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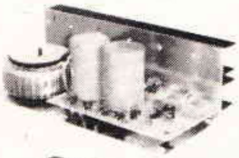

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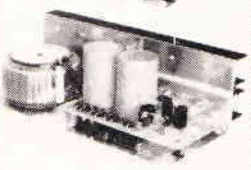

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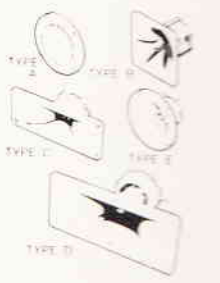

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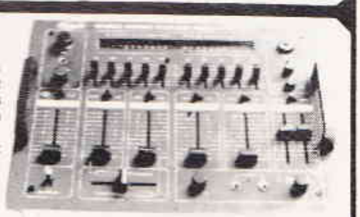

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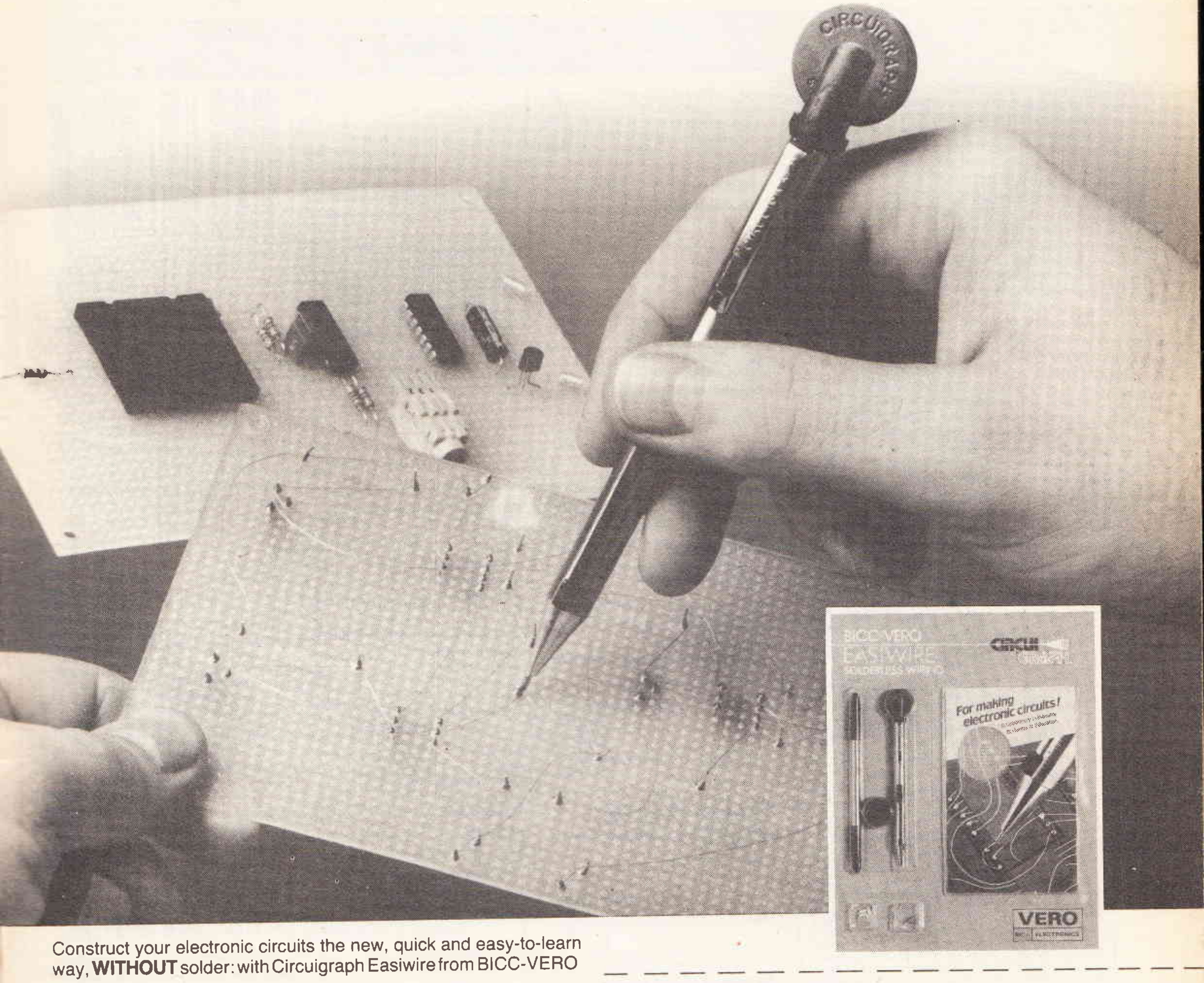

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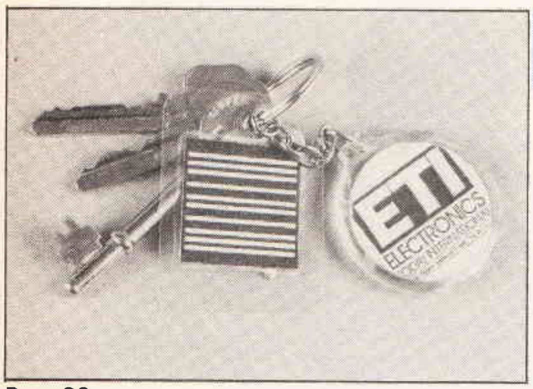
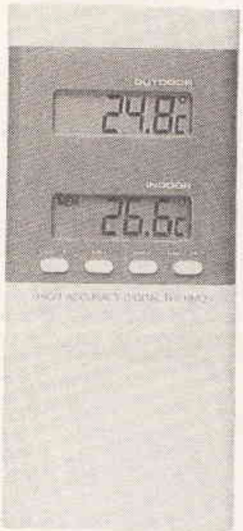
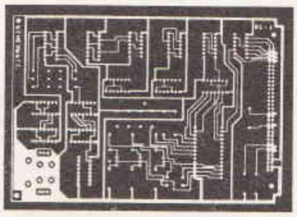


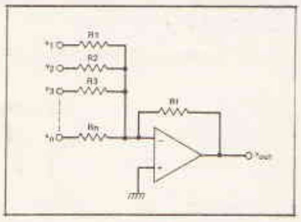
Page 22



Page 10

Volume 17 No. 7





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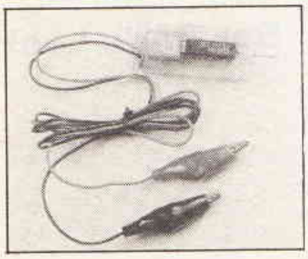
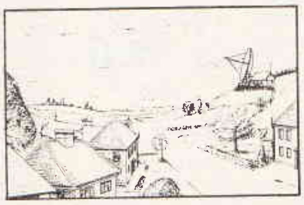
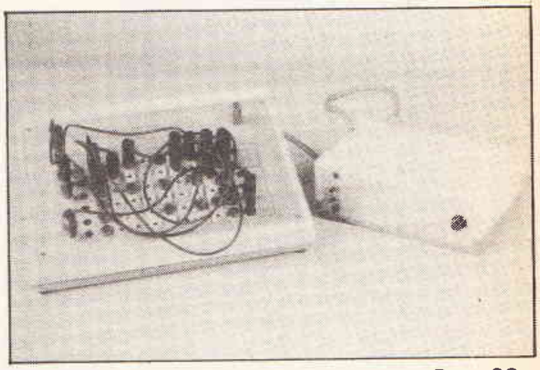
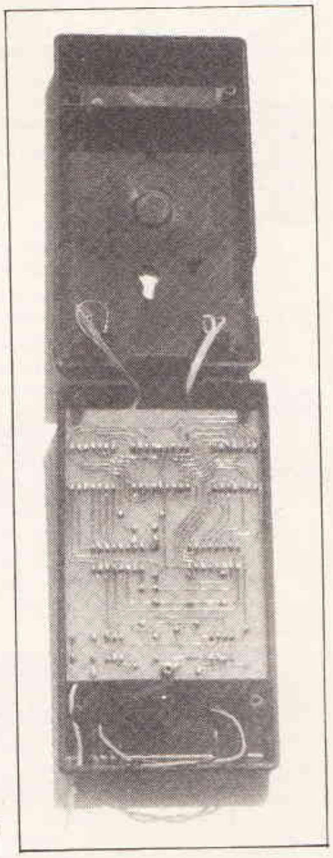




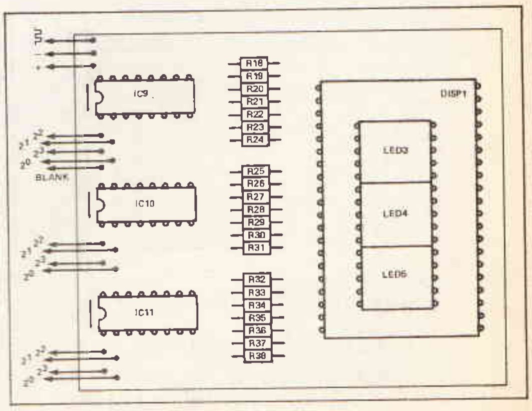


Page 38



Page 48

Page 36



NEWS

NEW GENERATION

Following the white paper detailing the plans for electricity privatisation a new private generation company, Thames Power, has been announced.

The company is to be set up jointly by Taylor Woodrow (the construction group), Balfour Beatty, BICC and Schroders (the merchant bank).

The company plans power stations to be built from scratch rather than refurbished from ex-CEGB stations. The first is to be a 1000MW station at Barking, using low-speed gas turbines.

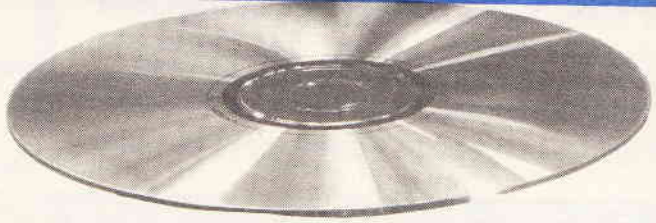
CAPS IN HAND

Exclusive to ETI readers, the audio module making KIA Electronics is giving away presents again.

The freebies are destined to continue into next year, with each offer supported by a datapack of specifications.

This month's free gift is a wide ranging collection of 40 capacitors. To get them just clip the coupon in the Classified section and send it with a 50p coin for post and packing to: KIA, 8 Cunliffe Road, Ilkley LS29 9DZ.

RECORDING CD IN 1989



Tandy has taken everyone by surprise by announcing the successful development of a record and erase compact disc system.

Entitled 'THOR-CD' (Tandy High-intensity Optical Recording), the first machines will be available in the US at the end of 1989 for around $500, with the price expected to fall still further as development continues. There will be only a minimal delay getting them onto the UK market through Tandy and other licensed outlets.

This is no WORM system, the discs are fully or partly erasable with no deterioration (erasing simply returns the dye polymer type media to its original state). The pits, formed thermally by laser, are structurally different but optically identical to the pits on a conventional CD. This gives complete compatibility — THOR recordings are playable on existing CD players.

Tandy THOR-CD is concentrating the initial launch on the CD audio market where it should receive a rapturous reception since it offers all the facilities of DAT plus fast access times, a lower price and the major advantage that present CD owners simply upgrade to THOR-CD without rendering their existing CD collections redundant.

The copy protect question that hangs over DAT (directly recording other CDs) applies equally to THOR. European and Japanese companies are shortly to hold a convention that will discuss copy protection on DAT and reach an agreement to bind all involved companies.

Tandy THOR says it will not consider itself bound by such an agreement and has yet to reach its own decision.

Tandy intends to licence the THOR technique to other hardware manufacturers while continuing development into both CD audio and CD-ROM. It claims strong interest to be coming from several major companies.

Philips denies any plans to use the THOR system, to work with or license from Tandy. It is developing its own record/erase system, but will be applying it principally to CD-ROM and business applications.

Sony points out that Tandy cannot even use the words 'compact disc' without license from itself and Philips. Both companies doubt Tandy's ability to invent such a system "massively ahead" of their own development, pointing out the help the announcement has given to Tandy's share price.

Sony also made it quite clear that as soon as Tandy machines hit the marketplace, Sony would be able to match the technology overnight.

For more (but certainly not full) details on THOR, contact Tandy UK, Leamore Lane, Walsall WS2 7PS. Tel: (0922) 710000. Tandy THOR-CD is based in Fort Worth, Texas on 0101 (817) 390-3693.

VOLVO LAUNCHES RDS

Radio Data System

Volvo is the first manufacturer offering a car radio system to use RDS (the Radio Data System). RDS enables the Volvo SR701 radio to identify the time, the station and the alternative frequencies broadcasting that station.

If the present signal degrades below a preset level, the radio searches for a better signal and switches automatically thus ensuring consistent reception through local disturbances (hills and built-up areas) and long-distance hauls (national frequency variations).

The radio can also latch onto local radio traffic flashes and interrupt anything else (national radio or a tape player) to give the driver regular local travel information.

The Volvo radio doesn't exploit RDS to the full — it doesn't continuously monitor the alternative frequencies looking for a better signal for instance, it only searches when the present signal becomes unacceptable.

A double headed receiver would be more effective and would also avoid the audible switching that occurs as the SR701 searches.

A further RDS facility not used by Volvo (and not yet broadcast) is the programme typing system (PTY) where an RDS radio can scan the VHF band looking for broadcasts of a certain type — jazz, MOR, news and so on. As soon as radios using this facility become available, the BBC will add a PTY code to the RDS datastream.

RDS transmits data on a 57kHz subcarrier added to the main transmission at source.

The Volvo SR701 costs £595, which is pretty expensive, even for a high spec radio. Although the future of RDS is assured by the major backing given by the BBC, consumer interest is likely to remain low until prices fall and facilities are enhanced.

Contact Volvo, Globe Park, Marlow SL7 1YZ. Tel: (06284) 77977.

CALIBRATE AND RADIATE

Repairs and calibration of anything from an Avometer to a 40GHz microwave source can be carried out by MSL of Hitchin.

Most of MSL's time is spent calibrating and upgrading megabucks hardware for the likes of Plessey, the MoD and the armed forces but the company is more than happy to take in small jobs from individuals and growing businesses.

The cost of the job obviously depends on the amount of work to be done — MSL can quote before they repair — but calibration of an Avo would normally cost about £18.

Meanwhile upstairs at MSL, some rather more sensitive testing is proceeding.

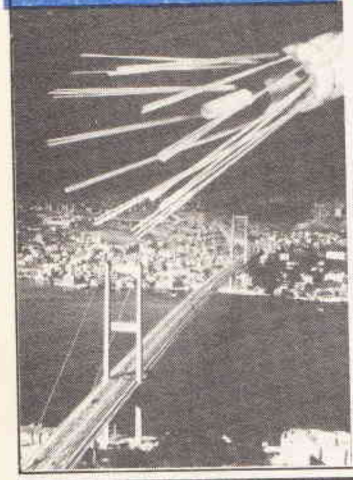
Screening VDUs against EM emissions which can be received and read at some distance is an enormously expensive task. The Tempest test rigs (see photo) supplied by MSL's 'Secure Systems' division can scan an enormous frequency range and lock onto any interesting emissions in the area.

The units are designed to check that your own equipment is sufficiently protected and the 40 or so Tempest rigs presently at large were supplied to the MoD (in Cheltenham but we're not allowed to say exactly where . . .).

MSL is anticipating an imminent mushrooming of interest in Tempest as commercial companies (particularly in the city) realise just how safe their own — and their competitors' — classified information really is.

For more information on calibration or Tempest contact MSL Calibration, Wilbury Way, Hitchin, Herts SG4 0TA. Tel: (0462) 421234.

LOW FIBRE



At 56 miles, the new fibre optic link from mainland Britain to the Isle of Man is the longest unboosted fibre link in Europe and probably the world.

But it will hold the record for mere months — BT has already laid a link due for operation in the late summer between Holyhead and Portmarnock in Eire — an unregenerated 80 miles.

Both links operate at 140Mbits/s with six pairs of fibres capable of handling 12000 simultaneous phone calls. Distributed feedback (DFB) single line lasers with very narrow spectral width enable the longer wavelength of 1535nm to be used, reducing attenuation and extending the range achievable without submarine boosters.

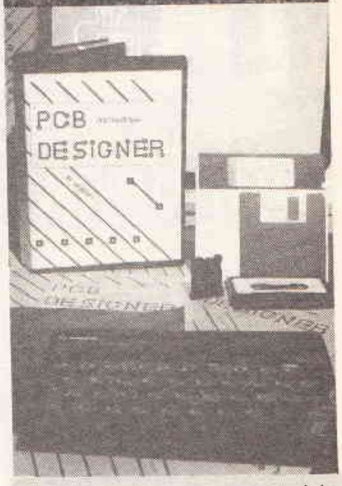
STC has put the system together and is now planning a still longer link from Southern England to the Channel Islands (83 miles).

Out in the rest of the world, STC is linking Barcelona to Majorca, Siemens has linked Europe to Asia by running fibre optics along the mile wide bridge spanning the Bosphorus in Turkey, and Cable and Wireless is inviting tenders to link the United States to Japan in co-operation with PTC of the US and IDC of Japan.

Back home, some 19000 miles of optical fibre is already installed under Central London making it the most advanced local network system in the world. A further 19000 miles is to be laid to complete the network which will eventually stretch from Euston to Covent Garden, London Bridge and Wapping.

Further information from BT on 01-356 5369, STC on 01-858 3291 and Cable & Wireless on 01-242 4433.

DESIGN SPECS



Spectrum owners can now join the computer-aided PCB design fraternity with a new package from Kemsoft.

PCB Designer runs on the 48K (or greater) machine and features all the basic copy, rotate and block move functions, plus a good sized library of pads, busses, edge connectors and so on.

The program is available on tape, microdrive, 3½in or 5¼in disc format but you will need an Epson or compatible printer and interface to get hardcopy output.

PCB Designer is reasonably priced at £19.95 including post and packing from Kemsoft, The Woodlands, Kempsey, Worcester WR5 3NB. Tel: (0905) 821088.

BAND THREE FREE

Following pressure from the growing Band III radio network, the Government has backed down on its proposals to reserve subband 3 of Band III for a fifth national TV channel.

The proposals were made public in January enraging private mobile radio users who had been planning to purloin the affected frequencies when the first two sub-bands fill up — estimated to happen in 1992.

Protests from the Electronic Engineering Association and the Network Operators Committee initially elicited no response other than that the fifth channel was merely a proposal.

This month's announcement promises no use of either Band I or III of the VHF spectrum for the extra channel.

For further information contact the EEA, 8 Leicester Street, London WC2H 7BN. Tel: 01-437 0678.

MITEYSPICE

The Miteyspice circuit simulation program for BBC micros has been redesigned to run on the Archimedes.

Miteyspice simulates both AC and DC and handles complex circuits with all standard components up to such things as multiwinding transformers.

A plotting routine can display the behaviour of 25 parameters.

The program costs £119 (same price for Archimedes or BBC).

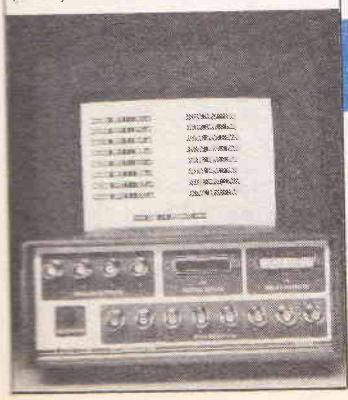
Contact: Those Engineers, 106a Fortune Green Road, London NW6 1DS. Tel: 01-435 2771.

INPUT OUTPUT

The new 2308 interfacing unit from Black Star of Huntingdon is a versatile little I/O device that will connect to just about any computer with an RS232 port.

It has eight analogue inputs, four analogue outputs, eight digital inputs and eight relay outputs. It also has a data logging memory with eight channels of 500 readings each.

The unit is very simply instructed in ASCII strings, so that any programming language can drive it. The 2308 costs £299+VAT from Black Star, 4 Harding Way, Huntingdon, Cambs PE17 4WR. Tel: (0480) 62440.



FREEBIES

Free from Klippon is the updated 48-page Main Line Products catalogue. It gives prices and technical data on active interface units, relays, connectors, enclosures and accessories.

Contact Klippon Electricals, Power Station Road, Sheerness, Kent ME12 3AB. Tel: (0793) 580999.

Imhof has a colour 52-page catalogue covering its range of racks and consoles. Free from Imhof, Ashley Works, Ashley Road, Uxbridge, Middlesex.

Not free is the new Rapid Electronics Components Catalogue out this month, available for £1.25 from Rapid, Hill Farm Ind. Estate, Colchester CO4 5RD. Tel: (0206) 272730.

WEST PREST

Westminster Cable Television has introduced Prestel services as standard to all subscribers.

The 6500 customers of the central London cable network select the Prestel option via a new X25 gateway link and are charged on a pay-as-you-view basis at 7p a minute. There will not be the usual Prestel registration charges.

Viewers' present controls are numeric only so cannot fully exploit the facilities available on Prestel but WCT plans to introduce alphanumeric keypads at a later date.

For more details contact WCT on 01-935 6699.

SKYPHONE

As intimated in October 1987's *Open Channel*, British Airways is introducing an aircraft-to-ground public telephone service using the Inmarsat satellite system with BT providing ground facilities at Goonhilly.

Racal has developed the high gain blade antenna with an aerofoil section to reduce drag for wide bodied airliners.

The Skyphone service will operate initially on transatlantic flights, with wallmounted cordless phone units. On validation of a credit (anything except M&S chargecards) the phone is released allowing calls to be made from the passenger's seat. In first class areas, phones may be fitted to each armrest or seatback.

The problems of taking incoming calls on a plane-based unit is solved by a text pager displaying messages to all passengers.

The range of services BT and BA are planning to provide on phone-in lines include news, stock market and currency changes, travel information and (wait for it) cricket scores!

Contact British Airways, PO Box 10, Hounslow. Tel: 01-759 5511.

BREAKING THE CODE

The scrambled Belgian STV channel Filmnet can be watched by British viewers with a new decoder being marketed by Supersat of Wolverhampton.

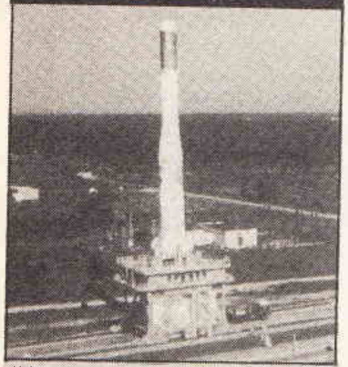
British viewers are unable to subscribe to Filmnet at present because the films are only licensed for broadcast to mainland Europe (similarly Premiere can only sell subscriptions inside the UK).

Supersat is planning a similar decoder for Premier broadcasts which will enable viewers to sidestep the annual £70 subscription rates — so long as the scrambling system isn't changed.

Both scramblers will retail at around £90. For full details contact Supersat, 32 Temple Street, Wolverhampton WV2 4AN. Tel: (0902) 773122.

NEWS

SPACED OUT OR IN?



The news that Britain will after all be helping out with Western Europe's Columbus space project is a great relief to just about everyone.

Not that our contribution is particularly generous (less than a quarter that of Italy, a sixth that of Germany and half that of France). Nor is it in keeping with the 'all for one' spirit of the up and coming unified Europe.

Britain's contribution will be almost entirely used for constructing the commercially useful polar-orbiting platform — handy for spotting mineral deposits and agricultural data as well as dropping a nice little earner in the lap of British Aerospace.

However, the long delay and apparent U-turn in confirming our commitment to Columbus will undoubtedly lead other countries to regard Britain as an unreliable partner in such ventures, especially where Government approval and funds are involved.

Canada must be feeling more than a little miffed at our sudden withdrawal from its Radarsat project — we had planned some £100m of investment (with significant business coming to British firms). The Canadian Science and Technology Ministry say they are 'disappointed' by our withdrawal. You bet they are.

The Government's original objection to the Columbus project was the European Space Agency's alleged inefficiency, coupled with doubts regarding the commercial benefits of investment in space. No doubt Britain's hesitation has helped tighten up the ESA's workings, but the Government should recognise the long term benefits of such research and of involvement with Europe.

Some things cannot be done alone, and space investment is one of them. This decision should not have been such a close call.

EUROPE OR BUST

The UK component industry is too insular and too small to survive, concludes an industry overview from Key Note Reports.

In 1987 the UK and world market in components revived from the slump of the previous two years. Prices strengthened and sales expanded. Now the industry is expecting steady but not dramatic growth for the rest of the decade.

In Europe companies are collaborating and merging in a realistic attempt to fight back against the competition from Japan and the USA.

However, mixed with this optimism is a strong apprehension that the European industry is still very much under threat and that the revival (as exemplified by Philips, Siemens, SGS and Plessey) may be too late.

The recovery came as companies realised that US and Japanese chip manufacturers would invariably supply their own companies before Europe, making in-house semiconductor capability absolutely essential for development and effective competition. In the UK both Plessey and STC bank on their semiconductor expertise to keep them ahead in their mainstream business.

The formation of GPT on top of the Plessey takeover of Ferranti's semiconductor operations demonstrated the way that restructuring will have to take place, and cooperation with the continent must be the next step. At the GPT launch at the end of March Roger Boardman, External Affairs Director, stressed that in the next few years European markets will become fused into one, and that GPT is, above all, an international company.

Other organisations are crying out for the Government to assist the industry, particularly in funding research and development where under capitalisation in the industry is a real handicap.

The Electronic Engineering Association proposed changes in taxation, exchange rate regulation, Government purchasing policies and education at all levels without which it says "Britain's world position as a major industrial nation is under threat." None of its proposals were implemented in the March budget.

A recent report from the DTI, produced in collaboration with a number of major UK companies, advocates a £225m per year Government programme to enhance the competitiveness of Britain's semi-conductor industry. It proposes spreading R&D costs among users and manufacturers.

Critics of the report such as Iann Barron of Inmos argue that such funding must be more selective and should favour the market leaders.

Another report, from the SRI, stresses that R&D (whosever it is) must be performed properly. About 50% of all R&D fails, it claims, because of inadequate information, unrealistic targets and hopeless technology transfer (getting R&D results into production). Cross fertilisation of research teams is vital, it says, while maintaining secrecy from outsiders.

That cross fertilisation will have to come from the rest of Europe.

EUROPE OPEN FOR BUSINESS

The Key Note Report costs £105 from Key Note, 28-42 Banner Street, London EC1Y 8DE. The EEA report *Industrial Growth* is available from EEA, 8 Leicester Street, London WC2H 7BN. The SRI report *Quality in R&D* is published by SRI, Menlo Park House, 4 Addiscombe Road, Croydon CR0 5TT. The DTI report *A National Plan for Silicon Microelectronics* from HMSO, 49 High Holborn, London WC1.

DIARY

Evaluating Supercomputers — June 1-3rd
Mount Royal Hotel, London. Contact Unicom Seminars on (0895) 56484.

Commodore Computer Show — June 3-5th
Novotel, London. Contact Database Exhibitions on (0625) 878888.

Special Effects Seminar — June 3-5th
Pinewood Studios. Contact British Kinematograph Sound and Television Society on 01-242 8400.

Information Technology And Office Systems — June 7-10th
Barbican Exhibition Centre. Contact BED Exhibitions on (09328) 65525.

European Satellite Broadcasting — June 8-9th
Tara Hotel, London. Contact Online International on 01-868 4466.

Optical Information Systems 88 — June 13-15th
Novotel, London. Contact Meckler Ltd on 01-931 9985.

Electronic Publishing 88 — June 14-16th
Wembley Conference & Exhibition Centre, London. Contact Online International on 01-868 4466.

Software Tools 88 — June 14-16th
Wembley Conference & Exhibition Centre, London. Contact Online International on 01-868 4466.

Denby Dale Mobile Rally — June 19th
Shelley Hill High School, Huddersfield, West Yorkshire. Contact Denby Dale Amateur Radio Society on (0484) 602905.

Networks 88 — June 21-23rd
Wembley Exhibition & Conference Centre, London. Contact Online International on 01-868 4466.

Private Switching Systems And Networks — June 21-23rd
IEE, London. Conference on telephone exchange technology. Contact IEE on 01-240 1871.

British Science And Technology Exhibition — June 22-26th
Brands Hatch. Contact Sci-Tech 88 on 01-834 6680.

Failsafe Control Systems — June 28-30th
National Liberal Club, London. Contact Unicom Seminars on (0895) 56484.

Intersatellite Links: Systems and Technology — June 29-30th
Royal Garden Hotel, London. Contact ERA Seminars and Exhibitions on (0372) 374151.

Computer Recruitment Fair — July 1-2nd
Rainbow Rooms, London. Contact Intro Ltd on (0491) 681010.

IEE Vacation School On Local Telecommunications Network — July 10-15th
Aston University, Birmingham. Contact IEE on 01-240 1871.

Image Processing And Its Applications — July 18-20th
University of Warwick. Conference organised by the IEE. Contact IEE on 01-240 1871.

Alvey Vision Conference — August 31st-September 2nd
Manchester University. Conference on Alvey-funded work in computer vision and image recognition. Contact AVC88 on (0235) 445840.

Compar 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.

COMEX 88 — September 13-15th
Sandown Exhibition Centre, Surrey. Contact Frametrack Ltd on 01-778 5656.

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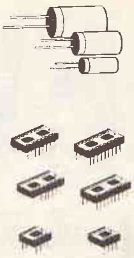
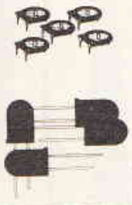
Refill those empty component drawers at a fraction of the normal price and don't be caught without that odd resistor or capacitor to complete your project. All components supplied are to full spec. and are not seconds or surplus stock.



Pack A:	650 x .25 watt resistor 47R-10M	£4.25
Pack B:	60 x Radial electrolytics 1uf – 1000uf	£3.25
Pack C:	30 x Polyester capacitors a or 0.01 uf – 1uf	£4.50
Pack D:	35 x horizontal presets 1k-1M	£3.00
Pack E:	30 x IC sockets 8, 14, 16 pin	£2.00
Pack F:	25 x Red 5mm LEDS	£1.75
Pack G:	25 x Green 5mm LEDs	£2.00
Pack H:	30 x 5mm LEDs 10 Red, 10 Green, 10 Yellow	£2.50
Pack J:	50 x 1N4148 silicon diodes	£1.00
Pack K:	40 x npn/pnp transistors BC/182/212 General Purpose	£2.25



FREE Solderless Breadboard (verobloc type). When you buy all ten packs. Prices exclude VAT (15%).

NEW ELECTRONIC GUARD DOG KIT

One of the best deterrents to a burglar is a guard dog and this new kit provides the barking without the bite! The kit when assembled can be connected to a doorbell, pressure mat or any other intruder detector and will produce a random series of threatening barks making the would be intruder think again and try his luck elsewhere. The kit is supplied complete with high quality PCB, transformer, all components and instructions. All you need is a mains supply, intruder detector and a little time. The kit even includes a horn speaker which is essential to produce the loud sound required. The "dog" can be adjusted to produce barks ranging from a Terrier to an Alsatian and contains circuitry to produce a random series of barks giving a more realistic effect.

XK125 Complete kit of parts £24.00

VERSATILE REMOTE CONTROL KIT

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

MK12 IR Receiver (incl. transformer)	£16.30
MK18 Transmitter	£7.50
MK9 4-Way Keyboard	£2.20
MK10 16-Way Keyboard	£6.55
601 133 Box for Transmitter	£2.60

TOOLS ★ TOOLS ★ TOOLS

Good quality tools selected to offer outstanding value for money.

650 004 6in mini. Snipe Nose Pliers. Serrated jaws and return spring. **£2.10**
650 005 6in lap jointed side cutters. Insulated handles and return spring. **£2.10**
650 006 Light duty cutters. Cutting capacity 0.22–1.2mm copper wire. **£1.60**
TOOL KIT – Contains: side cutters, snipe nose pliers, wire strippers, flat blade screwdriver, phillips screwdriver in black textured, reinforced and padded case which when opened out measures 240x205mm **£6.80**

650 007 Self-adjustable automatic wire stripper with built-in cable cutter. **£3.95**
650 012 Watchmakers Screwdriver Set. 1.0/1.4/2.0/2.4/3.0/3.8mm **£1.75**
650 019 Set of 4 Stainless Steel Tweezers. Straight nosed, straight noosed-reverse action, bent nosed, flat nosed. 110mm long. **£3.65**
650 502 Reliant 9–12V dc Drill. **£6.90**
650 500 Titan 12V dc Drill. **£10.25**
650 570 Saturn Mains Drill. **£16.50**
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High quality meter with features normally found in meters costing much more e.g. DISPLAY HOLD, MEMORY, CONTINUITY BUZZER and 10A AC/DC current ranges. High accuracy and automatic operation – a must for the professional or serious hobbyist. Size: 127 x 69 x 25mm.

AC Volts:	0-2-20-200-500V
DC Volts:	0-200m-2-20-200-1000v
AC Current:	0-20m-200mA (1.2%) 0-10A (2%)
DC Current:	0-20m-200mA (1.2%) 0-10A (1.5%)
Resistance:	0-200-2K-20K-200K-2M (1%)

Continuity Buzzer operates @ 20 ohm .. **£33.00**

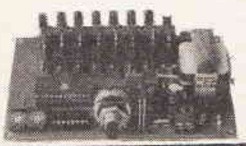
DISCO LIGHTING KITS

DL1000K This value-for-money 4-way chaser features bi-directional sequence and dimming. 1kW per channel **£19.25**
DLZ1000K – A lowe cost uni-directional version of the above. Zero switching to reduce interference **£10.80**
DLA/1 (for DL & DLZ1000K) Optional opto input allowing audio 'beat'/light response **77p**
DL3000K – 3-channel sound to light kit features zero voltage switching, automatic level control and built-in microphone. 1kW per channel **£15.60**

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

And the best thing about it is the price.

ONLY £31.50

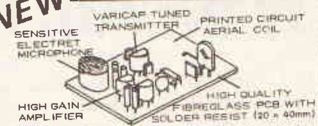


HOME LIGHTING KITS

These kits contain all necessary components and full instructions and are designed to replace a standard wall switch and control up to 300W of lighting.

TDR300K	Remote Control Dimmer	£18.00
MK6	Transmitter for above	£5.10
TD300K	Touchdimmer	£9.30
TS300K	Touchswitch	£9.30
TDE/K	Extension kit for 2-way switching for TD300K	£2.95
LD 300K	Light Dimmer	£4.75

NEW SUPER-SENSITIVE FM MICROBUG



Highly sensitive FM transmitter measuring only 45 x 25 x 15mm, including the built-in microphone. Frequency 88-100MHz enabling reception on a standard domestic FM radio. Range approximately 300m depending on terrain. Powered by 9V PP3 (7mA). Its small size and highly sensitive electret microphone makes it ideal for surveillance, baby alarm, etc.

INTRODUCTORY PRICE £5.50

NEW POWER STROBE KIT

Designed to produce a high intensity light pulse at a variable frequency of 1 to 15Hz this kit also includes circuitry to trigger the light from an external voltage source (eg. a loudspeaker) via an opto isolator. Instructions are also supplied on modifying the unit for manual triggering, as a slave flash in photographic applications or as a warning beacon in security applications. The kit includes a high quality pcb, components, connectors, 5Ws strobe tube and full assembly instructions. Supply: 240V ac. Size: 80 x 50 x 45.

XK124 STROBOSCOPE KIT £13.75

SECURITY PRODUCTS

Install your own burglar alarm and save pounds. All parts available separately.

950 120	Stair Pressure Mat	1.70
950 125	Floor Mat 29x16 ins.	2.60
950 130	External bell box - an ideal deterent on its own!	10.00
950 130	Xenon Beacon (12v)	10.50
950 140	Flush door/window contacts	1.22
950 143	Surface mounting contacts	1.05
960 160	Alarm Control Unit	

950 162 Alarm Control Unit
This unit incorporates all the features required to form the basis of a complete security system for the home or business. Operating off a 240v AC supply with facility to charge a 12v lead acid standby battery. The unit is housed in a white steel box 225x225x80mm. Full instructions supplied to connect normally open and closed sensors, bells, personal alarms etc. Separate entry and exit alarm delays. 2 zone operation complies with BS 4737 **price £39.95**

950170 DOOR PHONE
An attractively styled 2 station mains powered handset type door phone. Allowing conversation with visitors without opening the door. Free standing or wall mounted, connections to a 9 volt battery for standby. Electric doorlock release button which maybe used with our 701150 lock release mechanism. Ivory and Fawn body 210x100x70mm. **£27.95**

RECHARGEABLE SOLDERING IRON

Powerful cordless iron complete with table-top/wall-mounting charging bracket. Reaches soldering temperature in 10 seconds. Includes lamp which lights when soldering. Comes with mains charging unit and 12V car battery adaptor. **Special Offer £15.95**

ELECTRONIC WEIGHING SCALES

This kit contains a Single Chip Microprocessor, PCB, displays and all electronics to produce a digital readout of weight in Kgs. or Sts. and Lbs. In normal use a toothed wheel (pattern provided) is made to rotate when a weight is placed onto the scales, interrupting two infa-red beams. The processor counts the number of teeth passing the sensor (up or down, depending on which beam is broken first) and shows the reading on the LED display in Sts. & Lbs., Lbs. or Kgms. A PCB link selects the scale for bathroom or two types of Kitchen Scales. A linear version of the toothed wheel could also be used. Other uses include up/down counters. A low cost digital ruler could be made by using a wheel with the correct tooth to diameter ratio.

ES1 .... £6.50

TEN EXCITING PROJECTS FOR BEGINNERS

This Kit has been specially designed for the beginner and contains a SOLDERLESS BREADBOARD, COMPONENTS, and a BOOKLET with instructions to enable the absolute novice to build TEN fascinating projects including a light operated switch, intercom, burglar alarm, and electronic lock. Each project includes a circuit diagram, description of operation and an easy to follow layout diagram. A section on component identification and function is included, enabling the beginner to build the circuits with confidence.

ORDER NO XK118 .... £15.00

DVM/ULTRA SENSITIVE THERMOMETER KIT

Based on the ICL 7126 and a 3½ digit liquid crystal display, this kit will form the basis of a digital multimeter (only a few additional resistors and switches required – details supplied) or a sensitive digital thermometer (-50°C to +150°C) reading 0.1°. The kit has a sensitivity of 200mV for a full-scale reading automatic polarity and overload indication. Typical battery life of 2 years (PP3) **£17.00**

XK113 MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5 x 2.7 x 2cms. Requires PP3 9V battery.
IDEAL FOR BEGINNERS **£6.60**

MICROPROCESSOR TIMER KIT

Designed to control 4 outputs independently switching on and off at present times over a 7-day cycle. LED display of time and day, easily programmed via 20 way keyboard. Ideal for central heating control including different switing time for weekends. Battery back-up circuit. Includes box. 18 time settings.

CT6000K £47.20
XK114 Relay kit for CT6000, includes PCB, connectors and one relay. Will accept up to 4 relays. 3A/240V c/o contacts .. **£4.30**
701 115 Additional relays **£1.80**

PROPORTIONAL TEMPERATURE CONTROLLER KIT

Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine-making, etc. Max. load 3kw (240V ac) Temp. range up to 90°C. Size: 7x4x2.5cms.

MK4 £7.80

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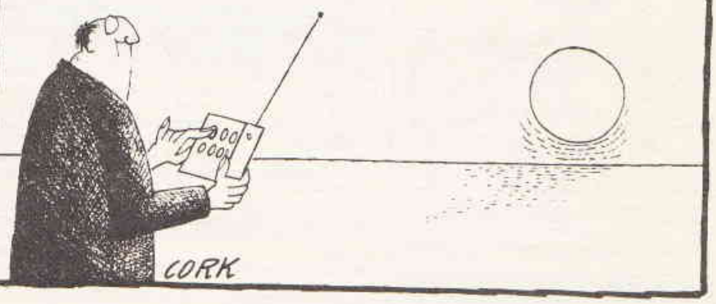
Next Month in

ETI
ELECTRONICS TODAY INTERNATIONAL

The August issue of ETI is brimming with goodies to brighten up the British summer. Hot on the heels of the Spectrum co-processor is the latest masterpiece from the workbench of Graeme Durant — a Spectrum EPROM emulator to turn your micro into a powerful development tool.

For the more musical amongst you there's a novel loudspeaker design to give top quality sound while taking up only the smallest part of your living room. For beginners there's a handy telephone amplifier. For the travelling man we've also got the low down on the design and implementation of the new fully automatic ticket system on the London Underground.

Plus, there's more on the breath rate meter for the Lucid Dream Stimulator, the second part of the analogue computer project and all the regulars which go to make ETI the UK's favourite electronics magazine.



The August ETI is out on 1st July 1988

DEGREES OF FREEDOM

WIN ONE OF SIX MAPLIN MIN/MAX DIGITAL THERMOMETERS

We've half a dozen digital min/max thermometers from Maplin (as reviewed in Once Over) up for grabs by six lucky readers.

To enter this free competition just match up the six temperatures on the entry form with each of the six cryptic descriptions. So, if you think the 'Body in question' is talking abut -273°C then put a 3 in the first box. The first six correct entries out of the editor's extra large pith helmet get the goodies.

The body in question ☐
Bradbury's burning books ☐
60% tin 40% lead ☐
Downright ☐
The old ice ☐
Gas Mark 5 ☐

1. 32°F	3. -273°C	5. 193°C
2. 188°C	4. 451°F	6. 98.4°F

Name ....

Address ....

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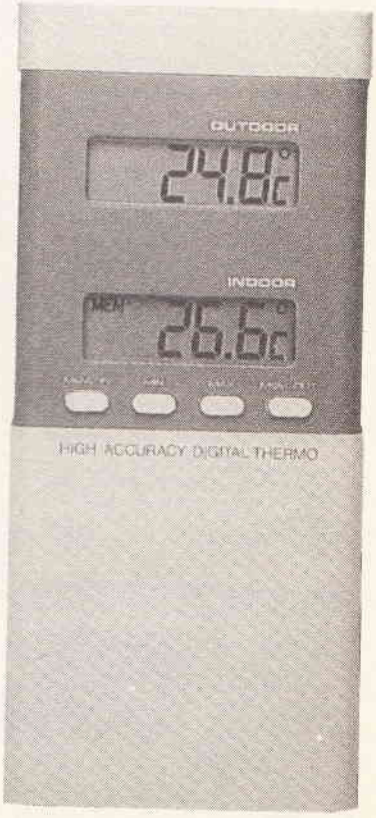
Complete this coupon and send it to: ETI Thermometer Competition, 1 Golden Square, London W1R 3AB to arrive by 1st July 1988.

Maplin (0702) 552961



Simultaneous readings of internal and external temperatures with minimum and maximum memory and display in Celsius or Fahrenheit.

READ\WRITE

ETI, THE FUTURE AND THE NATIONAL

On Saturday afternoon when I was in nine places at once and told I should be somewhere else, I found myself with ten seconds before the National. Switching on a portable TV I still had seven seconds left to see the starting prices and exciting line up of horses for the off.

After loosening my shirt, tie and cufflinks and seeing the on-course bookies with their customised Jags and Porsches, walkie talkies and radio phones, I reflected on the technical revolution quietly happening all around us.

Twenty years ago I would have switched on a thermonic valve television, it would have taken about four minutes to come on and I wouldn't even have seen the starting prices (but with a sixpenny bet I would have probably kept my Van Heusen shirt).

Born into the days of the newly invented Mazda thermionic valve, shaped like a 60 watt house bulb, with roll-your-own paper capacitors the same size, it is incredible that all this is now done with a micro-chip and it has happened in my lifetime.

I can't help but wonder what would have happened if the silicon chip had been invented instead of the valve. The answer would surely be a couple more steps today into tomorrow's world with surface mount miniaturisation in ETI every month. After all, how many articles and advertisers in ETI today mention valves, yet when I was 13 I built several valve amplifiers for the budding school Beatles combo, with EX80/81 rectifiers, matched pairs of ECL86 and a ECC83 preamplifier mixer. Together naturally with a bifilier-wound speaker transformer the size of a teapot.

Looking back at all the technical stages of innovation, the first crystal, the valve, the germanium transistor, the switch to silicon transistors and hence the silicon microchip, it would be interesting to see ETI in the year 4488. Obviously there is a limitation to the miniaturisation of silicon chips and components but by then silicon chips will be the thermonic valves of yesterday.

ETI readers will type their electronic components from a keyboard directly onto a substrate header the size of a pinhead for their project. Foil patterns will be replaced by the project's computer program and *1st Class* will be how to load ribbon spools of components invisible to the naked eye. The Portasol offer will give way to the 'computerised assembly printer' and a soldering iron will be an antique. High above the earth Space Shuttles and bases will have in-built computerised capability to replace any critical circuit failure within seconds, without human attention — automatically. Travel to and from space will be an everyday occurrence, probably by teleportation, reducing matter to a transmitted digital code which on arrival is decoded and reassembled. Even if not possible with living organisms it will most certainly be used for freight, so who will need the electronic car with a British Telecom Teleportation Box on every street corner ready to whisk you away to your destination ... no refunds and graffiti included!

Naturally, with the world population explosion we will all be watching the gorgeous Bonnie Langford on Doctor Who with a flexible loan bank manager circumnavigating moon orbit ... Of course we won't need money anymore. Everything will be direct debit by telepathy to our personal robot. In politics the Conservatives will still be in power with the Rt Hon Margaret Thatcher (the ninety second robotic world leader). Tony Benn will be head of the USSR Ultimate Soviet.

Oh well! Time to turn off the dream machine and return to the rhyme 'n' reason of washing my car!

Keith Lawrence
Ilkley, West Yorkshire

That all seems perfectly reasonable to us ... except the bit about Bonnie Langford being gorgeous!

CUTBACKS AT ETI

And finally, if you have to edit this letter for publication, I would be grateful if you could attempt to keep the tone intact — it's so annoying to be quoted out of context.

R'rd M'nd'r
K'm'ns'r, Worcs.

Quite so.

COUNTING ON ETI

A couple of years ago I constructed the Frequency Meter Module described in the April 1986 ETI. To calibrate the unit I built the crystal and divider arrangement shown then which used the 4060.

Your figure shows the 4060 with outputs Q4 to Q14 with no Q11 and this agrees with measurements taken with the frequency meter.

Last year I was thumbing through some data sheets from Maplin and noticed that they showed the 4060 with outputs from Q3 to Q13 with no Q10.

I asked Maplin which pin configuration was correct and they replied (not surprisingly) that their data sheet was accurate. I decided to let the matter rest but your comment in Read/Write in April regarding 'seething in silence' prompted me to seek your views on whether Mr Chappell or Maplin is correct.

Maplin's 1988 catalogue confuses the matter still further by agreeing with Mr Chappell and disagreeing with their own data (page 353).

W. Lochead
Largs, Ayrshire

The situation is that ETI and Maplin are both right (or both wrong depending on how you choose to look at it). The 4060 contains 14 flip-flops internally, with outputs available from FF4 to FF14 missing out FF10. If you number the outputs according to which flip-flop they come from then you get what Maplin put on their data sheet.

If you adopt the convention of labelling the outputs according to the power of 2 they represent, then the first FF would give Q0, the second Q1 and so on. The numbering lags one behind the flip-flop number. This is how Paul Chappell (and now Maplin) derives the output labels.

WANTED: BLUEPRINT

Here at ETI we are planning to introduce a new column to the back of the mag among the *Playback* and *Open Channel* pages. The title will be *Blueprint*, and the idea is for us to design circuits that readers are having problems with — *Tech Tips* to order.

Obviously we don't intend to custom design entire systems — don't expect the circuit for a complete computer. We're thinking more of helping you over any hurdles that are preventing you continuing or embarking on an otherwise attainable design.

So if you have any such problem, write down the details — the more the better — and send it to:

Blueprint
ETI
1 Golden Square
London W1R 3AB.

NOTED MARGINS

Continuing the correspondence on the 'new look' ETI. The wide margins criticised by Mr Dussart last month are actually quite useful for notes and amendments which can now be added close to the original project, where they won't get lost when the project is complete.

The two page index makes it difficult to identify the different types of article (projects, theory and so on). If the types of article could be given a distinctive appearance or perhaps a short description could be included, it might help.

Good luck,
Hugh Doherty
Castlewellan, Co. Down.

How true! We actually chose wide margins to look nice and make the pages more readable but yes, notes could be fitted in there. We've also marked projects out in the index this month – hope that helps.

HERE WE GO AGAIN

No, no, no. You've got it all wrong. *Doctor Who* is good (but not that good), *Lost in Space* was one of the better results of the 1960's but what we really need is the true gems of 25 year old sci-fi state-of-the-art embarrassment — *The Time Tunnel* and *Land of the Giants*.

Now, armed only with an unusually copacious wallet and the marvels of modern science, you too can benefit from all this culture, courtesy of the Sky and Super Channel satellite TV channels.

Thrill to the adventures of two men transported through time to disused movie lots while mission control suffers yet another 'power surge.' Gasp at a world filled with inhabitants the size of houses and papier maché plant life. Listen in horror to the appalling theme tunes ...

Yeah, well I expect you get the idea. Good these satellite TV systems, aren't they?

George Cratchet
Longcot, Oxon

It's good to know that satellite TV is being put to good use to benefit all mankind!

TTL – THE NEXT GENERATION

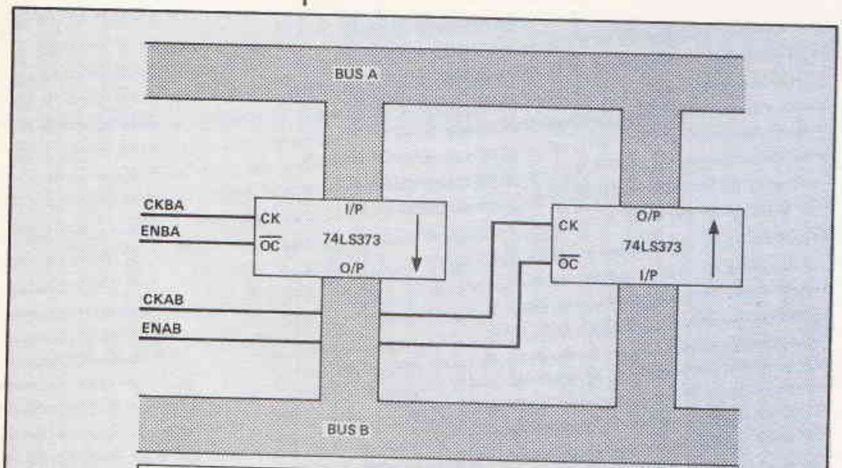
Alan Trevennor gives us the lowdown on some of the new TTL devices now available

NEW TTL

TTL (Transistor Transistor Logic) has been the most popular logic family since it was introduced way back in the early 1970s. Over the years the family has grown and many sub-families have been introduced which are faster and less power hungry.

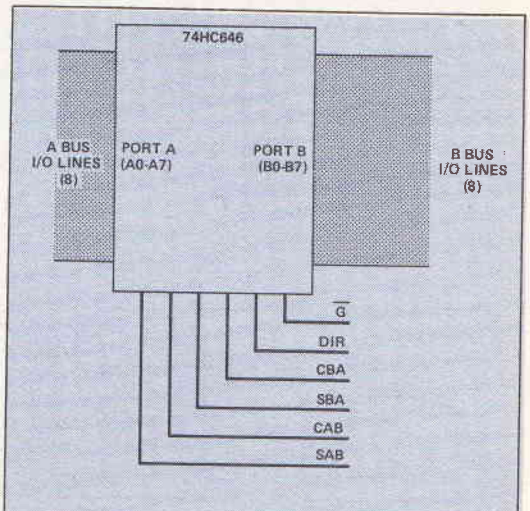
Many hobbyists and even some professional electronic designers use only the lower numbered chips in the TTL range. There are probably many reasons for this. The high numbered chips look expensive and many hobbyists still use elderly TTL data books dating from before the introduction of many of the more modern devices.

Whatever the reasons, this article makes a start at opening up the upper reaches of the TTL range by presenting full details on some of the more interesting devices and giving a summary of others.



SIGNAL	ACTION
CKAB	LATCH A BUS DATA
ENAB	ENABLE LATCHED A BUS SIGNAL ONTO B BUS
CKBA	LATCH BUS B DATA
ENBA BUS	ENABLE LATCHED B BUS SIGNAL ONTO A BUS

Fig. 1 Bus buffer conventional method



74HC646 CONTROL FUNCTIONS								
G	DIR	CAB	CBA	SAB	SBA	PA	PB	OPERATION
H H	X X	S ↑	S ↑	X X	X X	INP INP	INP INP	ISOLATION LOAD IN DATA
L L	L L	X X	X X	X X	L H	O/P O/P	INP INP	B DATA TO A BUS STORED B TO A BUS
L L	H H	X S	X X	L H	X X	INP INP	O/P O/P	A DATA TO B BUS SCORED A DATA TO B BUS

X = DON'T CARE
S = STATIC LEVER –EITHER HIGH OR LOW
H = HIGH
L = LOW

Fig. 2 74HC646 block diagram and truth table

Let's start with a chip which shatters the price myth — the 74646. This chip retails in its HC version (the 74HC646) for about £2.50. The chip is specifically designed to interface two 8-bit MPU data buses to one another, with the ability to latch the data on either bus and to tri-state the connection from either bus to the chip. Normally this would be done with a configuration like that shown in Fig. 1. As you can see this would involve at least two 74LS373 chips (and therefore two sockets) and some extra gates to synchronise the action of the circuit.

In Fig. 2 the 74HC646 is shown in block diagram form along with the truth table for controlling it. This chip contains not only all the logic to interface two buses but also the control logic to effect the transfer and storage of data between them. So the 74HC646 is not only a cost effective replacement for the previous circuit but occupies at least 50% less board space as well! Figure 3 is an extract from an application note for the 74HC646, showing it in action.

Another useful device is the 74LS682. This is an 8-bit comparator chip. In microcomputer address decoder and data analysis circuits it is sometimes required to perform comparisons of two 8-bit numbers. This used to require two 74LS86 XOR gate packages and two other gates to total all the outputs of the 74LS86 — as shown in Fig. 4. Using a 74LS682 chip for this job, as shown in Fig. 5, we have reduced the package count from four to one.

In addition to signalling that one input is equal to another, the chip also detects when one of the numbers is greater than the other. Once again the chip is priced so the cost of the two designs detailed here are comparable without accounting for the price of extra sockets needed for the version shown in Fig. 4.

The 74LS687 performs the same comparator function as the 74LS682 but has two active low enable inputs to switch on or off the comparison function. This allows you to select 'windows' when comparisons have to be made.

PADing

Figure 6 shows a circuit diagram for a programmable address decoder using a 74LS687. Such a circuit is very useful in a microcomputer when device addresses need to be adjustable to any 256-byte boundary — perhaps depending upon how much memory is fitted to the machine.

On power up the RESET signal (from the system power-on reset source) forces the NOR

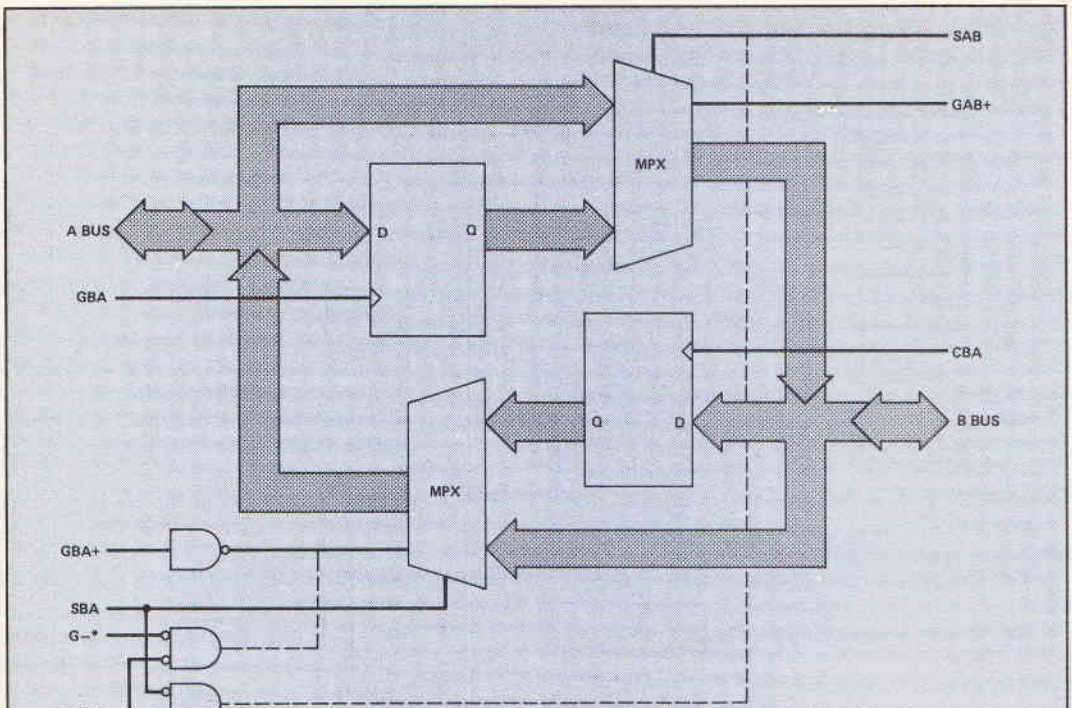


Fig. 3 Texas application sheet diagram

gate latch into its reset state. This disables the $\overline{G1}$ input of the 74LS687. The computer initialisation program decides where in the address space it wishes to place the device connected to the $\overline{CS}$ output of the circuit. It writes the upper eight bits of the desired address into the 74LS374 latch which should be addressed as an I/O port at a known address in the I/O page.

So the upper eight bits of the desired address are loaded into the 74LS374 and this action also causes the NOR latch to be set enabling the $\overline{G1}$ input of the 74LS687. The other enable input of the 74LS687 is enabled whenever the MPU signals that the address bus contains a valid memory address.

In Fig. 6 the signal $\overline{\text{ADDRESS BUS VALID}}$ is only theoretical and you should substitute a signal from your particular MPU which indicates a valid address on A0-A15. In a Z80 system for example this will be $\overline{\text{MREQ}}$. In a 6800 system it will be VMA.

The purpose of LK1 is to permit the circuit to be used to select a range of valid addresses (when addressing a memory array). With LK1 connected from $\overline{CS}$ to P>Q you can produce a chip select signal whenever the address output from the MPU is above the value in the 74LS374.

The 74LS590 is an 8-bit counter with an output register (or latch) — all in a 16-pin DIL package. Figure 7 shows the pin out of this chip.

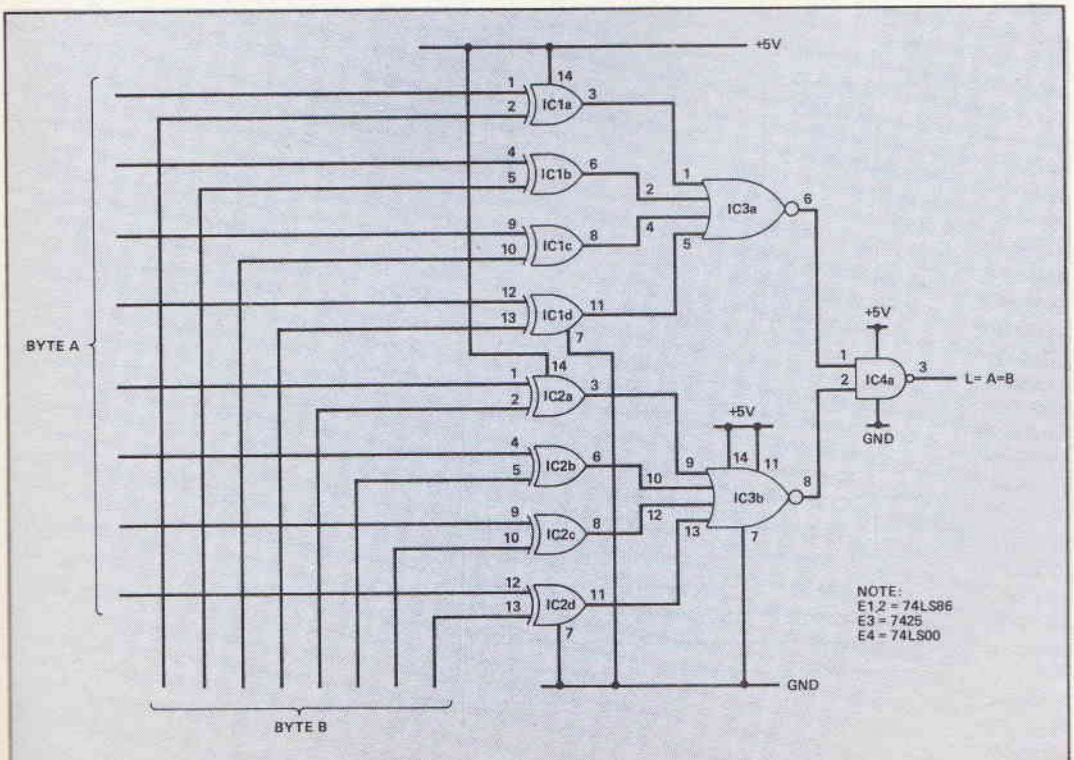


Fig. 4 8 bit comparator using 7486 + summing NOR g

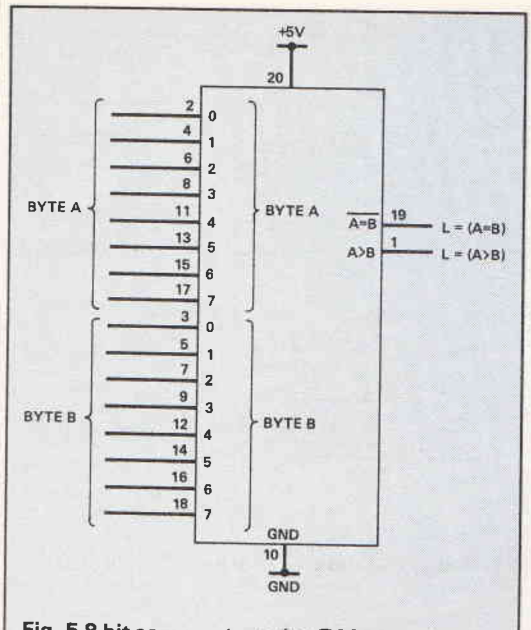


Fig. 5 8 bit comparator using 74682

The counter section is capable of operating with clock speeds of up to 20MHz. Another attractive feature of this chip is the tri-state outputs from the latch. (The 74LS591 is the same chip but with open collector outputs). This tri-state output capability makes the 74LS590 ideal for use in microprocessor bus oriented systems. Figure 8 shows a block diagram of the chip logic. The signal descriptions are as follows:

QA-QH The register outputs. Whenever a positive going edge occurs at this input the register is loaded with the contents of the counter.

$\overline{RCO}$ This is the carry output from the counter. A positive going edge will occur on this output whenever the counter contents change from &FF to zero.

$\overline{CLR}$ An input which, when taken low, clears the counter to zero.

CCK The clock input to the counter. The counter increments by one whenever a positive edge occurs at this input.

$\overline{EN}$ An input which must be taken low to enable counting to take place, and high to prevent it.

RCK A positive going edge on this input loads the output register with the counter contents.

$\overline{G}$ When this input is high the QA-QH outputs are in a high impedence state (tri-stated). When taken low, the data in the register is available at the QA-QH outputs.

Figure 9 shows how the 74LS590 can be used as an event counter in a microprocessor based system.

Table 1 gives a brief list of some of the devices in the 74400-742000 range which readers may find useful. Although hobby outlets may not have all the high numbered TTL chips in stock, they can usually obtain them for you quite quickly if you ask.

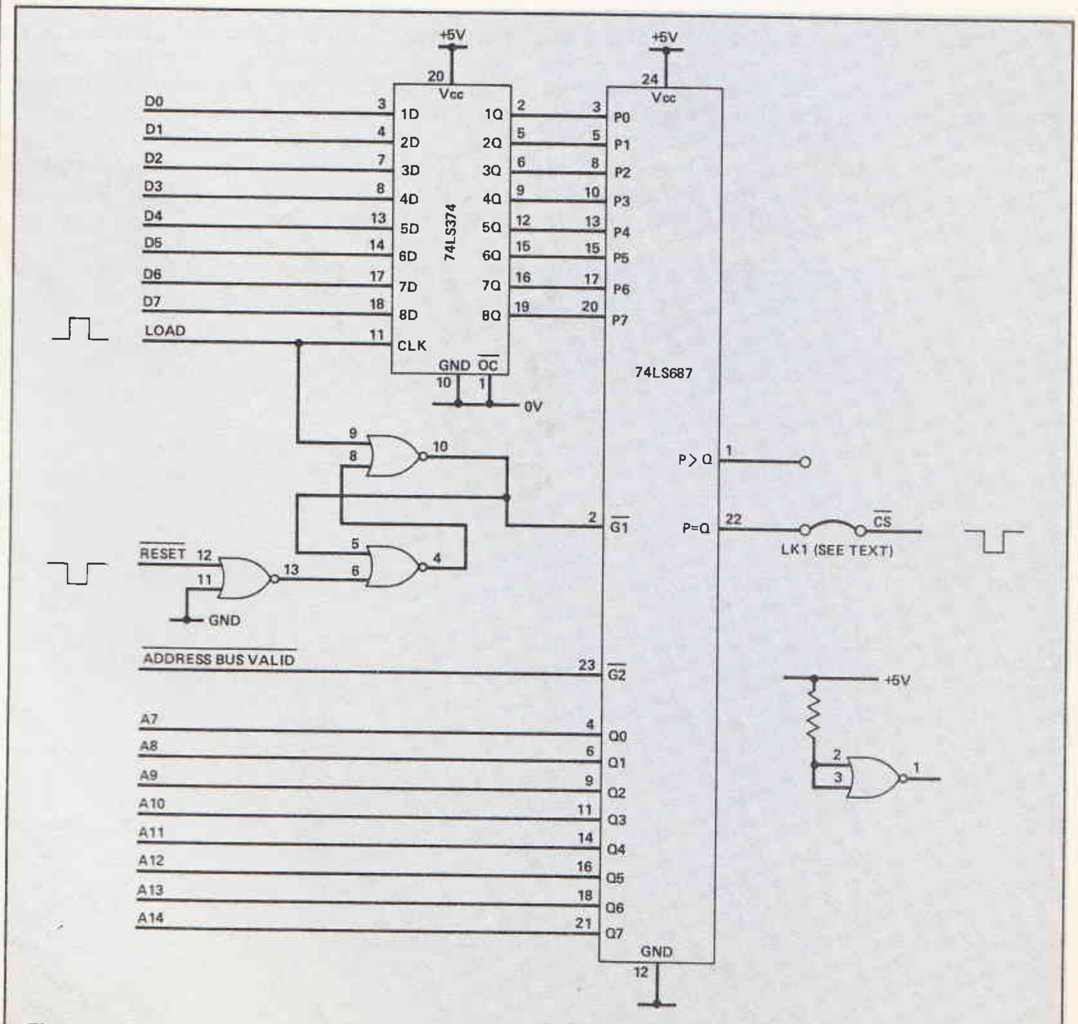


Fig. 6 Programmable address decoder

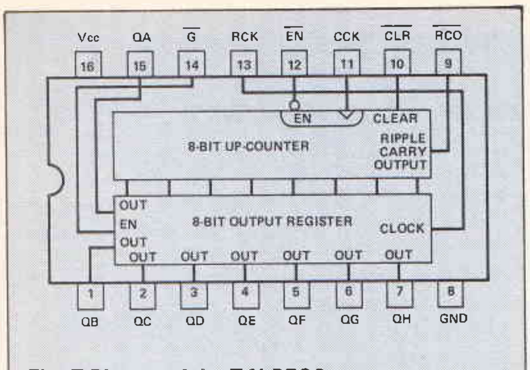


Fig. 7 Pin out of the 74LS590

Device	Functional description
74440	Quad tri-directional bus transceivers
74490	Dual decade counter
74593	8-bit counters with input registers and tri-state output
74595	8-bit shift registers with output registers
74600	Memory refresh controller
74604	Octal 12-input multiplexed latches — tri-state outputs
74608	Memory cycle controller
74610	Memory mapper
74630	16-bit ECC circuit
74632	32-bit ECC circuit
74673	16-bit SISO shift registers
74674	16-bit PISO shift registers
74677	16-to-4 bit address comparator
76850	16-to-1 multiplexer with tri-state outputs
74870	Dual 16-by-4 register files
74200	Direction discriminator

Table 1 Other chips of interest in the high TTL range

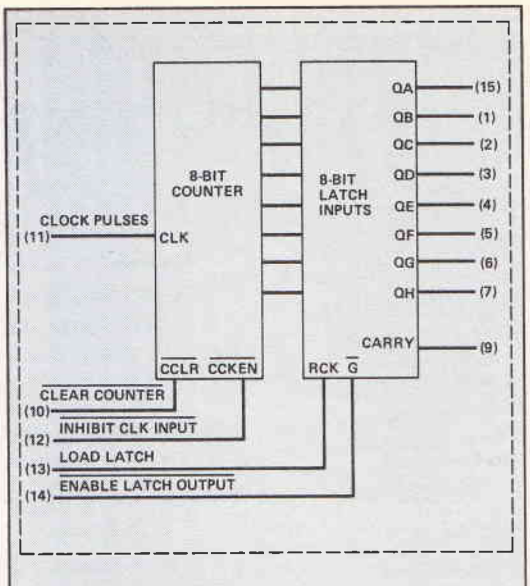


Fig. 8 Block diagram of chip logic of a 74LS590

Cricklewood is able to supply any T1 TTL chip by mail order. Contact Cricklewood Electronics, 40 Cricklewood Broadway, London NW2 3ET. Tel: 01-450 0995.

The TTL range will no doubt continue to grow, both in terms of device types and fabrication technologies. There is room for some more functions, for example some longer length counters would be nice! But whatever happens, TTL looks to have an assured future. ETI

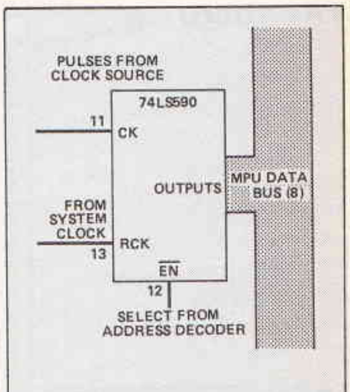
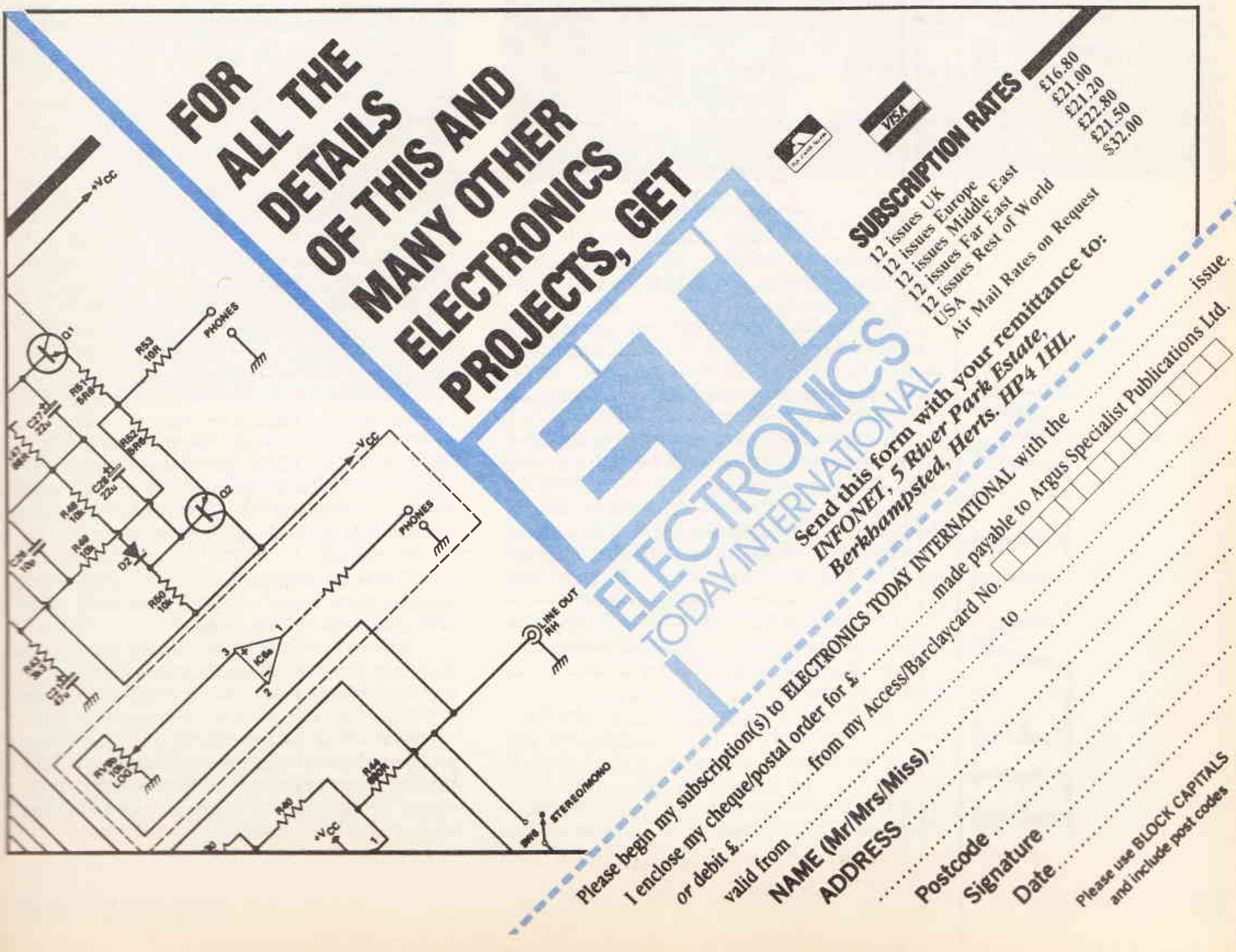


Fig. 9 Diagram of the 74LS590 as a counter in a MPU system



BBC DIY PCB

Malcolm Brown finds PCB design a doddle with Pineapple's autorouting software for the BBC micro

REVIEW

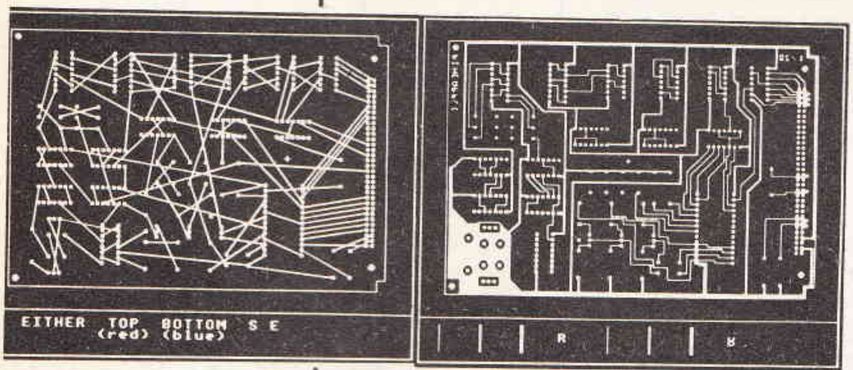
Although a computer based drawing package is a definite advantage when designing a PCB for a project, it still doesn't help with the really difficult and time consuming part — the actual design.

It is deciding where to take the tracks to avoid crossing them and to keep links to the minimum which is the most skilful and the hardest part.

Many professional PCB design workstations offer the facility of 'autorouting' the tracks — letting the computer work out the best design in much the same way it might work out strategy for a chess game.

That's fine for the professional workstations but some of these cost many thousands of pounds and are a little beyond the scope of the home enthusiast.

Pineapple's PCB package for the BBC micro has been around for quite a while (see the review in the March 1987 issue of ETI) and has commanded a great deal of respect as a remarkably professional design tool for the home constructor.



Now PCB has been given an upgrade to give it the autorouting capability of its high priced professional brethren and it will only cost you £55 to add on the extra.

PCB-AR (as the autoroute package is rather anonymously called) is, like PCB itself, supplied on ROM. The existing PCB ROM can detect the AR ROM's presence in the micro and so is extended in its capabilities accordingly.

At the tracking stage of a PCB design (after the component positions and labels have been defined) a function key is pressed to bring PCB-AR into action. Rather than now draw tracks between the pads on the on-screen board, the required connections are made directly. Each pad on the board is linked with a straight line to each other pad it is to connect to (see screenshots).

The resulting 'rats nest' is a visual representation of the entire circuit. A cursor is moved to the first pad and then a line is 'rubber banded' to the desired connection — it couldn't be easier.

However, it must be said that it is far from easy to make all the right connections with any complexity of circuit. It must be worked through methodically and logically to keep errors to a minimum. Many of the professional systems make things easier with printouts of a list of all the connections, with pre-defined labels for each pad, to enable a thorough check to be made.

PCB-AR does not produce a list and so it is all too easy to miss a couple of connections or to, say, connect the power supply to the wrong pin of an IC.

However, a few practice runs with the software begin to get you into the swing of thinking of circuits in this strange way and errors become less likely.

The rats nest can be stored on disk at any stage (so you can perform this tedious task in a few short, concentration-packed bursts) and it can be easily edited.

The editing procedure is simple too. The cursor is moved to one end of the connection under question and another function key pressed. This removes the connections to all other pads to leave a clear view of the suspect line. This can now be deleted or moved elsewhere.

The connections don't have to be from pad to pad. They can join two empty points on the board or a pad to a track already drawn in 'by hand'. This is especially useful for power or data buses around a board.

As each connection is entered some guidance is given for the automatic routing to come. Each connection (and its resulting track) can be biased to the top or solder side of the board or to both equally. To give the autoroute routine a bit of a hand the connection can be given a starting direction to try too.

When all the desired connections are made, another function key is pressed and the software gets on with routing them. This, of course, is where the really clever bit comes in.

You are given the choice whether to route tracks between adjacent pins on ICs and whether the connections list is to be sorted to give a bias of horizontal tracks on one side of the board and vertical ones on the other.

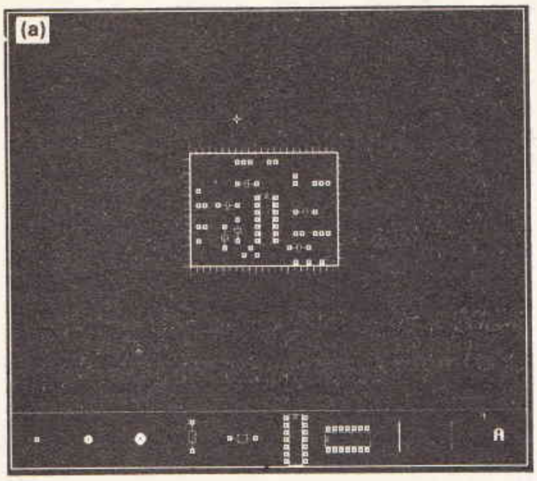
The autorouting algorithm takes a while to route any complex board but since it draws the tracks as it goes, it provides quite a tension filled spectacle to pass the time.

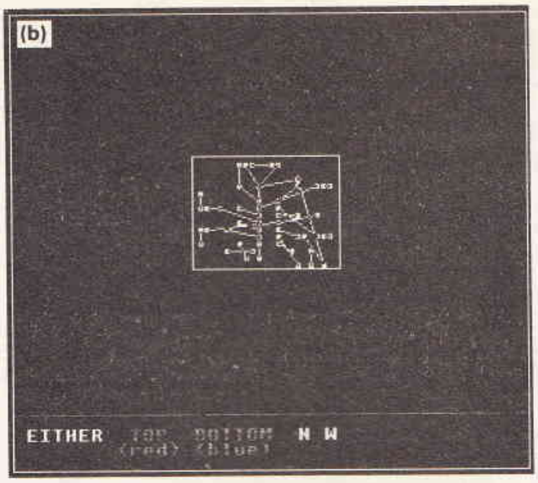
The algorithm works not unlike many game playing 'strategy' algorithms. Movement from any point is limited to North, South, East or West. Starting at a pad the program checks for obstructions in each direction and then checks each direction a distance further out from the original point and so on until a clear route to the destination is reached.

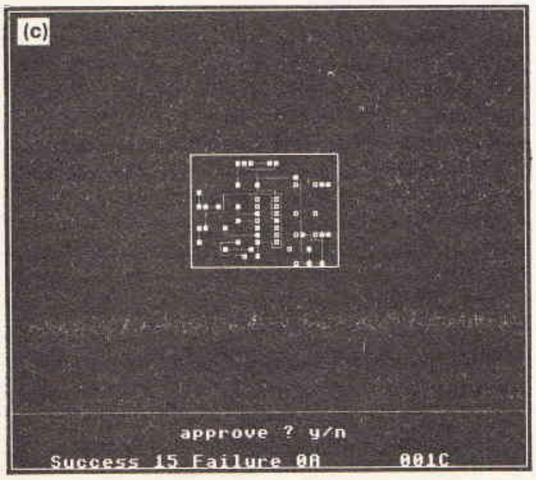
This is done for each of the connections you entered, in the same order as you entered them, until they have all been tried.

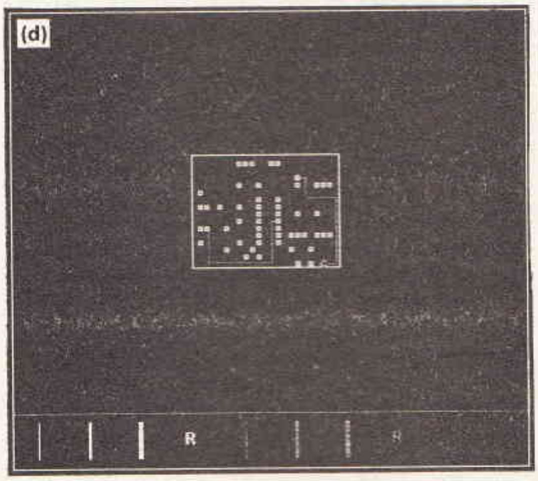
When it's finished, it reports any connections it cannot complete. Pressing a function key then highlights the connections it couldn't manage which can then can be altered or drawn in by hand.

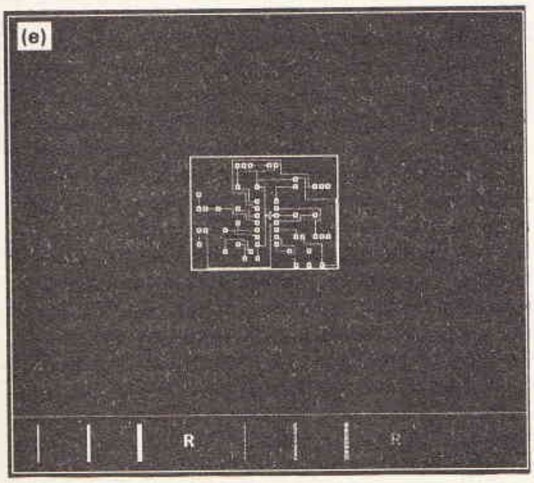
PCB-AR is not the end of PCB foil design problems. It does require methodical work to input the circuit connections and almost a knack for seeing how to turn its inevitable quirks to your advantage.

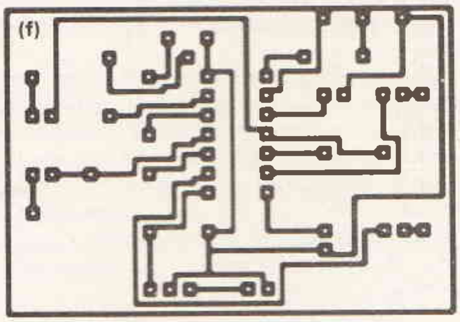












(a) Component placement screen. (b) Connection screen. (c) Initial attempt fails. (d) Manual guide tracks are added. (e) Successful attempt. (f) Final output.

However, I tried it out re-designing the PCB for the Dynamic Noise Reduction system (May's *First Class* project) and after a little fiddling, I must say I was impressed with the results.

It has some clear limitations. A maximum of 190 connections per board can be autorouted and the program will not (for the sake of speed) investigate connection routes outside a rectangle eight times the rectangle with the two connections at its opposite corners.

There is also a maximum rectangle of investigation of 3136 pixels — equivalent to a 3.7in × 3.7in square.

Finally PCB-AR always uses the same width of track — about 0.5mm — with the same minimum spacing. However, thicker connections can always be added later, manually.

Despite these constraints, PCB-AR is a truly remarkable piece of software. There is nothing to touch it at anything like this price. A couple of years ago, anyone suggesting this could be done on a standard model B BBC micro would have been considered naive at best.

For Beeb owners with any kind of regular interest in PCB design the PCB and PCB-AR combination is difficult to beat and thoroughly recommended.

PCB AR £55 as upgrade to PCB
£185 PCB + PCB-AR.
Pineapple Software,
39 Brownlea Gardens,
Seven Kings
Ilford IG3 9NL.
Tel: 01-599 1476.

ETI

BROUGHT TO LIGHT

Mike Barwise puts down his chips and has a light snack

For the next couple of months I am going to digress from the purely electronic into the field of basic opto-electronics — an increasingly important area in electronic systems design. At its simplest it impinges even on thoroughly familiar systems in quite unexpected ways. The other end of the opto-electronic spectrum (for want of a better word!) is in the still experimental spheres of optical computing and data storage, which is a subject that could fill several complete issues of ETI just describing the groundwork. However — let's start at the beginning.

The basic opto-electronic devices are the photo-diode and photo-transistor which are both *detectors,* and various sources of light (lamps, LEDs and lasers).

The Photo-Diode

Starting with the photo-diode, this looks like a conventional diode (very often silicon) but instead of being sealed in an opaque package, the diode junction is exposed via some kind of window so that light can fall on it.

There are two generally used characteristics of such a diode which yield alternative modes of operation. The first is the ability of the diode to generate an illuminance dependent *current*. When light shines on the diode junction, electrons are released from the cathode and drift towards the anode.

The resulting current flow is tiny, but proportional to the amount of light falling on the junction — within the extreme limits of the *threshold* (the minimum amount of light that causes any electrons at all to be released) and *saturation* (the maximum number of electrons per second the diode can release, regardless of illuminance level) of the diode. A theoretical circuit for this mode of operation is shown in Fig. 1.

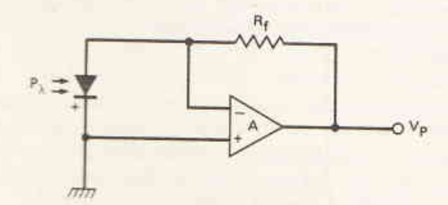


Fig. 1 Circuit for a photo-diode using current generation

The second characteristic of value is the change in *diode reverse leakage* with illuminance. In this mode the diode is reverse biased using a voltage as high as possible subject to the reverse breakdown voltage of the diode and the signal is detected as shown in Fig. 2.

This is again a linear relationship within the same limits, but the output signal from the diode is much greater. The penalty for this is a much higher noise level. It must be remembered that a reverse biased diode (a zener diode for example) has long been used intentionally as a noise source in electronic systems.

IN THE BEGINNING . . .
A quick nostalgia note — I remember the very first LEDs coming into the market place. They were about £2 each in those days (early in the '70s) and I don't think anyone realised their full potential then. The first advertised application was illuminated needles on aircraft instruments!

The photo-transistor functions in much the same way as the first diode case: light falling on the device generates a base current to turn the transistor on.

There are other detectors in common use, such as selenium cells, but these are mostly slow response low precision devices used more in solar batteries and so on than in detection or measurement systems.

Basic Emitters

Apart from sunlight (the oldest emitter of them all!) the earliest opto-emitter used in electronics was the filament lamp — a very inefficient light source. Most of its output is in the form of heat, its life is severely limited and it is impossible to make a precise spot source without mirrors and lenses (which further reduce the amount of light emerging).

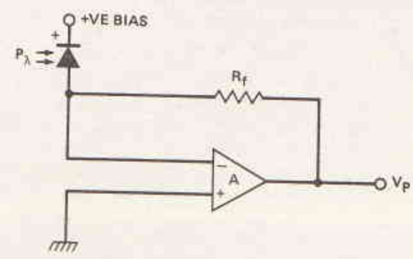


Fig. 2 Circuit for a photo-diode using reverse leakage

The first major breakthrough in emitters was probably the LED. This is a diode made of a special material (usually a compound based on gallium arsenide) which emits light when forward biased (when it is carrying a current) in addition to behaving just like any other diode. Heat generation is remarkably low and of course the size of the emitting element can be precisely controlled by normal semiconductor manufacturing techniques. Light output is not usually very great for the current consumed, although there are some so-called "high efficiency" LEDs, but the output spectrum extends well into the infra-red where detector diodes are normally most sensitive.

These are the two most basic emitters. Apart from one or two unusual applications, the filament lamp is of no further interest to us and we will use nothing but LEDs from here on. One of those unusual applications is worth mentioning though: a pecularity of the filament lamp is that when switched on or off, the filament brightens and dims *exponentially*. It brightens faster and faster the brighter it gets and dims slower and slower the dimmer it gets.

This is useful in the production of a very clean, distortion-free sine wave oscillator. If the lamp is driven by an amplifier output and shines on a photo-detector in the amp gain control chain, a classic feedback oscillator is created, which is constrained to a sinusoidal waveform by the lamp filament characteristics. However . . . onward, ever onward!

CHIP IN

Optical Couplers

It is very unlikely that emitters and detectors will be widely used except in coupled pairs of some form or other. The first and most obvious case is the *interrupter* (Fig. 3). This device is present in one or other of its two forms in the vast majority of computer printers, disk drives, video recorders, tape recorders ... the list is endless. Anywhere a moving object is to be detected, the interrupter is in use. The emitter (LED) is permanently lit and when an object enters the interrupter's field of view the light path to the detector is broken (transmission system) or completed (reflectance system).

The next case is the *opto-isolator*. This is an LED+photo-transistor pair or LED+photo-diode pair encapsulated in some compact opaque package, frequently an IC DIP. The point of the opto-isolator is twofold. Electrical isolation between the input circuit and output circuit can be as high as several kilovolts (so HT circuits can control or be controlled by logic or small signals with safety). Also the signal bandwidth of the opto-isolator can be controlled by a suitable choice of detector diode at design time. This serves an important role in noise reduction, typically in computer communications. This is worth going into in more detail, so here goes.

RFI Reduction

RFI is a new buzzword — Radio Frequency Interference, that's all! New legislation is coming in to control the extremely far-reaching effects of RFI caused by all the computers and communication channels now in operation.

So where exactly does RFI come from? Basically, every time a logic level changes in a PCB track or wire in your computer or its external cables, there is *overshoot* or *undershoot*, followed by *ringing*. Although the logic state may be switching at only a few kilohertz, the ringing frequency depends on the resonance of the wiring and may cover a bandwidth of several megahertz.

With this in view, let us take the case of a simple RS232C channel. The logic switching rate is normally no higher than 40kHz and the specification calls for a signal rise time no faster than 1µs, but the data cable is essentially unbalanced and therefore a lot of ringing of unpredictable frequency can take place. This gets referred via the computer's imperfect ground path and radiated from the whole length of the cable, as well as being superimposed on the signal itself.

The interposition of opto-isolation at each end of the cable between the comms device and the line driver chips dissociates the cable ground from the ground noise in the communication device and also (if its bandwidth is suitably chosen) will eliminate practically all the ringing in the signal, improving data haul distance.

The next step in opto-isolation is to separate the emitter and decoder and interpose a piece of optical fibre. This opens the door on all sorts of clever options which we will look at later on, but just for now let's stick with the RS232. In the previous example we had an electrical signal being converted into an optical signal and back again at each end of our comms link in the interest of isolation and reduction of RFI emission. However, external electrical noise can still be picked up by comms cable and it can be bad enough to spoil our data.

Now instead, we introduce the magical optical fibre with an emitter at one end and a detector at the other and the long signal haul performed on an optical signal. So long as the fibre is in an opaque jacket, *absolutely nothing* (for practical purposes) can be emitted or picked up by the data transmission link.

This is obviously a much better solution, but how does it work?

Optical fibre consists of a concentric arrangement of transparent materials (plastics, silica glass) of different *refractive index* (Fig. 4). This is a measure of the angle by which a beam of light of a given colour is deflected as it passes through the material. Different colours are deflected or refracted by different amounts, which is why we see rainbows through things like prisms, but a given colour (wavelength) of light is always refracted by the same amount, all other conditions (temperature and so on) being equal. This is the fundamental rule by which optical fibres work.

When light is passed into a perfectly straight piece of optical fibre, some of the light passes directly down the central axis but most of it diverges. Any particular beam following a divergent path will eventually strike the transition between the differing materials in the fibre. These are so chosen that practically all the light is refracted back into the centre of the fibre.

The real case in which the fibre is not perfectly straight works just the same, although a bit more light gets lost.

The Distance/Speed Trade-Off

I will not delve into numbers here as the problem gets quite difficult to quantise, but the principle is very simple. As we have seen, light entering the fibre takes a variable but large number of different paths. These will consist of different numbers of refractions and are therefore of different lengths. As light travels at a finite speed, the different bits of light which started out at the same time will arrive at different times.

Assuming a perfect square wave going into the fibre (which is theoretical and a best case, as all emitters take a bit of time to turn on fully) when the difference between the arrival time of the earliest and latest bit of light equals the half wavelength of the input square wave, the signal is totally lost due to the latest light from the last bit coinciding with the earliest light from the next bit.

In practice the situation is worse than this. RS232 is an *asynchronous* communication protocol. This means that reliable decoding of the incoming signal relies on a specific relationship between the on and off periods (marks and spaces) and also a predictable absolute duration. The tolerance for out of timing data bits is about 10%, so a "mushiness" due to differential propagation paths of this order will kill the data link.

The good news is that the length of fibre required for this problem to manifest itself is pretty long. You will most likely run out of optical power long before that length if you are using conventional LEDs, particularly if you use the cheap (affordable) plastic fibre, which is very lossy compared with (expensive) silica fibres.

In order to obtain much greater transmission distances, the use of silica fibre with laser diodes, or at least source of coherent light (some kind of laser) is essential. More of this next month. In the meantime, a good selection of plastics fibre optic components can be obtained from Electromail on (0536) 204555.

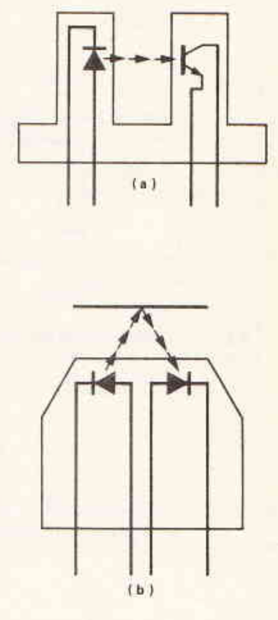


Fig. 3 Optical couplers as interrupters

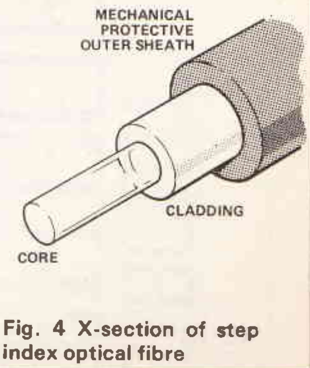


Fig. 4 X-section of step index optical fibre

OP-AMPS

Paul Chappell investigates all possible configurations of an op-amp and a couple of resistors

Last month I was looking at the basic parallel (or shunt) feedback circuit of Fig. 1a and concluded that the rule of thumb formula for the gain -R2/R1, was accurate to almost 0.01% for the resistor values shown. The formula predicts a gain of -10, whereas the actual gain is -9.99989. I hinted that there might be circumstances where the formula would not be so good and now it is time to find out when.

Suppose that I take an op-amp with a gain of 10^6 and connect the resistors shown in Fig. 1b. This would seem to give the entire circuit a gain of -10^6 and since this is what the op-amp itself would give without the resistors, it doesn't seem an unreasonable request.

Applying the exact formula for the gain:

$$\frac{V_{out}}{V_{in}} = -\frac{R2}{R1+10^{-6}(R1+R2)}$$

gives a figure of approximately 5×10^5, which is only half the gain predicted by the rule of thumb formula.

Table 1 shows the circuit gain for different resistor ratios against the value predicted by -R2/R1. At a predicted gain of -10^3 the true value is about 0.1% out, at -10^4 the error is about 1%, at 10^5 it has almost reached 10% and at 10^6 the true gain is only half the predicted value.

The last two entries represent an optimistic attempt to force more gain from the circuit than the IC itself has. It doesn't work. The circuit gain approaches the gain of the IC but never quite reaches it and certainly never exceeds it.

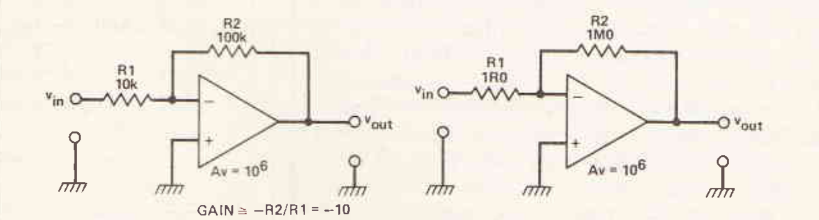


Fig. 1 (a) The basic parallel feedback circuit. (b) A circuit with a gain of -10^6?

The reason for the discrepancy is illustrated by Fig. 2 which compares the case where the resistors ask for a gain very much lower than the IC's own gain (Fig. 2a) with one where the required gain is equal to the IC's gain (Fig. 2b).

In the first case, the 10µV necessary to sustain the output of the amp at -10V is negligible in comparison to the input voltage, so the formula works well. An input of 1V gives an output of -10V so the circuit has a gain of -10 as we'd expect.

In the second case, the 10µV needed at the inverting input of the IC to sustain the -10V is very comparable indeed with the input! The idea, on which the rule of thumb formula depends (of the -ve input of the IC being a virtual earth) no longer works and the effective gain of the circuit is only half the predicted value.

Rule of thumb gain	Actual gain
-1	-1
-10	-9.99991
-100	-99.990101
-1000	-999.001997
-10000	-9900.9999
-100000	-90909.1736
-1000000	-500000.25
-10000000	-909090.992
-100000000	-990099.02

Table 1 Actual basic parallel feedback circuit gains compared with the rule of thumb values

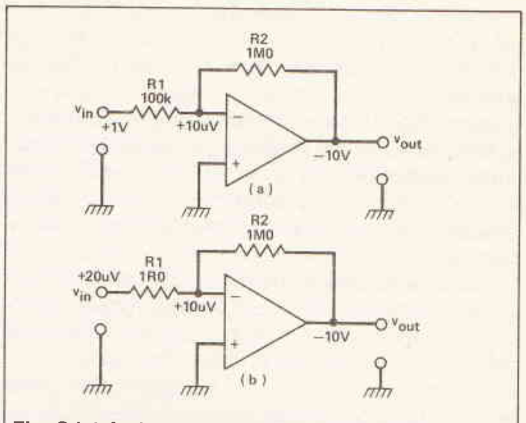


Fig. 3 (a) A circuit with a gain much lower than the op-amp's its gain. (b) Demanding a gain equal to the op-amp's gain

The shunt feedback circuit is such a useful configuration that I can't continue without giving you a moment to admire some of its best features. One consequence of the virtual earth at the -ve input is that the circuit can be used to sum voltages. Figure 4 shows how.

Suppose that the resistors R1, R2, R3 ... Rn and the feedback resistor Rf are all the same value. If all the input voltages v_1 to v_n are at 0V, no current will flow throughout the feedback resistor, so the output will also be at 0V.

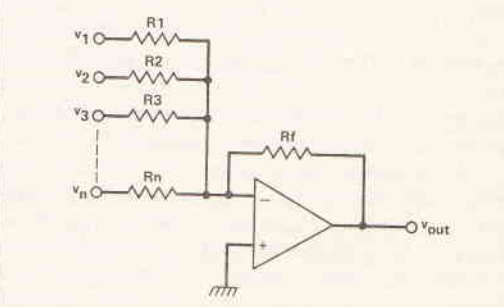


Fig. 3 Voltage summing circuit

If any one of the input voltages varies from 0V, a current will flow in the corresponding resistor and to maintain the -ve input at 0V the op-amp will cause the same current to flow in Rf. We have chosen to make Rf equal to the input resistors, so the voltage across it will be equal in magnitude to the input voltage. In other words, a voltage of v_n on any input will result in $-v_n$ at the circuit's output.

Since this applies to any input, by superposition the output from voltages appearing simultaneously on all inputs will be equal to (minus) the sum of all the input voltages. The circuit is often used to sum audio signals (and has even been used as a complete audio mixer in more than one hobby project!) or to sum voltages in analogue computer or control systems.

Replacing the feedback resistor (R2 in Fig. 1a) with a capacitor gives another useful circuit — an integrator (Fig. 4a). Once again, the op-amp acts to maintain the two input terminals at the same voltage and so draws all the input current through the capacitor:

$$i_1 = v_{in}/R = i_2 = -C\frac{dv_{out}}{dt}$$

$$\text{so } v_{out} = -\frac{1}{CR}\int v_{in}$$

The response of the circuit to a constant input voltage (it's often used in this way) is to produce a linear ramp which rises or falls at a rate determined by C, R and v_{in}. For R=1M, C=1μF and v_{in}=−1V, the output will ramp upwards at 1V per second.

The other common variation on the theme is to substitute a capacitor for the input resistor to give the circuit of Fig. 4b: a differentiator. Here the output voltage is given by:

$$V_{out} = -CR\frac{dv_{in}}{dt}$$

This circuit is useful if you are interested in the slope of a signal rather than its actual level. A practical example is last month's breathing rate monitor circuit, where C1 and R5 correspond to C and R of Fig. 4a. In the monitor, the input voltage will vary according to the type of diode chosen (or even between different samples of the same type), the room temperature and so on. On the other hand, whether the voltage is rising or falling at a fairly fast rate will depend primarily on whether the user is breathing in or out, so detecting the change in voltage rather than the voltage itself screens out a lot of unwanted effects. The reason for the other components used in the monitor will become clear when we start to think about turning the basic ideas into practical circuits.

A much less common variation is shown in Fig. 4c. Can you work out what it does? Why do you think it's not used more often? Can you think of any feature of the circuit that might be put to good use? Answers next month.

Series Feedback

The basic non-inverting (or series feedback) amplifier configuration is shown in Fig. 5. For an intuitive understanding of this circuit it's best to think in terms of voltages rather than currents. If v_{in} is at 0V, the output will also settle at 0V — the action of the output voltage and the two resistors won't let it settle anywhere else.

Suppose the input rises to 1V. This would push the output voltage upwards until the voltage at the −ve terminal also rises to (near as damn it) 1V. The action of the circuit is once again to maintain the two input terminals at the same voltage. If the −ve terminal is to be at v_{in}, then the output voltage must be at R1×v_n/R1+R2) so the rule of thumb gain formula for this configuration is: gain=R1/R1+R2). Once again, this is very accurate for low gains, and less and less accurate as the requested gain is increased.

I've done most of the work so far, so here's something for you to think about. Is it possible to make a non-inverting integrator and differentiator from Fig. 5 by replacing R1 or R2 with a capacitor? If not, what effect would the substitutions have?

I've just about exhausted the basic configurations possible with an op-amp and a pair of resistors but there's one more common circuit I should include. It's shown in Fig. 6.

With this circuit, if the input is at 0V then the output could also be at 0V. All the voltage conditions would be satisfied. But instead of the 'wobbly toy' effect, where a disturbance of the output gives a signal which pushes it back to its proper place, this circuit is more like an attempt to balance a razor blade on its edge.

The slightest movement of the output from its 0V position will result in a voltage at the +ve terminal which will tend to push it even further away. This creates an even larger voltage at the output, which increases still more the voltage at the +ve input, which gives a still larger voltage . . . and we have what used to be called a 'regenerative action' which causes the output voltage to topple until it hits one or other of the supply rails.

Given that the circuit has two artificially stable positions (artificial because the theoretical tendency is for the voltage to keep rising for ever — it's only the practical limitation of a finite supply voltage that stops the process) the question is — what will cause the circuit to switch between them?

Suppose the input is at 0V and the output is pushed hard against the positive supply rail at, say, +10V. We'll give the resistors values of R1=10k and R2=100k. The +ve input of the op-amp will be around 1V above the −ve input, so the output has every encouragement to stay just where it is! The only thing that would cause it to change would be if the +ve terminal went negative with respect to the −ve terminal, which would happen if the input voltage dropped below −1V. If this happens, the feedback action will cause the output to move smartly from the +10V rail to the −10V rail.

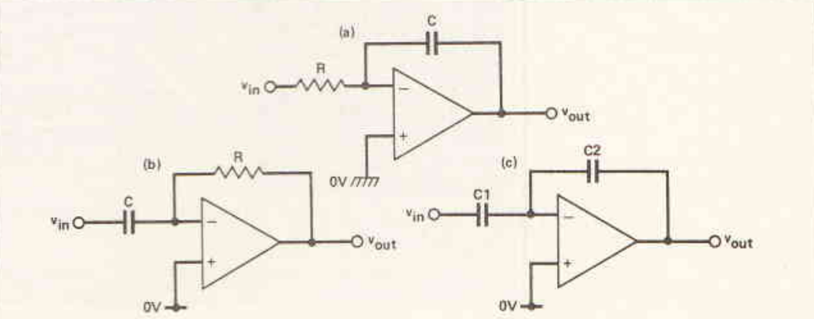


Fig. 4 (a) An integrator. (b) A differentiator. (c) The mystery configuration

To get it to change back again, it's not enough for the input to go back above −1V. Because R2 is connected to the output, which is now 20V lower than before, the input must go above +1V before the circuit will switch back. The result is a switching circuit with two different switching points. The voltage between them (in this case 2V) is called the 'hysteresis' and is what distinguishes this circuit from an ordinary voltage comparator. The circuit is often used to recover signals, particularly digital or switching ones, from noise (Fig. 6b). It's also useful where a circuit has to respond when a slowly changing signal reaches a certain voltage — a comparator without hysteresis might be inclined to switch this way and that when the signal is close to the reference point, whereas the circuit of Fig. 6a makes a decision and sticks to it!

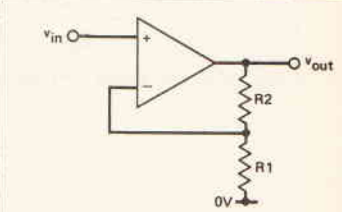


Fig. 5 The basic non-inverting amplifier circuit

Next month I'll be looking at some of the practical considerations that have to be taken into account when designing with real op-amps.

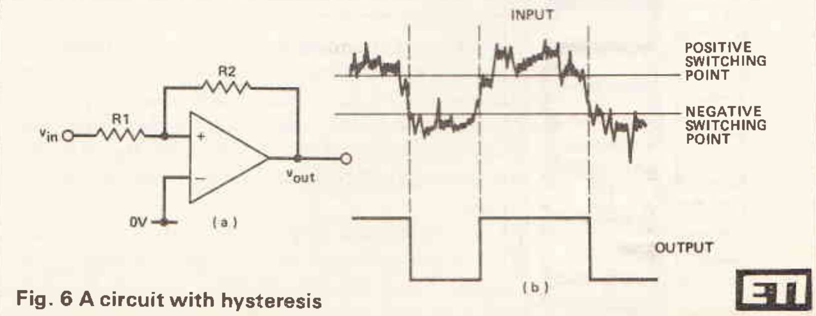


Fig. 6 A circuit with hysteresis

BAR CODE LOCK

Paul Wilson looks high and low for the bar

PROJECT

How would you like to impress your friends and confuse your burglars by unlocking your front door with a can of beans? Or a bottle of shampoo? Or a shrinkwrapped piece of Lymeswold blue? Or more sensibly with a small coded plastic key that you wipe over an innocent-looking sensor beside the door.

The ETI bar code switch is programmable to recognise a 14-bar key which is read by a reflective optical sensor. Verification of the code produces a short 'code accepted' pulse which can be used to open an electrically operated bolt or to trigger a relay for any purpose you may desire.

Attempts to operate the switch using the wrong key (or the wrong brand of beans) will sound an on-board alarm for a preset period — or until the correct key is used.

The barcode switch consists of two boards. The main decoder board contains the mains transformer and 12V PSU, code programming switches, decoding circuitry and also the piezo sounder. A 12V CMOS-compatible or open collector output is available to interface with external equipment.

A small pre-amp board fits in a small box with the optical sensor that scans the key. This sensor is the most important component in the system because its resolution determines the convenience of the key. If for instance the sensor could only resolve bars which were 5mm wide then a 14-bar key would end up being over 5in long. A key this long would not look very elegant attached to a key ring!

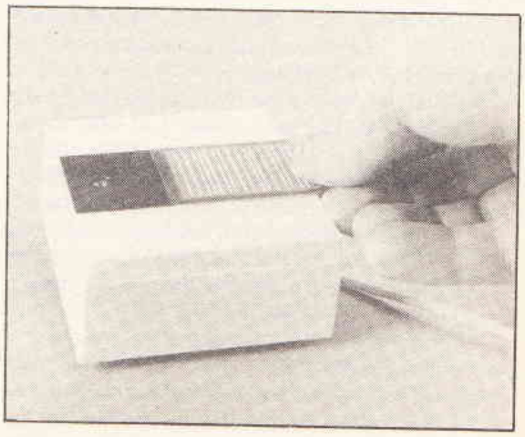
To produce a key of credit card size we need to resolve a narrow bar of 1mm and a thick bar of 2mm. There are two possible sensors depending on how rich you are.

If money is no object then the Hewlett Packard HBSC1100 reflective sensor with its resolution down to 0.19mm and its £27.00 + VAT price tag may be used. This device is designed to be used in bar code wands such as those used in many shops.

If this is too expensive then an RS sensor (see *Buylines*) may be used with the simple modification of partially covering its two sensing windows with a light proof material. Although the Hewlett Packard sensor wins hands down for performance and resolution, the RS price of about four quid is likely to persuade most constructors, myself included.

The key itself is a bar code such as that in Fig. 1 printed on paper and encapsulated in a plastic enclosure called a Pronta-pouch (honest!). This forms a flexible, waterproof and cheap key, somewhat like a credit card.

A program in BBC Basic is provided to



The correct wiping action to operate the lock.

produce the bar code on an Epson or compatible printer. The program should be easy to alter for other home micros.

As can be seen from Fig. 1 the code begins with a 3mm black border. No white can show before this. Following this is the 1mm black reference bar (this must always be a thin bar as the decoder uses it as a reference to determine the length of the bars of the actual code).

Then comes the actual bar code which is a simple binary code of up to 14 bars, in any combination of thin 1mm and thick 2mm black bars — a possible 16384 combinations.

Eight bars are used for the code in the key shown, giving the binary code 01101100 where 0 = thin and 1 = thick. A 3mm black border at the finish ends the code. All the white inter-bar spaces are 1mm wide.

Note that the key shown in Fig. 1 is symmetrical so it does not matter which way it is wiped across the sensor (this should help when getting used to using the switch).

The operation of the bar code switch can best be understood by looking at the block diagram in Fig. 2. The optical sensor consists of a LED which emits light onto the surface being scanned. Light will be reflected back to its receiver from white spaces. The output from this is amplified and filtered before being compared with a reference voltage (by the *bar comparator*) to determine whether a bar or space is present. Its output will be low (0) for a space and high (1) for a bar.

The *bar counter* is incremented by this comparator as the leading edge of each bar passes over the sensor so that each of the counter's outputs 1 to 14 become active when the corresponding bar in the code is over the sensor.

Two integrators are used to measure the time taken for the bars to pass over the sensor (see Fig. 3). As the thin reference bar is over the sensor, the reference integrator ramps negative (from its normally positive condition), ideally reaching about half the supply voltage and remaining there for the rest of the sweep.

The timing integrator is reset during each white space of the code. Its time constant is ⅔ that of the reference integrator so that its output goes (ideally) to 8V during a thin bar, and 4V during a thick bar. This is compared to the (ideal) 6V of the reference by the bar length comparator producing a zero output for a thin bar and a one for a thick bar.

There is a fair tolerance regarding the speed the key can be swept across the sensor. So long as the speed is constant the timing integrator should still cross the voltage set by the reference integrator at the correct points — the only difference being the voltage at which this reference voltage is set.

More important is the effect of changes in speed as the key is swept. An increasing speed could prevent thick bars reaching the reference voltage and a decreasing speed could push ramps from thin lines over the reference threshold, either effect giving a false decoding.

This circuit allows for an increase or decrease of almost 25%, which should cause few problems,

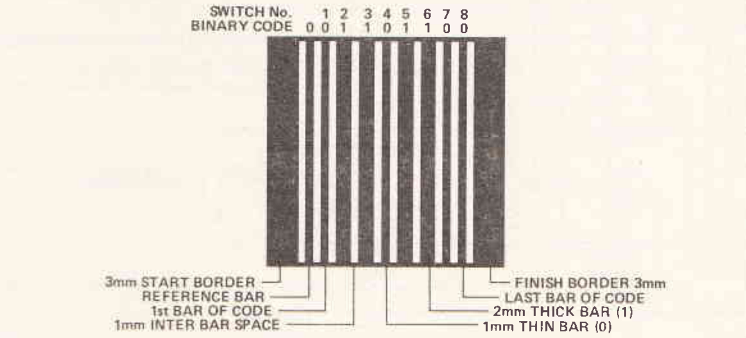


Fig. 1 An example bar code key

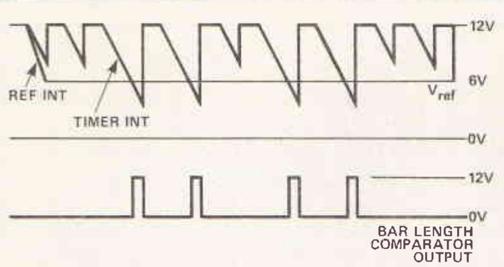


Fig. 3 Timing diagram for integrators using example bar code key

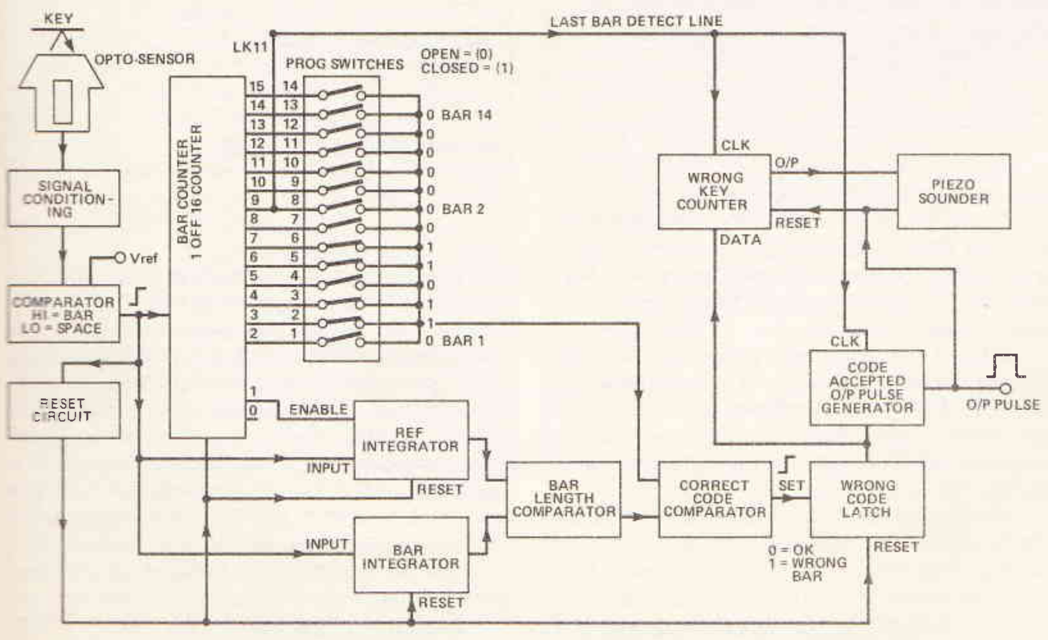


Fig. 2 Block diagram of the bar code switch

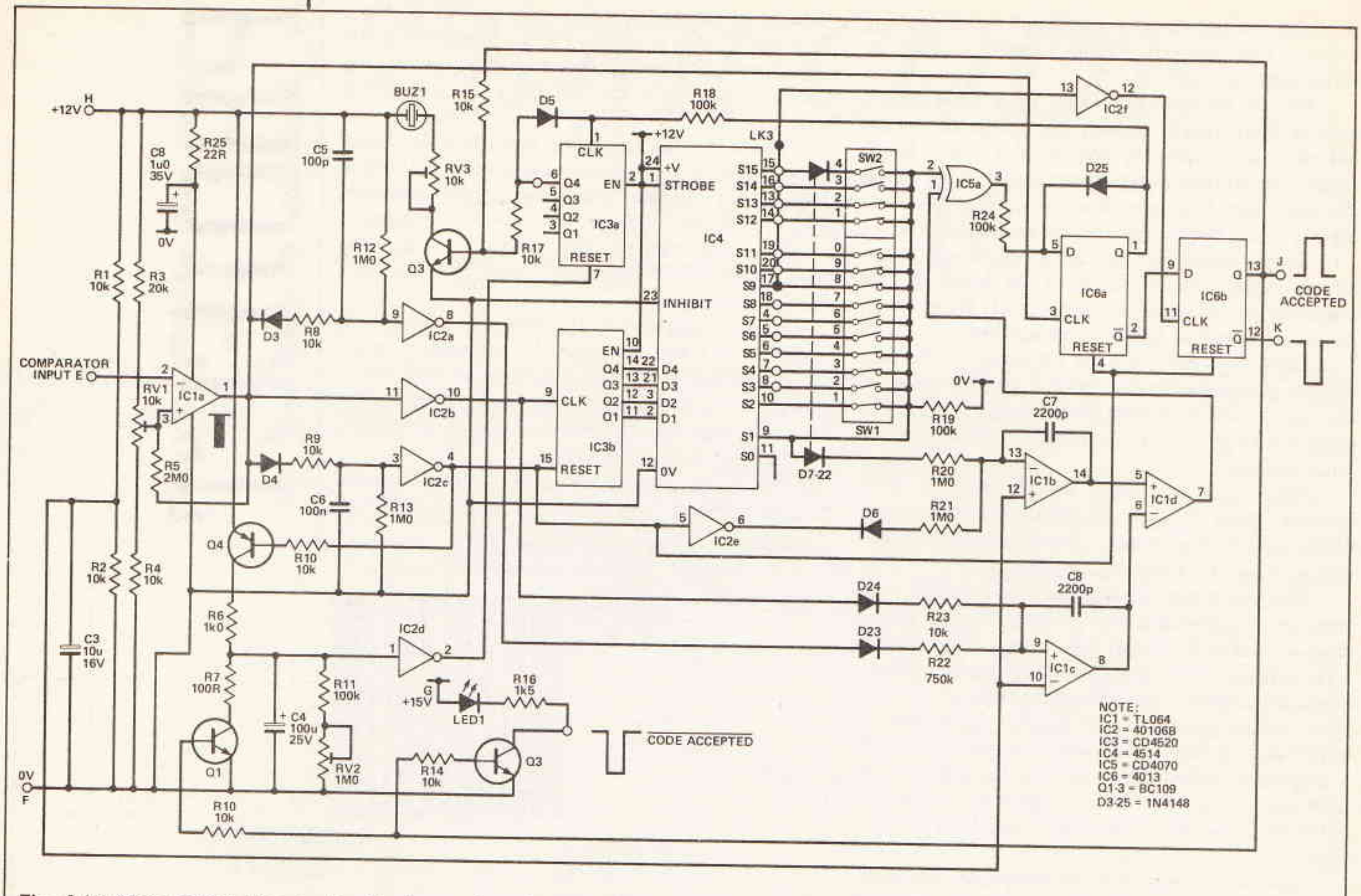
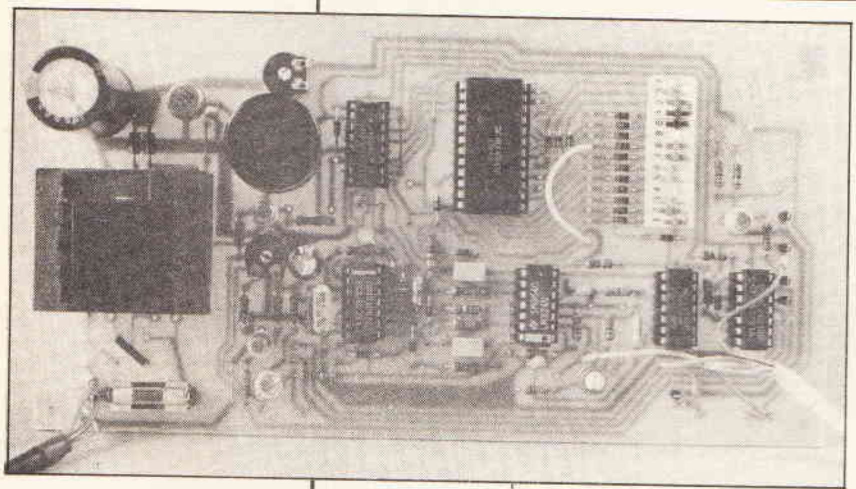


Fig. 4 (a) Main circuit diagram for the bar code switch



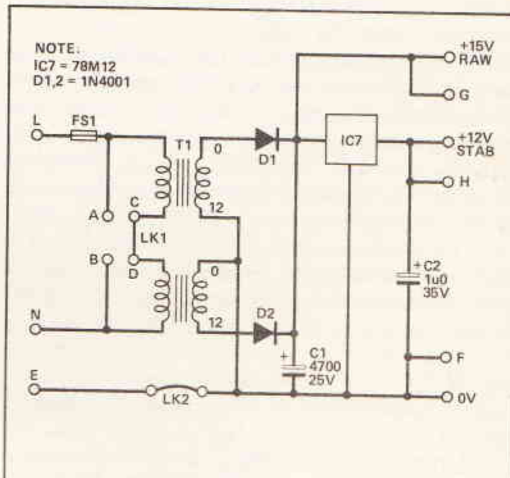


Fig. 4 (b) The power supply

PROJECT

particularly after a little practice.

The output of the bar length comparator (0 for thin, 1 for thick) is then compared with the output for the code programming switch for that bar (also 0 for thin, 1 for thick) by XORing them in the correct code comparator.

If they match, the output will be low. If they are different it will be high and this will set the wrong code latch high (where it will remain for the rest of the sweep regardless of later successful comparisons). The state of this latch determines whether the key is accepted or not.

The last bar detect line is connected to the last output of the bar counter that is needed for the length of code used. In the case of the code in Figs. 1 and 3 this is output 8. On the falling edge of this line (after the last bar on the key has been scanned) two things can happen.

If the wrong code latch has *not* been set high, the *pulse generator* will produce a short 100ms pulse which will in turn reset the wrong code counter and bleep the piezo sounder. This indicates that the correct key has been used.

If the wrong code latch *has* been set high then the code accepted pulse will be inhibited and the *wrong code counter* will be incremented. If this counter reaches an internally set number, say five, then it means that five consecutive attempts have been made to operate the switch with a wrong key and the piezo sounder will run continuously for a preset period to warn of the fact. If the correct key is used the sounder will be deactivated.

The reset circuit resets the system 100ms after the last bar passes the sensor. The bar code switch is then ready to decode another key.

HOW IT WORKS

The circuit diagram is shown in Fig. 4. The output of mains transformer T1 is rectified by D1 and D2 (Fig. 4b), then filtered by the reservoir capacitor C1 to provide +16V raw DC. Series regulator IC7 is used to provide the +12V regulated supply for the circuit.

R100 (Fig. 4c) provides about 35mA of current from the raw supply to illuminate the LED emitter in SENS1, keeping the dissipation in IC7 down. The varying current in the receiver phototransistor is converted into a voltage by IC100 and rises as more light is reflected. The sensitivity of this stage is adjusted by RV100. The output of IC100a is AC coupled in a ×47 inverting gain stage consisting of IC100b, R105 and R106.

The output from the preamp goes into the inverting input of IC1 (Fig. 4a). Its output is high for a space and low for a bar — IC2b inverts this and the low to high transitions clock IC3b, a 4-bit binary counter.

The counter drives IC4 to form a 1 to 6 sequential enabler. The active high output is incremented as the start of each bar passes over the sensor.

As soon as the leading edge of the first bar passes the sensor output SW1 becomes active. This is fed into the integrator formed by components D7, R20, C7 and IC1b. The output of IC1b will ramp negative until the leading edge of the next bar passes the sensor, ideally reaching 6V — this is the reference integrator's output (see main text). As each of the remaining 14 bars passes over the sensor they are timed by the timer integrator (D23, R23, C8 and IC1c).

IC2b provides a high level on the timer integrator's input for as long as the bar is over the sensor. A slightly stretched version of this is produced by D3, R8, C5, R12 and IC2a, and is used to reset the timer integrator during each space on the key.

The outputs of the integrators are compared by IC1d, producing a high for a thin bar (the timer integrator doesn't have time to ramp down as far as the reference) or a low for a thick bar (the timer ramps below the reference).

As the key is passed over the sensor each one of the bank of switches is selected sequentially by IC4's outputs S2 to S15.

These switches have been programmed for the correct key — a closed switch requires a thick bar, an open switch for a thin bar. The state of each switch is compared with the relevant bar by IC5a, producing a low if they match.

As long as all the bars match the switches then IC5a's output to the D input of flip-flop IC6a will remain low.

IC1a clocks the data through to the flip flop output and if all the codes match then the $\bar{Q}$ output of IC6a will remain high. The negative going edge of the last counter output clocks the data at $\bar{Q}$ to the D input of IC6B. If the correct key was used, the output Q of IC6b will be high and will turn on transistors Q1, Q2 and Q3. Q2 turns the sounder on and Q3 illuminates LED1.

The output of IC6b remains high until reset by IC2c going high when C6 is discharged by R13 (100ms). C6 gets charged by D4 and R9 during white spaces.

If at any bar the key failed to match the set switches, the Q output of IC6a will be high and is latched high by D25. R24 prevents this state being altered by any subsequent matches. So at the end of the sweep, the Q of IC6b is low and no code accept pulse is generated.

In addition, as IC6a goes high, the positive edge clocks binary counter IC3a to count the number of times the wrong key has been used.

After either five or nine attempts (link selectable) the piezo sounder is switched on as a warning, cleared either by using the correct key or automatically after a time set by C4, R11, RV2 and IC2d.

Construction

The sensor may be mounted in any suitable box, or even behind a window. The box should be at least 3in long to allow the key to be wiped smoothly across the sensor window.

The prototype used a standard 29mm deep surface mounting box and a standard blanking plate to match the mains and lighting boxes in my home.

A hole is required in the blanking plate for the opto sensor, about 10mm by 15mm as shown in Fig. 5a. On the prototype the sensor was mounted behind this using a bracket of aluminium (or tin plate) cut to the dimensions shown in Fig. 5b and folded to a 90° angle along line XY.

The unit was put together as shown in Fig. 6. Note how the bracket should overhang one of the 15mm edges by about 1mm.

The red filter for the front of the blanking plate should be about 85mm × 35mm, fixed into place with Bostic, Evostick or some other suitable brand name. When you've done that, you'll realise that you've just covered the mounting screws with the filter and you can't screw it to the wall. You'll need

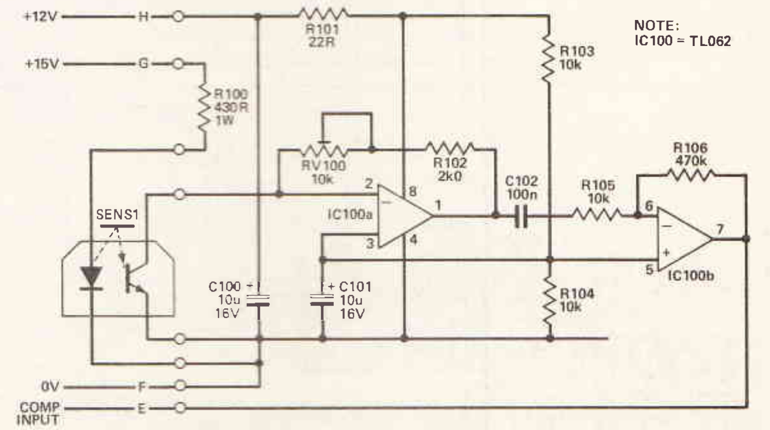


Fig. 4 (c) The sensor pre-amp

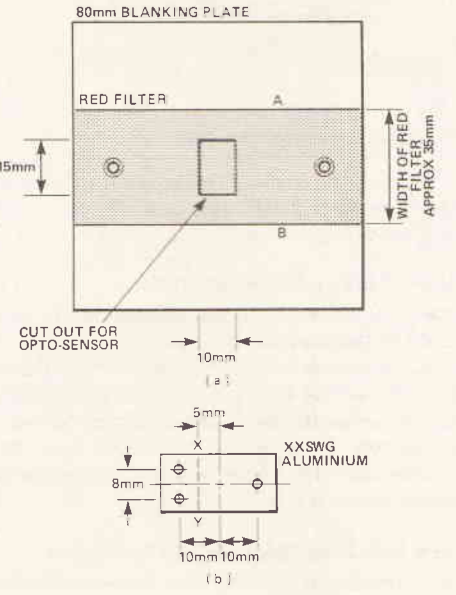
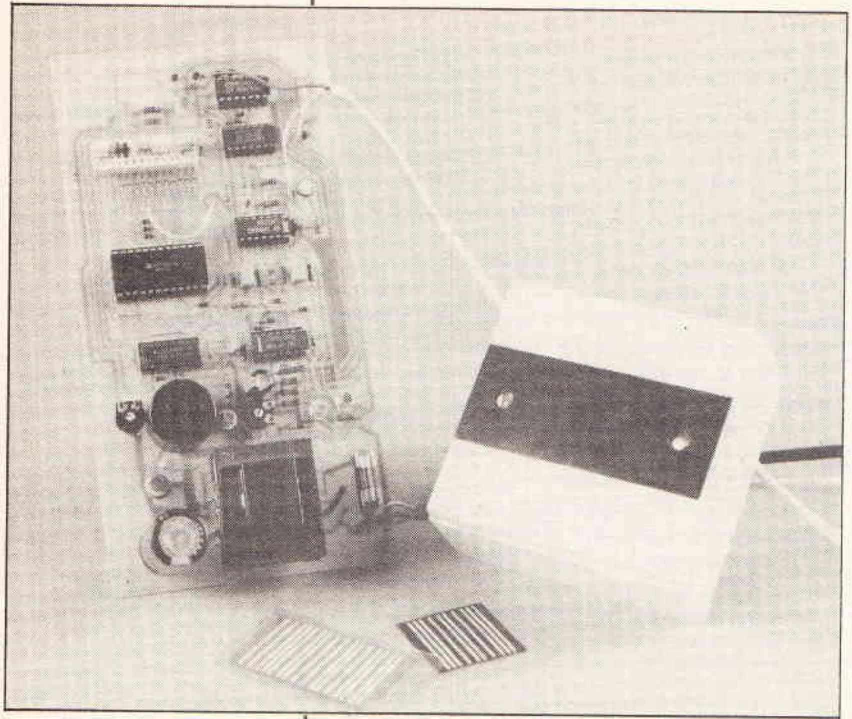


Fig. 5(a) Marking out details for blanking plate. (b) Dimensions of sensor mounting bracket



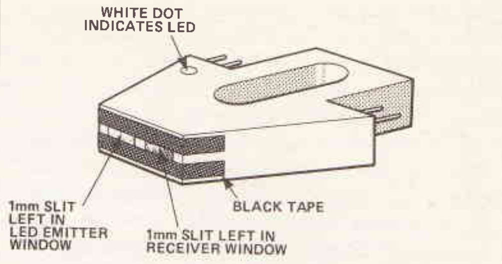


Fig. 7 Masking the opto sensor

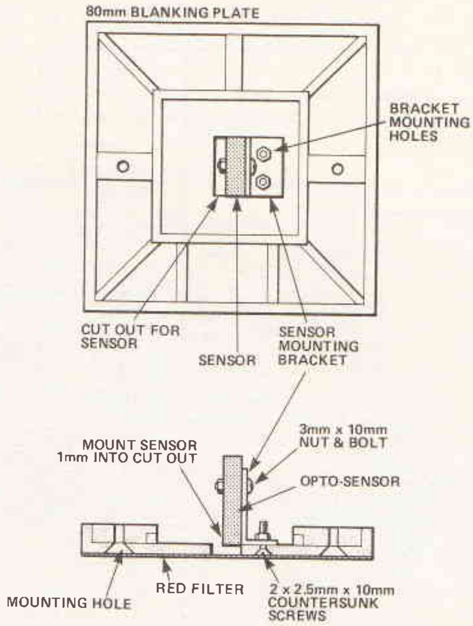


Fig. 6 Mounting sensor unit

to drill from the back of the box through the filter using a small drill bit, then from the front with a larger (5mm) bit.

Increasing Resolution

Figure 7 shows how the two windows of the sensor should be blanked off with tape leaving only a 1mm slit — necessary if the sensor is to resolve a 1mm bar code. Crepe tape (as used in PCB design) is better than insulating tape which may 'creep' if it gets warm. Take some time over this, as an accurate slit can avoid a good deal of fiddling compensation later.

Circuit Board Construction

The component overlay for the small preamp board is shown in Fig. 8.

Construction is very straightforward, beginning with the resistors and working through to the cermet trimmer RV100 and IC100. Check the polarity of the IC and the tantalum capacitors. Any type of 4-core cable can be used to connect to pads E, F, G & H.

Mount the sensor and put the PCB in the box.

The main board Fig. 9 is slightly more complicated but should cause no problems.

Start by fitting the ten PCB links.

LK1 is as shown for 240V mains. If 110V is to be used, replace LK1 with two links — one across AD and one across BC. LK2 joins the secondary 0V to mains earth.

Next fit the diodes (noting their orientation), then resistors and IC sockets. Take care with the orientation of electrolytic capacitors — especially the tantalums which short circuit very quickly if reverse biased. If using the recommended DIL switches, these should be fitted with identification numbers facing the transformer.

When fitting the mains transformer ensure the primary is facing the fuseholder, its pins should then fit into one of the two holes provided on the PCB.

With all components connected, make a final check of polarity and any possible splashes or shorts, then set all the presets to the centre and set the programming switches as shown in Fig. 8. Fit a mains cable to the three pads provided and connect the cable from the sensor to pads E, F, G and H.

Setting Up And Test

Most of the testing can be done with a voltmeter, though a scope is pretty handy when setting up the optical sensor.

Once mains is connected to the main PCB you must be extremely careful to avoid any part of your anatomy coming into contact with live tracks — at best such contact will produce a string of four letter words, at worst a prolonged silence.

First (with CMOS devices removed) check the PSU functions. The raw voltage at the junction of D1 and D2 should be about 16V DC with about 0.5V of 100Hz ripple on it. The stabilised line on the output of IC7 should be at 12V DC (with about 10mV of wideband noise on it).

Check that these voltages appear at the correct points on the preamp board then switch off and let C1 discharge before inserting the CMOS devices. Switch on again and check that the 12V line is still OK.

Make sure that LK11 goes only to the pad next to D16, corresponding to the eight bars used in the test key (Fig. 1). Place the blanking plate loosely on top of the box and make sure that the sensor is pointing away from any sources of electric light.

If you have a scope look at the output of the preamp IC100b, with your timebase set to 10ms/div and sensitivity at 2V/div (AC coupled).

PARTS LIST

RESISTORS (all resistors ¼W 2% metal film except where stated)

R1,4,8,9,10,14,15, 17,21,22,103,104, 105	10k
R3	20k
R5	2M0
R6	1k0
R7	100R
R11,18,19,24	100k
R12,13,20,105	1M0
R16	1k5
R23	750k
R25,101	22R
R100	430R
R102	2k0
RV1,4	10k ¼in cermet preset
RV2	1M0 sub mind preset
RV3	10k sub min preset

CAPACITORS

C1	4700µ 25V radial
C2,9	1µ 35V tantalum
C3,100,101	10µ 16V tantalum
C4	100µ 25V radial
C5	100p 10V polystyrene
C6,102	100n 250V polyester
C7,8	2200p polyester 5%

SEMICONDUCTORS

IC1	TL064
IC2	40106B
IC3	4520B
IC4	4514B
IC5	4070B
IC6	4013B
IC7	78M12
IC100	TL062
Q1,2,3	BC109
Q4	BCY70
D1,2	IN4001
D3-25	1N914, 1N4148 etc.
LED1	Red LED

MISCELLANEOUS

BUZZ1	piezo sounder (see Buylines)
FS1	100mA 20mm
T1	15-0 15-0 1VA per winding
SENS1	opto sensor OPB7030
SW1	10-way DIL
SW2	4-way DIL

IC sockets. 20mm fuseholder. Red filter. Sensor housing (80mm box and blanking plate, 22 SWG aluminium for bracket). Nuts and bolts.

When you've made a test key to the design in Fig. 1 (you could wipe your copy of ETI across the sensor but it's hardly elegant) hold it as shown in the photograph with the key on the red filter. Only the 3mm thick boarder should be actually on the box, the rest should hang over the edge. Wipe the key smoothly across the filter lengthways.

The easiest way to get the correct speed is to count like you do between lightning and thunder '1 and 2 and 3 and' sweeping from left to right on the numbers and returning the key to its start position on each 'and'.

The preamp output should resemble a burst of sine waves (with quite some distortion) each time the key is wiped. If this doesn't happen, adjust the height of the sensor until it does. If instead of sine waves the output just goes high then the slit in

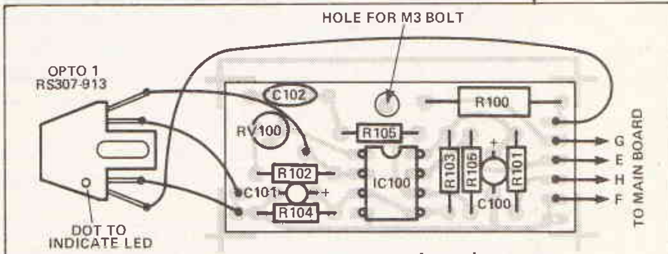


Fig. 8 Component overlay for pre-amp board

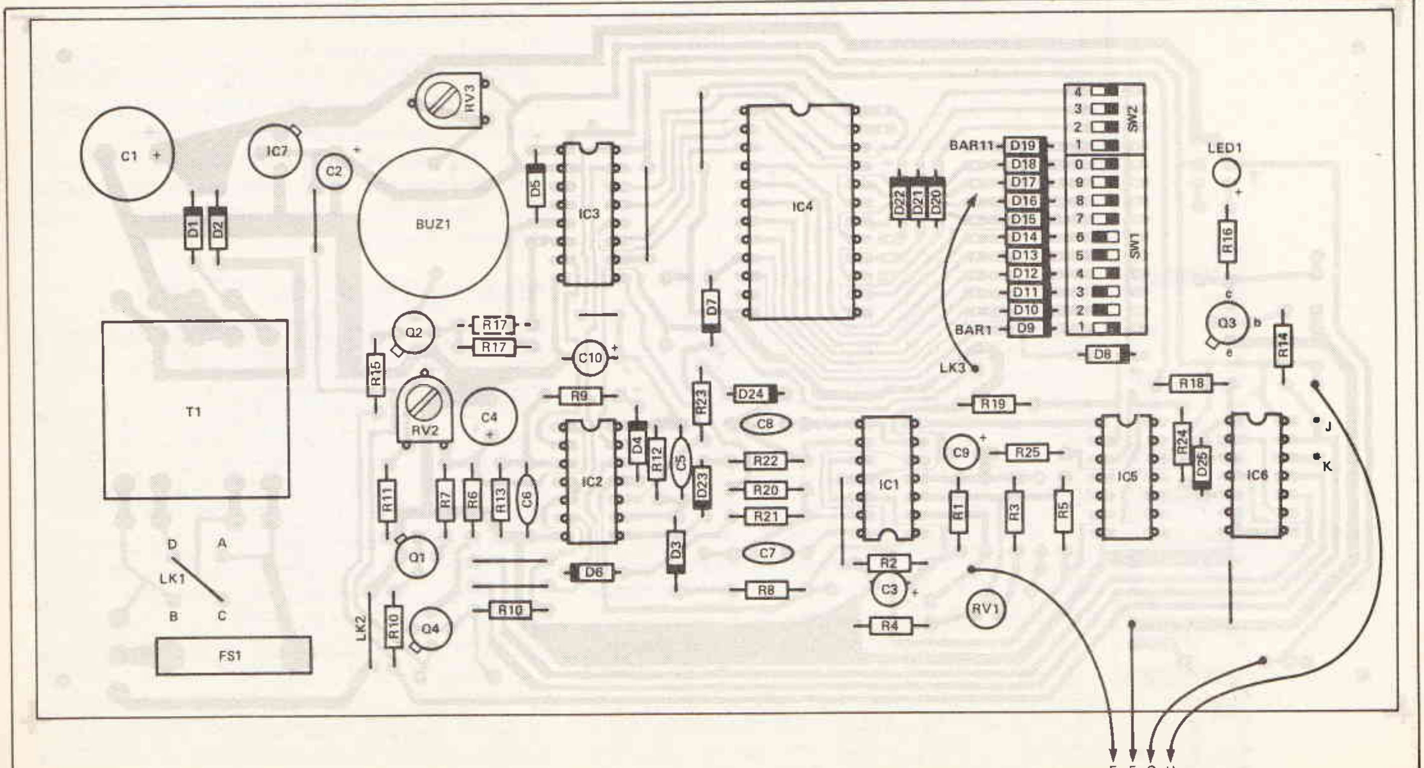


Fig. 9 Component overlay for main board

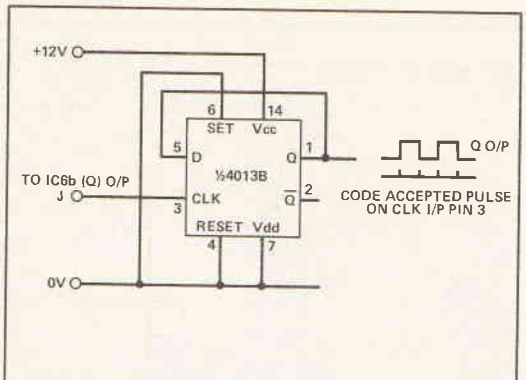
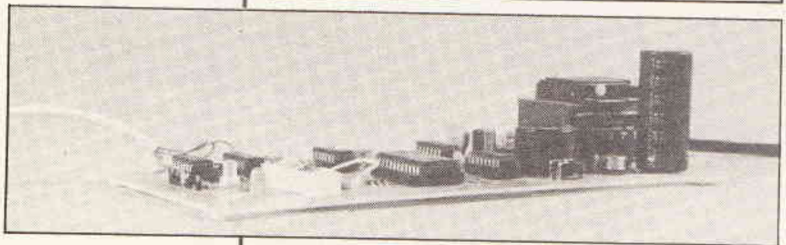


Fig. 10 Toggling a flip-flop with the output pulse



the sensing window is too wide.

Then adjust the sensor height to minimise the amplitude difference between the two different sine wave frequencies. Adjust RV100 to bring these amplitudes to about 8V peak-to-peak. Sweeping the key should now bleep the piezo sounder to show a correct code (otherwise either you're not sweeping properly or you've set the wrong code in the switches).

Using the scope to look at the output of the reference integrator IC1b, you can get some sweeping training by getting the voltage to drop from its normal 12V to as close to 6V as you are able. If you have a two beam scope you can look at IC1c to produce a display similar to Fig. 3.

Finally, fine tune the system by adjusting RV100 to give the best performance at varying sweep speeds.

Then tighten the sensor to the bracket, mount the preamp board by fitting a 3M × 10mm spacer to the sensor mounting bolt and attaching the PCB to the spacer with a 3M × 5mm bolt. Then close the box. With the box closed, make sure everything still works.

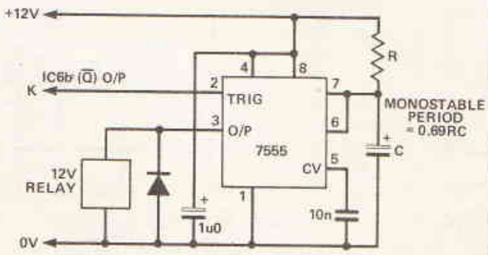
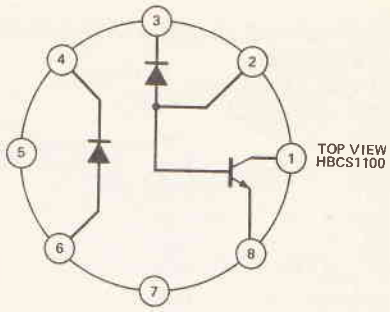


Fig. 11 Stretching the output pulse for a relay

Now change the required code by setting SW1 on the bank of switches 'on' and try the key again. After five attempts the piezo sounder should sound for about 90 seconds.

The volume is adjusted by RV3 and the time constant by RV2. For a much longer period change R11 but don't exceed about 10M. By moving both D5 and R17 to their alternative positions the number of failed sweeps required to sound the alarm is increased to nine. To identify longer codes up to 14 bars, link 11 should be moved to the relevant diode.



PIN	FUNCTION
1	TRANSISTOR COLLECTOR
2	TRANSISTOR BASE, PHOTODIODE ANODE
3	PHOTODIODE CATHODE
4	LED CATHODE, SUBSTRATE, CASE
5	NC
6	LED ANODE
7	NC
8	TRANSISTOR EMITTER

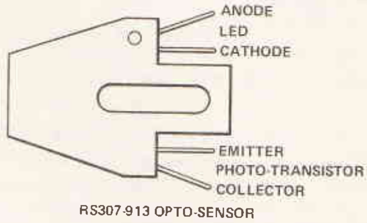


Fig. 12 Pinouts for the opto sensors

When mounting the completed sensor housing, make sure that the sensor doesn't face an electric light as this will toggle the comparator at 50Hz and eventually trigger the alarm.

For mounting outside, a sealed watertight box should be used and a bag of silica gel (as found in camera cases and so on) in the box would stop any condensation forming.

Applications

Figure 10 shows how the code accepted pulse can be used to toggle an external flip-flop for each correct sweep of the key. This could be used to deactivate an alarm system for instance.

Figure 11 shows how the code accepted pulse can be stretched using an external monostable. This could drive a solenoid in an electrically operated doorlock.

Making The Keys

Making the keys is easy, especially if you have a BBC computer and Epson printer, for which a program is provided in Listing 1.

The program prints the selected bar code twice with a 6mm bar in the middle so the printout can be folded in half and slipped into a Prontapouch (hooray for Prontapouches!). This produces a doublesided key.

The black bars obviously need to be as dark as possible so if your printer has been producing light grey listings recently, now might be a good time to replace the ribbon. Note that the program can compensate for an ailing ribbon by overprinting several times (line 90).

Anyone familiar with BBC Basic should understand most of the program with a few sidelong glances at the printer manual to sort out the VDU codes. It should run on the model B, B+ or

```
 10 REM ETI BAR CODE PRINTER
 20 MODE 3
 30 DIM bardata(15)
 40 VDU2:REM Enable Printer
 50 VDU1,27,1,64;:REM Initialise Printer
 60 VDU1,27,1,65,1,8;:REM Set Line spacing
 70 RESTORE 800
 80 code=0:hight=0:dots=70
 90 dark=3 :REM Number of overprints.
100 Nbar=0:REPEAT
110 READ code :REM Count dots in barcode
120 bardata(Nbar)=code :REM PUT DATA into Array
130 IF code=0 THEN dots=dots+20 :REM Thin Bar
140 IF code=1 THEN dots=dots+30 :REM Thick Bar
150 Nbar=Nbar+1 :REM Count Bars used in Barcode
160 UNTIL code=9
170 dots=dots*2 :REM Double Length code
180 Nbar=Nbar-1
190 Ldots=dots MOD 256 :REM n1 Bit Image Data
200 Hdots=dots DIV 256 :REM n2 Bit Image Data
210 PROCtop :REM Print top Border
220 REPEAT
230 FOR D=1 TO dark
240 VDU1,27,1,90,1,Ldots,1,Hdots;
250 REM LPRINT CHR$(27);"Z";CHR$(Ldots);CHR$(Hdots);
260 REM ESC Z sets Quadruple=density Bit Image Mode
240 Dots/inch
270 PROCbar(30,255):REM Print 3mm Black Border
280 PROCbar(10,0) :REM Print 1mm White Space
290 FOR A=0 TO Nbar :REM Print Barcode Forwards
300 bar=bardata(A)
310 IF bar=0 PROCshort
320 IF bar=1 PROClong
330 NEXT
340 PROCbar(60,255):REM 6mm Centre Bar
350 PROCbar(10,0):REM 1mm White Space
360 FOR B=Nbar TO 0 STEP-1 :REM Print Backwards
370 bar=bardata(B)
380 IF bar=0 PROCshort
390 IF bar=1 PROClong
400 NEXT
410 PROCbar(30,255):REM Print 3mm Black Border
420 VDU1,&0D
430 NEXT
440 VDU1,&0A,1,&0D :REM Print LF and CR
450 hight=hight+1
460 UNTIL hight=10 :REM height=30mm
470 PROCbottom :REM Print Bottom Border
480 VDU1,27,1,64;
490 VDU3:END
500 DEFPROCbar(length,data) :REM Print 1mm Bar, 2mm
Bar or Space
510 FORN=1 TO length
520 VDU1,data;
530 NEXT
540 ENDPROC
550 DEFPROCshort
560 PROCbar(10,255)  :REM Print 1mm Black Bar
570 PROCbar(10,0)    :REM Print 1mm White Space
580 ENDPROC
590 DEFPROClong
600 PROCbar(20,255)  :REM Print 2mm Black Bar
610 PROCbar(10,0)    :REM Print 1mm White Space
620 ENDPROC
630 DEFPROCtop :REM Print top border
640 FORA= 1 TO dark
650 VDU1,27,1,90,1,Ldots,1,Hdots;
660 PROCbar(dots,7)
670 VDU1,&0D
680 NEXT
690 VDU1,&0D,1,&0A
700 ENDPROC
710 DEFPROCbottom :REM print bottom border
720 FOR A=1 TO dark
730 VDU1,27,1,90,1,Ldots,1,Hdots;
740 PROCbar(dots,224)
750 VDU1,&0D
760 NEXT
770 ENDPROC
780 REM 0=Thin  Bar
790 REM 1=Thick Bar
800 DATA 0 :REM Reference Bar
810 DATA 0,1,1,0,1,1,0,0 :REM Bar Code Data, Max 14
820 DATA9:REM Bar Code Data Delimeter
```

Listing 1 BBC Basic program to print bar codes

Master and (if you're lucky) on the Archimedes as well. It has been written to work with any Epson or compatible printer with quad density bit image mode such as the RX80, FX80 and LQ100.

The REM statements need not be typed in but are included to help anyone convert the program to run on something else. See also the program notes in *The Program*.

If you can't print out your own codes, then a draughting pen and white paper can be used. But make sure the bar widths are accurate — the white spaces between are less critical except for the one between the reference bar and the first code bar.

Easier still use Letraset or the crepe tracks for PCB layouts.

Whatever you use, the only way of encapsulating the code is the legendary Prontapouch plastic pouches. This produces a small waterproof flexible key that is very easy to lose, so you had better make a couple of spares now you've got the hang of it!

ETI

THE PROGRAM

VDU1 is the command to send the next character or number to the printer only. The equivalent to line 240 (VDU1, 27, 1, 90, L dots, 1, Hdots;) in Microsoft Basic shown in Line 250 (LPRINT CHR$(27); CHR$(90); CHR$(Ldots); CHR$(Hdots);).

When a procedure is called as in line 270 (PROCbar(30,255)), the two values in brackets are assigned to the variables identified in that procedure's definition — line 500 (DEFPROCbar (length, data)). So length = 30 and data = 255.

The DATA statements starting at line 800 hold the binary data for the bar code. Line 800 holds the data for the Reference Bar, line 820 holds the value 9 which informs the program when all the data has been read. Both these values should not be altered. Line 810 holds the actual data for the code as set up on the programming switches, and produce your personal bar code.

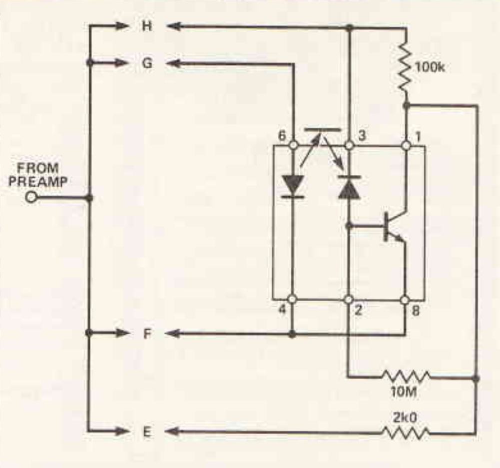


Fig. 13 Circuit connection for the HBCS1110 opto sensor

USING THE HBCS1110 OPTO SENSOR

For anybody wishing to use the more expensive Hewlett Packard sensor, the pin connections are shown in Fig. 13. The circuit in Fig. 13 shows how to connect the device to the pre-amp using three extra resistors — note that R106 should also be changed to 100k.

To make use of the improved resolution, the integrator time constants will have to be changed. If the bar thickness is halved then C7 and C8 must be halved (from 2200p to 1000p) and use polystyrene or monolithic ceramic rather than normal ceramics (which may cause the reference integrator to drift through leakage).

Obviously the barcode printing program will require altering to produce narrower bars.

BUYLINES

Most of the components used in this project should be available from your usual supplier.

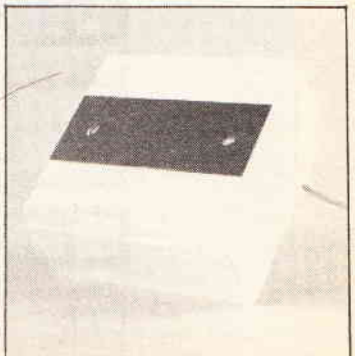
In the prototype the following components were obtained from Electromail: BUZZ1 (order code 249-794), SW1 (336-680), SW2 (337-548), the red filter (307-913), SENS1 (307-913). Electromail, PO Box 33, Corby, Northants NN17 9EL. Tel: (0536) 204555.

The sensor type is OPB7030 and is also available from other suppliers.

Note that the red filter should not be more than 1mm thick.

The more expensive HBSC1100 opto sensor is available from Farnell (Tel: (0532) 636311) or from Trilogic (Tel: (0274) 684289).

The Prontapouches are available at any Prontaprint shop — check your Yellow Pages or Thomson Local Directory.



POWER CONDITIONER

FEATURED IN ETI
JANUARY 1988

The ultimate mains purifier. Intended mainly for lowering the noise floor and improving the analytical qualities of top-flight audio equipment.

The massive filter section contains thirteen capacitors and two current balanced inductors, together with a bank of six VDRs, to remove every last trace of impulsive and RF interference. A ten LED logarithmic display gives a second by second indication of the amount of interference removed.

Our approved parts set consists of case, PCB, all components (including high permeability toroidal cores, ICs, transistors, class X and Y suppression capacitors, VDRs, etc.) and full instructions.

PARTS SET **£28.50** + VAT

Some parts are available separately. Please send SAE for lists, or SAE + £1 for lists, circuit, construction details and further information (free with parts set).

KNIGHT RAIDER

FEATURED IN ETI JULY 1987

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

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

The parts set consists of box, PCB and components for control, PCB and components for sequence board, and full instructions.

Lamps not included.

PARTS SET **£19.90** + VAT

CREDIT CARD CASINO

FEATURED IN ETI,
MARCH 1987

This wicked little pocket gambling machine measures only 3"x2"x½". It will play all kinds of casino games, including:

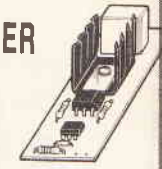
- Roulette
- Craps
- Pontoon

Our approved parts set comes complete with case; self-adhesive fascia; tinned and drilled printed circuit board; all components; hardware; full instructions and three different games to play!

PARTS SET ONLY **£5.90!** + VAT

Five extra games FREE with every order!

MAINS CONTROLLER



FEATURED IN ETI
JANUARY 1987

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

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

The mains controller connects directly to most TTL families with external components, and can be driven by CMOS with the addition of a transistor and two resistors (supplied).

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

PARTS SET **£6.20** + VAT!

THE DREAM MACHINE

FEATURED IN ETI
DECEMBER 1987

Adjust the controls to suit your mood and let the gentle, relaxing sound drift over you. At first you might hear soft rain, sea surf, or the wind through distant trees. Almost hypnotic, the sound draws you irresistably into a peaceful, refreshing sleep.

For many, the thought of waking refreshed and alert from perhaps the first truly restful sleep in years is exciting enough in itself. For more adventurous souls there are strange and mysterious dream experiences waiting. Take lucid dreams, for instance. Imagine being in control of your dreams and able to change them at will to act out your wishes and fantasies. With the Dream Machine it's easy!

The approved parts set consists of PCB, all components, controls, loudspeaker, knobs, lamp, fuseholders, fuse, mains power supply, prestige case and full instructions.

PARTS SET **£16.50** + VAT

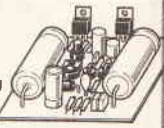
AVAILABLE WITHOUT CASE FOR ONLY **£11.90** + VAT

The S101 professional respiration and heart-rate monitor is the ideal instrument to keep track of your progress in any kind of fitness or sports training. The average adult resting heart rate is around 80 beats per minute. For an athlete at the peak of physical fitness it can be 50 or less.

How fit are you? How quickly is your jogging or sports training strengthening your heart and respiration? How quickly do you recover from oxygen debt after exercise? For your own sake, you need to know.

The approved parts set consists of: case, 3 printed circuit boards, all components (including 17 ICs, quartz crystal, over 75 transistors, resistors, diodes and capacitors), liquid crystal display, switches, plugs, sockets, LEDs, leads, electrodes and sensors, and full instructions.

ARMSTRONG 75W AMPLIFIER



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JULY 1988

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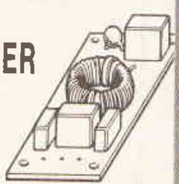

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Please note: the book, by Stern and Ray, is an authorised guide to the potential of bio-feedback techniques. It is not a hobby book, and will only be of interest to intelligent adults.

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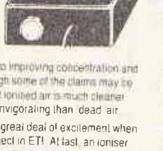

FEATURED IN ETI
JULY 1986

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

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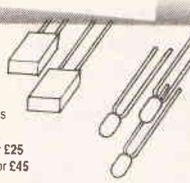

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AUGUST 1987

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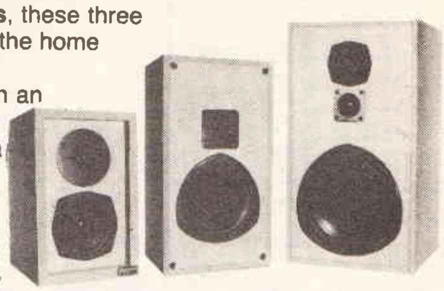

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TOP NOTCH IMPROVEMENTS

John Linsley Hood presents an update for the decoder of his 1987 stereo FM Tuner

Back in ETI February-April 1987, I described a high sensitivity low noise and distortion FM tuner circuit. The constructional kit now available gives a performance which is if anything better than my prototype, mainly I think to more effective internal screening and more careful choice of earthing points — an important point in any RF circuitry.

However, in any circuitry there are always areas of conflicting requirements where some compromise is necessary. One of these areas is the input HF (ultrasonic) filtering which precedes the stereo decoder system.

The update provided here develops a steep cut filter that may be of general interest to readers quite apart from its intended application in the FM decoder.

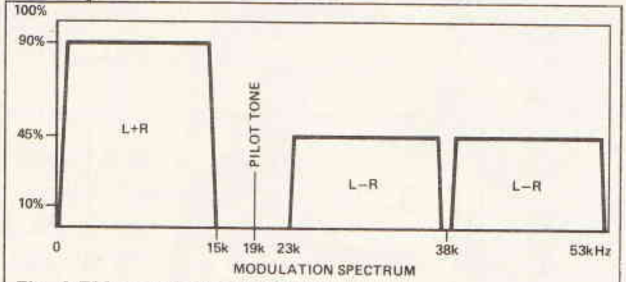

Fig. 1 FM modulation spectrum

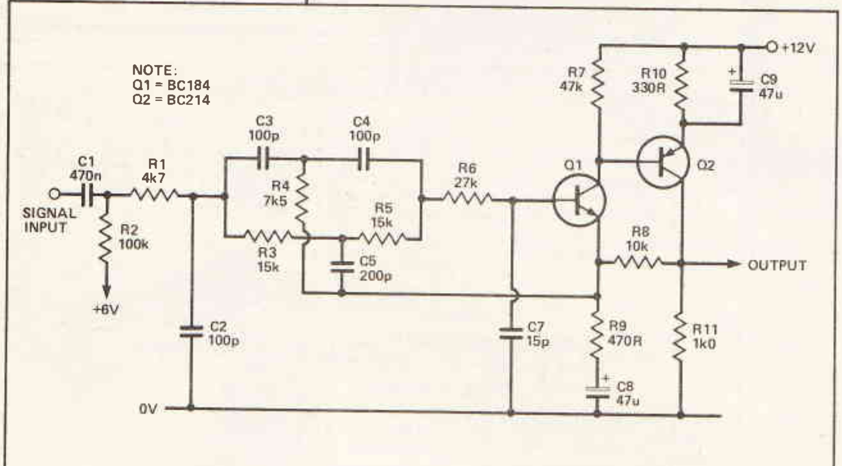

Fig. 2 Parallel T input filter circuit

UPDATE

A Good Reception

The FM stereo signal as broadcast (see Fig. 1) consists of a standard mono L+R signal occupying the 20Hz to 15kHz part of the modulation bandwidth. A further L–R signal occupies the 23-53kHz part of the output spectrum, based on a 38kHz subcarrier. This subcarrier is suppressed to prevent an unwanted intrusion of the L–R signal into the mono reception and a small amplitude, low distortion 19kHz 'pilot tone' is added to the mono signal to enable the 38kHz subcarrier to be regenerated at the receiver if required.

The stereo signal can be recovered by filtering off everything below 23kHz, demodulating to obtain the L–R signal and then simultaneously adding and substracting that from L+R using some kind of matrix.

Alternatively, the recovered 38kHz signal can be used as a switching waveform to route the total 20Hz-53kHz output from the FM demodulator to either one channel or the other. The result is the same as for the matrix system but is much simpler and therefore more popular.

For both systems the phase of the recovered 38kHz subcarrier must be accurately related to the pilot tone — particularly important for the switching method.

The snag is that the switching method works best with a squarewave subcarrier, which contains third and fifth harmonics. These harmonics — at 114kHz and 190kHz — will quite happily demodulate any wideband noise products occurring round these frequencies as additional audio noise.

What is required is a filter which has a flat frequency response from 20Hz to 53kHz and a good cut-off at say 100kHz to remove all possible noise products based on 114kHz or other harmonics of 38kHz. The filter must also not greatly alter the phase of the L–R modulation significantly in relation to the 38kHz subcarrier.

Unfortunately there is no such thing as a lowpass or highpass filter which doesn't cause an associated phase shift as a function of frequency. Generally, the more effective the filter and the sharper the cut-off slope, the larger that phase shift will be.

In simple FM tuners this problem is solved by not having any input filtering at all and accepting the somewhat worse S/N ratio resulting. In the original FM stereo decoder I used a straightforward three element 'bootstrap' circuit (Q1, 2, R1, 5 and C3, 4 in the original circuit) because this offered the best compromise between HF cut-off and transient performance. This gives a lowpass roll-off starting at 70kHz and an ultimate slope of about 18dB/octave.

A somewhat more exotic filter based on a bootstrapped 'parallel T' is shown in Fig. 2. This has less initial phase shift and a rather greater final attenuation — the frequency/phase characteristics are shown in Fig. 3.

This is just as effective in cutting out wideband input noise but introduces rather less phase shift over 23-53kHz region than the 'bootstrap' and so allows an improvement in stereo channel separation.

The final layout of the stereo decoder incorporating this input modification is shown in Fig. 8, with the overlay in Fig. 9. The need for an input HF filter can be demonstrated by putting a temporary short circuit across points P and Q to cut it out of circuit. You can then hear the extent to which the S/N ratio may be worsened by the commutation of HF noise components down into the audio band.

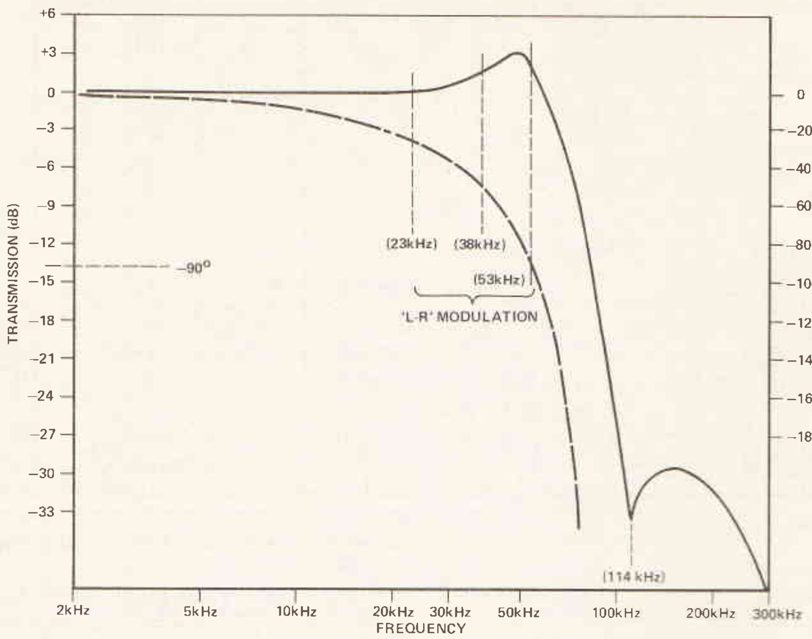

Fig. 3 Transmission and phase shift characteristics of parallel T circuit

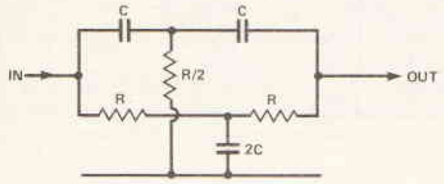

Fig. 4 Basic parallel T notch filter

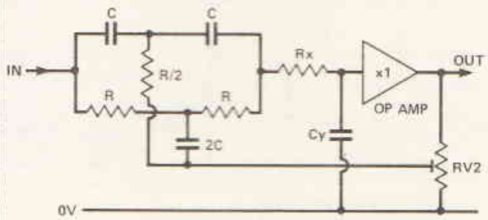

Fig. 6 Bootstrap circuit for parallel T

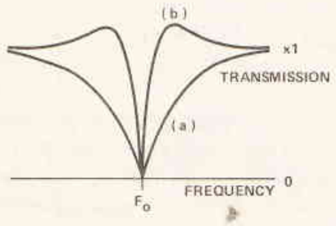

Fig. 5 Parallel T transmission characteristics

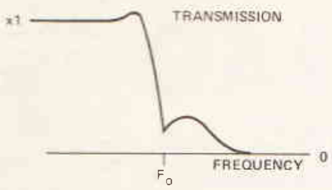

Fig. 7 Effect of lag components R_x and C_y

HOW IT WORKS

A simple 'parallel T' circuit of the kind shown in Fig. 4 will give a 'notch' in the frequency response, as shown in Fig. 5a, at a frequency given by

$$F_0 = \frac{1}{2\pi RC}$$

assuming that it is driven from a low source impedance, and that the load impedance is very high.

If the 'T' circut is 'bootstrapped,' as shown in Fig. 6, the steepness of the notch can be increased, as shown in Fig. 5b, to an amount determined by the output signal fed back by RVz. This can be converted into a 'low-pass' filter by the additional components Rx and Cy, which give the kind of frequency response shown in Fig. 7.

AFTERTHOUGHTS

There was a misprint in the values shown for C63 and C64, in the original article, (Fig. 6, page 36, April 1987). The correct value for these should be 330p.

I have also amended a few other values in the light of experience. Components R8, R7 and RV1 have been altered to give a rather higher gain in the decoder unit (to suit the characteristics of the CA3189) and R2 has been altered to slightly increase the mean DC level of the signal channel. I have also tidied up the switching arrangements for the 'stereo image width' selector SW2.

Apart from this and the output DC blocking capacitors C12,16, the only changes in Fig. 8 are those brought about by the modification to the input HF filter circuit.

With the amended input filter circuit, it is probable that the maximum channel separation will be given with RV2 set at, or near to, its minimum resistance value.

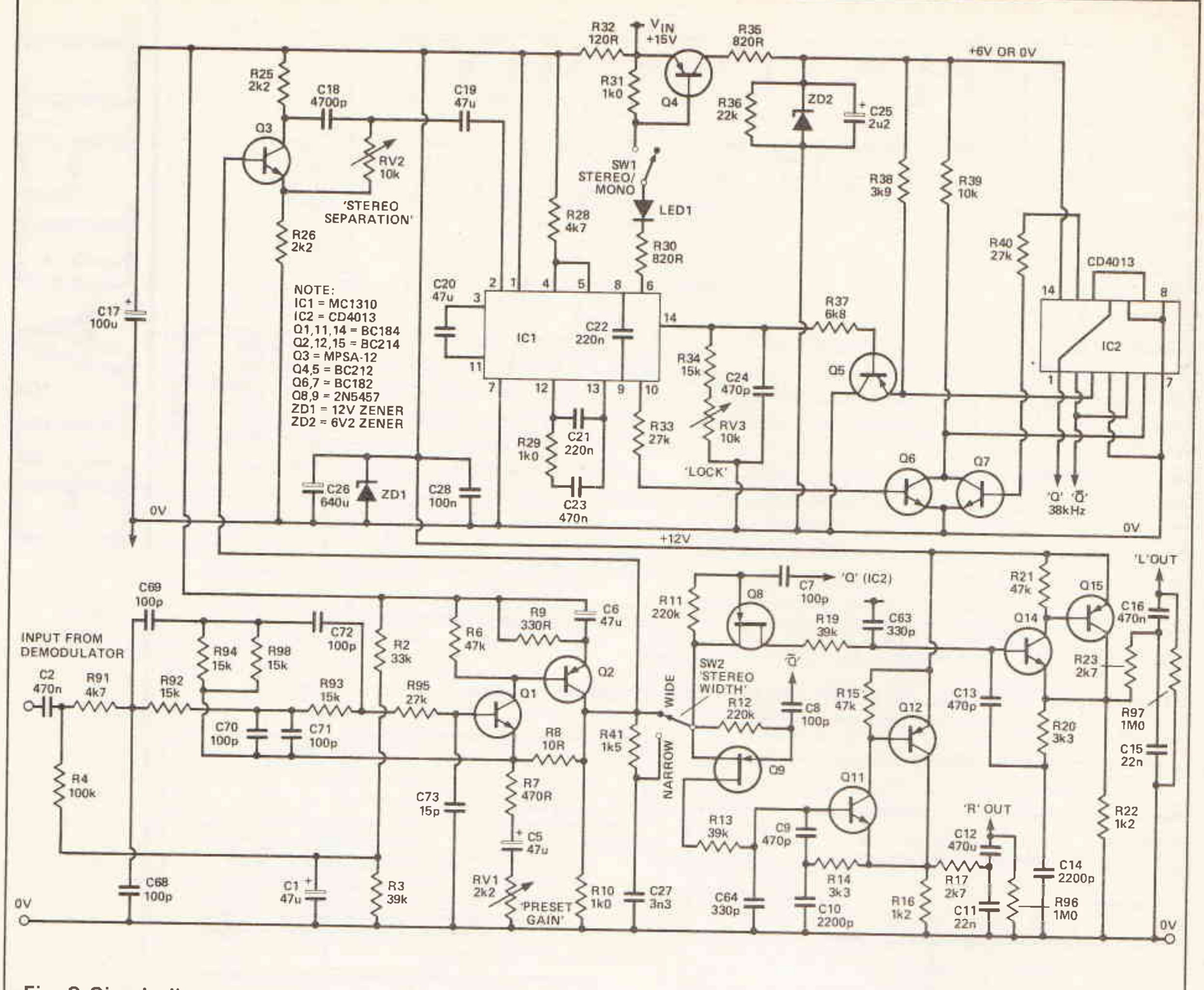

Fig. 8 Circuit diagram of the updated stereo decoder

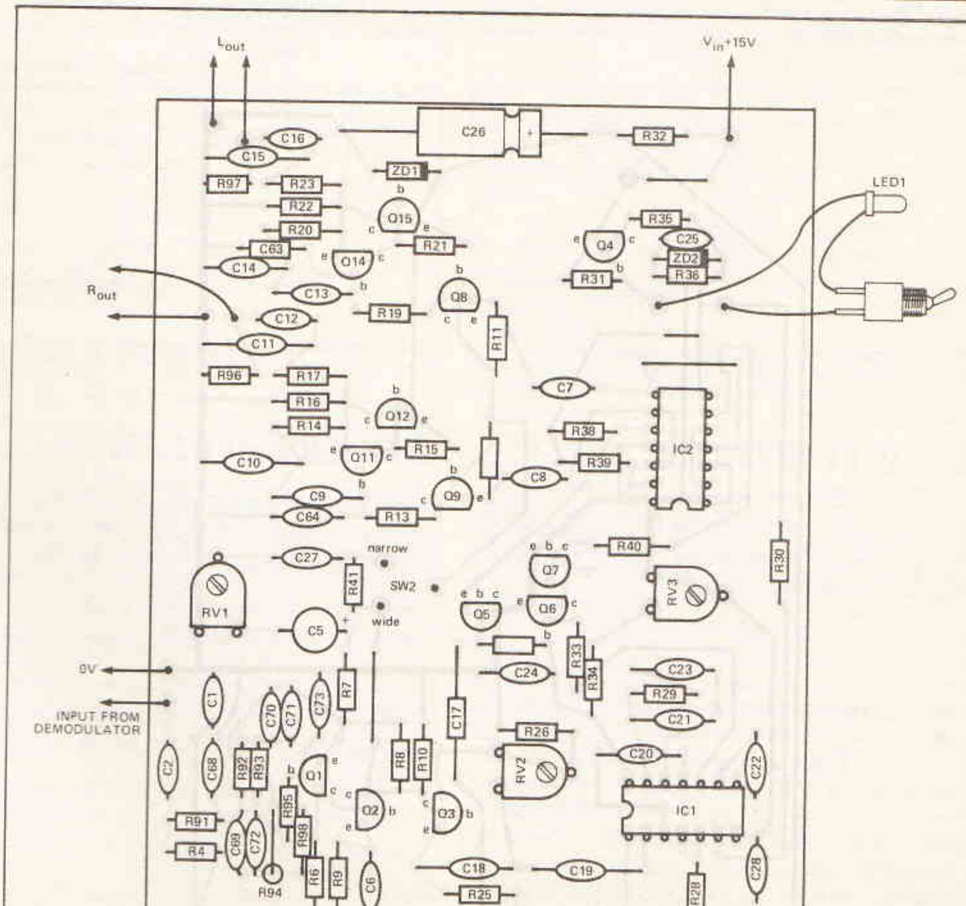

Fig. 9 Component overlay of the updated stereo decoder

PARTS LIST

RESISTORS (all ¼W 5% unless specified)

R2	33k
R3, 13, 19	39k
R4	100k
R6, 15, 21	47k
R7	470R
R8, 39	10k
R9	330R
R10	1k0
R11, 12	220k
R14, 20	3k3
R16, 22	1k2
R17, 23	2k7
R25, 26	2k2
R27	100R
R28, 91	4k7
R29, 31	1k0
R30, 35	280R
R32	120R
R33, 40, 95	27k
R34, 92, 93, 94, 98	15k
R36	22k
R37	6k8
R38	3k9
R41	1k5
R96, 97	1M0

CAPACITORS

C1, 5, 6	47µ 16V axial electrolytic
C2	0.47µ
C3	270n
C7, 8, 68, 69, 70, 71, 72	100p
C9, 24	470p
C10, 14	2n2
C11, 15	22n
C12	470µ
C13	470p
C16, 23	470n
C17	100µ 16V electrolytic
C18	4n7
C19, 20	47µ
C21, 22	220n
C25	2µ2 16V axial electrolytic
C26	640µ 16V axial electrolytic
C28	100n
C63, 64	330p
C73	15p

SEMICONDUCTORS

IC1	MC1310
IC2	CD4013
Q1, 11, 14	BC184
Q2, 12, 15	BC214
Q3	MPSA-12
Q4, 5	BC212
Q6, 7	BC182
Q8, 9	2N5457
ZD1	12V zener
ZD2	6V2 zener
LED1	panel mounting LED

MISCELLANEOUS

SW1, 2	SPST switches, as appropriate

PCB. 15V power supply. Case. Cable. Sockets etc. Component numbering has been selected to match the kits supplied by Hart and may consequently appear a little odd.

UPDATE

BUYLINES

Most components are easily available but Hart Electronic Kits (0691 652894) can supply all components in the design. Hart also produces the complete kit for John Linsley Hood's AM/FM tuner.

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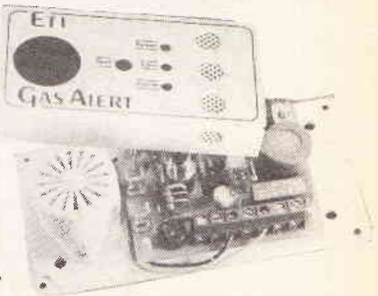

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EVERY BREATH YOU TAKE

Paul Chappell begins construction of his box of tricks

This month it's time to start nailing things together in our quest for the ultimate breath rate/heart rate/lucid dream stimulator money can build.

Choosing a case for the project was easy. I found a nice little hand-held box with a cut-out for the display, a battery compartment, supports for the PCB — just the thing.

Then I did my arithmetic. Take one small box, divide by 17 ICs, add an LCD display, multiply by several transistors and dozens of resistors and caps . . . and I couldn't be entirely sure what the answer was. The last time I worked out a problem like that, it had to do with a suitcase stuffed to bursting point and an extra pair of trousers to be fitted in somewhere. The answer on that occasion was broken straps and shirts over the floor. So much for empirical methods.

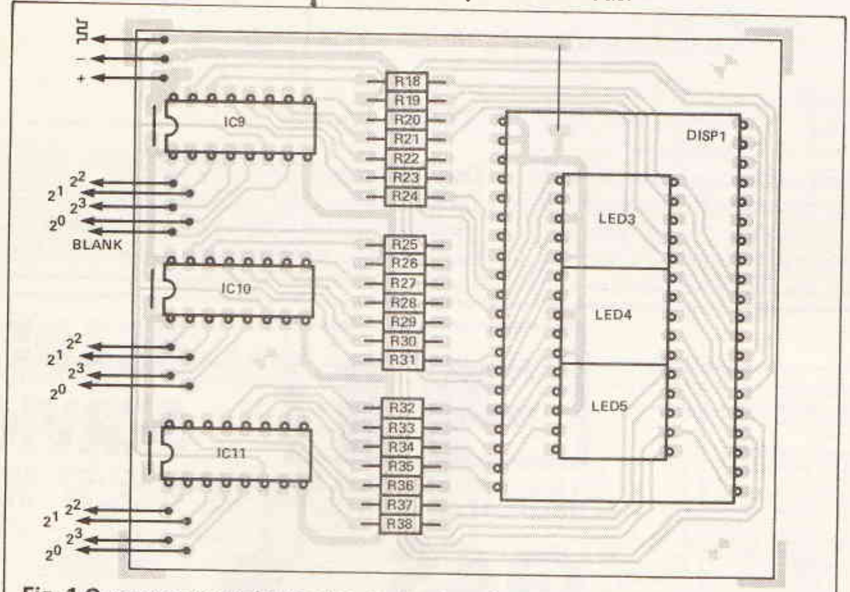

Fig. 1 Component overlay for the display board

Undaunted, I started to lay out the PCB for the display board. Subtract one LCD display and three ICs — that means the other board only needs to hold 14 ICs, all the resistors, all the caps, all the transistors . . . Take three weeks, divide by 142 cups of coffee (this month has been really heavy on the sums), take away the number of cigarettes you first thought of and the result, I can now definitely state, is a project.

This month I'll start you off with the easy bit — the display board. It's a fairly general purpose little board that you might like to use in other projects too. It accepts three digits of BCD information and translates them into a suitable format for driving an LCD display, or for three common cathode or common anode LED displays. This project uses the LCD version, since a single PP3 battery would not be at all happy at the prospect of supplying current for three LED displays.

Construction

The component overlay for the board is shown in Fig. 1. The LCD display should be socketed in two 20-way SIL socket strips — this lifts it to just the right height to appear under the display cut-out in the case, and more to the point avoids damaging the display.

The ICs can be soldered direct to the board — there's room to socket them if you like, but since the other ICs for the project have to be soldered directly to the PCB to allow through connections via their leads, there doesn't seem much point.

If you intend to use the LCD display, all the resistor positions on the board must be linked across with wire. For LED displays, resistors should be chosen to suit the display type used. For instance, if the displays require 20mA per segment (which is a reasonable value for most types) and you're running the circuit from 9V, allow a 2V drop for the LED, then calculate the resistor value by good old Ohm's law: R=7V÷ 20mA = 350R. Use the nearest preferred value: 330R.

If you are not sure about the display type you've got, choose one test segment, start with a 1k0 resistor, and reduce the value until the display is as bright as you like it. Then use that value of resistor in all the resistor positions on the PCB.

The board connections shown in Fig. 1 are for the LCD display. Although a link is shown in the circuit diagram for selecting LCD or LED, the board is arranged so that a link is only necessary for LED displays. Whatever you do, don't link across the two holes just above the input connections, or you'll short out the battery!

Figure 2 shows the connections and links for LED and LCD displays. The square wave is only needed for LCDs, so the only external connections in this case are to the power supply.

The Case

The thing that seems to cause most problems with home built projects is getting the appearance right. It's worth taking some trouble over, since although a PCB and dangling wires may be a thing of great beauty to an electronics enthusiast, to those of more limited perceptions it's just — how can I put this without offending — it's just a PCB with dangling wires. If you want to impress your friends, command the respect of your boss, get on with the neighbours and avoid having your head nailed to the floor, it's got to look good.

One decision I made fairly late on in the project was to use push-switches instead of toggles — just for the sake of appearance. If you intend to follow my example it means cutting a rectangular hole in the case, which is always more difficult than making circular holes. Even the best equipped workshop will only have a limited number of sizes of rectangular punches, so the chances are if you decide on a rectangular hole, it's got to be knife and forked.

When you have the case in front of you, you'll see that it has a smooth rectangular indentation in the top section, above the battery compartment. If you turn the top section over, you'll see that one of the mounting pillars is moulded below the top left hand corner of the indentation so it's obviously intended as a place to stick a label rather than a guide to an area to be punched out.

However, measuring the switches against the indentation show that it's just the right width and so makes a convenient guide to marking out the hole. It's too good an opportunity to miss, despite the pillar. What happens when you try making the hole by the usual knife and fork method of drilling holes all around the edge, then paring away the surplus plastic with a Stanley knife, is that you're left with a small corner of pillar obstructing the top left corner of the hole. The pillar is thick enough to stand having a small notch filed into it, and this completes the hole.

If you just want the breathing and heart-rate functions, that completes the awkward part of fitting out the case. The other two holes for the input sockets are simply drilled at the opposite end of the case. As long as you choose your positions carefully so that the sockets don't foul either PCB, there's no problem here. The LED holes (optional) can be drilled almost anywhere at the blunt end of the case — if the leads won't reach, just extend them a little with some insulated wire.

If you intend to make use of the dream stimulator and other attachments, there's more to do yet. The monitor connects to the add-ons by means of a 13-way cable, which is best connected using a 15-way D plug and socket. This will look better with the mounting flange behind the panel, but then the flange can cover up a multitude of wobbles if you're not 100% confident of your hole-making skills.

If you turn over the top section of the case, you'll see that there's a mounting pillar just above the battery compartment divider. The pillar isn't used in the project (a good thing too, since it's just about to be cut away), so there's no harm in drilling up the centre of it to give a handy reference point for marking out the case. Once drilled, the hole does two things. It marks the centre of the case, so you can make the hole smack in the middle, and it shows the position of the battery compartment divider. If you cut away more than ⅛in below the hole, you'll be in danger of slicing into a part of the case you'd rather like to keep.

It's OK to make a rectangular hole, but if you want to be a bit more fancy about it, angle the edges to follow the shape of the socket. Even on mass produced plastic mouldings for computers, it's rare to see any attempt made to curve the edges of the hole to fit the socket exactly. The holes are almost always trapezoidal.

The positions for the fixing holes can be found after making the hole for the socket by putting it in place and scribing through the holes in the flange. Drilling those completes the mechanical work and you can start down to assembling the electronic parts.

Next month we'll complete the constructional details and do the main board with its profusion of ICs and TARDIS-like dimensions. ETI

PARTS LIST

RESISTORS (all ¼W 5%)
R18-38 select for display (see text)

SEMICONDUCTORS
IC9, 10, 11 4543

MISCELLANEOUS
DISP1 LCD or LED display (see text)
PCB. Case.

BUYLINES

The case can be obtained from either Electronic Temperature Instruments (0903) 202151 or from Specialist Semiconductors at Founders House, Redbrook, Monmouth, Gwent.

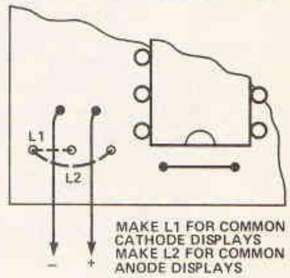

Fig. 2 Connections for LCD or LED displays

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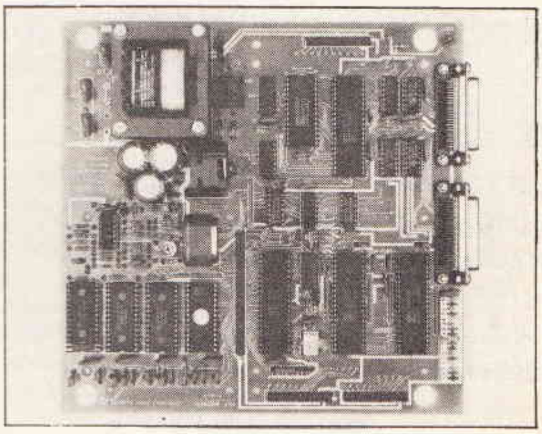

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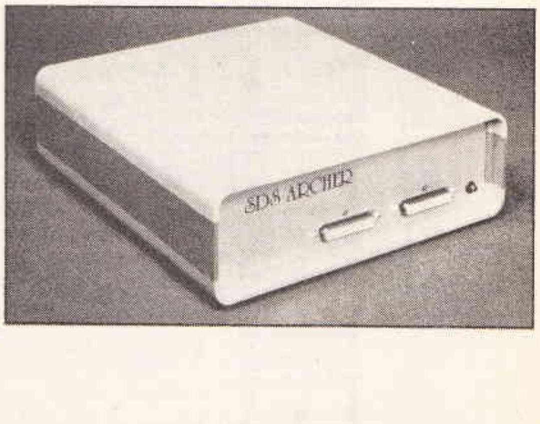

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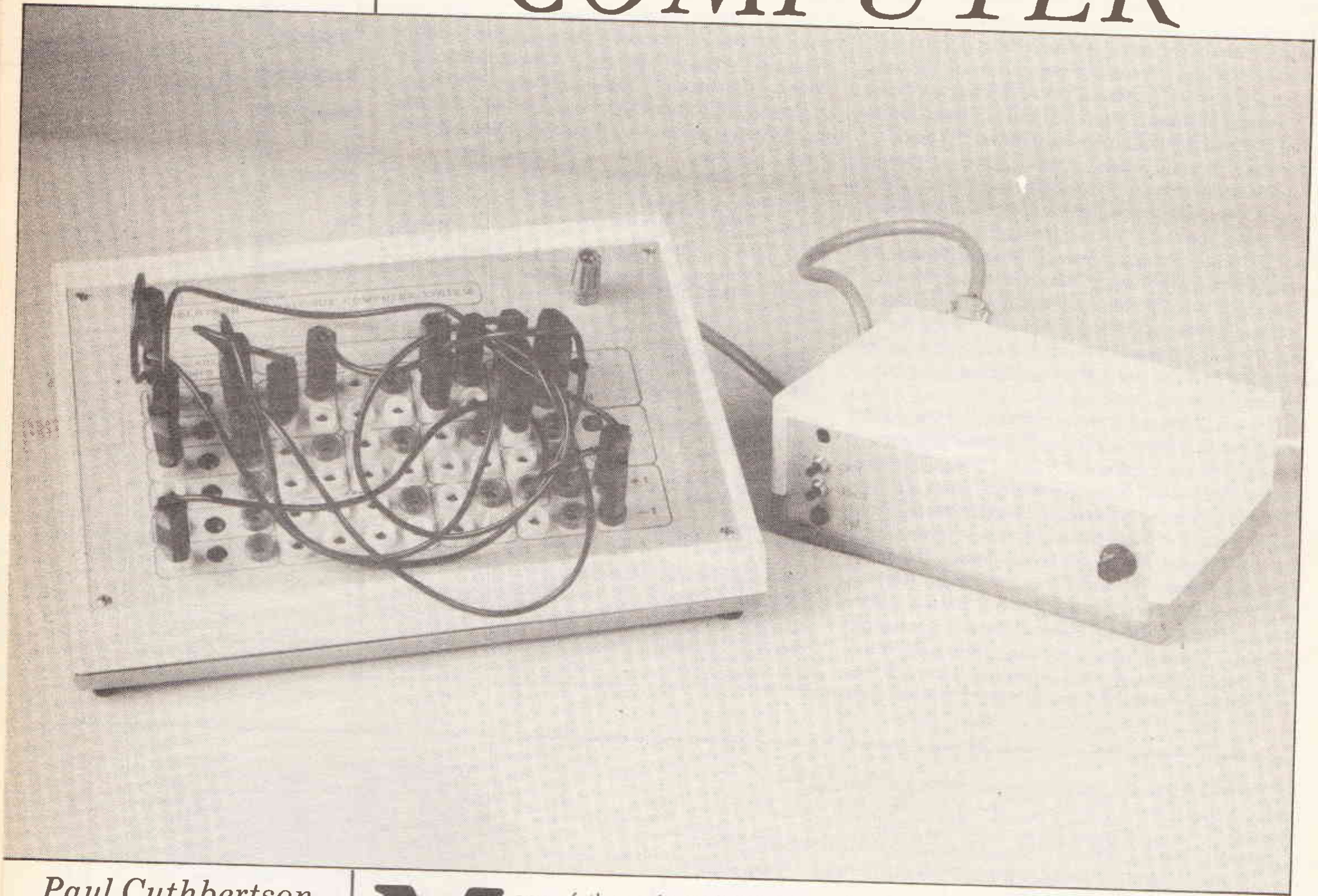
ANALOGUE COMPUTER



Paul Cuthbertson describes a small simple-to-build analogue computer for education or experiment

PROJECT

Many of the early analogue computers were true monsters, requiring four strong persons to lift them — and then with some difficulty. Fortunately, modern integrated circuits have come to the rescue and we can build a sensible small computer which, although no match for the performance standards and facilities of the bigger ones, represents considerable saving in weight, cost and power consumption.

This computer provides eight summing amplifiers, six coefficient multipliers and four integrators with over and under voltage indication. It is housed in two boxes — the power supply and the computer itself — with a cable connecting the two. The PSU can power a number of other units if the user wishes to install extra connectors for this.

There are controls for SET and HOLD on the power supply. The front panel of the computer is rather more complex. There is an overvoltage indicator, the four integrators, eight summing amplifiers, six coefficient multipliers and outlets for the ±10V references.

Such a small system is useful in a school or university laboratory or anywhere that experiments are done on control systems and such.

Mathematicians might like to note that in its present form the computer will solve linear differential equations, but not those which involve a function of two variables. Nor does it provide exponentiation or sinusoidal functions. However, the equipment to do this can be easily designed and if there is sufficient call for it, perhaps a future article may be devoted to such a unit. Even in its present form the system can be usefully employed in a number of ways in the lab.

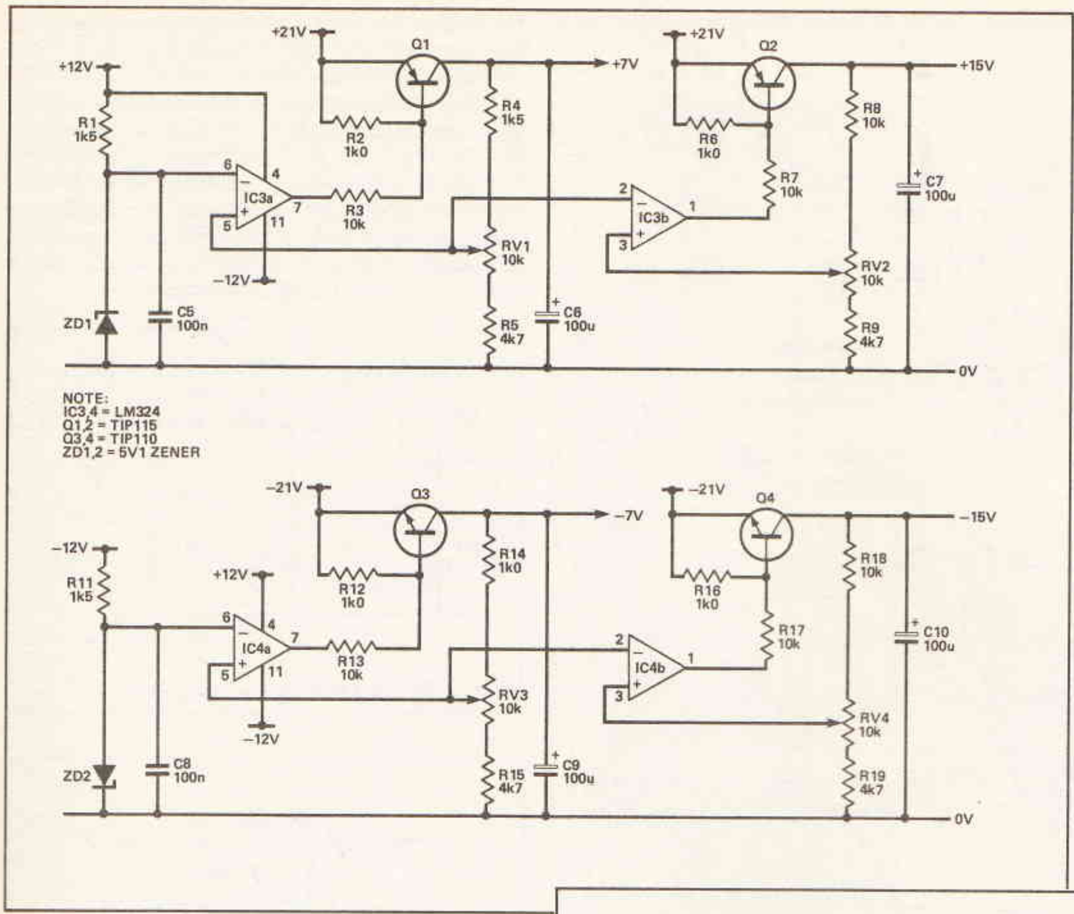
Construction

Start assembly with the PSU. Mount all the PCB components first. Figure 4(a) shows the component overlay for the PSU board.

Fit the wire links first. There are four holes by the transformer for links. The 240V operation, fit one diagonal link from northwest to southeast. For 120V, fit two links in a west-east direction. The link shown is for 240V operation. The link by the earth pads should not be fitted if you intend fitting the computer into a large system of controls.

Now solder the smaller components in place, making sure metal film resistors are fitted in the right places. Lastly, fit the transformer and the power transistors on their heatsinks. The transistors should be fixed to the heatsinks before inserting and soldering to the board. No insulator is needed.

Fit the board into the case with the transformer to the rear and drill the four fixing holes in the case base in line with the mounting holes in the PCB. Drill a hole for the mains cable, fit a grommet



HOW IT WORKS: PSU

The power supply provides ±7V and ±15V for any computer unit to use as well as the SET and HOLD signals.

The circuits for positive and negative halves of the PSU are practically identical and are shown in Fig. 1.

Preregulators, IC1,2 give ±2V to power the PSU op-amps as they cannot withstand the full unregulated supply voltage (approximately ±21V) across their supply pins.

A reference supply of 5.1V is generated across ZD1, which is then applied to the op-amp IC3. When the voltage at the wiper of RV1 is equal to that of the reference voltage, the feedback loop is in equilibrium. However if the output voltage tends to droop, the op-amp drives negative, causing more current to flow in the series pass transistor Q1 and thereby raising the output voltage. Similarly if the output voltage rises, the op-amp output goes positive, cutting down the current flowing in the pass transistor.

Resistors R2,3 are chosen so the pass transistor is able to cut off when the op-amp output is at or near the op-amp supply voltage.

Very little current flows in the 0V line. It isn't a power supply line as such, but provides a 0V reference for signals. This results in quiet, stable operation.

A similar circuit derives the ±15V supply. A special feature is that the 15V supply tracks the 7V supply. The 15V supply will not reach its full voltage if the 7V supply is pulled down or has failed for any reason. This protects the CMOS circuitry which uses the 7V supplies but which may be fed from circuits employing the 15V supplies. The tracking is accomplished by using the feedback signal from the 7V supply as the reference voltage for the 15V supply.

The performance of the supplies as regards load regulation and drift is quite exceptional.

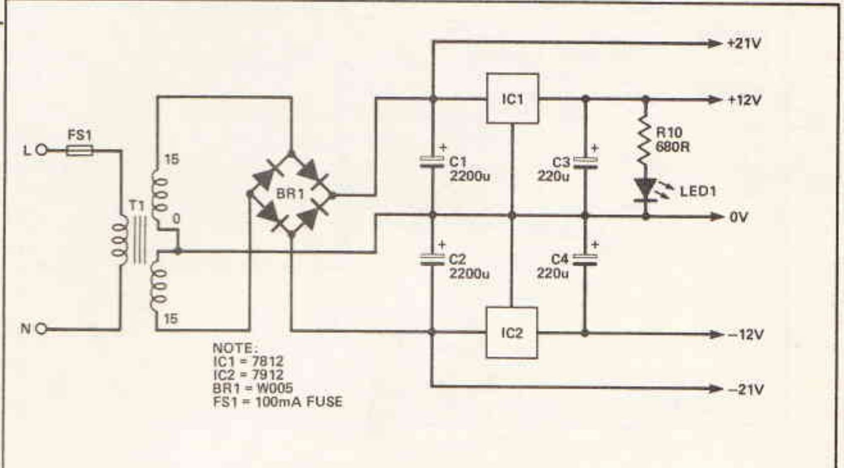
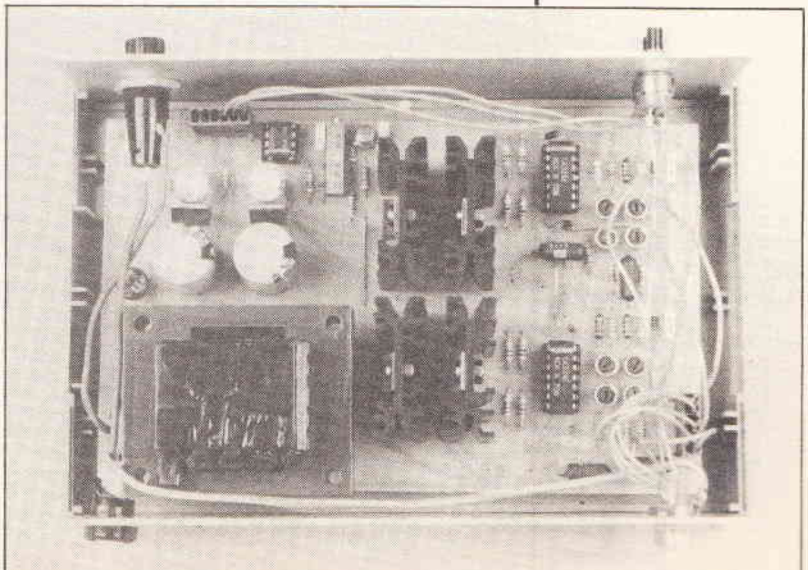


Fig. 1 The power supply circuit diagram



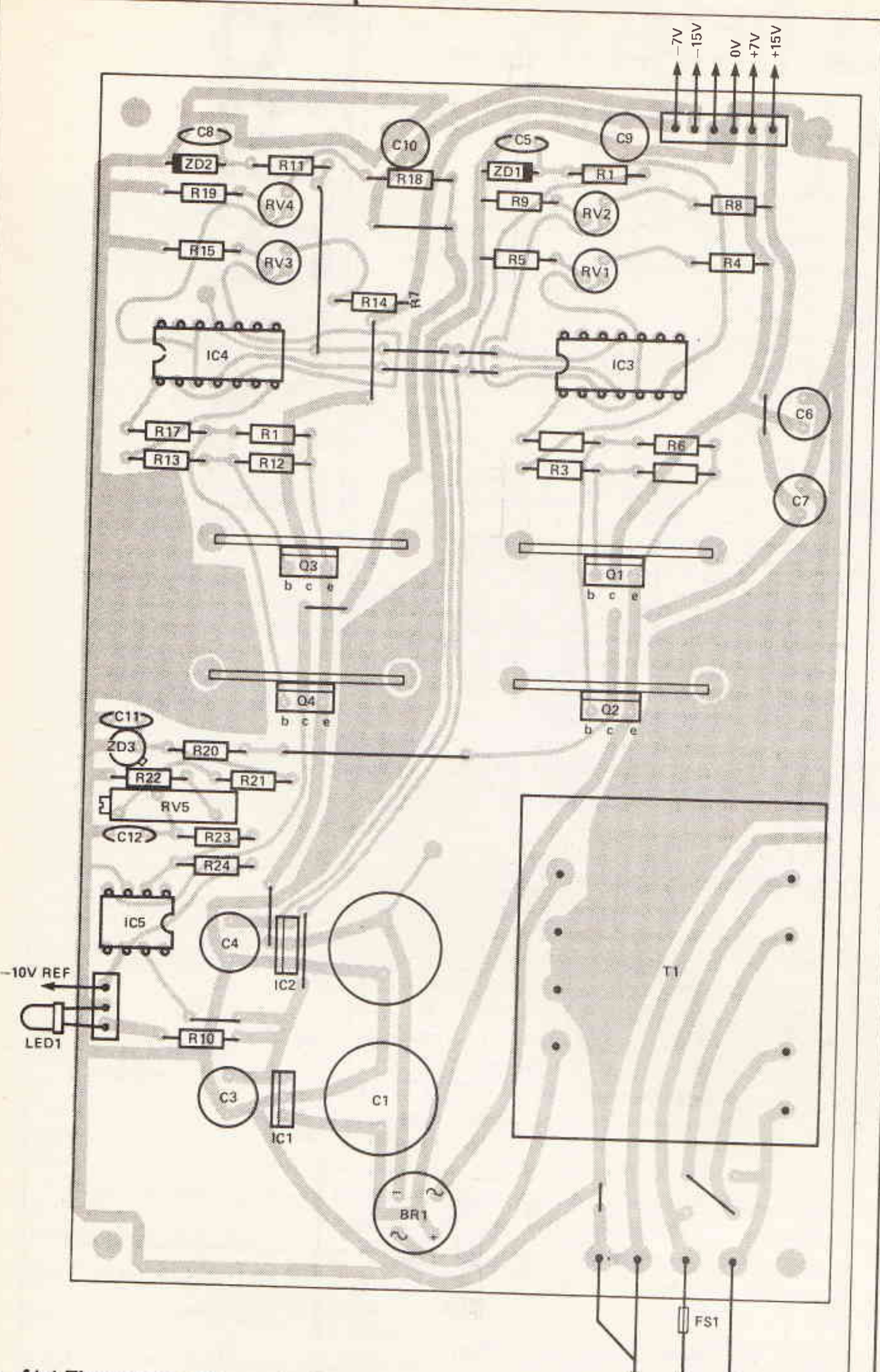


Fig. 4(a) The component overlay for the power supply

and solder the neutral and earth wires directly to the board with the 100mA fuse in line with the live connection.

Bolt the board to the case and after drilling holes and mounting the two switches (SET and HOLD), the LED and the power D-connector, wire them to the board as shown in Fig. 5. The connector blocks are not essential and the wiring can be made directly to the PCB but removable connectors enable the board to be easily taken from the case for repair or alteration.

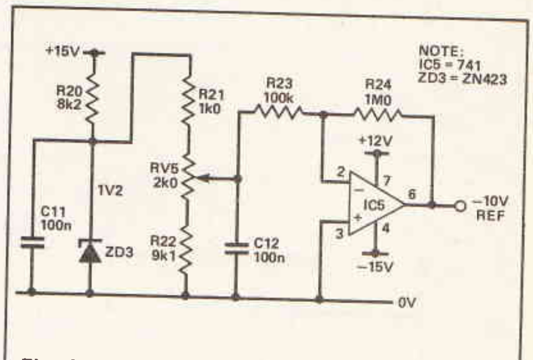


Fig. 2 The -10.00V reference source

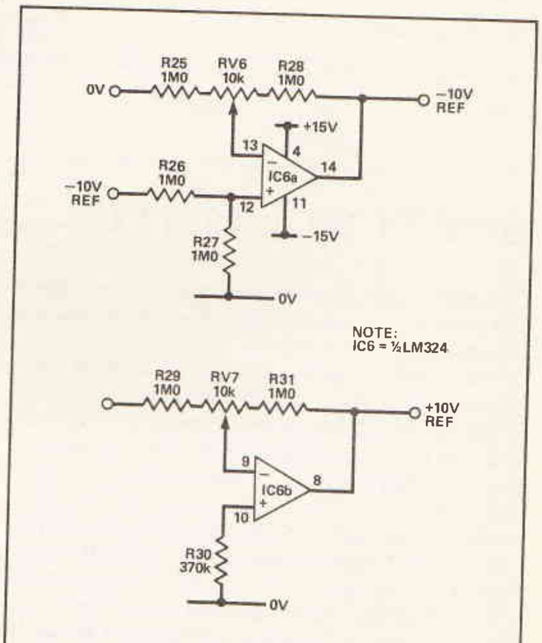
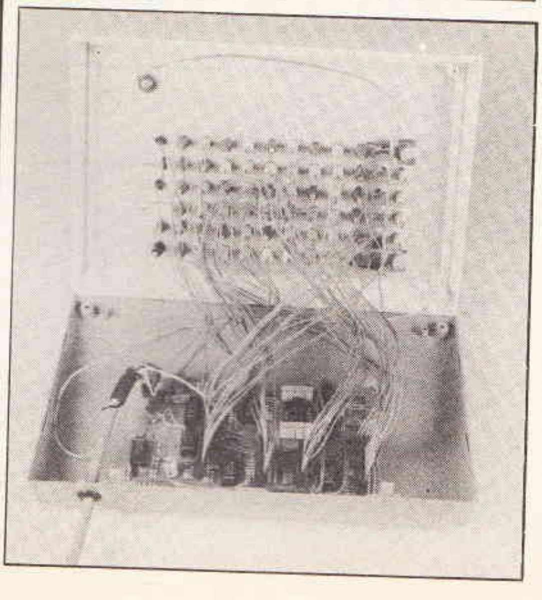


Fig. 3 The voltage reference buffers



HOW IT WORKS: VOLTAGE REFERENCE

The voltage references are shown in Figs. 2 and 3. Fig. 2 shows the master reference providing -10.00V which is located in the PSU and Fig. 3 shows the two slaves located in the computer unit itself.

A band gap reference diode (ZD3) provides approximately 1.26V to an adjustable divider circuit (R21-RV5-R22) the output of which is buffered and multiplied by ten by IC5. This circuit is fed from the +12V and -15V supplies — if the -15V supply should fail then the master reference will be unable to provide possibly damaging voltages to other circuits.

The positive and negative slave references are an inverting and a non-inverting buffer respectively. Their gains are slightly adjustable (about 1% either side of unity) giving fine control over the reference voltage.

PARTS LIST: PSU

RESISTORS (all 5% ¼W unless specified)

R1,11	1k5
R2,6,12,16	1k0
R4,14	1k5 1%
R5,9,15,19	4k7 1%
R8,18	10k 1%
R10	680R
R20	8k2
R21	1k0 1%
R22	9k1 1%
R23	100k 1%
R24	1M0 1%
RV1-4	10k sub-miniature horiz preset
RV5	2k0 20-turn preset

CAPACITORS

C1,2	2200µ 25V radial electrolytic
C3,4	220µ 16V radial electrolytic
C5,8,11,12	100n ceramic
C6,7,9,10	100µ 16V radial electrolytic

SEMICONDUCTORS

IC1	7812
IC2	7912
IC3,4	LM324
IC5	741
Q1,2	TIP115
Q3,4	TIP110
ZD1,2	5V1 zener
ZD3	ZN423 voltage reference
BR1	W005
LED1	red LED

MISCELLANEOUS

FS1	200mA fuse and holder
SK1	15-way female D-connector
SW1,2	Push to make switch
T1	15-0-15 12VA PCB mounting mains transformer

PCB. Case. T0220 heatsinks. Grommet. 6-way and 3-way minicon PCB connectors. Wire. Nuts and bolts.

BUYLINES

Most of the components for this project are easily available. The transformer used and a complete kit of parts for the whole computer is available from the Grampian Electronic Components, 266 Clifton Road, Aberdeen AB2 2HY (Tel: (0224) 495549). Further details are available from Grampian.

The PCB is available from the PCB service.

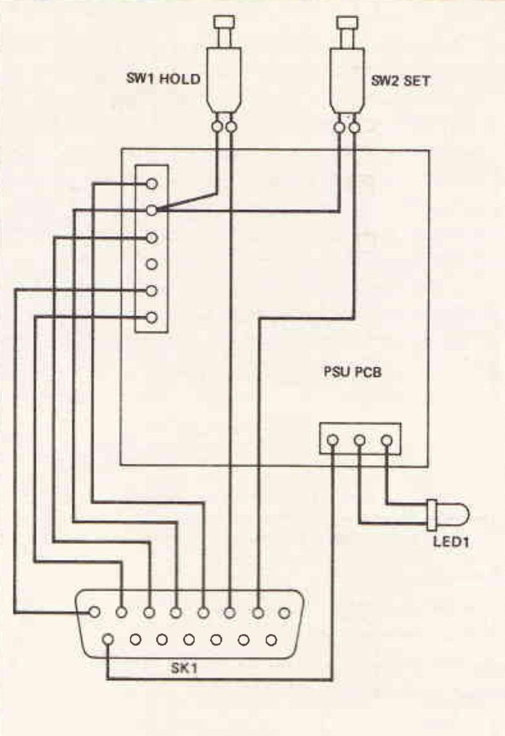


Fig. 4(b) Wiring the socket and switches

HOW IT WORKS: MULTIPLIERS

One of the coefficient multipliers is shown in Fig. 6. These are simply potentiometers with a buffer amplifier on the output. The potentiometer is mounted on a small board at the front panel. The op-amps are on the main board. The circuits for each are identical and numbered 900-1400.

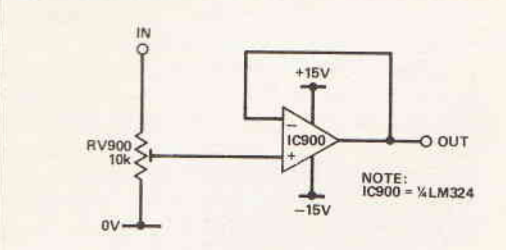


Fig. 5 Wiring the PSU switches and D-connector

HOW IT WORKS: INTEGRATOR

An integrator is shown in Fig. 7. The resistors R1500-RV1500-R1501 attenuate the incoming signal by a factor of two to render it safe for use in the analogue switch, IC1500. RV1500 adjusts the time constant of the integrator. When the HOLD pushbutton is released, the analogue switch IC1a is closed, allowing a current to flow in R1502, charging the parallel integrating capacitors C1500, 1501 and causing the output voltage of op-amp IC1502 to ramp. Pressing HOLD opens IC1a and integration stops, regardless of the input voltage.

Pressing SET closes IC1501, shorts the integrating capacitor and discharges it. The SET line also forces a reset of the overvoltage circuit.

Initial conditions (the 'starting point' of the integrator) are summed with the integrator output by IC1503. When IC1502 output is at 0V, the initial condition voltage appears at IC1503 output inverted.

The four diodes connect to the overvoltage circuit.

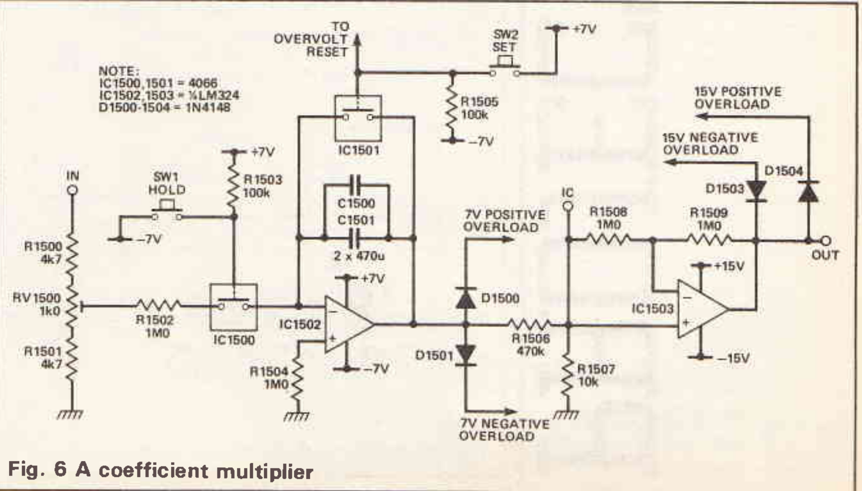


Fig. 6 A coefficient multiplier

HOW IT WORKS: SUMMING AMPS

The summing amplifiers (see Fig. 8) are the classic inverting circuit. Each of the inputs is either a ×1 or a ×10 input depending on the value of the input resistor (R107-113). Eight summers are provided — three 2×1, 1×10, four 3×1 and one 5×1, 2×10. Summer 1 (5×1, 2×10) is shown. The circuits for the others are identical and the components numbered 200, 300 ... 800 with resistors R100-103 and R107-110 omitted and the value of R111-113 and R115 altered.

The inverting input of the op-amp (IC100) is maintained as a virtual earth point. The currents from all the inputs are summed at the inverting input of the op-amp. The sum of these current flows in the feedback resistor (R114).

When inputs are unused, offset voltages due to bias currents might be a problem. These tiny currents need an external path to flow in. We need not tie unused inputs to 0V when using the computer, since the grounded 10K (resistors) R101-107) provide a path for the input bias currents to follow.

Looking at it another way, when an input is unplugged, the impedance seen by the op-amp input does not change as much as it might, as there is a (relatively) small resistor shorting the other end of the input resistor to 0V. A similar technique is employed at the integrator inputs as well.

The resistor on the non-inverting input (R115) of any op-amp is always chosen to be approximately equal to the parallel value of all the input resistors (R107-113). See Table 1 for a list of the values used in these circuits.

The two diodes D100, 102 route the output voltage to the overload detector. More on this later.

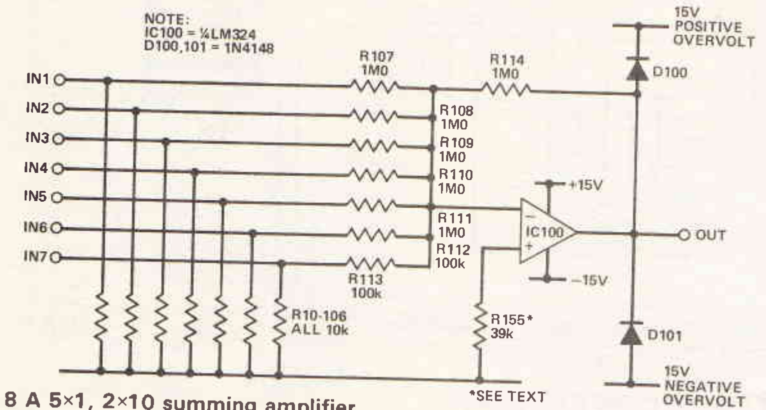


Fig. 8 A 5×1, 2×10 summing amplifier

SUMMING AMP	INPUT RESISTORS 1M0	100k	R107 (207 . . .) VALUE
5×1, 2×10	Five	Two	39k
3×1	Three	—	330k
2×1, 1×10	Two	One	82k

Table 1 R107 values for different summing amplifiers

Next month the construction of the main computer unit and use of the whole system will be described.

HOW IT WORKS: OVERVOLTAGE

The overvoltage circuit is shown in Fig. 9 and consists of a window comparator and a latch. The potential divider R36-38 develops approximately +5.1V at the non-inverting input of IC7a and −5.1V at the inverting input. Two rails carrying information about the maximum voltages present on any of the outputs of the summers and integrators, are applied to the potential divider R32, 33. A similar pair of rails concerned with minimum voltages is applied to the divider R34, 35.

Normally the outputs of the two op-amps IC7a, b are positive. Whenever a voltage greater than about 10.2V plus one diode drop appears on the 15V overvolt rail or a voltage greater than about 5.1V plus one diode drop is applied to the 7V overvolt rail, the op-amp IC7a will go negative, pulling down the inverting input of IC7c via D1 and R39. The output of IC7c will swing positive, turning on Q5 and LED2.

Due to the hysteresis (positive feedback) applied by R41,41, IC7c stays latched in the positive condition, even when the output of IC7a swings back positive. R40 ensures the inverting input of IC7c stays at 0V when not disturbed by an overvolt condition. Should the SET button now be pressed, +7V is applied to the anode of D3, causing the latch IC7c to be reset, turning off Q5.

Negative voltages out of range are dealt with in the same way with IC7b output swinging negative. The diodes tied to the overvolt rails provide an analogue wired-OR, preventing the monitored circuits from interfering with one another. Sections of the integrators which are powered from ±7V (and cannot be expected to attain ±10V!) are tied to the 7V overvolt rails. All others are tied to the 15V overvolt rails.

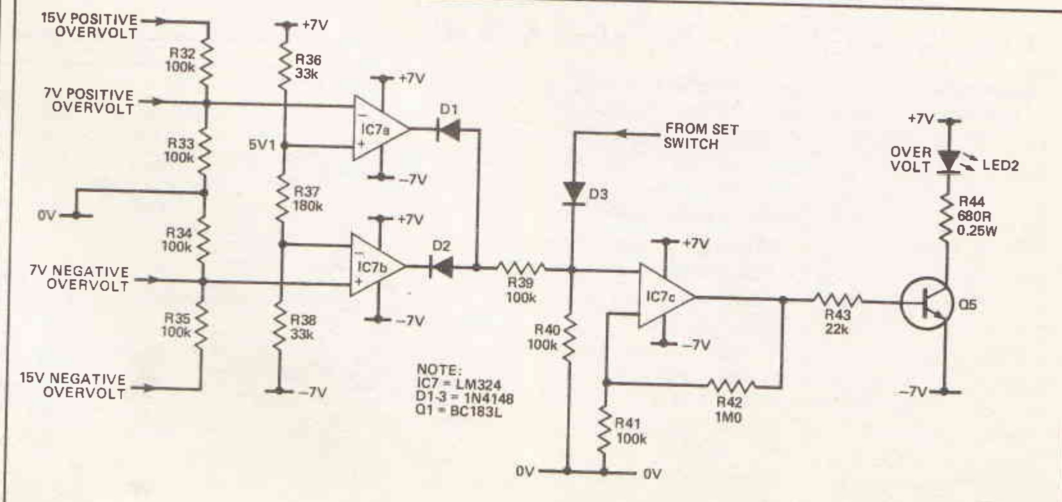


Fig. 9 The overvoltage warning circuit

Interak 1

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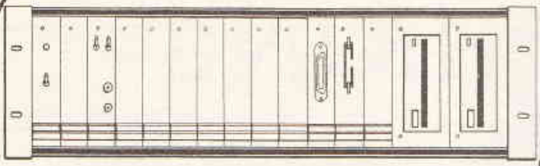

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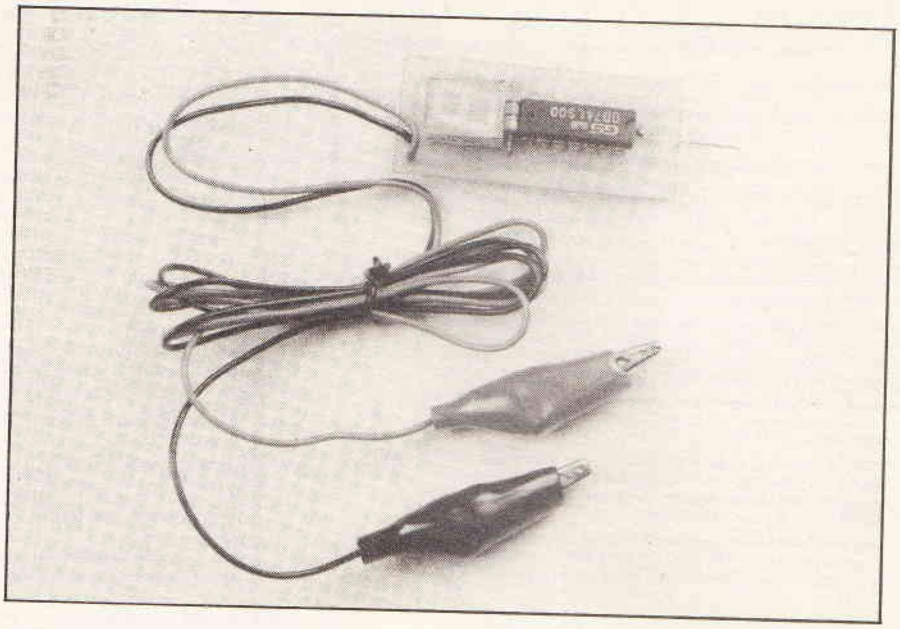
LOGICALLY SPEAKING

Probe the inner self of faulty digital circuits with this extremely simple logic probe from Rashid Adat



One of the more difficult aspects of electronics is dealing with an errant circuit. What to do when things go wrong? Some test gear is essential when diagnosing faults. For analogue circuits a simple multimeter is the bare minimum. For digital projects, the equivalent of a multimeter is the logic probe.

Impressive sounding though it is, a logic probe is in fact less complex than a multimeter — a simple version like this one can be built for just a few pounds.

A logic probe is a voltmeter which acts only digitally. It tells you if a part of the circuit under test is at a high or low logic level. This probe is designed to work with TTL circuits only (CMOS circuits usually use too high a supply voltage), levels it will detect are 2·5V for a high level and 0-0.8V for a low level.

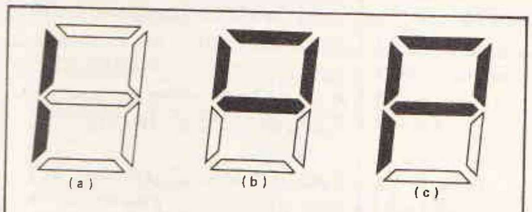


Fig. 1 The logic probe's display

The probe uses a 7-segment LED display to show the results (Fig. 1) and gives a 0 display when a low level is detected and a 1 when a high level is detected. If the test point is oscillating between the two, the two displays combine to form a P for pulse — clever, huh?

Construction

Like all 1st Class projects this one can be built either using the printed circuit board design given (Fig. 2) or on stripboard (Fig. 3). The PCB design is marginally smaller and simpler to construct but using stripboard is considerably less messy than

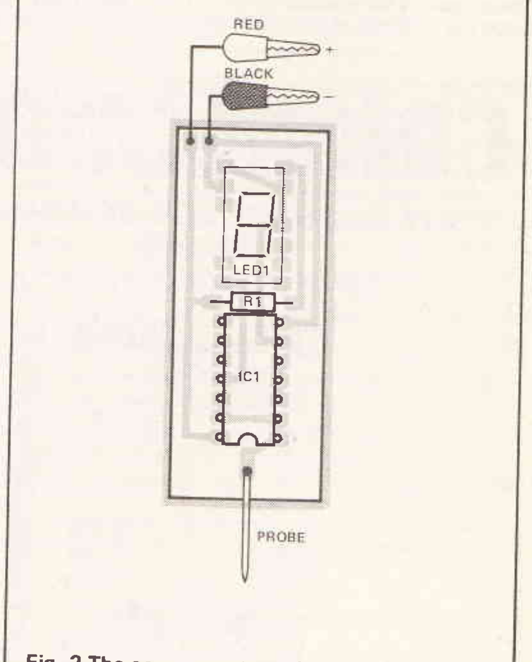


Fig. 2 The component overlay for the PCB probe

PARTS LIST

RESISTORS (5% ¼W)

R1	470R

SEMICONDUCTORS

IC1	7400
LED1	Common anode 7-segment display

MISCELLANEOUS

PCB or stripboard. Probe tip. Red and black crocodile clips. Connecting wire. Suitable case.

1st CLASS

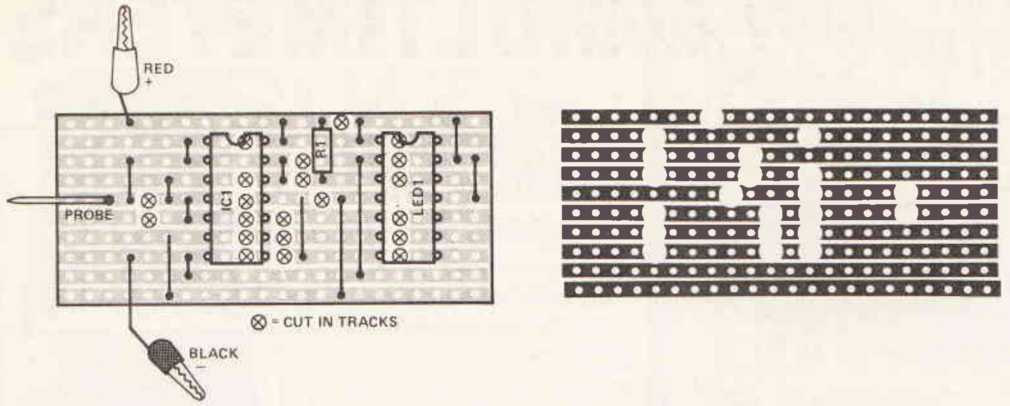


Fig. 3 The component overlay and track cut positions for the stripboard version

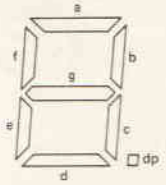


Fig. 4 The standard labelling of a 7-segment display

BUYLINES

No problems with this one. The LED display is available from many sources including Maplin (part No FR36P). The PCB is available from the ETI PCB Service. See P61 of this issue for details.

getting the etching tank out!

There are very few components for this project and so order of assembly hardly matters at all. Make the stripboard track cuts carefully and check the positioning of each component before soldering.

Leave soldering the LED display until last as this is the most easily damaged component and the most expensive. Go easy with the soldering iron when you come to it and leave it to cool a little after soldering each pin.

There is no need to use an IC socket for IC1 as these chips are so cheap that you would have to damage a couple before recovering the cost of the socket.

Probing Stuff

The most difficult aspects of assembling this project are the mechanical ones — what to use for the probe tip itself and what to house the completed board in.

A large darning needle was used for the prototype probe. This serves quite well but is a little vicious. A few inches from the pointed end of a metal knitting needle would perhaps be the ideal.

Whatever is used for the probe tip, be sure to solder it firmly into position as all the strain of stabbing at the errant circuit is taken at this solder joint.

Any convenient small case can be used to house the probe. After some searching, the prototype was finally dressed in the wide and colourful plastic body of a highlighter felt tip pen with the probe projecting where the nib once was and the two flying leads protruding from the pen top.

In Use

Of course we hope you never have to use this project! However, assuming the worst happens, simply attach the red crocodile clip to a part of the circuit connected to the positive supply (5V) and the black clip to the earth (0V). Touching the probe tip to any part of the circuit will now display 0 for a low logic level, 1 for a high level and P for a pulsing voltage.

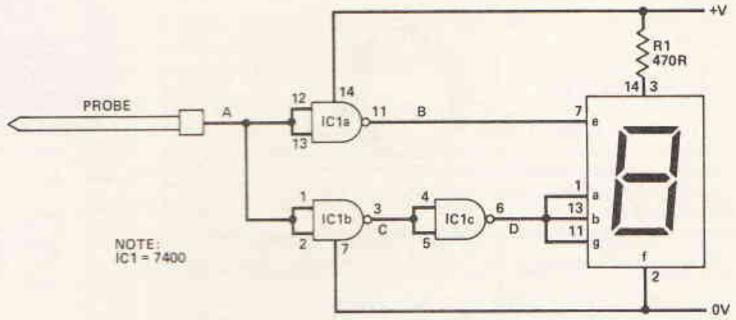


Fig. 5 The circuit diagram of the probe

HOW IT WORKS

The circuit diagram of the logic probe is simple in the extreme and is given in Fig. 5. The one IC is a quad NAND gate IC containing four NAND gates of which only three are used. All of these have their two inputs connected together to be used as inverters. Whatever logic level is presented at the input is reversed at the output — a high level (1) input gives a low level (0) output and vice versa.

If the probe (connected to point A) is touched to a high level voltage then NAND gate IC1a inverts this to give a low at point B which allows current to flow from the supply, through current limiting resistor R1 and LED segment e (lighting it) to the point B.

When the probe is low, point B is high and at the same potential as the supply, so no current can flow through segment e.

The gates b and c invert the probe signal again and so when the probe is high, point C is low and point D high, extinguishing segments a, b and g. When the probe is low these three segments light.

Segment f is always lit and segments c, d and the decimal point are not used. So the two possible segment patterns (see Fig. 3) depend on the voltage at the probe tip.

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NOTE: It is illegal to operate a transmitter in the UK without a licence.

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AMERICAN EXPRESS

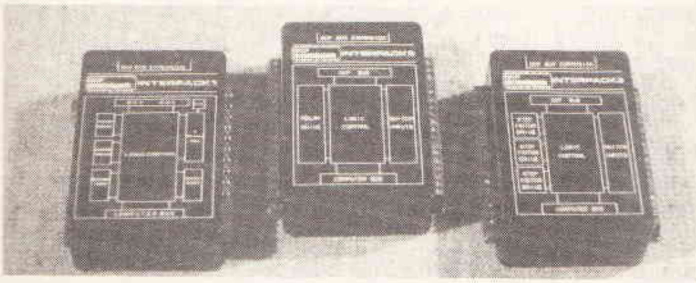
DCP RESULTS

The competition in the February 1988 issue to win one of DCP Microdevelopments' interfacing modules, the Interpacks, attracted a high standard of entry.

The winning idea for the most original and ingenious application for an Interpack module was from Neil Connor of Glasgow (though currently in Oman) who suggested connecting hospital patients' ECG signals to a computer through the ADC of an Interpack 1 where they could be selected and monitored on screen and an alarm automatically raised if certain limits exceeded. An Interpack 1 and a BBC micro Intercard has been despatched to Mr Connor.

DCP was so impressed by the entries that two extra runners up prizes of £10 discount vouchers for DCP products have also been awarded to Simon Green of Ashford and J H Greenstein of Liverpool.

Our thanks to all who entered and our congratulations to the winners.



BAR CODED

Since ETI is never a magazine to do things by halves, we've decided that two competitions in a single issue isn't nearly enough so we're throwing in another one for good measure.

On this month's cover there is a bar code pattern (you did notice that didn't you?). Of course there are some numbers along the bar code but take it from us that these do not bear any relationship with the bar code itself (they're our ISSN number, actually). We've got a six month subscription to this worthy mag up for grabs for the first person who can correctly tell us what numbers the bar code represents. If you can break *that* code and find the message hidden in those numbers as well, then we'll make it a year's subscription.

Send in your entry to arrive before 1st July to:
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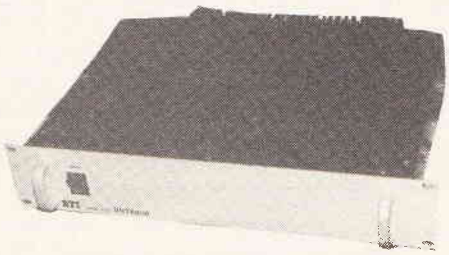

THE GENTLE GIANT

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Full circuit description in ETI April-June 1988

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THE ETI BELL BOY

Now James Main knows when the Avon lady has called

PROJECT

Are you one of those people who doesn't spend much time indoors? I am. If I'm not working, I'm off down the shops or taking the car for a run. The end result is that I never know whether anyone's been at the door looking for me.

Whatever your reason for being out, it would be useful to know how many people had been at your door when you weren't around to answer it!

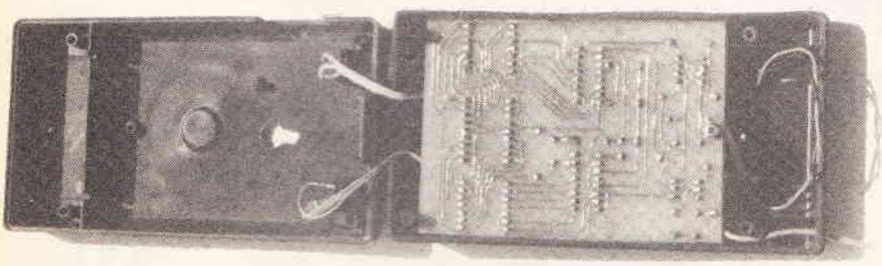
This simple unit will count up to 99 callers (which is ample for most people, unless you're bothered by double glazing salesmen!) and display at the touch of a button when you get back in.

The Bells, The Bells

Doorbells come in all shapes, sizes and bell voltages so it was felt an opto-isolator chip should be used to keep the two apart. The unit will therefore operate with *any* type of door bell — AC or DC — with a suitable series resistor.

Figure 2 shows how the unit is connected to your doorbell circuit.

People will often ring a door bell repeatedly. This would give rise to counting errors if pushing the bell-press incremented the counter directly. To prevent this, a 60 second delay is incorporated so the counter can be clocked only once every 60 seconds. Hopefully your caller will have given up and gone home inside that minute!



Construction

Construction is very straightforward. Details of the circuit board are shown in Fig. 3.

Fit the three wire links first, followed by the resistors, the diode and the capacitors. The ICs come next. Being CMOS, you should really use sockets for the 4026s and the 555C. Having said this I didn't bother, as there was limited headroom in the box I was using.

If you observe static procedures (earth yourself frequently or use a proper wrist earthing strap) you shouldn't experience any problems with soldering them straight in. Remember that IC2 is the 'wrong' way around on the circuit board.

The box shown is a plastic calculator-style box which I found to be well suited to this application. It has a built in battery compartment with slide off lid and a stylish cut-out for the display. The

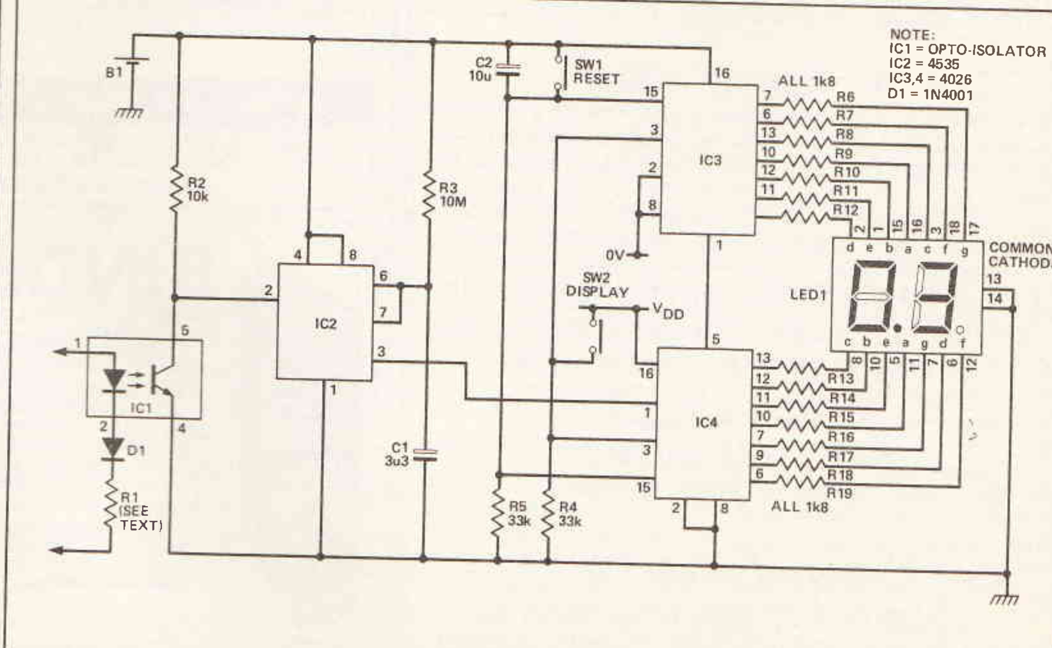


Fig. 1 The circuit diagram of the Bell Boy

circuit board fits snugly into the upper half, fastened by a single self-tapping screw at the bottom. Two holes for the push switches at the top and a small hole at the bottom for the bell interconnection wire are the only other things required.

Testing And Use

The first thing you need to ascertain is the voltage your bell works at. Check this with a multimeter or look at what it says on the battery or transformer.

For testing purposes, a spare PP3 can be used as the bell input. Temporarily fit the corresponding resistor (1k5) for R1. After checking carefully that all the IC's are in the right way round, apply power. Check that the Display button works. You should see **00** on the display.

If nothing appears, switch off and check all your connections again. Assuming everything is OK, take out your spare PP3 and apply 9V across the trigger input of the unit. Pin 2 of IC2 should go low when you do this.

Check the voltage on pin 3 (output) of IC2. Don't worry if this is found to be high before you apply a trigger, as the IC will trigger when you first connect the power rail. Wait until the output goes low, then apply a triggering voltage. Pin 3 will go high for approximately 60 seconds. Check the display, which should have incremented. Check that pushing the reset returns the count to zero. Finally, count up to ten and check that both digits are working.

HOW IT WORKS

The full circuit diagram is shown in Fig. 1. Bell voltages of 1.5V upwards can be accommodated by selection of the value of R1 (see Table 1) which is in series with the internal diode of the opto-isolator, IC1.

D1 protects against excessive reverse voltages appearing across the internal diode which could damage it. The input to the unit is taken directly from the bell on buzzer.

When IC1 is activated, the internal phototransistor conducts, taking pin 2 of IC2 low. IC2 is the CMOS version of the popular 555 timer IC, using less current and requiring fewer external components than a conventional 555.

IC2 is configured as a monostable multivibrator, with a period of 60 seconds. A high to low transition on pin 2 triggers the IC, taking the output at pin 3 high, the rising edge of which increments counter/driver IC4. R3 and C1 are the monostable timing components, the values of which you can play around with if you require a longer or shorter delay.

IC3 and IC4 are a pair of cascaded 4026 CMOS counter/driver ICs. Each timing cycle of IC2 will clock IC4. As IC4 changes from 9 to 0, a carry pulse is produced at pin 5 which clocks IC3 (the tens counter), and so on.

Pins 15 of IC3 & IC4 are taken high to reset the count to zero. When the unit is first connected, C2 charges via R5 producing an initial reset pulse. Any subsequent resets are provided by taking pins 15 high via push switch SW1.

For power saving, the display is normally disabled. This does not interfere with the counting operation however, and the count can be displayed at any time by taking pin 3 high via push switch SW2.

Resistors R6-R19 form the series resistors to the dual digit common cathode LED display. These are of a value to keep power consumption to a minimum whilst maintaining a visible display.

Bell voltage	R1
1.5V	50R*
3.0V	300R
4.5V	600R
6.0V	900R
9.0V	1k5
12.0V	2k2

*Omit D1 and replace with a wire link

Table 1 Values of R1 for different bell voltages

Assuming you know your bell voltage, fit the correct value (see Table 1) otherwise work your way down from a high resistance until you find one that works reliably. The value is not critical as the opto-isolator will work over a wide range.

Wire the input leads directly across the transducer in the bell box. If it doesn't work, reverse the leads.

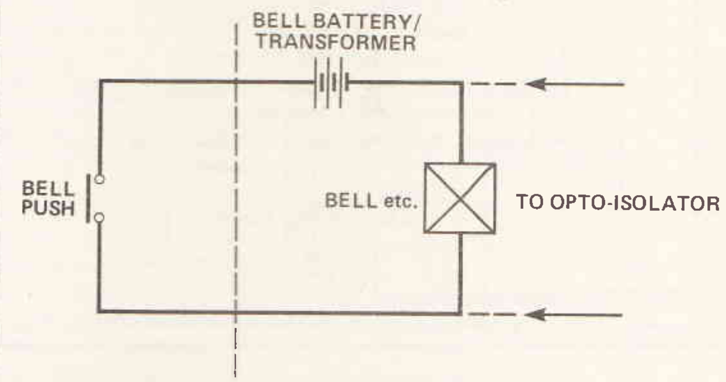
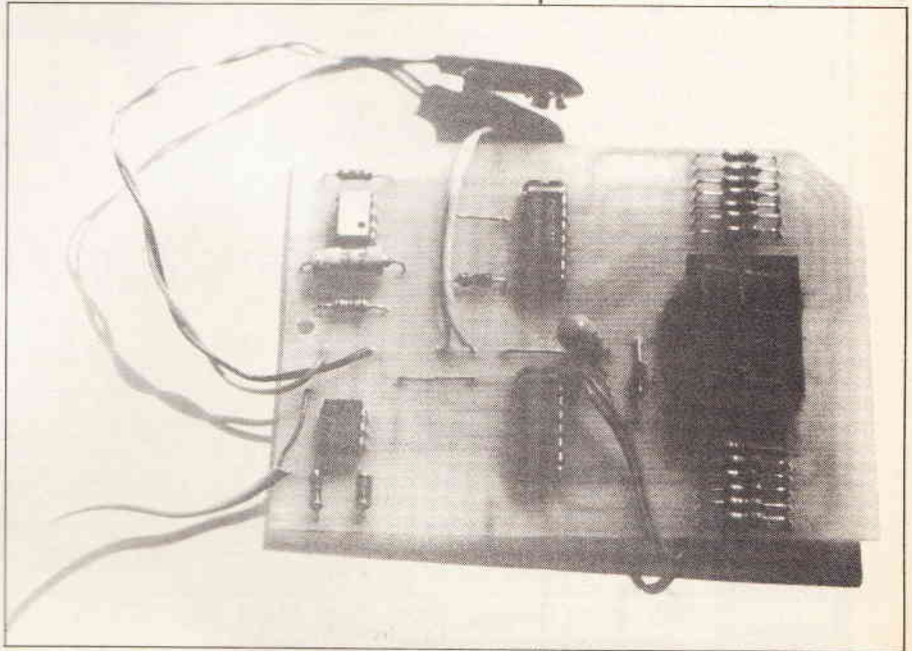


Fig. 2 Connecting the unit to your bell circuit

BUYLINES

Most of the parts used for the doorbell counter are available from usual suppliers. The optoisolator used in the prototype was from Maplin (part no. WL35Q) as was the display (BY66W) and the case (YK24B).

The PCB is available from the PCB service as usual.



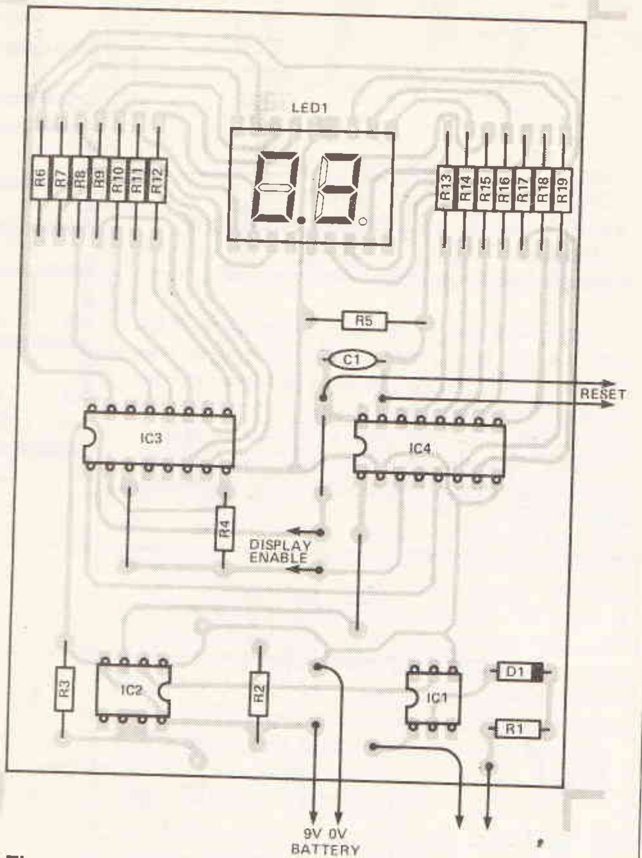


Fig. 3 The component overlay

PARTS LIST

RESISTORS (all ¼W, 5%)

R1	See Table 1
R2	10k
R3	10M
R4, 5	33k
R6-19	1k8

CAPACITORS

C1	3µ3 63V axial electrolytic
C2	10µ 16V tantalum

SEMICONDUCTORS

IC1	Opto Isolator (see Buylines)
IC2	4555
IC3, 4	4026
D1	1N4001
LED1	dual digit common cathode display

MISCELLANEOUS

B1	PP3 battery and clip
SW1	SPST push switch

PCB. Case. Filter for display. Bell wire. Nuts and bolts.

Further Uses

As the circuit is basically a counter, it can be used in a wide variety of applications at home and in the classroom. To use the unit as a straightforward counter, reduce the timing components R3 & C1 to a value such that they merely provide a debouncing action on the input trigger — so glitches and contact bounce will not clock the counter erroneously.

ETI

PINEAPPLE SOFTWARE

Programs for the BBC model 'B', B+, Master and Master Compact with disc drive

DIAGRAM II - now also available for ARCHIMEDES

Diagram II is a completely new version of Pineapples popular 'Diagram' drawing software. The new version has a whole host of additional features which make it into the most powerful and yet quick to use drawing program available for the BBC micro. The new features mean that 'Diagram II' can now be used for all types of drawings, not just circuit diagrams. Scale drawings are possible and the facilities for producing circles and rubber banded lines together with the pixel drawing routines make any type of drawing possible. This advert has been produced completely using Diagram II.

Summary of Diagram II features:-

1. Works on all model BBC computers and makes use of Shadow memory if poss.
2. Rapid line drawing routines with automatic joins for circuit diagrams.
3. Rubber band line and circle drawing modes.
4. Makes use of the Acorn GXR rom to produce ellipses, arcs, sectors, chords and flood filling.
5. Pixel drawing mode allows very fine detail to be added.
6. Defined areas of screen may be moved, copied, deleted or saved to disc.
7. On-screen cursor position indication allows scale drawings to be made.
8. Keyboard keys may be defined to print User Defined Characters allowing new character sets to be used.
9. Wordprocessor files may be loaded and formatted into defined areas.
10. Up to 880 UDC's if shadow memory available, 381 without shadow.
11. Compatible with Marconi Trackerball and most makes of 'mouse'.
12. All 'Diagram Utilities' are included.
13. Completely 'scaleable print routines allow any area of the diagram to be printed either horizontally or through 90deg. in scales that may be varied in 1% steps allowing up to 18 mode 0 screens to be printed on an A4 sheet (still with readable text).
14. Smooth scrolling over the whole area of the diagram.

Diagram II consists of a set of disc files and a 16k Eprom. The disc is formatted 40T side0 and 80T side2. Please state if this is unsuitable for your system, or if you require a 3.5" Compact disc

DIAGRAM II - £55.00 + vat P & P free

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Pointer Rom (available separately)	£ 12.50	+ vat
Trackerball to mouse adapters	£ 8.00	+ vat
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PCB

Pineapple's now famous PCB drafting aid produces complex double sided PCB's very rapidly using any model BBC micro and any FX compatible dot-matrix printer.

The program is supplied on Eprom and uses a mode 1 screen to display the two sides of the board in red and blue either separately or superimposed. Component layout screens are also produced for a silk screen mask.

The print routines allow a separate printout of each side of the board in an expanded definition high contrast 1:1 or 2:1 scale. The print time is typically about 5 mins. for a 1:1 print of a 7" * 5" board. This program has too many superb features to adequately describe here, so please write or 'phone for more details and sample printouts.

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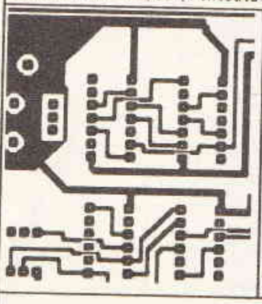

PCB AUTO-ROUTING

See review in this issue

This brand new addition to the PCB program greatly increases the power of the software and speeds the design of PCB's even more.

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The program is in the form of a second Eprom and full features are available on a standard model 'B.'

Please write or 'phone for full details.

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ADFS Utilities Rom

ADU is an invaluable utility for all ADFS users. It adds over 22 new *commands to the ADFS filing system as well as providing an extensive Menu facility with over 35 sub commands covering areas such as repeated disc compaction, saving and loading Rom images, auto booting of files and many more.

Copying of DFS discs onto ADFS discs can be made in one pass with automatic creation of the required directories on the ADFS disc. All functions are fully compatible with Winchester drives including *BACKUP which allows backing up of Winchesters onto multiple floppies.

New *commands are as follows:- *ADU, *BACKUP, *CATALL, *CHANGE, *DFSADFS, *DIRALL, *DIRCOPY, *DIRDESTROY, *DIRRENAME, *DISCEDIT, *DRIVE, *FILEFIND, *FORMAT, *KILLADU, *LOCK, *MENU, *PURGE, *PWRBRK, *UNLOCK, *VERIFY, *VFORMAT, *WIPE

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Access

TEST GEAR CIRCUITS

TECH TIPS

Robert Penfold presents a proliferation of probes, prods and prestige projects

AF Signal Generator

The 'traditional' audio signal generator (a Wien bridge oscillator, thermistor stabilisation to generate the sinewave output and amplifier/clipping circuit to produce a squarewave signal) works well but the thermistor required is both expensive and difficult to obtain. Worthwhile if a genuinely hi-fi sinewave output is required but otherwise there are cheaper choices.

This design is of the Wien bridge/clipping variety but uses an operational transconductance amplifier as the basis of the stabilisation circuit. The harmonic distortion is well under 1% over the audio frequency range and there are no significant variations in the output level over the full frequency range (15Hz to 150kHz in four ranges). The maximum output level is 1.5V peak-to-peak for sinewave signals and 6V peak-to-peak for squarewaves.

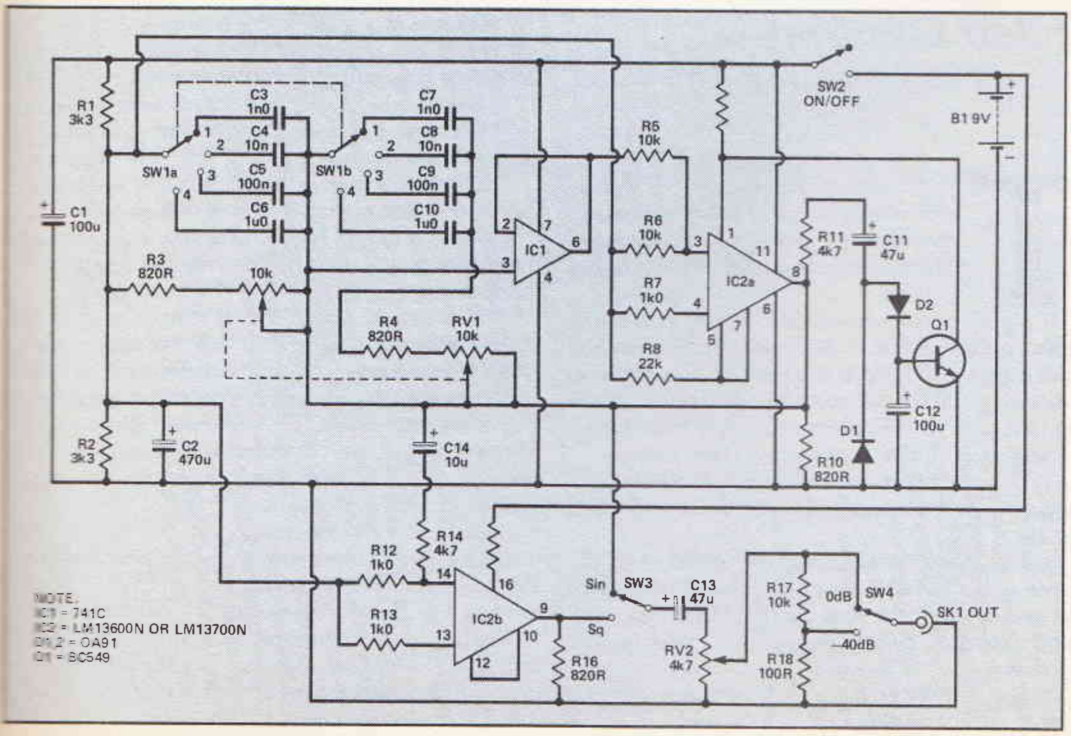
The familiar Wien network is present at the front end of the circuit with RV1 giving continuous tuning over each range capacitors. These capacitors should have an accuracy of 5% or better to give good frequency setting accuracy on all ranges using a single frequency scale and to ensure that there are no gaps in the frequency coverage.

For oscillation, the Wien network must provide positive feedback over an amplifier with a voltage gain of at least three. However, a gain only fractionally higher than this results in strong oscillation and a clipped output. In practice the only way of obtaining a consistent output level is to use some form of automatic gain control circuit to stabilise the circuit.

In this circuit IC2a operates as a standard transconductance VCA circuit. The LM13600N (and the almost identical LM13700N) have a built-in output buffer that avoids the need for an external buffer stage.

High input impedance is needed so that there is minimal loading on the Wien network and IC1 is accordingly used as a voltage follower at the input. R9 biases IC2a for quite high gain and the circuit oscillates strongly initially. Some of the output signal is rectified, smoothed and fed to the base of Q1 which biases it hard into conduction so it diverts the bias current for IC2a, stopping the oscillation. There is a negative feedback action in force here and after a settling time of around two seconds the circuit oscillates gently with a good quality sinewave output signal. The feedback accurately maintains the output level if there is any shift in the amplifier's gain or a change in the losses through the Wien network. Transconductance amplifiers are not the most linear of devices but by keeping the output level down to about 1.5V peak-to-peak it is possible to obtain good distortion performance.

IC2 is a dual device with its spare section used as a high gain amp to clip the sinewave signal and provide the squarewave output. SW3 is used to select the desired waveform, RV2 is the volume control attenuator and SW4 can be used to reduce the output by 40dB.



Current Tracer

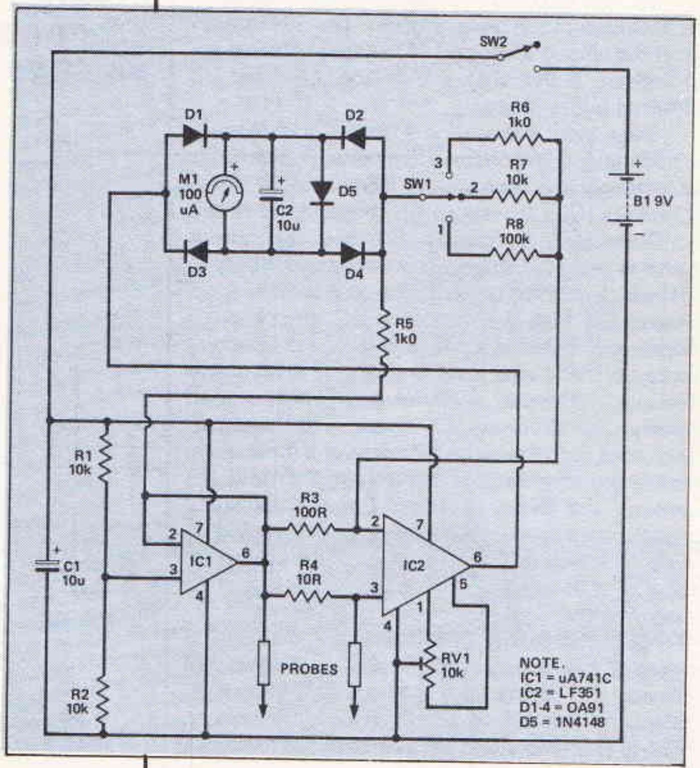
Most electronic service work is based on voltage rather than current checks for the very good reason that current checks require a break to be made in the circuit but voltage tests do not.

A few commercial test instruments attempt to make current checks as simple as the voltage variety — the most sophisticated use a Hall effect sensor to detect the magnetic field produced by a current flow. Units of this type are very expensive.

An inexpensive alternative is to use a circuit that is really a highly sensitive voltmeter giving an indication of relative current by placing the two test prods a few millimetres or more apart on a printed circuit track or component leadout wire.

The resistance present (although low) causes a voltage drop proportional to the current flow. In practice this means detecting voltages that will often be less than a millivolt.

This method does not give exact measurements of current flows. The resistance through the track or leadout wire, and the contacts between the prods and the conductor will affect readings. However a few experiments with a current tracer of this type on a couple of circuit boards will soon give a good idea of the sort of readings to be expected. Subsequent checks on faulty equipment will reveal current flows that are obviously incorrect.



The circuit has IC2 in what is a form of precision full wave rectifier, with the output driving a panel meter — a tuning or level meter having a full scale sensitivity of about 100μA should suffice. The reason for using a full wave rectifier is that the input could be of either polarity and might even be AC.

D5 protects the meter against severe overloading. IC2 provides amplification as well as linearising the rectifier circuit. SW1 provides three levels of sensitivity. With R8 selected the gain of circuit is quite high (about 1000) leading to possible strong voltage offsets so RV1 has been included in the circuit as an offset. This is adjusted to zero the meter with no input applied and R8 switched into circuit (adjustment of RV1 is much easier if a multi-turn type is used). Input resistor R4 is very low to avoid stray pick up of electrical noise.

The circuit requires dual balanced supply rails, but IC1 acts as a supply splitter to give ±4.5V from a 9V battery.

When using the unit bear in mind that readings are proportional to the distance between the two test prods. Using the greatest possible distance will give strong readings and a clearer indication of the current flow, especially when tracing relatively small currents. In general, range 1 is suitable for currents of a few milliamps to a few tens of milliamps, range 2 for higher currents of up to several hundred milliamps and range 3 is only needed when tracing high currents.

Pulse Generator

This circuit produces repetitive signals with a wide range of pulse widths and mark-space ratios — extremely useful when developing and testing digital circuits.

Simple circuits based on C-R timing networks have the drawback of possible inaccuracies and with crystals and digital ICs now costing relatively little, a crystal controlled circuit with pulse widths and frequencies guaranteed to a very high degree of accuracy can be constructed quite cheaply.

This circuit provides output cycle durations of 1-9μs in 1μs increments. These can be multiplied by 10 or 100.

The pulse duration can be varied over the same range but obviously the pulse width cannot be greater than the time permitted for one complete output cycle! Anti-phase outputs are provided.

The circuit can be easily be extended to give longer cycle and pulse times if desired.

Q1 provides a 1MHz clock signal to IC3 which operates as a sort of 'divide-by-N' counter, providing brief output pulses at regular intervals of between 1 and 9 clock cycles depending on SW2.

IC1 and IC2 form divide-by-ten circuits to extend each clock cycle from 1μs to 10 or 100μs.

The pulses then set a simple flip/flop based on IC4c and IC4d and reset a second divider/counter circuit. This circuit is much the same as the first one, providing a reset pulse to the flip/flop after a period of time controlled by SW3 and SW4.

In order to obtain longer output cycle and pulse times it is necessary only to add divider stages into both counter circuits and to use switches with the appropriate number of positions for SW1 and SW3. For example, three extra divider stages per counter would extend the maximum cycle/pulse times to some 900ms in 100ms increments.

IC4a inverts the output of the flip/flop to produce the Q output — high for the period set on SW1, 2 and low for the period set on SW3, 4. IC4b inverts this signal to provide the $\overline{Q}$ output.

The circuit is shown as having a 9V supply rail, but it works well with any supply voltage of 5-15V. The supply voltage must match that of any digital circuit driven from the outputs.

TECH TIPS

Voltage Probe

Although a multimeter is the standard instrument for DC voltage checks, there are alternatives. For difficult (high impedance) circuits an electronic voltmeter or an oscilloscope can be used. At the other end of the scale there is the relatively recent development of the voltage probe — a simple hand-held instrument with LEDs forming a bargraph display.

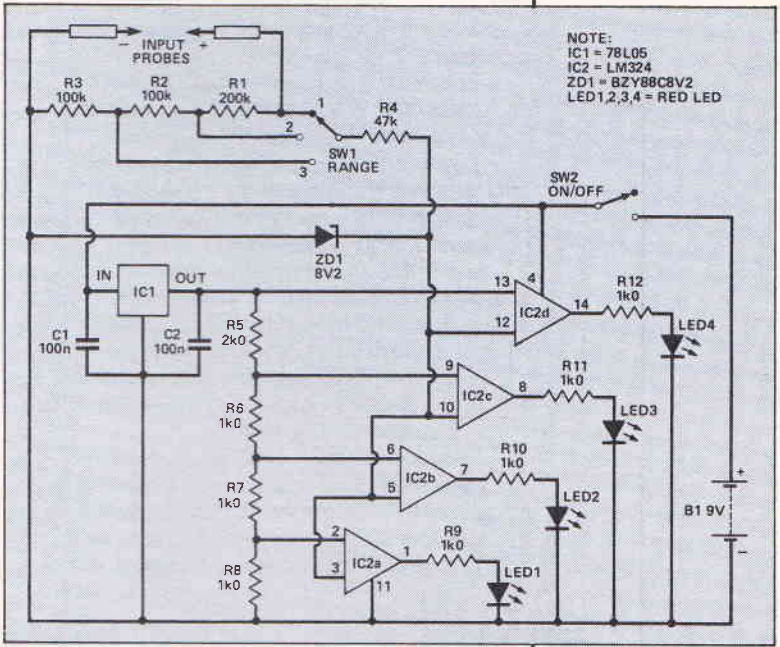
The most simple circuits for probes are purely passive and are of limited value in electronic testing due to their low and inconstant input resistance. Active circuits are more suitable for electronic circuit testing but the most sophisticated of voltage probes still provide only a very rough indication of the voltage levels present. However, much voltage testing (checking that a suitable supply voltage is present for example) does not require great precision of measurement and a voltage probe used in context can be a very handy test instrument.

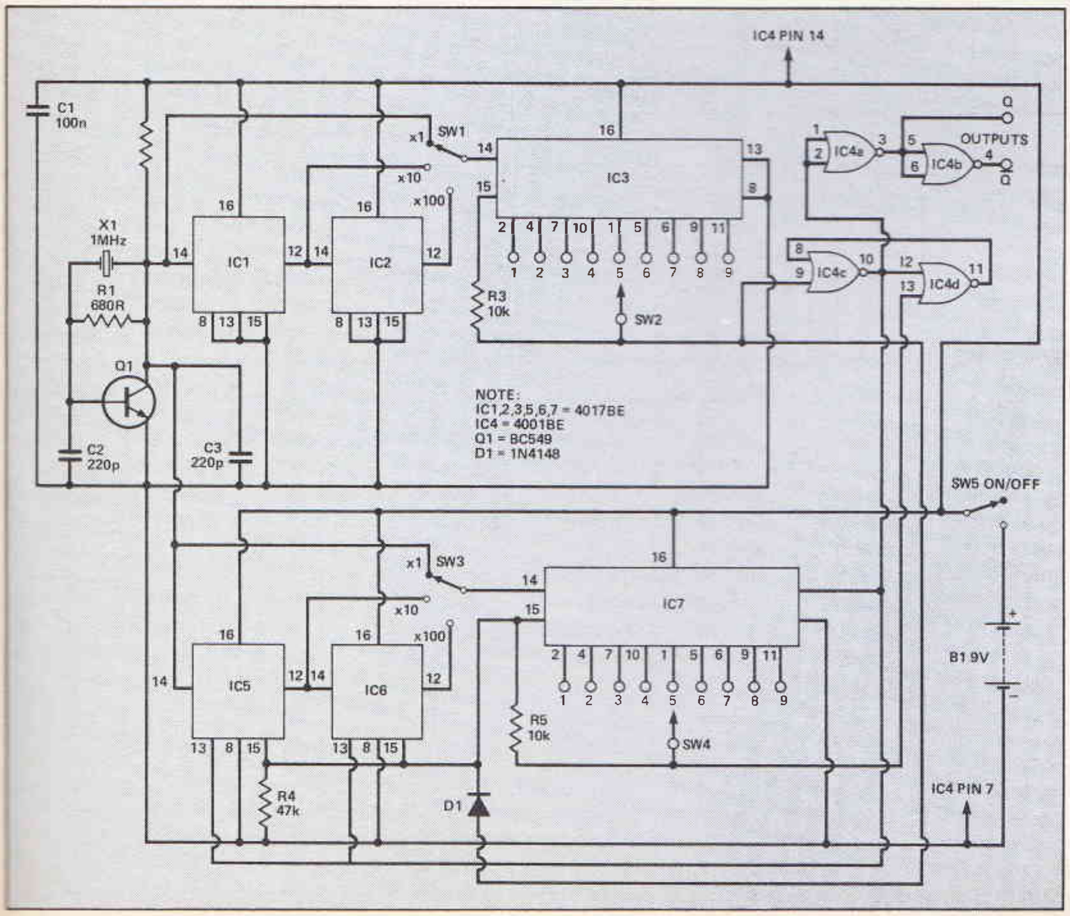
This design has four LEDs with normal voltage indication points of 2, 4, 6 and 10 volts with an input attenuator that enables the sensitivity to be doubled or halved. This enables DC voltages in the range 1-20V to be gauged with reasonable accuracy.

The unit has an input resistance of around 400k. While this does not compare well with an digital multimeter, it compares quite well with a decent analogue multimeter. The circuit incorporates overload and reverse polarity protection.

R1-3 and SW1 form the input attentuator which has attenuation levels of 0, 6 and 12dB. Protection against excessive input voltages is provided with D1 normally clipping the input at about 8.2V and becoming an ordinary forward-biased silicon diode to clip a reverse polarity voltage input at about 0.65V.

The bargraph driver is based on quad op-amp IC2, all four amplifiers operating as voltage comparators. The inverting input of each comparator is fed with a reference voltage and the input voltage is fed to the non-inverting inputs, so that an input voltage exceeding the reference level will send the amp high and activate its LED indicator. Reference voltages of 1, 2, 3 and 5V are required. The 5V reference is provided by monolithic voltage regulator IC1 and the other voltages are derived from this via a potential divider (R5 to R8). Note the LM324 is used as it is suitable for single supply rail operation.





Deluxe Voltage Probe

The standard LED voltage probe described above is an extremely useful piece of 'take anywhere' test gear, but the lack of precision can be frustrating on occasions.

This 'deluxe' version gives the low cost and portability of an ordinary type but with a degree of accuracy much closer to that of an analogue multimeter. This is achieved by using a miniature meter rather than the LED bargraph to provide the readout. The small scale of the meter and its non-linear nature still limit the accuracy of the unit slightly and the unit could be built as a high precision bench unit with a full-size meter if preferred.

The unit has three ranges with FSD of 1V, 10V and 100V. The input impedance is about 20M on the 1V range and 10M on the other two.

Touch contact switching gives a convenient means of range switching for a hand held unit. A CMOS quad analogue switch IC6 forms the basis of this part of the circuit.

R19 forms an input attentuator in conjunction with R14 to R18 selected via three switches by IC3, a CMOS 4017BE 'one of ten' decoder. IC3 is reset when the fourth output goes high so it is effectively a 'one of three' decoder, with each output driving one of the switches. LEDs indicate which voltage range is currently in operation.

The clock signal for IC3 is provided by IC2, a low power 555 timer operating as a low frequency astable circuit. However, it only oscillates when the operator's skin resistance bridges the touch contacts. In order to change ranges it is just a matter of touching the contacts until the unit cycles through its ranges to the point where the appropriate range indicator lights up.

Of course the electronic range switching could be replaced with a mechanical switch if preferred but a standard rotary type is rather large and cumbersome for a hand-held unit.

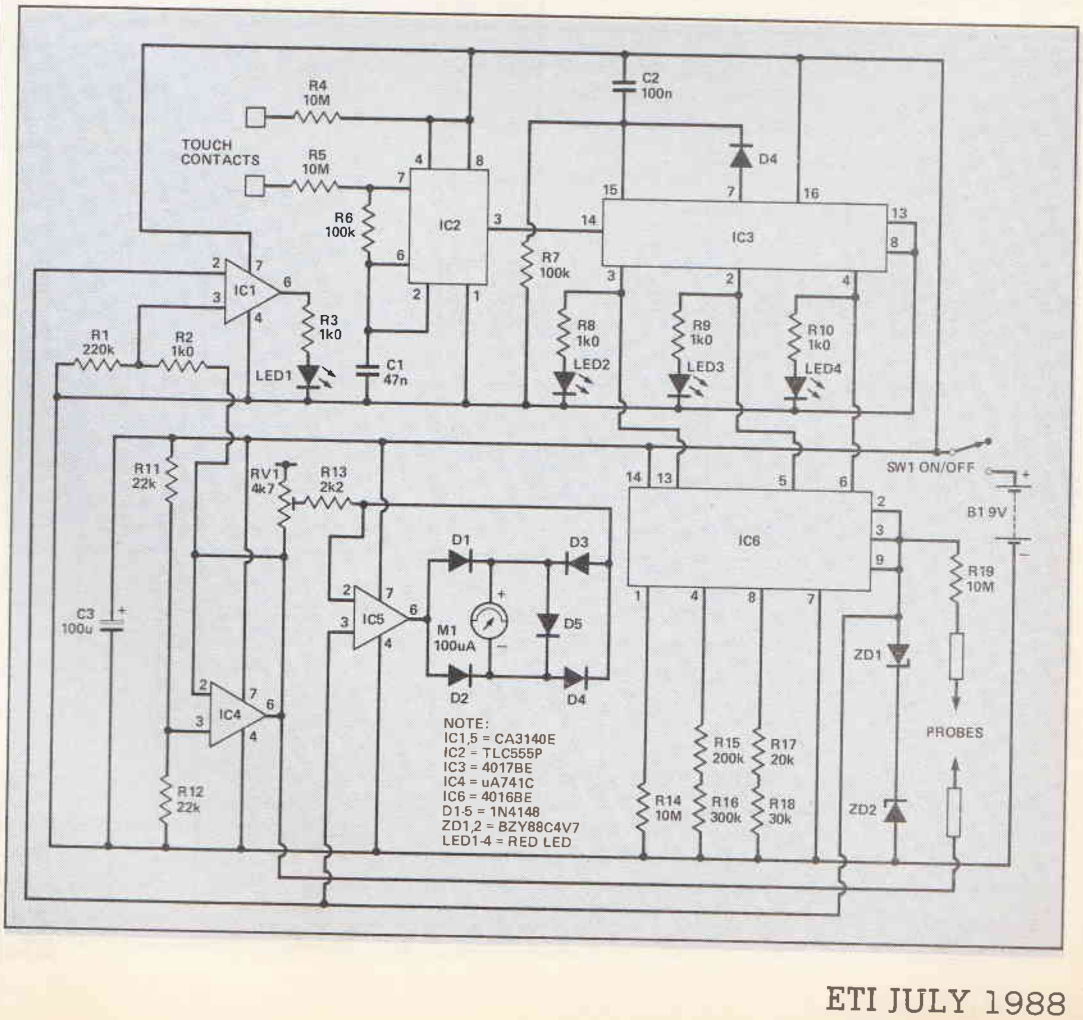
The voltmeter circuit requires dual supplies but the unit is powered from a single 9V battery with IC4, R11 and R12 acting as a supply splitter to effectively give dual 4.5V supplies. IC5 is used in a configuration that is reminiscent of an AC millivoltmeter circuit and this results in the unit responding properly to inputs of either polarity.

Using RV1, calibrate the unit against a known voltage that is close to FSD on one range — for example you could use a multimeter to measure the true output voltage of a 9V battery and then use this to calibrate the unit on its 10V range. Provided R14-19 are all 1% tolerance components the unit should then be very accurate on all three ranges.

D5 provides the meter with overload protection and ZD1,2 protect the circuit against excessive input voltages.

IC1 is used as a voltage compressor and this gives input polarity indication via D1. D1 is switched on if the input is of reverse polarity.

Assuming the unit is constructed in probe form, the obvious scheme of things is to have the meter at the rear of the case, a long metal probe fitted at the front, with SW1 and the touch contacts anywhere on the body of the unit where they are easily operated. The negative test lead can consist of about ½ metre of flexible insulated wire terminated in a small croc clip. Note that miniature (32mm square) meters are available from Electrovalue.



TECH TIPS

Transistor Checker

This simple gadget is an in-circuit transistor checker. It alternately forward biases the test device and short circuits its base and emitter terminals. An LED indicator is connected in the collector circuit of the transistor under test and should flash if the device is serviceable.

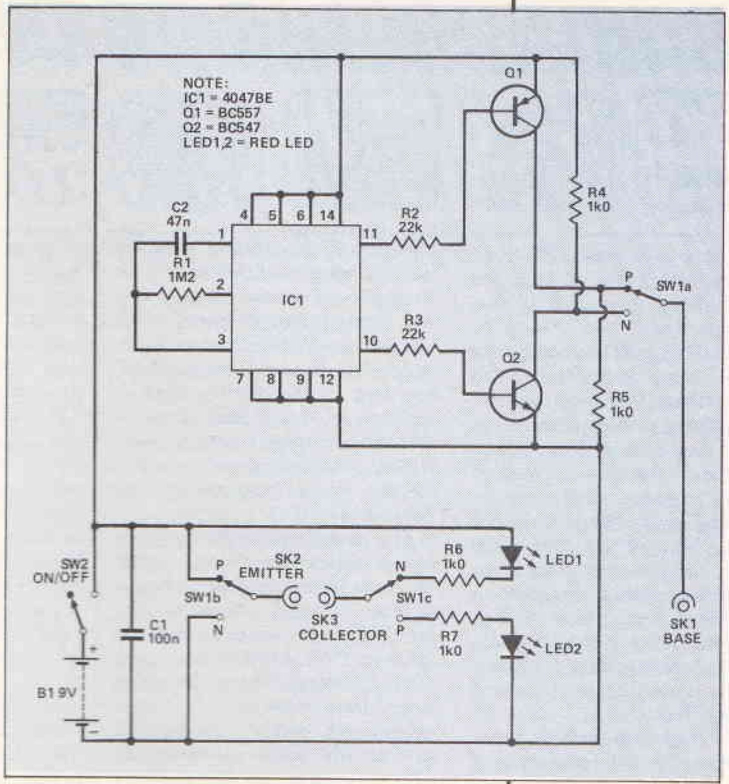
The circuit has IC1 operating in the free running astable mode with an output frequency of a couple of Hz. Switching transistors Q1 and Q2 are driven from its outputs, and these provide the base-emitter short circuiting for PNP and NPN devices respectively. R4 or R5 provides a forward bias to the base terminal of the test transistor during the half cycles when Q1 and Q2 are switched off.

Separate LEDs are used for the NPN and PNP modes. This helps to simplify the NPN/PNP switching and reduces the risk of the unit being inadvertently used while switched to the wrong mode.

When making in-circuit tests it is important to realise that components connected to the device under test can affect results. This will sometimes result in the LED not fully switching off and could result in it not switching on properly (although this never seems to happen in practice).

If the LED switches on and off properly it is highly unlikely that the tested device is faulty.

If the LED fails to switch properly, check the suspect transistor out of circuit to make quite sure it really is a 'dud.'



ETI

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PLAYBACK

As this is to be my last *Playback* column, I make no apologies for returning to topics I have covered before.

First of all DAT. It is surely as a result of pressure by the record industry that DAT recorders are still not easily available. It seems to me that they have shot themselves in the foot. If we draw the analogy between analogue audio cassettes and DAT, we see that once cassettes caught on and many people had cassette recorders, there was a substantial market for prerecorded audio cassettes. The overall market is greater because cassettes can be played in cars. Last year more cassettes were sold than vinyl records.

DAT could perhaps have taken over from the old technology of ordinary cassettes and expanded this market further. This was by no means a foregone conclusion because the DAT mechanism is complicated and therefore more expensive than compact cassette mechanisms but whatever chance there was is now much less because of the record industry's stand.

The question they should have asked themselves is: 'Would the industry have made more sales if the compact cassette had never been invented?' The evidence seems to say no.

Go For Gold

Audio fads come and go but one of the most bizarre has to be the idea of using gold plated mains plugs. Hi-fi equipment actually runs on DC and contains transformers, rectifiers and so on to produce this DC. The active circuits cannot tell how the DC came to be there, whether it comes from batteries, 240V mains or whatever.

The only time when the means of generating the DC matters is when the method is inadequate and the power supply is disturbed in some way.

So, if the mains plug makes good contact with the socket and does not arc and spark and generate interference it does not matter what the mains plug is made of.

I am sure that the idea of gold plated mains plugs will continue regardless of what I say and I am waiting for some opinions to be expressed as to what sort of coal burnt at the power station produces the most suitable electricity for hi-fi.

Distortion

We should not lose sight of the fact that the raison d'etre of hi-fi is to listen to music, so a consideration of the characteristics of musical sounds will give a useful perspective. Although hi-fi amplifiers are frequently tested with a sinusoidal input, most musical instruments produce a very different waveform.

For first hand evidence of this, compare the sound of a tuning fork which is an almost pure sinewave with that of a guitar. Alternatively, display the waveform from an electric guitar pickup on an oscilloscope.

The waveform from the bass strings appears to contain almost as much third harmonic as fundamental. Normally, however, the waveform is approximately symmetrical about the zero axis, which means that there is little even harmonic content. A closer examination of the waveform will reveal little trace of harmonics above the third, so that the note consists mainly of fundamental and third harmonic, with a trace of fifth and higher orders.

This result conforms to common sense. After all, there is no reason for the string to vibrate assymmetrically, which is what would be required to produce even order harmonics. Equally, it is unlikely to support high order harmonic vibrations. School physics experiments show that it is difficult to make a string behave in this way.

All this suggests that an amplifier with a low level of distortion, of such a nature as to produce mainly third harmonic distortion, will change the character of musical notes only a little. On the other hand an amplifier with the same overall level of harmonic distortion but producing significant amounts of higher order harmonics, will change the character of the sound rather more.

A gentle bend in the amplitude response of an amplifier will produce low order harmonics, while an abrupt glitch will produce high order ones as well. The actual amplitude of the harmonics will depend on the total extent to which the response is non-linear (whether the non-linearity is gentle or sharp).

This may be a reason for the preference for power MOSFETs in hi-fi amplifiers, rather than bipolar transistors. A trace of crossover distortion in a bipolar output stage will generate high order harmonics — 5th, 7th, etc, while the same amount of distortion in a MOSFET amplifier will concentrate the harmonic energy in the third harmonic.

Of course, in an ideal world no amplifier would have any distortion at all, so the question would not arise.

Andrew Armstrong

ONCE OVER

Okay, I'll admit it. I'm a sucker for gadgets. Give me a shoehorn with a digital clock in it and I'll demand it doubles as a bedside radio into the bargain. If I were let loose in Hong Kong I'd be broke in about three hours.

However, not all 'gadgets' are as silly as a time-telling shoehorn. Maplin seems to be heavily into temperature measurement these days. As well as the temperature modules reviewed last month. Maplin has a nifty range of fully fledged thermometers as well.

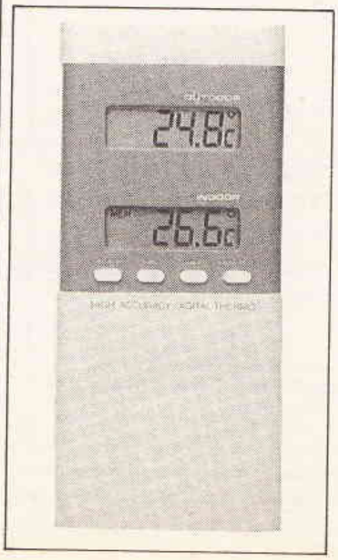
These are all based on the temperature modules (or close relatives, at least) but put into nice plastic cases with a battery compartment and all the right buttons on the front in a way which the humble hobbyist can't manage.

This means the thermometers cannot be used for control applications (not without hacking apart the nice case anyway) but they are ideal for telling you how hot (or cold) it is, which is what you really wanted to know anyway, wasn't it.

The two thermometers looked at here are based on the min/max temperature module (and not the one with a clock built-in).

The names get very confusing with all these variations on a theme so I'm going to call the model you'll find in the Maplin catalogue as YP16S 'the big one' and a new model you won't find there (but orderable as YP95D) 'the little one'. The big one's bigger than the little one — clever huh? First the big one.

This is a handsome brute which you'll be pleased to know has just come down in price to £14.95. It measures about 7×7×¾in and has two displays, one for indoors (using a sensor inside the case) and one for the wide blue yonder (using a sensor on the end of about ten feet of thin cable).



The external sensor can handle –40°C to 50°C which should cope with most extremes of the British climate and the internal one is happy between –5°C and 50°C. If these are exceeded, suspect your central heating! Under and over temperature displays are given outside these ranges.

The external sensor is equipped with a little spring clip which can be screwed to a wall to mount the probe about an inch from the brickwork. Just what the native wildlife will make of such a tempting treat if it is within reach is another matter, but still.

The back of the main case has a mounting to hang it on the wall inside and it appears to be suitably shock, splash and anything else resistant to be mounted anywhere within reason.

Each display clearly gives its current temperature (updated every ten seconds) in ½in high LCD numerals. A switch on the back allows you to pick Celsius or Fahrenheit.

Four soggy rubber type buttons on the front allow the maximum or minimum temperature reached since the beast was last reset to be displayed — independently for each display. Either of the minimum and maximum memories can also be reset to the current temperature with these too.

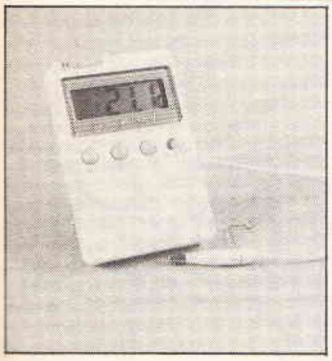
Maplin quote an accuracy of about ±1°C for this thermometer. Given its resolution is 0.1°C, this isn't too hot (if you'll excuse the pun). The situation is made worse by the two entirely separate modules which go to make up this thermometer. Each display shares only a couple of switches. That's all. Even the two HP7 batteries used are for a module each.

The calibration of each module is almost bound to be different, so somewhat misleading readings arise.

Leave the thermometer sitting right next to its 'external' probe and you can end up with two different readings. The review model was about 1°C out in this respect.

However, you may be luckier and have two more closely matched modules. It should be possible to calibrate the modules yourself by altering the sensor resistor but no instructions are given for this and at best it would be a fiddly job.

Nevertheless, considering a decent mercury-in-glass min/max thermometer (with only one 'sensor') costs about ten quid, the Maplin model is pretty good value



— and of course it's dead impressive!

Maplin's 'small' thermometer is a new model hot off the Taiwanese (or wherever) factory conveyor belt.

This is a much smaller unit, measuring about 4×2½×½in. The big thermometer has a lot of spare space in it but this model is more squeezed into its case. A wall mounted slide-in holder is provided and a fold out stand.

The small model provides the same temperature ranges and the same accuracy. Just one display (½in again) is used with a switch on the front to select readings from the internal or the external sensor. The external probe is again on the end of about ten foot of cable and has a spring clip mount.

A small size (AAA) battery is used in this model. It takes up less room but these are less easy to buy and more expensive than their larger HP7 cousins. However, as the battery lasts about a year, this isn't really a problem.

Three rubbery switches are provided on the front panel and these are used in the same way as the larger unit to display and reset the maximum and minimum memories.

The only hitch with just the one temperature module using two probes is that the minimum and maximum memories can only record the extremes from the probe currently switched into circuit. You cannot, say, display the inside temperature while recording the outside minimum or maximum.

Another slight niggle is the omission of a °C/°F switch. I'm sure the module makes provision for one (the LCD display certainly does) so it would be nice to see one included if, like me, you are still in the dark ages when it comes to the weather forecast.

Otherwise this is a nifty little unit and well worth the £12.95 Maplin demands.

Maplin Electronic Supplies, PO Box 3, Rayleigh, SS6 8LR. Tel: (0702) 552911.

Malcolm Brown

BOOK LOOK

Programmable Logic Handbook by Geoff Bostock. Collins Professional Books £25.

With the market for programmable logic getting on for £¾billion and rising still, it is surprising that no comprehensive manual and reference work exists to help your poor humble design engineer get to grips with the situation. Could this be it?

This work of some 240 pages bravely attempts the almost impossible — to be exhaustive yet concise, to cover the whole sphere of programmable logic from cell architecture and history via logic principles to examples of complete designs of some sophistication.

I cannot, with as much pessimism as I can muster, say that it has wholly failed.

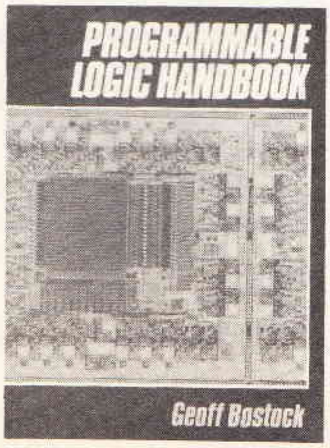
For someone in my professional position (the experienced occasional user of PLD) it is a worthwhile reference work but one which I would get my boss to pay for rather than buy for myself.

The early chapters look at semiconductors in general and the principles of logic, examining the currently available architectures in some detail. He continues with design methods and programmable logic applications.

Mr Bostock has indeed brought together under one cover a wealth of information but I feel that there is little present in this work which is not fairly readily available in the many excellent PLD manufacturers' support manuals.

On the positive side, I do think that the *Programmable Logic Handbook* could serve a useful purpose as a bench book for final year undergraduate project work, where it could well stimulate enquiry into PLD among newcomers with access to more detailed background information.

Mike Barwise



OPEN CHANNEL

Quite a few people have been asking me recently what the advantages and disadvantages of Band III private mobile radio are, compared with cellular telephones. Well, the first thing to do is simply to look at it.

Private mobile radio (PMR) is meant to be used specifically by selected groups of users — *closed user groups* if you want to give them a name — in which each member of the group needs to be in frequent contact with other members and the group's base.

Now, this doesn't have to be on the old 405-line television frequencies of Band III. There are already about 400,000 PMR users who operate at a number of other frequencies through the electromagnetic spectrum. It just happens that Band III, which was in use for TV until 1987, is now free. Further, technology has advanced somewhat recently and by borrowing a few of the tricks from cellular radio systems, PMR at Band III offers significantly improved features, facilities, performance and quality over PMR of the past.

In the past PMR has suffered drastically through a shortage of air space and was (and still is) often congested, mainly because fixed channels are allocated to particular equipment and if an allocated channel is busy because someone else is using it then your equipment can't. Cellular techniques of random allocations of channels as and when required give significant improvements in air space efficiency. For example, if one channel is busy, your equipment tries on another channel. If that's busy, too, the equipment tries another channel and so on. It's these efficiency improvements which give Band III PMR its main advantage over older PMR systems.

Is this any advantage over cellular telephones? Well, it depends what you want. A cellular telephone in every one of your company's fleet of cars will give you every bit as good inter-staff communications of course. Nobody's denying that. What it will also give you, however, is an extremely large telephone bill. With cellular telephones, as well as phoning the office your staff can phone home, phone the bookies, phone the takeaway, phone the boyfriend/girlfriend, phone Auntie Ethel in Australia and Uncle Tom Cobbley and all. If you don't think that's true of your staff, some research undertaken by Philips has shown the average customer call charge is over £500 per annum — and do you have any *real* reason to believe your staff are better than average?

PMR means that staff can only call each other if you are in a closed user group, or base. PMR gives a different style of mobile communications, which is more suited to some needs than cellular radio.

Out Of The Frying Pan . . .

Talking of cellular telephones, the first offspring of the second-generation of cellphones (that is pan-European digital cellular devices) look set to be up and running shortly. The ECR 900 consortium of by AEG, Alcatel and Nokia — three big European names in cellular equipment — has hinted that orders will probably be placed by the end of 1988 across the continent, including UK.

The system is scheduled for start-up by the early part of the next decade and will allow mobile users to roam anywhere in Europe, still able to make and receive calls. The digital aspect of the system will mean higher speech quality, good data communications facilities, greater air space and (so I am led to believe) lower cost. I will wait to have this latter feature qualified.

Bug Off

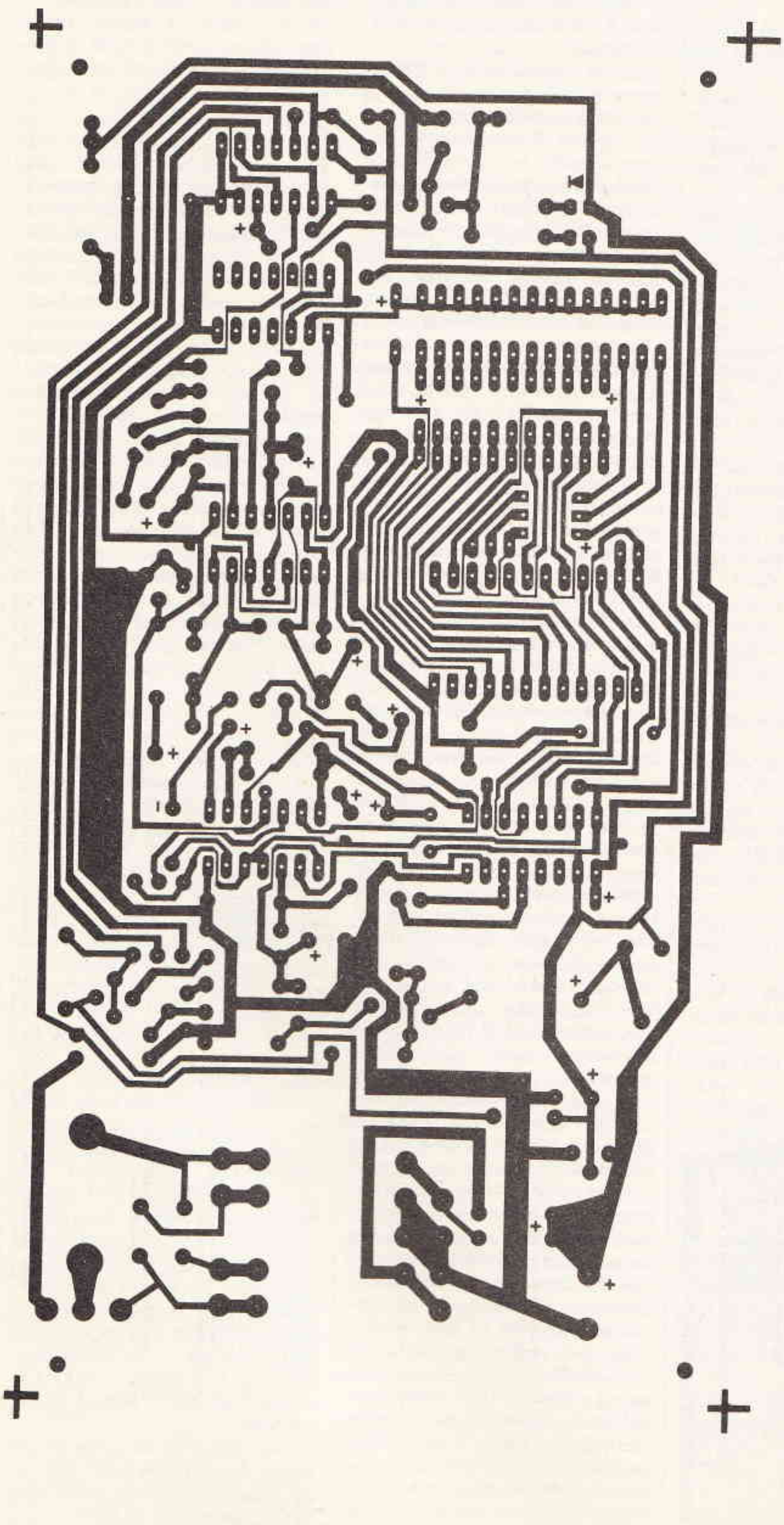
The UK's first prosecution for industrial espionage phone bugging occurred a little while back. Without going into too much detail, Dixon's, the high street retail organisation, hired a private detective to spy on former employees who left to go to work for rival firm, Comet. The private detective did what, I suspect, most private detectives would do in the circumstances and bugged their private phones. Unfortunately for him, he got caught and is now serving his time to prove it.

Industrial espionage aside, which can and does occur, the case has caused concern at the Home Office. The judge stated that although the tapping of telephone lines is against the law, there seems to be no Act which makes listening in to cellular telephone conversations illegal. He is also reported to have said that companies were perfectly entitled to engage in industrial espionage — including electronic eavesdropping — as long as phone lines aren't tapped in the process!

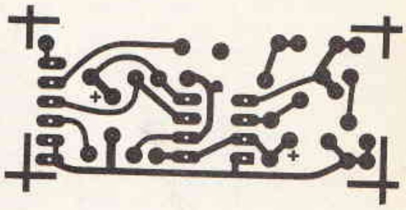
One presumes the judge knows his law. I imagine the department at the Home Office which looks after this is now in a bit of a tiz.

Keith Brindley

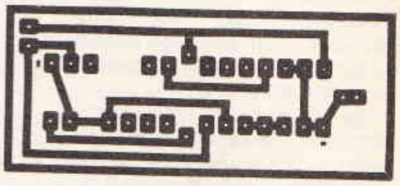
PCB FOIL PATTERNS



The Bar Code Lock main board

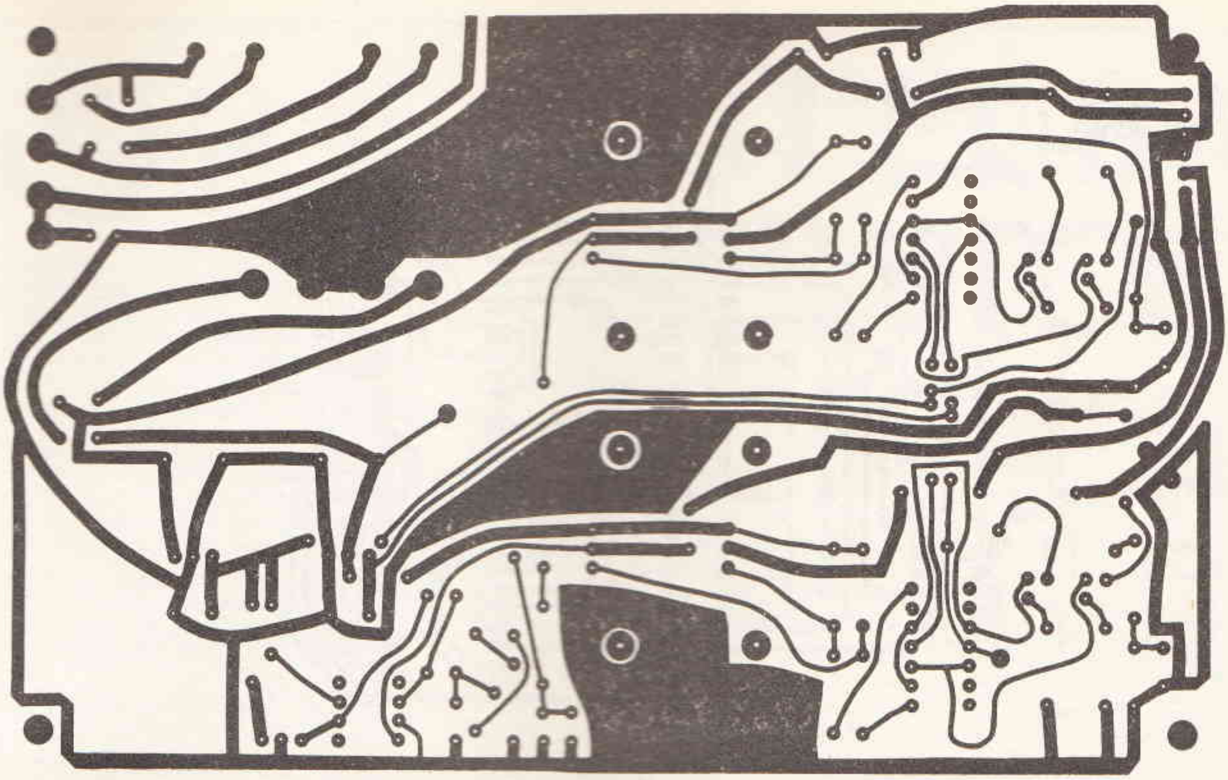


The Bar Code Lock pre-amp board

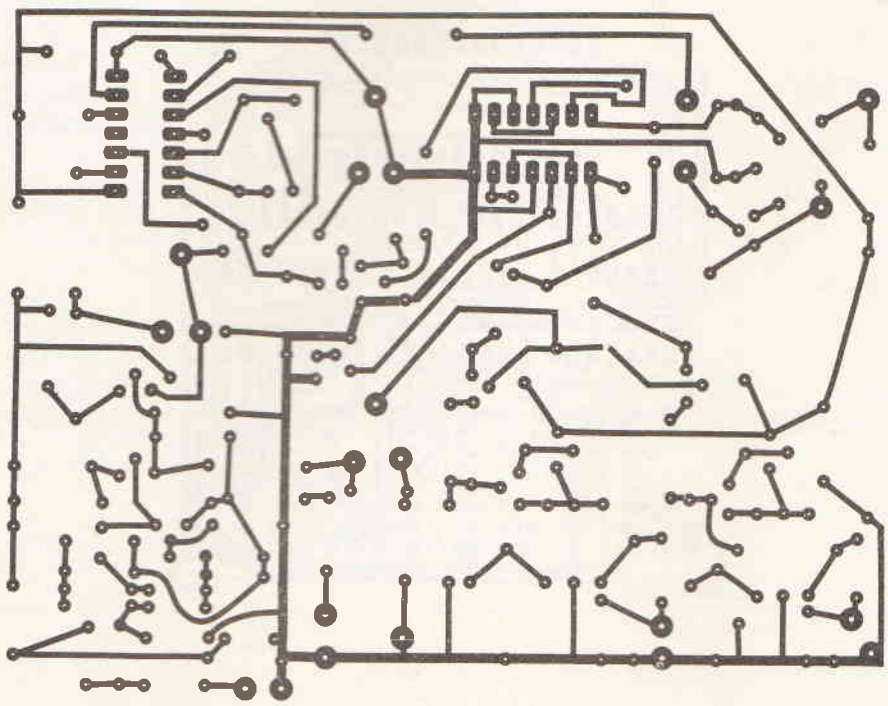


The Logic Probe PCB foil pattern

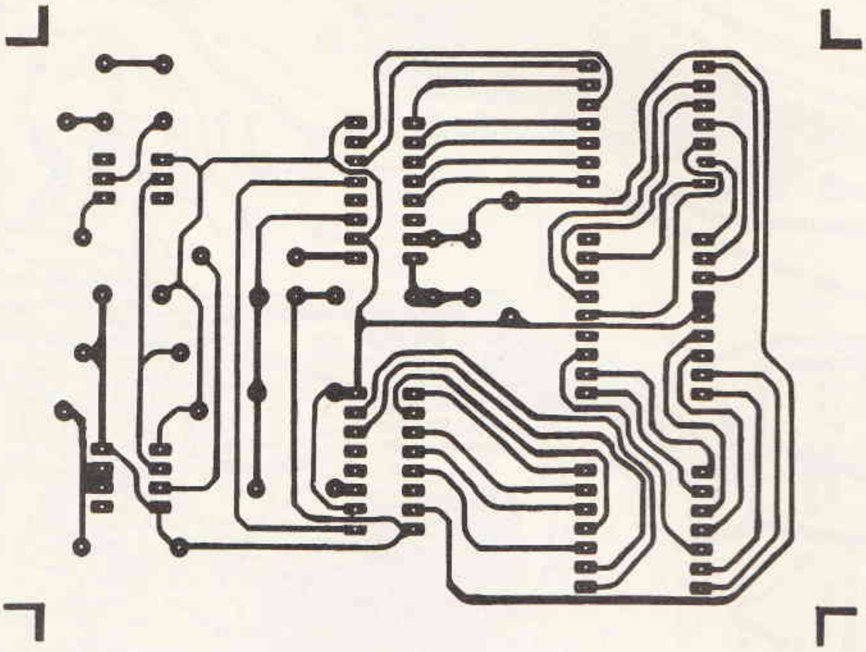
The example bar code



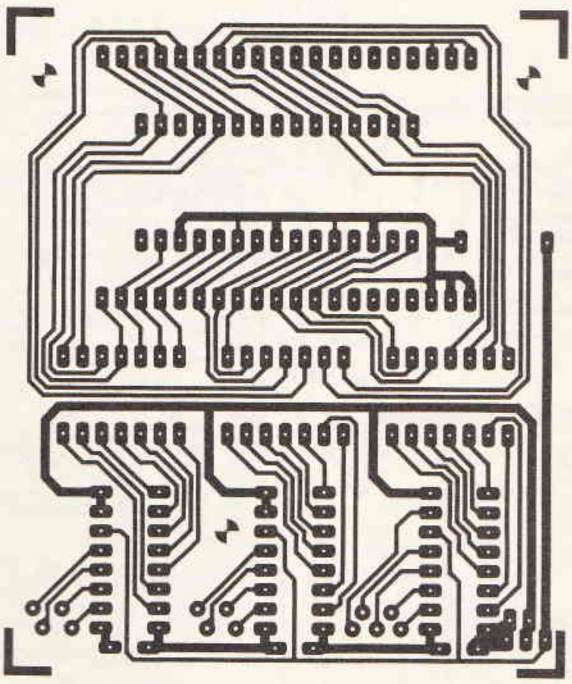
The Analogue Computer power supply board



The updated FM Tuner Decoder board



The Bell Boy foil pattern



The Breath Rate Meter display board

OOPS!

EEG Monitor (September 1987)
In Fig.3a the pins of IC1 connected to the power rails are shown swapped around. In Fig.4a R7 is unlabelled and is between C3 and C6. In Fig.5 C20 should be £10 and R18 is unlabelled. It lies between R17 and R19.

ETI Concept (October 1987)
The Power Board parts list wrongly lists R6 as 270R. This should be 270k. Also, note that the power board's 0V rail must *not* be connected to Earth or the 0V rail of the CPU board.

Printer Buffer (November 1987)
The software for the EPROM had three errors listed. The byte at 039A should read 20, at 039B 14 and at 0492 30. All numbers are in Hex.

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 1N4148's anyway). In the text the reference to zener diode D5 should read zener diode ZD1.

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.

Clean Up Campaign (January 1988)
In the component overlay (Fig. 3) ZD1 is incorrectly orientated. The positive terminal should be the southern end.

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 Outport 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.

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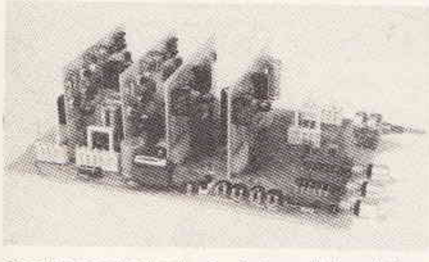

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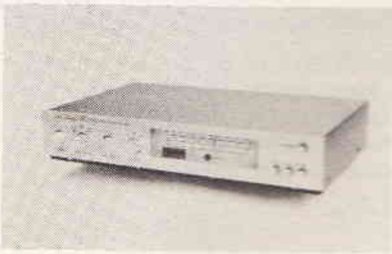

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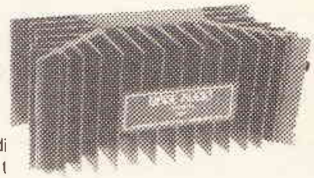

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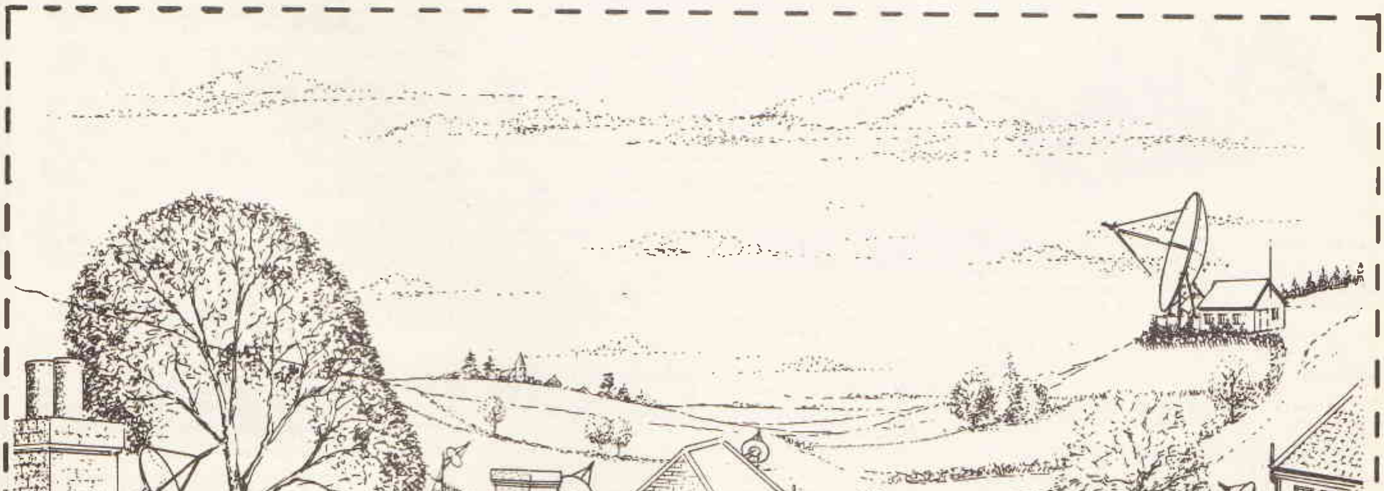
Readers who missed part one of this competition can obtain a valid part 1 coupon by sending a SAE to ETI at this address.



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- Ultra low noise LNB

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RULES

1. All entries must be on the published coupons or on photocopies accompanied by the published tokens.
2. Entry is open to all UK resident readers of ETI except employees and their families of Argus Specialist Publications, Pace Micro Technology and Vivor Satellite Systems.
3. All entries must be received at the ETI Editorial Offices by July 1st 1988.
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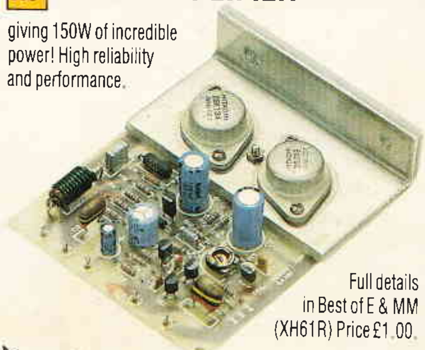

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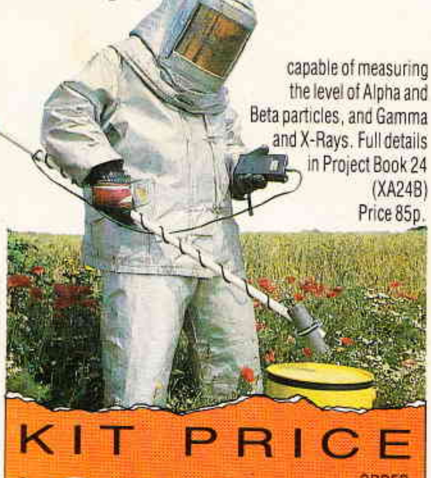

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