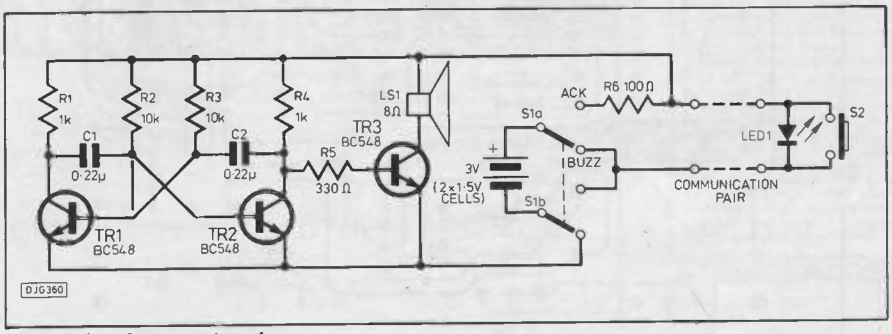
Upstairs Alert

In our household there exists a well known problem, which occurs at meal times when someone calls from downstairs 'dinner's ready' I cannot always hear them from upstairs in my room. The usual solution to this problem is for the person downstairs to ring a hand bell. However, this solution is not fool proof and requires the person upstairs to shout back ok or to also have a bell in order to give an acknowledge signal, so that the person downstairs knows the bell has been heard. In my case, matters are made worse since I often have my hifi on quite loud requiring the bell ringer to ring hard in order to push out more dB's than my hifi!



Circuit for the upstairs alert

One Sunday afternoon I decided a hi-tech solution was required. Using a few bits out of my 'rubbish box' I cheaply and quickly constructed the circuit given. The circuit uses two 1.5v cells to power it and the average power consumption is very low.

S2 and LED1 are fitted downstairs and linked to the rest of the circuitry upstairs via a pair of wires. TR1 and TR2 form an oscillator with TR3 as a power stage to drive the loudspeaker. S1 is a biased one way double pole change over switch, biased to the buzz position. Normally S1 is in the buzz position and S2 is not made. In this condition LED1 is not on since it is reverse biased, and also power is not supplied to the oscillator. If S2 is now pushed, to call the person upstairs, then power is supplied to the oscillator and a buzz is heard. The person upstairs acknowledges the buzz by flicking S1 over to the ACK position. This forward biases the led, with the current limited by R6 (assuming S2 has been released) and thus the acknowledge signal is given. If S2 is not released then the led will not light.

The only problem that may arise when installing the system is if the two wires used for the communication from upstairs to downstairs are identical. In which case it may be necessary for someone to hold S1 in the acknowledge position while the led is tried both ways round in order to find the correct way.

T. Watson, Ferndown

Speaker Protection

When the power is first applied to any amplifier, there is a period of time during which the output coupling capacitor in series with the loudspeaker has to charge. This charging current causes a loud 'thump' transient which could possibly damage a good quality and expensive loudspeaker.

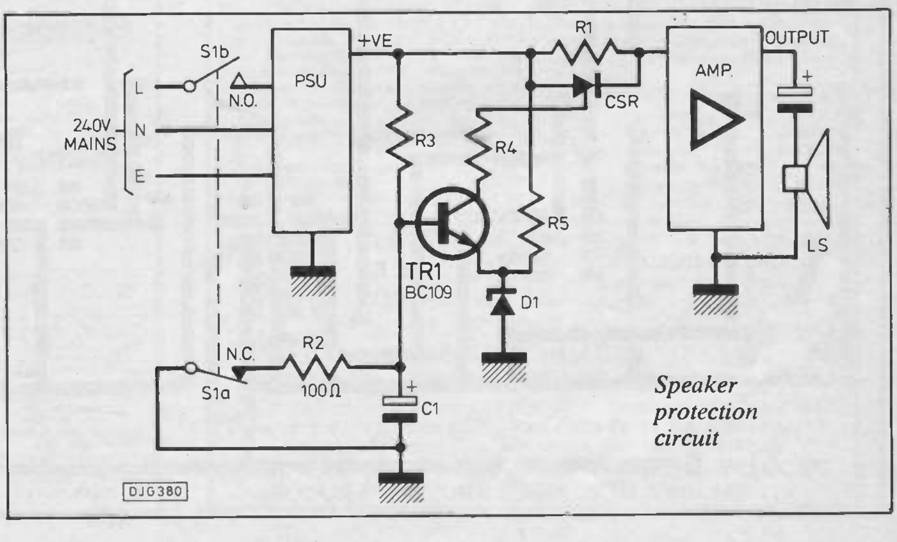
Even if the amplifier is dc coupled at its output, the positive and negative rails must rise at the same rate to avoid large transient currents in the loudspeaker coil. With these thoughts in mind, the writer developed the circuit illustrated.

The power supply is considered to be a stiff constant voltage source. S1a is linked to the mains on/off switch and at switch on the power supply produces full voltage almost immediately. Since S1a is now open, capacitor C1 starts to charge, its voltage increasing exponentially with a time constant of C1 and R3. During this time, the amplifier is taking current but at a reduced voltage due to the voltage drop across R1. This reduced voltage means that the charging currents available to cause damage to the loudspeaker are much reduced. Meanwhile C1 continues to charge towards the 'cut on' voltage point of TR1 panel mounted switch. At this point TR1 conducts, the collector current flows and provides trigger current to fire the scr. When the scr fires, it effectively shorts out the limiting resistor R1, the amplifier now has its full supply voltage and the charging current transient has been avoided.

At switch off, the amplifier output slowly discharges as the supply voltage falls, C1 discharges rapidly through S1a and R2 to re-initialise the circuit.

R3 C1 gives delay time constant; R3 must be chosen to saturate TR1; D1 zener sets trigger point; R5 is zener maintaining resistor; RA sets scr gate current limit; R1 should be a wire wound limiting resistor.

A.B. Bradshaw, Sandy.



Speaker protection circuit

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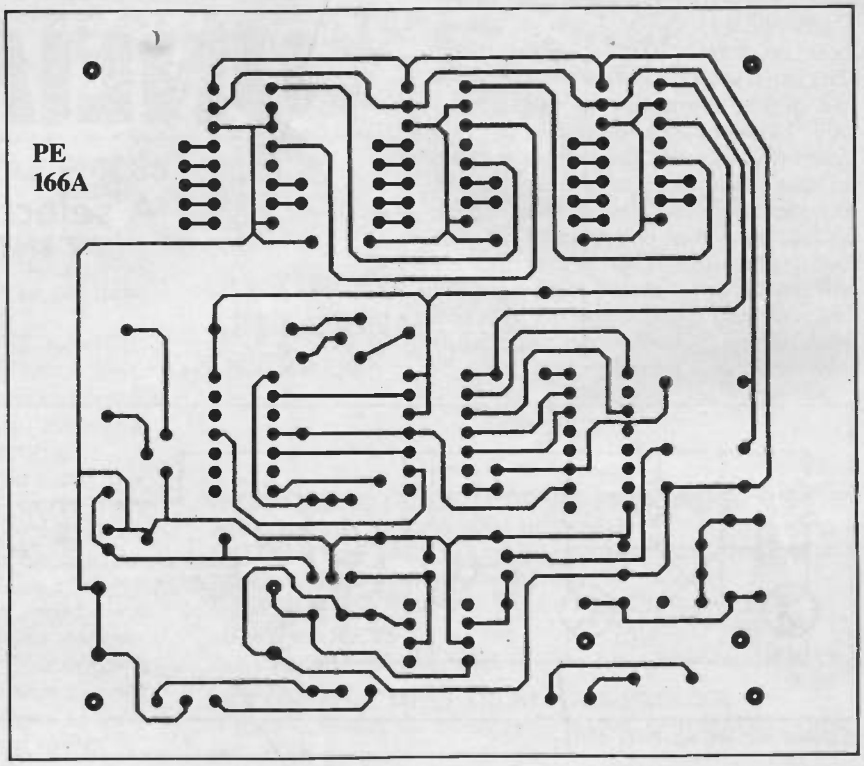
Develop PCB in Sodium Hydroxide (available from chemists) until clean track image is seen, wash in warm running water. Etch in hot Ferric Chloride, frequently withdrawing PCB to allow exposure to air. Wash PCB in running water, dry, and drill holes, normally using a 1mm drill bit.

(PCB materials and chemicals are available from several sources – study advertisements.)



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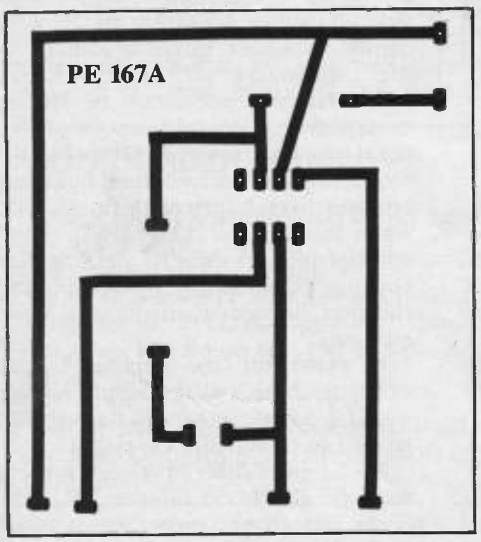

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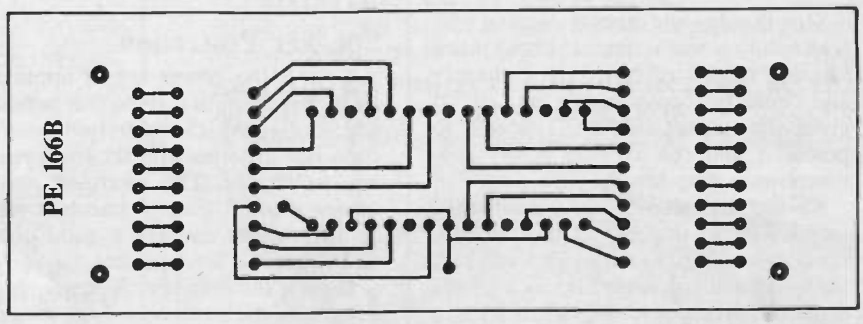

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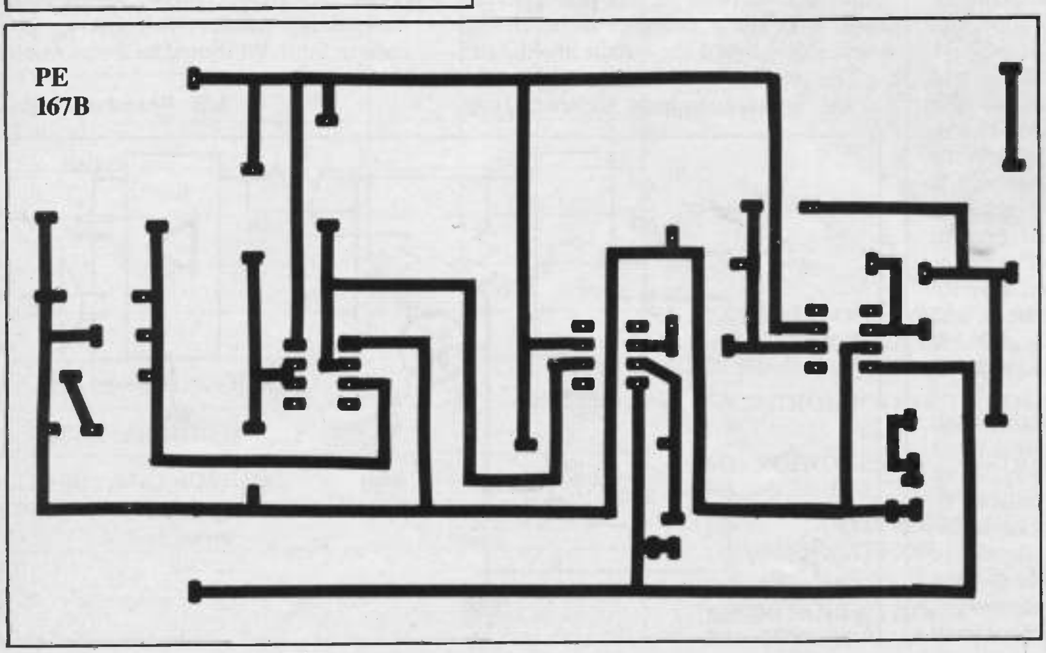

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4008 38p	4098 50p	74LS55 17p	74LS253 350	8080A 400p	75188 60p	7924 40p
4009 20p	4099 45p	74LS73 28p	74LS256 60p	8085A 300p	75189 60p	78L05 28p
4010 21p	4501 30p	74LS74 22p	74LS257 42p	8155 360p	75195 185p	78L12 28p
4011 13p	4502 38p	74LS75 28p	74LS258 42p	8156 360p	75322 130p	78L15 28p
4012 13p	4503 32p	74LS76 28p	74LS259 58p	81LS95 120p	75324 340p	78L18 28p
4013 19p	4504 55p	74LS78 28p	74LS260 48p	81LS96 130p	75325 155p	78L24 28p
4014 35p	4505 200p	74LS83 43p	74LS266 28p	81LS97 130p	75365 145p	79L05 40p
4015 34p	4506 60p	74LS85 45p	74LS273 52p	81LS98 130p	75450 45p	79L12 45p
4016 18p	4507 33p	74LS86 30p	74LS279 40p	8224 270p	75451 42p	79L15 48p
4017 31p	4508 70p	74LS90 32p	74LS280 140p	8226 270p	75452 42p	7818KC 100p
4018 33p	4510 37p	74LS91 75p	74LS283 60p	8228 270p	75453 65p	7824KC 100p
4019 28p	4511 40p	74LS92 38p	74LS290 30p	8243 250p	75454 65p	LM309K 100p
4020 35p	4512 42p	74LS93 30p	74LS293 30p	8250 850p	75480 135p	LM317K 220p
4021 38p	4513 80p	74LS95 47p	74LS365 37p	8087 1100p	75491 60p	LM317T 180p
4022 36p	4514 75p	74LS96 60p	74LS366 37p	8251 300p	75492 60p	LM323K 420p
4023 13p	4515 75p	74LS107 32p	74LS367 35p	8253 320p	8T26 95p	LM723 40p
4024 25p	4516 40p	74LS109 34p	74LS368 38p	8255 310p	8T28 110p	78HGKC 570p
4025 13p	4517 120p	74LS112 38p	74LS373 55p	8256 1200p	8T31 330p	78HO5KC 800p
4026 60p	4518 38p	74LS113 32p	74LS374 55p	8257 350p	8T95 90p	78H12KC 700p
4027 18p	4519 30p	74LS114 35p	74LS375 58p	8259 360p	8T96 110p	78GUIC 190p
4028 29p	4520 38p	74LS122 400p	84LS390 50p	8271 3400p	8T97 90p	79GUIC 215p
4029 35p	4521 90p	74LS123 42p	74LS393 45p	8272 1200p	8T98 110p	79HGKC 800p
4030 17p	4522 50p	74LS124 85p	74LS399 80p	8279 450p	**VOLTAGE REGULATORS**	
4031 90p	4526 40p	74LS125 38p	74LS629 105p	8282 300p		
4032 54p	4527 44p	74LS126 36p	74LS641 110p	8283 400p		
4033 60p	4528 40p	74LS132 40p	74LS642 200p	8284 440p	7805 35p	
4034 80p	4529 75p	74LS133 34p	74LS644 280p	8287 360p	7812 35p	
4035 45p	4532 52p	74LS136 35p	74LS645 170p	8288 650p		
4036 180p	4551 80p	74LS138 35p	74LS670 72p	8748 1100p	**ZENERS**	
4037 75p	4553 190p	74LS139 35p	74LS674 400p	8755 1400p		
4038 48p	4555 29p	74LS145 83p	74LS687 270p	AY3-1015 290p	400MV	
4039 190p	4556 38p	74LS147 120p	**COMPUTER ICS**	AY5-3600 570p	BZY88 RANGE	
4040 38p	4557 190p	74LS148 90p		SP0256AL2 500p	2v7 to 39V	6p
4041 38p	4583 60p	74LS151 32p		Z80ACPU 180p		
4042 30p	4584 30p	74LS153 40p	2114 200P	Z80BCPU 500p	1.3W	
4043 36p	4585 42p	74LS154 90p	2532 330P	Z80ADMA 650p	BZX61 RANGE	
4044 38p		74LS155 41p	2716 200P	Z80APIO 230p	2v7 to 39V	12p
4045 72p	**74LS SERIES**	74LS156 47p	2732 280P	Z80BPIO 480p		
4046 45p		74LS157 30p	2732A 300p	Z80ACTC 250p	**LED**	
4047 45p	74LS00 15p	74LS158 33p	2764 240p	Z80BCTC 480p	LED 3mm RED	5p
4048 27p	74LS01 15p	74LS160 48p	27C64 550p	Z80ASIO 660p	LED 3mm YEL	10p
4049 18p	74LS02 15p	74LS161 50p	27128 350p	Z80ASIO-1 700p	LED 3mm GRN	10p
4050 20p	74LS03 15p	74LS162 48p	27256-25 400p	Z80ASIO-2 700p	LED 5mm RED	5p
4051 38p	74LS04 15p	74LS163 46p	41256-15 300p	Z80ADART 680p	LED 5mm YEL	10p
4052 37p	74LS05 15p	74LS164 43p	256DRAM 300p	74S188 175p	LED 5mm GRN	10p
4053 37p	74LS08 15p	74LS165 65p	4116 75p	74S189 210p		
4054 53p	74LS09 15p	74LS166 74p	4164 110p	74S201 240p		
4055 52p	74LS10 15p	74LS168 92p	6116 160p	74S287 190p		
4056 52p	74LS11 15p	74LS169 65p	6264-15 250p	74S288 160p		
4060 40p	74LS12 15p	74LS170 80p	6502 300p	74S289 180p		
4063 52p	74LS13 22p	74LS174 39p	6502A 400p	74S387 200p		
4066 20p	74LS14 30p	74LS175 42p	65C02 930p	75107 80p		
4067 130p	74LS15 15p	74LS190 55p	6503 570p	75108 80p		
4068 13p	74LS20 15p	74LS191 52p	6520 170p	75109 110p		
4069 13p	74LS21 15p	74LS192 50p	6522 330p	75110 80p		
4070 13p	74LS22 15p	74LS193 51p	6530 1050p	75112 140p		
4071 13p	74LS24 38p	74LS194 53p	6532 480p	75113 105p		
4072 13p	74LS26 15p	74LS195 52p	6545 880p	75114 130p		
4073 13p	74LS27 15p	74LS196 82p	6551 530p	75115 130p		
4075 13p	74LS28 15p	74LS197 52p	6800 210p	75121 125p		
4076 45p	74LS30 15p	74LS221 56p	6802 220p	75122 125p		
4077 13p	74LS32 17p	74LS240 55p	6803 800p	75150 110p		
4078 13p	74LS33 17p	74LS241 55p	6808 500p	75154 110p		
4081 13p	74LS37 16p	74LS242 55p	6809 800p	75158 140p		

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XK125 Complete kit of parts **£21.95**

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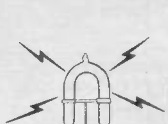

Designed to produce a high intensity light pulse at a variable frequency of 1 to 15Hz, this kit also includes circuitry to trigger the light from an external voltage source (eg. a loudspeaker) via an opto isolator.
Instructions are also supplied on modifying the unit for manual triggering, as a slave flash in photographic applications or as a warning beacon in security applications. The kit includes a high quality pcb, components, connectors, 5Ws strobe tube and full assembly instructions. Supply: 240V ac. Size: 75x50x45.

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This kit includes all components (+ transformer) to make a sensitive IR receiver with 16 logic outputs (0-15V) which with suitable interface circuitry (relays, triacs, etc – details supplied) can be used to switch up to 16 items of equipment on or off remotely. The outputs may be latched (to the last received code) or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits.
Supply: 240V AC or 15–24V DC at 10mA.
Size (excluding transformer) 9 x 4 x 2 cms.
The companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available MK9 (4-way) and MK10 (16-way), depending on the number of outputs to be used.

MK12 IR Receiver (incl. transformer) **£14.85**
MK18 Transmitter **£7.50**
MK9 4-Way Keyboard **£2.00**
MK10 16-Way Keyboard **£5.95**
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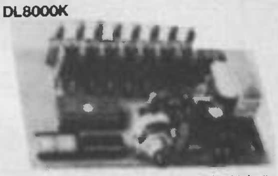
DL3000K –3-channel sound to light kit features zero voltage switching, automatic level control and built-in microphone. 1kW per channel. **£14.25**

The DL8000K



The **DL8000K** is an 8-way sequencer kit with built in opto-isolated sound to light input which comes complete with a pre-programmed EPROM containing EIGHTY — YES 80 different sequences including standard flashing and chase routines. The KIT includes full instructions and all components (even the PCB connectors) and requires only a box and a control knob to complete. Other features include manual sequence speed adjustment, zero voltage switching. LED mimic lamps and sound to light LED and a 300W output per channel. And the best thing about it is the price: **ONLY £28.50.**

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XK121	LOCK KIT	**£15.95**
350 118	Set of keyboard Switches	**£4.00**
KB12S	12-Way Membrane Keyboard	**£9.98**
701 150	Electric Lock Mechanism	**£16.50**

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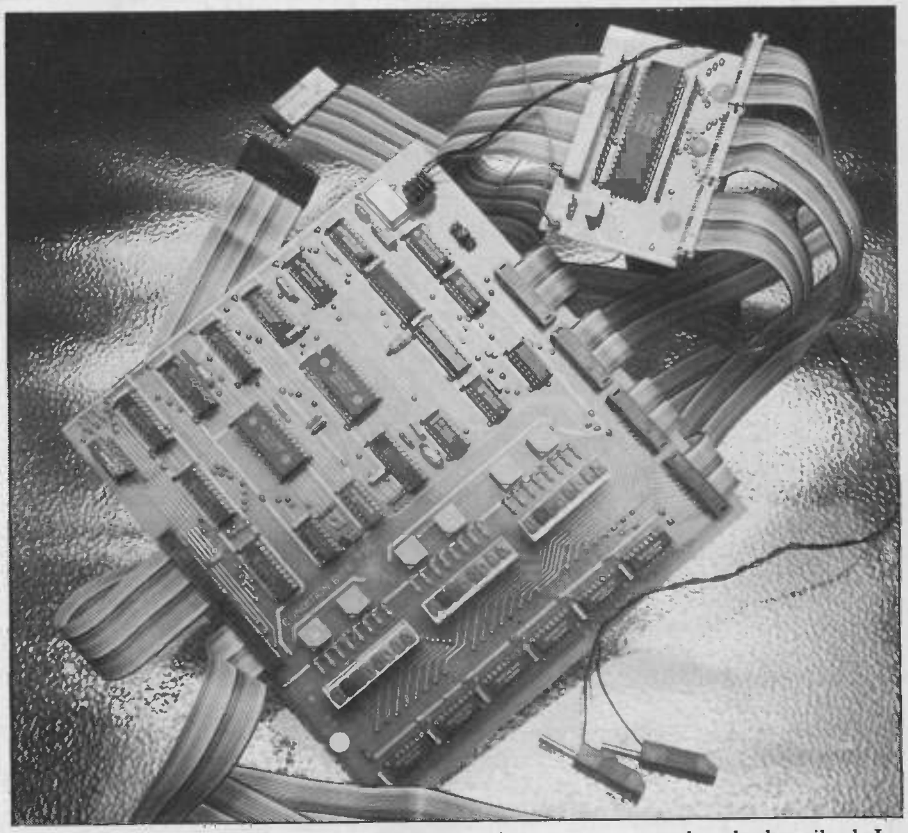
LOGIC ANALYSER

PART TWO BY MICHAEL SWEET

USING THE LOGIC ANALYSER

Concluding the construction of this project board, and a discussion about its operational use with the BBC microcomputer



Connection to the BBC microcomputer is via the user port connection and a rom socket. The program will find for itself the rom socket number used. For initial trial purposes you should set the condition bits switches all to DON'TCARE states and not connect any condition bit input. Then using the recommended connections set a triggering address which the program is known to access. It is recommended that initially the clock qualifier is not used and it be attached to either V_{SS} or V_{CC}. All connections may be made directly to the microprocessor pins on the target system, the plug-in connector for the 6502 microprocessor is a convenient way to make all these connections.

Chain the program "6502" from disc. Leave the disc in place as further data must be loaded. The program takes the user step by step through the necessary sequence of questions. All questions are highlighted by colour as are the options available at any stage. The first choice is whether to use the latching pod hardware option or not. Essentially this pod latches data at the part of the clock cycle when it is valid so that when the pod is used the user will not be able to detect changes on the data lines as they happen. Briefly if timing problems on the target system are of major interest the latching pod should *not* be used, while if disassembly is the major interest the pod should be used as it significantly extends the amount of disassembly possible as well as the upper range of processor frequencies which can be handled. The only other step at which a user may have difficulty is when asked for the interrupt vectors of the target system of these are not known. The device may be used to find this information and Appendix 1 describes the procedure.

When the device has been triggered data is taken into upper memory area of the BBC ram. Software procedures treat this data in a variety of ways and store the data generated. Some of this software is in machine code form and this together with the data files, occupy the memory area above &5E00. Access to the data areas of this address range so that data may be checked and details of the contents is given within the address menu chosen by pressing key A at the main option stage of the program.

Should the device not encounter the trigger condition the message NOT TRIGGERED will remain on the vdu screen. If program re-entry is desired press "escape" key on the BBC keyboard and follow the instructions given. The user should be aware that using a CLOCK QUALIFIER condition which is never met will also cause NOT TRIGGERED to be continuously displayed, (for example, if the EXT CLK lead is attached to V_{SS} and a High qualifier set) even though all trigger conditions are met. Sometimes the information that the trigger condition has not be encountered is in itself most valuable.

MORE OPERATION DETAIL

Essentially the LA consists of a number of gates through which data is channelled at the appropriate times as controlled by signals from the BBC user port. The operation involving the hardware occurs in two stages: the data gathering stage and the transfer of memory block stage. Subsequently the data is treated internally within the BBC microcomputer as already described. In the data gathering stage 2K bytes of data are loaded into RAM1 and RAM2. During this stage data access from the test circuit through buffers LD1 and LD2 is allowed by signal PB1 being low. Addresses are incremented at the logic analyser clock rate by the outputs from counters LMH whose outputs access the ram address pins via buffers LA and L/C, the latter chip also buffering the WE and CS lines during this stage. The start and stop signals for data loading depends on the mode. In the POST mode the start signal is the TRIGR signal and the stop signal is address bit 11 going high. In the PRE mode address cycling repeats following the start signal until the TRIGR signal stops this cycling. Buffers LD1 and LD2 are only open while awaiting triggering and during data collection. This limited exposure of target system to the analyser reduces the risks of spurious data occurrence.

In the transfer of memory block stage all the above buffers are closed and signal PB5 is sent low allowing access to the BBC microcomputer generated CS

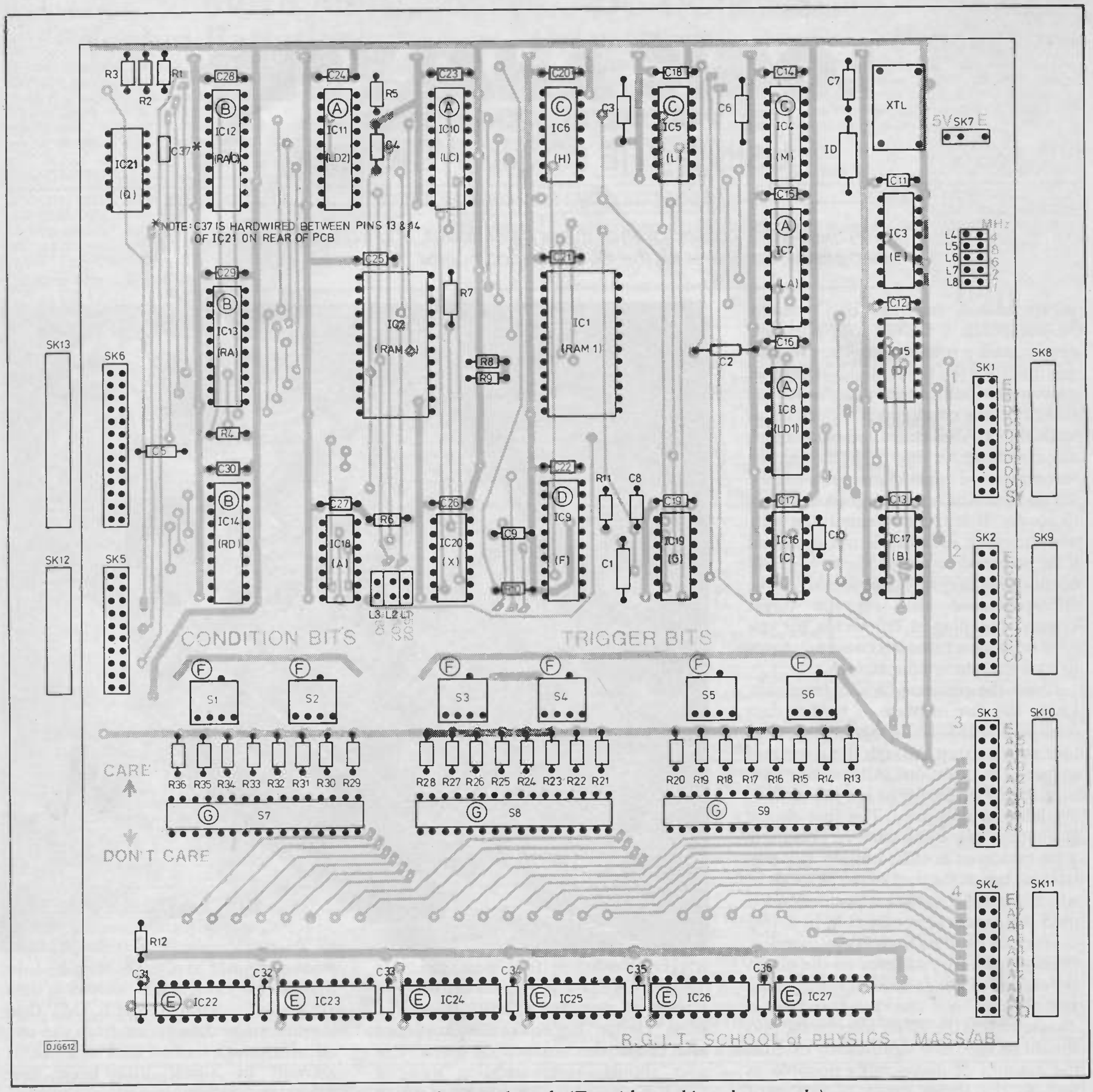


Fig 3. *Component positioning details on the printed circuit board. (Top side tracking shown only)*

The double-sided PCB is available through the PE PCB Service. Photocopies of the tracks and through-hole connections are available from the Editorial Office.

and OE enable signals and address bus so that data from RAM1 and RAM2 may be read into the BBC ram. The choice of which of RAM1 and RAM2 is selected during this stage is via signal PB6 which controls the route of the OE signal through the 74LS125 chip denoted A. Again the buffers between the BBC microcomputer and the logic analyser are open only during the data transfer stage.

The selection of PRE or POST mode is via signal PB4 which is low for POST. The signal and its inverse are fed to gate F (Fig.1) which controls the paths of triggering and stop and start signals to the heart of these operations (chip G) which is essentially an S-R flip flop.

DATA GATHERING — POST TRIGGER MODE

In POST operation a high logic level to pin 1 (reset) sets input A high. Since both inputs A and B have to be low to allow clock signals on pin 11 to be passed out on pin 8 of G then this prevents the clocking signal to pin 5 of L in the set of counters L, M, H. This RESET signal is sent by sending PB7 high for a microsecond or so, the same signal also resets the counters L, M, H to zero. The route of the reset signal is F6 to F14 via delay (Q) to G1. The delay is not material here, being essentially for use in the PRE trigger mode.

Following the high on G1 clocking occurs from G8 to the counters. Thus addresses are incremented from (0)000 0000 0000 gated through LA and L/C [PB2 low] together with the correct control signals for writing to each of the rams. During this operation the data from the test system is allowed access through LD1 [PB1 low] and the two data control lines SYNCH and DATAVALID through LD2 [PB0 low]. Address generation at the chosen ECLK rate and data storage continue until address (1)000 00000000 is generated. This sends H7 high and hence also signal B high to G10 thus stopping the clocking so that the data in the rams now stays fixed. Meanwhile the main program has been awaiting the low to high transition on

H7, whch is connected via F8 to F12 to CB1, before continuing. The RAM OE signals are high throughout the data writing sequence. This whole process has allowed 2Kbytes of data to be written into the RAMS.

PRE-TRIGGER MODE

In the PRE mode PB4 is high. This mode requires an additional stage since it is possible to begin a search at various times before the trigger condition occurs. To clarify this let us say that the target system is in a loop with the trigger condition occurring once every 1000 system clock cycles; in this case depending on when we commence there could be between 1 and 999 target system clock cycles before the trigger condition is met and accordingly 1 to 999 times the clocking ratio (clocking ratio = LA clock frequency/target system clock frequency) of data loaded (up to the maximum 2Kbytes of memory constraint). Accordingly it is necessry to do two things:

a) to clear the LA memory before the start so that spurious data is not examined, unlike the POST case the 2Kbytes of data is not all overwritten. This is achieved by overwriting high logic states to the few bits of RAM2 which are used. RAM1 is less important and may contain almost any data, this is easily recognised as spurious.

b) to lay a sign so that within the software steps taken later it is possible to recognise when the trigger condition occurs.

This is achieved by delaying the TRIGR signal which will stop data cycling using the Newport 8450 delay line. The effect of this is to allow a few cycles of clocking and data collection to occur with the BTRIGR/DATA VALID signal high. This signal is always low during valid data collection so that these few cycles enable the trigger condition to be recognised as the first few addresses in which invalid data is signalled following a block of valid data. This signal is stored as bit 3 in the BBC ram while the other useful signal to RAM2 is stored as bit 7. This is the synch data which is stored as a low signal to indicate an opcode cycle.

Whether a POST or PRE triggger condition is selected the clocking signal input to pin G11 may be chosen to be qualified by an external clock qualifier signal or not, and also allows choice of data entry only on a high or low logic level of the qualifier signal as desired.

READING THE DATA FROM THE LA RAMS TO THE BBC

The data has now been collected into the LA rams (provided of course the trigger condition was met) and whether PRE or POST triggering was used with or without a clock qualifier the data now has to be read. The data reading operation commences by closing the access to test system data lines (via LD1, LD2) and to LA board address and control lines (via LA and L/C). The data is then read to the host BBC microcomputer by enabling buffers RA/C, RA (to allow access of host generated address and control lines) and RD (to allow access of data from the LA board to data bus of the host).

The data is read in two stages. Signal PB6 high allows RAM2 data to be read (synch and data valid data) while PB6 allows RAM1 data (the main data) to be read. The machine code routine responsible for this temporarily suspends the Basic rom on the microcomputer to allow access to the external ram via the rom socket connection for this purpose. For POST trigger operations the above steps are sufficient and the trigger condition data is automatically loaded at the base address of the memory area used (&7000) with the corresponding synch/data valid data at its base address (&6600). However as we have seen for PRE-triggering the trigger condition may be anywhere in the 2Kbytes. Software procedures then search the memory area &6601 – &6DFF for the trigger condition sign and the external data is reloaded with this address as the start address with the effect that the trigger condition is loaded at the end of the allocated data area (at &77FF) and the corresponding synch/data valid data at the end of its allocated area (at &6DFF) with the data leading up to each preceding it, some of this data may of course not be valid which is easily recognised by the state of bit 3 in the corresponding byte of the range &6600 – &6DFF.

OTHER FACILITIES

The facilities so far described are available for all target systems, clock frequencies and for all LA board chosen frequencies. The data being loaded at &7000–&77FF and DATA VALID and SYNCH information at &6600–&6DFF. The number of occurrences of a particular data item and corresponding control information depends on the ratio (R) of LA clock frequency/system clock frequency. Providing that this ratio is high enough (for unlatched data 8 is best, when using the data latching pod 4 is recommended though 2 is usable), it is possible to obtain an accurate cycle by cycle listing by checking the number of occurrences of data and listing only those which occur in appropriate numbers. The software does this for all target systems for which the clocking frequency and ratio R are suitable. It is important that the user answers correctly the questions posed on these frequencies to ensure that the cycle by cycle listing is correctly assembled. The software does not assemble a cycle by cycle listing when clock qualifier conditions are superimposed as these alter the ratio R unpredictably since in general there exists an infinite variety of clock qualifier possibilities.

At this stage the program displays the data collected onto the VDU screen and allows a choice of options. These are to print the page currently displayed on a printer; to display in logic level format the data from the trigger position (TRACE), to repeat trigger or to change the current address. The change of address allows any useful address range to be displayed on the vdu or printed. The TRACE facility has its own inbuilt method for change of address location displayed.

Providing that the cycle by cycle listing was allowed another option becomes available, namely disassembly. However it is necessary that the microprocessor on the target system matches the one for which you have the software and for

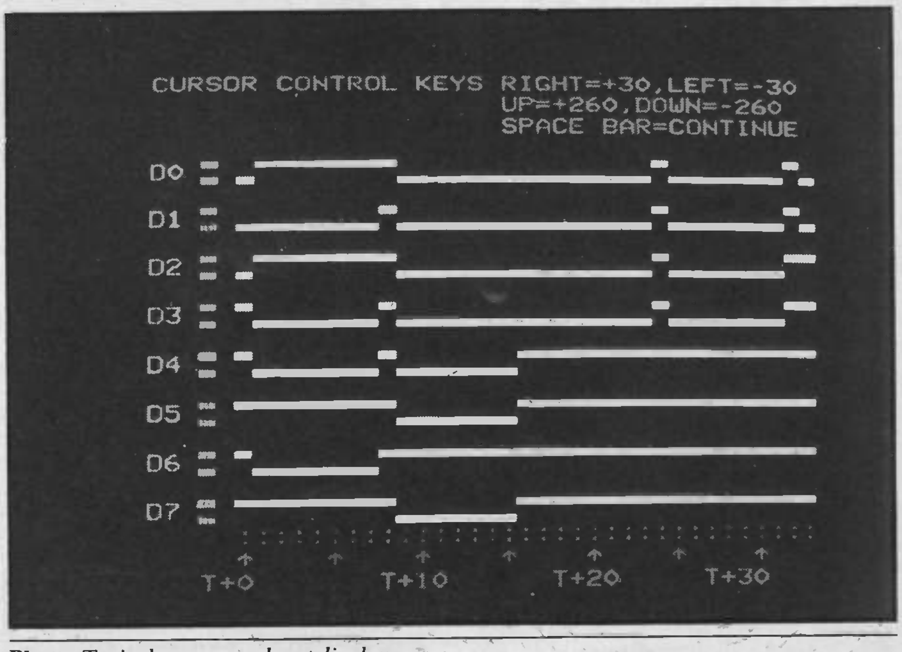


Photo: *Typical screen read-out display* which the opcode and other data has been loaded from disc. The present version is for a 6502 microprocessor. When the disassembly option is entered a check routine is carried out with the user before commencement to ensure the appropriate conditions apply for proper operation. Provided this is the case each opcode in the cycle by cycle file (signalled by a low bit 7 in the corresponding cycle by cycle synch/data valid file) is checked for validity and a disassemblable file is created, also an opcode only file. The former file is subsequently disassembled. Disassembly always starts at a nominal address but once an absolute address has been encountered all subsequent addresses are absolute.

The distinction between nominal and absolute addresses is made clear by colour coding on the vdu screen and printing a double asterisk for absolute addresses. The single asterisk addresses are for branch jump addresses calculated with respect to the nominal start address but not yet absolute. One other problem occurs and that is that the disassemblable data area of memory has to have *some* data in it at the start and this will remain at the end if it has not been overwritten. If the end of the normal data file happens to occur with an opcode this spurious data will be interpreted as the corresponding data for that opcode. &BB has been chosen as this dummy data and must be viewed with suspicion if it occurs at the end of disassembly (and at the end of the disassemblable file). The software also carries out special checks when an interrupt occurs and provided that the vectors have been entered proper disassembly through interrupts occurs. Failure to enter the vectors results in one or two false disassembled bytes. Finally a signature analysis routine is provided for the cycle by cycle or disassembled files. This is particularly useful as a rapid check that systems are working predictably.

APPENDIX 1

Procedure for Finding Vectors for NMI, RES and IRQ for 6502 Microprocessor

Attach the 16 trigger lines to the address pins, T0 to A0, T1 to A1 etc to T15 to A15 and the data lines to the data pins on the microprocessor D0 to D0 etc to D7 to D7, synch line to pin 7 and EXT CLK to any relevant point (if you have no particular plans for a clock qualifier attach it to V_{SS}).

Set the trigger condition to XX FFFA.

Do a POST trigger, no clock qualifier run having entered N responses when asked about knowledge of vectors.

In the display at &7000 upwards which appears upon triggering the first two data bytes which appear repeatedly are the NMI vector in reverse order. A typical BBC-B display with 16MHz selected by the selector link is:

20 A0 0 0 0 0 0 0 0 0 D
D D D D D D D D 20 20 2C 2C

From this the NMI vector is 0D00.

If a double check is required enter A then C and now the NMI will be displayed at &7800, &7801 in the cycle by cycle data as 0 D.

Note that NMI interrupts may not be occurring in your system in which case NOT TRIGGERED will be continuously displayed. An NMI can be forced by touching a wire connected to V_{SS} to pin 6 of the microprocessor.

Repeat the whole process with XX FFFC as trigger to give the RES vector (pin 40).

Repeat the whole process with XX FFFE as trigger to give the IRQ vector (pin 4).

The pin number in brackets is the pin to which the wire connected to V_{ss} should be touched to force the interrupt type if it is not occurring. Once you have determined the vectors for your system it may well be worthwhile to program one of the function keys to enter all the responses to this series of questions.

APPENDIX 2

Notes on the Signature Analysis Option

Signature analysis is a technique used mostly as an overall check on the proper operation of an electronic circuit or components. A test probe is applied to a node in the circuit operating under some cyclic condition and a crc (cyclic redundancy check) sum determined between the circuit generated start and stop signals. This is compared with signature obtained for the circuit operating correctly under the same conditions, if it is the same then that node is functioning correctly. Clearly for the technique to be applicable the steps between the start and stop signal must be predictable (eg the suspension of a program execution to service an interrupt service request would lead to a depar-ture from the expected signature even if the circuit were operating correctly).

The calculated crc sum for signature analysis purposes is displayed using a slightly different set of symbols from the hexadecimal codes as shown

Hexadecimal	: O-A, B, C, D, E, F
Signature	: O-A, C, F, H, P, U

Normally signatures are determined for a definite time window comprising a number of clock pulses within the START and STOP signals. A typical signature analyser thus has four connections to the test rig namely start, stop, clock and data channel. In the present array this is extended somewhat by the provision of 8 parallel data channels while the start and stop signals depend on the mode chosen as follows:

	POST TRIGGER	PRE TRIGGER
START	TRIGGER pulse	May be anywhere within collected data bytes
STOP	May be anywhere within collector data bytes	TRIGGER pulse

We now have to decide to which data we apply the technique. The candidates are: as collected data file; cycle by cycle data file; disassemblable data file; opcode only data file.

The as collected data file suffers from unpredicatable data during the part of the clock cycle when the "switch-over" occurs and thus produces varying signatures even for a normally working board so that this is not satisfactory.

The cycle-by-cycle file is more predictable, the only problem in using this is that when the data to be written to ram/rom/I/O varies from one occasion to another it will affect the signature so that this must be used with caution.

The disassemblable data file is the preferred option. Signatures are predictable. A drawback is that disassembly is not always possible.

The opcode data file could be used but the information within it is even more restricted and it is never available when the disassemblable data file is not, so it is not recommended.

Two other problems arise and should be noted if this facility is to be used.

1. Interrupts occur at unpredictable times (if they are allowed) so that the methods is of very limited (or no) use under such circumstances.

2. For the PRE trigger condition a variable number of bytes are stored depending on the relative instants when recording is started and when the trigger pulse occurs. Choice of the default condition allows *all* the collected and valid bytes to be used but the recommended procedure is to standardise on a small number of bytes so that on *most occasions* this number will be collected. The recommended number is 16. If a higher number is chosen that number of bytes will occur, before the trigger condition is met, less frequently and this will mean time spent on extra attempts before success is achieved. PE

The author acknowledges the considerable assistance given with the printed circuit board layout design by A. Baxter.

Software and further details about the Logic Analyser are available direct from the author: Dr M.A.S. Sweet, Robert Gordon's Institute ofTechnology, School of Physics, St Andrew Street, Aberdeen, AB1 1HG. Tel: 0224 633611 Ext 541.

READERS' LETTERS

HAPPY RETURNS

Dear Ed,

I first started taking PE in 1968 as a school boy of 13, and it became a major influence in my decision to take up electronic engineering, and later computing, as a career. I continued reading PE without a single break until the mid-80s when I felt that its standards had declined, and I cancelled my order with the local newsagent.

However, without any action on my part, the newsagent recently started to deliver PE again. Imagine my delight when I saw that the old PE had returned – simple, elegant circuits, good articles written with style and accuracy, and ads relating to electronics rather than computer games.

I am now subscribing again. Many thanks!

N.R. Tilley, C.Eng MIEE, Woodbridge.

Welcome back to the fold! **Ed.**

ERNIE BINGO

Dear Ed,

I have been asked to build an 'Ernie' for bingo use by a local club. Can you help?

I find your mag very good as I do a lot of equipment building for this social club.

D.G. Green, Fleet.

With the proliferation of computers around that have random number generators built into them I cannot see that attempting to build one is going to prove cost effective.

However, if you are intent on doing it, one approach would be to amplify a white noise signal until the spike levels were high enough to trigger a counter. A second noise source could be treated likewise to trigger a gate controlling the first counter. I regret though, that I cannot offer you any diagrams, or to design it for you.

Nice to know that you like PE so much, and wish you every success with your equipment building.

Ed.

CONTROL BIT

Dear Ed,

I would be pleased to see more publicity given to the MC14500BPC 1-bit data bus processor.

This chip can be used to control many physical movements and react to inputs from sensors in a faster reaction time in some instances than a microprocessor. The software is extremely simple to write, to achieve sequences of on-off states in many transducers. This chip appears to have been neglected in favour of the usual 8-bit microprocessor chips.

As a user of this chip in machine control systems I would be glad to know if other readers have made use of it, and in what applications.

G.T. Mathys, Liphook.

GRAPHIC LIQUIDATION

Dear Ed,

I wish to display variable linear X and Y graphs on an lcd screen that can be viewed from a distance. It seems that the only non-alphanumeric lcds available need numerous separate gating chips which will make my application prohibitively expensive and require a very complex printed circuit board. Do you know of any LCDs that will do this job cheaply and simply be means of built-in multiplexed decoding?

J. Goodchild, Glasgow.

I cannot find any in my supply of catalogues – does anyone out there in PE Reader Land know of any? **Ed.**

HATCHET MAN?

Dear Egiter

Oh no! Not another egg timer!

Year after year we are assaulted and insulted and overcharged for stupid, idiotic, moronic, insipid, demented egg timer designs. How many have you done since PE first began to insult its readers with egg timers? You give us the screaming abdabs.

Yours eggsacktly,
Egg Timer Collector

And does your hard boiled Ed have egg on his face? Not at all, it takes a lot to shell shock me, and some of my unscrambled views are laid out in the Editorial on page nine. But I must hatch out the theme a bit further, especially as the yoke is that I can find no trace of ETs in the master index we keep nestling in the office. Unless the index is not all that it's cracked up to be, or someone has poached a page, it seems that PE has never published an ET.

Can one of you be egged-on to tell me if I've overlooked a PE ET somehow? I'll send a brand new copy of the next available issue (autographed if you want!) to the first person who deflates my ego by telling me how many I've missed, and in which month of which year. Somehow I don't think my post bag will boil over from answers on this one. Still, you never know, even Eds occasionally become addled, and I was looking on a Frieday...

It beats me why ET Collector preferred to be semi-anonymous (surely he's not a yokel from Egham?), and I couldn't make out some words he had written – perhaps they were yet more free range adjectives. Despite it's eggcentricity, his letter was food for thought; and a timely chance to whip up a few bad egg wisecracks again!

Eg.

LOST AND FOUND

Dear PE,

I have just discovered what I have been missing for the last two years – your magazine, especially the Solar Cells article by Ian Garner in Dec 87. I hope you follow up this article with circuits which make use of the cells. I don't just mean heating systems; what about battery chargers and other power supplies?

Also, I must give great credit to Andrew Armstrong for the Semiconductor series which is running in phase with the course I am presently studying – a two year BTEC diploma in telecommunications.

I look forward to receiving the next issue of a most interesting and thought creating magazine.

P. Perry, Tyne and Wear

Thank you. You are not alone in your discoveries, or your wishes. We do, and shall, try to bring you what you want.

Ed.

Writicism

An amusing situation was recently reported about the letters page of a Scottish newspaper.

Somehow one reader's letter became published on three separate occasions, each time with a different caption. The author of the letter eventually wrote in again, saying he was pleased that his first leter was so interesting, but should it wear out, he would be glad to write another one!

It's unlikely to happen at PE, we get a wide selection from which to choose — keep them coming folks ...

Ed.

bookmark

Another selection of newly published books to while away the dark winter nights.

Electrostatic Loudspeaker Design and Construction. R. Wagner. Tab Books. £11.60. ISBN 0-8306-2832-0. Many audio purists believe that electrostatic speakers offer the ultimate in sound quality, though the price can be a deterrent. To combat the problem, Ronald Wagner has written this comprehensive book as a thorough guide to building them for oneself. He discusses the theory at some length, and describes not only the circuit considerations, but also full woodworking details. Your Editor recalls his early speaker assembly days and wishes he'd had this book then.

33 Fun-and-Easy Weekend Electronics Projects. A. Guzman. Tab Books. £6.95. ISBN 0-8306-2861-4. An ideal set of simple projects for novices and addicts alike. Many of them will probably take less than an hour to put together, some perhaps even less time. There are too many to list, but they include alarms, a crystal set, radios, signal generators, test gear etc. Component lists are given, and pcb foil patterns are also shown. There should be a lot of pleasure found from this book. One gripe, though, I wish imported American books would not quote American suppliers for components that are readily available from UK sources.

TEACHER LIGHTSHOW

BY TIM PIKE

The sixth in a series of articles aimed at pupils studying for GCSE Electronics examinations in the summer of 1988

Back to good old electro-mechanical switching, with a relay-operated light show that stimulates parts of the brain that most circuits don't reach.

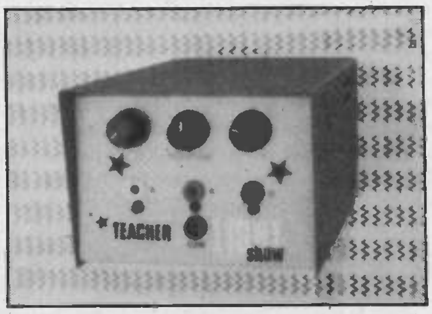
In the sixth article of this series I shall look step by step at switching circuits which might ultimately be frequency sensitive and capable of operating mains devices.

There have been many practical projects published over a number of years which might loosely be described as "sound to light units". Although what I offer here could also come into that category, its origins are rather different.

Many readers will have heard of the problems which the 'meningitis' virus can cause especially in young children. Shortly after the Autumn term started last year, I heard from a friend and ex-colleague of mine that his young son had caught the virus while on holiday in France. One of the possible effects of meningitis is to cause irreversible damage to certain areas of the brain.

A great deal of research has gone into finding methods of treatment which produce some improvement in the affected child. The most well known of these originated in Hungary and often goes under the name of 'conductive education'. Essentially it consists of a long term programme of regular exercise aimed at stimulating other parts of the brain into performing the duties of those damaged parts. It must be said that already it has met with a fair degree of success. Although most of the treatment requires physical exercise of a strenuous and arduous nature, other forms of mental stimulation are also to be encouraged. The visual stimilation by a number of flashing lights, which are activated either by music or by sounds which the baby himself makes, is one example. Rather than arrange the lamps inside a black cabinet, which is the standard disco technique, it would be more appropriate here to offer three output channels each of which can drive a mains device at, say, up to 100W. The user might then connect three standard table lamps positioned around the room in such a way as to attract the baby's attention to different parts of the room according to the frequency of input sound.

Clearly there are other possible applications for such a system. Disabled or elderly people might make use of it to switch on (or off) some mains equipment without having to move to



the appliance concerned.

It is apparent that according to its final purpose some modification to the output stage may be required. I am going to concentrate on a general system which will possess the features shown in Fig. 1.

Fig.1. *General system requirements*

AUDIO INPUT

In order to keep costs down and to make the system as general as possible, the input transducer may be a low-cost microphone or perhaps even a telephone mouthpiece. I will assume that this device will produce an output of a few millivolts. The first requirement of the system then is to amplify this relatively small input signal to generate a voltage range of perhaps a few volts. This could be achieved by using a multi-stage transistor amplifier, perhaps like the one used in the *Teacher Radio* (PE Dec 87) or in the *Teacher Talkback* (PE Jan 88) but I am keen in this article to explore some of the simple possibilities which operational amplifiers (op amps) can give.

In practice, all filter circuits are constructed from a combination of resistive and non-resistive components. If the circuit contains only resistors, capacitors and inductors then it is said to be a 'passive' circuit. Fig. 2 shows the simplest passive low-pass filter consisting of just one resistor and one capacitor. This is called a single-section RC circuit or a 'first order' RC circuit. The frequency response of such a circuit is shown in Fig. 3. This response is clearly nothing like the idealised shape of Fig.4a there is no identifiable 'corner' to the response, In many applications the presence of a well defined corner is vital. A real improvement is obtained if an inductance is added to the filter (Fig. 5). The "roll-off" is much steeper (generally twice the slope) and a much sharper corner can be obtained. (Fig. 6).

Inductors are very valuable in filter design where a precisely defined response is concerned and yet there are disadvantages. Inductors can be expensive to buy and they tend to pick up magnetically induced 'hum' from any mains devices close by. Although extensive screening will elimate the latter problem, this only adds further to the cost.

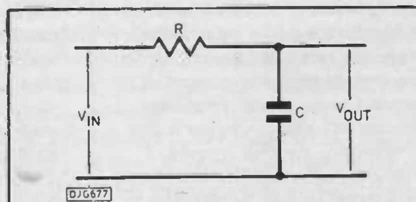


Fig.2. *First order R C circuit*

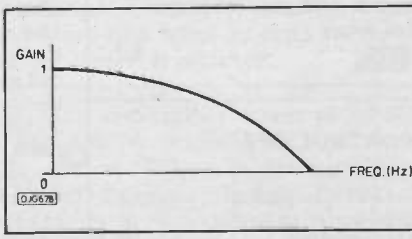


Fig.3. *Frequency response for Fig.2.*

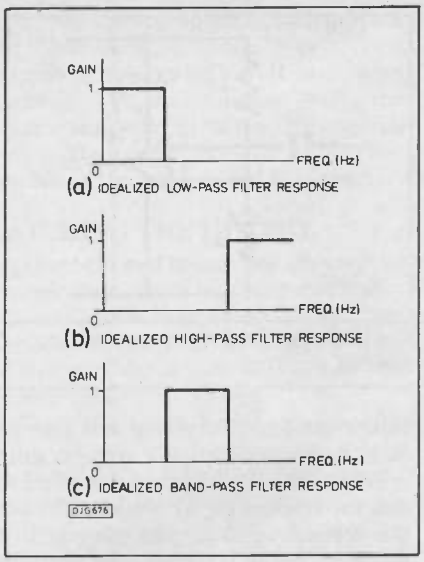


Fig.4. *Idealised filter responses*

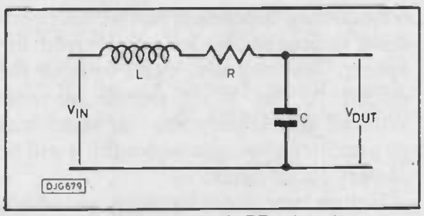


Fig.5. *Single section LCR circuit*

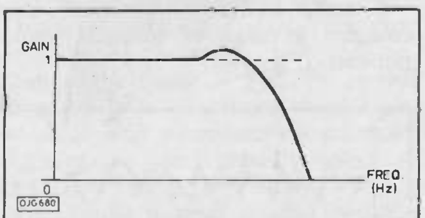


Fig.6. *Frequency response for Fig.5.*

ACTIVE FILTERS

Fortunately, it is possible to simulate the behaviour of an LCR filter using only resistors and capacitors if an active device (one which gives amplification) is included. The obvious choice again is to use an op amp. It is well beyond the scope of this article to look into the analysis of active filter circuits but such are the advantages when compared to the use of inductors that I will give a standard band-pass circuit based on a 741 op amp. We will then look at the important features of this circuit to see how it can be made to suit our purpose.

Since this will again depend upon type, we will opt for a 470 input resistor to the op amp. This effectively gives the amplifier an input impedance of 470 as all other input paths to the 741 have very high resistance values (greater than 1M). We know that we may need a gain of perhaps 2000 to bring the tiny input signal up to a standard of a few volts. So we choose a feedback preset resistor of 1M in series with a 470 resistor. The simple pre-amp of Fig. 7 results. The 741 requires dual voltage supply rails and so

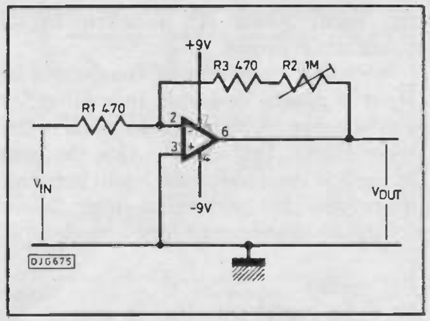


Fig.7. *Simple pre-amp with gain between 1 and 2000.*

± 9V will work very well. Either two PP3 batteries or a dual power supply (such as *Teacher Power*, PE Nov 87) can be used. Note that the pin identifications for the 741 have been included on the diagram in Fig. 7. Pins 1, 5 and 8 are not required and can be left unconnected.

FILTER CIRCUITS

Any circuit which is designed to respond differently at different frequencies may be called a filter. Essentially there are three possibilities. The so-called low-pass filter will pass without attenuation (loss) all frequencies from 0Hz up to some agreed maximum. Ideally this filter would have a response which looks like Fig. 4a. In a similar way the high-pass filter will allow frequencies above a certain value to pass without attenuation (Fig. 4b). The so-called band-pass filter allows a pre-defined range of frequencies to pass. Both upper and lower limits of the band-pass filter may be fixed by suitable choice of component values. It should be clear that the low-pass and high-pass filters are both special cases of the more general band-pass filter. (Fig. 4c).

GCSE students are required to be familiar with both the standard inverting voltage amplifier (Fig. 8) and the non-inverting voltage amplifier (Fig. 9). Both of these circuits make use of negative feedback to control the response of the otherwise very high gain 741 op amp.

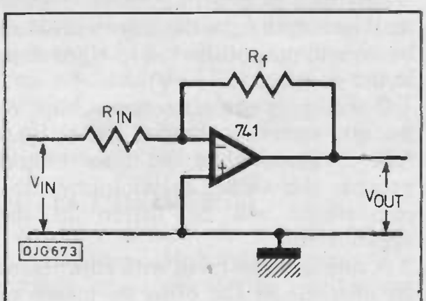


Fig.8. *Defined gain inverting amplifier*

The non-inverting circuit of Fig.9 gives a voltage gain as shown below:

$$\text{Gain} = \frac{V_{OUT}}{V_{IN}} = 1 + \frac{R_1}{R_2}$$

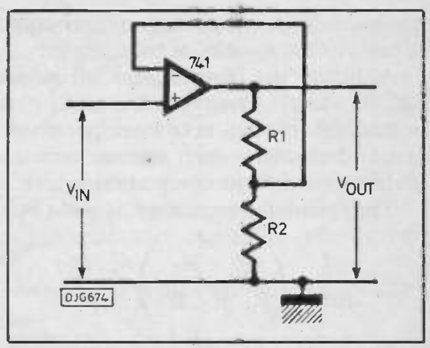


Fig.9. *Defined gain non-inverting amplifier*

Whereas, the inverting circuit (Fig. 8) follows the slightly simpler relationship:

$$\text{Gain} = \frac{V_{OUT}}{V_{IN}} - \frac{R_F}{R_{IN}}$$

Students of GCSE are not required to be able to derive these two formulae, merely to know the circuit configurations and the corresponding gain relationships.

Since we are dealing with an alternating input signal, there is no disadvantage to using the slightly simpler inverting circuit. Since we do not know how much gain will be needed (as this depends upon the type of input transducer in use), it makes sense to adapt Fig.8 to give variable gain.

A further consideration is that we should aim to match the input impedance of the amplifier to the output impedance of the transducer in use.

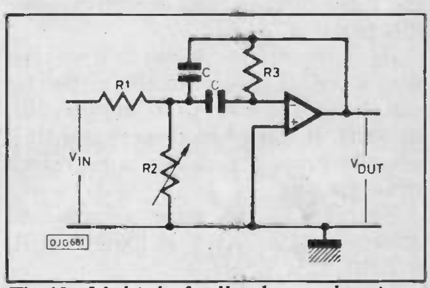


Fig.10. *Multiple feedback tuned active filter*

Fig. 10 shows a multiple-feedback tuned active filter. Note that between the output and the input there are two feedback paths. Resistor R3 provides one; capacitor C provide the other. The resistor R2 is variable and allows the resonant frequency (f_o) to be varied without affecting the bandwidth (the range of frequencies over which the filter

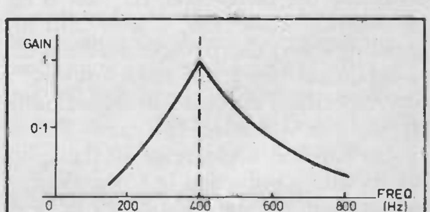


Fig.11. *Typical response for Fig.10.*

passes a large proportion of the input signal) or the maximum voltage gain.

Although the mathematics is beyond GCSE level some readers may be interested in the relationships which exist between the various circuit parameters and the component values.

The resonant frequency, f_o is given by:

$$f_o = \frac{1}{2\pi C}\left(\frac{R_1 + R_2}{R_1.\ R_2.\ R_3.}\right)^{1/2}$$

The bandwidth, Δf is given by:

$$\Delta f = \frac{1}{\pi C\ R_3}$$

The voltage gain at resonance, A_{max}, is given by:

$$A_{max} \approx \frac{R_3}{2R_1}$$

To take a particular set of values, if R_3 = 100k, R_2 = 68, R_1 = 47k and C = 150Ω then the resonant frequency is 400Hz, the bandwidth is 21Hz and the maximum gain is approximately one.

Fig. 11 shows the expected frequency response for this set of values. Notice how sharp the response is around the resonant frequency.

THREE CHANNELS

It would be very convenient to use this same circuit arrangement, albeit with different values of R and C, to form the three filter circuits needed to solve this problem.

R_2 is the variable device so if we start with a pre-set resistor of 100Ω, then we can change the value of R_2 from say 10Ω to 100Ω. It should be clear that if R_2 is actually zero, the circuit is prevented from working.

Keeping to the same values used above, if R_2 is 10Ω, f_o is 1061Hz. If R_2 is 100Ω, f_o is 335Hz.

Ideally, our three channels should perhaps have resonances of 200Hz, 500Hz and 2kHz to give a reasonable spread without extending into the limits of hi-fi!

The values used above will provide the middle one of these three but will not extend down to 200Hz or up to 2kHz. This, therefore, requires a change of some other component.

An increase in value of C will reduce f_o in inverse proportion. But it will also decrease the bandwidth, Δf. This is undesirable, since the circuit already exhibits a very sharp response. We could compensate for this reduction by a corresponding decrease in the value of R_3 but this will affect the gain.

On balance, an increase of the value of R_2 with a reduction in C should give a minimum resonant frequency of close to 200Hz. If we also include a fixed 10Ωresistor on the zero side of the pre-set then we will be sure not to short out the input when R^2 is taken to its minimum position.

With the exception of the setting of R_2 it is highly desirable that all other components are the same for each of the three filters. This ensures that the gain of each is the same, which will help out when we come to the next stage. So we fix the filter values as follows:-

R_1	47k
R_2	5k preset with 10Ω in series.
R_3	100k
C	47n (x2)

Circuit parameters are then:
A_{max} = 1

f = 68Hz.
f_o (min) = 160Hz.
f_o (max) = 3400Hz.

Fig. 12. shows the final filter circuit with these component values.

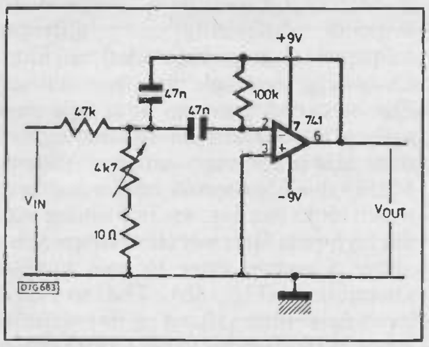


Fig.12. *Final filter stage (one of three)*

VOLTAGE COMPARISON

We must now isolate the resonant (or near resonant) response of each filter circuit from its behaviour at all other frequencies. This could be done in a number of ways, but in keeping with the emphasis thus far on the use of op amps, we might use another 741 device (for each channel) to compare the peak output voltage from the filter with a known reference voltage.

An open-loop arrangement ensures that the output from this stage will either be close to the positive rail (+V) or close to the negative rail (−V).

If we apply the reference voltage to the non-inverting input of the op amp (pin 3) then, when the filter output exceeds this value, the output of the comparator will be driven to the negative rail.

A simple divider, but with adjustment on one side or the other by means of another pre-set resistor, gives flexibility to determine the sensitivity of this part of the circuit. Fig. 13 shows the voltage comparator stage. Note that a small value capacitor is needed to couple the signal from the filter into the comparator. Direct coupling could cause a problem if there was a dc element present in the output of the filter. The

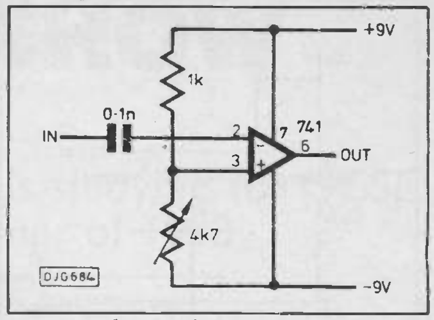


Fig.13. *Voltage reference stage (one of three)*

choice of a fixed 5k resistor and a preset 5k resistor gives reference voltages from −9V to +6V. We will probably need to aim for referencing at about +1V, but this depends upon the gain from the first preamp stage and the gain from the filter stage.

We now have a switching signal which is frequency dependent but we could not drive an appreciable load direct from the opamp. We may also need to hold the output on for a set period of time. Without this facility the 'on' state may go unnoticed because generally it will be of very short duration.

Before we consider how to satisfy these last two constraints let us just look at the response of the system so far.

Consider an audio input signal which contains a range of frequency components. (Fig. 14a).

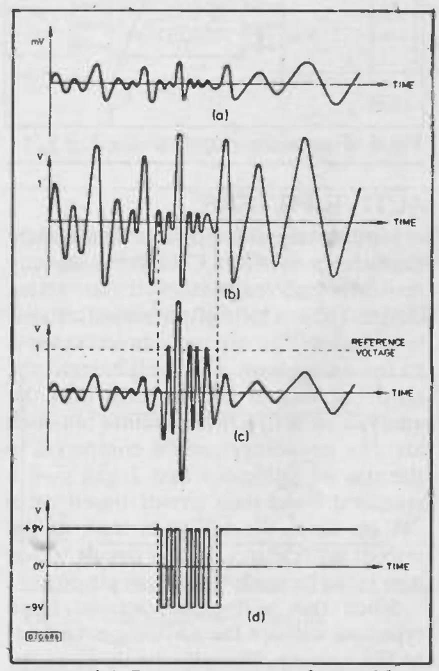


Fig.14. *(a) Representation of variable frequency input signal. (b) Amplified signal. (c) Effect of filtering. (d) Comparator output.*

The preamp will amplify all frequency components equally (Fig. 14b). The filter circuit will produce a gain of about one, close to its resonant frequency. It will 'reject' all other frequencies (Fig. 14c).

The open loop comparator will compare the input signal from the filter with its reference voltage (1V). If the input exceeds 1V the output from the comparator will fall to the negative rail (−V). At all other times the output will remain at the positive rail (Fig. 14d).

LATCHING THE OUTPUT

As mentioned above, the duration of a single pulse from the comparator may be very short. According to the final application of the circuitry, an 'on' time of between about one second and one minute may be required.

The standard method for lengthening pulses with which GCSE students should be familiar is to use a monostable circuit (sometimes known as a pulse stretcher).

The simple two transistor arrangement for such a circuit is shown in Fig.15. This circuit, as its name suggests, has only one truly stable state. This occurs when transistor TR2 is on and TR1 is off. It is possible to trigger the circuit into a "quasi-stable" state with TR1 on and TR2 off. It will remain in this state for a period given by:

$$t = 0.69\ (R \times C)$$

Suppose then that we choose R to be 10k and C to be 1000 μF. The time period will then be around 6.9 seconds.

Triggering the monostable into its second state is easily achieved by shorting the base of TR2 to earth. Alternatively, electrical triggering (which is what we require) is possible with negative going pulses coupled to the base of TR2.

The simple rectifier diode (1N4148) shown in Fig.15 achieves this aim.

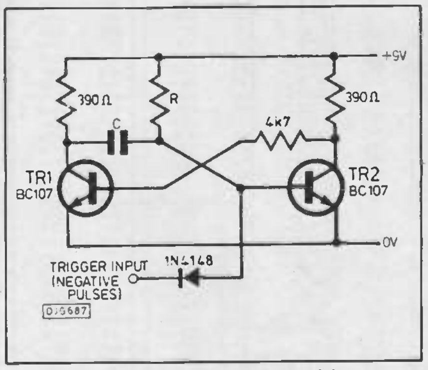


Fig.15. *Two-transistor monostable circuit*

The output is best taken from the collector of TR2 because the rising pulse on TR1 collector will suffer from the retarding effect of the capacitor, C.

Although this simple discrete circuit is easy to follow, it suffers from a lack of versatility, a degree of instability and unreliable triggering. All of these disadvantages are overcome if the monostable is constructed around a standard 555 timer.

The 555 is an eight pin integrated circuit. The connections required to form

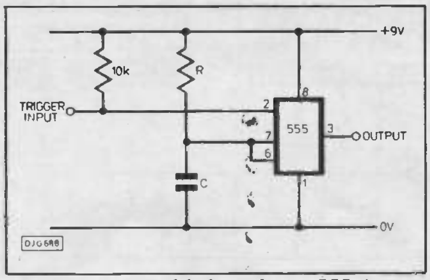


Fig.16. *Monostable based on a 555 timer*

a monostable circuit are shown in Fig.16. The output pulse length will be given by:

$$t = R \times C \text{ seconds.}$$

The circuit is triggered when the input pulse falls from a high level to a low level. The output goes high for the duration given by the product of R and C in seconds. R must be stated in ohms and C in farads.

One of the features of the 555 monstable is that if the trigger is kept low after falling from a higher state, then the output will remain high. It is important therefore that the input pulses are of relatively short duration.

We can adjust the duration of pulses by changing the reference voltage for the comparator stage.

VARIABLE LATCHING TIMES

Again, according to the final application, the output may need to be able to respond quite quickly to a number of separate triggering pulses (for example if a musical signal is generating the triggering method) or it may be required to 'hold' the output state for a much longer period of time.

It will be convenient therefore if the duration of latching is one of the parameters which the user can control. This is easily accommodated if the resistor, R, is swopped for a variable type.

Choosing a relatively large value for C (say 1000μF) means that if R is then a 100k potentiometer, time delays of up to 100 seconds are possible. This would seem to be more than adequate. It is most unlikely that an output time of less than a second could ever be of much practical use so a 1k resistor is included in series with the potentiometer to make adjustment to this minimum very easy.

OUTPUT DRIVER

In order to meet the original design brief we now need only to provide a suitable relay (on/off type) and some panel indication of correct function. A led will show that the output pulse is present whether or not the relay is being used to complete another circuit. The standard 555 timer is capable of both sourcing and sinking 200mA of current. This means that it can either provide or accept up to 200mA current into/out from its output.

Most relays have coil resistances of at least 100Ω and so using a 9V power supply the relay should not need more than 100mA. The led will require about 20mA but we are still well within the stated maximum current for the 555.

It is important to remember to add a diode in reverse bias across the relay coil to prevent the damaging effects of back emf.

Fig. 17 shows the simple driver circuit.

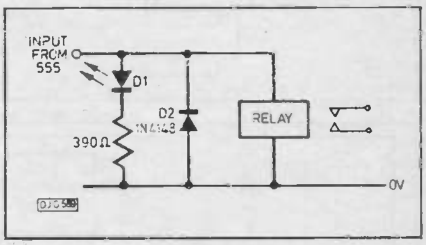


Fig.17. *Relay output stage.*

CONSTRUCTIONAL HINTS

The circuit diagram for the three channel light controller is shown in Fig.18. Since the three filters are identical only the first one is shown in full. Should you feel that, either for

COMPONENTS FOR THREE CHANNELS

RESISTORS

R1,R2	470Ω (2 off)
R3	47k (3 off)
R4	10Ω (3 off)
R5,R6,	100k (6 off)
R7	1k (3 off)
R8	10k (3 off)
R9	390Ω (3 off)

POTENTIOMETERS

VR1	1M Preset
VR2, VR3	4k7 Lin Rotary (6 off)
VR4	100k Lin Rotary (3 off)

CAPACITORS

C1, C2	47n (6 off)
C3	100n (3 off)
C4	1000μF (3 off)

SEMICONDUCTORS

D1	Red led (3 off)
D2	1N4148 (3 off)
ICI – IC3	741 (7 off)
IC4	(3 off)

MISCELLANEOUS

Relays to suit output requirements (3 off), simple microphone or telephone mouthpiece, PP3 batteries (2 off) or power supply (± 9V), dpst switch, 8 pin dil sockets (10 off), printed circuit board(3 off), wire, solder.

CONSTRUCTORS NOTE:

The printed circuit board is available through the PE PCB Service.

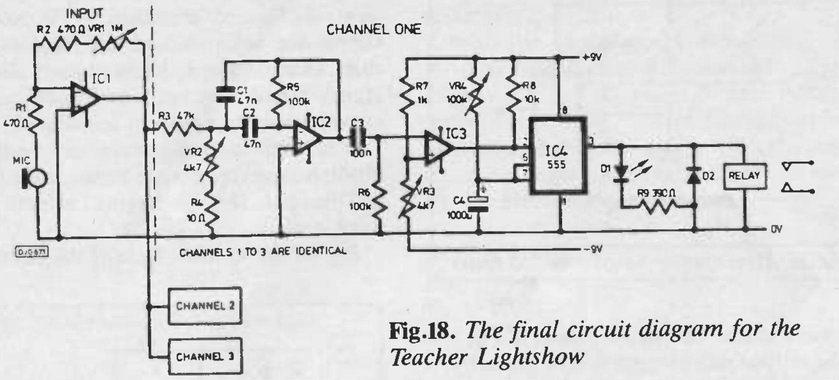


Fig.18. *The final circuit diagram for the Teacher Lightshow*

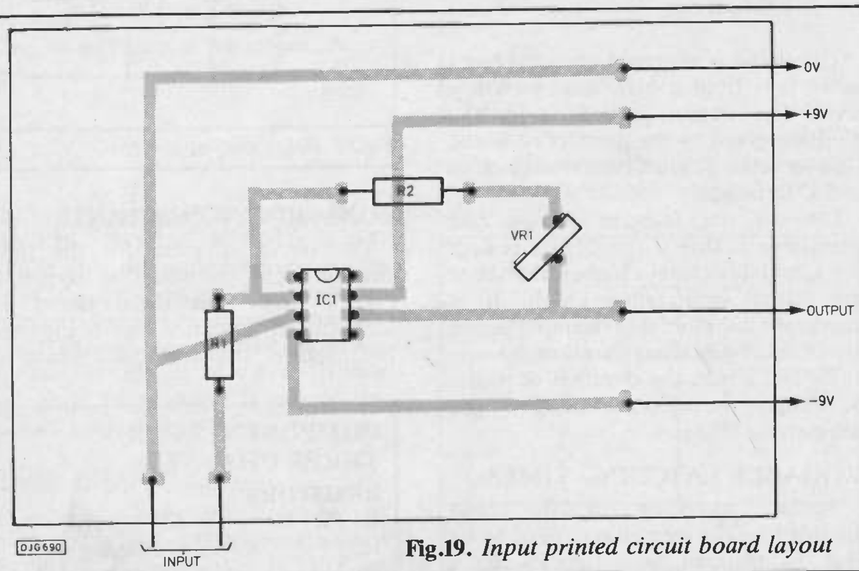
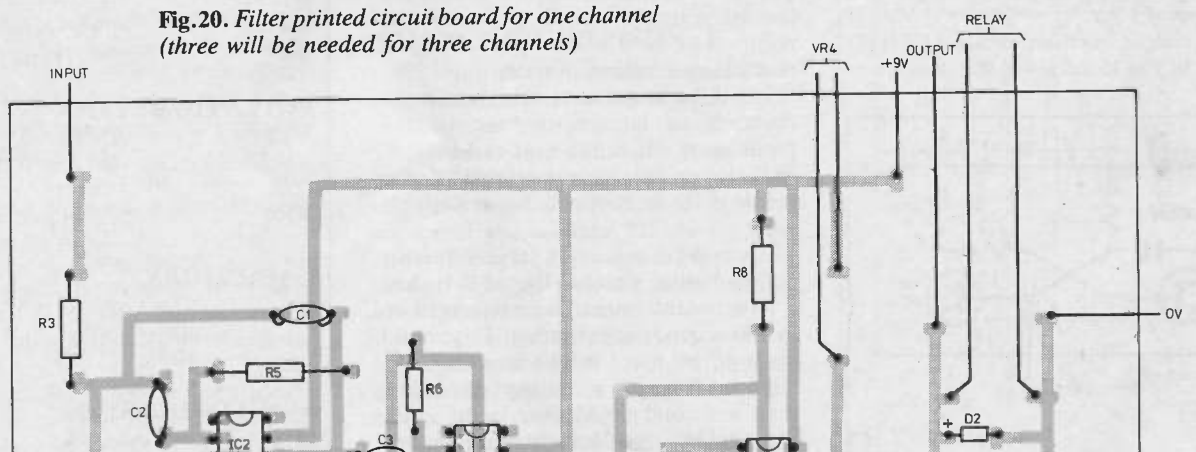


Fig.19. *Input printed circuit board layout*

Fig.20. *Filter printed circuit board for one channel (three will be needed for three channels)*



Tim Pike is Deputy Headmaster of the Ramsden School for Boys in Orpington, Kent. He has taught Electronics to 'A' level standard for thirteen years.

reasons of expense or time required, the full circuit is too demanding, you could just build one channel to begin with.

I have suggested two printed circuit layouts in Fig. 19. The smaller board is for the input stage. The larger is the board for one complete channel, and should be repeated for each extra channel required. I would strongly advise this modular approach to construction even if you are going for the whole unit.

Testing is best carried out on each stage. The use of an oscilloscope, if available, would be helpful to check on the gain, the duration of pulses after the signal has passed through the comparator stage, and in checking that your filter circuits are working properly.

I would advise injection of an audio signal after the initial pre-amp stage at a peak-to-peak level of about 2V. This enables you to operate with just single frequencies to start with until you are sure that all the various stages are functioning.

Once built and working there is no limit to the number of different devices which you could run from your relay outputs. Those of you with great musical gifts as well as some simple mathematics might try using the unit to convert musical notes into a three bit binary count on the outputs!

Good luck anyway.

In Part 7 next month, Tim Price will look at Digital Circuitry.

OUR REGULAR LOOK AT ASTRONOMY

SPACEWATCH

BY DR PATRICK MOORE

One brown dwarf seems to be a will-o-wisp, but another has appeared on the horizon. Meanwhile, evidence of planet-forming gathers out in the stars.

The world's largest optical telescope, at the Keck Observatory atop Mauna Kea in Hawaii is now being constructed, and the observatory itself is practically complete. At present the most powerful telescope in the world is the Palomar 200-inch reflector, which was completed as long ago as 1948. (The Russian 236-inch at Zelenchukskaya is larger, of course, but it has never been really satisfactory.)

The Keck telescope will have a 10-meter mirror, but it is of new design; there are 36 hexagonal mirrors, which will be fitted together to make the complete paraboloid. All in all, the light-grasp should be four times greater than that at Palomar. The mounting should be ready this autumn, and if all goes well we may expect 'first light' in January 1990. Meanwhile, tests on the great William Herschel telescope in La Palma have been virtually completed, and it has become clear that the telescope is even better than had been expected.

In the Solar System, investigations have continued with regard to the Pluto-Charon system. It now seems that Charon has almost half the diameter of Pluto itself, but the two worlds are not alike; Pluto shows traces of methane frost, while on Charon it has been found that there is no sign of methane, and that the surface layer is water frost. Just why the two are so different is not yet clear.

Some time ago there were reports that the first 'brown dwarf' star had been found – associated with the faint red dwarf Van Blesbroeck 8. This now seems to be spurious, but there are reports of a genuine brown dwarf in a more distant system, 47 light-years away. I will have more to say about it in a future article.

Using the Anglo-Australian Telescope at Siding Spring in New South Wales, two astronomers – Paul Hewett and Stephen Warren – have identified a new quasar which seems to be more remote than any previously found. Its distance has been estimated as 14,000 million light-years, which may not be so very far from the boundary of the observable universe. It is of the 20th magnitude, and lies not far from the south galactic pole. Interestingly, it is not a strong radio source, and the discovery was made by optical means.

BETA PICTORIS

In 1983 IRAS, the Infra-Red Astronomical Satellite, found that various stars – including the brilliant Vega and Fomalhaut, and the southern Beta Pictoris – were associated with cool material which could possibly be planet-forming. With each star, calculations indicated a 'depleted region' in the midst of each cloud, in which the density of the material was relatively low. These regions extended 20 to 30 astronomical units from the central stars. Dr Dana Backman, of the Kitt Peak Observatory in Arizona, maintains that these regions could be formed and maintained by planet-sized bodies in the low-density areas; these bodies would, so to speak, 'sweep up' the dust.

Of special interest is Beta Pictoris, whose distance is of the order of 78 light-years. The plane of the star system, in

The Sky This Month

Throughout February the evening sky is dominated by Venus, which reaches magnitude −4 and remains visible in the western sky for several hours after sunset. At its most brilliant, Venus can cast a perceptible shadow (try photographing it!) but it will actually be even brighter during March, when it will be around half-phase. During February it is well over 60 per cent illuminated; any telescope will show the phase, and so will good binoculars. Of course, no telescope will reveal any prominent surface markings, since all we can see is the upper part of the dense, cloudy atmosphere.

Mercury is not well-placed this month; Jupiter, however, remains prominent in the south-west after sunset. Of the other planets, both Saturn and Mars are morning objects in the Sagittarius area. On February 23 they are only 1.3 degrees apart, and this may be another phenomenon of interest to astronomical photographers.

The Moon was new on February 2, and full on the 17th. There are no eclipses this month, and neither are there any important meteor showers.

Orion remains very prominent for much of the night, together with its brilliant retinue – including Sirius, the brightest star in the entire sky; though Sirius is a pure white star, its rather low altitude means that it seems to flash various colours of the rainbow. Almost overhead, look for Capella in Auriga, the Charioteer; close beside it is the little triangle of stars making up the 'Hædi' or Kids – two members of which are remarkable eclipsing binaries, though neither is due to show any phenomena this month. The Square of Pegasus has almost disappeared in the west; in the east Leo, the Lion, is coming into view. Of course Ursa Major, the Great Bear, is on view; in the north-east, it never sets over any part of the British Isles, and there must be very few people who cannot pick out the seven stars which make up the pattern popularly known as the Plough.

Look, too, for the Milky Way, which is excellently placed this month. City-dwellers never have a good view of it, but if you observe it from the darkness of the countryside it is truly impressive. Binoculars will show that it is made up of stars, and it is tempting to think that the stars in it are so crowded that they are in imminent danger of colliding with each other; actually, the Milky Way is nothing more than a line of sight effect, caused by the fact that we are looking through the main plane of our flattened system or Galaxy.

which the 'cloud' of material lies, is edgewise-on to us, and so appears as a line (it has been optically recorded from the observatories in Chile). However, by comparing the amount of heat radiated by the 'cloud' to the amounts which could be expected from particles of different sizes at different distances outward, it is possible to trace a more rarefied central region.

Dr. Backman records: "All we get from the simple calculations I have made is a lower limit to the size ... My impulse is that objects in the interiors of these clouds are likelier to be planet-sized, rather than something bigger like a dwarf star." The dust clouds themselves seem to be made up of very small particles: "In the case of Beta Pictoris, the particles are micron-sized, only a little larger than the particles in cigarette smoke." On the other hand: "While Beta Pictoris might be the most outrageous example of what is going on, it may not be the best star to go hunting for planets around."

Certainly the 'infra-red excesses' seem to be common. They have been traced in 25 of the 134 stars so far carefully examined – in fact, some 20 per cent. Vega's disk of material is almost face-on to the Earth, though it seems to be less dense than that of Beta Pictoris; what will other stars reveal?

One thing is definite: a planet-sized object has much less surface area than an equal mass of small, individual particles, and to a satellite such as IRAS the Earth would be quite undetectable from the distance of Beta Pictoris – or even the much closer Vega and Fomalhaut. On the other hand, Backman does not rule out the possibility that similar equipment on a planet orbiting these stars might record some sort of dustcloud associated with the Sun. It is too early to say much more, but it is very clear that these researches are of special interest and importance. As Backman says: "Our study is just one more nail in the coffin of any idea that planets are rare." PE

THE PRINTING DETECTIVE

BY BRIAN FROST

A SERIAL 'TEC ON THE HI-TECH TRAIL

An RS232/Centronics interface is a useful upgrade for the popular Amstrad 8256/8512 wordprocessor. All the software needed is already in the Amstrad. Brian Frost describes how he traced it to its lair...

WELL over 35,000 of the Amstrad 8256/8512 word processor 'typewriters' have now been sold and it is universally agreed that Alan Sugar of Amstrad 'got it right' when he bundled a computer, printer and word processing software into a package at low cost. It has everything that is necessary to create, edit and print high-quality documents all in the one package and many people are very satisfied with the results.

The supplied printer provides good quality but is slow, especially when printing longer documents in nlq mode, making a popular upgrade for word processor users to fit a higher quality printer to the machine. Other users have wished to be able to communicate their documents between one system and another, and the natural upgrading process that will cause many users to eventually opt for another machine will require that they can transfer material out of the 8256/8512 and into the new machine.

No data can be sent out of the machine without the addition of an interface which Amstrad provide as an optional extra. It offers RS232 and Centronics connections, and everything is provided to allow such facilities as split baud-rates for Prestel operation. On examination it turns out that the software is already inside the machine, and this project describes hardware that can be used in place of the Amstrad interface, yet appears identical to the machine but is around one third of the price.

FEATURES

The software for the interface is already resident in the 8256/8512 and provides the capabilities for its control from the supplied cp/m utilities. These will be described later. The interface allows the use of an external printer connected as RS232 or to the Centronics port and the supplied printer may be disabled and the new printer operated as the default.

A modem can be connected and operated with split baud rates on transmit and receive, necessary for such systems as Prestel. The split may be reversed for sending data or files.

DESIGNING THE INTERFACE

It may be of interest to describe the way the interface was designed since it involves a certain amount of detective work rather than original creative electronics. (*Eat your heart out Miss Marple! Ed.*) My motivation was the need to possess a simple RS232 connection to the compu-ter for file transfer to other machines, and realising that the driver software was already resident in my machine I decided to use it to find out what key hardware was required.

Amstrad's laudable commercial success is based on marketing the right product at the right price and I quickly found, as others have remarked, that getting technical information from them is .... well, difficult. One can hardly blame them I suppose, but this difficulty seemed to make it all the more of a challenge to come up with an equivalent to their interface.

Of course it turned out to be more difficult than I first anticipated. I tackled the software in my 8256 using a good monitor/tracer package and discovered that the first hurdle to getting at the software was the initialisation check that the 8256 performs on the serial interface. This is made on boot-up by detecting the presence of register(s) in the serial interface using dummy writes and setting a flag to indicate to other parts of the software the condition 'interface is present/is not present'.

LUCKY SIGNS

I was lucky at this point because before trying to discover what dummy operations were being performed to verify the interface, I had found the ascii string that contains the sign-on message. On inspection, this was found to be complete with the part that informs you that the serial interface is fitted. It transpired that the flag was simply the placement of the string terminator (OOh) over the 's' of the word 'serial' with the result that no interface information was displayed on-screen. Changing this 'OOh' back to ascii 's' resulted in the utilities Device and Setsio that support the serial interface accepting information. (When in Basic, the command:

POKE &HFE52,&H53

does the same job.)

With the ability now to trace the software through to the serial interface routines, I discovered that all the low-level control routines were even better hidden than I had anticipated. These routines are machine dependent, and so it was no real surprise to find that although the cp/m routines sit in memory and can be traced and disassembled, machine dependent routines and such things as screen memory are hidden away in 'bank-switched' memory. This is a neat way of incorporating many extra features or lengthy software without taking up memory space from cp/m. This 'hidden' memory is accessed by bank-switching instructions which overlay the hidden memory over the 'normal' memory. This makes tracing very difficult due to problems of location of the tracer (in one bank) and the code one is tracing (in another bank).

CODED SOLUTION

The solution was to write a very simple piece of code using one of the Z80 block move operations which, when located in the common area of memory from cOOOh to ffffh, would swop to the bank of interest where the serial interface routines are located. It then became practical to copy as much as possible from these routines up and into the common area before switching the bank back again prior to copying this 'copy' back to the same numbered locations, but now in 'accessible' memory. This had the advantage that not only could all the routines of interest be copied (once the general position was known) but that the tracer could directly operate on them in 'real' memory because the code was now resident at the correct addresses.

This proved to be the solution and it was possible to trace and disassemble the machine dependent routines that implemented the cp/m calls to the serial interface. The routines of interest are modular and generally have no interaction, so inspection of each routine revealed a different aspect of the hardware, such as baud rate, or uart type. For example the first question was

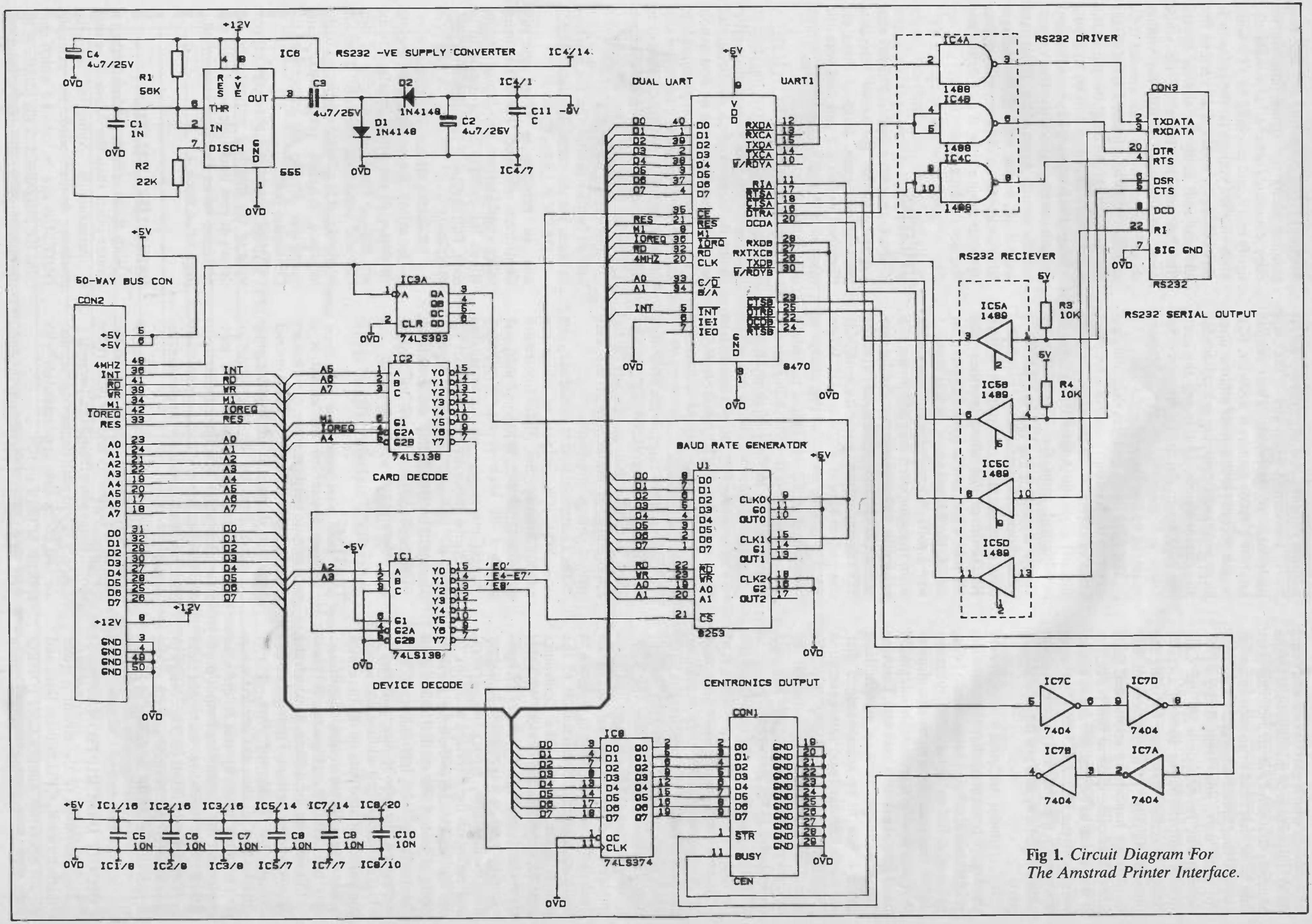


Fig 1. *Circuit Diagram For The Amstrad Printer Interface.*

to establish which uart device was being used. Inspection of the flags used by the routines that send out an ascii character and those that read in an ascii character showed that the device was the Z80 'dart' (or dual uart, now termed the 8470). Subsequent investigation of the Centronics output routine showed a crafty dodge to reduce hardware by using the unused half of it to implement the Centronics handshake strobe and busy lines. It became clear at this point that it was going to be just as easy to implement both the RS232 and the Centronics connection together and to construct the entire interface, and not just the RS232 part.

By a similar technique of software tracing, it transpired that the software-programmable baud-rates were being generated by an Intel 8253 programmable timer rather than by use of uarts that are now available with integrated baud-rate generators 'on-chip'. The Alan Sugar technique is very evident here when it has to be acknowledged that, although on-chip baud rate generation results in the saving of one chip, the actual cost would be, increased by several pounds which would be a very backward step for Amstrad.

Having established the identity of the devices in use, the physical port addresses came easily from inspection of the software, the only remaining discovery being the mechanism and addressing of the Centronics output port. Knowing already that the Centronics strobe and ready/busy had been implemented on the unused half of the dual-uart, I wrote a looping program in basic to send the character 'A' to the printer after assigning the Centronics port to be the listing device. With this character being repeated every 10 milliseconds or so, it was possible to trigger the oscilloscope from the general addressing on the interface and look to see which addresses in the interface were being repeated. Those that referred to the uart could be ignored since they comprised the strobe operations, but when an unexpected address access was compared with the data on the data lines it was found that it coincided with the data bits '41h' (the character 'A'), and so this must be the address at which the data was being written. From the simplicity of this write operation, it was obvious that all that was needed was a simple 8-bit latch at this address to implement the Centronics output port.

With the hardware addresses and devices defined, it was only necessary to interconnect the devices and fill in the details of the circuit as shown in Fig.1.

CIRCUIT DESCRIPTION

The operation of the circuit is quite straightforward, CPU address lines and the i/o operation control lines IOREQ and M1 are combined in the main address decoder IC2 which provides an active low output when any of the card addresses is selected. This output enables a second address decoder, IC1, which decodes lower-order address lines to provide individual chip-select lines for the circuit blocks. In this way the uart, the 8253 timer and the Centronics octal latch are mapped at the addresses required by the internal software.

The 8253 timer supplies the baud rate clock to the uart and requires a supplied clock of 2MHz. Since this is not available directly from the Amstrad connector, it is obtained from the Z80 4MHz by simple division using IC3, a 74LS393.

To provide the serial RS232 capability, lines from the uart pass out through an RS232 driver IC4 which translates the 5V uart logic levels into the specified RS232 bipolar swings of greater than −5 to +5 volts. No negative rail is available from the computer, so a 555 timer IC6 is used in a charge-pump circuit to provide approximately −9V. Every time the 555 timer output goes high, C3 is charged to almost +12V via D1. When the 555 output goes low, this charge is transferred to C2 via D2 to provide a −ve rail of around −9V. Although not stabilised, this method of generating a negative rail from a positive one is low in cost and effective for currents of less than round 20mA. *(It's similar to RAP's circuit in his Real World Interfacing article. Ed.)*

Received RS232 signals are presented to an RS232 receiver IC5 which provides level detection but is actually more importantly in protection of the uart against voltage transients.

The Centronics port is provided by the octal latch IC8, outputs of which are taken directly to the Centronics connector, these being defined as standard ttl logic levels. Centronics connections require an accompanying data strobe provided from the uart via IC7, to provide protection against damage. The BUSY line returned from a Centronics printer is also buffered by IC7 before presented to the uart.

TESTING

Having assembled the circuit it is necessary to perform some rudimentary tests to avoid damage to the Amstrad. Any such damage is undesirable since the signal lines on the rear connector come directly from an internal gate-array chip which is soldered directly to the Amstrad pcb and looks expensive to purchase and decidedly unpleasant to replace.

Having checked that all chips are the correct way around, apply +5V to the connector on the 5V and 0V pins. There should be no more than 200mA drawn.

Apply 12V to pin 8 on the edge connector and check that approximately −9V appears at pin 1 of IC4.

As an additional precaution it is well worth applying 5V to the unit and then running along the signal lines on the edge connector with a 1k resistor tied firstly to 0V, and secondly to +5V, while observing the voltage on the pin with an oscilloscope or meter. This verifies that all pins can easily be driven by the Amstrad and that there are no 'stuck' lines. In the case of 0V, the voltage should be no more than around 0.5V, and for the 5V check the voltage should rise to over 3V. 'Pulling' the pin in this way verifies that it looks like an input.

When the hardware has been checked, the unit can be connected to the Amstrad and the system powered-up. If the hardware is ok, during boot-up the message 'SIO/Centronics add-on' will appear between the number of disk drives and the size of the memory disk.

UTILITIES

There are two supplied utilities that are relevant for the serial interface, Device and Setsio. Both of these are described in Book 1 supplied with the machines, but here are brief descriptions.

DEVICE.COM.

Device allows the serial interface to be assigned to various output or input channels to allow data to be routed depending on its source or destination. For example, a popular application is to route printed data away from the supplied printer to a printer connected to either the serial or Centronics connection on the interface. The command:

DEVICE LST:=SIO

sets all further printing on the machine to occur via the serial interface. Also:

DEVICE LST:=CEN

sets all printing to occur via the Centronics interface. There are many other combinations and typing Device allows the existing configuration to be seen. Full details of Device are on page 87 of Book 1.

SETSIO.COM.

The utility Setsio allows the various attributes of the serial interface to be set, such as baud rate, number of stop bits and handshake protocol. This will be needed if the device connected to the interface requires (say) 2400 baud operation. It has no effect on the Centronics port.

Typing Setsio will show the current state of the interface settings, and full details of how to change baud rates will be found under the Setsio command o page 94 of Book 1.

USING THE UTILITIES

Both these utilities are used when a printer other than the Amstrad printer is permanently connected to the machine. A file called, for example, DOIT.SUB can be created which contains the assignment of the printer to be the default printer and sets the baud rate to suit it. For example, the file contains would be:

DEVICE LST:=SIO
SETSIO 4800

to set the printer to be the list device and to set the interface to 4800 baud. Typing DOIT or booting the disk with DOIT.SUB present would automatically install the printer.

FREEBEE FOR MODEM USERS

Amstrad supply a rather useful program for those of you who wish to connect up a modem on the interface. This is a program called 'MAIL232.COM' and it is buried together with the Locoscript word processor command file on side one of disk one. Copy it on to a spare disk and run it by typing 'MAIL232' under cp/m.

This program has been described as a 'glass teletype' in that it allows communication with bulletin boards or with other users of modems, either in 'real-time' by typing on the keyboard, or, more usefully, using file transfer.

KEY	FUNCTION
F1	'Framing'. Allows baud rate, data bits, parity, stop bits and handshaking modes to be set.
F3	Sets data to be sent from a file or received by a file. All received data enters the specified file until you press ALT and STOP. Also allows hexadecimal mode to be selected for program transfer.
F5	The keyboard may be set ONLINE or OFFLINE.
F7	Change terminal emulation mode and exit to cp/m.

TABLE 1.

When accessing bulletin boards it is only necessary to open an empty file, dial the number and log on to the bulletin board and walk through the menus that you require. When you have completed the operation and disconnected, all of the material that was displayed on the screen has been saved in the file and may be examined at leisure. In the same way, you may prepare an ascii file containing a letter or information that you wish to send and after establishing the link the file can be sent with a simple command.

For reasons of space the commands are here in brief but try it and see. After typing 'MAIL232' there will be a sign-on message followed by the main menu. All operations are controlled by the function keys in Table 1.

While in this menu, any characters received via the modem are displayed on the screen, and any keyboard typing is sent out via the modem. So dial-up your local bulletin board and off you go!

CONCLUSION

The interface described provides both serial communication and a Centronics printer port using the existing Amstrad driver software already resident in the 8256/8512. The capabilities of the Amstrad interface are duplicated with this hardware as a low-cost replacement.

PE

BOOKMARK

Electronics and Electronic Systems. G. H. Olsen. Butterworths. £19.95. ISBN 0-408-01369-9. Although this 400 page book has been written for first and second year undergraduates reading for degrees in electronics, electronic engineering, physics and allied subjects, those whose interests are less academic will find much to benefit them from its information. Its intention is to provide a thorough grounding in the ever-changing area of electronics. Basic circuit theory, for both analogue and digital electronics, is covered, well interspersed with formulae. Many practical circuits are included, and the subjects are treated in a down-to-earth fashion.

Practical Digital Electronics Handbook. M. Tooley. PC Publishing. £6.95. ISBN 1-870775-00-7. Many readers will know that Mike Tooley is a contributor to PE and to other magazines. Within the 200 pages of this book he aims to provide readers with a practically based introduction to digital circuits and logic families, together with sections on microprocessors and various memory devices for internal and external control. An appendix then covers items like tools and test equipment. Applications for the latter are discussed, and nine practical constructional projects are presented for strip-board assembly.

These newly released books are available through any good bookshop.

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This timer tracker counts the hours while any piece of low-power equipment (such as hi fi) is in use, by detecting operation through the secondary winding of a mains-isolated transformer. A counter IC divides by 3600 to give one pulse every hour.

APPLIANCE TIMER

BY KEVIN JONES

HOLY HOUSEWORK, BATMAN! – TIME FOR A CLEAN UP!

Manufacturers of record and tape decks often specify that the stylus be checked every 100 hours, or that the heads be cleaned every 20 hours. It can be extremely difficult to estimate accurately how long equipment has been used, and very easy to forget about maintainance altogether.

The project described here keeps track of the total time an appliance has been used, and shows the number of hours on three seven-segment displays. It works by detecting the mains current flowing to the equipment, and so can be used on any low-current mains powered apparatus. Some potential alternative functions include measuring lamp usage and TV addiction.

The display is designed to light only when a mains current is detected, thus providing confirmation of correct operation. The decimal point after the display is intended to flash at one second intervals while the unit is running.

There is a reset switch for the display, mounted on the PCB inside the case. This serves to protect it from stray dusters and little fingers.

CIRCUIT DESCRIPTION

The mains current is detected by an LT700 audio output transformer (T2) with its secondary connected in series with the mains neutral line (Fig.1). This unconventional circuit is very effective in practice. The impedance of the secondary coil is quoted as only 3.2Ω, and so causes a negligible voltage drop. The circuit is isolated electrically from the mains. The output voltage from the primary winding can be quite significant, necessitating clipping diodes D4 and D5. The drawback is that the transformer is not intended to handle large currents. FS1 is included in case anyone should try to time the toaster.

Completed Appliance Timer

A simple inverting amplifier is formed by ICI, R3 and R4. When a current is square wave (the sinusoidal input, greatly amplified and clipped). When no current is detected by T2, the output is biased via R1 and R2 to negative saturation.

D6 and R5 remove the negative part of the output from IC1, producing an output between the supply voltage and 0V suitable for driving the counter circuitry. D7, R6 and C3 smooth this signal to give a d.c. voltage, which saturates Tr1 and turns on the display only when a current flows through T2.

A number of transistor alternatives to IC1 were tried, none as sensitive and few as economical on power. D3 and C2 provide the minimal negative supply current required.

Since the display takes almost all of the 100mA or so available from T1, cmos is used for the counter circuitry. This also removed the need for supply voltage regulation, D1, D2 and C1 working completely satisfactorily.

IC2 is a seven stage binary counter, and IC3a causes the output from pin 4 to divide the input by 50. This is the seconds output and flashes the decimal point via Tr2.

IC4 is a 12-stage divider, configured with IC3b to form a divide-by-3600 counter. This produces one pulse every hour, driving the conventional series of 4033 counter-driver ICs.

The reset pins of IC5 to IC7, normally pulled low by R11, are sent high when the reset switch is pressed. IC4, the hours divider, is reset at the same time, via D8, to stop IC3b from clearing the whole system at the end of every hour. R10 prevents S1 and D8 from forcing the output of IC3b high

CONSTRUCTION

This project will be connected to the mains for very long periods, so extra care should be taken in construction to ensure safety and reliability. Normal mains safety procedures should be observed.

The two-PCB layout of the prototype is recommended, as this gives a very neat layout with only single-sided boards. Use of IC sockets is advised, especially for IC2-IC7. T2 should be installed last, as it protrudes somewhat from the board and may make subsequent insertion of other components difficult. The lugs on T2 should be pushed through larger holes in the main board and then folded down, for mechanical security.

The faces of the three displays may not be flush with one another if they are pushed fully home into the display board. These displays should be aligned accurately before soldering.

COMPONENTS

RESISTORS

R1,R6,R11	10k (3 off)
R2,R3,R8, R12-R32	220R (24 off)
R4	100k
R5	1M
R7	1k
R9	68R
R10	330k

All resistors 1/4W carbon 5%

CAPACITORS

C1,C2	64μ 10V electrolytic
C3	4μ7 tantalum

SEMICONDUCTORS

D1-D3	1N4001 (3 off)
D4-D8	1N4148 (5 off)
TR1,TR2	BC108 (2 off)
IC1	741
IC2	4024BE
IC3	4082BE
IC4	4040BE
IC5-IC7	4033BE (3 off)
X1-X3	TIL730 (3 off)

MISCELLANEOUS

FS1	1A fast-blow fuse
S1	PCB mounting push-to-make switch
T1	6-0-6V sub-miniature mains transformer
T2	Lt-700 audio output transformer

Case approx. 100x150x50mm, PCBs, stand-offs and spacers (4 of each), panel-mounting fuseholder, panel-mounting "Euro" input and output mains connector.

CONSTRUCTOR'S NOTE:
The PCBs are available through the PE PCB Service.

Joining the two boards together can be time-consuming, with 23 connections to make. The constructor should be careful to make sure that not only is the wiring correct, but also that the wires are all of a suitable length and do not tangle.

The prototype was a snug fit in a 100x150x50mm aluminium box. If a metal case is used in this project, it **must** be earthed. The display board was held back from the front panel by brass spacers, which were filed down until the seven segment displays stood flush with the panel. The Texas Instruments TIL730 displays used in the prototype have a very attractive grey finish when off, and would be rather spoiled by a red filter.

At the back, "Euro" type mains connectors are used, as these are much cheaper and smaller than normal 13A equipment and have a current rating way in excess of what is required.

TESTING

Full testing of the timer is of necessity a rather lengthy affair. When the unit is first plugged in, the display should not light. If it does, make sure that T1 is

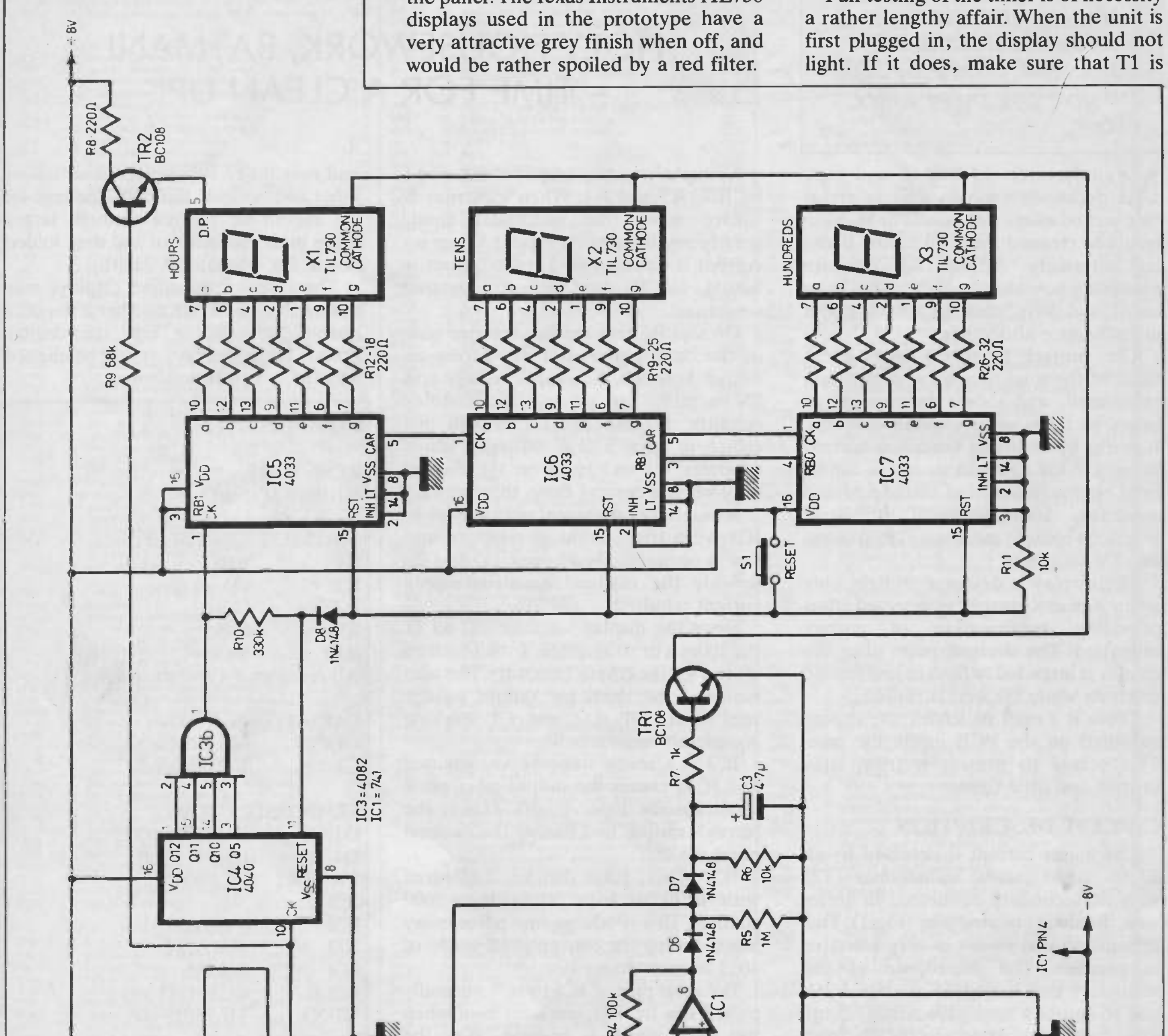
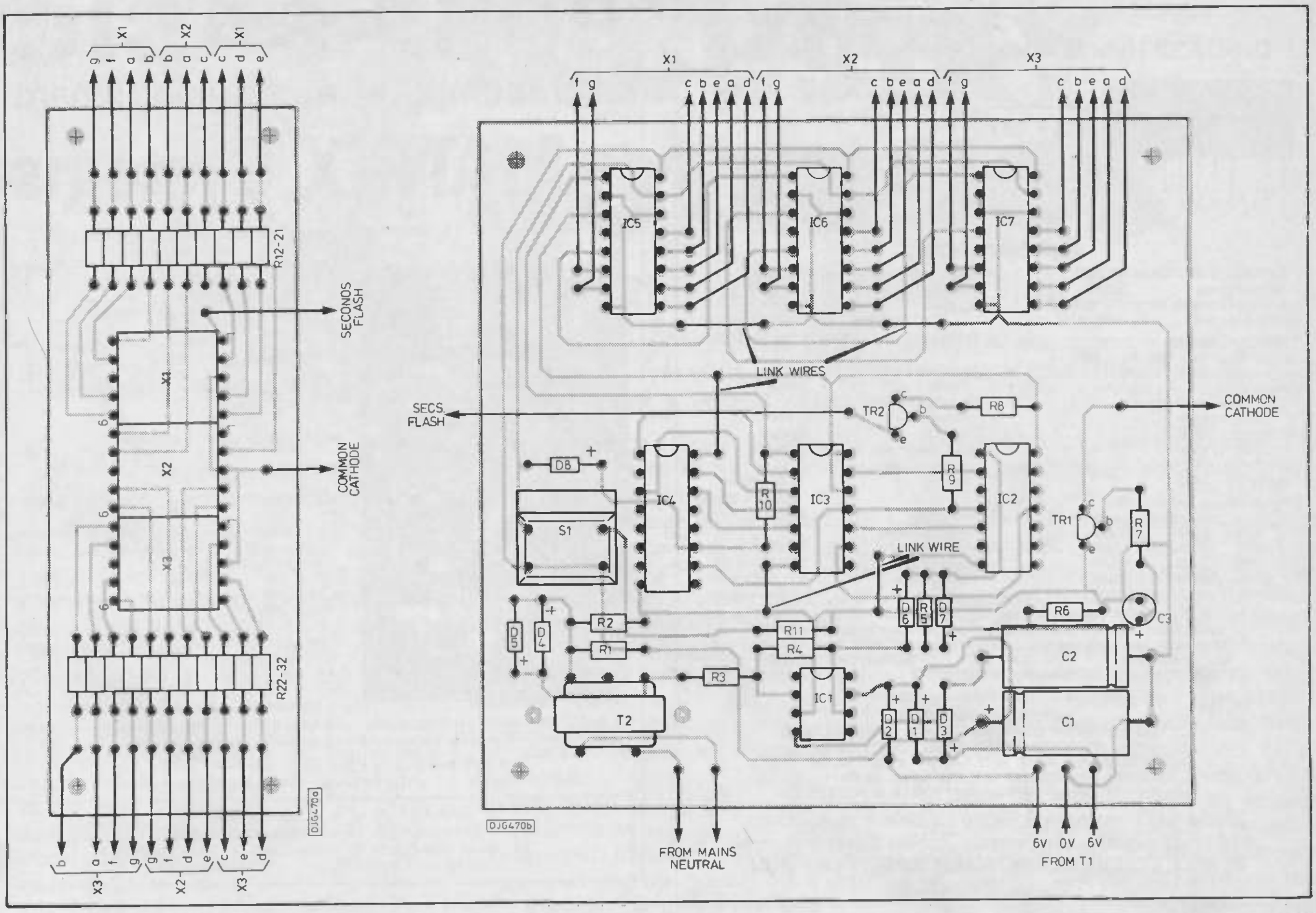


Fig. 1. *Circuit diagram of the Appliance Timer*



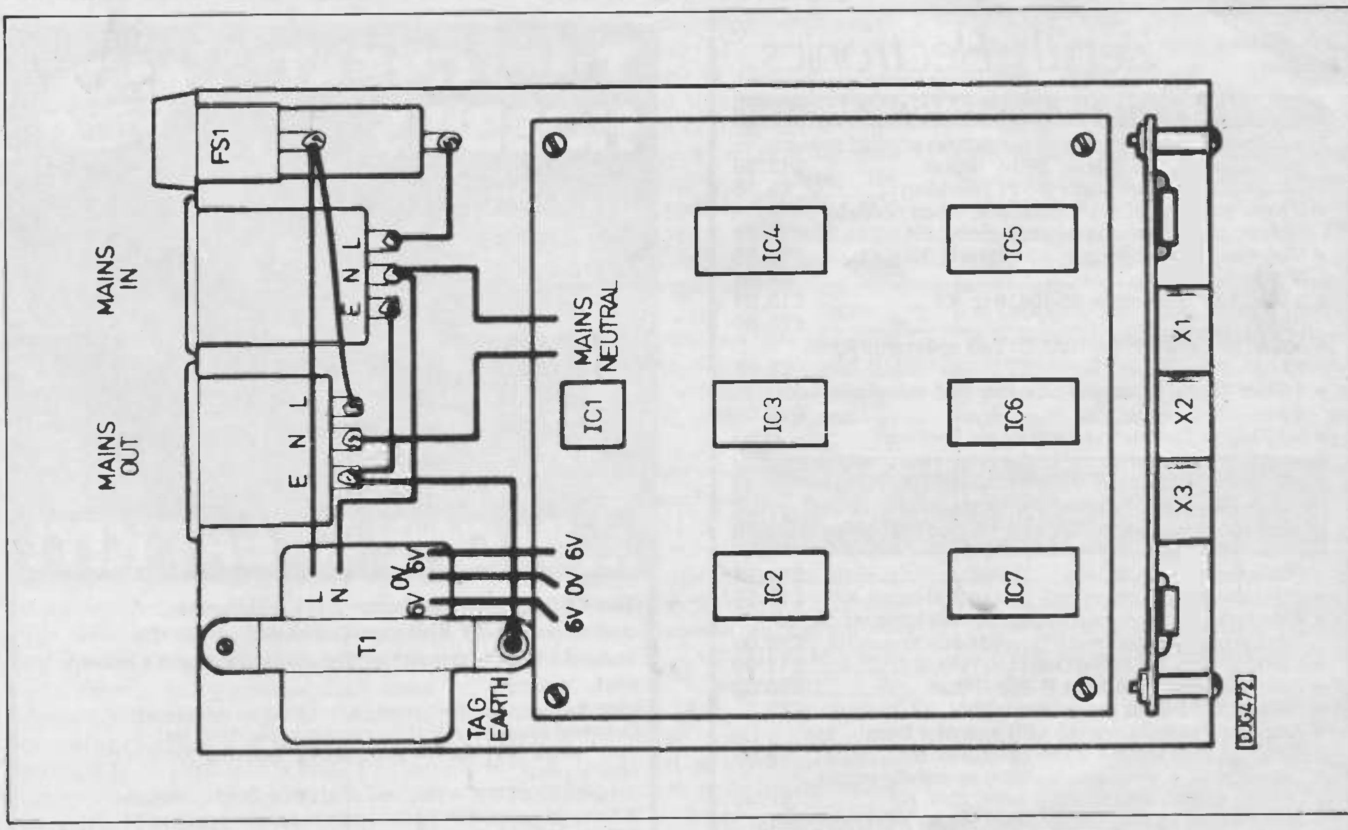


Fig. 2. *(Top)*
Printed circuit board layouts

Fig. 3. *(Bottom)*
Wiring details for Appliance Timer

connected across the input mains connector and not the output, in which case it will be detecting its own supply current. When an appliance is plugged in and switched on, the display should light if IC1 is working properly, and the right-hand decimal point should flash, confirming correct operation of IC2 and IC3a. Pressing S1 should reset the display to 0. Apart from that, it is just a case of waiting and seeing that the display increments every hour. PE

REPORT BY TOM IVALL

INDUSTRY NOTEBOOK

THE GERBIL AND ELECTRONICS

It is agreed that a higher standard of technical education is vital for our society's future development, but technical education alone is not enough to develop civilised individuals.

What are we to make of the Government's proposed reforms to state education? Do they mean anything in relation to the UK electronics industry? At the time of writing the proposals are contained in a Bill before Parliament – the so-called Gerbil (Great Educational Reform Bill). In due course they are likely to become a new Education Act for England and Wales and thus enforceable by law on everyone involved in the state system.

People are saying that the proposed reforms are as sweeping as those brought in by the Education Acts of 1870 (compulsory attendance at school), 1902 (free education paid for through the rates) and 1944 (secondary education for all). This is probably true as regards the controversial idea of allowing the principle of market forces to operate in education. But in what Mr Baker, the Secretary of State for Education, calls "the bedrock of our proposals", the establishment of a national curriculum in schools, the Gerbil doesn't look particularly exciting. In fact national curricula have been common practice in much of Europe for a long time and most people in Britain already seem to agree with the idea.

You may have gathered already that the national curriculum is one that is standardised and compulsory in all schools. It consists of the three 'core' subjects of mathematics, English and science, plus the seven 'foundation' subjects of history, geography, technology, music, art, physical education and (in secondary schools) a modern foreign language. Schools will have a statutory duty to teach these subjects. The Government will check that they do so by testing the children at certain ages.

Of course, many schools teach them already. You may not consider the choice of maths, English and science as core subjects to be particularly bold. But the three educational core subjects for the ancient Persians, according to Xenophon, were riding horses, shooting straight and telling the truth. So we have in fact come quite a long way since then, and today's core is very specifically designed to suit the nature of our modern, industrialised society.

If anything in the Gerbil is significant to the world of electronics I think it must be the national curriculum. First of all, a thorough education in the three core subjects plus technology should help those children who eventually come to work in electronics to understand what they are doing, both technically and in relation to the outside world.

Understanding provides the necessary psychological basis for positive attitudes, critical thinking and creativity. The worker who doesn't understand what he/she is doing and is content to function like a robot will be treated like a robot. There will be no personal development, little career advancement and no benefit to the industry other than what could be given by a machine.

Anyone who has to make decisions or create strategies at the middle management level in the electronics industry is forced to grapple with the new technological developments which are still coming thick and fast. The new advances are often so far beyond the individual's own technical training that the only way to get to grips with them is to go right back to first principles. This usually means physics and maths

Here you are safe, on a bedrock, because the fundamental laws of nature don't change from day to day and the relationships of mathematics are based on a logic valid since the time of Aristotle. Working forward from first principles to the present frontiers of the technology may not be easy, but you can be sure you're not going to get lost or make silly mistakes.

As for English, the other core subject, this is obviously important for effective human communication in industry – which is, after all, a kind of society held together and depending on communication. Animal-like noises, juvenile babble or street-corner slang may be fine in certain situations but are useless or counter-productive when applied to high technology. Furthermore, the native language, spoken or written, is often an essential instrument for clear thinking and expression. Faulty grammar can hide confused thinking without the speaker or writer being aware of it. And it's very doubtful if maths and physics could be understood through equations, graphs and tables alone.

But so far I have only considered those children who will actually work in Britain's future electronics industry. What about the much larger groups who wil be consumers of electronics users of electronics-based services and heirs to the military-industrial complex which this technology has helped to build up?

If the national curriculum really works, it should educate our future citizens to make choices, personal and political, on the basis of truly humane and civilised values. Ideally it would be something like the 'liberal' education of the late 19th century that aimed to turn out well-rounded individuals. History will teach what civilised values have existed in the past. Art and music will express them directly in intense, personal ways.

Through such education our future citizens might be able to achieve a more balanced view of what life is about, a realisation that technological power is only one aspect of civilisation. They would then keep the worst manifestations of the electronics market-place in check. At the moment these seem to be the trivial (consumer gadgetry) and the threatening (weapons systems). Such applications are prominent on the market because they make a lot of money for their manufacturers. Demand springs from boredom on the one hand and fear on the other.

Some applications are benign or neutral in their character, like telecommunications and automation. Others are directly supportive to human life, like medical instrumentation and prosthetic devices, but are obviously under-valued as the designing and manufacturing rewards are so small.

A better educated, more civilised, society in Britain would be reflected in different priorities and choices. There would be a shift in the balance of electronic applications towards the benign and the supportive. The industry itself would change in character as it responded to a different pattern of demand. PE

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0·1/35, 0·22/35, 0·47/35, 3·3/16, 4·7/16 – 14p 4·7/35 – 15p
2·2/35, 4·7/25, 10/5 – 15p 4·7/35, 6/8/16 – 16p 10/16,22/6 – 20p
22/16 – 30p 33/10 – 30p 47/10 – 35p 100/6 – 40p

Aluminium Electrolytics (Mids/Volts)
1/50, 2·2/50, 4·7/25, 4·7/50, 10/16, 10/25, 10/50 – 5p 22/16, 22/25 – 6p
22/50, 47/16, 47/25, 47/50 – 6p 100/16, 100/25 – 7p 100/50 – 12p
100/100 – 14p 220/16 – 18p 220/25, 220/50 – 10p 470/16, 470/25 – 11p
1000/25 – 18p 1000/35, 220/25 – 22p 4700/25 – 70p

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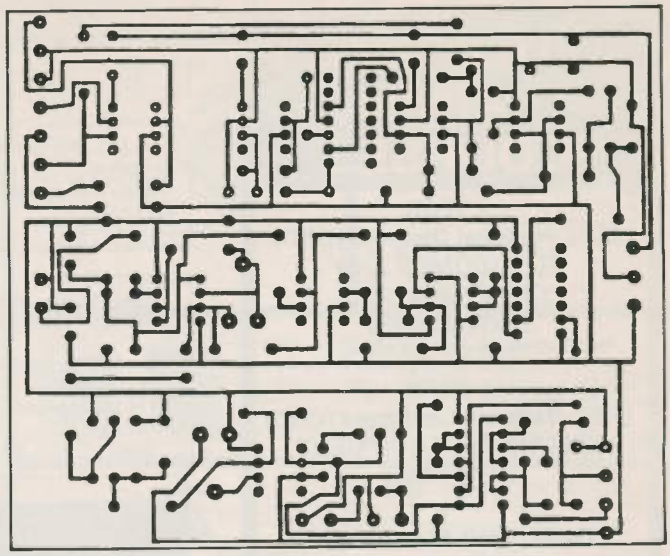

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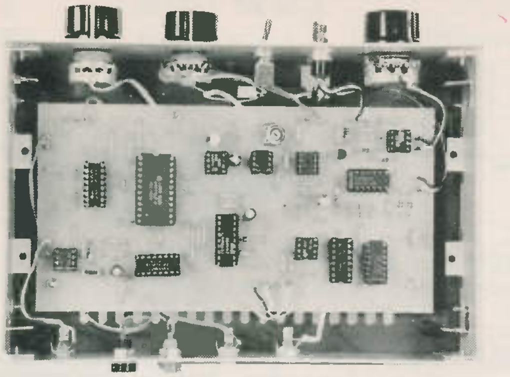

NICE AND EASY DOES IT

BUILDING the projects published in PE is a lot easier than some of you perhaps might think. Especially when you use one of our professionally made printed circuit boards.

It's almost like painting by numbers. All the PCBs are fully drilled, and basically all you need to do is slot in the components and carefully solder them to the PCB track pads. Their places are shown in the drawings published with the project.

IDENTITIES

Component identities are usually clearly marked on them. Even if they are colour coded, like some resistors and capacitors, their values are easily worked out from component colour code charts. From time to time we publish these charts, but if you don't already have one, send a 9in x 4in stamped and self-addressed envelope to the Editorial office asking for one.

TOOLS

For many projects you only need a few simple tools – Soldering iron between 15W and 25W, with a bevelled tip. Damp sponge for keeping the tip clean. Good multicore solder of 18swg or 22swg grade. Fine nose pliers for wire shaping. Adjustable spanner or heavy pliers for tightening nuts. Miniature screwdriver for adjusting preset controls. Small wire cutters for trimming component leads. Drill and selection of bits for drilling holes in boxes. Strong magnifying glass for checking joins in close up. It's also preferable to have a multimeter for setting and checking voltages. There are some very good low cost ones available through many of our advertisers, but get one that is rated at a minimum of 20,000 ohms per volt. Many projects do not require you to have a meter, but if you are serious about electronics, you really should have one.

ASSEMBLING THE PCB

Authors will sometimes offer their own advice on the order of assembly, but as a general guide, it is usually easier to assemble parts in order of size. Start though with the integrated circuit sockets. Please use them where possible, they make life much easier than if you solder the ICs themselves – with sockets you can just lift out an IC if you want.

Then insert and solder in order of resistors, diodes, presets, small capacitors, other capacitors, and finally transistors. Clip off the excess component leads after you have soldered them. Now use a magnifying glass, ideally one that you can hold to your eye, and take a good look at the joins, checking that they are satisfactorily soldered, and that no solder has spread between the PCB tracks and other joins. Be really thorough with visual checking since errors like this are the most likely reason for a circuit not working first time.

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