ETI
ELECTRONICS TODAY INTERNATIONAL

THE ELECTRONICS, SCIENCE & TECHNOLOGY MONTHLY
OCTOBER 1988 £1.40

Be it Known

THAT the reader has satisfied the ordinances and regulations of the Magazine and in the month of October 1988 anno Domini has been admitted entry to the

Careers and Education Special

having satisfied the examiners in the subjects

Electronics in the Classroom
Post A-level courses – full list
Careers – what the companies want

and having completed the required laboratory projects

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Hi-Fi Peak Programme Meter
Powerful Air Ioniser

Signed and sealed this second day of September in the year of our Lord nineteen hundred and eighty eight.

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OMP100 Mk II Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz —3dB, T.H.D. 0.01%, S.N.R. —118dB, Sens. for Max. output 500mV at 10K, Size 355 × 115 × 65mm.
PRICE £33.99 + £3.00 P&P.

OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 80, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. —125dB. Size 300 × 123 × 60mm. PRICE
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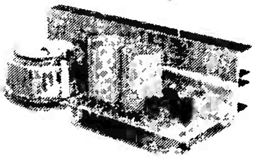
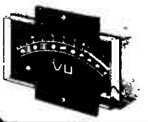
PRICE £62.99 + £3.50 P&P.



OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 350, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. —130dB, Size 330 × 147 × 102mm. PRICE
PRICE £79.99 + £4.50 P&P.

NOTE: Mos-Fets are supplied as standard (100KHz bandwidth & Input Sensitivity 500mV). If required P.A. version (50KHz bandwidth & Input Sensitivity 775mV). Order Standard or P.A.



Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D. diodes (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 × 27 × 45mm.
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LOUDSPEAKERS 5" to 15" up to 400 WATTS R.M.S.

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POWER RANGE
8" 50 WATT R.M.S. Hi-Fi/Disco.
20 oz magnet 1½" ally voice coil Ground ally fixing escutcheon Res Freq 40Hz Freq Resp to 6KHz Sens 92dB PRICE £10.99 Available with black grille £11.99 P&P £1.50 ea
12" 100 WATT R.M.S. Hi-Fi/Disco
50 oz magnet 2" ally voice coil Ground ally fixing escutcheon Die cast chassis White cone Res Freq 25Hz Freq Resp to 4KHz Sens 95dB PRICE £28.60 + £3.00 P&P ea

McKENZIE
12" 85 WATT R.M.S. C1285GP Lead guitar/keyboard/Disco
2" ally voice coil Ally centre dome Res Freq 45Hz Freq. Resp. to 6.5KHz Sens. 98dB PRICE £29.99 + £3.00 P&P ea
12" 85 WATT R.M.S. C1285TC P.A/Disco 2" ally voice coil. Twin cone.
Res. Freq. 45Hz Freq. Resp. to 14KHz PRICE £31.49 + £3.00 P&P ea
15" 150 WATT R.M.S. C15 Bass Guitar/Disco.
3" ally voice coil Die-cast chassis Res. Freq. 40Hz Freq. Resp. to 4KHz PRICE £57.87 + £4.00 P&P ea
10" 60 WATT R.M.S. 1060GP Gen. Purpose/Lead Guitar/Keyboard/Mid. P.A.
2" voice coil. Res. Freq. 75Hz Freq. Resp. to 7.5KHz Sens. 99dB. PRICE £19.99 + £2.00 P&P
10" 200 WATT R.M.S. C10200GP Guitar, Keyboard, Disco.
2" voice coil. Res. Freq. 45Hz. Freq. Resp. to 7KHz. Sens. 101dB PRICE £44.76 + £3.00 P&P
15" 200 WATT R.M.S. C15200 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 5KHz. Sens. 101dB. PRICE £62.41 + £4.00 P&P
15" 400 WATT R.M.S. C15400 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 4KHz. Sens. 102dB PRICE £89.52 + £4.00 P&P.

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5" 70 WATT R.M.S. Multiple Array Disco etc.
1" voice coil Res. Freq. 52Hz Freq. Resp. to 5KHz Sens. 89dB PRICE £22.00 + £1.50 P&P ea
8" 150 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 48Hz Freq. Resp to 5KHz Sens. 92dB PRICE £32.00 + £1.50 P&P ea.
10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1" voice coil Res. Freq. 35Hz Freq. Resp. to 4KHz Sens. 92dB PRICE £36.00 + £2.00 P&P ea.
12" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil Res. Freq. 35Hz Freq. Resp. to 4KHz Sens. 94dB PRICE £47.00 + £3.00 P&P ea

SOUNDLAB (Full Range Twin Cone)
5" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil Res Freq 63Hz Freq Resp to 20KHz Sens 86dB PRICE £9.99 + £1.00 P&P ea
6½" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil Res Freq 56Hz Freq Resp to 20KHz Sens 89dB PRICE £10.99 + £1.50 P&P ea
8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1¼" voice coil Res Freq 38Hz Freq Resp to 20KHz Sens 89dB PRICE £12.99 + £1.50 P&P ea
10" 60 WATT R.M.S. Hi-Fi/Disco etc.
1¼" voice coil Res Freq 35Hz Freq Resp to 15KHz Sens 89dB PRICE £16.49 + £2.00 P&P

PANTEC

HOBBY KITS. Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 × 46 × 14mm (9 volt) **Price: £8.62 + 75p P&P.**

3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 × 84 × 12mm (12 volt) **Price: £14.49 + 75p P&P.**

SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHz. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 × 70 × 22mm (9/12 volt). **Price: £17.82** Transmitter 80 × 50 × 15mm (9/12 volt). **Price: £11.29** P&P + 75p each. S.A.E. for complete list.

3 watt FM Transmitter

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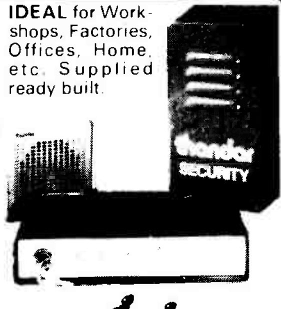
POSTAL CHARGES PER ORDER £1.00 minimum. OFFICIAL ORDERS WELCOME, SCHOOLS, COLLEGES, GOVERNMENT BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER VISA/ACCESS/C.O.D. ACCEPTED

Access

BURGLAR ALARM

Better to be 'Alarmed' then terrified.
Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units complete with interconnection cable. **FULLY GUARANTEED.**

IDEAL for Workshops, Factories, Offices, Home, etc. Supplied ready built.



Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.
Indoor alarm — Electronic swept freq siren 104dB output.
Outdoor Alarm — Electronic swept freq siren 98dB output. Housed in a tamper-proof heavy duty metal case.
Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

SAVE £138.00 Usual Price £228.85
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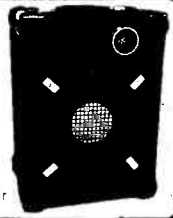
OMP LINNET LOUDSPEAKERS

The very best in quality and value. Made specially to suit todays need for compactness with high sound output levels. Finished in hard wearing **black** vynide with protective corners, grille and carry handle. All models 8 ohms. Full range 45Hz - 20KHz. Size 20" × 15" × 12". Watts R.M.S. per cabinet. Sensitivity 1W 1mtr dB

OMP 12-100 Watts 100dB. Price £149.99 per pair.
OMP 12-200 Watts 102dB. Price £199.99 per pair.
Delivery Securicor £8.00 per pair



OMP 19" STEREO RACK AMPS

Professional 19" cased **Mos-Fet** stereo amps. Used the **World** over in clubs, pubs, discos etc. With twin Vu meters, twin toroidal power supplies. XLR connections. MF600 Fan cooled. **Three models** (Ratings R.M.S. into 4 ohms). Input Sensitivity 775mV.

MF200	(100 + 100)W.	£169.00	**Securicor**
MF400	(200 + 200)W.	£228.85	**Delivery**
MF600	(300 + 300)W.	£322.00	**£10.00**

1 K-WATT SLIDE DIMMER

★ Control loads up to 1Kw
★ Compact Size 4⅓" × 1" × 2½"
★ Easy snap in fixing through panel cabinet cut out
★ Insulated plastic case
★ Full wave control using 8 amp triac
★ Conforms to BS800
★ Suitable for both resistance and inductive loads. Innumerable applications in industry, the home, and disco's, theatres etc.

PRICE £13.99 + 75p P&P

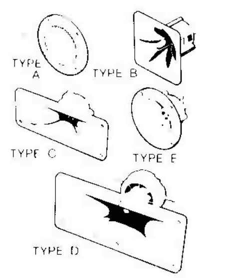
BSR P295 ELECTRONIC TURNTABLE

★ Electronic speed control 45 & 33⅓ r.p.m. ★ Plus Minus variable pitch control ★ Belt driven ★ Aluminium platter with strobed rim ★ Cue lever ★ Anti-skate (bias device) ★ Adjustable counter balance ★ Manual arm ★ Standard ½" cartridge fixings ★ Supplied complete with cut out template ★ D.C. Operation 9-14v D.C. 65mA
Price £36.99 £3.00 P&P.

ADC Q4 mag. cartridge for above **Price £4.99 ea.** P&P 50p

PIEZO ELECTRIC TWEETERS · MOTOROLA

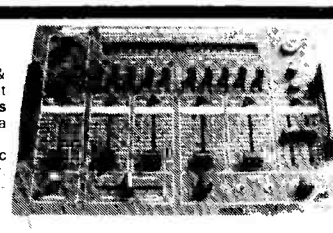
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers **Price £4.90 each + 40p P&P**
TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.99 each + 40p P&P**
TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc **Price £6.99 each + 40p P&P**
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £9.99 each + 40p P&P**
TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £5.99 each + 40p P&P**
LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket 85 × 85 mm **Price £3.99 + 40p P&P**

STEREO DISCO MIXER

STEREO DISCO MIXER with 2 × 5 band L & R. graphic equalisers and twin 10 segment L.E.D. Vu Meters. **Many outstanding features** 5 Inputs with individual faders providing a useful combination of the following: 3 Turntables (Mag), 3 Mics, 4 Line plus Mic with talk over switch. Headphone Monitor. Pan Pot L. & R. Master Output controls. Output 775mV. Size 360 × 280 × 90mm.
Price £134.99 — £3.00 P&P



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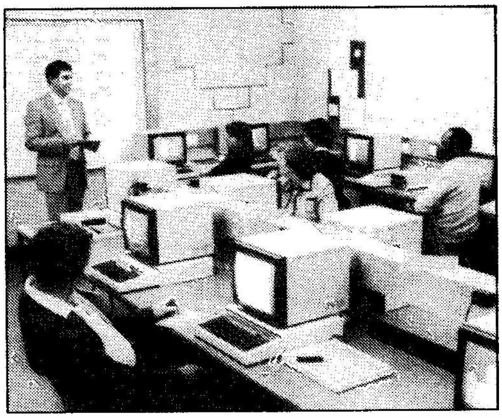
October 1988

VOLUME 17 No 10



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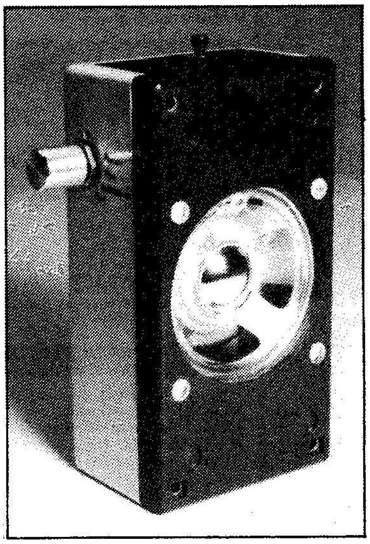

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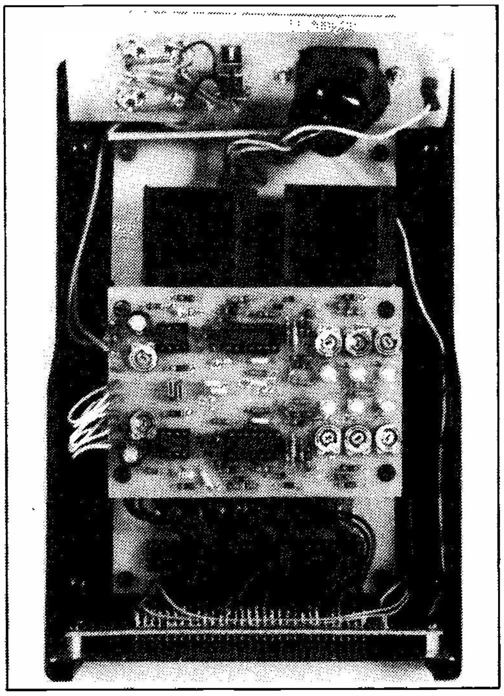
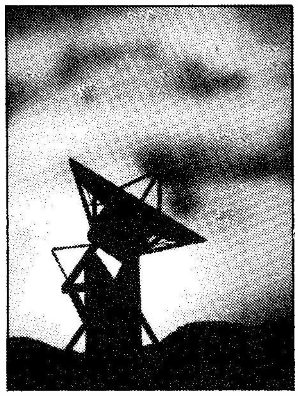
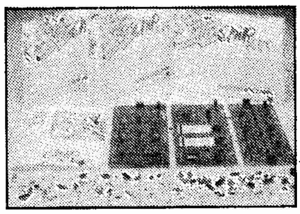


REGULARS





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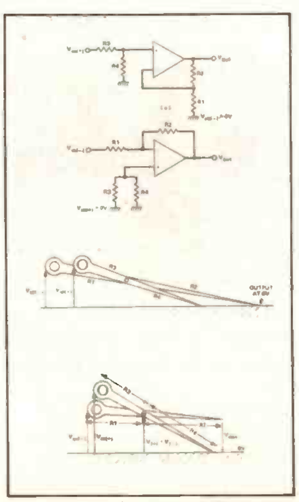
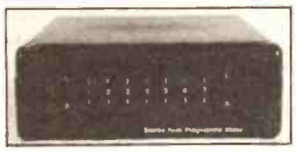
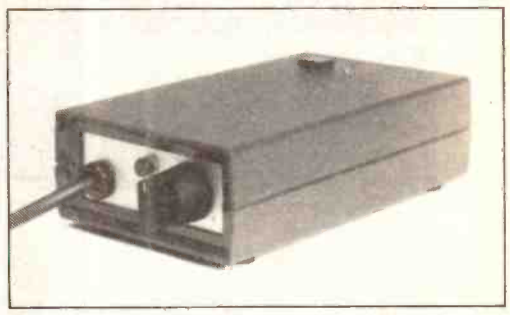
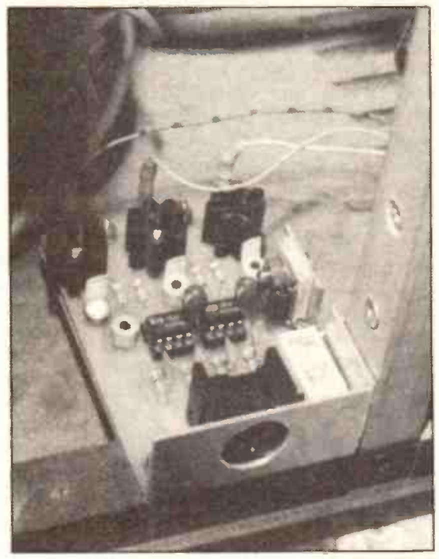
ETI
ELECTRONICS TODAY INTERNATIONAL

FEATURES/PROJECTS









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Our thanks to Vivien Lunniss for the calligraphy on this month's cover.

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NEWS

THE PRICE OF POWER

Plans to regulate electricity prices after privatisation are hopelessly over-confident, the Government warned by the area distribution boards.

The pricing policy presently proposed follows the lines of gas and telephone charges which are allowed to increase by inflation less an X-factor. The X-factor for BT has recently been set at 4½% and ministers are intending to fix the electricity X-factor between 1% and 2%.

The area boards are arguing that they will have hardly any scope to reduce costs and that the X-factor should be no more than 0.3%. This figure would prevent ministers from pointing to the price advantages of a privatised electricity industry.

Meanwhile details have been announced of Big G and Little G — the two amusingly titled generating companies to be formed from the break-up of the CEGB. The site listings proposed would give Big G nearly 40000MW capacity compared to Little G's 18800MW. All nuclear generation is included in Big G's allocation. It is possible that these figures may change slightly should some stations be allocated to other private companies.

PADDINGTON BARE

Paddington College's fight to keep its Radio Amateurs' Examination Course running in the face of ILEA's savaged budgets has led to an empty publicity fund and complete dependency on good enrolment figures for survival. It is likely that all other RAE courses in London will close as a result of the cuts.

ETI is pleased to give a little free publicity. The course not only covers the syllabus for the City and Guilds RAE exam (with an excellent pass rate of close to 90% in recent years) it also makes use of college facilities to provide an elementary grounding in electronics as well as an Amateur Radio Licence.

Attendance is twice a week (terms from mid-September to May).

The enrolment will take place from 5th-9th September between 1 and 4pm and 6 and 8pm on the 3rd floor, Paddington College, Paddington Green, London W2 1NB. Tel: 01-402 6221 for further information.

ASTRA SKY PALS

Amstrad has produced its prototype for the £199 receiving equipment for Murdoch's Astra-based PAL satellite channels. Amstrad has already placed orders with Marconi to produce the LNBs for the systems — the dish designs are completed and contracts for the actual receiver units should be finalised in the next month. Amstrad is confident that the equipment will be available by March next year.

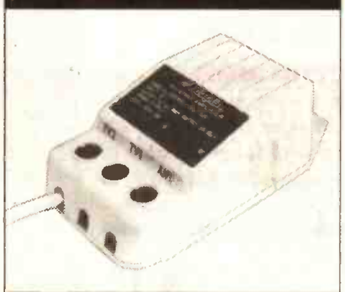
There has however been a question mark put over the entire Astra operation by the continued talks between Eutelsat and the consortium headed by Robert Maxwell and WH Smith. Eutelsat plans to have 32 transponders available on two satellites to be launched in 1991.

If the Maxwell consortium were to withdraw from Astra, the attraction to UK viewers of a single satellite receiver like Amstrad's would be significantly hit. Mr Murdoch is believed to have a get-out clause in his contract with Astra that could be exercised should other English-speaking Astra possibilities go elsewhere.

Meanwhile, BSB is considering countering Amstrad's budget receivers by subsidising sales of its equipment to BSB subscribers.

Several schemes are being considered, with the general idea of maximising the immediate uptake of BSB's channels at its launch next summer. It has also contracted Scottish firm Fortel for exclusive rights to its flat antenna design which could be combined with a budget receiver to retail around £250.

TV AMP



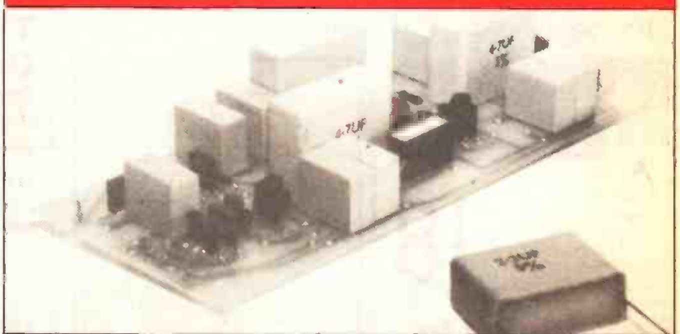
Maplin has added a remarkably cheap aerial amplifier to its range of aerial products.

The amp has a gain of 7dB with an extra co-ax output for driving a second television.

It is mains powered and can be wall mounted if required.

The price is just £11.95 inclusive — Maplin's product code is YP41U. Contact Maplin on (0702) 554161.

CAPITAL CAPACITORS



Audiokits of Borrowash has introduced a new range of high quality audio polypropylene capacitors.

The Audiocap polypropylenes are of radial construction in a rectangular case and their small physical size makes them useful for upgrading amplifiers currently fitted with polyester or polycarbonate caps (an upgraded Virtuoso pre-amp — ETI June-November 1986 — is shown in the photo).

They are available from 10n to 4Mu7 at 63V rating from Audiokits, 6 Mill Close, Borrowash, Derby DE7 3GU. Tel: (0332) 674929.

PCBS FROM PCWS

CADsoft has produced a new version of its printed circuit board design utility. The Amstrad CPC version was reviewed in ETI March 1988 and the program is now available to run on Amstrad PCW8256 and 8512 computers.

As with the CPC version, the program can produce single or double-sided boards, displaying tracks on opposite sides simultaneously. Printout is high quality double-sized onto a normal Epson or equivalent dot matrix printer.

The price is £29.99 fully inclusive and ETI readers can obtain full details and sample printouts by sending an SAE to CADsoft Systems, 18 Ley Crescent, Tyldesley, Manchester M29 7BD. Tel: (0942) 870376.

ATARI ADD-ONS

Atari ST owners can use their computer as a spectrum analyser or oscilloscope using two new units from Kuma Professional Software.

The K-Spect forms a low frequency spectrum analyser with two channels used as A or B, A+B or B/A. The signal can be locked or free running with a range 0 to 25kHz in 1kHz steps.

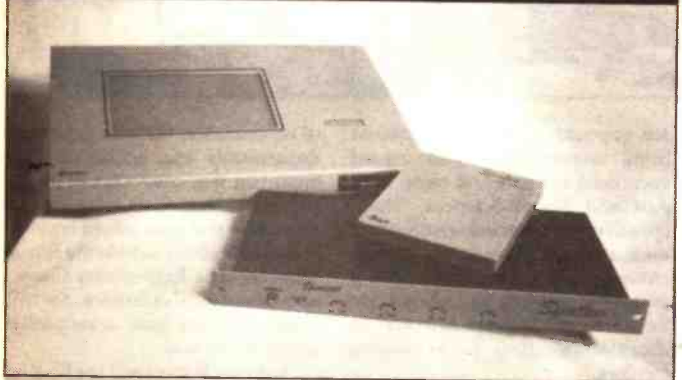
The K-Scope oscilloscope is aimed at audio frequency capture up to 30kHz.

Both units consist of an interface box (which connects to the Atari's ROM port) and relevant software.

They cost £149.95 each or £239.90 for the pair.

Contact Kuma, 12 Horseshoe Park, Pangbourne RG8 7JW. Tel: (07357) 4335.

2MHz MIDI



MIDI communication at 2MHz is on the way from Syntec Digital Audio in the form of MINI (Musical Instrument Networking Interface).

MINI allows connection of up to 126 instruments at node points around a network ring. A total of 8064 channels (64 for each node) thus become available.

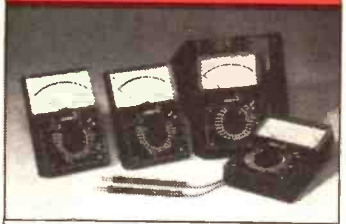
Upgrading a system to use MINI is not easy and certainly not cheap. Each MIDI instrument requires a MINI to MIDI converter and the routing systems get so complex that a master controller is required to implement routing programs.

With a complete ring of instrument nodes formed (including the MINI Master Controller) busses are specified using instrument names (identified as the nodes are created). The MINI bus information is held by the Master together with Routing Programs (also names rather than numbers) which store combinations of busses.

Once a network is defined it is quite a job to rearrange things so MINI is certainly best suited to permanent studio set-ups. Prices vary from £800 to £3,000 for the Master Controller and a 4-way MIDI converter costs £700.

Contact Syntec Digital Audio, 628 Chester Road, Sutton Coldfield, West Midlands B73 5JR. Tel: 021-373 9858.

METERS



Multimeters at either end of the price scale have been introduced by Universal Instruments this month. In the pocket money and birthday pressie range are four Iskra meters, the cheapest of which is the model 46. This features 23 measurement ranges covering AC and DC volts and amps, plus resistance. It costs £19.50.

The model 45 has wider operating parameters, slightly greater accuracy and an audible short circuit test. The 45 costs £34.33. All four Iskra meters display by analogue moving coil.

Universal has also introduced the latest Hioki digital multimeter, a 4½-digit instrument with resolution to 10µV. It has a wideband frequency response so can give accurate RMS readings even of distorted waveforms. The 3230 costs £318.05.

All prices exclude VAT. For more details contact Universal, Unit 62, GEC Site, Whetstone, Leicester LE8 3LH. Tel: (0533) 750123.

TRANNY TRAINING

A training package for the BBC B and B+ entitled *Understanding Transistors* has been produced by Computer Aided Training of Frizington in Cumbria.

The package is designed for use on GCSE, ITEC and BTECII courses and is supplied with a simple ready built board comprising a transistor switch and common emitter amplifier. A pack of components required for the different experiments is also provided. The board connects to the BBC micro via D-connectors to the joystick port and is powered from the micro's 5V output.

The software supplied monitors the circuit to display two currents and six voltages as numerical values and in graph format, with an option to display values as on an oscilloscope.

A third screen displays the circuit diagram showing the currents flowing and the voltages at each node.

Worksheets for 30 experiments are provided — these are free of copyright so they can be photocopied for multiple or future use.

Computer Aided Training estimates the work could be completed superficially in about 10 hours although some 40 hours of detailed study could be obtained.

Understanding Transistors costs £39 inclusive.

Contact J McCormack, CAT, 1 Windergate, Frizington, Cumbria CA26 3QS. Tel: (0946) 810597.

SUPERTRONIC SHOPPING

Birmingham's electronics boulevard, Hurst Street has a new attraction for component shoppers. Supertronics, at 65 Hurst Street, is the third of Marco Trading's retail outlets and will be stocking the whole range of its mail order catalogue from components and ICs through to opto-components and burglar alarms.

Supertronics will also be operating an on-site audio and video repair service with a resident engineer. Contact Supertronics, 65 Hurst St., Birmingham B5. Tel: 021-666 6504.

PUSH FOR ACTION

Some heavy duty push-buttons and indicators are being marketed by Invader in Swindon, including the pictured chunky mushroom stop button — part of the Highland series 04.

All the range have oil-sealed contacts and many are panel sealed to standard IP65. The maximum switch rating is 10A at 500V AC.

Contact Invader, Bridgewater Close, Hawksworth, Swindon SN2 1TZ. Tel: (0793) 613201.

SURVEY WINNERS

The ETI Readers' Survey department was flooded with returned forms following our June issue. Many thanks to all who took part and when the ETI programmers have completed their machinations we'll be taking note of your views.

Meanwhile the 25 winners of the free six month subscriptions are: A J Cunnell, West Norwood. P J Lawrowitch, Stockport. J A Bruce, Braintree. A C Pidsley, Chudleigh. G A Mape, Manchester. Imerio Ballarini, Cricklewood. L Eastwood, Weybridge. S Wylie, Burchetts Green. A C Owen, Sheffield. A Hulse, Wigan. G Smith, York. S Eyces, Corsham. A J Perkins, Bracknell. N James, Thornton Heath. P Dooley, Greasby. K Ozwell, Grimsby. S Pearce, Loughborough. T Hawkins, Southampton. S Coce, Norwich. T Barwick, Clapham. D Lewis, Llandaff. A C Booth, Brighton. D Walton, Bracknell. J W Welch, Scunthorpe. G W Peale, Wolverhampton.

These lucky winners will get six free copies of ETI commencing with the November issue (existing subscribers will have their subscriptions extended).

TITCHY TESTER

A titchy tester for 6 and 12V batteries is being marketed by Alpha Electronics.

The BQ200A hand-held voltmeter would be suitable for checking vehicle battery and charging systems — power is taken from the system under test so that no internal batteries are used. The 3½-digit display is accurate to within 20mV and indicates polarity signals.

The unit is sealed and guaranteed for twelve months. It costs £26.00+VAT. Contact Alpha Electronics, Unit 5, Linstock Trading Estate, Atherton, Manchester M29 0QA. Tel: (0942) 873434.

RESISTANCE IS LOW

Low value resistors are part of a new range of components from Welwyn Electronics. The W30 series resistors are designed primarily for current sensing and are available with values between 10 milliohms and 91milliohms, with wirewound cement-coated construction. Rated dissipation is 3W at room temperature but they can withstand 10 times the rated power for about 5s.

Contact Welwyn Electronics, Bedlington, Northumberland NE22 7AA. Tel: (0670) 822181.

INSIGHT

Access to higher education must be widened effectively and quickly, otherwise the employers and economy of the UK will be denied the skills and competence necessary to survive. This is the message of a report from the Industry Matters Education Industry Forum, an initiative of the Royal Society for the Encouragement of Arts, Manufacturers and Commerce.

The report challenges the deeply rooted systems for gaining entry to higher education in this country as failing to select those most likely to gain from the studies.

The dominance of A-levels in selection procedures for degree courses has become widely accepted mainly because it provides an easy method for admissions tutors to reduce the piles of UCCA forms to a manageable quantity quickly and with a minimum of effort. A-levels have thus become the standard ticket to universities and polytechnics and have thereby gained dominance in the school curriculum without necessarily providing the breadth and balance of relevant subjects that should be sought in those entering higher education.

This system is positively unhelpful for mature and non-standard entrants. The A-level ticket is maintaining higher education in a role that nurtures a thin stream of excellence when industry is crying out for a broad highway of competence. Within this, excellence should have its part to play but would not create the current situation where the best become the enemies of the good.

The report however ignores the obvious solution that higher education should be available to more people rather than simply to a different mix. If the system is at present full to capacity and yet produces only a thin stream of excellence, widening the stream can only be achieved by pumping in additional resources — otherwise the results already attained will be lost.

The immediately obvious source of such assistance is the Government but with the present ministerial policies of autonomy in education at all levels additional financing is unlikely to say the least.

A second possibility is a system that positively encourages private company sponsorship of higher education in the form of tax relief and incentives similar to those available in the United States. Many academics are opposed to such measures as being unavoidably biased toward vocational subjects and away from Arts and Social Sciences. These arguments unfortunately lose much of their strength against the current climate where just this type of bias is exercised annually as colleges are forced to use natural selection to allocate dwindling funds among faculties.

The report from Industry Matters argues that more government money may well be necessary but this is in addition to the attitude changes vital for a more solidly based and broadly trained workforce capable of competing with foreign competitors. Various areas are marked out for attention. Selection procedures should make better use of profiles and experience as well as A-level grades. Entry for mature and non-standard candidates should be simplified and Open University foundation courses more widely accepted.

Modular format courses should be encouraged to assist entry and enable exemption for experienced students, it says. Course objectives should be clearer so that relevant skills in candidates can be identified.

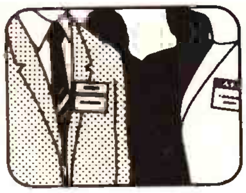
The report also criticises the lack of co-operation between admission departments and employers. It is important that employers as well as courses understand the advantages of candidates that have gained expertise and qualifications outside the A-level situation. The Engineering Council and Standing Conference on University Entrance have already taken action to this end.

Industry Matters and the RSA are keen that this report does not simply make its recommendations and then gather dust. The national organisation is seeking the assistance of various relevant organisations (notably the Council for Industry and Higher Education) in establishing a working group to seek a method of positively encouraging wider access to higher education.

It stops short of pressing the Government to take action but is refreshing in its admission that a report such as this can only achieve limited objectives and cannot hope to change an entire cultural system through its recommendations alone.

The report *Raising The Standard — Wider Access To Higher Education* is available from Industry Matters, 8 John Adam Street, London WC2N 6EZ. Tel: 01-930 0120.

DIARY



Insight On-site — September 6th
Excelsior Hotel, Birmingham. Seminar on electronic security systems. Contact Philips Scientific on (0223) 245191

Insight On-site — September 7th
Novotel Manchester West, Manchester. Seminar on electronic security systems. Contact Philips Scientific on (0223) 245191.

Insight On-site — September 8th
Hilton National, Leeds. Seminar on electronic security systems. Contact Philips Scientific on (0223) 245191.

Conpar 88 — September 10-16th
Manchester. Contact British Computer Society on 01-637 0471.

Plasa Light And Sound Show — September 11-14th
Olympia, London. Contact the Professional Lighting And Sound Association on (0323) 646905.

European Conference On Optical Communication — September 11-15th
Brighton Centre, Brighton. Contact IEE on 01-240 1871.

International Police Exhibition And Conference — September 12-15th
Barbican Centre, London. Mainly radio and communications technology. Contact Major Exhibitions on 01-446 8211.

Comex 88 — September 13-15th
Sandown Park Exhibition Centre, Surrey. Contact Frametrack on 01-828 2905.

Personal Computer World Show — September 14-18th
Earls Court Exhibition Centre, London. Contact Montbuild Exhibitions on 01-486 1951.

Microjoining 88 — September 20-21st
The Welding Institute, Cambridge. Symposium on miniature electronic assembly. Contact The Welding Institute on (0223) 891162.

International Broadcasting Convention — 23-27th September
Exhibition Centre, Brighton. Contact IEE on 01-240 1871.

European Gallium Arsenide Conference — September 24-26th
Jersey, Channel Islands. Contact The Institute of Physics on 01-235 6111 for the venue.

Semiconductor International — September 27-29th
Jersey, Channel Islands. Contact The Institute of Physics on 01-891 5051.

Electronics In Engineering Design Show — September 27-30th
NEC, Birmingham. Contact Cahners Exhibitions on 01-891 5051.

BBC Radio Show — 30th-9th October
Earls Court, London. 'Spectacular extravaganza' to celebrate 21 years of BBC Radio 1, 2, 3 and 4. Exhibition, live shows, etc. Contact BBC Radio Show, PO Box 100, Chatham, Kent ME5 BLJ

Electronic Displays 88 — October 4-6th
Wembley Conferenece & Exhibition Centre, London. Contact Blenheim Online on 01-868 4466

Computer Graphics 88 — October 11-13th
Wembley Conference & Exhibition Centre, London. Contact Blenheim Online on 01-868 4466.

Digital Signal Processing Seminar — October 13th
Heathrow Penta Hotel, London. Contact ERA Technology on (0372) 374151

Desktop Publishing Show — October 13-15th
Business Design Centre, London. Contact Database Exhibitions on 061-456 8383

Satellite Systems For Mobile Communications And Navigation — October 17-19th
IEE, London. Conference organised by IEE. Contact IEE on 01-240 1871

Internepcon — October 18-20th
Metropole Exhibition Centre, Brighton. Contact Cahners Exhibitions on 01-891 5051

Testmex 1988 (Electronic Testing & Measurement) — October 18-20th
Business Design Centre, London. Contact Network Events on (0280) 815 226

IC Outlook — October 19th
Centre Point Building, London. Market overview seminar. Contact Dataquest on 01-583 9171

Commercial Awareness And Business Skills For Young Engineers — October 21-23rd
Strand Palace Hotel, London. Contact IEE on 01-240 1871.

READ\WRITE

KUDOS AND PEANUTS

As an occasional contributor to ETI, I feel I must respond to Mr Burton's letter in the August issue.I understand his point of view but suspect he does not appreciate the difficulties involved in preparing a project for publication.

Let us consider the cost of project building. There is no way a home-brew project can compete with mass-market electronics turned out in their hundreds of thousands by factories in Japan or anywhere else. Components are bought in quantity at rock bottom prices and assembled by the cheapest of labour.

The home-brew project cannot compete on quality. Japanese goods are not what they used to be — quality is the main selling point these days. Finish is certainly out — when was the last time you made something that looked as good as even an average pocket radio? Mechanics represent the major difficulty, as anyone who has tried to make a tuning dial will testify. CD mechanisms stand no chance!

Having ruled out 99% of all possible magazine projects as uneconomic, what is left? There are three main areas. Consumer goods limited to the high cost luxury items, such as high quality audio gear, for example. This section of the market does not sell enough of anything to make economy of scale really count. By building equivalent equipment from constructional articles, you effectively side-step the cost of development by splitting it with everyone else who buys the magazine. What a designer is paid for his article is peanuts compared to industrial development costs anyway. The classical examples of this kind of project are the Linsley Hood audio gear and the various musical projects (keyboards, MIDI and the like).

Test gear also represents a good hunting ground, and there are plenty of those in the pages of ETI. Meters, scopes, analysers, whatever, are all extremely expensive commercially but many are more accurate than the typical hobbyist would require. The hobbyist does not represent a significant market, so there are not many products aimed at him. Where a kit is offered (sometimes to accompany a magazine project), is it any wonder that no-one else can do it much cheaper? No manufacturing costs are involved in marketing a kit.

The last niche where the hobbyist reigns supreme is the odd-ball project. By this I mean the sort of thing that is a gimmick or that wouldn't have a commercial market anyway. There have been dozens of those in ETI and rather than disparage anyone else's project, I might as well castigate my Digibaro as being in this category.

But wait. Who said DIY is about saving money on commercial items? It might be to some but there are plenty of people who would disagree. If you dismiss cost as irrelevant to the fun of making something for yourself (or pain, grief and frustration, more like) that first market of mass imports opens up once more. If you think I'm wrong, how is it that Heathkit has survived all these years? Their kits cost far more than a ready made item on the open market but people make them knowing everything is ready, all the problems have been solved and you get a professional finish.

As a final point, I wish to mention the rewards offered to the contributor of a magazine article. Why have them at all? Mr Burton does not, I am sure, realise how long it takes to develop a fully fledged project. To provide all a magazine such as ETI required would not be economic if entirely done in-house. External contributors don't get paid very much. Usually it works out at just enough to cover the cost of developing a project in the first place.

So why do we do it? Partly it's the kudos of having something in print, of course. It's certainly not the money. In the main, you want to make something and you have the technical skills to design it yourself. Hell and high water will not stop you building that project and get it working but home-brews cost money and if someone else can be persuaded to foot some of the bill so much the better. It's not that easy, either. First of all you have to persuade the editor that he wants it, then you have to write it, neither of which are necessary if your project is for only private consumption!

When I was starting out, I read the high-flying articles avidly but with no intention of building one. I was getting to understand how the designs were put together, learning my craft as it were. To this day I have never built a magazine project, at least not without bending it out of all proportion. Mr Burton may not have these inclinations but if, after all I have said, he still sees the esoteric article as a waste of space, perhaps he should be reading one of the electronics comics (mentioning no names).

Ken Wood
Ipswich, Suffolk

Mostly agree with all that. We must say though that DIY projects can sometimes compete on quality and cost despite what you say. Finish is always a stumbling block.

As to the rewards, while we acknowledge that contributors payments are unlikely to ever compete against the pools in the windful category, they can be a fairly hefty pile of peanuts!

Any budding designers out there interested in peanuts, kudos or just supporting the best non-comic electronics mag, please get in touch.

Next Month in ETI

ELECTRONICS TODAY INTERNATIONAL

IT'S A STEAL!

The November issue of ETI sees the return of the annual ETI giveaway. On the cover of the November issue you will find a small bag crammed to the gills with valuable components all ready for you to build the ETI Burglar alarm. There have of course been burglar alarms before, but never a free burglar alarm (surprising, really, when you consider that the clear up rate for crimes of breaking and entering is only around 17% and so there are an awful lot of free burglars around!)

As if that wasn't enough from us generous ETI types, the following issue will feature a free PCB on which to mount your components along with a series of expansions to turn your free alarm into a comprehensive protection system.

Meanwhile, back in the November issue, there's a wealth of other goodies, well worthy of protecting! Are you out of control? — not to worry we have the lowdown on control strategies to restore order to your life. Do you not know your digits from your doobries? — our feature on analogue to digital converters will solve all that as well.

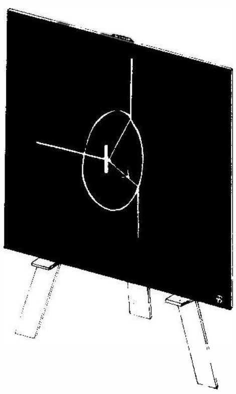
Plus, for those long winter nights there's plenty to keep the soldering iron warm and you busy. There's a Chronoscope for the shooting fraternity and a NiCd rechargeable battery charger for the the beginners, to name but two.

And there's all the rest that go to make ETI the best electronics magazine to buy this and every month.

November ETI — out October 7th

CLASS OF 88

Steve Morgan takes a look at the new presentation of electronics in education and sees if there are any lessons to be learned



EDUCATION

Electronic Engineering as a subject at degree level has been around for a long time (the microprocessor becomes an adult next year!) but over the last ten years it has slowly been accepted as a subject in its own right at secondary school level.

O-level Electronics has been an option in many schools for at least five years but has often been treated as an extension of Physics with 'the more practically able' pupil being advised to take up this option. This situation has fortunately changed as teachers and pupils have realised the demanding range of design, problem solving and practical skills required in Electronics. Recently talking to a group of 16 year olds who had freshly emerged from this year's exam torture session, it appears that Electronics is rated as close to the top of the list of difficult subjects.

However, despite being rated highly at an academic level and the increasing shortage of engineers in industry, the numbers of students wishing to follow a course at a higher level is considerably smaller than those going into business and accountancy. It's hard for the 'oily overall' image of engineering to compete with a time manager, a Porsche and flat in Chelsea. If the shortage continues perhaps an 'electro-yuppie' will eventually emerge from the oily overall.

This general shortage of engineers and technologists together with the falling numbers of students on science and engineering courses has led the government to introduce a new national curriculum in which science and technology become a compulsory part of education for all in the hope of increasing the level.

The 'new' approach to science teaching will be to provide a 'balanced science course' (useful for weighing up the options) containing physics, chemistry and biology in one subject. Technology subjects like electronics, craft design and technology (CDT) and control technology will be more widely available. Science will also become a larger part of the primary school curriculum.

GCSEs And AS Levels

The GCSE is the new exam for 16 year olds and for those not taking the exam a national profiling system is being introduced to give information about each pupil's progress across the whole range of compulsory schooling.

The major change in moving from O-levels to GCSEs is the use of more in-course assessment through project work, practical work and written assignments in addition to the usual homework. Feel sorry for the poor teacher who has to set and mark this lot as well as filling in all the new assessment forms and finding time do the odd bit of teaching!

The GCSE Electronics syllabuses aim to build knowledge, understanding and skills by practical investigations of electronic systems. Design, problem solving, construction, testing and communication skills are developed by following projects through from the initial idea to final realisation. Applications examples are used to show how electronics can help in society and the environment such as aids for the deaf, blind and handicapped, monitoring pollution, improving the quality of life at work and leisure. The emphasis is definitely on relevance to the world we live in rather than the pursuit of knowledge for its own sake.

Practical activities account for up to 40% of marks obtainable (depending upon the exam board) and there are two written exam papers at the end of the course which together determine the final grade ranging from A to G. A major part of the practical work is the project in which the pupil has to design, construct, test and report on a circuit or system for a particular application.

Pupils are expected to know a range of standard building blocks (amplifiers, logic gates, buffers and so on) and to have a working knowledge of basic components, electrical quantities and fundamental concepts. They examine systems (signals and transducers, interfacing and microcomputers) and systems applications in telecommunications, television and radio. Passive and active components are studied and a logic course is included. There are also more general topics such as electronics in society and safety.

The As Have It

At A-level more changes are afoot. In order to broaden the subject base and/or reduce the level of specialisation AS-levels have been introduced. These are roughly equivalent to half an A-level and can be taken as complementary subjects to the usual type. A sixth former might for example study two A-levels and two AS-levels.

As far as Electronics is concerned there are A-levels, AS-levels and an A-level electronics endorsement to a normal Physics A-level. The teaching material covered in an A-level electronics course is basically the same as that in the GCSE course and only differs in the depth of treatment. A GCSE pupil would be expected to know the function of logic gates in terms of a truth table and simple applications whereas an A-level student would also learn the characteristics, rise time, propagation delays in quantitative terms and design techniques using Boolean Algebra and Karnaugh maps.

Top-down or Bottom-up is not a reference to the posture to be adopted for GCSE teaching but to the continuing argument about whether to use the systems approach for teaching or to start at component level. Having tried both approaches over a period of ten years there is little evidence to show that one approach is better than another and like a good diplomat I find that a compromise between the two is most agreeable.

One exam board which will remain nameless has obviously been fruitlessly debating the same point since it has cleverly designed its GCSE and A-level syllabuses so that 'each syllabus leaves teachers free to adopt a bottom-up, top-down or middle-up/down approach to electronics in the classroom'!

At a practical level the systems approach uses ready made plug together modules so that a temperature controller, say, can be quickly constructed from a thermistor block, a comparator block, a relay driver block and a small motor acting as a fan.

The problem here is that pupils find component identification difficult since all the boards 'look the same' and they lack practice in use of colour codes and in basic component forming, simple wiring and layout skills. The problem is highlighted in project work where they are suddenly asked to bring together a range of underdeveloped skills.

From the teacher's point of view the systems approach requires a great deal of material in hand since systems can be rapidly and reliably constructed in a short time. There is nothing worse than trying to cope with 30 budding electronics boffins racing each other to plug together as many modules as possible in seemingly random order, having completed your carefully planned practical exercise in 10 minutes.

On the other hand the 'bottom-up' approach using components inserted into some form of prototyping board or breadboard soon becomes limited since the average pupil finds circuit construction beyond a handful of components too time consuming and unreliable. Once again there is little in the way of structured teaching material available for this approach and the burden falls upon the teacher.

This problem was highlighted in a recent report from a task group on assessment and testing methods in secondary education headed by a Professor Black. The group expressed concern over pressures on teacher time, class sizes and resources for practical work.

The reduction of class sizes is a matter for Mr Baker's balance sheet but the provision of teaching material is a matter I have recently had to address as leader of a product design team at the Polytechnic of Wales.

The Polytechnic of Wales recently established an Electronics Centre to provide consultancy and short-course development services to industry. Recognising the lack of suitable electronics teaching material available, a survey of teachers was undertaken to identify ways of reducing pressures on teacher time and school Electronics budgets. The result was the design of the Chipkits range of electronics teaching aids (see *Once Over*). Chipkits comprise three boards covering the basics of analogue and digital electronics each with a teaching package providing component lists, background theory, practical assignments, extension exercises and homework questions designed to assist teachers and encourage more pupils to take up a career in this exciting field of engineering.

The TVEI Programme

Although only GCSE and A-levels have been mentioned so far these are not the only courses on offer. Many schools offer a range of TVEI modules in addition to GCSEs. The Technical and Vocational Educational Initiative was set up to develop work related skills (as well as testing pronunciation and memory of its title).

The Certificate of Pre-Vocational Education (CPVE) is also on offer in some schools and colleges and this leads into BTEC (Business and Technical Education Council) courses like ONC and OND (Ordinary National Certificate and Diploma) which can then be used as an entry into HNC and HND courses.

If you've managed to keep a clear head through all those abbreviations you now know that the education environment is about as dynamic as you can get. One certain thing is that whichever route is followed in electronics education and subsequent careers there will always be plenty of interest and opportunity. ETI

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THE NEXT STEP

Higher education courses in electronics are many and varied. How to choose between them?

COURSES

For students starting their second A-level year this month, the time has come to make the decisions that concern life beyond the schoolroom. Applications for university and polytechnic degree courses have a December 15th deadline and although colleges and institutes of higher education will often consider candidates submitting applications in the spring and summer, to make sure of a place applications should be sent early in the new year.

The decisions to make over the next few months are numerous and important — they will decide not only how the next three or four years are spent but which way your career will be heading after that.

The first decision is whether to enter higher education at all or to head into the workplace straight from A-level. This is usually an easy choice to make — and if it isn't then the safest thing to do is apply for higher education anyway. Backing out of a course can be embarrassing but is a whole lot easier than trying to edge in at the last minute. Some colleges may even agree to defer entry for one year or two — although usually only if the job is for a specific period and preferably relevant to the course.

A third option is taking a year out. Many colleges strongly approve of a constructive period in the real world before starting a course. Some even give preferential treatment to such applicants. The year out need not be working in industry — a world tour of crop harvesting shows equal initiative and ambition. Most places will again agree to defer entry until the following year.

The temptation for students planning to take a year off is to sit out of the application process this time around. It is far safer and much more reassuring to get a course established and a place reserved now. After all, this time next year you'll be island hopping in Greece or road building in Tasmania and the last thing you'll want to do is spend hours telephoning home co-ordinating your parents' efforts at course hunting.

Once the decision to enter higher education has been made, the course and the level of qualification must be chosen. As an ETI reader the lure of an electronics qualification is probably strong but do bear in mind the differences between electrical and electronic work, the relevance of the word engineering and also the other more specialised subjects available. If you are certain that it is electronics in sound and music that interests you and little else, for instance, you might be more happy on a course like Salford's Electroacoustics option.

If you have any doubts as to your preferred area, a broader course encompassing Electrical and Electronic Engineering is probably a safer bet. Remember that you will meet many new areas of study which could turn out to be the subject you've been looking for all your life. Take with a pinch of salt the common advice that it is easy to concentrate on your particular interest by selecting relevant options in your third or fourth year — this is not always the case.

University

Many A-level students (and often teachers) think of a university degree as one rung above those awarded by polytechnics and colleges. Although this is certainly untrue in terms of course content and academic achievement, there does remain a certain prestige value. Competition for university degrees is more fierce than for any other type of establishment and the grades required for entry are correspondingly high. This year an estimated 160000 students will apply for the 70000 places available. This means that a slip of a single grade in your A-level results and conditional offers may be withdrawn.

Polytechnics

Polytechnic degrees score over university degrees on a number of points. The first is the control of course content. While universities are autonomous bodies and can run courses with any content they wish, polytechnics have their courses reviewed by the Council for National Academic Awards (CNAA). Electrical and Electronic Engineering degrees are being aligned to provide an emphatic engineering applications orientation and these degrees are marked out by awarding a BEng rather than a BSc (it is possible that some courses may still award a BSc if review is due to take place shortly).

A second advantage is that if your A-levels go horribly wrong, there may be a HND course at the polytechnic on to which you can transfer.

Life at polytechnic is little different to life at university and the degrees count for just as much. Unless you are totally confident of achieving top A-level grades (and few people can truthfully claim that) it is sensible to apply to both.

Colleges and Institutes of HE

The entry grades for these establishments are significantly lower and the courses are often regarded as an easy option. Yet in some cases degrees are validated by nearby universities and certainly the workload will be at least as high (terms will probably be longer as well). Again colleges and institutes have the advantage of running other electronics courses if A-levels go badly.

Diploma of Higher Education

A DipHE is equivalent to two years of a degree and has similar entry requirements. There is however only one DipHE in Electrical and Electronic Engineering run in Britain — organised by Thames Poly.

HND

Higher National Diplomas are offered by the Business and Technical Education Council (BTEC). These courses run at polytechnics and colleges taking two years of full time study, often combined with a year in industry as a three year sandwich. The entry requirement is usually the study of two A-levels — preferably Maths and Physics — only one of which needs a successful pass. BTEC National Certificates (see below) are alternative qualifications to A-levels if the relevent modules have been completed.

It may be possible for outstanding students on HNDs to transfer to degree courses and it is worth checking where this is allowed.

Conversion Courses

For students who made the wrong choices at A-level and have found themselves unable to apply for engineering degrees and HNDs because their subjects are wrong, there are one year conversion courses called Higher Introductory Technology and Engineering Conversion Courses (HITECC). These run mainly at polytechnics and can be taken as a forerunner of another course there or elsewhere.

BTEC Qualifications

Apart from HNDs, BTEC validates a variety of courses for students leaving school following GCSEs and for people with previous training in electronics wishing to update their skills or learn new specialisations.

Each BTEC course consists of various units of study organised by the attended college but subject to BTEC validation and moderation. The BTEC First Certificate of Achievement consists of a single module and can be completed in three months (or a year of part-time study). Normal entry requirements for such a course are 3 GCSEs.

The longer courses are BTEC's National Certificate (ONC) and National Diploma (OND). Again studied in modular form, the National Certificate generally takes 15 months of full-time study which can be geared toward desired specialisations by selection of different modules. As with other BTEC courses the study involves substantial practical experience and project work. Entry requires 4 GCSEs or O-levels.

The National Diploma is half as long again as the National Certificate, extended by the study of additional modular units and usually offered as a full-time course with the usual scholastic holidays.

Completion of any ONC or OND course is qualification for entry to BTEC Higher National Certificate (HNC) courses or for the HNDs mentioned above. Note that while ONCs and ONDs can usually be started at the beginning of any of the three terms, HNCs and HNDs start only in September. If you want to apply, get on the phone now!

Colleges offering BTEC courses also run short refresher courses using individual BTEC units.

Details of BTEC courses can be obtained from The London Electronics College, 20 Penywern Road, Earls Court, London SW5 9SU (telephone 01-373 8721) or participating colleges and polytechnics.

Employment Training

Well worth a mention is the latest training scheme for the unemployed from the Training Commission (the Manpower Services Commission that was). Under the banner of ET (Employment Training) some 600000 places on the scheme will eventually be available each year — it gets under way this month.

The Training Commission is emphasising the structured and strategic study hopefully to BTEC or City and Guilds lèvel — and participation is purely voluntary to ensure committment on the part of both trainees and training providers.

The scheme is in two stages operated initially by an approved Training Agent who offers advice and support to applicants culminating in an individual action plan to be carried out by the Training Manager in the second part of the scheme.

For full details of ET contact the Training Commission, Room E433, Moorfoot, Sheffield S1 4PQ. Tel: (0742) 703810.

Non-attendance Courses

It is of course possible to study from home while working full time. Teaching packages exist from open learning enthusiasts' courses such as those offered by the National College of Technology in Bicester (Tel: (0296) 613067) right up to degree level Open University courses requiring extreme dedication and a great deal of time.

Listings

The lists that follow detail all non-university degree courses and all BTEC HND courses. University courses have been omitted since these are freely available from UCCA (telephone (0242)222444).

ADDRESSES

CITY OF BIRMINGHAM POLYTECHNIC – Perry Barr, Birmingham, B42 2SU (Tel:021-356 9193)
BLACKBURN COLLEGE – Feilden Street, Blackburn, BB2 1LH (Tel:(0254) 55144)
BOLTON INSTITUTE OF HIGHER EDUCATION – Deane Road, Bolton, BL3 5AB (Tel:(0204) 28851)
BRIGHTON COLLEGE OF TECHNOLOGY – Pelham Street, Brighton, BN1 4FA (Tel:(0273) 685971)
BRIGHTON POLYTECHNIC – Moulsecoomb, Brighton, BN2 4AT (Tel:(0273) 693655)
BRISTOL POLYTECHNIC – Coldharbour Lane, Frehchay, Bristol, BS16 1QY (Tel:(0272) 656261)
BUCKINGHAMSHIRE COLLEGE OF HIGHER EDUCATION – Queen Alexandra Road, High Wycombe, HP11 2JZ (Tel:(0494) 22141) and Newland Park, Gorelands Lane, Chalfont St. Giles, Bucks, HP8 4AD (Tel:(02407) 4441)
CAMBRIDGESHIRE COLLEGE OF ARTS AND TECHNOLOGY – East Road, Cambridge, CB1 1PT (Tel:(0223) 63271)
THE POLYTECHNIC OF CENTRAL LONDON – 309 Regent Street, London, W1R 8AL (Tel:01-580 2020)
COVENTRY (LANCHESTER) POLYTECHNIC – Priory Street, Coventry, CV1 5FB (Tel:(0203) 24166)
COVENTRY TECHNICAL COLLEGE – Butts, Coventry, CV1 3GD (Tel:(0203) 57221)
DERBYSHIRE COLLEGE OF HIGHER EDUCATION – Kedleston Road, Derby, DE3 1GB (Tel:(0332) 47181); Western Road, Mickleover, Derby, DE3 5GX (Tel:(0332) 514911) and Matlock, Derbyshire, DE4 3FW (Tel:(0629) 2383)
DONCASTER METROPOLITAN INSTITUTE OF HIGHER EDUCATION – Waterdale, Doncaster, DN1 3EX (Tel:(0302) 22122)
GWENT COLLEGE OF HIGHER EDUCATION – College Crescent, Caerleon, Newport, Gwent, NP6 1XJ (Tel:(0633) 421292) and Allt-yr-yn Avenue, Newport, Gwent, NP9 5XA (Tel:(0633) 51525)
HATFIELD POLYTECHNIC – P.O. Box 109, Hatfield, Hertfordshire, AL10 9AB (Tel:(07072) 79000)
KINGSTON POLYTECHNIC – Admissions Office, Kingston Hill, Kingston upon Thames, KT2 7LB (Tel:01-549 1141)
LANCASHIRE POLYTECHNIC – Prestón, PR1 2TQ (Tel:(0772) 22141)
LEEDS POLYTECHNIC – Calverley Street, Leeds, LS1 3HE (Tel:(0532) 462903)
LEICESTER POLYTECHNIC – P.O. Box 143, Leicester, LE1 9BH (Tel:(0533) 551551)
LIVERPOOL POLYTECHNIC – Rodney House, 70 Mount Pleasant, Liverpool, L3 5UX (Tel:051-207 3561), F.L. Calder Campus, Dowsefield Lane, Liverpool, L18 3JJ (Tel:051-428 4041), I.M. March Campus, Barkhill Road, Liverpool, L17 6BD (Tel:051-724 2321) and C.F. Mott Campus, Liverpool Road, Prescot, Liverpool, L34 1NP (Tel:051-489 6201)
LUTON COLLEGE OF HIGHER EDUCATION – Park Square, Luton, LU1 3JU (Tel:0582) 34111)
MANCHESTER POLYTECHNIC – All Saints, Manchester, M15 6BH (Tel:061-228 6171)
MIDDLESEX POLYTECHNIC – Admissions Enquiries, 114 Chase Side, London, N14 5PN (Tel:01-886 6599)
NEWCASTLE UPON TYNE POLYTECHNIC – Ellison Building, Ellison Place, Newcastle upon Tyne, NE1 8ST (Tel:091-232 6002)
NEWHAM COMMUNITY COLLEGE – High Street South, London, E6 4ER (Tel:01-472 1480)
NORTH EAST LONDON POLYTECHNIC – Assistant Registrar, Longbridge Road, Dagenham, Essex, RM8 2AS (Tel:01-590 7722) and Information Unit (01-599 5750)
NORTH LINCOLNSHIRE COLLEGE – Cathedral Street, Lincoln, LN2 5HQ (Tel:(0522) 30641)
THE POLYTECHNIC OF NORTH LONDON – Holloway Road, London, N7 8DB (Tel:01-607 2789)
NORTH STAFFORDSHIRE POLYTECHNIC – Stoke on Trent Site:– College Road, Stoke on Trent, ST4 2DE (Tel:(0782) 744531) Stafford Site:– Beaconside, Stafford, ST18 0DE (Tel:(0785) 52331)
NORWICH CITY COLLEGE OF FURTHER AND HIGHER EDUCATION – Ipswich Road, Norwich, NR2 2LJ (Tel:(0603) 660011)
OLDHAM COLLEGE OF TECHNOLOGY – Rochdale Road, Oldham, OL9 6AA (Tel:061-624 5214)
OXFORD POLYTECHNIC – Gypsy Lane, Headington, Oxford, OX3 0BP (Tel:(0865) 819000)
PLYMOUTH POLYTECHNIC – Drake Circus, Plymouth, PL4 8AA (Tel:(0752) 221312)
PORTSMOUTH POLYTECHNIC – Museum Road, Portsmouth, PO1 2QQ (Tel:(0705) 827681)
RAVENSBOURNE COLLEGE OF DESIGN AND COMMUNICATION – Walden Road, Chislehurst, Kent, BR7 5SN (Tel:01-468 7071)
SALFORD COLLEGE OF TECHNOLOGY – Frederick Road, Salford, M6 6PU (Tel:061-736 6541)
SHEFFIELD CITY POLYTECHNIC – Pond Street, Sheffield, S1 1WB (Tel:(0742) 20911)
SLOUGH COLLEGE OF HIGHER EDUCATION – Wellington Street, Slough, SL1 1YG (Tel:(0753) 34585)
SOUTH BANK POLYTECHNIC – Borough Road, London, SE1 0AA (Tel:01-928 9898)
SOUTH GLAMORGAN INSTITUTE OF HIGHER EDUCATION – Western Avenue, Cardiff, CF5 2YB (Tel:(0222) 551111)
SOUTH LONDON COLLEGE – Knight's Hill, West Norwood, London, SE27 0TX (Tel:01-670 4488)
SOUTHALL COLLEGE OF TECHNOLOGY – Beaconsfield Road, Southall, Middlesex, UB1 1DP (Tel:01-574 3448)
SOUTHAMPTON INSTITUTE OF HIGHER EDUCATION – East Park Terrace, Southampton, SO9 4WW (Tel:(0703) 229381)
SUNDERLAND POLYTECHNIC – Langham Tower, Ryhope Road, Sunderland, SR2 7EE (Tel:(0783) 5676231)
TEESSIDE POLYTECHNIC – Borough Road, Middlesborough, TS1 3BA (Tel:(0642) 218121)
THAMES POLYTECHNIC – Wellington Street, Woolwich, London, SE18 6PF (Tel:(01-854 2030)
TRENT POLYTECHNIC – Burton Street, Nottingham, NG1 4BU (Tel:(0602) 418248)
THE POLYTECHNIC OF WALES – Treforest, Pontypridd, Mid Glamorgan, CF37 1DL (Tel:(0443) 480480)
WATFORD COLLEGE – Hempstead Road, Watford, WD1 3EZ (Tel:(0923) 57500)
WEST GLAMORGAN INSTITUTE OF HIGHER EDUCATION – Townhill Road, Swansea, West Glamorgan, SA2 0UT (Tel:(0792) 203482)
WILLESDEN COLLEGE OF TECHNOLOGY – Denzil Road, London, NW10 2XD (Tel:01-451 3411)

KEY
FT full-time
SW sandwich
HE higher education

COURSES

Electrical and Electronic Engineering

Brighton Polytechnic	B Eng(Hons) and B Eng	FT3
Coventry (Lancaster) Polytechnic	B Eng(Hons) and B Eng	SW4
Hatfield Polytechnic	B Eng(Hons) and B Eng	SW4
Huddersfield Polytechnic	B Eng(Hons) and B Eng	SW4
Liverpool Polytechnic	B Eng(Hons) and B Eng	SW4
Manchester Polytechnic	B Eng(Hons) and B Eng	SW4
Newcastle upon Tyne Polytechnic	B Eng(Hons) and B Eng	SW4
North East London Polytechnic	BSc	SW4
North Staffordshire Polytechnic	B Eng	FT3
Plymouth Polytechnic	B Eng(Hons) and B Eng	SW4
Portsmouth Polytechnic	B Eng(Hons) and B Eng	FT3
South Bank Polytechnic	B Eng(Hons) and B Eng — option in Building Services Engineering	SW4
	M Eng	SW4⅔
Sunderland Polytechnic	B Eng(Hons) and B Eng	FT3
Thames Polytechnic	B Eng(Hons) and B Eng	FT3
	Engineering (Electrical) and Electronic)	(Dip HE FT2)
Trent Polytechnic, Nottingham	B Eng(Hons) and B Eng	FT3
The Polytechnic of Wales	B Eng(Hons) and B Eng M Eng	SW4

Electronic Engineering

City of Birmingham Polytechnic	B Eng(Hons) and B Eng	SW4
Bolton Institute of HE	B Eng	FT3
Brighton Polytechnic	B Eng(Hons)	FT3
Brighton Polytechnic	BSc(Hons) Microelectronics and Information Processing	SW4
The Polytechnic of Central London	B Eng(Hons) and B Eng	FT3
Gwent College of HE	B Eng Electronic and Instrumentation Systems	SW4
Kingston Polytechnic	B Eng(Hons) and B Eng Electronic systems Engineering	SW4
	M Eng Electronic Systems Engineering	SW4⅓
Lancashire Polytechnic	B Eng(Hons) and B Eng	SW4
Leicester Polytechnic	B Eng(Hons) and B Eng	SW4
Middlesex Polytechnic	B Eng(Hons) and B Eng	FT3 SW4
	M Eng Microelectronic Engineering Design and Production	FT4
The Polytechnic of North London	BSc(Hons) and BSc Electronic and Communications Engineering	FT3
North Staffordshire Polytechnic	B Eng(Hons)	FT3 SW4

Combined Sciences with electronics option

Brighton Polytechnic	BSc(Hons) and BSc Combined Sciences: Science Majors — permitted parings from Biology, Chemistry, Computer Studies, Electronics, Energy Studies, Geography, Mathematics, Physics, Statistics	FT3 SW4
Hatfield Polytechnic	BSc(Hons) and BSc Combined Studies — major or twin mode from Chemistry, Computing, Electronics, Human Biology, Applicable Mathematics, Applied Physics, Psychology, Statistics; twin mode only in Astronomy, Business Operations, Applied Geology, Manufacturing Systems, Philosophy	FT3
Kingston Polytechnic	BSc(Hons) and BSc Applied Science — Bioanalytical Science or Earth Science or Mathematical Modelling Science or Applied Physics with Microelectronics and Computing or Resources Science or Chemistry with Microelectronics and Computing	FT3
Leicester Polytechnic	BSc(Hons) and BSc Combined Studies — two subjects in years 2 and 3 from Accounting*, Biology*, Chemistry*, Computing‡, Electronics*, Law, Marketing, Mathematical Sciences*, Medical Laboratory Sciences*, Physics* (*subject available in FT and SW modes. ‡subject available in SW mode only)	FT3 SW4
North Staffordshire Polytechnic	BSc(Hons) and BSc Combined Science — two from Biology, Ceramics and Mineral Products Technology, Chemistry, Computing, Electronic Instrumentation, Geology, Physics, Statistics and Operational Research Methods	FT3
Oxford Polytechnic	BSc(Hons) and BSc Science — Modular degree in two fields chosen from Biology Catering, Computer Studies, Environmental Biology, Food Science and Nutrition, Geology, Mathematical Studies, Microelectronic Systems, Physical Sciences or one arts field listed in the Arts section, or one double field as listed in the appropriate part of the Science section	FT3
West Glamorgan Institute of Higher Education, Swansea	BTEC HND — option in Computer Aided Design Microelectronics, Optoelectronics	FT2

Electrical and Electronic Engineering

Bolton Institute of HE	BTEC HND	FT2
Coventry (Lanchester) Polytechnic	BTEC HND	FT2 SW3
Derbyshire College of HE	BTEC HND	FT2
Gwent College of HE	BTEC HND	FT2
Huddersfield Polytechnic	BTEC HND	SW3
Leeds Polytechnic	BTEC HND	SW3
Liverpool Polytechnic	BTEC HND	FT2
Manchester Polytechnic	BTEC HND	FT2
Middlesex Polytechnic	BTEC HND Electrical Eng.	FT2
Newcastle upon Tyne Polytechnic	BTEC HND	FT2
North East London Polytechnic	BTEC HND — Electrical Electronic and Telecommunication options	FT2 SW3
North East Wales Institute of HE	BTEC HND	FT2
North Staffordshire Polytechnic	BTEC HND	FT2 SW3
Norwich City College of Further and HE	BTEC HND	SW3

Oldham College of Technology	BTEC HND - Microelectronics or Power options	FT2
Plymouth Polytechnic	BTEC HND	FT2 SW3
Portsmouth Polytechnic	BTEC HND	FT2
Salford College of Technology	BTEC HND	FT2
Sheffield City Polytechnic	BTEC HND	SW3
South Bank Polytechnic	BTEC HND	FT2
Southall College of Technology	BTEC HND — Electronics or Power options	FT2
Sunderland Polytechnic	BTEC HND	SW3
Thames Polytechnic	BTEC HND	FT2
Trent Polytechnic	BTEC HND	FT2
The Polytechnic of Wales	BTEC HND	FT2
Willesden College of Technology	BTEC HND	FT2 SW3

Electronic Engineering

Blackburn College with Lancashire Polytechnic	BTEC HND — (Year 1 at Blackburn, year 2 at Lancashire)	FT2
Cambridgeshire College of Arts and Technology	BTEC HND	FT2
Gwent College of HE	BTEC HND	FT2
Hatfield Polytechnic	BTEC HND	FT2 SW3
Kingston Polytechnic	BTEC HND	FT2
Lancashire Polytechnic	BTEC HND	FT2
Leicester Polytechnic	BTEC HND	SW3
Liverpool Polytechnic	BTEC HND	FT2
Middlesex Polytechnic	BTEC HND	FT2 SW3
North East Wales Institute of HE	BTEC HND	FT2
North Lincolnshire College	BTEC HND	FT2
Sheffield City Polytechnic	BTEC HND Electronic Engineering (Microprocessor Applications)	FT2 SW3
Slough College of Higher Education	BTEC HND	FT2 SW3
South Glamorgan Institute of Higher Education	BTEC HND	FT2
Southampton Institute of Higher Education	BTEC HND	FT2

Electronic and Communications Engineering

Coventry Technical College	BTEC HND (Telecommunications industry)	FT2
Liverpool Polytechnic	BTEC HND	FT2
The Polytechnic of North London	BTEC HND	FT2
Ravensbourne College of Design and Communication	BTEC HND Communications Engineering (Television and Broadcasting)	FT2
South Glamorgan Institute of Higher Education	BTEC HND	FT2
South London College	BTEC HND	FT2

Electronic Engineering and Computing Technology

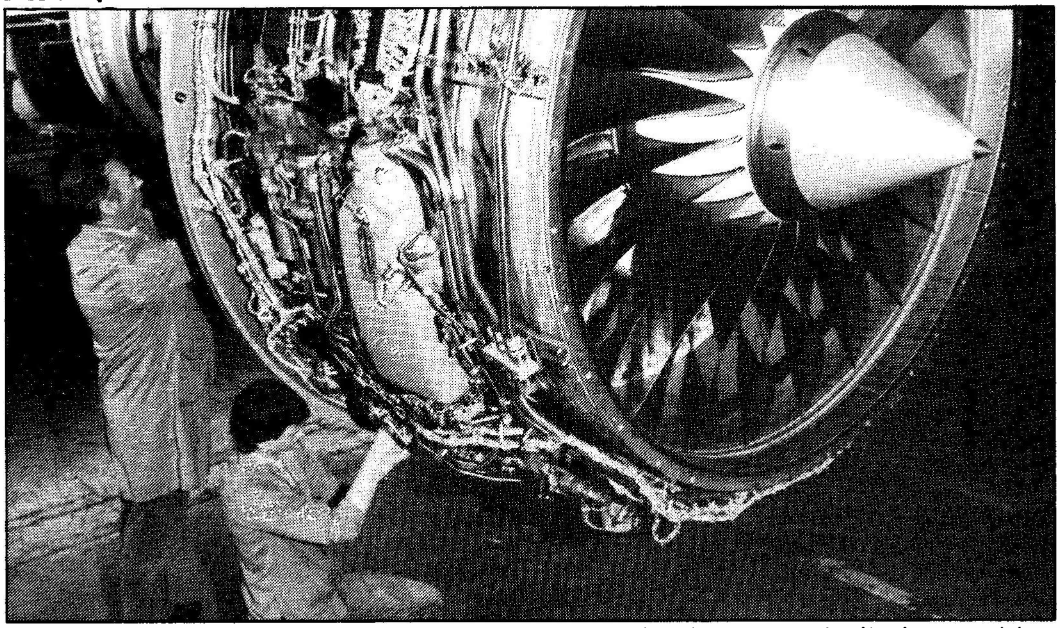
City of Birmingham Polytechnic	BTEC HND	SW3
Brighton College of Technology	BTEC HND	FT2
Doncaster Metropolitan Institute of HE	BTEC HND	FT2
Luton College of Higher Education	BTEC HND Electronics and Computing Technology	FT2
North Staffordshire Polytechnic	BTEC HND Electronics and Computer Technology	FT2

COURSES

Thanks to the London and South-Eastern Regional Advisory Council for Further Education for permission to reproduce the course listings from their publication *A Compendium Of Advanced Courses in Colleges of Further and Higher Education*, price £3.60 from The LSE Regional Advisory Council, Tavistock House South, Tavistock Square, London WC1H 9LR. Tel: 01-388 0027.

ETI

RECRUITMENT IN THE REAL WORLD



The time is ripe for undergraduates to reach for their CVs and SAFs. Six companies in the employment market for electronics graduates display their wares and explain their recruitment methods

CAREERS

In the final year of most degree courses, electronics students discover that the number of timetabled lectures and courses are drastically reduced from the nine to five arrangement of the first two or three years. Often whole afternoons are left free for the students to spend as they wish. Officially the time is allocated to allow research and work on the final year project (which usually runs over the winter and spring terms) but for many students the first few months pass all too quickly and the extra hours are slept away or spent polishing performances on the squash court.

The following term is then filled with concentrated project work coupled with the growing anxiety nurtured by the ever approaching final exams. On top of this the milk-round starts, with companies touring around the country inviting applications and organising interviews through the busy second and third terms.

Completing application forms takes an enormous amount of time and careful thought — first impressions do count and in most cases it is the application form that provides the initial contact between the employers and potential employees. Forms are best completed individually, partly to show enthusiasm and interest but mainly so that each application can be carefully tailored to show experience relevant to that particular company.

The most common complaint from employers (and the most common cause of failure at interview) is lack of preparation on the part of candidates — not only in finding out about the company but in thinking through personal history and its relevance to employers. All this can be tackled during the first term when time can be spent identifying personal strengths and weaknesses, reading up on prospective companies and preparing a draft CV and application form.

Some companies will accept applications at any time — even in the first and second years — although the main problem here is that it is much harder to compare different companies and keep your options open. Accepting a position is not necessarily an irreversible decision but should be treated with rather more caution than say choosing higher education courses where having a couple of back-up possibilities is common practice.

By your final year you should have a fair idea of the type of work that interests you. If you haven't, then most careers services operate some kind of computer career matching which questions your interests and skills to produce a list of possible occuptions. The results are generally very accurate, invariably hold a few surprises and can be very encouraging for people at a loss for ideas.

A qualification in Electrical and/or Electronic Engineering is a valuable commodity. It should be remembered that any degree opens doors to jobs in all sorts of careers completely disassociated from the subject studied. Engineering subjects are also considered to be among the hardest to study so these degrees are even more valuable for general use. Be prepared to be asked why you didn't persue that subject as a career — engineering subjects are also among the most job-specific and branching off can be considering indicative of a bad degree choice or even failure.

The other option open is to continue higher education. Electronics provides a great many subjects for post-graduate research and sponsorship can make life as a Ph.D student more comfortable financially. Post-graduate courses are by no means limited to the college attended for the degree (although the process of application is simplified if you stay put).

To give you some idea of how the electronics industry conducts its recruitment, a selection of employers have provided us with details of their recruitment procedures, their requirements for candidates and their most common causes for complaint. This is not the place to go into an analysis of the interview situation, how to sit, what to where and when to laugh. These techniques can be learnt and should be practised unless you are a natural interviewee — again careers services should help.

Practice and preparation bring confidence and hopefully success in establishing your first choice of career. With forty years ahead to regret your decisions, it is worth climbing out of bed and off the squash court to put in some time and effort to get it right.

AB Electronic Products Group

AB Electronics works in a wide variety of high technology fields, based primarily in South Wales but with subsidiary operations in south-east England and in West Germany, Austria, France and Sweden. It presently employs over 5500 people.

There are various areas of specialisation. AB manufactures components and sub-assemblies for almost every area of the electronics industry and can provide back-up for subcontracting assembly which includes design, development, assembly and testing facilities, sub-contracting work for companies such as IBM and British Telecom.

AB's Automotive Electronics division designs and manufactures vehicle electronics — anything from simple sensors and controls to complete vehicle/driver control systems. Its products are highly regarded in the industry and are used by Jaguar, Mercedes, BMW and Austin Rover among others.

The Microelectronics division has invested heavily in the rise of surface mounted assemblies, keeping the whole company at the forefront of this rapidly expanding technology.

There are also subsidiary companies in cable, satellite, military and aerospace electronics where extreme high quality and reliable operation are essential to meet stringent defence and CAA standards.

AB has recently opened its Technical Centre in Newport where new product ideas and techniques are generated and tested through to the developed stages. The advances achieved in the Centre are then passed to the main AB divisions. This Technology Centre is staffed by a high proportion of graduates.

Recruitment is publicised through ROGET, GET and GO. The company also visits universities and polytechnics during the Spring term, depending on the number and quality of applications already received. AB takes students for work experience and successful placements may lead to permanent posts. There is also a well designed degree sponsorship scheme which includes a bursary and a useful two week induction training before the degree course begins.

Across the company last year, 450 graduate applicants were considered of which 250 were interviewed. The first interviews are informal two way discussions where the general attitude and flexibility of candidates can be assessed. The most common cause for failure at this stage is lack of awareness of how AB operates and what it is looking for. Another common problem is an inability to communicate in a straightforward non-jargon language.

The second interview stage is more formal. Technical matters are examined and more detailed personal assessment is made. AB's priorities here are to determine technical ability, particularly in areas of specialities relating to current operations and upcoming diversification. Communication skills are also important and adaptability is essential.

The number of successful applicants last year was 25 graduates and 5 postgraduates.

Thanks to the concentration of the company's various activities in South Wales, successful applicants receive a wide variety of basic training without the need to move around the country. Training commences with two weeks of induction followed by four to six months on design and development, four to six months in production engineering and control with some time in purchasing or sales. This follows four months in a test/product engineering department moving through a wide range of short term projects.

During this training programme (usually near the beginning) all recruits spend three months off work attending an Engineering Practice course at college if necessary. Further training as required is arranged on an individual basis. The final stage of training is a first appointment under the supervision of an experience engineer, which is usually completed about two years after joining the company.

Contact AB Electronic Products Group PLC, Abercynon, Mountain Ash, Mid Glamorgan CF45 4SF. Tel: (0443) 740331.

Geophysical Service International Ltd

Geophysical Service International Ltd is an oil seismic exploration company operating throughout Europe, Africa and the Middle East.

The company is based in Bedford and was originally part of Texas Instruments Ltd as the European branch of TI's geophysical operation (the original TI was set up to use a new method of seismic study for oil in Texas) but now the company is part of the Halliburton group of companies. Data gathered by GSI or provided by its oil clients is processed in a number of GSI centres — the largest of which in this respect is Bedford which has extensive computer data processing technology.

There is a large graduate population at GSI. Recruitment doesn't take place in the usual annual drive, vacancies are advertised throughout the year and there is a rolling run of interviews. It does take part in the university and polytechnic milk run in the second academic term but welcomes applications to its Bedford headquarters at any time.

After preselection from CVs and application forms interviews take place in Bedford. There are separate interviews, with the technical staff (to establish technical background, capability and so forth) and with the personnel department (to examine interpersonal skills).

A good electronics background is essential for applicants in these fields, preferably with an emphasis on practicality. GSI require candidates with the ability to self-start and to make decisions in the field. Candidates should be confident but not over confident.

Despite this emphasis on individual skills, teamwork is an important quality for employees at GSI. Teams operate in marine data gathering situations as well as in the field so that the ability to operate effectively in an integrated operation is essential.

The majority of electronics graduates taken into Geophysical Service International last year are training as instrument engineers to operate in the field.

For more information contact GSI, Manton Lane, Bedford MK41 7PA. Telephone: (0234) 27011.

Mars
Group of companies in the UK

Mars Group of Companies In The UK

The activities of the Mars Group of companies stretch far beyond the manufacturing of sweets that you can eat between meals without ruining your appetite. Mars Incorporated runs eight businesses in Britain, keeping each as a separate company operating with a high degree of autonomy.

Mars Electronics is based in the Reading area and produces a wide range of 'transactional' electronics (mainly electronic systems for cash payment, coin vending and data retrieval). Products are taken from conception right through design, prototyping and manufacture to an international marketplace.

Mars Confectionery needs little introduction. The UK snack market is worth £11 billion a year and in the chocolate arena Mars has six of the top ten brands. Electrical and electronic engineers are employed mainly in manufacture and development.

Master Foods produces brand foods such as the Dolmio range of Italian pasta and sauces, Yeoman and Tyne Brand. Master Foods has achieved dramatic growth in recent years. Electronic engineers work in R&D, control and production.

Pedigree Petfoods has locations in Melton Mowbray and Peterborough and produces Pedigree Chum, Pal, Whiskas, Kit-e-kat and others. Electrical engineering graduates are involved in control, development and production.

Four Square is based around the Klix range of drinks systems, now the market leader. Operations are international and graduates in electronics are required for design of the microprocessor-driven dispensers, research and other areas.

Graduate recruitment is centralised for the Mars Group in Maidenhead. Specific vacancies are advertised in the national press together with the annual graduate recruitment drive through ROGET and university careers services.

Last year the group received about 4000 milk-round applications. The interview rate at Mars is high and some 1500 interviews took place. These are carefully structured to examine applicants for a broad range of skills, not simply those in which they have been educated. Graduates can and do move between companies in the group so that the ability to adapt and succeed in a variety of environments is essential.

At interview Mars aims to examine a candidate for initiative, decisiveness, planning ability and problem analysis — important skills in both management and research. Equally important are the skills needed to integrate with an open working environment — Mars gives great emphasis to interpersonal skills; the ability to communicate and persuade effectively.

The commonest problem Mars encounters in candidates is lack of preparation. Interviewees are often unaware of the range of qualities required and react badly to unexpected general questions which have not been properly considered beforehand.

From the 1500 graduate interviews conducted for the Mars group last year there were 38 successful applicants, all commencing at salaries not less than £11500.

Once inside the company, graduates are trained for two or three years. This training is both technical and non-technical and will involve several different job functions to give a broad knowledge base to generate both understanding and mobility between different areas of business.

From an early stage, graduates work on a specific project of real and significant impact within the graduate's area of work. A recent example of such a project at Four Square was the design, installation and commissioning of a control system for a new coffee-grinding plant for Klix. Projects may be tackled in a group or alone but either way regular individual reviews are held to assess progress and plan training for the future.

Graduate recruitment is flexible and engineers are welcome in commercial as well as technical functions.

Contact Mars Graduate Recruitment Manager, Shoppenhangers House, Shoppenhangers Road, Maidenhead, Berkshire SL6 2PX. Tel: (0628) 39211.

NE

NE Technology Ltd

While career hunting among the giants of the electronics and engineering industries, it should be remembered that there are a large number of smaller companies offering graduate opportunities that in many respects cannot be matched by multinationals. Many people find the politics and attitude of large company operations a stifling and daunting atmosphere in which to work and prefer the more friendly attitudes that can be achieved in a smaller company.

NE Technology Ltd is a new company formed following a management buyout of Nuclear Enterprises. The company designs, develops and manufactures instruments involved in the measurement of radiation, primarily for use in the nuclear industry at Sellafield and similar locations and also equipment for medical radiotherapy under contract from the NHS.

NE employs 200 people and is based in Beenham in Reading. It operates four project teams developing its radiation equipment. Vacancies are advertised through the Current Vacancies listings from Central Services and require attributes specific to the posts available. One of the positions available at present for instance is for a software engineer familiar with C and MSDOS for 6800s together with a working knowledge of IBM PCs. Such specific criteria are rare within the sphere of general applications and if your personal skills and interests match a smaller company's requirements then a successful career can be established very quickly.

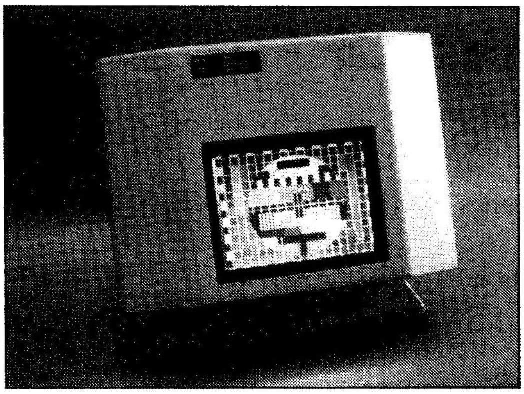
NE expects to receive between thirty and forty applications for each post and reduces these through a preselection procedure based on relevant experience and qualifications to around six interview candidates. These are invited to Reading for a 2-stage interview process. A personnel interview is followed by a meeting with the head of department and project team to which the candidate is applying.

Although the quality of candidates by the time interviews are reached is high, the most common failing is the inability of applicants to apply their academic knowledge to practical problems and that subjects studied as part of a degree course are understood only in theoretical terms. Applicants are also often unable to effectively express themselves to demonstrate their particular abilities. This second failing is probably caused by ineffective preparation and inexperience in the interview situation.

Successful candidates at NE Technology Ltd are allocated to the relevant project team and undergo a training program that involves an initial induction in the various operations of NE (finance, marketing, production and so forth) to familiarise the entrant with the operation of the company as a whole.

For further information contact NE Technology Ltd., Bath Road, Beenham, Reading, Berks RG7 5PR. Tel: (0734) 712121.

Philips UK



The entire Philips organisation employs over 340000 people worldwide. Over 20000 of these are based in the UK. The Dutch base of Philips has resulted in the company profits suffering from the weakness of the dollar in the last two years. Semiconductor operations were also hit by the slump of 1984 and 1985. Despite these adverse conditions Philips last year achieved a 7% increase in sales and is highly active in the graduate recruitment arena, last year accepting 150 graduates to UK posts.

A certain amount of recruitment also takes place for graduates transferring directly to the Philips bases in the Netherlands, either immediately or after training in the UK.

Graduate recruitment in the UK is centrally organised at Redhill and an annual vacancy booklet is produced entitled 'Graduate Opportunities with Philips' which details all positions available to UK graduates over the following twelve months. The 1989 edition is due for publication in November and is distributed to all universities and polytechnics. It is also available from the address below.

The detail of this booklet ensures that graduates apply for a specific position within the company rather to the group as a whole. Applications are initially examined by the centralised recruitment base — they dealt with 1500 applications during the 1988 milk-round (to April). Candidates with suitable experience are invited either for primary interview there or are referred directly to the section involved.

The milk-round tour of colleges from January to Easter is often the venue for the centralised preliminary interviews and the majority of those interviewed were referred for secondary interviews, which take place in the separate sections of Philips. These in-depth interviews consist of two stages — an initial panel interview relating to echnical ability and experience followed by a personal intereview to determine communication skills, the aptitude to learn and the candidate's personal strengths and weaknesses. The ratio of second interviews to successful candidates is around the industry norm — about 4:1.

As candidates have applied for specific vacancies it is expected that they will possess some relevant experience to that position either as academic knowledge or practical work experience in the industry (or even both). For successful candidates each job has specific training to augment that experience with internal training facilities recognised by most professional institutions as providing the basis for gualifications further to degree awards where appropriate.

For further information contact Philips Electronics Graduate Recruitment Office, Cross Oak Lane, Redhill, Surrey RH1 5HA. Tel: (0293) 785544.

PHILIPS

Rolls-Royce plc

Rolls-Royce plc needs little introduction. The company has 42,000 employees working at sites in Derby, Bristol, Glasgow, Leavesden (near Watford), Ansty, Coventry and at a number of overseas subsidiaries.

Rolls-Royce is amongst the world leaders in the design, development and manufacture of gas turbine engines, Their engines power airlines, executive jets, fighter aircraft, helicopters, ships and power stations all around the world.

The search for graduate begins early with substantial school liaison to increase young people's awareness of engineering in general and of the variety of training programmes offered by the Company. The actual graduate intake is advertised through the normal recruitment literature (GO, GET, DOG, ROGET and so on) and through autumn visits to universities and polytechnics where students are able to talk informally about the company and the possibilities it offers.

Candidates that are shown by their applications to have the requisite qualifications are usually interviewed on the University and polytechnic milk-round. If successful at this stage they will be invited to attend a Company selection day — Candidates are interviewed by personnel and technical specialists so that their aptitudes and aspirations can be explored in detail.

The important qualities applicants should show at interview are analytical ability, communication skills, enthusiasm and drive. The most common cause for complaint among interviewers is that candidates are inadequately prepared — not only in their knowledge of the work and products of Rolls-Royce plc but in their own attributes and experience.

All engineering graduates undertake a training period of one or two years which includes periods of drawing instruction and workshop training. This is followed by a 'design-and-make' project. Thereafter attachments are arranged in a variety of departments designed to give the graduate a broad understanding of engineering at Rolls-Royce. Those who do wish to specialise in electronics are able to do so. The last of these moves is usually to the area where trainees will take up their first permanent position.

Rolls-Royce is strong on leisure activities and provides sports and social clubs which are extensively used by its many young graduate employees. Graduates entering the company as engineers can expect to start on £9,500.

ETI

ROLLS ROYCE

COMPETITION RESULTS

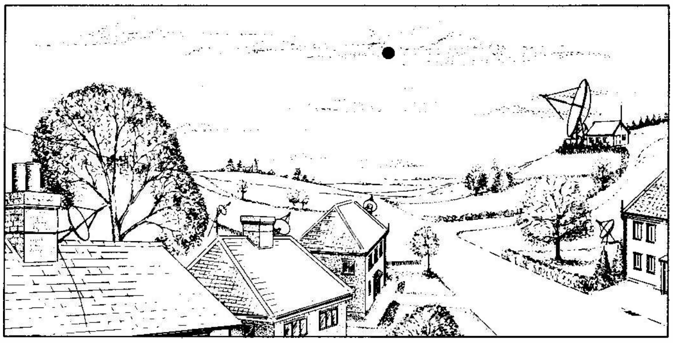
REACH FOR THE SKY

The reach for the sky competition in the June and July issues brought in a flood of entries from readers avid to win the £1300 satellite TV system. The judges' decision on the order of importance of the features listed was:

1. Unobstructed southerly views
2. Receiver bandwidth
3. Baseband output
4. Single button channel selection
5. Receiver remote control
6. Parental channel lock
7. Receiver styling

The position of the low flying satellite in the part II spot-the-satellite competition is shown below and the lucky winner drawn out of the ETI stetson was: Mr P Burrows of Colliers Wood in London.

Mr Burrows will soon be adorning his garden with a Pace SR640 satellite receiver, Vivor 90cm dish and assorted other bits and pieces to make him the envy of his neighbourhood.



DEGREES OF FREEDOM

The competition in the July issue to win one of six Maplin maximum/minimum thermometers also attracted a record number of entries. The vast majority of readers had little difficulty deciphering the cryptic temperature descriptions. The answers were:

The body in question	body temperature	98.4°C
Bradbury's burning books	the book 'Fahrenheit 451'	451°F
60% tin 40% lead	melting point of solder	188°C
Downright	absolute zero	−273°C
The old ice	melting point of water	32°F
Gas mark 5	according to the Assistant Editor's Mum's cookbook	193°C

The six lucky winners, first out of the Editor's boot, were:

Mr T K Parkinson of Hartlepool
Mr S Hall of Aberdeen
Mr J R Gray of Manchester
Mr R P Willis of Northampton
Mr C Carey of Folkestone
Sgt Menzies in Gilbraltar

Our thanks to all who entered, congratulations to the winners and commiserations to the not-so-lucky-this- time.

GOING IT ALONE

BUSINESS

Les Sage talks about Sage Audio — how it expanded out of the bedroom into a 3000 sq ft factory — and gives some insights into starting your own business

The thought of starting your own business runs through the minds of many people. It has been a dream of mine ever since my school days. In the last few years it has become virtually a fashion to be your own boss with help available from the government, banks and various small firms organisations. Whether you will be successful or not is entirely up to you — probably the best incentive of all!

The business of electronics is quite different to other general businesses such as shopkeepers, hairdressers, builders and plumbers which make up over 40% of new small firms. Electronics covers such a wide area of disciplines that it is essential to know exactly which area you want to concentrate on.

Your Potential

Right from the start you must have a clear personal objective. Only then will it be possible to direct a company in such a manner as to realise these objectives. Those who simply have a vague feeling that it would be a good idea to start up on their own or have visions of an easy life ahead and plenty of money would be well advised to abandon the idea from the beginning.

It is not my intention to repeat all the information easily available elsewhere but to concentrate on how I personally made the decision and decided to establish Sage Audio, and to eventually build the company into a stable and successful position as a market leader.

Background

Your background is important to the success of your business. Your business will almost certainly be based on past experiences in one particular field, whether this is audio, radio, computing, design and development or whatever.

I have always at heart been interested in audio sound reproduction from the mid 1960s when I bought a pair of Sinclair Z12 germanium 12W power amplifiers and was suitably impressed by their sound quality.

Prior to setting up Sage Audio, I worked for 12 years for Thorn EMI Ferguson in Essex in the development department designing hi-fi equipment. There I learnt a great deal both technically and in experience and studied for various qualifications.

I have always had a flair for inventiveness and achievement and this was the major influence in the success of Sage Audio. Many new and innovative ideas were born while I was employed by Thorn, including the constant Vce, constant current distortionless amplification block which was to form the heart of all Sage Audio products.

In 1981 I moved to Bradford and worked for Bradford Engineering Centre — a large research and development laboratory. Here, Sage Audio was finally born. At BEC I was engaged in developing a wide range of products from stereo TV to switch mode power supplies to high frequency video circuits. The experience gained from some of the country's top research engineers combined with my previous audio knowledge and a few short courses on business study armed me with all the tools necessary to 'go it alone'.

My first step into business, and a step I would advise anyone to take, was to start up while still employed. I started by selling high quality components both for the audio market and the power industry. This also involved selecting and grading power components to very tight specifications.

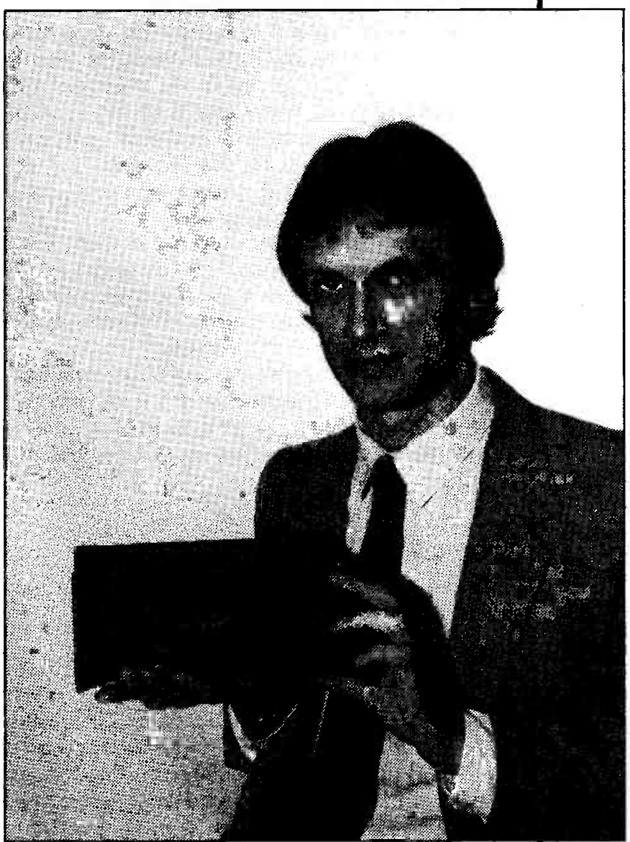
At this time I had been researching for around 18 months into very high speed video amplifiers and SMPS circuitry. I soon realised that in video high performance *means* high performance and anything with a slew rate of less than 500V/µs is laughed at.

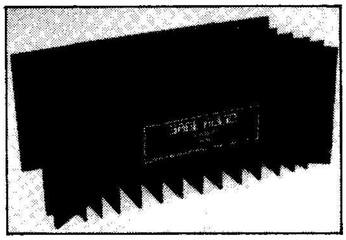
Using my graded components and some novel techniques I managed to build an amplifier with a staggering performance specification of over 9000V/µs, a 3dB power bandwidth of DC to 200MHz at 50V output and a risetime of 1.7ns.

This was for use on a 64kHz line rate high performance VDU monitor. Through my incessant urge for achievement (or possibly just out of curiosity), I often wondered what this high slew rate amplifier would actually sound like if connected to a loudspeaker.

Since MOSFETs were still in their infancy, as output devices I used a couple of T9064 high frequency transistors which use a very special multi-emitter fingered structure and was truly amazed at the clarity and openness of the sound. I was clearly hooked on high slew rate amplification and from then on any other audio amplifier sounded lifeless in comparison.

I decided to design a good audio power amplifier with a high specification based on the video techniques I had pioneered. In 1984, BEC decided to move to London and this finally gave me the incentive to leave full time employment and to really go it alone.





Within one week I had formulated a rough business plan, sought advice from my solicitor and bank and finally made up my mind.

Product Development

Most ETI readers nowadays firmly associate me with high quality, high specification power amplifiers. However, in 1984 these were still just a dream. I planned right from the start that if a business is to succeed, it must be in manufacturing and not just component distribution. After all we cannot all be shopkeepers or there would be no customers!

A short college course (or three!) on business studies helped me on my way, firmly implanting the notion that a country's wealth is based on its manufacturing capabilities and not just selling imported goods.

To develop a new and highly innovative product such as the Superamp in a professional manner would take at least a year and a great deal of money. As bank loans are difficult to come by for new businesses (usually requiring three year's trading first) I started Sage Audio in 1984 as an electronics consultancy business to build up the required cash to launch the main business of audio power amplifiers. During this time I could do as much market research as I liked.

Market Research

It cannot be stressed enough how important market research is to a product's success. Information gathered will enable you either to indentify an existing market or to accurately estimate whether or not a market could be created.

One market which stood out like a sore thumb to me was the need for good quality audio modules at realistic prices. Market research showed that in the past ten years British hi-fi had flourished in the specialist hi-fi shops overshadowing imported units on the simple basis of good sound quality — names such as Krell, Musical Fidelity, Quad and Naim. Even today much of this equipment remains expensive for the average enthusiast who is left to buy a foreign midi stack system with his limited budget.

My market research revealed a large gap in the market for hi-fi quality power amplifiers. Manufacturers come and go but none offer real hi-fi performance by today's standards. Such names as ILP, Crimson, BK and so forth have filled the gap at the lower end of the market (for discos and the like) with cost effective modules of average technical performance using standard components.

However, the British hi-fi scene has made leaps and bounds in performance in the last ten years and there was a clear requirement for a top quality module at a realistic price to match today's hi-fi systems and to compete with all the big names.

The whole concept of the Sage Audio modular hi-fi is its flexibility, ease of construction and low cost enabling a custom hi-fi system to be built equal to or better than esoteric (and expensive!) units from the big names in hi-fi.

Question Time

How did you raise the finance to launch your new power amplifiers?

I knew I had the product but not the cash to develop it. The Superamp/MOS range of power amplifiers we see today use very advanced circuitry and components including the latest surface mount devices and matched semi-conductors throughout. The cost of introducing SMD technology and the need for special output devices was prohibitive.

Nevertheless I went ahead. I invested £8000 of my own money and a £2000 government grant and took no wage from the business for a year.

During this period I could not easily get a bank loan. I had to earn extra cash to cover the R&D costs.

A stroke of luck came my way in the shape of a US company which I had contact with during my early days as a design consultant. The commission was to design a audio duplex chip for use in some telecommunications equipment. To cut a long story short, the circuitry was designed in just six weeks, the chip mask designed in the US and manufactured in the Far East.

The design was a single chip which encompassed a microphone amplifier, automatic level control, patented duplex control circuitry and an audio output stage. A full 2-wire feedback-free no hands communications system could then be built.

This chip design has been exclusively licensed to them for four years but by January 1989 will be on sale worldwide.

Could a future ETI project be based around this chip of yours?

Yes, certainly. I plan to produce such a project early in 1989 especially for ETI.

This chip helped raise the finance to fully develop the Super series power amplifiers you see today.

At what stage did you acquire premises?

Most of the early development work was done at home in a bedroom converted to a laboratory and then later moved to the garage. At this time I was doing all the work on my own. However, by late 1985 I managed to acquire premises in Bingley close to the famous Ilkley Moors. These were required for production of the newly designed Superamp.

I started by subcontracting most of the building and assembly work out to private firms. I also took on a part time secretary and part time assistant.

Money was tight despite the royalties received from the duplex chip but more design work for various companies came in, including work for an SMPS which really helped in those days.

What about the MOSFET amplifiers — How did they evolve?

Despite the fact we claim our bipolar Superamp module can outperform all other MOSFET modules, market research (and our customers) showed us the hi-fi market was really for MOSFETs (especially for digital audio equipment). Unfortunately at that time the only MOSFETs around were the H-pack types used by most other manufacturers which could not meet our stringent specification requirements.

You see, we wanted to achieve virtually zero distortion of any kind which required extremely accurately matched MOSFETs. The design goal for the SuperMOS was 250V/μs and 0.0001% distortion, although this finally ended up as 0.0002%. To achieve this specification, we managed to find a company to build a special MOSFET to our specifications with tight tolerances on certain parameters.

This was necessary as the SuperMOS amplifier uses class A output circuitry and hardly any feedback at all hence the need for special output devices designed for active class A use. These cost us an arm and a leg each and had to be purchased at a minimum of 5000 pairs per year. This took most of the profits from the Superamp project. From then on the original SuperMOS took off and this has been our steady bread and butter ever since.

What is your main market for these modules and are these markets those you anticipated?

The majority of our customers are hi-fi enthusiasts and hobbyists both in this country and abroad. In fact 60% of our trade is abroad and we have sold to just about every country, although the majority of export orders are from Denmark, Sweden, Australia, Hong Kong and (of all places) Japan.

Superamp modules have been sold to schools and Universities, science institutions, physics laboratories, TV and radio stations, banks and even 20 or so SuperMOS modules for use as ultra low distortion power supplies in the Sahara Desert!

Many of the orders, particularly in the last year, have come from sources undreamed of — hotels, PA contract companies, the army and the motor trade.

Export particularly caused us to increase our staff in 1986/7 to four full time and three part time. We also required telex and later fax machines to improve our trading position worldwide.

What about the SuperMOS MkII — what made you develop such an amplifier in the light of the success of the original SuperMOS module?

Actually, this came about due to some inaccurate earlier market research. We assumed the SuperMOS I rated at 150W in class A mode would be sufficient for domestic hi-fi systems. This is not so. With modern loudspeakers, the days of 100W hi-fi are long gone. All the big names in hi-fi now produce 250W top of the range systems. People kept asking us if it was possible to obtain more power from the modules.

We decided that to remain the number one power amplifier manufacturer we had to develop a MkII version with an output capacity to cover the range 100-500W still in pure class A mode.

This was a tall order but we achieved it and in the process added six other sound improvements. This module was designed to compete directly with the biggest and best power amplifiers available from Japan and the US such as Krell, Musical Fidelity, Citation and the like, but at a reasonable price compared to these ready built units.

Has the SuperMOS MkII been as successful as the MKI?

The SuperMOS II with its higher power capacity has appealed to a much larger market and its phenomenal success has caught us with our pants down. Since its launch in February this year, sales have now outstripped all other modules.

We have now had to move to larger premises in Bradford and have acquired a 3000sq ft factory for production of this and all other units. We do not subcontract out any work now. It is all done in house. This has meant a further increase in staff to eight full time and two part time.

There has been some delay in fulfilling orders in the wake of this massive increase in sales and move of premises but all our customers have been patient and understanding. I'd like to take this opportunity to thank them.

Have the banks been helpful to you when you expanded?

As it happens, we have not had to take a bank loan as yet. We have consistantly piled all profits back into the business, making it as financially sound as possible before we ask for a loan.

Now you have expanded, what are the plans for the future of Sage Audio — or are these secret?

Not at all. There have been many changes within the company over the last few months. The expansion has caused us to flex our muscles a little more. We have gained some loudspeaker cabinet manufacturing capacity and hope to introduce a range of loudspeakers, mainly for export, by spring 1989.

Sage Audio, as it was, does not now exist. For tax reasons, we have split the business into three companies. Sage Audio will continue the main activities of amplification modules. Sage Hi-fi will concentrate on loudspeaker manufacture. Sage Electronics is a pure research company developing new products and ideas, not necessarily relating to audio — such as SMPS.

With fingers in so many pies, we hope to remain a stable company with a steady growth rate.

Will the speakers continue the Sage tradition and be sold in kit form?

No, loudspeakers will be ready built but will offer the option of 'bi-amping' with a compartment to house the electronics. They will be called the 'Seven Sages'.

Will there be a SuperMOS MkIII?

Definitely not. We have gone as far down the high performance amplifier road as we can. We have had no competition for the SuperMOS I modules in three years and do not expect anyone to compete on the SuperMOS II for a long time to come.

To be launched in January 1989 will be a range of three very high powered modules called the power series. These are 500W, 1000W and 1500W class AB power amplifier modules with a performance specification similar to the SuperMOS I modules. They will not be integral like the Super series but will have a plate construction with only the driver circuitry encapsulated and separate output MOSFETs with a bolt-on heatsink. This gives them the advantage of repairability. These too use specially built output devices and these are aimed at the professional market to whom we currently sell the SuperMOS II.

Also to be released at the same time is a matching pre-amplifier for the Super series modules.

You mentioned tax earlier. Can you give advice to readers on tackling this problem and where they should go to seek advice on starting up a business.

Tax is a frightening subject to most people as it is very complicated and few ordinary people understand anything about it.

I found my local tax office to be very friendly, helpful and patient while I learnt about the subject and sorted out their questions. You don't receive a tax demand for at least 18 months from first trading so it is not a worry at the start.

For general advice on running the business I found the 'Small Firms' centres very useful, friendly and helpful, particularly the Small Firms centre in Leeds City Square. They have given me much free advice and guidance on a number of points — premises, law, finance, export and so on.

If you do decide to go it alone, have clear business objectives and make sure you have done your market research. Ensure you have at the very least £1000 spare 'gambling' money to invest in the business. Be prepared to work long hours for apparently little or no rewards at first. Be willing to learn and ensure your spouse is understanding and behind you all the way. Good luck!

OP-AMPS

Paul Chappell maintains the balance between noise and signal by rejecting the common mode

So far in this series I have only looked at the way in which the op-amp itself can influence circuit performance (and there's still a lot of ground to cover yet!). This month I'd like to take a break from that aspect of things and take an initial look at another — why one circuit configuration may be preferable to others in a given application when all apparently do the same job.

It's a theme that will crop up frequently as we see more varied and complicated circuits, but for this month I'll kick off with something fairly simple: differential amplifiers.

All the circuits considered so far have expected to see an input with respect to some fixed voltage in the circuit — usually the 0V line. If the input is said to be at 1V it implicitly means 1V with respect to the reference voltage.

It can sometimes happen that a signal to be processed will be in the form of a difference between two voltages, both of which may vary. Sometimes they may vary symmetrically about some voltage, possibly 0V. In other circumstances they will not. Circuits which respond to the difference between two voltages are known variously as subtractors, differential amplifiers or instrumentation amplifiers (although the latter term also carries connotations of high performance).

I will refer to them all impartially as differential amplifiers.

Differential signals can occur in all kinds of situations. When a low level signal has to travel some distance by cable, for example, it is often advantageous to send it as a 'balanced' signal along two wires. The idea is that any radiated noise will affect both wires identically, since they run in close proximity as part of the same cable. As long as the impedances at either end of one cable match those at the corresponding ends of the other, the interference should result in a pure common mode signal at the receiving end. That is to say, both wires will rise and fall in voltage identically, so an amplifier which responds to the *difference* in voltage will see no noise at all. It can be very effective in practice.

Sometimes it is possible to cancel out certain imperfections in a circuit by driving two identical signal paths in 'opposite directions' or by causing an imbalance in two normally identical voltages or currents. Two types of circuit that frequently use this technique are analogue multipliers and digital to analogue converters.

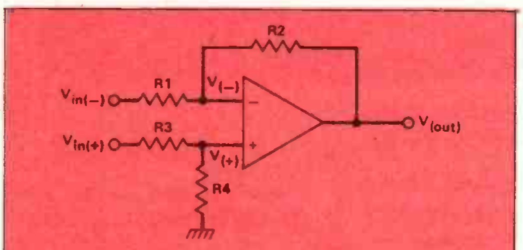


Fig. 1 The differential amplifier

In theory you can obtain all the information you want by detecting deviations of just one of the outputs from its mean value but using both outputs allows the effects of temperature drift and some circuit non-linearities to be cancelled out.

A whole class of circuits which generate differential signals are bridge networks, which occur in all kinds of guises. Yet again, medical equipment which detects voltages generated by some function of the body will frequently be arranged to respond to a voltage difference to obtain the benefits of noise cancellation. The list is endless.

One desirable feature of differential amplifiers highlighted by all these applications is that it should respond to the difference in voltage between its inputs while ignoring any voltages common to both. This property is known as common mode rejection and the basic figure of merit for any differential amplifier is its common mode rejection ratio or CMRR. This is simply the amplification it gives to differential signals divided by the amplification (hopefully much less than 1) of common mode signals.

A simple differential amplifier is shown in Fig. 1. The condition for a common mode input to leave the output unchanged is: $\frac{R1}{R2} = \frac{R3}{R4}$ and an easy way to achieve this is to make R1 = R3 and R2 = R4.

Scissors

The best description I can think of for the way the circuit works is that it's like a pair of scissors. Let me explain. If the table-top in Fig. 2a represents 0V, the action of R3 and R4 is like one half of a pair of scissors with the tip of the blade resting on the table. The input voltage $v_{in(+)}$ is represented by the height of the handle above the table and the point where the other blade will be joined represents $v_{(+)}$, the voltage at the + terminal of the op-amp.

The action of the op-amp is to adjust its output voltage so that the + and − terminals remain at the same voltage, so the second blade is joined at the $v_{(+)}$ point which now represents both $v_{(+)}$ and $v_{(-)}$.

Now suppose that $v_{in(+)} = v_{(-)}$. This is equivalent to having the two scissor halves closed. (These are special scissors in which both the blades and handles lie side by side when closed. They can also open in either direction!) The effect of a common mode voltage is simply to move the scissors about the blade tips, always in the closed position (Fig. 2b).

Apply a differential voltage (open the handles) and the blades will open, with the tip of the R2 blade representing the output voltage (Fig. 2c). Now apply a common mode voltage again (move the handles, keeping the *vertical* distance apart the same) and the output voltage (the height of the R2 blade tip above the table) will remain unchanged — the common mode signal is once again rejected (Fig. 2d.)

Suppose that one of the resistor values is changed. Let's say the value of R2 is increased, as in Fig. 2e. If a common mode signal is now applied, even with the two inputs at the same voltage, the output will vary. The common mode signal is no longer rejected.

If you find the scissor analogy helpful, you can extend it to cover any resistor values. Figure 2f represents the situation where the ratio of R1:R2 is the same as the ratio R3:R4, but R1 ≠ R3 and R2 ≠ R4, which is the general condition for the common mode signal to be rejected. With a little thought you'll see that the tip of the R2 blade will remain on the table (the output will be at 0V) as long as the two handles are at the same height. If you . . . but I can hear the yawns of those who don't care for mechanical analogies, so I'll have to leave you to work out the details for yourself.

Sooner or later we're going to have to come up with a formula for the output of the circuit in terms of the inputs. There's a hard way and an easy way to go about it.

Looking at Fig. 1 again, the output voltage can be calculated by equating the currents through R1 and R2 as we did for the basic shunt feedback circuit way back in June. This gives:

$$\frac{v_{out} - v_{(-)}}{R2} = \frac{v_{(-)} - v_{in(-)}}{R1}$$

Now, we don't want the $v_{(-)}$ in the equation since we don't know (or care very much) what its value is. In the shunt feedback circuit we recognised that $v_{(-)}$ would remain as near as dammit at 0V and so set it to zero. In this circuit it will once again be at the same voltage as $v_{(+)}$, which will be at some voltage set by $v_{in(+)}$, R3 and R4. To be exact, it will be at $v_{in(+)} \times \frac{R4}{R3+R4}$. If you substitute this value for $v_{in(-)}$ in the first equation, then rearrange it to give v_{out} = (something) $v_{in(+)}$ + (something else) $v_{in(-)}$, the job is done. If you reckon I'm going to do it, you can think again! This is the hard way.

What you end up with, in fact, after half a page of algebra is:

$$v_{out} = v_{in(+)}\left(\frac{R4}{R3+R4}\right)\left(\frac{R2+R1}{R1}\right) - v_{in(-)}\frac{R2}{R1}$$

I don't know about you but I don't find that formula very convincing. After all, it's easy to make a mistake, to get a sign wrong, to transcribe a resistor subscript incorrectly or whatever, in half a page of calculations. And it's not immediately obvious from inspection of the circuit whether the formula is correct or not.

Here's the easy way to derive the formula and to see how it works. By superposition, the output arising from both inputs acting together will be the sum of the outputs from each acting on its own. If we let $v_{in(+)}$ be the active input, then mentally rearrange the circuit as Fig. 3a, it becomes a series feedback amplifier having a gain of $\frac{R2+R1}{R1}$ from the + input of the op-amp. The input signal $v_{in(+)}$ is 'potted down' by R3 and R4 by a factor of $\frac{R4}{R3+R4}$ before being amplified, so the total contribution to the output is:

$$v_{in(+)}\left(\frac{R4}{R3+R4}\right)\left(\frac{R2+R1}{R1}\right)$$

Now it's the turn of the $v_{in(-)}$ input. This time the circuit reduces to Fig.3b, and the contribution made by this input we can write down immediately as: $-v_{in(-)}$ R2/R1.

So the output due to both inputs will be:

$$v_{out} = v_{in(+)}\left(\frac{R4}{R3+R4}\right)\left(\frac{R2+R1}{R1}\right) - v_{in(-)}\frac{R2}{R1}$$

This time, I know what each term means and feel a lot more confidence in the formula. I hope you do too!

If we now apply the condition for the common mode signals to cancel, the cumbersome formula reduces to a much simpler one:

$v_{out} = k\,(v_{in(+)} - v_{in(-)})$, where k is the ratio R2/R1 and (since they have to be equal) also the ratio R4/R3. If all the resistors are made equal in value, the result is simpler still: $v_{out} = v_{in(+)} - v_{in(-)}$. The circuit will then just generate a signal with respect to ground equal to the difference between the two inputs. Any common mode signal will not affect the output at all.

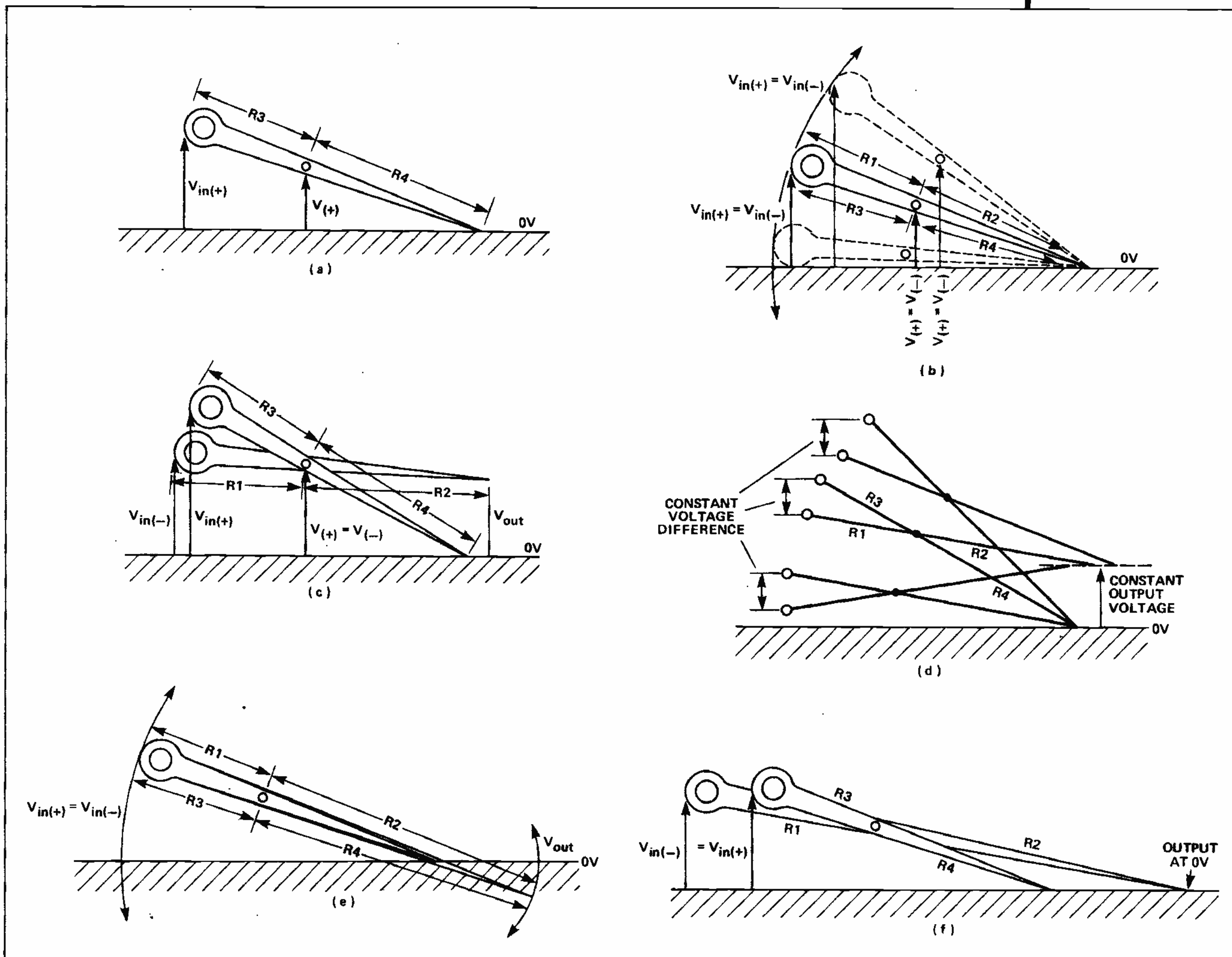


Fig. 2 The scissor analogy

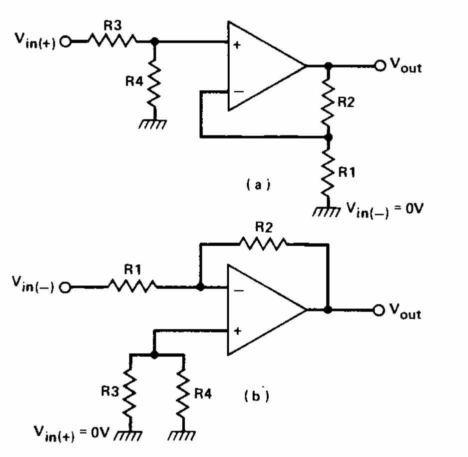


Fig. 3 Deriving the formula the easy way

To get some gain out of the circuit, all that's required is to make the value of k equal to the gain required by adjusting the resistor ratios. For a gain of 10, for instance, R2 would be 10×R1 and R4 would be 10×R3.

It might seem that we've already found a differential amp that has perfect common mode rejection and can amplify the signal by any amount. Why look any further? The answer is that sooner or later we have to leave the let's-pretend world of theory where if you want resistors to be equal in value all you have to do is to say they are. Trying to build the thing with real components is not so easy.

The first shock comes when you try to calculate just how closely matched the resistors must be to give a respectable common mode rejection. If the resistor ratios are unbalanced by 1%, for instance, the CMR is reduced from perfection to a mere 49dB. An imbalance of 0.1% will give 66dB rejection, which is certainly good enough for many purposes but not up to the 100+dB that is normally expected of an instrumentation amplifier. The figures are for the unity gain version of the circuit, by the way.

The situation is further complicated by the fact that the output resistances of the drive circuit appear in series with R1 and R3. If the drive circuit is floating with respect to the differential amp, the effect is to produce a gain error, which may not be a serious matter. If the drive circuit shares a common supply or ground line with the differential amp, the output resistances must be perfectly matched to avoid degrading the CMR.

Yet another point to be considered is the input resistance of the circuit. The resistance seen at $v_{in(+)}$ is always R3+R4, but at $v_{in(-)}$ the input resistance will depend on what's happening at $v_{in(+)}$! A common mode signal will see an input resistance of R1+R2 but to a differential signal it will be $R1(k+1)/(k+2)$, where k is the gain of the circuit. If the input resistances are balanced for common mode signals (as they must be if these are to be effectively rejected) then the differential drive circuit will be seeing different input resistances at the two terminals, which may cause problems of its own.

To sum up, you might consider this circuit when:

- It is not essential to achieve a very high CMRR.
- It is not important to be able to trim the gain and CMR independently.
- The output resistances of the drivers are equal and very small in comparison to R1 and R3.

For more demanding applications you will need a better circuit. Since I've spent longer than I intended on this one, the high performance versions will be along next month.

GERRADA MARWEH BIKEBELL

Fed up with peds in your path? Road hogs clogging up the roundabouts? Build Keith Brindley's electronic bikebell and make 'em jump

To classify this project as a push-bike bell is something of a misnomer, really. It certainly doesn't ring (or even sound like a bell!) and it has no moving parts, either. Nevertheless, it'll help you to be noticed as you pedal along and that's all a conventional bike bell is meant to do.

Apart from not sounding like a bell, the Gerrada Marweh is significantly louder that any mechanical counterpart fitted to your handlebars can ever be.

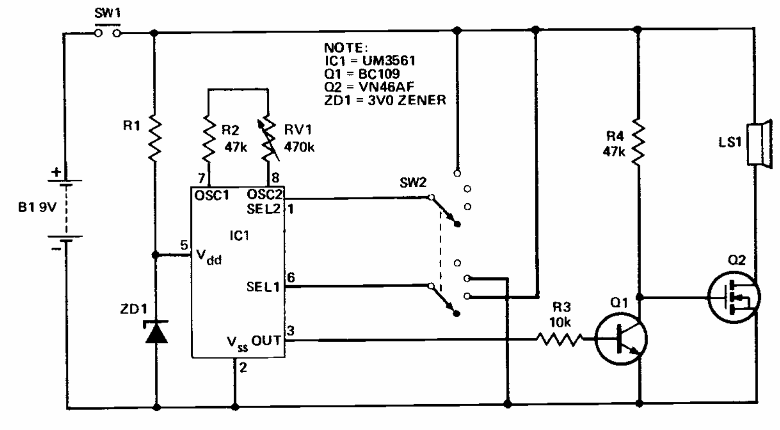


Fig. 1 The circuit diagram of the bikebell

It's based around the UM3561 siren sound generator IC, which allows selectable siren sounds and effects to be produced — namely police, ambulance and fire engine sirens and a laser gun-type effect. The output of the UM3561 is only just sufficient to drive a piezo sounder, though, which wouldn't create enough volume to scare off a fly, so the output's beefed up a little with a VMOS FET device.

The UM3561 is an LSI device (see *How It Works*) which is meant for use in toys and models as a simple-to-use and low-cost tone generator. Readers may have heard toys and models using this chip.

Power

The Gerrada Marweh is nothing if not power greedy. The circuit itself, in this form, will run from around 4V through to 14V so it is possible to run it from dry-cell batteries or even a car battery. Readers must bear in mind, however, that the circuit positively devours current — it *must* do to be able to produce this much volume for such a low voltage.

At 14V for example, around 600mA must be provided. At 9V around 400mA is required. The point

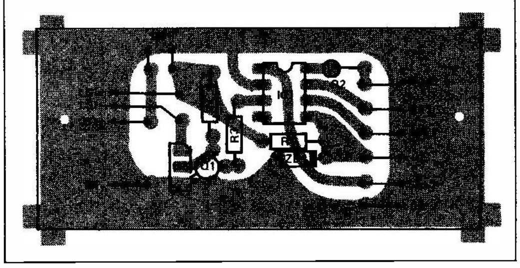
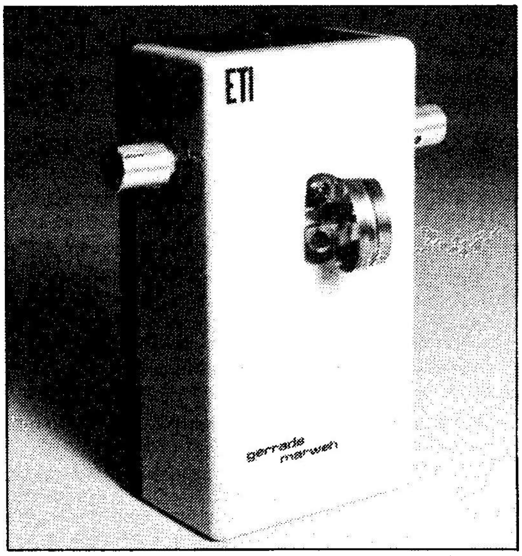


Fig. 2 The PCB component overlay



we're making is that ordinary dry-cells, which have quite a large internal resistance, won't be able to supply the power demanded. At the very least, the circuit will need an alkaline battery and a PP3-sized battery will give excellent results.

Readers may wish to go to the expense of a rechargeable NiCd battery. Incidentally, next month's *1st Class* project is a NiCd recharger which will be capable of recharging your precious PP3-sized rechargeable battery. (Do we spoon feed you, or do we spoon feed you?)

Construction

In this project design size was a major criterion. We wanted the project to be as small as possible (small enough to fit to a bike's handlebars) without sacrificing too much volume. The result is a fairly compact project which does need a little care in construction. By and large, development depends on the case you choose to house the project and if you use a different one to the case we used for our prototype, you'll have to adapt.

Start with the bare PCB or stripboard. Carefully saw, cut, file it to shape and make sure it fits into the case and can be bolted down. Next, mount and solder all passive components, that is, the resistors, capacitors, PCB pins, following the component layout shown in Fig. 2 or 3. If you use PCB pins for off-board connections (recommended!) you can leave the battery, speaker, switch, push-button and potentiometer wiring till later. If you don't use PCB pins, now is the time to solder in wires for the above.

Next, fit the semi-conductors in the order transistors Q1, Q2, then the UM3561 IC1. A word of warning about the UM3561 — it's a CMOS device and may be damaged by static discharges. In practice, fitting a CMOS IC merely requires it to be inserted without coming into contact with a large static voltage. Once in circuit it should be OK. Static voltages generated on the human body may be large enough to do damage to a naked chip, so take care. It's probably best to fit the chip into a DIL IC holder soldered into the PCB, as in this way you don't have to solder the chip itself.

1st CLASS

HOW IT WORKS

Figure 1 shows the circuit of the ETI Gerrada Marweh push-bike electronic bell. It's not complicated. Integrated circuit IC1 is a UM3561 siren sound generator requiring a power supply of around 3V, so a voltage regulator comprising zener diode ZD1 with series resistor R1 is used to provide this from the battery voltage.

The UM3561 comprises a number of internal parts (shown in Fig. 2) including an oscillator, control circuit, counter, tone generator and ROM. The oscillator frequency is set by the value of an external resistance connected to the OSC pins of the chip. For defined sirens, the oscillator frequency should be about 100kHz, corresponding to a resistance of 240K. In the Gerrada Marweh a potentiometer and series resistance is used as the external resistance, providing a variable frequency oscillation whose maximum frequency (minimum potentiometer resistance) is set by the series resistance.

Two pins SEL1 and SEL2 on the IC allows a choice of one of four effects depending on how these pins are connected to each power supply rail. Rotary switch SW2 connects the pins accordingly. Table 1 lists the connections to the two selection pins, and the resultant effects.

Stored in the ROM are data patterns relating to the four available effects. As the oscillator output is counted by the counter, one of the patterns is cycled through, selected by the control circuit and then passed to the tone generator.

Output from the UM3561 is a variable frequency squarewave with an amplitude nearly that of the supply voltage (3V). This voltage is amplified to around that of the battery voltage with a single common emitter transistor amplifier formed around transistor Q1. A VMOS FET transistor Q2 is driven directly from Q1's collector giving sufficient current gain to power up a loudspeaker with around 4 watts of power.

PARTS LIST

RESISTORS (all ¼W 5% unless specified)	
R1	1k0
R2,R4	47k
R3	10k
RV1	470k lin pot
SEMICONDUCTORS	
Q1	BC109
Q2	VN46AF
ZD1	3V0 zener diode
IC1	UM3561
MISCELLANEOUS	
B1	PP3 battery
SW1	push button
SW2	4-way rotary (at least 2-pole)
LS1	5W 8R 3in mylar speaker

PCB or Stripboard. 8-pin DIL socket. Knobs. Case (150 × 80 × 50mm). Battery clip. Handlebar clamp. Nuts and bolts.

SEL1	SEL2	Effect
NC	NC	Police siren
+	NC	Fire engine siren
–	NC	Ambulance siren
NC	+	Machine gun

Table 1. Connections to the UM3561 siren sound generator IC selection pins and the resultant effects

1st CLASS

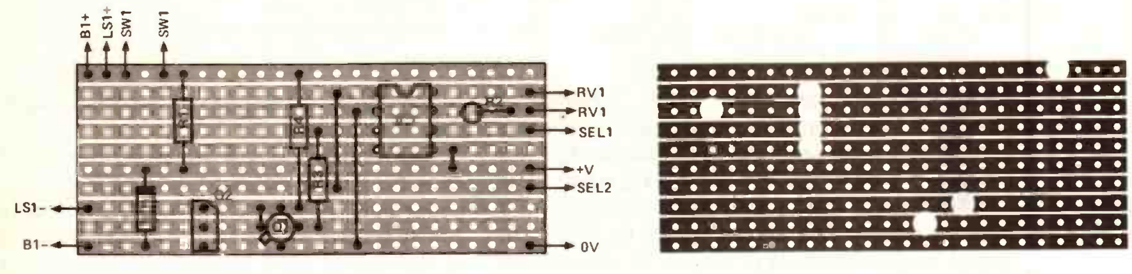


Fig. 3 The Stripboard component overlay and track cutting diagram

Now leave the PCB aside while you drill the case for all controls and fit the speaker. Holes for controls are self-explanatory and depend on how you intend to mount and fasten the project to your bike. Talking of fastening, it's a tricky problem. We found a number of solutions. The best appear to be plumbing clips for 22mm copper or plastic pipes. Another are awning clips found in caravan accessory shops. Inventive readers may have other ideas.

Fixing the speaker into the chosen case is not easy. The inside of the case must be partly milled away to accommodate it.

Once the speaker is shown to fit properly, the holes for mounting bolts and the hole for the cone itself can be drilled and filed out. The speaker used is a mylar cone type and is specifically intended for outside sirens and buzzer applications. The mylar cone provides weatherproofing and splashproofing, making it ideal for this project. With this in mind, the prototype's speaker cone is accessible directly from the underneath, making physical damage to the cone a possibility. It's not essential to fit a protective grill but some readers may feel the need, particularly if the Gerrada Marweh is to be fitted to a young child's bike where prying fingers, lollipop sticks, friends' toys and so on are liable to be encountered.

Once the speaker is fitted, the project can now be put together. Fit the PCB into the case, fit all controls and wire up the switches according to the wiring scheme shown in Fig. 4. Now, fit a suitable heatsink to the VMOS FET transistor. This must be as large as possible, without obstructing other parts and the controls in the case. Smear the metal face of the transistor with heatsink compound before bolting the heatsink to it, to ensure maximum heat transfer.

No setting up is required. Merely select the effect you require, set the speed control to about mid-position, put in your ear-plugs and press the push-button.

BUYLINES

The UM3561 and mylar speaker are both available from Maplin. All other components should be available at your local supplies outlet. The PCB is available from the PCB Service.

ETI

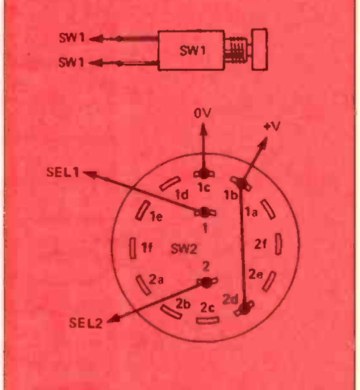
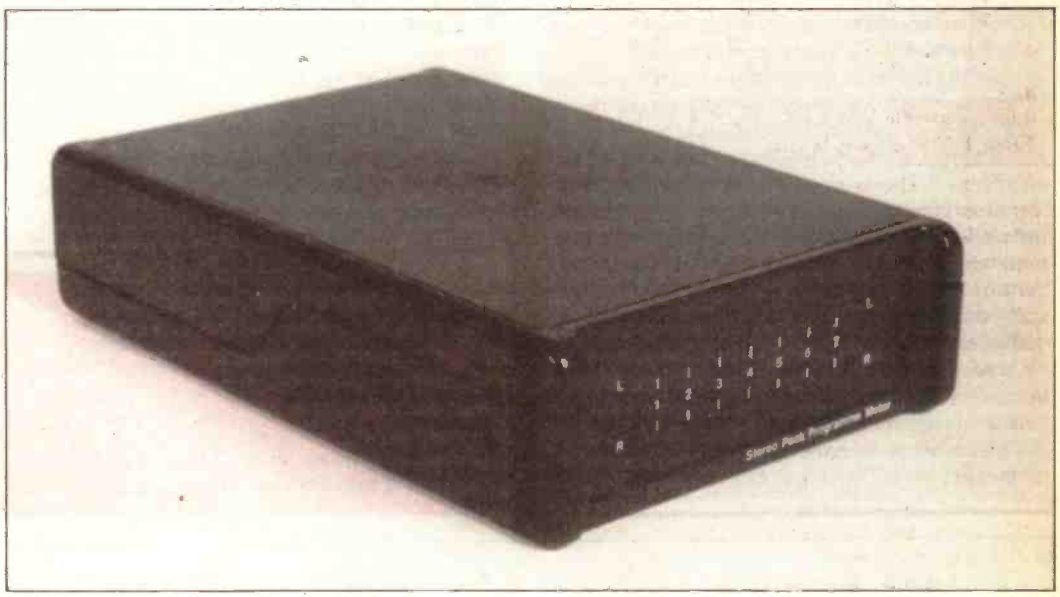


Fig. 4 Wiring up the switches

PEAK PROGRAMME METER

Ian Coughlan peaks at the right time with his high quality stereo meter



PROJECT

There are two major differences between the typical peak programme meter and the VU meters that are more familiar to most people. The PPM has very different ballistics — it attacks quickly and decays slowly so that peak signal levels are clearly displayed. In addition the PPM's scale is roughly linear whereas the scale of a VU is anything but.

A Different VU

Let's look at the VU meter in more detail. The audio signal is rectified and integrated to produce a reading corresponding to the average signal level (the PPM shows the peak level). At the left end of the scale is -20, at the right end is +3VU. About two-thirds of the way along is 0VU, which by convention corresponds to +4dBm.

Put a sine wave into the VU meter at a level of +4dBm and it will read 0VU. Simple. Put a typical audio signal in at an average level of +4dBm and it will still read 0VU, although the needle will jump around a bit in response to the signal.

A typical audio signal however, contains peaks that will be rather more than +4dBm. Since a VU meter integrates, these peaks will not produce a proportionate increase in meter reading and the audio system can be driven into overload even though the VU meter says everything is fine.

This may be relatively unimportant — analogue tape recorders for example exhibit a 'soft' overload characteristic and the distortion is not too objectionable. Other media are not always so forgiving. Digital recording systems, radio transmitters and indeed audio amplifiers have very sharply defined upper limits. Drive them even a little above their limits and they simply will not go — the signal will clip and the resulting distortion is very nasty indeed.

Obviously the best signal-to-noise ratio from an audio path is obtained running as close to the upper limit as you can, short of overload. If all you've got is a VU meter, the peaks are not going to register so you'll have to allow a considerable amount of headroom above the average signal level for these peaks and that's going to compromise the performance at the bottom end.

Enter The PPM

The fast response of the PPM means that the magnitude of peaks within the signal can be monitored with precision and if you know where your system's upper limit is (it's easy to find — just increase the signal until the output clips), adjust the level so that the peaks are just below the limit. You may want to allow headroom for extra large peaks, but with pre-recorded or broadcast material the recording engineers will have squashed those out long before they get to you!

Not just any old meter can be used for a PPM. Only specialised (and expensive) movements have the necessary ballistics, most ordinary movements being far too slow. The PPM to be described in this article uses LEDs in place of a meter movement and they're as fast as anyone could want! Cheap too — the cost of producing this stereo PPM with built-in power supply is less than the price of one PPM meter with drive card. True, it doesn't have the ultimate accuracy of such a meter but in side-by-side comparisons monitoring typical programme material, no visual differences could be observed. Besides, LEDs look pretty.

The PPM scale is quite distinctive. Unlike the VU meter which tends to squeeze the area of interest into the top half of the scale, the PPM stretches this area out so that it spans the full width of the scale as shown on the photos.

PPM1 on the left corresponds to -12dBm, PPM7 on the right is +12dBm. In the centre of the scale is PPM4, which is 0dBm. The scale markings are equally spaced, each 4dBm from its neighbours.

PPM	Volts RMS	Volts Peak	dBm
1	0.195	0.275	-12
2	0.308	0.436	-8
3	0.489	0.69	-4
4	0.775	1.095	0
5	1.228	1.736	+4
6	1.946	2.752	+8
7	3.084	4.36	+12

Note:
0dBm is referred to 1mW in 600R, accepted as 0.775V RMS.

Table 1 PPM display levels

Table 1 shows the PPM numbers with their corresponding dBm levels and voltage levels (RMS and peak). To achieve this linear scale a non-linear amplifier is needed and Fig. 1 shows the desired transfer function of this amplifier. The function is realised in this design by a technique known as discontinuous approximation. The output of the non-linear amplifier does not change in a smooth, continuous manner, instead the transfer function consists of a series of straight lines, designed to approximate to the desired curve as shown in the dotted curve. The slope of the amplifier is made to change at each breakpoint and the more breakpoints and slopes there are the more accurate will be the approximation.

This design uses three breakpoints and four slopes, which is quite adequate for the application. Figure 2 illustrates the technique.

For all input voltages up to +1V, the gain of the amplifier will be -1 since Q1 will be non-conducting (its base is held at -0.3V). As the output falls below -1V, Q1 will begin to conduct providing an extra feedback path around the amplifier. The feedback resistance is now effectively R3 in parallel with R2, so the gain becomes -0.5. Further breakpoints can be added as shown.

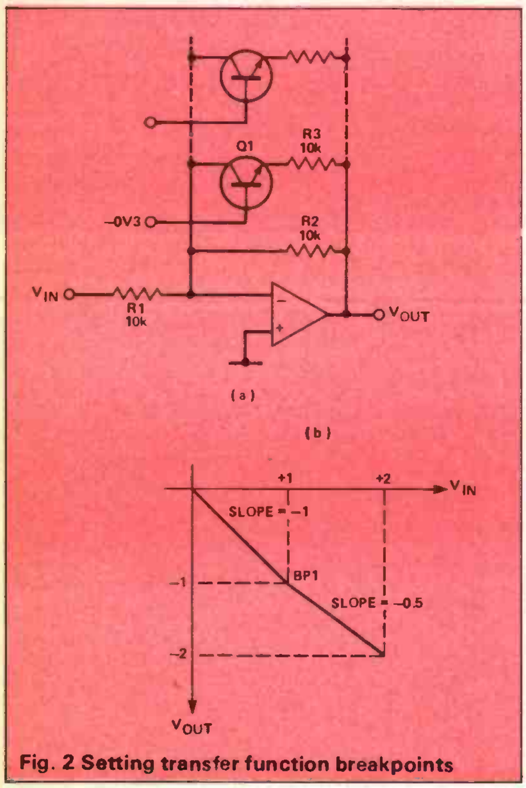


Fig. 2 Setting transfer function breakpoints

Construction

The front and rear panels (supplied with the recommended box) should be cut and drilled as shown in Fig. 5. Drilling the holes in the front panel will not be as easy as it looks. The trick is to drill the four large holes first and fix stripboard to the panel with the holes aligned with the positions of the LED holes. Now drill pilot-holes in the panel, 1mm in diameter, using the strip as a jig. Remove the stripboard and drill the holes out to 2mm. But be warned — don't just rush ahead and do it. Practise on a piece of scrap material first. I ruined four or five pieces before I got it right!

When you're happy with the panels, rub them down with wet 'n' dry paper, clean them and then prime and paint them. Spray-painting gives a much better finish than brush-painting. When the paint is dry, apply dry-transfer lettering and protect this with a light spraying of Letracote or Letfix aerosol varnish.

Fix the phono sockets, slide switch, and IEC mains inlet to the rear panel. Also, fit a solder-tag to

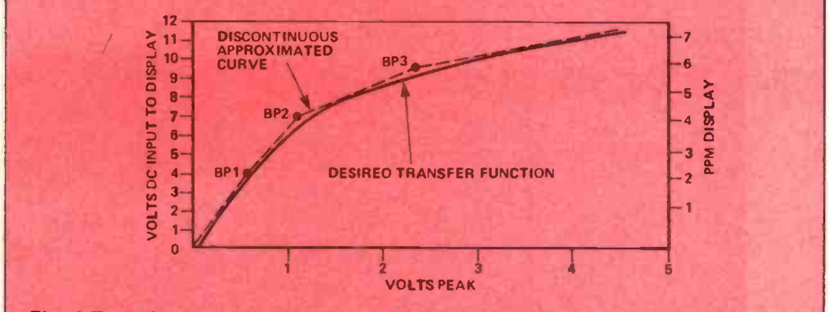


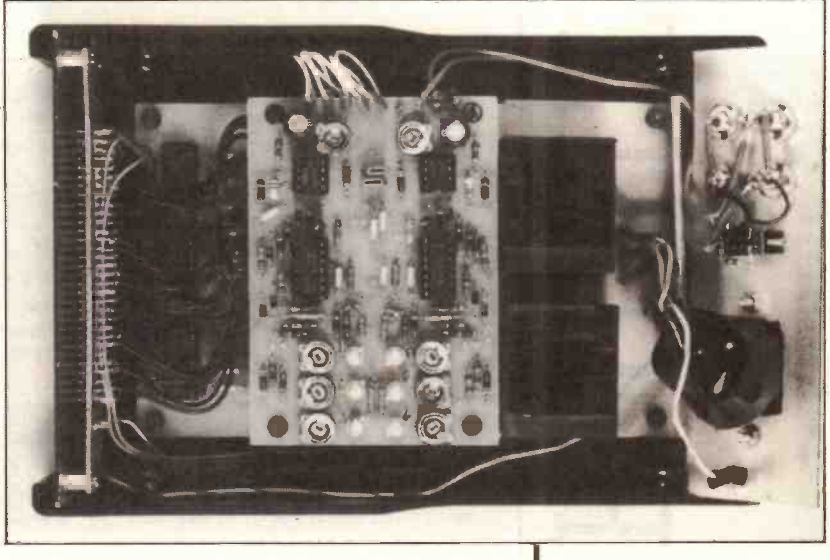
Fig. 1 Transfer functions for the peak programme meter

the rear panel for the earth connection: mains voltages are present within the unit and it's up to you to see that it is safe to use.

Solder R55 and R56 to the slide switch, SW1. Put all the LEDs into a piece of stripboard (observing polarity) but don't solder them yet. Guide the LEDs through the holes in the front panel, and fix the stripboard to the panel using countersunk screws from the front and 6.35mm (¼in) spacers. Fix a solder-tag to one of the screws — this is the earth connection for the front panel.

If all the LEDs fit snugly, solder them to the stripboard and cut the tracks between the cathodes. The tracks connecting the anodes can be left intact, since all anodes are commoned together anyway.

Now is a good time to check that all LEDs work using a power supply of about 12V and a



PROJECT

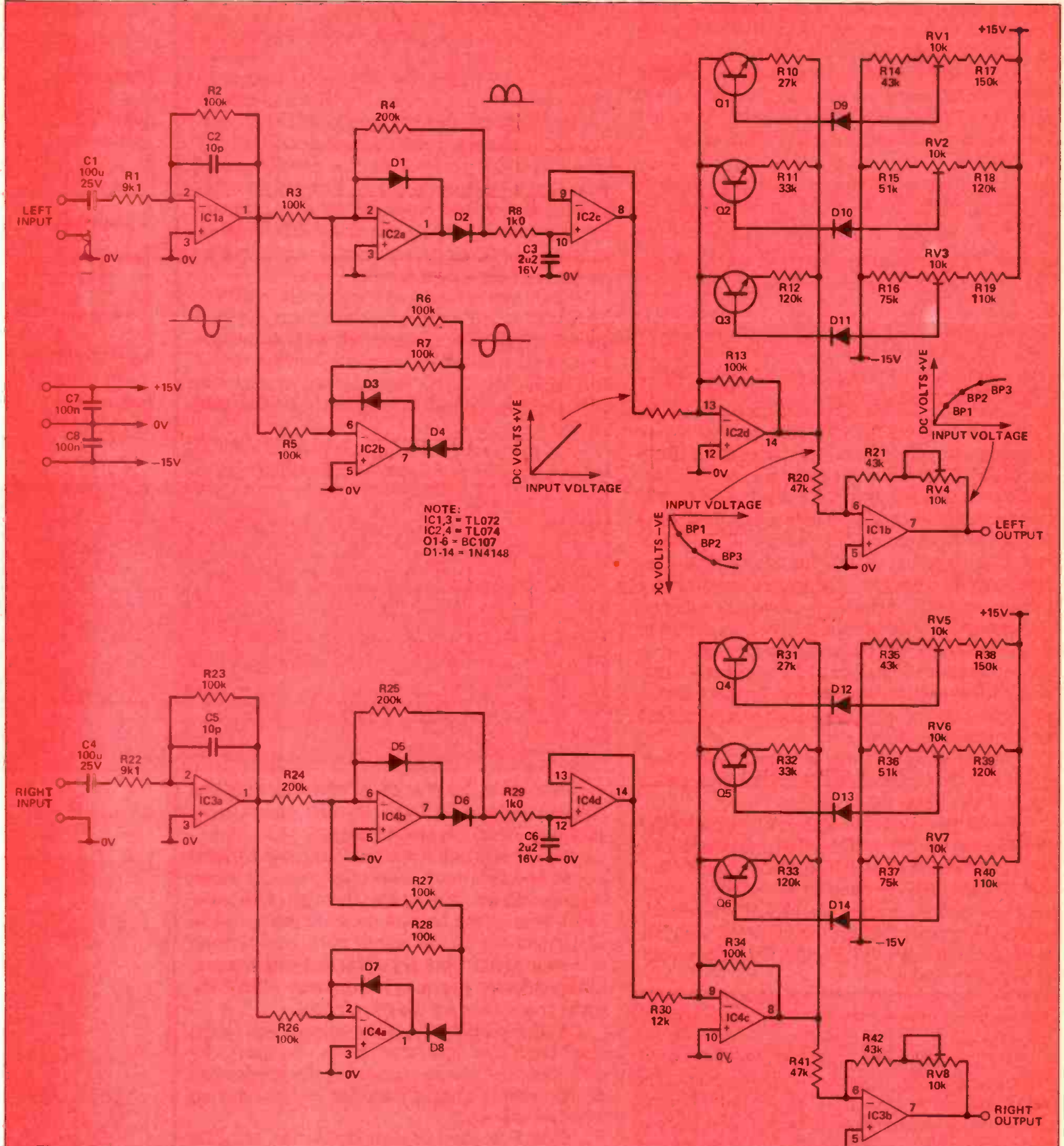


Fig. 3 Circuit diagram of the small board

HOW IT WORKS

The circuit diagrams of the two boards are shown in Figs. 3 and 4. Apart from the power supply, the PPM consists of identical circuits so for reasons of clarity only one half will be described.

IC1a is an inverting amplifier with a gain of about 20dB when SW1 is in the –20dBm position and unity gain when in the 0dBm position. In this way the PPM can be used on professional equipment with signal levels of 0dBm and also on domestic equipment which has a much lower signal level. Note that the input impedance will be 9.1k in the –20dBm position and 100k in the 0dBm position.

IC2a and b are configured as a full wave rectifier. IC2a will ignore the positive half-cycle of the signal waveform, but will invert the negative half-cycle. IC2b will do just the reverse. The resulting signal on D2's cathode will be positive-going and is used to charge C3 via R8. The voltage on this capacitor is equal to the peak input signal level.

The charging time-constant is determined by R8 and C3, the discharge time-constant is determined by R4 in series with R8 and C3. This is what gives the PPM its fast attack/slow decay characteristic. IC2c buffers the voltage on C3.

IC2d is the non-linear amplifier and its operation is described elsewhere in the article. RV3 sets breakpoint 1 (BP1), RV2 sets BP2 and RV1 sets BP3.

Before BP1 is reached, the gain of the stage is R13/R9. Above BP1 but below BP2, R12 is in parallel with R13 and the gain falls accordingly. Above BP2 but below BP3, R11, R12 and R13 are all in parallel. Above BP3, R10, R11, R12 and R13 are in parallel.

Thus as the input rises, the gain of the stage drops to a lower value at each breakpoint.

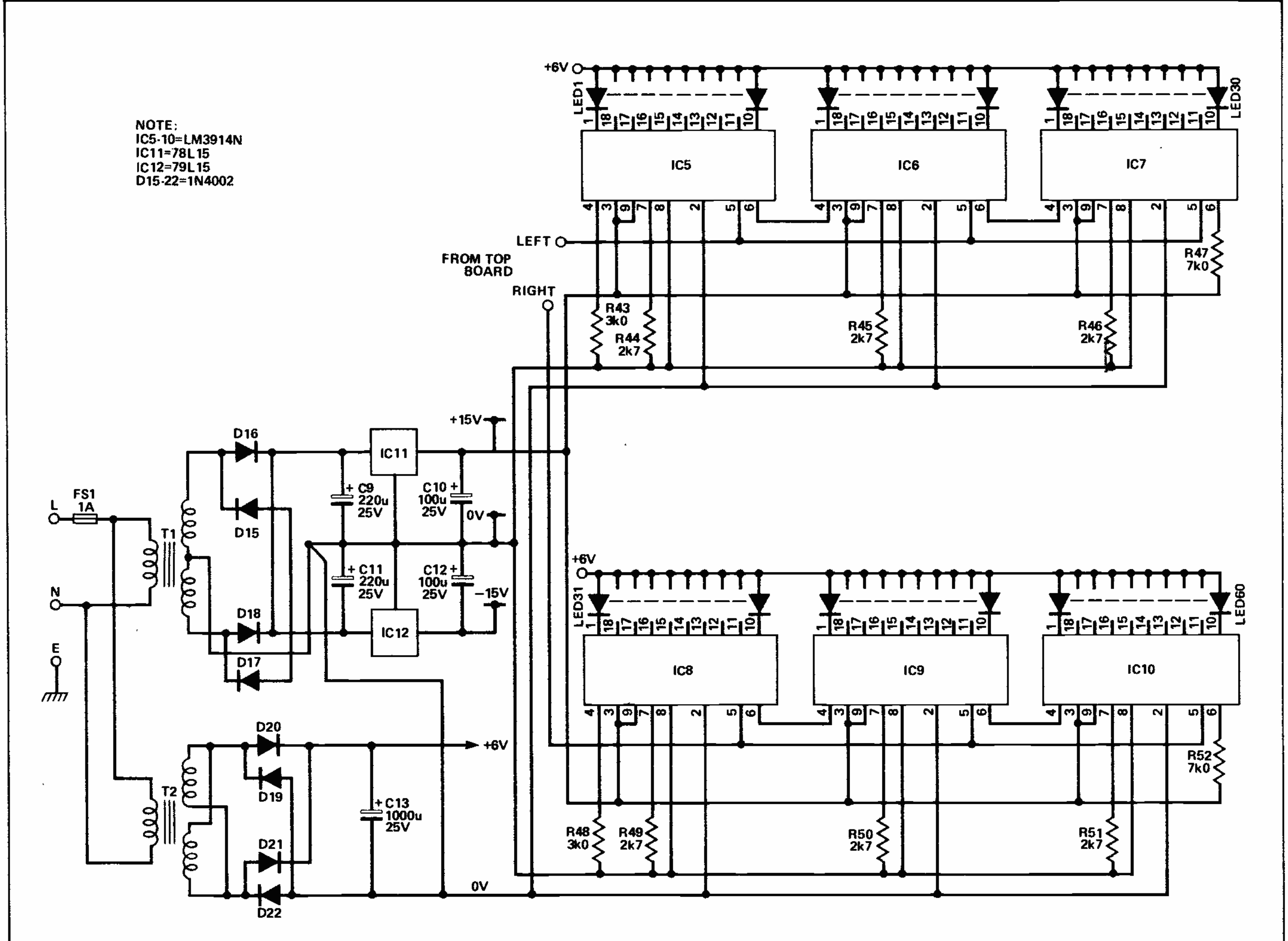


Fig. 4 Circuit diagram of main board

series resistor of say 4k7. If all is well, slide a piece of thin card down between the two rows of LEDs, to prevent light from one row spilling into the next. Put the front and rear panels to one side.

Check both PCBs for short circuits before you start on then. The overlays are shown in Figs. 6 and 7. Insert the through pins from the copper-side of the large board and from the component side of the small board. This will keep all the wiring between the boards, resulting in a neater overall appearance.

Fit and solder links, resistors, capacitors, DIL sockets, presets, fuse-clips, transformers and semiconductors (except ICs) to both boards. Connect the lettered points on the underside of the small board, using insulated 7/02 wire, and put this board to one side.

Note that two resistors on the large board (R47, 52) are select-on-test, so these cannot be fitted until their value is known.

Some initial tests should be made at this stage. Pop a 500mA fuse into the fuse-clips and connect a pair of insulated wires to the live and neutral pins. Be careful! A healthy respect for high voltage is a good thing.

Apply power and check for +15V and −15V on the appropriate pins. If all is well, disconnect the power and insert the LM3914s into their sockets, being careful to put them in the right way round (they're quite expensive devices).

Temporarily connect an LED to the LED3 position and another to the LED27 position. Connect a potentiometer (preferably a multiturn preset about 10k) between +15V (clockwise end) and 0V (anti-clockwise). Connect the wiper to the LEFT input pin.

Switch on the power again and adjust the potentiometer for +11.25V on its wiper. R47 must now be selected so that LED27 is only just on. Another preset (20k) will make this easier. When the value is known, solder R47 into place. It may be necessary to fit two or more resistors in series or parallel. Now check that LED3 is on above a voltage of +1.25V on the wiper of the multiturn preset.

The above procedure must now be repeated for the RIGHT channel, so move the LEDs over to LED33 and LED57 and move the wiper of the mutltiturn preset to the other input. Once you're

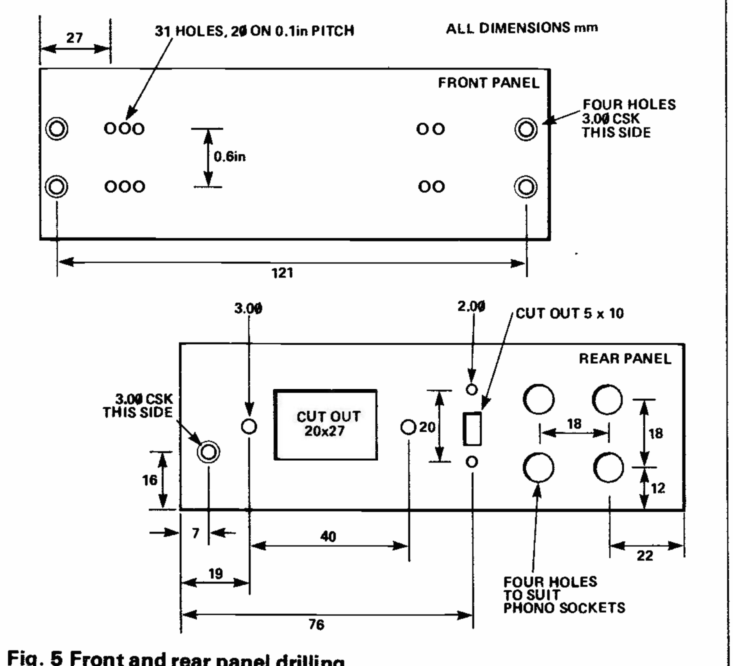


Fig. 5 Front and rear panel drilling

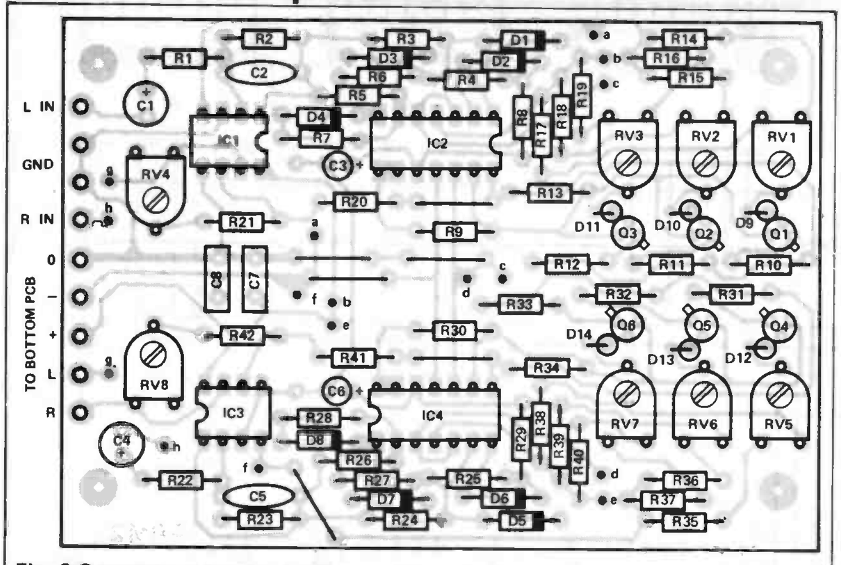


Fig. 6 Component overlay for the small board

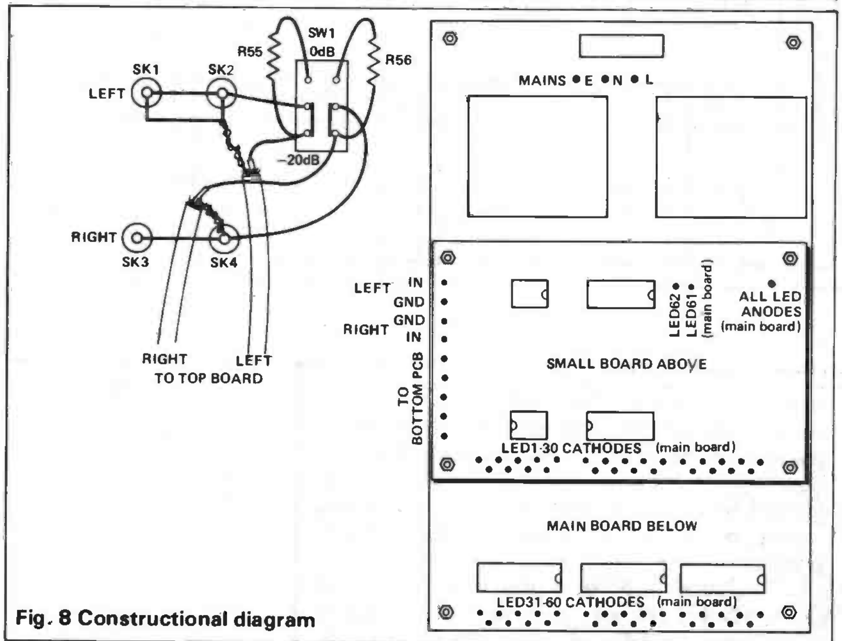


Fig. 8 Constructional diagram

PARTS LIST

RESISTORS (all ¼w 5% unless specified)	
R1, 22	9k1
R2,5,6,7,13,23, 26,27,28,34	100k
R3,4,24,25	200k
R8,29	1k0
R9,30	12k
R10,31	27k
R11,32	33k
R12,18,33,39	120k
R14,21,35,42	43k
R15,51	51k
R16,37	75k
R17,38	150k
R19,40	110k
R20,41	47k
R43,48	3k0 2%
R44,45,46,49,	91K
50,51	2k7
R47,52	7k0 (Nominal: see text)
R53,54	3k9
R55,56	91k
RV1-8	10k skeleton preset
CAPACITORS	
C1,4,10,12,13	100μ 25V electrolytic radial
C2,5	10p polystyrene
C3,6	2.2μ 16V tantalum bead
C7,8	100n ceramic
C9,11	220μ 25V electrolytic radial
C10	100μ 25V electrolytic radial
SEMICONDUCTORS	
IC1,3	TL072
IC2,4	TL074
IC5-10	LM3914N
IC11	78L15
IC12	79L15
Q1-6	BC107
D1-14	1N4148
D15-22	1N4002
LED1-62	red 2mm flat top LED
MISCELLANEOUS	
FS1	1A 20mm fuse
SK1-4	Phono sockets
SW1	DPDT sub-miniature slide switch
T1	0-15 0-15 3VA PC mounting transformer
T2	0-6 0-6 3VA PC mounting transformer

Case. IEC mains connector and insulating boot. 20mm fuse clips. 20mm spacers. 6.35mm spacers. IC sockets. Solder tags. Stripboard. Cardboard. Pins. Silicone rubber sleeving. 16/02 & 7/02 insulated wire. Nuts and bolts. 22swg link wire.

BUYLINES

Most components should be available from any supplier. The transformers used in the prototype were from Electromail (Tel: (0536) 204555), order codes 207-841 and 207-829. The LEDs are order code 588-689. The case used was from West Hyde ((0296) 20441), code BB0710. The prototype was actually built used two lids and no base, but the size of case given here is recommended. Note that voltage ratings given for capacitors represent minimum ratings.

happy with both channels, disconnect the power and remove all the other temporary connections.

Wire in the cathodes of the 62 LEDs. The left hand LED of each channel (LED61, 62) are lit at power on and connect to the centre of the main board. The display for the left channel then runs from LED30 to LED1 and for the right channel from LED60 to LED31.

Fix the two boards together with 1in spacers. Fit the ICs to the small board.

Cut a piece of card and fit it to isolate the input sockets from the mains end of the PCB. Drop the two PCBs into the box and fix the assembly into place. Fit the front and rear panels and wire them to the large PCB as shown in Fig. 8. Remember to fit an insulating boot to the IEC mains connector and to connect the earth wires.

Calibration

Calibrating the PPM is very straightforward. You'll need an audio oscillator, capable of producing up to +12dBm (3.08V RMS). The procedure is identical for both channels, so do the left channel as described here and then the right channel, with appropriate changes to component references.

Set the slide switch on the rear panel to the 0dBm position. Apply a sine wave at a level of −8dBm (308.4mV RMS) to the left input, and adjust RV4 until the meter reads PPM2.

Increase the signal level to 0dBm (775mV RMS) and adjust RV3 for PPM4. Increase the signal level to +4dBm (1.228V RMS) and adjust RV2 for PPM5. Increase the signal level again to +12dBm (3.084V RMS) and adjust RV1 for PPM7.

PROJECT

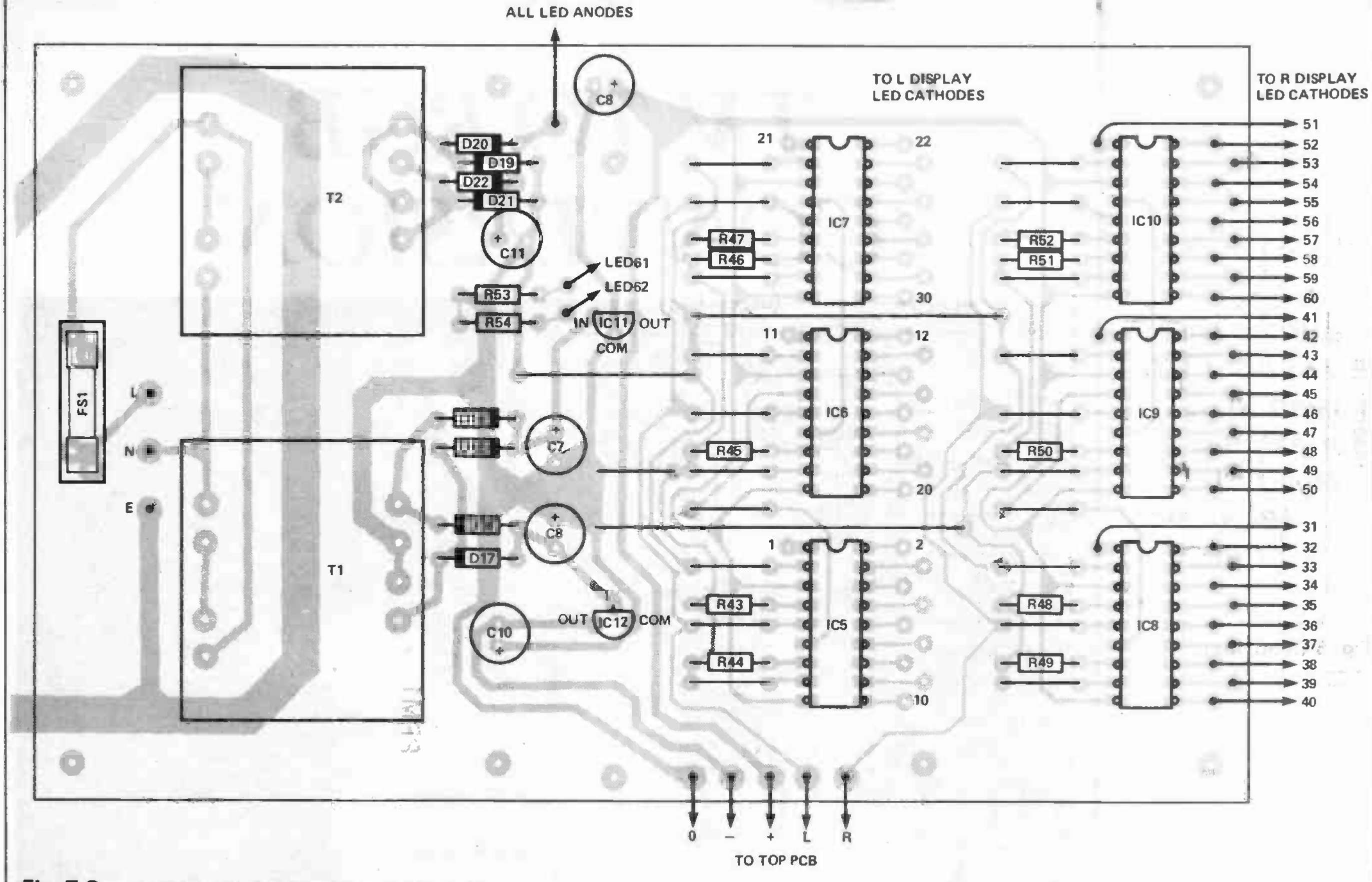


Fig. 7 Component overlay for the main board

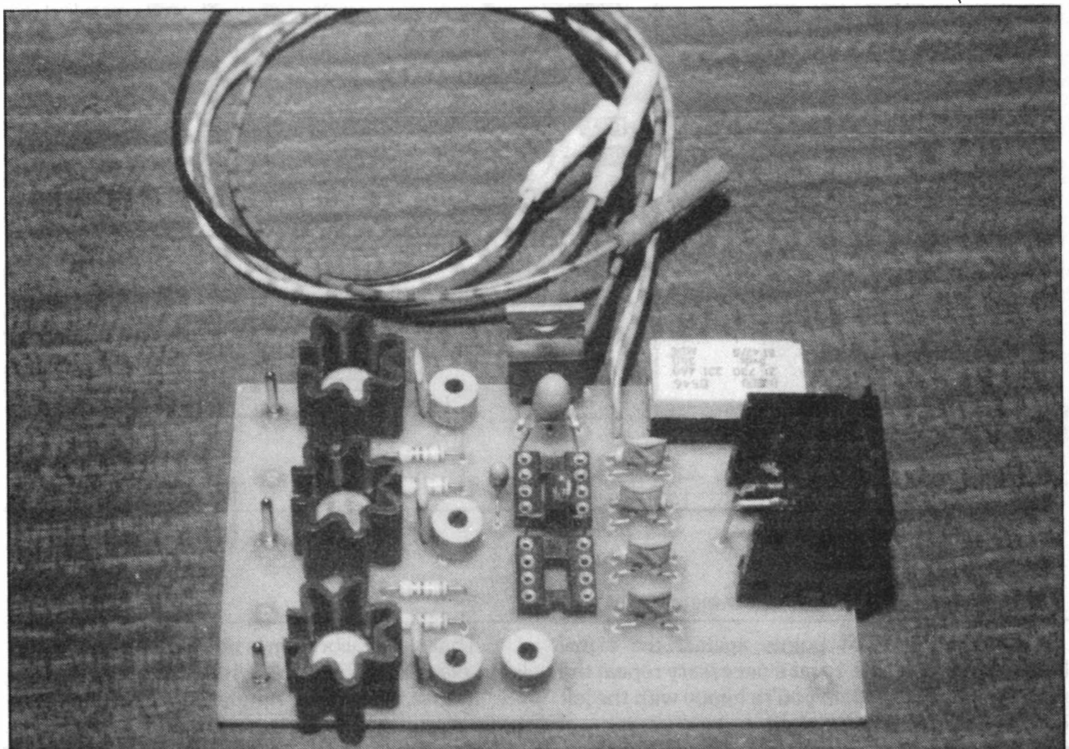
Check the PPM points against the signal levels shown in Table 1 and if necessary repeat the above procedure. When you're happy with the left channel, move onto the right.

That's all, calibration is now complete. Fix the lid in place and the PPM is ready for use.

In use, the PPM simply connects into the audio circuit you want to monitor.

TV TO RGB CONVERSION

David Lerche has converted his TV to work as an RGB monitor and has provided an RGB buffer board for his Electron for good measure



The RGB interface prior to fitting the opto-isolators

There have been many designs for TV RGB conversion circuits published in the past. However, they tend to suffer from the one basic disadvantage of requiring a transformer to isolate the TV set from the mains. This component is not only expensive and bulky but it usually won't fit inside your set. This means connecting it into the mains lead where it is probably a hazard and certainly an eyesore. It doesn't make a nice piece of furniture lying around your living room carpet and no doubt the rest of your family will complain about another piece of 'computer junk' cluttering up the living room.

This design overcomes this problem. By using high speed (10MHz) opto-couplers, complete electrical isolation of the computer from the TV set is achieved, as well as providing a video bandwidth greater than the resolution of most TV tubes. The interface is only 2x3¼in so it will easily fit inside most sets, while still providing the same degree of safety one expects from a transformer.

The original design was built to interface an old HMV Colourmaster television to an Acorn Electron computer via the RGB DIN socket. Any of the BBC range of computers will work with this interface and it has been tested on both a model B and a Master. It shouldn't take much alteration to make it work with any other type of computer, provided it has the necessary RGB outputs.

As far as the RGB outputs from the Electron are concerned, they are fed directly from a 74LS08 to the RGB DIN socket and not from emitter followers as in the Beeb. This means the Electron can drive short interface leads of two or three feet without too much problem but longer than that and ringing starts to occur on the trailing edge of signals, giving trails on the screen. An emitter follower circuit which fits inside the Electron is given later.

Construction

There are no real construction problems. The component overlay is shown in Fig. 2. Transistors Q1, 2 and 3 require small heat sinks. They don't run appreciably hot but as there is anywhere from 0V to 200V on their collectors, it is better to be safe than sorry.

There is not much room for capacitor C5 between IC1 and IC2. It may be necessary to mount it high to allow the ICs to be fitted.

RLA1, D1, RV1, R1 and C1 are only required for automatic switch over of signal from television to computer and can be omitted otherwise.

Modifying your TV

It is essential you have some expert knowledge before you remove the rear cover from your set to begin the modifications. Remember there are very high voltages involved in generating TV pictures.

The internal workings of TV sets are so varied that it is impossible, within the scope of this article, to cover all the possibilities, particularly with regard to any sync circuit modifications. All I can do is show you how I modified my set. I should say that with many modern receivers it is almost impossible to carry out such modifications, as most, if not all of the video processing is carried out inside one of those large many legged integrated circuits.

The set that I modified (fairly old by today's standards) had a Thorn 3500 chassis so the following description will make references to that.

PROJECT

HOW IT WORKS

Fig. 1 shows the interface circuit. The R, G, B and sync signals leave the computer through the 6-pin DIN socket, to drive the LEDs inside opto-couplers IC1, 2 via resistors R1, 2, 3 and 4.

The small capacitor across each resister is needed to improve HF response, although I found it made very little difference subjectively. The sync then goes on to drive the video output and sync operator stages of the TV set.

Although the computer sync signal also drives the video output transistors of the TV set, the sync signal is also the 'colour black' which effectively switches off the video output transistors leaving the interface transistors to drive the tube cathodes on their own.

The outputs from the opto-couplers drive the emitters of the output transistors, by way of presets RV2, 3 and 4. The 'grounded base' configuration is needed to allow a voltage change from the 5V logic level, up to the 100 or so volts necessary to drive the tube cathodes.

The +5V supply from the computer activates relay RLA1. This relay is provided so that the video signal from the TV set can be routed through the interface, which will automatically switch between off air signal and computer syncs every time the computer is switched on.

If you are not sure about the layout of your own set, write down the model number and go to the reference section of your local library to consult *Electrical & Radio Trader* or the *Newnes Radio and Television Service Manuals*.

The open collectors of the RGB interface output transistors Q1, 2 & 3 are connected to the cathodes of the CRT. They are in parallel with the set's own video output transistors and share their collector load resistors. Even though they are left in circuit when the RGB interface is not in use, they have no loading effect on the normal operation of the television.

On the Thorn 3500 the output of the luminance delay line is disconnected from the base of the first video transistor (Fig. 4) and connected by a short fly lead to the interface relay. The output from the interface relay is connected to the base of the first video transistor.

This effectively allows the interface to automatically switch the set between incoming TV signal and RGB signal when the computer is switched on

PARTS LIST

RESISTORS (all ¼W 5%)	
R1-4	68R
R5-8	560R
RV1	1k0 cermet preset
RV2-4	2k0 cermet preset
CAPACITORS	
C1-4	220p ceramic
C5	4µ7 6.3V tantalum
C6	33µ 6.3V tantalum
C7	220n 6.3V tantalum
C8-10	330p ceramic
SEMICONDUCTORS	
IC1, 2	6N137
IC3	7805
Q1-3	BF259
D1	1N4148
MISCELLANEOUS	
SKT1	6-Pin PCB mounted DIN socket
RLA1	5V 2-pole, 2-way relay
PCB. T03 Heatsinks. Connecting wire.	

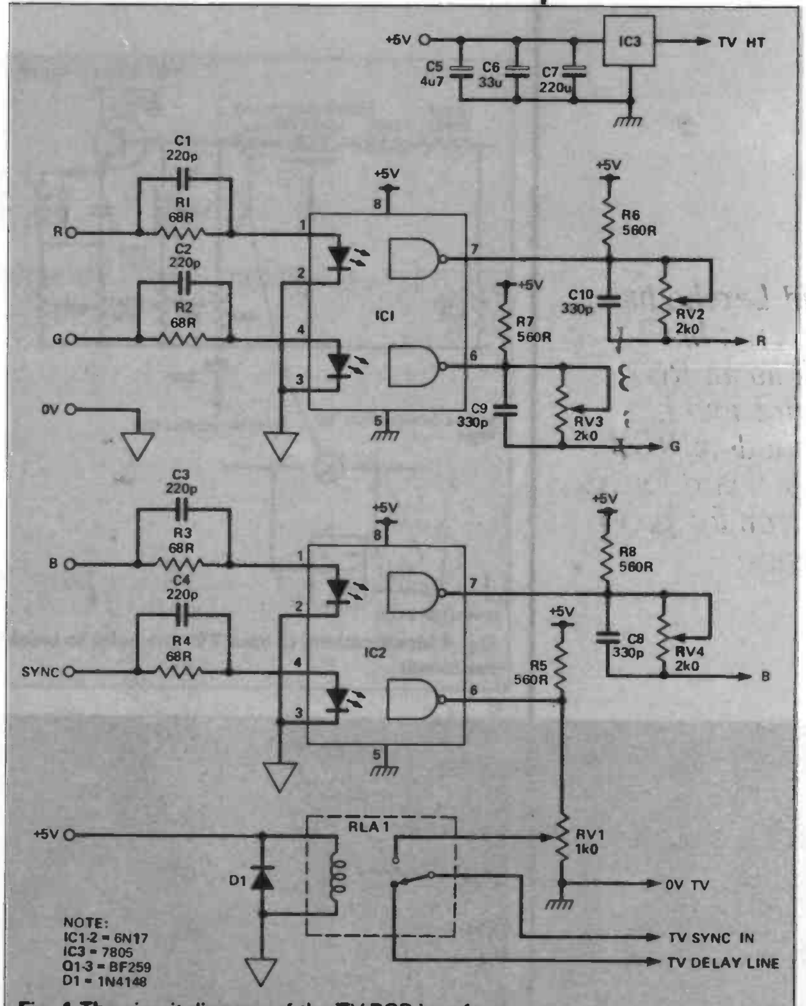


Fig. 1 The circuit diagram of the TV-RGB interface

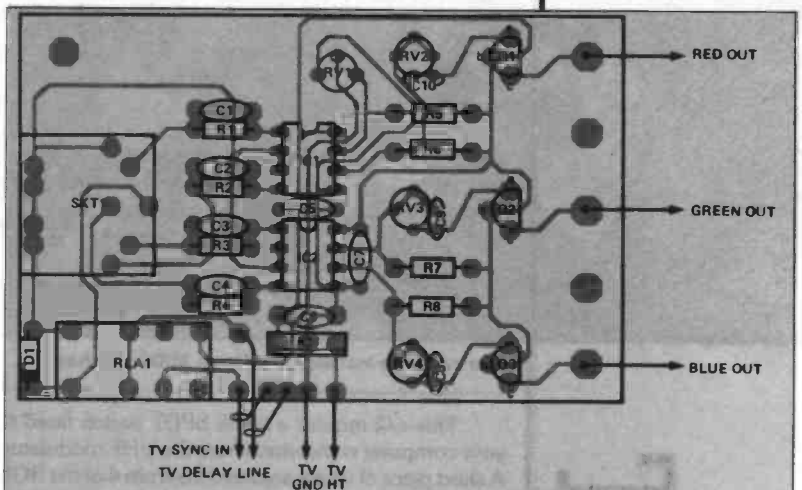


Fig. 2 The component overlay for the TV-RGB interface

or off, or when the RGB lead is plugged in or out.

If the set is receiving an 'off air' signal while the RGB interface is in use, the chrominance component of that signal will break through to give peculiar colour effects on the screen. This problem is easily remedied by either slightly detuning your set so that the colour killer circuit works, or by turning the colour control knob to a position where the colour picture would normally go to black and white.

Apart from the controls mentioned, none of the set's other controls (brightness, contrast and so on) will have any effect on the picture from the computer. RGB picture quality is set only by the 2k0 presets (RV2-4) on the interface board.

Should you consider that breaking into the video circuit of your television is not what you wish to do, a simpler but less automatic approach can be adopted.

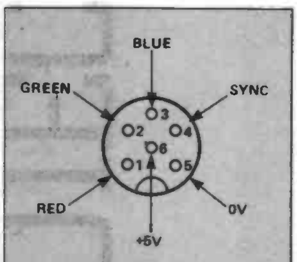


Fig. 3 Pinout of the BBC micro and Electron RGB monitor socket

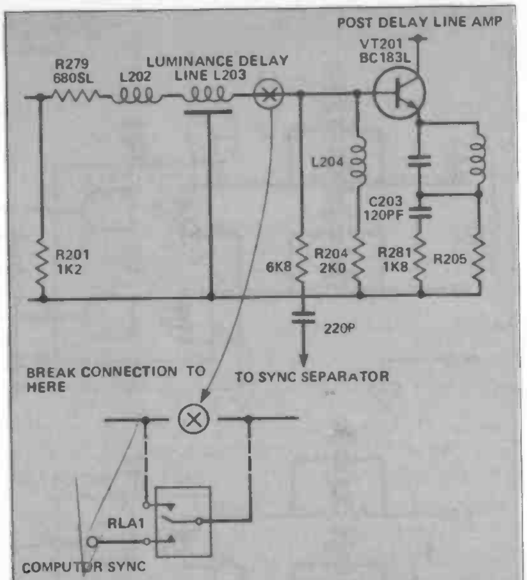
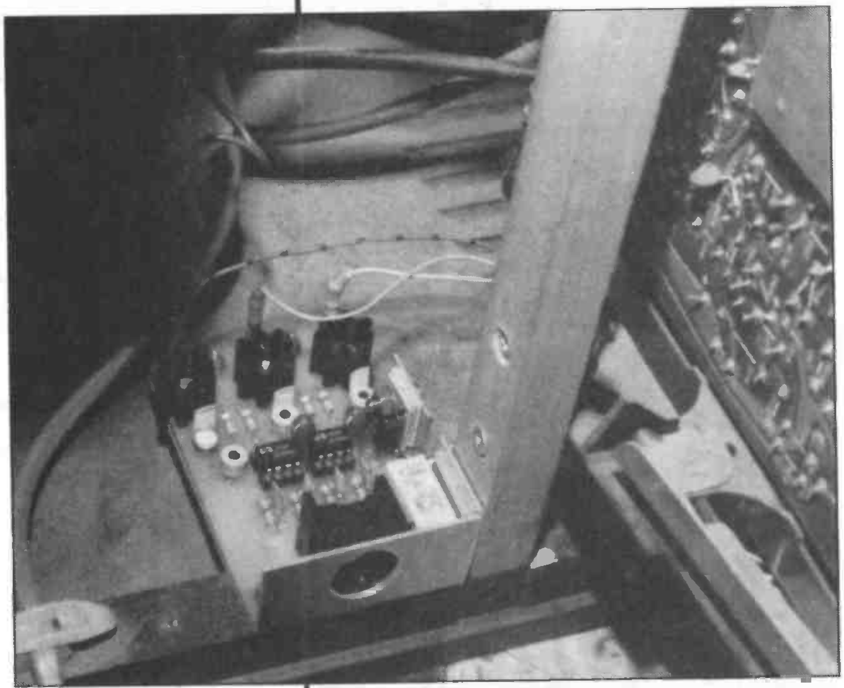


Fig. 4 Modifications to your TV. The point to break the circuit


The interface installed in a Thorn 3500 TV chassis

This will require a small SPDT switch fitted to your computer somewhere near the UHF modulator. A short piece of wire is soldered from pin 4 of the RGB socket (sync) on the inside of the computer, to one pole of the SPDT Switch. The video signal that would normally got to the UHF modulator goes to the other pole. The centre contact of the switch now goes to the UHF modulator (Fig. 5).

This will now supply syncs and a black level signal to your television aerial socket when the switch is in the RGB position and standard UHF computer video when it is in the other position. Connect the RGB video outputs as before and connect the RF output of your computer to the aerial input of your TV set.

Tune your TV to your computer (channel 36) and again turn the colour control to black and white. You will now have two leads from your computer to your television. The RF lead providing the sync signals while the RGB lead provides the information.

If you use this method of connection, the sync signal components and the relay on the RGB interface board can be dispensed with.

I derived the +5V supply for the output side of the RGB interface from the TV set's normal HT, if you have difficulty doing this then a separate +5V supply will have to be found. As the current consumption is quite low, one of the mains adapters for personal stereo recorders would be ideal. The 7805 on this interface was dropping about 25V, so it was essential to provide it with a heat sink. I used the RGB interface aluminium mounting bracket for this, bolting the 7805 directly to the aluminium. This puts the bracket at the same potential as the chassis of the set so make sure your DIN plug cannot touch the aluminium. If you are in any doubt use a mica washer under the 7805 to isolate it.

Testing

Adjust the controls on your set to obtain a black and white off-air signal, set all the pre-sets on the RGB interface to mid-position, connect up the interface to the computer and switch the computer on. You should hear the interface relay click (if fitted) if all is well. If not, switch off and investigate.

Assuming that the relay works, you should have a picture of sorts. If the picture is not locked steady, adjust RV1 until it is, or adjust your tuner if you are using the computer modulator to supply the syncs. Now it is just a case of adjusting RV2-4 for the best possible picture.

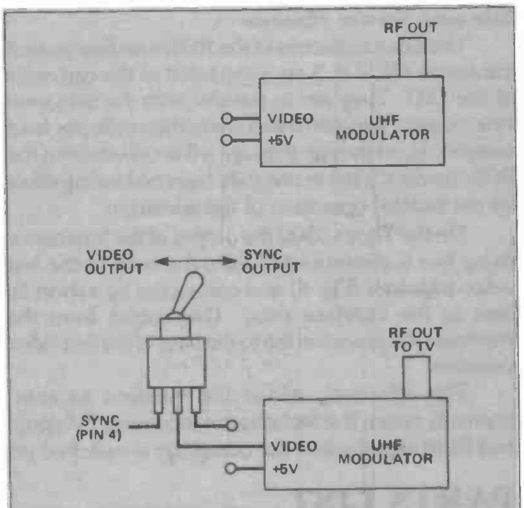


Fig. 5 Alternative connections for a source of the sync

Electron RGB

For users of the Electron, its RGB output is not buffered with emitter followers as is the Beeb's, and so long monitor cables cannot be used. To solve this small problem I have designed an add-on emitter follower interface to install in the Electron to give it the same RGB output capability as the BBC micro.

Construction

There should be no problem building the interface (Fig. 6). The only tricky bit is fitting it inside the Electron itself. The pads marked N and S on the component overlay are for wire links to the Electron's PCB. They should have about an inch of 26swg wire soldered in, with the wire hanging down from the under (copper) side of the board.

It is better to put a small loop in the end of the wire on the component side, to stop it from being pulled through the board while it is being soldered in.

Once you have built the interface driver, remove the main PCB from the computer and locate resistors R45, R46 and R47 (68R) situated near the RGB DIN socket (Fig. 8). Unsolder the resistors and fit the six

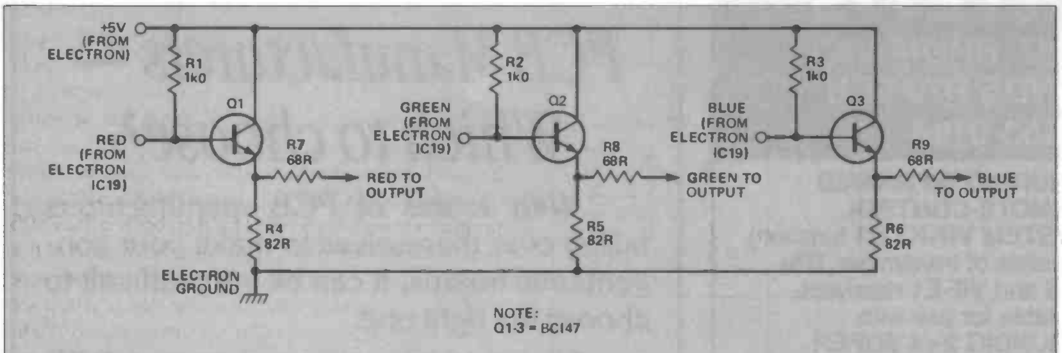


Fig. 6 The circuit of the emitter follower RGB buffer

HOW IT WORKS

The three transistors Q1-3 are acting as emitter followers for the R, G and B colour signals coming from IC19 (74LS08) within the computer. They provide a lower impedance drive to the DIN socket than IC19 can on its own. This allows you to use a longer RGB lead between your computer and monitor or TV set without ringing occurring. It also gives a much brighter and more saturated picture when driving professional monitors, particularly when it is driving into a 75R load. The 1k0 resistors from the base leads of the transistors to +5V are extra pull-up resistors to assist the outputs from IC19.

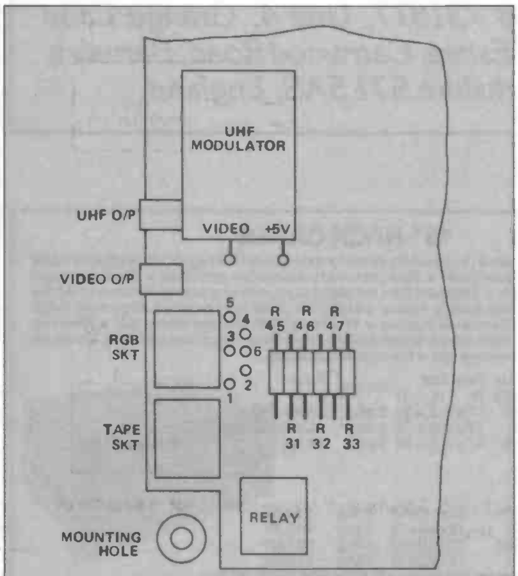
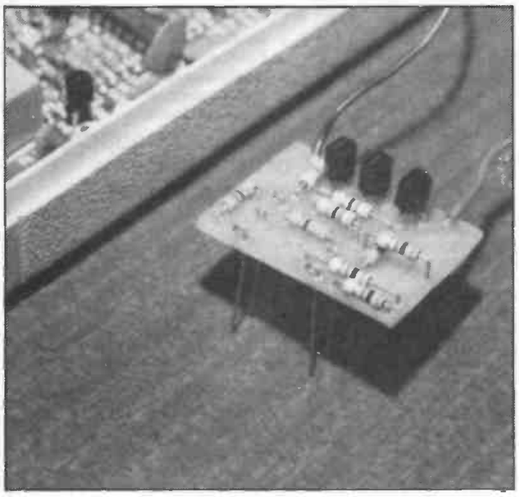


Fig. 8 The positions of the resistors to remove from the Electron


The Electron RGB buffer prior to installation

wires from the underside of the interface driver into the holes left by the resistors, with the wires from the S pads going to the holes nearest the front of the computer and from the N holes to the rear.

Solder the driver board in position, making sure it sits as low as possible, use a bit of post card underneath for insulation if necessary. This is to make sure that when you re-assemble your Electron, the keyboard cable does not foul the interface board. Connect the +5V lead from the interface board to the collector of transistor Q7 on the Electron PCB and the 0V lead to capacitor C21, soldering the wire to the leg of the capacitor nearest the front of the computer.

Reassemble your Electron, plug in the RGB lead, switch on and you should be rewarded with a much better picture than you had before.

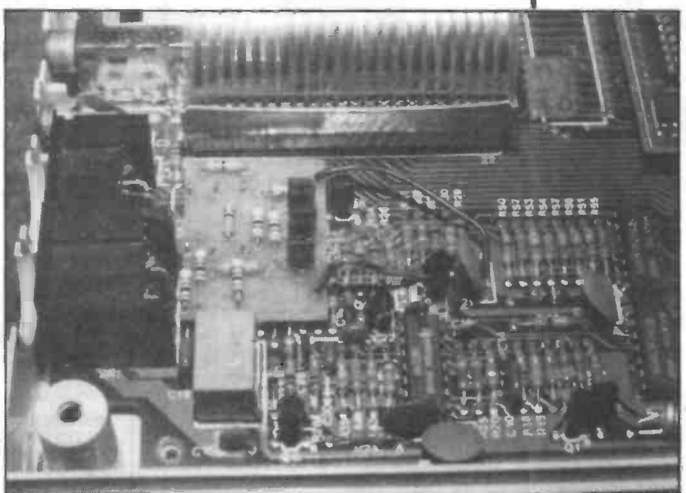
PARTS LIST

RESISTORS (all ¼W 5%)

R1-3	1K0
R4-6	82R
7-8	68R

SEMICONDUCTORS

Q1-3	BC147


The RGB buffer installed in the Electron

BUYLINES

Most of the components used in both the TV interface and the RGB buffer board are easily available. The opto-isolators (IC1, 2) are available from Electromail (Tel: (0536) 204555) as part 302-104 as is the relay as part 345-741. The PCBs are available from the ETI PCB service. Details at the end of this issue

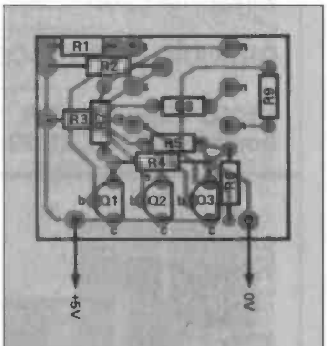
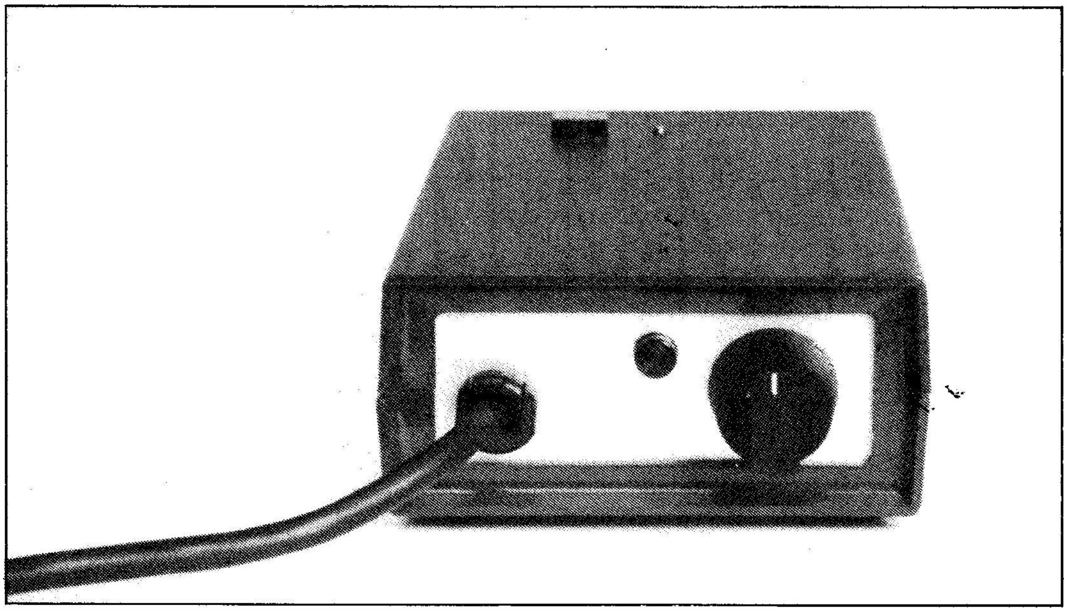


Fig. 7 The component overlay for the RGB buffer board

ETI

THE VARIAT-ION

PROJECT



Paul Chappell is fit and healthy thanks to this super powerful, variable and ion-counting air ioniser

The most spectacular demonstration of an ioniser's powers has got to be the vanishing smoke trick. It's what got me hooked, anyway. Ionisers are usually promoted as health aids — they heal the sick, make the blind see, cause the lame to dance the hornpipe and probably raise the dead too if some of the more frenzied hype is to be believed. But it's the odd way they behave that really grabs your attention.

You don't need to be a member of the magic circle to baffle people with the smoke trick. The only equipment you need is an ioniser, a glass jar and a cigarette. Pass the ioniser around your audience. Look: no fans, no filters, no moving parts. Puff cigarette smoke gently into the glass jar until the air inside is a thick, grey smog. Invert the jar over the ioniser. The smog swirls around for a few seconds and suddenly the air is crystal clear again!

This, you explain to your audience, is one of the ioniser's minor powers. For an encore it will cause the blind to dance, the dead to see and may even heal the hornpipe. Or will it?

The Great Ion Debate has been aired (pun slightly intended) at one time or another in just about every science publication from New Scientist to the International Journal of Biometeorology. Research papers on the subject have appeared in almost any medical journal you care to name. Air ions have been investigated by such diverse bodies as NASA (when looking at the environment needed in space capsules), Mercedes Benz (ditto in cars) and the World Health Organisation. Yet still there's no overall agreement on what ions can do for you or just how important they are.

Ions In The Air

Air ions are nothing more than gas molecules which have either gained or lost an electron. Add an electron and you get a negative ion, or neg-ion for short. Subtract an electron and you end up with a pos-ion.

Ions occur naturally from a variety of causes: by the friction of one layer of air on another (like school electrostatics experiments where charges are generated by rubbing glass or plastic rods with a cloth), by the action of ionising radiations (ultra-violet rays from the sun or nuclear 'background' radiation from naturally occurring minerals), from the electrical discharges associated with thunderstorms, from waterfalls and from many other sources.

The natural ion density in open countryside, far from city pollution, varies from around 300 to 1000 ions/cc of air. Close to vast ion generators, like the Niagara falls or the sea, levels of 2000 ions/cc and above can be measured.

In man-made environments the ion count is likely to be much lower. In cities, the life of each ion is much shortened by air pollution — smoke, dirt, traffic fumes and so on. In houses, whether in town

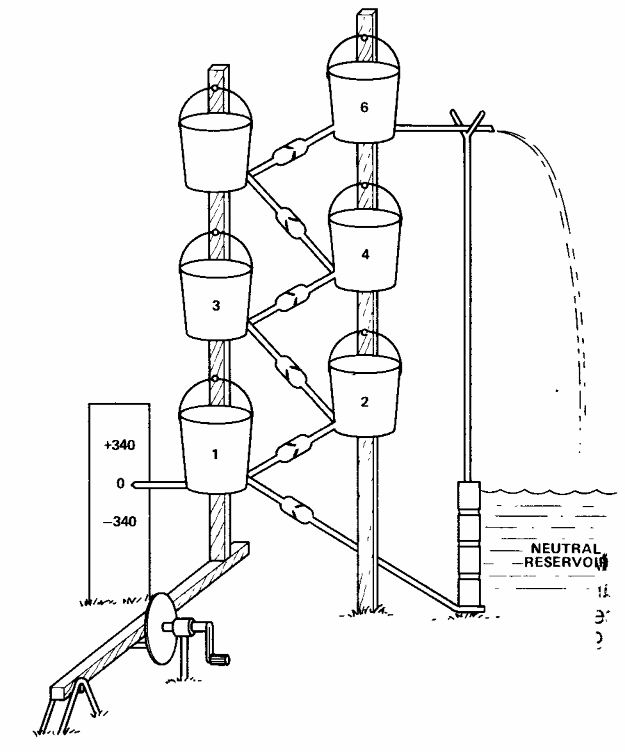


Fig. 1 A new kind of water pump

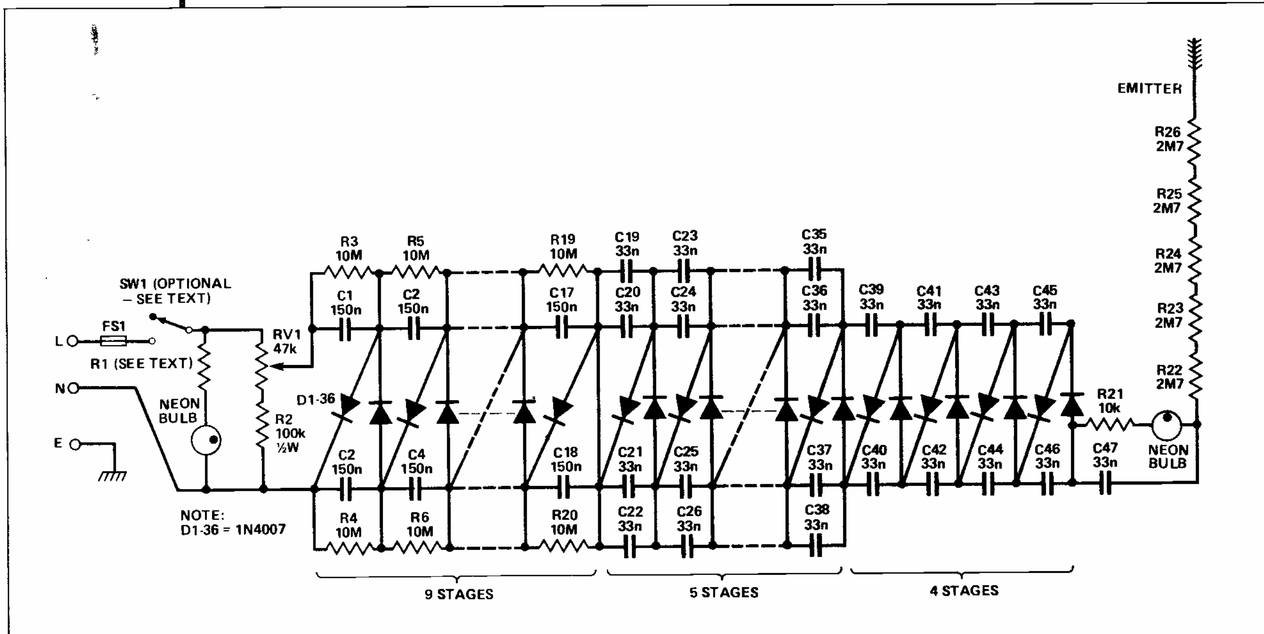


Fig. 2 The circuit of the Variat-Ion

or country, the effects of modern building and furnishing materials all act to remove ions from the air quicker than natural processes can replace them. The undisputed result is that most people spend most of the time breathing ion impoverished air. The case for owning an ioniser, then, is that living in ion-starved air has bad effects, whereas breathing ion-rich air has good ones.

Vitamins Of The Air

A demonstrably beneficial effect of ionising the air is the one you've already seen. Ionisers remove dirt, fumes and dust that might otherwise end up in your lungs. What happens is that as the particles come into contact with air ions, they pick up a greater and greater negative charge until they are drawn, by electrostatic attraction, to the nearest uncharged surface. Inside a jar, with an ioniser producing half a billion ions every second, this happens very quickly indeed. In a room the process takes a little longer, perhaps half an hour to remove most of the dust but it happens just the same. In a city street the pollution producers (cars, for instance) work so fast that the process doesn't stand a chance.

The effects of the neg-ions themselves are so profound that they are often described as 'vitamins of the air'. In a normal healthy person they seem to bring about feelings of tranquility and freedom from stress and worry — general state of well-being. In short, breathe in those ions and you'll feel great!

The evidence is partly anecdotal (people who have ionisers say they feel good and who am I to argue with them?) and partly physiological. The two main demonstrable effects are a reduction in serotonin levels and an increase in alpha activity in the brain.

Serotonin is a neurohormone which is produced in response to emotional stress. It has its part to play in the normal functioning of our bodies but when too much is produced too often the results can be counter-productive. The effects range from depression and irritability to (at worst) migraine headaches, nausea and vomiting.

Neg-ions help to prevent over production of serotonin — the hormone responsible for these unpleasant feelings. The way this is measured, if you're interested, is by detection of serotonin itself and a harmless by-product known as 5HA in urine samples (don't you wish you hadn't asked?). Measurement of the quantities of these two substances shows how much serotonin is being produced and how effectively the body is breaking it down. The effects of neg-ions in reducing serotonin levels and aiding its breakdown are well documented.

As far as alpha activity is concerned, ions have the effect of increasing the duration and amplitude of this type of brain activity. Broadly speaking, electrical brain activity (as picked up by electrodes on the head) can be split (on the basis of frequency) into four main types: beta, the highest frequency associated with active thought; alpha, linked to pleasure and relaxation; theta, which indicates a state of reverie and delta, which only appears during sleep. For choice, unless you're driving a car or doing something else that needs your full attention, alpha is the state to be in.

Neg-ions have been recommended for all kinds of specific complaints but the strongest evidence for their beneficial effects is in the treatment of respiratory complaints (asthma, hay fever, bronchitis), migraine and, surprisingly, burns. The action of cleaning the air has to be of benefit in itself for any kind of respiratory disorder and the further effect of speeding up the action of the cilia (the cleaning cells in the respiratory tract) helps too. As far as burns are concerned, the rapid healing and reduced scar tissue seems to arise from ions absorbed directly by the skin rather than inhaled. Next time I burn my finger on the soldering iron I'll hold it above the ioniser and let you know. . .

My latest ioniser is one for the connoisseur. If you just want a small ioniser for your bedside the Direct-Ion (ETI, July 1986) will fit the bill admirably (and is quite a lot cheaper in parts). If you want one with enough power to run several multi-point emitters, variable ionisation potential and a built-in ion counter, the Variat-Ion is the ioniser for you.

There are all kinds of ways of producing ions, from radioactive sources to water sprays but by far the most convenient, predictable and safe method is to do it electrically. The principle is to create a high voltage and to apply it to one or more sharp points. Since charge density increases as radius of curvature gets less, the surplus electrons will be crammed tightly into the points and will gladly step off onto any passing air molecule. The molecule, now negatively charged, will be repelled from the point to make way for the next.

This accounts for the 'ion breeze' you feel if you put your hand close to the emitter.

Positive ions have an initial stimulating effect but after a while feelings of tiredness and irritation set in, which is why ionisers go for the negative ones.

A Novel Water Pump

I really must tell you what happened to me earlier this week. I was passing the Neutral reservoir when I saw a group of people gathered around what looked like a lot of buckets hung on a pair of wooden posts. I stopped to take a closer look and discovered that the water board were trying out a new kind of manual pump. From memory, it looked something like Fig. 1.

Close to the reservoir was a tall wooden post on which had been hung a number of buckets, one above another. A few feet from the first post was a second one, similarly hung with buckets. The first post had been driven into the ground, whereas the second was supported on a kind of lever arrangement so that it would move up and down as the operator turned a crank. With the crank in the resting position, the bottom bucket was at just the same level as the water in the reservoir.

When the operator turned the crank, the second post fell and the bottom bucket immediately began filling with water through a hose from the reservoir. By the time the post was at the lowest extent of its travel, the bucket was full. As the crank lifted the post to its highest level with bucket 2 at the same height, the water began to transfer from bucket 1 to bucket 2 until the levels in each were the same. I asked why the water didn't simply go back the way it came into the reservoir and was told that each hose was fitted with a non-return valve which only let the water through in one direction.

With each movement of the post, a quarter of the water in each stationary bucket was moved into the one above. After three complete cycles of the crank, the bottom of the top bucket had just a little water in it. It will never catch on, I thought. Too much work for too little water! Now, if they made the lower buckets bigger than the higher ones . . .

The Circuit

The internal workings of the ioniser are shown in Fig. 2. It is based on a Cockroft-Walton diode and capacitor ladder, which is similar in some ways to a string of buckets (capacitors) connected by hoses (wires) with non-return valves (rectifiers) in them. The action is not as inefficient as the water pump analogy might lead you to believe — each capacitor is 'floating' on the voltage of the one before, so a more accurate analogy would have a load of nested buckets, each floating on the water contained in the one below! The analogy gives a general idea of the circuit in operation, though — enough for you to work out the details for yourself if you're interested.

The circuit is quite tricky to analyse in any detail but one principle that does emerge, and is applied in the Variat-Ion, is that the circuit is at its most efficient when the capacitors lower down in the chain are as

PARTS LIST

RESISTORS (all ¼W 5%)

Note: All resistors, with the exception of R1, R2 and R21, should have a proof voltage of at least 1kV and a working voltage of 500V or more.

R1	150k (not needed if complete panel lamp used)
R2	100k ½W
R3-R20	10M (33M slightly better, if you can get them)
R21	10k
R22-26	2M7
RV1	47k lin pot

CAPACITORS

C1-C18	150n X2
C19-C46	33n X2
C47	47n 250V

SEMICONDUCTORS

D1-D36	1N4007

MISCELLANEOUS

PCBs. Retex 'Elbox' 145×90×41mm case. Neon lamp. Plastic lens. Fuse and clips. Knob. Strain relief bush. Mains flex. Connecting wire. Emitter brush. Plastic offcut for rear panel. Nuts and bolts.

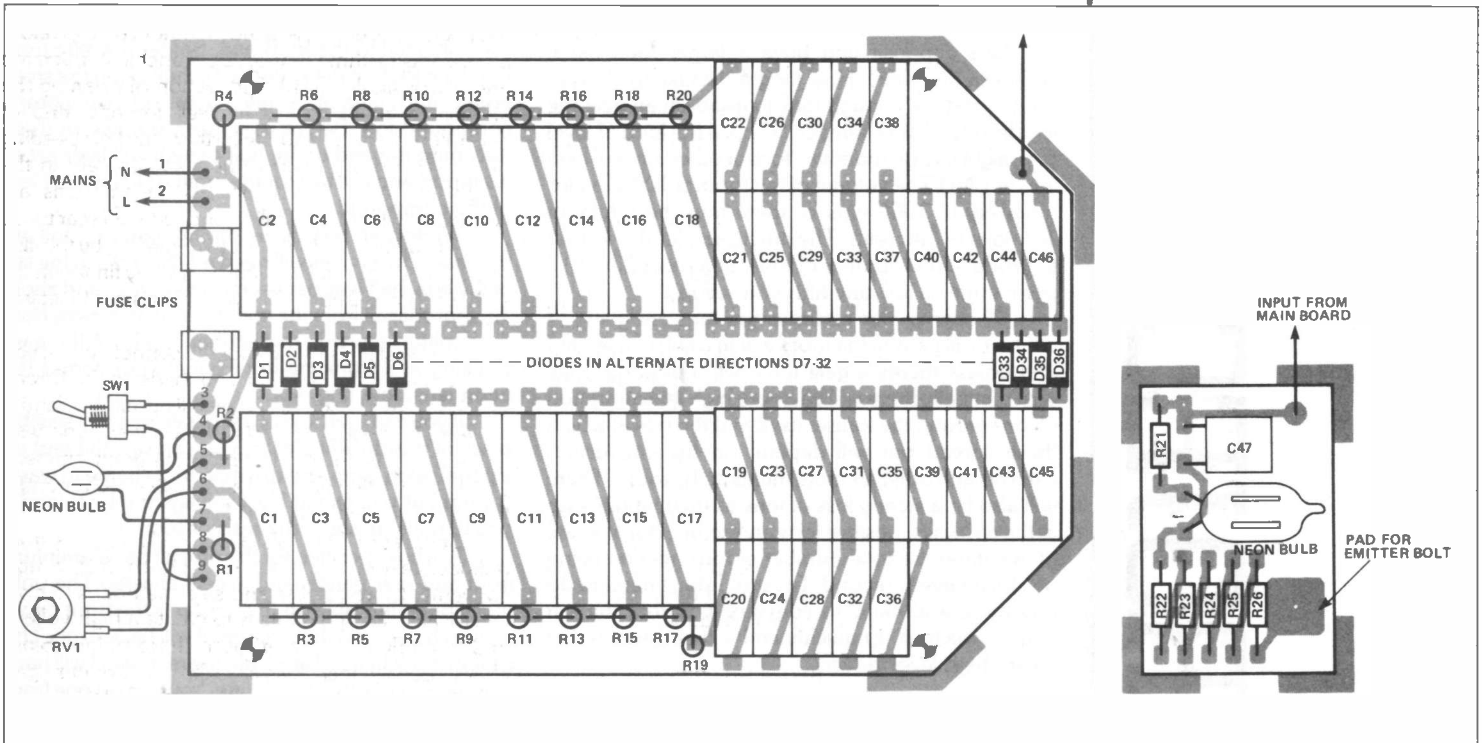
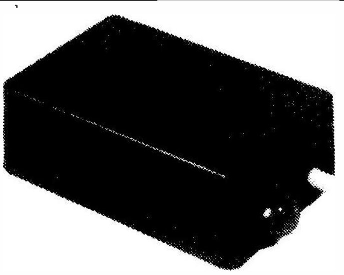


Fig. 3(a) Component overlay for the main PCB. (b) Component overlay for the ion counter PCB



The original Direct-Ion ioniser (July 1986) on which the Variat- Ion is based

large as possible. Increasing the value of the higher capacitors has diminishing effect, so the place to spend your available space and money is at the beginning of the chain where the effects are enormous! The first 18 capacitors in the chain are 15 times as large as those used in the earlier Direct-Ion, giving this ioniser plenty of spare power — enough to drive several multi-point emitters.

At the very top of the chain (the junction of D36 and C46) comes the ion counter. As the emitter ionises the air, the electrons attached to passing molecules are supplied by a current drawn through the resistor chain R22 to R26. The more ions created, the higher the current.

Most of the time the emitter current is supplied by C47, giving a steadily rising voltage across it. Sooner or later the voltage will rise high enough for the neon bulb to strike. the bulb draws current from C47 for a short time until the voltage across the capacitor will no longer sustain conduction. The neon, having discharged the capacitor by about 50V, goes out and will not conduct again until the voltage across C47 has once more risen to its striking voltage.

The value of C47 should be somewhere between 10n and 100n. If it's less than 10n, the flashing will barely be bright enough to see. If it's much above 100n, the time between flashes is too long — you have to sit by the ioniser for minutes at a time to judge the output. The value I've specified in the parts list is 47n, which will give about one flash every thirty seconds with an average emitter — a lot quicker with a good emitter and quicker still if you bring your hand or face within a foot or so of the tips to draw the ions away.

Assuming that each electron emerging from the emitter results in the creation of one ion, the number of ions generated between successive flashes of the counter is easily calculated. To bring a 47n cap from the neon's extinguishing voltage to its striking voltage — a difference of 50V — requires a total charge of 2.35×10^{-6} Coulomb (this is just calculated from $q=CV$). The number of electrons which will have a total charge of 1 Coulombs is 6.24×10^{18}, so multiplying this by 2.35×10^{-6} gives the total number of ions created: 1.47×10^{13} or roughly fifteen billion ions. If the counter flashes at its average rate of once every thirty seconds, the Variat-Ion is creating thirty billion ions every minute!

Let's suppose you have a larger than usual bedroom of $100m^3$. How long will it take the Variat-Ion to produce enough ions to establish an average ion density of 1000ions/cc? (This is the kind of level you might find on mountain tops or other areas of high ion density.) The volume of the room is 10^8cc, so for a density of 1000 ions/cc there must be a total of 10^{11} ions in the room. The time taken for this ioniser to produce this number of ions, at a rate of 3×10^{13} per minute, is just one fifth of a second!

Of course, this assumes the ions are going to diffuse to all parts of the room within a fifth of a second and unless there's a gale force wind blowing, they won't. Initially there will be a very high concentration of ions around the ioniser itself and the rate at which these spread out will depend on the convection currents and other air movements in the room. There will also be a steady loss of ions as they hit particles in the air, walls, positive ions and so on. But at a rate of five times the total number of ions needed being produced every second, I'm sure I don't need to do any more arithmetic to convince you that the ion density will built up quickly and will be sustained at a very high level indeed.

Construction

The component layout for the main PCB is shown in Fig. 3a. Put in the rectifiers first or you'll find yourself trying to poke them between two tall rows of capacitors, which ain't easy. The rectifiers at the narrow end of the PCB are fairly close together — whether they will all lie flat against the board or not depends on the manufacturer of the particular rectifiers you buy. The diameter of 1N4006/7s varies from one make to another. The best way to proceed to to put in every second diode (which will all point in the same direction so it's easy to check for one pointing the wrong way) and then fill in the gaps with the rectifiers pointing in the opposite direction, letting them sit a little above the PCB if necessary.

When you come to solder the diodes (and all the other components for that matter) it's a good idea to cut the leads to size first and solder afterwards. The bugbear of any EHT circuit is power loss through corona discharge from sharp points or edges which encourage discharge. If your soldering iron is too hot, you can also get spikes of solder when you remove the iron from the joint. Soldering along a row of leads one after another should keep the iron cool enough.

After the rectifiers, put in the capacitors. With encapsulated types it usually happens that the leads are not exactly central when they emerge from the case. The PCB allows for a slim gap between adjacent capacitors, but if one seems to be a tight fit, turning it around should cure the problem. Finally, solder in the resistors and a few inches of insulated wire to join the 'hot' end of the board to the emitter board.

At this stage, clean the board thoroughly with isopropyl alcohol or a proprietary board cleaner of some kind, then spray on a few coats of anti-corona compound. This isn't absolutely essential but if you want to prevent unnecessary losses in the circuit it's a good idea. Spray both sides of the PCB and give it at least fifteen minutes to dry between coats. It will try your patience but it's well worth the bother.

While you're waiting for the anti-corona spray to dry, you can assemble the emitter and ion counter board (Fig. 3b). Leave a little slack in the neon bulb leads to allow it to be positioned under the lens later on. Once again, cut the component leads before soldering. After soldering the components, push a 20mm M3 bolt through the hole in the large, square pad, with the head on the copper side of the board (Fig. 4a), put on a nut to hold it in place, then solder the bolt head to the PCB pad. Solder the wire from the main PCB to the small PCB, then clean the small board and give it a few layers of anti-corona compound too. Before you spray, put two or three nuts onto the end of the bolt (which will later act as a support and contact for the emitter) to keep it clear of the compound.

While both boards are drying, you can drill out the case. The emitter will need a 1/8in hole in the top of the box, half way between the two sides and about 1in (not critical) from the end. Half an inch away from the emitter, towards the left-hand side of the case (looking at it from the front panel end) comes the neon lens hole (Fig. 4b).

If you can't get hold of a separate lens or a suitable piece of translucent plastic, you can saw the end off a panel neon lamp and use that. It's a shame to waste a lamp but you can at least salvage the bulb (and if you're really miserly, the resistor too!).

The box specified for the project has aluminium front and rear panels and a steel chassis. The only metal part allowable on the ioniser is the front panel — the chassis and the rear panel will have to go. The chassis is not needed at all, but the rear panel will have to be replaced with a plastic one. You can cut one from the plastic case of a retired project, using the metal panel as a template or you may use some other suitable material.

The front panel has to be drilled for the mains lead (which must be fitted with a strain relief bush), the neon lamp and the pot RV1. If you use a separate resistor R1, neon bulb and lens (wired as in Fig. 3a), the 'mains on' indicator can go in any convenient position. If you use a panel neon assembly (wired as in Fig. 4c — note that R1 is no longer required) the hole must be mid-way across the panel and fairly high up so that the neon body is well clear of the components on the PCB. The pot and mains inlet positions you can arrange according to taste but wiring is a darn sight easier if you put the inlet to the left and the pot to the right. It also helps if you bolt the pot to the panel with its tags facing upwards.

Now that the boards are dry you can solder the fuse holder clips to the PCB (if you'd soldered them earlier they'd be covered in goo by now!) Also solder three 3in lengths of insulated wire for the pot connections and a similar length for the neon lamp connection. Push the mains wire through the strain relief bush, then push the bush through the panel hole, squeezing the bush with pliers to clamp the wire firmly. there should be about 4in of mains lead on the inward side of the panel. Strip off all but ¼in of the outer insulation and cut the live and neutral wires back to about 1½in length. Strip the ends and solder them to the PCB.

By this time you will feel more like a snake handler than an electronics enthusiast, with several feet of mains wire connected to the large PCB connected to the small PCB and a metal panel dangling somewhere along the way. To tidy everything up, screw the main PCB into the case (using four no.4 6.4mm self tapping screws), slot the front panel into the lower section of the case and tape the small PCB temporarily to the main PCB to prevent the link wire from flexing and maybe breaking.

Now the front panel has to earthed. In the prototype I used a neon lamp with a metal body which fixed to the front panel with a nut and shakeproof washer. A 0BA solder tag fitted neatly over the body and was held between the washer and the panel. The earth wire was soldered to the tag.

Now solder the neon lamp wires and the pot wires (makes it much easier with the terminals facing upwards, doesn't it?) and check out your wiring carefully with Fig. 4c. There is provision on the PCB for an on/off switch if you want to fit one. I didn't — the ioniser is left on day and night and I've never wanted to turn it off! There is also provision for fitting a separate neon bulb and resistor if you prefer this to using a complete lamp assembly. Connections are shown in Fig. 3a.

Remove the tape holding the small PCB to the large one. Twist another nut onto the emitter bolt and rest a shakeproof washer on top of it. Push the end of the bolt through the hole in the case lid and adjust the position of the nut so that when it is pushed against the lid the PCB will be level with the neon bulb just underneath the lens. Above the case top, drop another washer onto the bolt, put on another nut and, holding the PCB so that it doesn't twist around, tighten up the nut to hold the PCB firmly in place (Fig. 4d). Just to make sure the nuts don't work loose, you can apply a little Loctite or Superglue or some similar preparation.

Push the back panel into the bottom case section and bring the two halves of the case together. Put in the case screws, tighten them up, push on the plastic feet and you're done. Apart from the emitter, that's it.

Emitters

The emitter used on the prototype was an airgun cleaning brush. It works well, but a rifle cleaning brush is better, and a brush with 'V' shaped wire soldered to the top is best of all (Fig. 6a). The wire is sharpened by cutting it with a pair of flush-cutting wire cutters used 'upside down' — that is, with the flat side of the cutters pointing away from the brush and the bevelled side towards it. The brush simply screws onto the emitter bolt — the chances are that the thread won't quite match (I took my brush along to the local hardware shop and they couldn't find *any* thread to match it!) but it should screw down far enough to be held firmly. As a last resort you could solder an M3 nut to the bottom of the brush, but it shouldn't be necessary.

If you fancy experimenting with different emitters (and since the effectiveness of the ioniser depends very much on the quality of the emitter it's certainly worth doing) there are all kinds of things you can try. A very effective emitter, although it doesn't look very pretty, is a length of stranded connecting wire with about ½in of insulation removed and the strands separated out so that they point upwards, sidways, all directions. If you remove 2in or so of insulation, you'll find the strands will be attracted to your finger. With 6in of bared wire, you've got an electric forest that will wave about if you pass your hand above it!

I have been told that carbon fibres make a very effective emitter. Rumour has it that it's possible to buy reels of the stuff in a kind of carbon rope from which the individual strands can be separated out. So far I've been unable to track down a source so I can't give a first hand report. If you find any — try it!

Sewing needles can make fairly good emitters, especially if you use several of them. Outside the case they would be a menace — imagine having a restless night and impaling your hand on one — but inside the case they'd be fine. The way to arrange it is to get hold of an offcut of copper clad board, solder the needles along one edge (stainless steel doesn't solder too well, so you may need to fix the needles in place

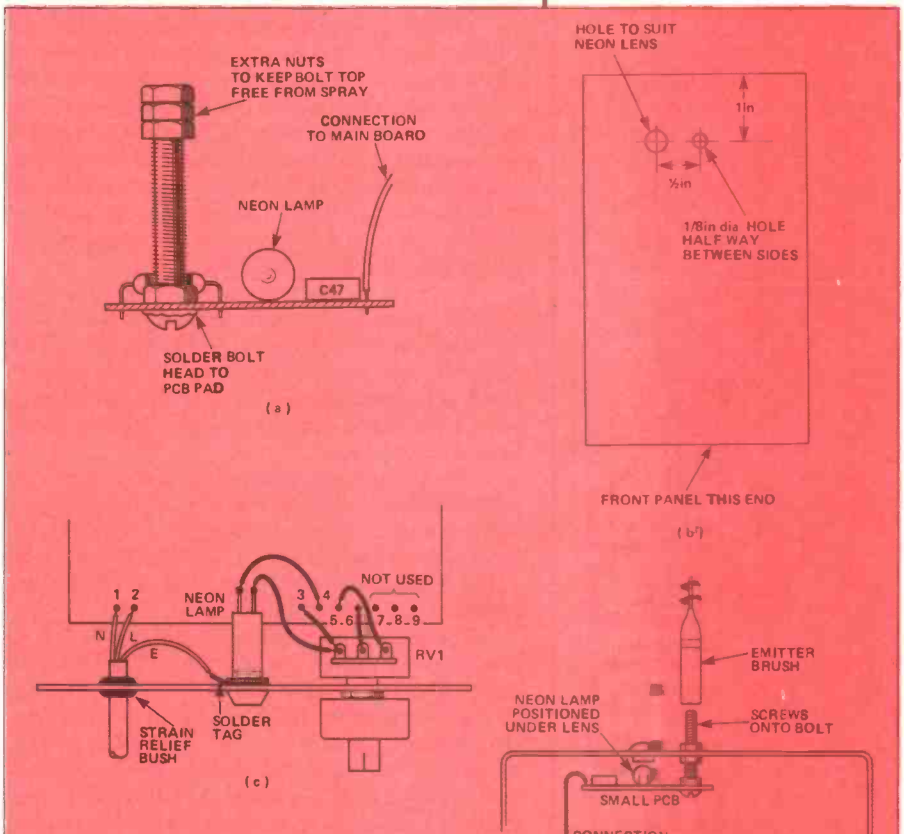
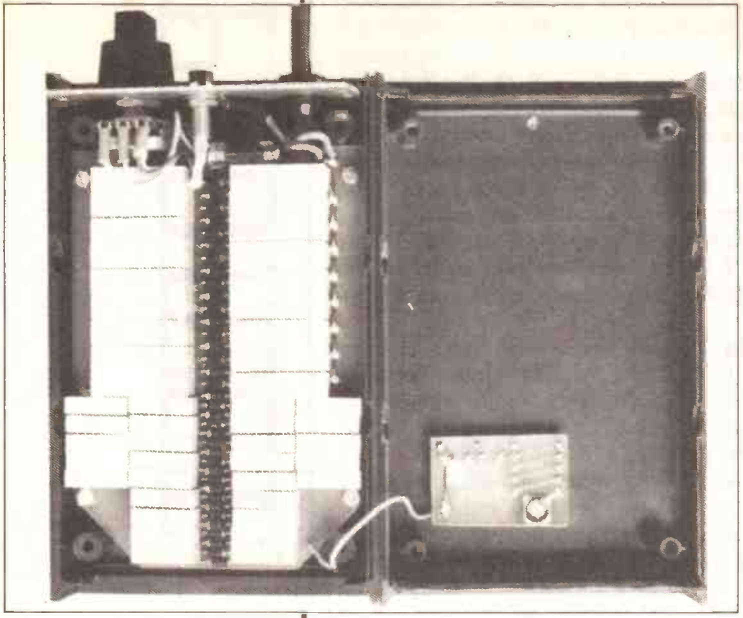


Fig. 4(a) The assembled ion counter PCB. (b) Hole positions on the case top. (c) Front panel wiring. (d) Ion counter and emitter assembly



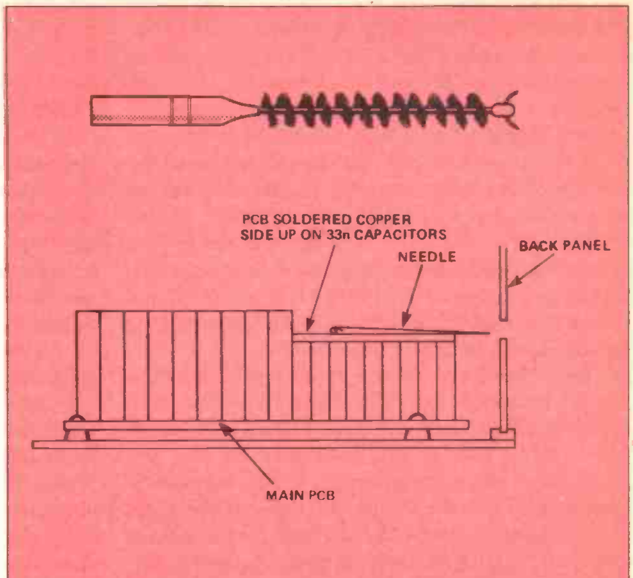


Fig. 5(a) The ultimate emitter. (b) An enclosed emitter

PROJECT

some other way) then glue the board copper side up onto the 33n caps at the end of the main PCB. Drill a 3/16in hole for each needle in the plastic end panel of the case and you have a completely enclosed ioniser (the needle tips should be about ¼in behind the holes). This won't give you a better ioniser but if it is to be used by children it may be preferable to having an exposed emitter. (Fig. 5b).

The general rule is that anything with sharp points or edges will make a good emitter. Come to think of it, a razor blade would probably work well, although comments about pins outside the case should be multiplied by a factor of 99 billion where razor blades are concerned. Inside the case — why not?

Certain types of houseplant make excellent ion emitters. I remember hearing once that somebody was actually making plant pots with an ioniser built into the base, although I've never actually seen one. Have to be a bit careful watering the plants with a 5kV ion generator in the vicinity, I should think. If you want to try it out, choose a plant with sharp, pointy leaves, stand it on a polythene bag, run a wire from the ioniser's output bolt to the soil in the plant pot and you've got your very own triffid.

If you put your hand close to one of the leaves, it will be drawn towards you. Let the leaf touch you and it will spring back again. A very shy triffid. The reason is, of course, that the leaf discharges as soon as it touches your hand. Plants don't seem to mind being ionisers and some say they grow better when treated in this way.

The Variat-Ion is quite powerful enough to run several emitters — you can spread empty plastic boxes with gun brushes attached all round the room and run them all from the one ioniser. The best scheme is to give each brush a separate series resistor so that it can select its own operating voltage.

The ionisation potential control can be left at maximum for most types of emitter. The time you need a lower potential is if the emitter has very fine points, like the carbon fibres, needles or (possibly) the razor blade! If you use too high a potential, all that happens is that the current density in the point will melt it, round it off and make the ion emission less efficient. The best thing is to bring the control up from minimum until you feel a distinct breeze from the points and leave it on the setting where that first occurs. If you can afford to waste a few emitters, you can try setting the control higher, then check an hour later to make sure that the ionisation rate is just as strong. If the ion counter is flashing less frequently, you've got the control set too high, so start again. Keep the windows open while you're doing this to keep the ion density in the room fairly low, since the rate of emission will drop off in any case as the room becomes saturated with delicious neg-ions.

Safety

The Variat-Ion works by raising a piece of metal to several thousand volts above its surroundings. In the version with the external emitter it is possible to touch both the high voltage part and an earthed object (such as the front panel of the ioniser itself) simultaneously. For any healthy adult this experience is not in the least dangerous, or even shocking, if you'll excuse the pun, since the current available is very small. The circumstances where I would advise caution are either if you have any reason to suppose your heart is dodgy, if you (or anyone else who may come into contact with the ioniser) have a pacemaker or if young children are likely to have access to it. In any of these cases, the safest thing would be to make the fully enclosed version where the ionising points cannot be touched.

The current available from the ioniser will depend to some extent on the quality of the mains earth in your house. In mine, I measured 75μA on the prototype. The maximum current from the ionising tip to mains neutral (which is the maximum current available no matter how good your earth) was 110μA. The current needed to have any effect on a healthy adult is well over 100 times as great so there's a good safety margin.

The main problem with young children is not that the current itself may harm them but that the surprise of a sudden tingle (which they will feel more keenly through sensitive skin than you will through your tough fingertips) might cause them to drop the ioniser or knock it onto the floor, with who knows what results? If in doubt, enclose the points, OK?

If you have to dismantle the ioniser for testing or any other reason after it has been turned on, be sure to discharge it thoroughly by touching the neutral prong of the mains plug to the emitter. There are resistors to bleed away the charge on the larger caps but with any EHT circuit you can't be too careful.

Living With Ions

When you try out the ioniser the first thing you might notice in a quiet room is a gentle hiss from the emitter.

If you don't — put it a bit closer to your ear! The gentle breath you feel on your hands or face a few inches from the emitter is the ion breeze I spoke of earlier.

It's quite understandable if you feel a little wary of the ioniser at first. The best thing is to approach it boldly. Touch the emitter with the back of your hand. You'll hear a little squeak as you make contact but you shouldn't feel anything at all. The only way you can get a tingle from the ioniser is to touch some earthed surface (like the front panel of the ioniser itself) and to hold a finger about 1/8in from a flat part of the emitter — the shaft of the gun brush. Alternatively, you can touch the emitter and hold a finger close to the front panel. The sensation comes about because conduction in your finger takes place in a series of quick pulses as your body charges and discharges. Touch the emitter and earth without leaving a gap and you'll feel nothing again. So now you know, and there'll be no surprises!

The Variat-Ion is designed to run continuously, day and night. If you don't want the bother of moving it around the house, the best place for it is by your bedside where you will have the benefit of ionised air for eight hours or so at a time. Because its strong action in precipitating dirt and dust from the air, its a good idea to stand the ioniser on a washable surface a few feet away from the nearest wall. The dust will then fall in the carpet and be swept up during normal household cleaning. Too close to a wall and it may taint the paint or wallpaper, which will not be too popular with the Mizz.

The lightest and most active ions are found close to the emitter, so the nearer the ioniser is to your bed, the better. This is particularly important when it is being used to treat respiratory complaints, which seem to need the small, highly mobile ions. If you're just looking for a general improvement in mood and brain function, put it anywhere in the room.

Some people like to hold the ioniser quite close to their face and breathe deeply for minutes at a time. This, they say, makes them feel fresh and alert. Others just like to know there's an ioniser around the place and may not touch it for weeks at a stretch. Some move it from room to room during the day, and even take it to work with them. Others prefer to let the ions build up in one single room. Some say their ioniser has changed their life. Others say they can't be sure but look uncomfortable if you suggest turning it off!

There are as many ways to live with an ioniser as there are individuals, but one thing's for sure: anybody who's ever owned an ioniser would never again want to be without one.

ETI

BUYLINES

The Retex case for the project is available from West Hyde Developments (standard version) or Specialist Semiconductors (with plastic rear panel). Suitable resistors can be obtained from a number of suppliers but the rule is to check before ordering since most ¼W types are only rated for 300V. Half watt resistors are a better bet. Gun cleaning brushes can be obtained from any huntin', shootin' and fishin' shop (look under 'Arms and Ammunition' in Yellow Pages). Class X capacitors will be available from any large component catalogue, as will board cleaning preparations and anti-corona compound.

A complete parts set for the project can be obtained for £29.32, inclusive of postage and VAT from Specialist Semiconductors, Founders House, Redbrook, Monmouth, Gwent NP5 4LU. Components are available individually from the same source.

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E8402-4	Modular Pre-amp Relay, PSU	F
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E8405-6	Drum Synth	F
E8406-1	Oric EPROM Board	O
E8406-2	Spectrum Joystick	E
E8406-3	Audio Design RIAA Stage	G
E8406-4	AD Buffer/Filter/Tone	H
E8406-5	AD Headphone Amp	F
E8406-6	AD Preamp PSU	K
E8406-7	AD Power Amp	H
E8406-8	AD Power Amp PSU	J
E8406-9	AD Stereo Power Meter	F
E8406-10	AD Input Clamp	C
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E8408-3	Infra-red Alarm Transmitter	E
E8408-4	Infra-red Alarm Receiver	F
E8409-1	EX42 Keyboard Interface	F
E8409-2	Banshee Siren Unit	F
E8410-1	Echo Unit	F
E8410-2	Digital Cassette Deck	N
E8410-3	Disco Party Strobe	H
E8411-5	Video Vandal (3 boards)	N
E8411-6	Temperature Controller	D
E8411-7	Mains Failure Alarm	D
E8411-8	Knite Light	D
E8411-9	Stage Lighting Interface	F
E8411-10	Perpetual Pendulum	E
E8412-1	Spectrum Centronics Interface	F
E8412-4	Active-8 Protection Unit	F
E8412-5	Active-8 Crossover	F
E8412-6	Active-8 LF EQ	F
E8412-7	Active-8 Equaliser	F
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E8502-1	Digital Delay Expander	N
E8502-2	Data Logger	J
E8503-1	Combo Preamplifier	F
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E8511-9	Second Line of Defence	M
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E8512-2	MTE Pulse Generator	H
E8512-3	Specdrum	L
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E8604-2	Matchbox Amplifier	C
E8604-3	Matchbox Amp Bridging Version	C
E8604-4	MTE Analogue/Digital Probe	M
E8605-1	Microlight Intercom	E
E8605-2	Baud Rate Converter	M
E8605-3	Baud Rate Converter PSU Board	C
E8605-4	Portable PA	H
E8606-1	MIDI-CV Converter Board	H
E8606-2	MIDI-CV Converter PSU	D
E8606-3	Troglograph	F
E8606-4	80m Receiver	H
E8606-5	Sound Sampler	R
E8607-1	Direction	E
E8607-2	Upgradeable Amp, MC stage (Stereo)	G
E8607-3	BBC Motor Controller	F
E8608-1	Digital Panel Meter	G
E8608-2	Upgradeable Amp, MM stage (mono)	H
E8609-1	Mains Conditioner	E
E8609-2	Experimental pre-amp	F
E8609-3	Upgradeable amp, Tone board (mono)	H
E8609-4	Upgradeable amp, Output board (mono)	F
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E8701-1	RGB Converter	F
E8701-2	Mains Controller	D
E8701-3	Flanger	H
E8701-4	Audio Selector main board	M
E8701-5	Audio Selector PSU	H
E8701-6	Tacho-Dwell	F
E8702-1	Ratemeter main board	K
E8702-2	Ratemeter ranging board	F
E8702-3	Photo Process Controller (3 bds)	O
E8702-4	LEDline display board (2 off)	K
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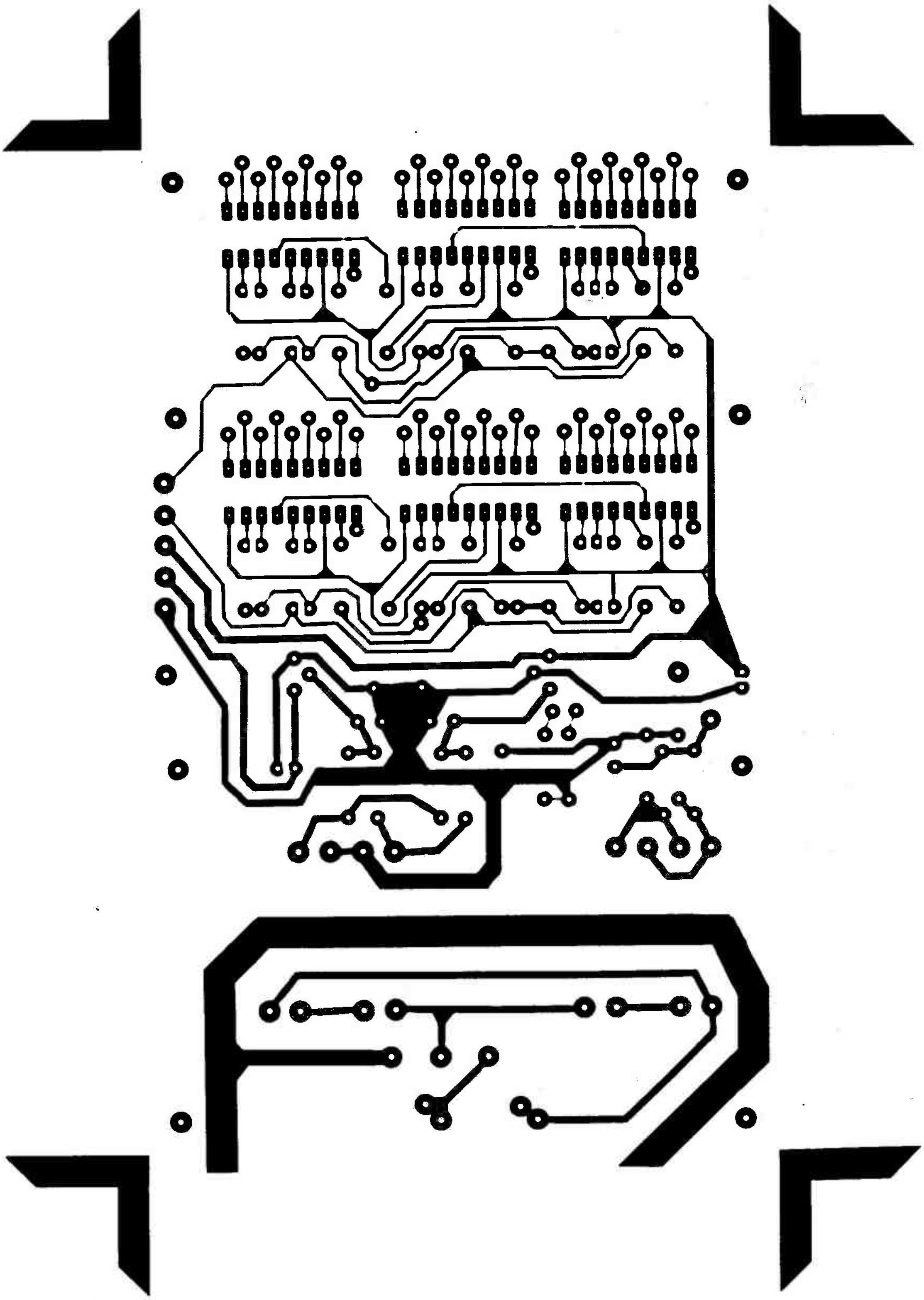
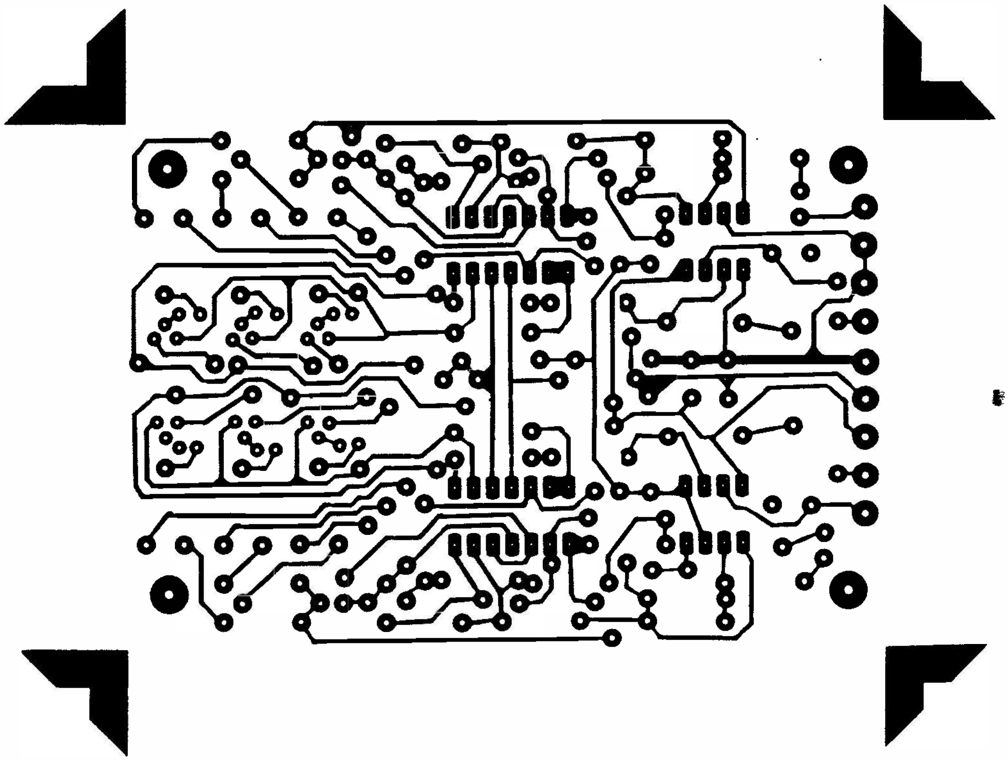
E8706-2	MIDI Keyboard CPU	U
E8706-3	MIDI Keyboard Front Panel	O
E8706-4	Flame Simulator	G
E8707-1	MIDI Keyboard PSU	H
E8707-2	Telephone Alarm	J
E8707-3	Nuclear Strategy Simulator	J
E8708-1	Remindalite	F
E8708-2	Rear Wiper Alarm	G
E8708-3	Rev Counter	F
E8708-4	Car Alarm	F
E8708-5	Knight Raider	J
E8709-1	Boiler Controller	G
E8709-2	Amstrad Sampler (2 bds)	P
E8709-3	Portable PA	G
E8709-4	EEG Monitor (2 bds)	L
E8710-1	Concept CPU board	N
E8710-2	Concept Power board	K
E8710-3	Concept display board	G
E8710-4	Hyper-Fuzz	F
E8710-5	Big Digits digit board	N
E8710-6	Big Digits minute board	F
E8710-7	Big Digits battery board	G
E8711-1	Quiz Controller	E
E8711-2	256K Printer Buffer	N
E8712-1	Heating Management System	O
E8712-2	SWR Meter	H
E8712-3	Dream Machine (free PCB)	D
E8801-2	Passive IR Alarm	H
E8801-3	Deluxe Mains Conditioner	G
E8801-4	RGB Dissolve	L
E8802-1	Electric Fencer	E
E8802-2	Telephone Intercom	L
E8802-3	Transistor Tester (2 bds)	L
E8802-4	Spectrum Co-processor CPU	N
E8803-1	Co-processor RAM board	N
E8803-2	Beeb-Scope (3 bds)	O
E8803-3	Jumping Jack Flash	E
E8804-1	Spectrum Co-processor Interface Board	N
E8804-2	Combo-lock	E
E8804-3	Kitchen Timer	E
E8805-1	Virtuoso 2U PSU	M
E8805-2	Virtuoso 3U PSU	N
E8805-3	Bicycle Speedometer	F
E8805-4	Dynamic Noise Reduction	E
E8806-1	Universal digital panel meter	L
E8806-2	Universal bar graph panel meter	K
E8806-3	Virtuoso power amp board	N
E8806-4	Virtuoso AOT board	G
E8806-5	Metal detector	E
E8806-6	Bicycle dynamo backup	D
E8807-1	Bar Code Lock (2 bds)	N
E8807-2	Analogue Computer Power Board	L
E8807-3	Bell Boy	F
E8807-4	Logic Probe	C
E8807-5	Updated FM stereo decoder	J
E8807-6	Breath Rate display board	F
E8808-1	Breath rate main board	H
E8808-2	Breath rate switch board	C
E8808-3	Telephone recorder	D
E8808-4	Analogue computer main board (2 bds)	M
E8808-5	Random number display	O
E8809-1	Spectrum EPROM Emulator	M
E8809-2	Frequency meter (2 bds)	P
E8809-3	Travellers' Aerial Amp	E
E8810-1	Gerrada Marweh Bikebell	E
E8810-2	Peak Programme Meter (2bds)	N
E8810-3	Variat-Ion ioniser	K
E8810-4	TV-to-RGB converter	E
E8810-5	Electron RGB buffer	C

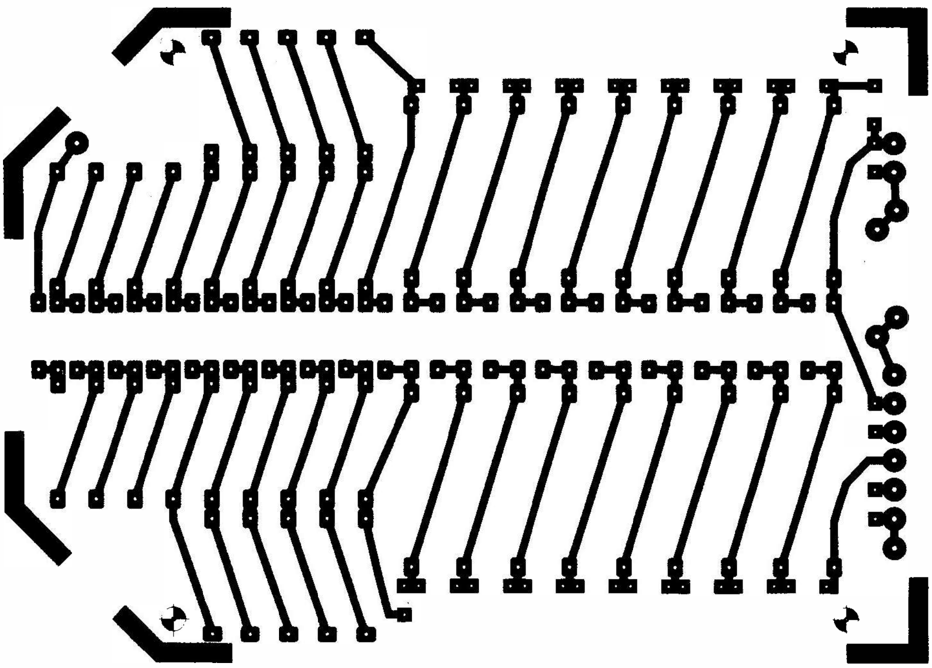
PCB FOIL PATTERNS



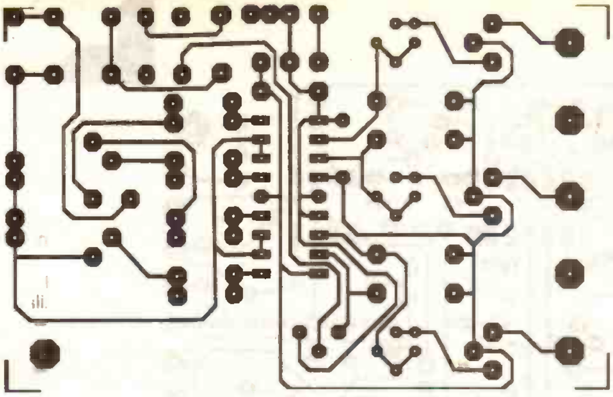
The Peak Programme Meter main board



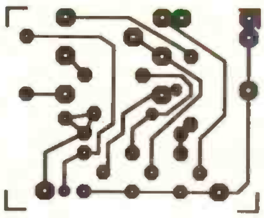
The Peak Programme Meter small board



The Variat-Ion ioniser main board

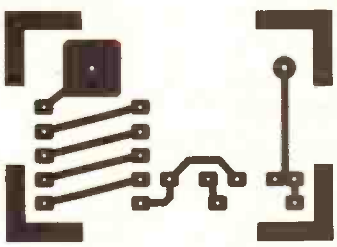


The TV-RGB converter board



The Electron RGB booster board

The Gerrada Marweh bikebell foil



The Variat-ion emitter board

OOPS!

Dream Machine (December 1987)
The transistors used in this project are ST1702. BC108s can be substituted.

Heating Management System (December 1987)
A 4116 is not a suitable alternative to the 6116 specified. A 4016 RAM chip will suffice. In Fig. 1 the junction of R1/D5 should connect to D1-4/C1 and not cross. The zener diodes above the temperature sensor ICs (IC16-19) should be deleted. C4 should be 220n and not 220µ. C7-10 should be 10µ. Q2-7 should be 2N3904 and not BC3904.

RGB Auto-Dissolve (January 1988)
In Fig. 5 there are marked two D6's. The right hand one should be D5 (they are both 1N148's anyway). In the text the reference to zener diode D5 should read ZD1.

Power Conditioner (January 1988)
There is confusion between the values of R7 and R8 in the Parts List and Fig. 1. These should be: R7-27k, R8-10k and not as given in the Parts List. In addition, ZD1 is incorrectly orientated in Fig. 3. The positive terminal should be at the southern end.

Passive Infra-Red Alarm (January 1988)
Fig. 2(a) shows the base of Q1 connected to ground and to R14. It should be connected only to R14.

Transistor Tester (February 1988)
The foil pattern for the main board was printed reversed left-right on the foil pages.

Spectrum Co-processor (March 1988)
Mogul Electronics, given in the Buylines as suppliers of the RAM chips, have moved to: Unit 11, Vestry Estate, Sevenoaks TN14 5EU. Tel: (0732) 741841.

Dynamic Noise Reduction (May 1988)
The LM1894 is no longer available from the sources listed but it can be obtained from the author. Please address orders to Manu Mehra, 88 Gleneagle Road, Streatham, London SW16 6AF.

QL Output Port (Tech Tips May 1988)
Several problems with the diagram for this one. A5 should read AS — that is, address strobe. Pins 22 and 24 should be connected to +5V and the junction of the (only) resistor and diode connected to VPA on the QL.

QWL Loudspeakers (August 1988)
Some dimensions were missing from Fig. 7. The bass driver port centre should be 3¾in above the base of the baffle panel. The notches in the side of the tweeter cut-out are ½in wide. The top plate is missing from the cutout diagram (Fig. 6). This is 7 × 4⅝in.

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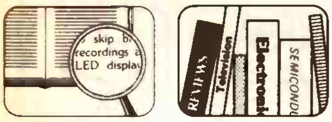


Video Techniques (2nd ed) by Gordon White. £30. Heinemann Professional Publishing, Halley Court, Jordan Hill OX2 8EJ.

With a title like *Video Techniques*, you could be forgiven for thinking that this was yet another book of hints for the amateur videographer — and an expensive one at £30 a throw. But you'd be wrong.

A closer look reveals a well thought-out guide to the history of video and its transformation since it all started (over 50 years ago) with Baird and Scheonberg.

The author, Gordon White, has written the book 'to help the young engineer with only the new technical knowledge to understand the reason why the system operates as it does' and he shows how today's methods of operation and design have been influenced by the experiences of yesterday.

Each chapter covers a wide area of subject. For example, *The Television Waveform* starts with its basic principles, the first scanning method (amazingly patented by Nipkow in 1884!) through its development by the Baird company in the early thirties until the acceptance of the EMI system by the Beeb in 1937.

It deals with present day standards and conversion systems right up to the latest enhanced and extended definition television. There are plenty of easy-to-understand circuits and block schematics but White avoids technical explanations 'unless it is to illustrate a principle, *Video Techniques* does not describe circuitry or individual pieces of equipment as these rapidly change'.

He always reminds you of the origins of each subject, be it cameras, recording techniques, post production, studio design, transmission and reception methods and takes you through all the stages of research and development, finally giving his considered view of the future.

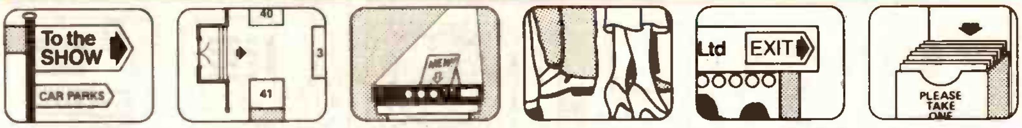
Even the enthusiastic semi-technical amateur who might not understand all the circuits and schematics will find plenty to interest and inform in the easy-to-read pages.

This second edition brings us into the world of digital television and White points out how the very nature of broadcasting is changing as the new technology gives the producer and viewer more and more sophisticated facilities, making the point that the engineer is once again having to adjust and re-educate himself.

This book will certainly help to make that task easier and, at the same time, make him aware of those early pioneers whose achievements still influence today's Video Techniques.

James Talbot

APRS SHOW REPORT



June of this year saw the annual exhibition for all those people in the professional audio market at London's Olympia 2, organised for the 21st time by the Association of Professional Recording Studios — the APRS. This year 174 exhibitors showed some 6000 visitors to the show exactly what all the best equipped studios will be sporting during the next year.

The show saw some interesting developments which, although only available to those people whose annual income looks like a telephone number at present, will no doubt filter down to the rest of us in the foreseeable future.

Let's Get Digital

Yes folks, 'digital' is this year's buzzword. Just about everything at the show was in some way digital or at least 'equipped for the digital age' — whatever that means. Most directly relevant was the launch of several DAT recorders from several of the major manufacturers, most notably Sony and Casio with their portable DAT models.

Not surprisingly the Casio model has set out to be the cheapest on the market retailing for about £800. However much of the broadcasting industry has or are about to opt for Sony's PCM-2500 which is considered to be more 'in the field reporter' proof.

At the other end of the spectrum comes the Sony PRODAT 1 and 2 which sport electronically balanced analogue inputs as well as both domestic and professional EBU digital inputs.

To compliment this wave of digital mastering we find ourselves with digital replacements for just about everything that you would normally find in a studio. It all stems from the fact that the end result is only as good as the weakest link in the audio chain — something the industry is taking great delight in telling us as it means they can sell virtually complete new set-ups to existing studio owners.

Many of the mixing desk manufacturers have taken the easy option of taking last year's model, cleaning up the circuitry a bit and calling them 'digital ready'. However, an equal number of companies have actually made important steps forward in audio technology.

Yamaha's DMP-7 eight-into-two digital mixer is not only totally digital from input to output stage but has four effects processors built-in and motorised faders. All this and MIDI control to allow automated mixdown as well. Watching the unit in action is quite amazing: seeing the faders reposition themselves within the blink of an eye certainly made me feel like robbing a bank in order to get the £4000 needed to buy it.

To make life even easier Yamaha has teamed up with Steinberg (best known for their sequencer software) to produce an on-screen editor package which allows you to save and load various mixer settings via an Atari ST. Furthermore you have full control over all parameters at the click of a mouse. In a similar vein was the

Matchless Mixing desk from TAC. This is a conventional desk with a MIDI interface on it allowing software such as the JMS (Jellinghaus Music System) C-Mix package on the ST to change volume level and EQ settings via MIDI allowing syncronisation between a sequencer and the recording console.

Harman Audio is excited about the launch of its new desk. The whole exercise comes under the title of the REMIS project — (rather like a Fredrick Forsythe novel). It is a British designed, SMPTE automation assisted mixing console which is hoped to blow away the competition in the £10-25,000 price bracket.

Be Direct

Another area of activity is Direct to Disk recording — the process of multitrack recording directly on to a hard disk drive. This allows digital sound quality, precise yet non-destructive editing facilities and as many as 200 individual tracks, depending on the size of the song and the memory. In effect these are incredibly large samplers with much more control.

New England Digital was first to produce such a system called the Synclavier which has built up quite a reputation for itself not to mention a large user base of musicians such as Trevor Horn, Paul Hardcastle and Frank Zappa.

However, there is some competition from Digital Audio Research with the Soundstation II, selling itself as a total music production console.

If we may I'd like to get back to the analogue world of tape (remember tape?). In particular Tascam and TOA, who are both launching new 8-track recorders. They've managed to squeeze eight tracks onto a standard audio cassette and I have to admit that it sounds quite respectable.

Little Boxes

It wasn't all expensive large boxes at the show. There were many expensive small things as well! The new Rebis Multigate gives you up to four different noise gate treatments at any one time. From Citronic we have the SPX7-21 15-band graphic equaliser, the MPX9-11 background music mixer and zoning unit and the SPX5-41 active crossover each costing between £340 and £450.

Sound Technology had nothing really new on their stand but as distributor of Alesis effect units in this country an insider reliably informed me of a new MIDIverb which will allow four different effects running at the same time. The unit will be called the Quadraverb.

Mr Speaker

Loudspeaker manufacturers were also in evidence. HH Electronics had the TA series of PA monitors complete with the C1 system controller. From Tannoy we have a sneak preview of the new AV Pro series designed for control room monitoring. These should be available by October.

With such chunky speakers coming onto the scene you may well be after a sound analyser and it just so happens that Electromusic has just released a nice one christened the Scanalyser which thanks to its unique sweep filter can display detail that the competition can't manage.

Bits And Pieces

Sifam Ltd were showing off their range of audio meters, knobs and faders

whilst Ampex displayed various formats of magnetic tape including the new Ampex 478 featuring better than average wind characteristics, improved low print performance and a new high speed backcoating. Not only that but it sounded good as well! Klotz had all 58 varieties of cable on show in addition to the Neutrik connectors as well as the Mikro and Nano PA speaker ranges which they also distribute.

Obviously the current wave of digital equipment on show points the way towards how we will be composing and recording in the future. All we have to do now is wait.

Darrin Williamson

PLAYBACK

Recently the *New Scientist* published an article concerning the much reduced longevity of certain compact discs, a story seized upon and later sensationalised by the good old non-technical popular press (one paper even claimed an 'exclusive'!) Embellishments aside, the true nature and potential seriousness of the problem may well have been blown out of proportion.

To some extent the originators of the CD format have laid themselves open to such a broadside by virtue of their initial claims of 'perfect sound forever'.

Nothing lasts forever, especially if it is a plastic/aluminium sandwich destined for a considerable amount of abuse.

Bringing things up to date this latest scare concerning the life-expectancy of CD's is generally attributed to the specialist Nimbus and Mobile Fidelity pressing plants. Both companies have highlighted the alarmingly high failure rate of certain discs derived from some other (competing) plants.

Long-term archiving experiments have indicated that 95% of all conventional discs offer a stable and acceptably low error-rate over a three year period, while some 5% of discs show an increase in the digital error rate of up to 200 times after just two years of careful storage.

Some discs have apparently deteriorated so rapidly as to be rendered useless after just a few months!

Current evidence suggests a gradual oxidation of the aluminium reflector layer is responsible. The gradual build up of fibrous residues conceal the minute 0.4x0.1μm 'pits'. However, this aluminium reflector layer is vapour deposited onto the encoded portion of the CD's polycarbonate window, the rear surface being quickly sealed by a thin layer of lacquer.

Air

Air should therefore be excluded from the inside of the disc, severely hampering any oxidation mechanisms. However, a degree of uncertainty is thrown into the equation by the actual thickness and durability of the lacquer itself, especially when some pressing-plants are employing inappropriate solvent-based inks to decorate this thin layer.

Considering this rear surface may be less than 30μm thick, many halogenated solvents would easily penetrate the lacquer before fully volatilising from the ink itself. Even if this only occured on the microscopic level, the aluminium surface would still be sufficiently exposed for a gradual, parasitic oxidation.

This leads onto another variable: the actual thickness of the aluminium reflector itself. To all intents and purposes the amount of aluminium used is determined by the required reflectivity of the finished system but a quick examination of different discs reveals that this 'requirement' has been loosely interpreted. In fact the layer inside some discs is so thin as to be completely transparent, while other discs remain totally opaque when held up to the light.

Pin Holes

This situation is quite removed from the obvious loss of information caused by 'pin-holes'. It seems to me the thinner the layer the more readily will it be consumed by oxidation. This is particularly important if oxidation is actually occurring from the rear surface, the digitally encoded information being stored on the front surface of the aluminium.

Adding fuel to the long-term archiving tests, other researchers have employed short-term accelerated aging techniques, extrapolating the results to predict failure in 'real' time.

This generally involves a periodic cycling of both temperature and humidity, stressing both the chemical and physical stability of the materials to their limits. While this may be a trifle OTT and perhaps unrepresentative of domestic abuse, the results concerning the premature demise of some discs is consistent. These methods have provided an excellent proving ground for the protagonists of gold and platinum-layer discs.

Physics & Chemistry

It would appear reasonable to assume that some pressing plants have not examined the physics and chemistry of CD manufacture in sufficient depth, their own poor products reflecting badly on the remainder of the industry. I have no doubt that names will be named in the very near future!

Meanwhile, certain uncharitable individuals have suggested that the manufacturers of such noble-metal discs have a vested interest in disparaging the conventional aluminium varieties. However, gold-coated CD's cost two to three times the amount of ordinary discs and currently offer only a very limited repertoire. At £11 a throw the silver-coloured discs are a bitter pill to swallow. I can hardly envisage £20-£30 'equivalents' selling like hot cakes.

Unfortunately then, this kind of ill-considered scare-mongering may end up back-firing on the very pressing plants that 'leaked' the information in the first place.

Paul Miller

OPEN CHANNEL

Get Smart! Yeh. I used to watch it, too! But the Smart I want to talk about here isn't the TV prog of yesteryear. It's the little piece of plastic which we'll all be carrying around in our wallets before too long, which looks set to replace existing credit cards and give us a few extra features as well.

Smartcards, on the face of it, are just like credit cards but embedded into them is semiconductor memory or processing power, which enables them to hold information. If the holder of a Smartcard wishes to buy something, the shopkeeper now doesn't need to telephone for authorisation because all relevant financial details are held digitally on the card. Merely reading the information with the use of a cheap card reader is sufficient to show that funds are available and the transaction can go ahead.

But purchases aren't the only use to which Smartcards can be put. Medical details, car log book, drivers' license, library ticket, etc ad infinitum can all be held and manipulated on the smartcard. For example, in South Wales a DHSS-financed experiment is underway to investigate the potential of smartcards in medicine-management. Doctors' patients are issued with smartcards holding prescription history, allowing patients to purchase drugs and medicines at chemists. The smartcard used in the experiment is manufactured in the UK by Cumana and holds up to 128K of information.

The amount of information which can be stored depends largely on technology, with 256K smartcards being common but the Japanese are in on the act, with current smartcards of 1Mb storage capabilities. It seems the sky's the limit.

So what are the technical problems in smartcards? The major one appears to be the method of getting all the information on in the first place and off when required. Such large amounts of data into such a small card require highly accurate read/write methods — the most common being magnetic, optical and, most recently, radio transceivers (used by GEC).

The introduction of all these varieties of smartcards will mean we will need more wallet space (already bulging) but if service providers get their technical heads together to define a single standard, it could be that all current plastic cards can be incorporated into a single smartcard.

What about cost? Smartcards cost around £3 to produce at present, while plastic cards with simple magnetic stripe information cost only around 10p. Greater numbers of smartcards will cause the price to tumble. Anyway, the cost is but a small

price to pay for the added security against card fraud. Estimates have already been made that the use of smartcards will prevent at least 60% of current card frauds — which means savings of many £m over existing plastic cards.

Defining A Standard

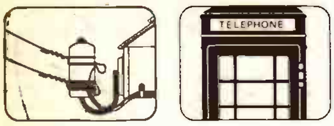
Until recently, it has been generally assumed that when the medium-powered television satellite Astra starts to transmit it will do so using the MAC (multiplexed analogue component) standard. SES, the Luxembourg-based organisation launching and running the Astra satellite have always said the Astra is transparent to television standards — whatever standard the programme providers beam-up will be beamed back down again to the users.

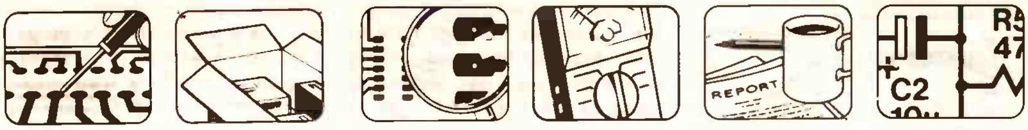
It has looked likely that the D2-MAC standard would be common (more by default than design) whereas the future British Satellite Broadcasting DBS satellite is planned to transmit according to the D-MAC standard. Use of either of these standards requires that users will need either (1) a new television capable of receiving and displaying the high quality MAC pictures or (2) a decoder to convert the received MAC signals to the PAL format common in terrestrial television receivers throughout most of Europe.

However, Rupert Murdoch's recent decision to use four of Astra's 16 transponders to broadcast his Sky Television channels to the PAL format has upset the apple-cart somewhat and has some far-reaching effects to the industry.

First, being on the PAL standard transmissions can be received by users owning existing televisions, for the price of an aerial (the infamous dish — around 60cm in diameter) and a simple receiver. Such receivers have been around for a few years now, in the small but growing satellite TV market, merely receiving the microwave transmissions from the satellite and converting them into UHF PAL signals directly receivable by an existing television. Current satellite TV receivers start at around £600, and go

ONCE OVER





up to around £2000. The high cost is partly because they use a much larger dish (1-2m) but mainly because they sell in low quantities.

The idea with Astra and following satellites is that the smaller dishes and higher volume production will make the receivers much cheaper and so more accessible by Joe Public. To this end Alan Sugar's Amstrad has indicated a committment to produce £200 systems, enabling us all to receive satellite transmissions extremely cheaply. In effect, Rupert Murdoch and Alan Sugar will tap a market which hitherto appears to have gone unnoticed.

Alan Sugar's part in all this is worthy of note. Amstrad, as readers will know, produces cheap and cheerful hi-fi, television, video cassette recorders and so on in large quantities. Alan Sugar was, until recently, a founder of BSB and the DBS venture. As I noted in this column when he pulled out of the consortium (September 1987) his going indicated that he did not wish to be part of an organisation producing low-to-medium volume equipment, at a high price.

In retrospect, it would appear that Alan Sugar was aware of Rupert Murdoch's intention to create four channels of satellite broadcast television using the PAL standard, knowing that high-volume, low-priced equipment is his forte.

Second, the Sky/Amstrad combination will mean that other potential programme providers will probably consider transmitting in PAL too. I am willing to put my money on this. Lead times in writing, editing and production of ETI will mean that readers may already have heard of other such channels on Astra which haven't yet got off the ground as I pen this.

Effectively, in a single, seemingly innocuous move, Murdoch and Sugar must have delayed European DBS plans, will have left DBS providers with a product they may not be able to sell and may have scuppered DBS altogether in its present form.

If Astra launches successfully in November as planned, for £200 Mr and Mrs Public could be sitting down after their Christmas lunch to around an extra 20 television channels (16 on Astra and a handful more on existing satellites) on their existing TV set. For Joe, his wife and the kids, the question will not have been whether to wait and pay more for three channels of high quality pictures and stereo sound (which DBS/MAC will give) but will have been the more more poignant question, why wait at all?

Keith Brindley

Chipkits, produced by the Polytechnic of Wales, are a series of modules intended to assist training in electronics. Three main modules are currently available: the Transistor Module, the Op-amp Module, and the Logic Module. In addition, an I/O Module of two PCBs with parts ready mounted, (including a loudspeaker, a motor, a microphone and so on) is also available for all three. Each main module consists of a printed circuit board, components and an instruction book and each kit is supplied in a smart plastic briefcase-style carton.

The printed circuit boards are fitted with sockets suitable for the type of components used in each module. The sockets, some test pins and screw connectors for power, inputs and outputs are interconnected to permit circuits to be built up without being so interconnected as to constrain the type of circuit.

Legend printing on the top face of the boards shows what is connected to where and labels some of the components, for example 'op-amp 1'. The bottom faces of the boards are fitted with rubber feet so that they do not scratch the table top.

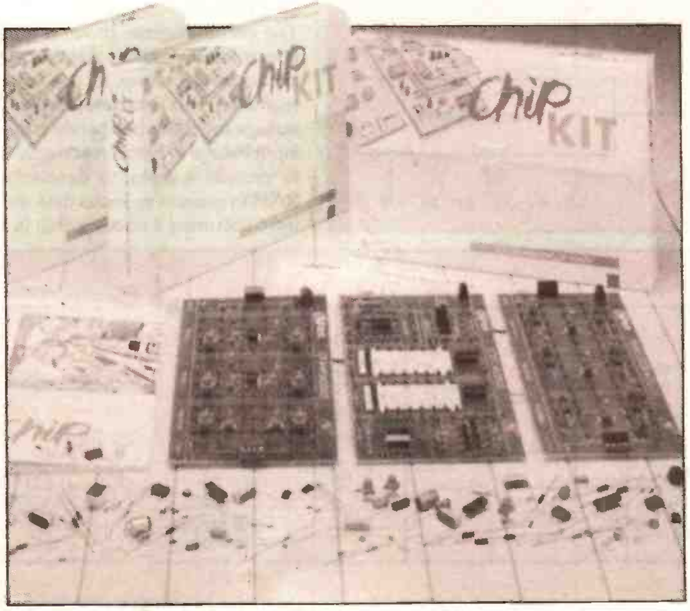
The instruction books provide some basic information such as resistor colour codes, component identification information and so on. They explain how to bend a component lead and insert it in the socket. There is also some background information — for example, the op-amps book shows the internal equivalent circuit of a 741. Most of each book, however, is devoted to experiments designated Lab 1, Lab 2 and so on.

A fair amount of information on each experiment is provided for the student but these are definitely not self-teaching kits for the beginner. The layout of the course clearly expects an experienced tutor to be present, to explain the results of the experiments and to teach the student how to operate any test equipment required. For each experiment there are tables to fill in with results, questions to answer and diagrammatic oscilloscope screens for copying the observed waveforms. The manual which comes with each kit is therefore the basis of the student's lab notebook, rather than a textbook.

The experiments at the beginning of each book are extremely basic and suitable for the beginner who may have some background in physics but has never built a circuit in his or her life. The first experiment in the transistor module is to connect a diode and a resistor in series, with a signal generator across the two ends and measure the resulting waveforms on an oscilloscope. The experiment goes on to show what happens when capacitors of various values are added to this classic half wave rectifier circuit. Other experiments include a common emitter AC coupled amplifier stage, astable and bistable flip-flops, etc.

In the op-amps module I was slightly surprised to see that the initial experiments were based on the use of an op-amp as a comparator rather than as a linear amplifier. This makes some sense in that an op-amp without external components to provide negative feedback has such a high gain that it works as a comparator for most practical purposes but I think I would have started with linear circuits.

Most of the circuits shown are not practical in the sense that, although they will work in the context of an experiment, nobody would actually design with them in that form. For example, a push-pull audio output stage is shown using two transistors with their bases and emitters connected together to boost the current output of an op-amp. A circuit for serious use would normally include biasing for the transistors to reduce crossover distortion, and emitter resistors to improve temperature stability.



The logic module first covers the basic combinational logic functions, NAND, NOR etc. It proceeds via the 555 timer (which I had always classified as an analogue IC) to sequential logic circuits, using a 555 monostable circuit to provide a clean clock pulse from an ordinary push button switch.

All the logic ICs used are 74LS series TTL. This type of logic is going out of fashion but is probably a good choice for the training modules because it is hardy and cheap to replace.

Correct wiring of the experiments is aided by the way the connections are arranged, with the IC connections brought out to large rectangular arrangements of pins over which cardboard push-out pin diagrams can be laid.

The general presentation of the kits is good. The PCBs are coated with solder resist on both sides and the top face is printed with connection information. Closer inspection shows that the quality of etching is poor, many of the tracks having ragged edges. Some of the soldered joints would not pass normal industrial inspection, either.

It is not likely, though, that these points would affect the utility of the kits in most cases. In a few cases I can envisage a unit having a short between two tracks or a non-functional soldered joint but for the most part the effect is cosmetic. The boards and sockets on the whole are spacious, visually clear and much easier to use than the normal type of push-in breadboard.

The level at which the subject is covered is probably most suitable for school sixth forms or first-year higher education students and their equivalents. The flexibly structured PCB and step-by-step workbooks impose a certain clarity on the subject in hand and, as my guinea-pig pointed out to me, structured courses like this are useful for keeping the instructor to the point as well as the students.

Transistor Module £32.41, Op-Amp module £33.68, Logic Module £37.39, IO kit £26.23, all plus VAT and carriage. Available from: The Electronics Centre, The Polytechnic of Wales, Pontypridd, Mid Glamorgan, CF37 1DL.

Andrew Armstrong

This column is a service to readers to provide electronic designs to order. Many a project never gets further than the drawing board because of difficulties with one small part. If you are stuck for a circuit or a technique, let the ETI expert help you out. Send your requirements, with as much detail as possible, to ETI Blueprint, 1 Golden Square, W1R 3AB.

This month's Blueprint request comes from Mark Cox of Derby.

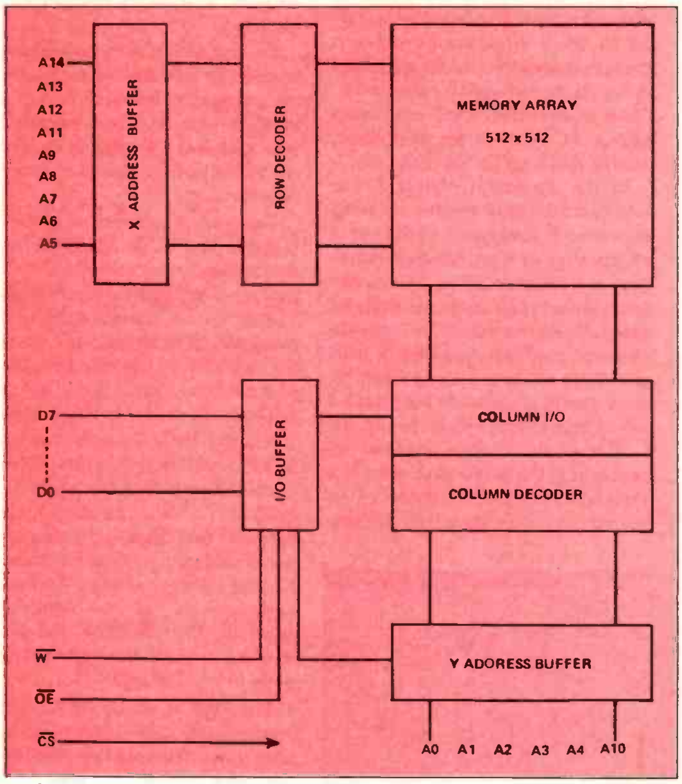
I would like a circuit to provide battery backup to a 62256 (256K) static RAM, using a 3V6 100mAH NiCd. The battery should recharge but not overcharge from the 5V power supply when this is present. How long would the battery take to discharge when providing the 40μA standby current of the RAM and how long would it take to recharge!

You haven't given me enough details about your application to design a specific solution — for example I don't know whether there is any circuitry in the main unit which could write data to the RAM without the operation of a manual toggle switch. For this reason and to make the answer of wider relevance, I have provided a general solution to the problem. You can leave out any parts which you do not need.

For general reference the first diagram shows the internal arrangement of the 62256 RAM. When active, this chip is rated to draw a maximum of 15mA.

The chip also has two standby modes. When the chip select line is at the logic 1 minimum level (2.2V) a maximum of 3mA is drawn. If the chip select is within 200mV of the positive supply voltage, the standard version of the chip is rated to draw typically 40μA at 5V. No maximum is given but one might estimate a figure of 100μA as a working maximum. A low power version of the chip is also available. This is rated to draw 2μA typically at 5V.

The standard device is not rated for battery backup operation, though it is likely that many standard devices will work in this mode. The low power device is rated for memory retention down to a supply voltage of 2V.



Battery Consumption

If you were to use a standard power chip in memory backup mode and if it drew the typical 40μA over the battery voltage range then the battery life could be calculated. It is not usually possible to recover all the rated capacity from a NiCd partly because it will self discharge gradually so not all the current goes to the memory chip. If we assume that 80% can be recovered then the sum is 80mAH/40μA = 2000 hours. To allow a further safety margin, because even if a standard chip works on memory backup it may not work down to such a low voltage as the low power type, you could assume the battery will last for at least two months.

This calculation is pessimistic in its assumptions. If you are particularly lucky the battery could last for a year.

Using the low power chip, the current consumption is so low as to render the self discharge of the battery the main factor in determining the life. One particular type of memory backup battery is rated at 50% charge retention after 12 months. Normally the self discharge slows as the battery becomes discharged so it is likely that a battery life of two years would be possible using the low powered chip.

Most memory backup batteries are rated at 10mA charge for cyclic applications, 1mA trickle charge rate. While a charged battery is on charge, its voltage rises above the nominal voltage, so in the circuit shown in the second figure, the charge rate will be above 1mA for a deeply discharged battery but under 1mA when the battery is well charged. The battery will be fairly well charged after three days with power applied and fully charged after five days.

The Circuit

The circuit diagram shows a typical power supply, with a voltage detector circuit on the input to the voltage regulator. This is to detect when the voltage regulator has barely enough input voltage to function correctly and to provide a signal to deselect the RAM to prevent spurious data writes from occurring if another chip in the circuit goes berserk as the power fails.

The comparator compares the voltage on the storage capacitor with the reference voltage. The ratio of the potting down resistors gives switching levels of 7V to switch the PSU OK signal off and 8.5V to switch it back on again. The hysteresis between these switching levels is intended to take account of ripple on the capacitor. If more than about 1.25V ripple is expected then the hysteresis should be increased.

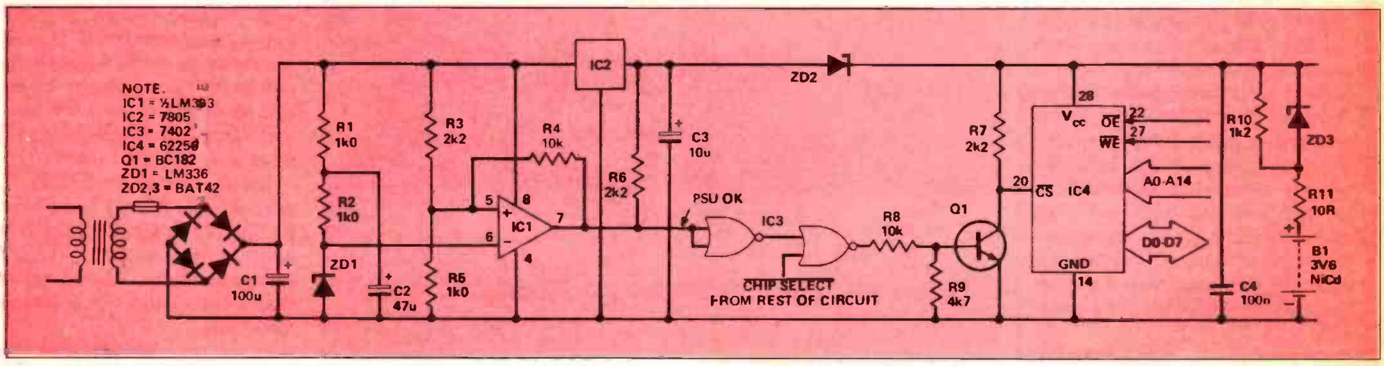
Continuing the story of the PSU OK signal, the chip select ($\overline{CS}$) is gated together with PSU OK by the two NOR gates shown. The RAM is only selected if the PSU OK signal and the externally generated $\overline{CS}$ signal both agree that it should be. The $\overline{CS}$ signal to the RAM is controlled by a transistor so that, when the transistor is off the $\overline{CS}$ pin will be held at the supply voltage, thus minimising standby power consumption.

If the NOR gate ICI gives an invalid output when the power supply fails, a spurious write will still be impossible. The values of R8 and R9 ensure that Q1 cannot be switched on when the power supply falls below approximately 3V.

If the PSU OK signal is not needed and if the externally $\overline{CS}$ signal can be changed to logic 1 to select instead of logic 0 then ICI can be omitted.

The power supply to the RAM is via a Schottky diode which prevents the battery supply from powering other circuitry while giving minimum voltage drop when the RAM draws power from the main supply. The charging rate of the battery is limited to approximately 1mA by R10, while the RAM is powered via D2. At a current drain of 40μA the voltage drop of a 1k2 resistor is only 50mV so D2 could be omitted with little effect but it is included to take account of any brief pulse of current which may occur at switch on or off.

R11 is included to limit the short circuit current. This is not strictly necessary but it may prevent damage in case a track is accidentally short circuited in the course of experimentation. **Andrew Armstrong**



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