

EVERYDAY

JUNE 1996

PRACTICAL

# ELECTRONICS

FULLY S.O.R. £2.45

**FREE!** *INSIDE*  
**GREENWELD**  
**SPRING CATALOGUE**  
**SUPPLEMENT**

**ULTRA FAST  
FREQUENCY  
GENERATOR/COUNTER**

**'SCOPES**

*Insight into this versatile  
piece of test gear*

**TELEPHONE LINK**

*Build yourself a simple  
phone for home,  
workshop, etc.*

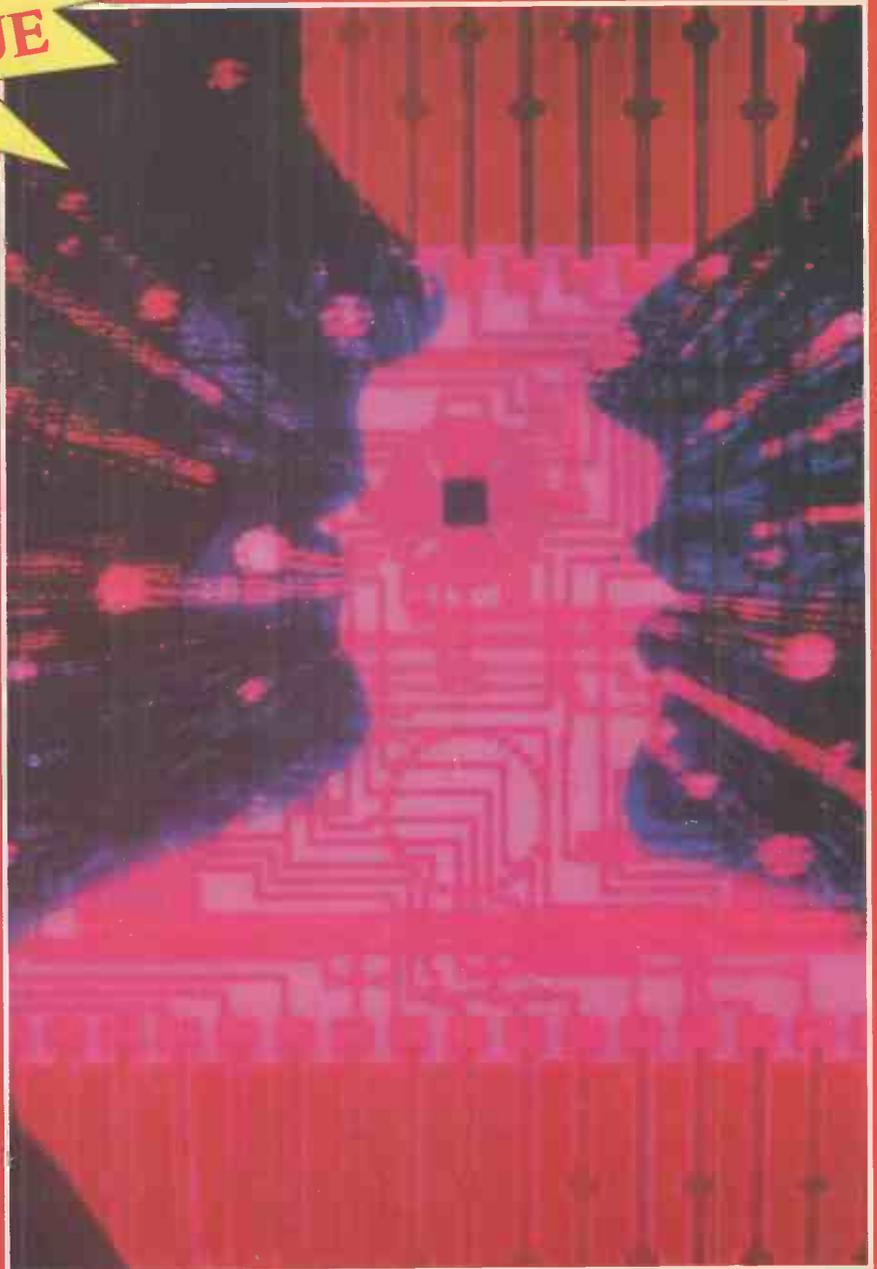
**SARAH'S LIGHT**

*Toddler's cot light -  
banish fears of the dark*

**VU DISPLAY AND**

**ALARM**

*Watch  
out for  
sound  
overload*



**THE NO. 1** INDEPENDENT  
MAGAZINE FOR  
ELECTRONICS TECHNOLOGY  
& COMPUTER PROJECTS



**SURVEILLANCE TELESCOPE** Superb Russian zoom telescope adjustable from 15x to 60x complete with metal tripod (impossible to use without this on the higher settings) 66mm lens, leather carrying case £149 ref BAR69

**RADIATION DETECTOR SYSTEM** Designed to be wall mounted and connected into a PC, ideal for remote monitoring, whole building coverage etc. Complete with detector, cable and software. £19.95 ref BAR75.

**WIRELESS VIDEO BUG KIT** Transmits video and audio signals from a miniature CCTV camera (included) to any standard television! All the components including a PP3 battery will fit into a cigarette packet with the lens requiring a hole about 3mm diameter. Supplied with telescopic aerial but a piece of wire about 4" long will still give a range of up to 100 metres. A single PP3 will probably give less than 1 hours use. £99 REF EP79. (probably not licensable!)

**CCTV CAMERA MODULES** 46X70X29mm, 30 grams, 12v 100mA. auto electronic shutter, 3.6mm F2 lens, CCIR, 512x492 pixels, video output is 1v p-p (75 ohm). Works directly into a scarf or video input on a tv or video. IR sensitive. £79.95 ref EF137.

**IR LAMP KIT** Suitable for the above camera enables the camera to be used in total darkness! £5.99 ref EF138.

**REMOTE CONTROL/TANDBATA TD1400 MODEM/VIEWDATA** Complete system comprising 1200/75 modem, auto dialler, infra red remote keyboard, (could be adapted for PC use?) psu, UHF and RGB output, phone lead, RS232 output, composite output. Absolute bargain for parts alone! £9.95 ref BAR33.

## 9 WATT CHIEFTAN TANK LASERS

Double beam units designed to fit in the gun barrel of a tank, each unit has two semi conductor lasers and motor drive units for alignment. 7 mile range, full circuit diagrams, new price £50,000? us? £349. Each unit has two gallium Arsenide injection lasers, 1 x 9 watt, 1 x 3 watt, 900nm wavelength, 28vdc, 600hz pulse frequency. The units also contain an electronic receiver to detect reflected signals from targets, five or more units £299 ea. £349 for one. Ref LOT4.

**TOWAY MIRROR KIT** Includes special adhesive film to make two way mirror(s) up to 60"x20". (glass not included) includes full instructions. £12 ref TW1.

## NEW HIGH POWER RF TRANSMITTERS

**AMPLIFIERS** Assembled PCB transmitters, 4 types available, 12.6vdc 90 watt 1.5-30mhz 75 ohm in/out FM/AM £75 ref RF1  
12.6vdc 40 watt 50-200mhz 50 ohm in/out FM/AM £65 ref RF2  
28vdc 125 watt 1.5-30mhz 75 ohm in/out FM/AM £85 ref RF3  
28vdc 100 watt 50-200mhz 50 ohm in/out FM/AM £75 ref RF4  
A heat sink will be required, ring for price and availability.

If you intend using these as audio transmitters you will need a also need a preamp. Complex module available at £40 ref RF5.

**COMPUTER/WORKSHOP/HI-FI RCB UNITS** Complete protection from faulty equipment for everybody! Inline unit fits in standard IEC lead (extends it by 750mm), fitted in less than 10 seconds, reset/test button, 10A rating. £9 each REF MMS.

## RADIO CONTROLLED CARS FROM £6 EACH!!!

All returns from famous manufacturer, 3 types available, single channel (left, right, forwards, backwards) £6 ref LOT1. Two channel with more features £12 ref LOT2. Two channel proportional (plug in crystals etc) £35 ref LOT3-

## THOUSANDS AVAILABLE RING/FAX FOR DETAILS!

**MAGNETIC CARD READERS** (Swipes) £9.95 Cased with flyleads, designed to read standard credit cards! they have 3 wires coming out of the head so they may write as well! complete with control electronics PCB, just £9.95 ref BAR31

**WANT TO MAKE SOME MONEY? STUCK FOR AN IDEA?** We have collated 140 business manuals that give you information on setting up different businesses, you peruse these at your leisure using the text editor on your PC. Also included is the certificate enabling you to reproduce (and sell) the manuals as much as you like! £14 ref EP74

**PANORAMIC CAMERA OFFER** Takes double width photographs using standard 35mm film. Use in horizontal or vertical mode. Complete with strap £7.99 ref BAR1

**COIN OPERATED TIMER KIT** Complete with coin slot mechanism, adjustable time delay, relay output, put a coin slot on anything you like! TV's, videos, fridges, drinks cupboards, HI-FI, takes 50p's and £1 coins DC operated, price just £7.99 ref BAR27.

**ZENTH 900 X MAGNIFICATION MICROSCOPE** Zoom, metal construction, built in light, shrimp farm, group viewing screen, lots of accessories. £29 ref ANAYLT.

**AA NICAD PACK** Pack of 4 tagged AA nicads £2.99 ref BAR34

**PLASMA SCREENS** 22x310mm, no data hence £4.99 ref BAR67

**NIGHTSIGHTS** Model TZS4 with infra red illuminator, views up to 75 metres in full darkness in infrared mode, 150m range, 45mm lens, 13 deg angle of view, focussing range 1.5m to infinity. 2 AA batteries required. 950g weight. £199 ref BAR61. 1 years warranty

**LIQUID CRYSTAL DISPLAYS** Bargain prices, 16 character 2 line, 99x24mm £2.99 ref SM1623A  
20 character 2 line, 83x19mm £3.99 ref SM2020A  
16 character 4 line, 62x25mm £5.99 ref SM1640A

**TAL-1 110MM NEWTONIAN REFLECTOR TELESCOPE** Russian. Superb astronomical scope, everything you need for some serious star gazing! up to 169x magnification. Send or fax for further details £249 ref TAL-1

**GOT AN EXPENSIVE BIKE?** You need one of our bottle alarms, they look like a standard water bottle, but open the top, insert a key to activate a motion sensor alarm built inside. Fits all standard bottle cameras, supplied with two keys. SALE PRICE £7.99 REF SA32.

**GOT AN EXPENSIVE ANYTHING?** You need one of our cased vibration alarms, keyswitch operated, fully cased just to fit it to anything from videos to caravans, provides a years protection from 1

## WOLVERHAMPTON BRANCH NOW OPEN AT WORCESTER ST W'HAMPTON TEL 01902 22039

PP3 battery, UK made. SALE PRICE £4.99 REF SA33.

**DAMAGED ANSWER PHONES** These are probably beyond repair so just £4.99 each. BT response 200 machines. REF SA30.

**COMPUTER DISC CLEAROUT** We are left with a lot of software packs that need clearing so we are selling at disc value only! 50 discs for £4, that's just 8p each!! (our choice of discs) £4 ref EP66

**IBM PS2 MODEL 160Z CASE AND POWER SUPPLY** Complete with fan etc and 200 watt power supply. £9.95 ref EP67

**DELL PC POWER SUPPLIES** 145 watt, +5, -5, +12, -12, 150x150x85mm complete with switch, flyleads and IEC socket SALE PRICE £9.99 ref EP55

**1.44 DISC DRIVES** Standard PC 3.5" drives but returns so they will need attention SALE PRICE £4.99 ref EP68

**1.2 DISC DRIVES** Standard 5.25" drives but returns so they will need attention SALE PRICE NOW ONLY £3.50 ref EP69

**PP3 NICADS** Unused but some storage marks. £4.99 ref EP52

**DELL PC POWER SUPPLIES** (Customer returns) Standard PC psu's complete with fly leads, case and fan, +12v, -12v, +5v, -5v SALE PRICE £1.99 EACH worth it for the bits alone! ref DL1. TRADE PACK OF 20 £29.95 Ref DL2.

**GAS HOBS AND OVENS** Brand new gas appliances, perfect for small flats etc. Basic 3 burner hob SALE PRICE £24.99 ref EP72. Basic small built in oven SALE PRICE £79 ref EP73

**RED EYE SECURITY PROTECTOR** 1,000 watt outdoor PIR switch SALE PRICE £6.99 ref EP57

**ENERGY BANK KIT** 100 6"x6" 6v 100mA panels, 100 diodes, connection details etc. £69.95 ref EF112.

**PASTEL ACCOUNTS SOFTWARE**, does everything for all sizes of businesses, includes word processor, report writer, windowing, networkable up to 10 stations, multiple cash books etc. 200 page comprehensive manual. 90 days free technical support (0345-326009 try before you buy!) Current retail price is £129, SALE PRICE £9.95 ref SA12. SAVE £120!!

**COMPLETE PC 200 WATT UPS SYSTEM** Top of the range UPS system providing protection for your computer system and valuable software against mains power fluctuations and cuts. New and boxed, UK made Provides up to 5 mins running time in the event of complete power failure to allow you to run your system down correctly. LAST FEW TO CLEAR AT £49 SAVE £30 ref LOT61

**BIG BROTHER PSU** Cased PSU, 6v 2A output, 2m o/p lead, 1.5m input lead, UK made, 220v. SALE PRICE £4.99 REF EP7



Check out our  
**WEB SITE**

<http://www.pavilion.co.uk/bull-electrical>

**RACAL MODEM BONANZA!** 1 Rascal MPS1223 1200/75 modem, telephone lead, mains lead, manual and comms software, the cheapest way onto the net! all this for just £13 ref DEC13.

**4.6mw LASER POINTER, BRAND NEW MODEL NOW IN STOCK!** supplied in fully built form (looks like a nice pen) complete with handy pocket clip (which also acts as the on/off switch.) About 60 metres range! Runs on 2 AAA batteries. Produces thin red beam ideal for levels, gun sights, experiments etc. just £39.95 ref DEC49 TRADE PRICE £28 MIN 10 PIECES

**BULL TENS UNIT** Fully built and tested TENS (Transcutaneous Electrical Nerve Stimulation) unit, complete with electrodes and full instructions. TENS is used for the relief of pain etc in up to 70% of sufferers. Drug free pain relief, safe and easy to use, can be used in conjunction with analgesics etc. £49 Ref TEN1

**RUSSIAN MONOCULARS** Amazing 20 times magnification, coated lenses, carrying case and shoulder strap £29.95 REF BAR73

**PC PAL VGA TO TV CONVERTER** Converts a colour TV into a basic VGA screen. Complete with built in psu, lead and s/w are. Ideal for laptops or a cheap upgrade. Supplied in kit form for home assembly. SALE PRICE £25 REF SA34

**EMERGENCY LIGHTING UNIT** Complete unit with 2 double bulb floodlights, built in charger and auto switch. Fully cased! 6v 8AH lead acid req'd. (secondhand) £4 ref MAG4P11.

**YUASHA SEALED LEAD ACID BATTERIES** Two sizes currently available this month. 12v 15AH at £18 ref LOT8 and 6v 10AH (suitable for emergency lights above) at just £6 ref LOT7.

**ELECTRIC CAR WINDOW DE-ICERS** Complete with cable, plug etc SALE PRICE JUST £4.99 REF SA28

**AUTO SUNCHARGER** 155x300mm solar panel with diode and 3 metre lead fitted with a cigar plug. 12v 2watt. £8.99 REF SA25.

**ECLATRON FLASH TUBE** As used in police car flashing lights etc, full spec supplied, 60-100 flashes a min. £6.99 REF SA15B.

\*SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

## BULL ELECTRICAL

250 PORTLAND ROAD, HOVE, SUSSEX

BN3 5QT. (ESTABLISHED 50 YEARS)

MAIL ORDER TERMS: CASH, PO OR CHEQUE

WITH ORDER PLUS £3 P & P PLUS VAT

PLEASE ALLOW 7-10 DAYS FOR DELIVERY/PHONE ORDERS

WELCOME (ACCESS VISA, SWITCH, AMERICAN EXPRESS)

TEL: 01273 203500

FAX 01273 323077

E-mail [bull@pavilion.co.uk](mailto:bull@pavilion.co.uk)

**24v AC 96WATT** Cased power supply. New. £9.99 REF SA40

**MICRODRIVE STRIPPERS** Small cased tape drives ideal for stripping, lots of useful goodies including a smart case, and lots of components. SALE PRICE JUST £4.99 FOR FIVE REF SA26

**SOLAR POWER LAB SPECIAL** You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire, buzzer, switch plus 1 relay of motor. Superb value kit SALE PRICE JUST £4.99 REF SA27

**RGB/CGA/EGA/TLT COLOUR MONITORS** 12" in good condition. Back anodised metal case. SALE PRICE £49 REF SA16B

**PLUG IN ACORN PSU** 19v AC 14w. £2.99 REF MAG3P10

**13.8V 1.9A PSU** cased with leads. Just £9.99 REF MAG10P3

**UNIVERSAL SPEED CONTROLLER KIT** Designed by us for the C5 motor but ok for any 12v motor up to 30A. Complete with PCB etc. A heat sink may be required. £17.00 REF: MAG17

**PHONE CABLE AND COMPUTER COMMUNICATIONS PACK** Kit contains 100m of 6 core cable, 100 cable clips, 2 line drivers with RS232 interfaces and all connectors etc. Ideal low cost method of communicating between PCs over long distance utilizing the serial ports. Complete kit £8.99. Ref comp1.

**VIEWDATA SYSTEMS** made by Phillips, complete with internal 1200/75 modem, keyboard, psu etc RGB and composite outputs, menu driven, autodialler etc. SALE PRICE £12.99 REF SA18

**AIR RIFLES** 22As used by the Chinese army for training purposes, so there is a lot about! £39.95 Ref EF78. 500 pellets £4.50 ref EF80.

**PLUG IN POWER SUPPLY SALE FROM £1.50** Plugs in to 13A socket with output lead, three types available, 9vdc 150mA £1.50 ref SA19, 9vdc 200mA £2.00 ref SA20, 6.5vdc 500mA £2 ref SA21.

**VIDEO SENDER UNIT.** Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 100' range! (tune TV to a spare channel) 12V DC op. Price is £15 REF: MAG15 12v psu is £5 extra REF: MAG5P2

**"MINUTE RADIO TRANSCENERS** A pair of walkie talkies with a range up to 2kmin open country. Units measure 22x52x155mm. Including cases and earpieces. 2x2P3 req'd. £30.00 pr. REF: MAG30

**"FM TRANSMITTER KIT** housed in a standard working 13A adapter!! the bug runs directly off the mains so lasts forever why pay £700? or price is £15 REF: EF62 (kit) Transmits to any FM radio.

**"FM BUG BUILT AND TESTED** superior design to kit. Supplied to detective agencies, 9v battery req'd. £14 REF: MAG14

**TALKING COINBOX STRIPPER COMPLETE WITH COIN SLOT MECHANISMS** originally made to retail at £79 each, these units are designed to convert an ordinary phone into a payphone. The units have the locks missing and sometimes broken hinges. However they can be adapted for their original use or for something else?? SALE PRICE JUST £2.50 REF SA23

**GAT AIR PISTOL PACK** Complete with pistol, darts and pellets £12.95 Ref EF82B extra pellets (500) £4.50 ref EF80.

**6"x12" AMORPHOUS SOLAR PANEL** 12v 155x310mm 130mA. SALE PRICE £4.99 REF SA24.

**FIBRE OPTIC CABLE BUMPER PACK** 10 metres for £4.99 ref MAGSP13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

MIXED GOODIES BOX OF  
MIXED COMPONENTS WEIGHING 2 KILOS  
YOURS FOR JUST £5.99

**4X28 TELESCOPIC SIGHTS** Suitable for all air rifles, ground lenses, good light gathering properties. £19.95 ref R/7.

**RATTLE BACKS** Interesting things these, small piece of solid perspex like material that if you try to spin it on the desk it only spins one way! in fact if you spin it the 'wrong' way it stops of its own accord and go's back the other way! £1.99 ref GIJ01.

**GYROSCOPES** Remember these? well we have found a company that still manufactures these popular scientific toys, perfect gift or for educational use etc. £6 ref EP70

**HYPOTHERMIA SPACE BLANKET** 215x150cm aluminised foil blanket, reflects more than 90% of body heat. Also suitable for the construction of two way mirrors! £3.99 each ref O/L04.1

**LENSTATIC RANGER COMPASS** Oil filled capsule, strong metal case, large luminous points. Sight line with magnifying viewer. 50mm dia, 86gm. £10.99 ref OK604.

**RECHARGE ORDINARY BATTERIES UP TO 10 TIMES!** With the Battery Wizard! Uses the latest pulse wave charge system to charge all popular brands of ordinary batteries AAA, AA, C, D, four at a time! Led system shows when batteries are charged, automatically rejects unsuitable cells, complete with mains adaptor. BS approved. Price is £21.95 ref EP31.

**TALKING WATCH** Yes, it actually tells you the time at the press of a button. Also features a voice alarm that wakes you up and tells you what the time is! Lithium cell included. £7.99 ref EP26.

**PHOTOGRAPHIC RADAR TRAPS CAN COST YOU YOUR LICENCE!** The new multiband 2000 radar detector can prevent even the most responsible of drivers from losing their licence! Adjustable audible alarm with 8 flashing LEDs gives instant warning of radar zones. Detects X, K, and Ka bands, 3 mile range, 'over the hill' 'around bends' and 'rear trap' facilities, micro size just 4.25"x2.5"x.75". Can pay for itself in just one day! £79.95 ref EP3.

**SANYO NICAD PACKS** 120mmx14mm 4.8v 270 mA/h suitable for cordless phones etc. Pack of 2 just £5 ref EP78

**3" DISCS** As used on older Amstrad machines, Spectrum plus3's etc £3 each ref BAR400.

**STEREO MICROSCOPES BACK IN STOCK** Russian, 200x complete with lenses, lights, filters etc very comprehensive microscope that would normally be around the £700 mark, our price is just £299 (full money back guarantee) full details in catalogue. Ref 95/300.

## WE BUY SURPLUS STOCK FOR CASH

BUYERS DIRECT LINE 0860 425692

FREE CATALOGUE

100 PAGE CATALOGUE NOW

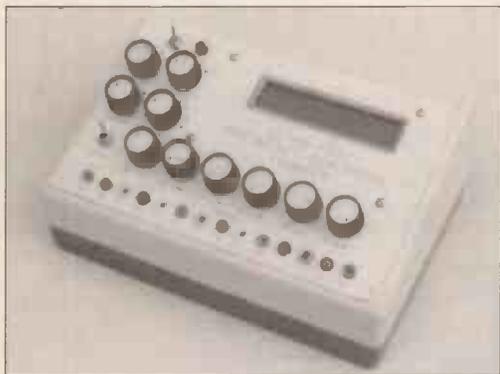
AVAILABLE, 50P STAMP OR FREE

ON REQUEST WITH ORDER.



## Projects

- SARAH'S LIGHT** by Steve Aze 422  
Banish fears of the dark by giving your child control over it
- ULTRA-FAST FREQUENCY GENERATOR AND COUNTER - 1** 434  
by John Becker  
Build this multi-frequency item of test gear and greatly enhance your workshop facilities
- VU DISPLAY AND ALARM** by Max Horsey 444  
Simple audio-visual stereo monitoring. A *Teach-In '96* project
- PULSTAR** by Phil Green 456  
Model radio controller servo alignment without tears!
- HOME TELEPHONE LINK** by Michael McLoughlin 468  
It's good to talk - especially if the chat is free, which it is with this personal home phone link



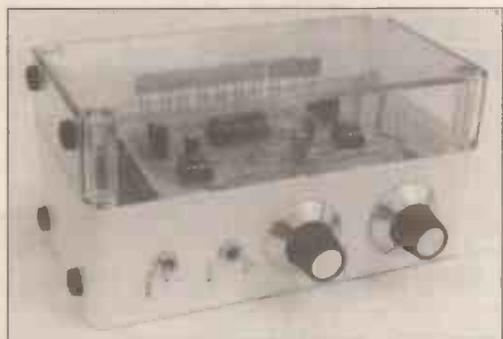
## Series

- INTERFACE** by Robert Penfold 440  
Inputting parallel data into a PC's serial port via a 6504 UART.
- TEACH-IN '96 - A Guide to Modular Circuit Design - 8** 450  
by Max Horsey  
Showing how simple modules can be used as the building blocks for larger designs. Signal mixing, position-to-voltage sensing and VU display chips
- MORE SCOPE FOR GOOD MEASUREMENTS - 1** 462  
by Roy Bebbington  
Don't be blinded by technology, you can use it to help you see better - especially if it's an oscilloscope!
- CIRCUIT SURGERY** by Alan Winstanley 476  
555 astable - fun with!; different strokes; Wheatstone's origins, relay contact suppression; Class act
- AMATEUR RADIO** by Tony Smith G4FAI 484  
EMC and kits; the Amateur's Code; Megs Morse tuition; ISWL new publication



## Features

- EDITORIAL** 421
- NEW TECHNOLOGY UPDATE** by Ian Poole 428  
Light emitting polymers could produce displays to rival c.r.t.s and l.c.d.s.
- INNOVATIONS** 431  
Everyday news from the world of electronics
- FOX REPORT** by Barry Fox 442  
Tandy Syndrome and the fax conundrum; Going, going, gone - American owned British broadcasting?
- BACK ISSUES** Did you miss these? 449
- OHM SWEET OHM** by Max Fidling 454  
Piddles also does a good turn when Max takes on the neighbour's stereo!
- SHOPTALK** with David Barrington 454  
Component buying for *EPE* projects
- MINISCOPE REVIEW** by Robert Penfold 460  
Taking a close look at an l.c.d. digital scope that's ideal for the "home user".
- FAX ON DEMAND** 475  
Need a recent *EPE* article today? Try our new "instant" Service!
- ELECTRONICS VIDEOS** 478  
Our range of educational videos
- DIRECT BOOK SERVICE** 479  
A wide range of technical books available by mail order
- PRINTED CIRCUIT BOARD SERVICE** 482  
PCBs for *EPE* projects - some at "knockdown" prices!
- ADVERTISERS INDEX** 488
- Readers Service • Editorial and Advertisement Departments** 421



© Wimborne Publishing Ltd 1996. Copyright in all drawings, photographs and articles published in **EVERYDAY PRACTICAL ELECTRONICS** is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.

Our July '96 Issue will be published on Friday, 7th June 1996. See page 411 for details.

Surplus always wanted for cash!

# THE ORIGINAL SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always wanted for cash!

## LOW COST PC's -

### SPECIAL BUY AT 286

40Mb HD + 3Mb Ram

LIMITED QUANTITY only of these 12Mhz HI GRADE 286 systems Made in the USA to an industrial specification, the system was designed for total reliability. The compact case houses the motherboard, PSU and EGA video card with single 5 1/4" 1.2 Mb floppy disk drive & Integral 40Mb hard disk drive to the front. Real time clock with battery backup is provided as standard. Supplied in good used condition complete with enhanced keyboard, 640k + 2Mb RAM, DOS 4.01 and 90 DAY Full Guarantee. Ready to Run!  
Order as HIGRADE 286 **ONLY £129.00 (E)**

Optional Filled extras: VGA graphics card £29.00  
1.4Mb 3 1/2" floppy disk drive (instead of 1.2 Mb) £19.95  
NE2000 Ethernet (thick, thin or twisted) network card £39.00

## LOW COST 486DX-33 SYSTEM

Limited quantity of this 2nd user, superb small size desktop unit. Fully featured with standard 3mm connectors 30 & 72 pin. Supplied with keyboard, 4 Mb of RAM, SVGA monitor output, 256k cache and integral 120 Mb IDE drive with single 1.44 Mb 3.5" floppy disk drive. Fully tested and guaranteed.  
Only **£399.00 (E)**  
Many other options available - call for details.

## FLOPPY DISK DRIVES 3 1/2" - 8"

5 1/4" or 3 1/2" from only £18.95!

Massive purchases of standard 5 1/4" and 3 1/2" drives enables us to present prime product at industry beating low prices! All units (unless stated) are BRAND NEW or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. All are IBM-PC compatible (if 3 1/2" supported on your PC).

- 3 1/2" Panasonic JU363/4 720K or equivalent RFE £24.95(B)
- 3 1/2" Mitsubishi MF355C-L 1.4 Meg. Laptops only £25.95(B)
- 3 1/2" Mitsubishi MF355C-D 1.4 Meg. Non laptop £18.95(B)
- 5 1/4" Teac FD-55GR 1.2 Meg (for IBM PCs) RFE £18.95(B)
- 5 1/4" Teac FD-55F-03-U 720K 40/80 (for BBC's etc) RFE £22.95(B)
- 5 1/4" BRAND NEW Mitsubishi MF501B 360K £22.95(B)
- Table top case with integral PSU for HM 5 1/4" Floppy or HD £29.95(B)
- 8" Shugart 800/801 B" SS refurbished & tested £195.00(E)
- 8" Shugart 810 B" SS HH Brand New £195.00(E)
- 8" Shugart 851 B" double sided refurbished & tested £250.00(E)
- Mitsubishi M2894-63 B" double sided NEW £275.00(E)
- Mitsubishi M2896-63-02U 8" DS slimline NEW £285.00(E)
- Dual 8" cased drives with integral power supply 2 Mb £499.00(E)

## HARD DISK DRIVES

End of line purchase scoop! Brand new NEC D2246 B" 85 Mbyte drive with industry standard SMD interface. Ultra hi speed data transfer and access times, replaces Fujitsu equivalent model. Complete with full manual. Only **£299.00** or 2 for **£525.00 (E)**

- 3 1/2" FUJIK-309-26 20mb MFM I/F RFE £59.95(C)
  - 3 1/2" CONNER CP3024 20 mb IDE I/F (or equiv) RFE £59.95(C)
  - 3 1/2" CONNER CP3044 40mb IDE I/F (or equiv) RFE £89.00(C)
  - 3 1/2" RODIME R030575 45mb SCSI I/F (Mac & Acorn) £99.00(C)
  - 3 1/2" WESTERN DIGITAL 850mb IDE I/F Brand New £185.00(C)
  - 5 1/4" MINISCRIPE 3425 20mb MFM I/F (or equiv.) RFE £49.95(C)
  - 5 1/4" SEAGATE ST-238R 30 mb RLL I/F ReLur £69.95(C)
  - 5 1/4" CDC 94205-51 40mb HM MFM I/F RFE tested £69.95(C)
  - 8" FUJITSU M2322K 160Mb SMD I/F RFE tested £195.00(E)
- Hard disc controllers for MFM, IDE, SCSI, RLL etc from £16.95

## THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER CABLE COMPATIBLE

The TELEBOX is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by makers such as MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD etc. The composite video output will also plug directly into most video recorders, allowing reception of TV channels not normally receivable on most television receivers (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. TELEBOX MB covers virtually all television frequencies VHF and UHF including the HYPERBAND as used by most cable TV operators. A composite video output is located on the rear panel for direct connection to most makes of monitor or desktop computer video systems. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard.

- TELEBOX ST for composite video input type monitors £36.95
  - TELEBOX STL as ST but fitted with integral speaker £39.50
  - TELEBOX MB Multiband VHF/UHF/Cable/Hyperband tuner £69.95
- For overseas PAL versions state 5.5 or 6 mHz sound specification.  
\*For cable / hyperband reception Telebox MB should be connected to a cable type service. Shipping code on all Telebox's is (B)

## DC POWER SUPPLIES

Virtually every type of power supply you can imagine. Over 10,000 Power Supplies Ex Stock. Call for info / list.

## IC's - TRANSISTORS - DIODES

OBSELETE - SHORT SUPPLY - BULK

6,000,000 items EX STOCK

For MAJOR SAVINGS - CALL FOR SEMICONDUCTOR HOTLIST

## VIDEO MONITOR SPECIALS

One of the highest specification monitors you will ever see - At this price - Don't miss it!

Mitsubishi FA3415ETKL 14" SVGA Multisync colour monitor with fine 0.28 dot pitch tube and resolution of 1024 x 768. A variety of inputs allows connection to a host of computers including IBM PCs in CGA, EGA, VGA & SVGA modes, BBC, COMMODORE (including Amiga 1200), ARCHIMEDES and APPLE. Many features: Etched landscape, tilt switching and LOW RADIATION MPR specification. Fully guaranteed, supplied in EXCEL-

LENT little used condition. Tilt & Swivel Base £4.75  
VGA cable for IBM PC included.  
External cables for other types of computers CALL

Only £119 (E) Order as MITS-SVGA

## 5000 Monitors from stock !!!

HERCULES, EGA, CGA, VGA, SVGA - 6 to 26" + Many special items - CALL with your needs!

Just In - Microvitec 20" VGA (800 x 600 res.) colour monitors. Good SV condition - from £299 - CALL for Info

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with both RGB and standard composite 15.625 KHz video inputs via SCART socket and separate phono jacks. Integral audio power amp and speaker for all audio visual uses. Will connect direct to Amiga and Atari BBC computers. Ideal for all video monitoring / security applications with direct connection to most colour cameras. High quality with many features such as front concealed fader controls, VCR correction button etc. Good used condition - fully tested - guaranteed  
Dimensions: W14" x H12 1/4" x 15 1/2" D.

Only £95 (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with standard connection 15.625 KHz video input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen burn). In attractive square black plastic case measuring W10" x H10" x 13 1/2" D. 240 V AC mains powered.

Only £79.00 (D)

KME 10" 15M10009 high definition colour monitors with 0.28" dot pitch. Superb clarity and modern styling. Operates from any 15.625 khz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13 1/2" x 12" x 11". Good used condition.

Only £125 (E)

## 20" 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & optional sound input. Attractive leak style case. Perfect for Schools, Shops, Disco, Clubs, etc. In EXCELLENT little used condition with full 90 day guarantee.

20"....£135 22"....£155 26"....£185 (F)

## SPECIAL INTEREST ITEMS

- MITS. FA3445ETKL 14" Industrial spec SVGA monitors £245
- 2Kw to 400 kw - 400 Hz 3 phase power sources - ex stock £750
- Broadcast Electronics Inc FX30 FM exciter 80-108 MHz £750
- Stanelco STA15 15kW RF induction heater system £750
- IBM 8230 Type 1, Token ring base unit driver £950
- IBM 53F5501 Token Ring ICS 20 port lobe modules £750
- IBM MAU Token ring distribution panel 8228-23-5050N £95
- AIM 501 Low distortion Oscillator 9Hz to 330kHz, IEEE £550
- Trend DSA 274 Data Analyser with 6703(2M) 64 Vo £950
- HP APOLLO RXT00 system unit £950
- HP6621A Dual Programmable GPIB PSU 0-7 V 160 watts £1800
- HP6264 Rack mount variable 0-20V @ 20A metered PSU £675
- HP54121A DC to 22 GHz four channel test set £750
- HP7580A A1 8 pen HPGL high speed drum plotter £1850
- Marconi 6310 Programmable 2 to 22 GHz sweep generator £6500
- EG-NG Brokdeal 95035C Precision lock in amp £650
- OTC Ltd 1550 SM Stabilised IR laser calibration source £2250
- Lynch Dynamics 2kW programmable vibration test system £950
- Computer 16mm CTC auto iris lenses 'C' mount - NEW £125
- Kelthley 590 CV capacitor / voltage analyser £3750
- Rocal ICR40 dual 40 channel video recorder system £1200
- ICN 80-250 240v single phase flow solder machine £2200
- ICI R5030UV34 Cleanline ultrasonic cleaning system £1200
- Mann Tally MT645 High speed line printer £1200
- INTEL SBC 486/133SE Multibus 486 system, 8Mb Ram £1150
- Zeta 3220-05 A0 4 pen HPGL fast drum plotters £1450
- Nikon HF-X-11 (Ephiphot) exposure control unit £1450
- Motorola VME Bus Boards & Components List. SAE / CALL £550
- Trio 0-18V dc linear, metered 30 amp bench PSU. New £1950
- Fujitsu M3041R 600 LPM band printer £1250
- Fujitsu M3041D 600 LPM printer with network interface £1250
- Perkin Elmer 2998 Infrared spectrophotometer £3750
- VG Electronics 1035 TELETEXT Decoding Margin Meter £950
- Andrews LARGE 3.1 m Satellite Dish + mount (For Voyager) £375
- Thurlby LA 160B logic analyser £1995
- Sekonic SD 150H 18 channel digital hybrid card recorder £575
- Densel MUD 0185AH 1Kva UPS system with batts NEW £485
- System Video 1152 PAL waveform monitor £300
- Test Lab - 2 mtr square quietised acoustic test cabinets £650
- Kenwood 9601 PAL Vectorscope - NEW

Please call for further details on the above items



## 19" RACK CABINETS

Superb quality 6 foot 40U Virtually New, Ultra Smart Less than Half Price!

Top quality 19" rack cabinets made in UK by Optima Enclosures Ltd. Units feature designer, smoked acrylic lockable front door, full height lockable half louvered back door and louvered removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the most versatile we have ever sold. Racks may be stacked side by side and therefore require only two side panels to stand singly or in multiple bays. Overall dimensions are: 77 1/2" H x 32 1/2" D x 22" W. Order as:

- OPT Rack 1 Complete with removable side panels. £335.00 (G)
- OPT Rack 2 Rack, Less side panels £225.00 (G)

## 32U - High Quality - All steel RackCab

Made by Eurocraft Enclosures Ltd to the highest possible spec, rack features all steel construction with removable side, front and back doors. Front and back doors are hinged for easy access and all are lockable with five secure 5 lever barrel locks. The front door is constructed of double walled steel with a 'designer style' smoked acrylic front panel to enable status indicators to be seen through the panel, yet remain unobtrusive. Internally the rack features fully slotted reinforced vertical fixing members to take the heaviest of 19" rack equipment. The two movable vertical fixing struts (extras available) are pre punched for standard 'cage nuts'. A mains distribution panel internally mounted to the bottom rear, provides 8 x IEC 3 pin Euro sockets and 1 x 13 amp 3 pin switched utility socket. Overall ventilation is provided by fully louvered back door and double skinned top section with top and side louvers. The top panel may be removed for fitting of integral fans to the sub plate etc. Other features include: fitted castors and floor levelers, prepunched utility panel at lower rear for cable / connector access etc. Supplied in excellent, slightly used condition with keys. Colour Royal blue. External dimensions mm=1625H x 635D x 603 W. (64" H x 25" D x 23 3/4" W)

Sold at LESS than a third of makers price !!

## A superb buy at only £195.00 (G)

Over 1000 racks - 19" 22" & 24" wide 3 to 44 U high. Available from stock !! Call with your requirements.

## TOUCH SCREEN SYSTEM

The ultimate in 'Touch Screen Technology' made by the experts - MicroTouch - but sold at a price below cost!! System consists of a flat translucent glass laminated panel measuring 29.5 x 23.5 cm connected to an electronic controller PCB. The controller produces a standard serial RS232 or TTL output which continuously gives simple serial data containing positional X & Y co-ordinates as to where a finger is touching the panel - as the finger moves, the data instantly changes. The X & Y information is given at an incredible matrix resolution of 1024 x 1024 positions over the entire screen size !! A host of available translation software enables direct connection to a PC for a myriad of applications including: control panels, pointing devices, POS systems, controllers for the disabled or computer un-trained etc. Imagine using your finger with 'Windows', instead of a mouse !! (a driver is indeed available!) The applications for this amazing product are only limited by your imagination!! Complete system including Controller, Power Supply and Data supplied at an incredible price of only **£145.00 (E)**  
Full MicroTOUCH software support pack and manuals for IBM compatible PC's £29.95 RFE - Tested

## LOW COST RAM & CPU'S

INTEL 'ABOVE' Memory Expansion Board. Full length PC-XT and PC-AT compatible card with 2 Mbytes of memory on board. Card is fully selectable for Expanded or Extended (286 processor and above) memory. Full data and driver disks supplied. RFE. Fully tested and guaranteed. Windows compatible. £59.95(A1)  
Half length 8 bit memory upgrade cards for PC AT XT expands memory either 256k or 512k in 64k steps. May also be used to fill in RAM above 640k DOS limit. Complete with data.  
Order as: XT RAM UG. 256k. £34.95 or 512k £39.95 (A1)

## SIMM SPECIALS

- 1 Mb x 9 SIMM 9 chip 120ns Only £19.50 (A1)
- 1 Mb x 9 SIMM 3 chip 80 ns £23.50 or 70ns £24.95 (A1)
- 1 Mb x 9 SIMM 9 chip 80 ns £22.50 or 70ns £24.00 (A1)
- 4 Mb 70 ns 72 pin SIMM - with parity - Only £95.00 (A1)
- 8 Mb 70 ns 72 pin SIMM - no parity £159.00 (A1)
- INTEL 486-DX33 CPU £55.00 INTEL 486-DX66 CPU £69.00 (A1)

## FANS & BLOWERS

- EPSON D0412 40x40x20 mm 12v DC £7.95 10 / £65
  - PAPST TYPE 612 60x60x25 mm 12v DC £8.95 10 / £75
  - MITSUBISHI MMF-D6D12DL 60x60x25 mm 12v DC £4.95 10 / £42
  - MITSUBISHI MMF-08C12DM 80x80x25 mm 12v DC £5.25 10 / £49
  - MITSUBISHI MMF-09B12DH 92x92x25 mm 12v DC £5.95 10 / £53
  - PANACA 12-3.5 92x92x18 mm 12v DC £7.95 10 / £69
  - EX-EQUIP AC fans. ALL TESTED 120 x 120 x 38 mm specify 110 or 240 v £6.95. 80 x 80 x 38 mm - specify 110 or 240 v £5.95
  - IMHOF B26 1900 rack mt 3U x 19" Blower 110/240v NEW £79.95
- Shipping on all fans (A). Blowers (B). 50,000 Fans Ex Stock CALL

## Issue 13 of Display News now available - send large SAE - PACKED with bargains!



ALL MAIL & OFFICES  
Open Mon-Fri 9.00-5.30  
Dept PE. 32 Blggin Way  
Upper Norwood  
LONDON SE19 3XF

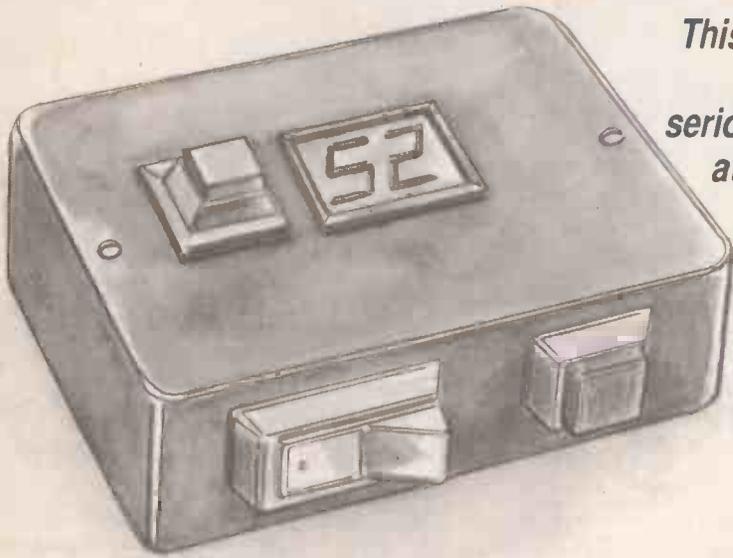
LONDON SHOP  
Open Mon - Sat 9.00 - 5.30  
215 Whitehorse Lane  
South Norwood  
On 68A Bus Route  
N. Thornton Heath &  
Selhurst Park SR Rail Stations

DISTEL ©  
The Original  
FREE On line Database!  
Info on 20,000+ stock items!  
RETURNING SOON!

ALL ENQUIRIES  
**0181 679 4414**  
FAX 0181 679 1927

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bona Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Cheques over £100 are subject to 10 working days clearance. Cash on delivery (A1)=£4.00, (B)=£5.50, (C)=£8.50, (D)=£12.00, (E)=£15.00, (F)=£18.00, (G)=CALL. Allow approx 6 days for shipping - faster CALL. Scotland surcharge CALL. All goods supplied to our Standard Conditions of Sale and unless stated guaranteed for 90 days. All guarantees on a return to base basis. All rights reserved to change prices / specifications without prior notice. Orders subject to stock. Discounts for volume. Top CASH press paid for surplus goods. All trademarks etc acknowledged. © Display Electronics 1996. E & O. 01/5

# GAMES COMPENDIUM



*This simple PIC based project is meant just for fun, not for serious gamblers, it may be used at home or for fund raising for your favourite club or charity. It consists of one of four electronic games, selected on power up.*

*All the games are displayed on a dual seven-segment display. The games are Bingo, Dual Dice, Roulette and Lottery.*

## ADVANCED NiCAD CHARGERS

*Chargers for rechargeable NiCad batteries are fairly common nowadays. Various types are available which accept a variety of cell sizes and capacities, and some are quite sophisticated. The problem is that some are not, especially at the cheaper end of the market. Readers may wonder exactly what current is being pushed into their expensive cells, especially when they start to become warm! Another difficulty occurs when the user forgets to remove the cells on completion of charging, so that they carry on receiving current long after the full charge has been achieved.*

*Two circuits are presented here. The first will provide a precise charging current that can be tailored to suit the cells to be charged, whilst the second has an additional feature for reducing the charge rate after a suitable period to keep the cells fresh and ready for use without damaging them.*

## TWIN-BEAM INFRA-RED ALARM

*Designed to connect to an existing alarm system, or to be used independently, this twin-beam IR detector helps protect against unauthorised entry through doors, windows or passageways – a Teach-In '96 project.*

## THE NET

*The Internet and the World Wide Web get plenty of mentions in the media these days but what are they, how do they work, what is on them, how do you get connected, what can they do for you? Our Internet specialist Alan Winstanley lays it all bare in understandable language, without the hype and padding, in this special feature next month.*

*Alan will also follow up with our own Net Work page every month, looking at what's interesting, new and developing on The Net (including our own EPE Web Site) – with a bias towards the electronics enthusiast of course.*

**EVERYDAY**

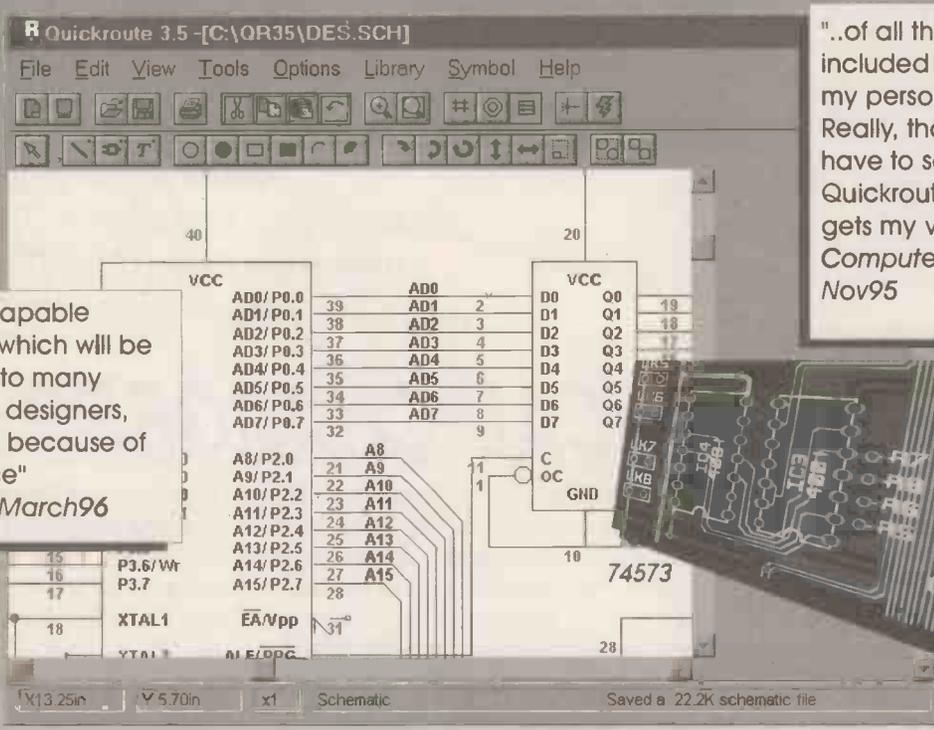
**PRACTICAL**

# ELECTRONICS

**JULY ISSUE ON SALE FRIDAY, JUNE 7**

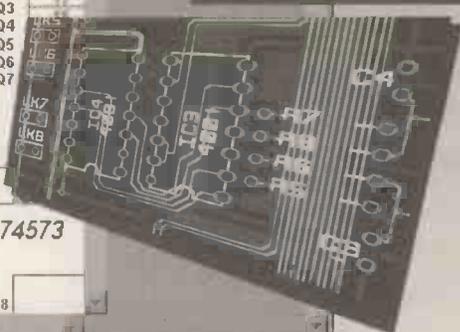


# 3 Good Reasons..



"..a very capable package which will be of interest to many electronic designers, especially because of its low price"  
*CAD/CAM March96*

"..of all the products included here, this is my personal favourite... Really, that's about all I have to say about Quickroute - it certainly gets my vote!"  
*Computer Shopper Nov95*



## ..to choose Quickroute 3.5 Designer (apart from the price £149\*)

### 1 Schematic Capture

Creating schematics is easy in Quickroute 3.5 Designer for Windows. Simply select the symbols you require from the libraries and connect the pins using nets. Junctions are automatically placed for you, and correct connections are indicated visually to ensure accurate schematics. Once you are finished just click on the schematic capture button to turn your schematic into a PCB rats-nest.

### 3 Design Checks

Quickroute 3.5 Designer also includes both design rule checking (DRC) and a simple connectivity check. The connectivity check compares your PCB with the original schematic and gives a pass/fail if there are any differences.

### 2 Assisted PCB Routing **NEW**

Quickroute 3.5 Designer is capable of manual PCB routing or assisted routing using Quickroute's built in RouteASSIST™ technology. To use this simply click on a start and finish node, and RouteASSIST does the rest. Alternatively, you can route manually with rats automatically removed using the 'rat-check' feature.

Quickroute 3.5 Designer costs just £149.00. Post & packing is £5 (UK), £8 (Europe) and £12 (Worldwide). \*V.A.T must be added to the total price. Quickroute 3.5 is also available in two more powerful versions: PRO (£249) and PRO+ (£399). Contact Quickroute Systems Ltd for full details and a brochure or visit our WWW site and download a free demo.



Tel/Fax 0161 449 7101



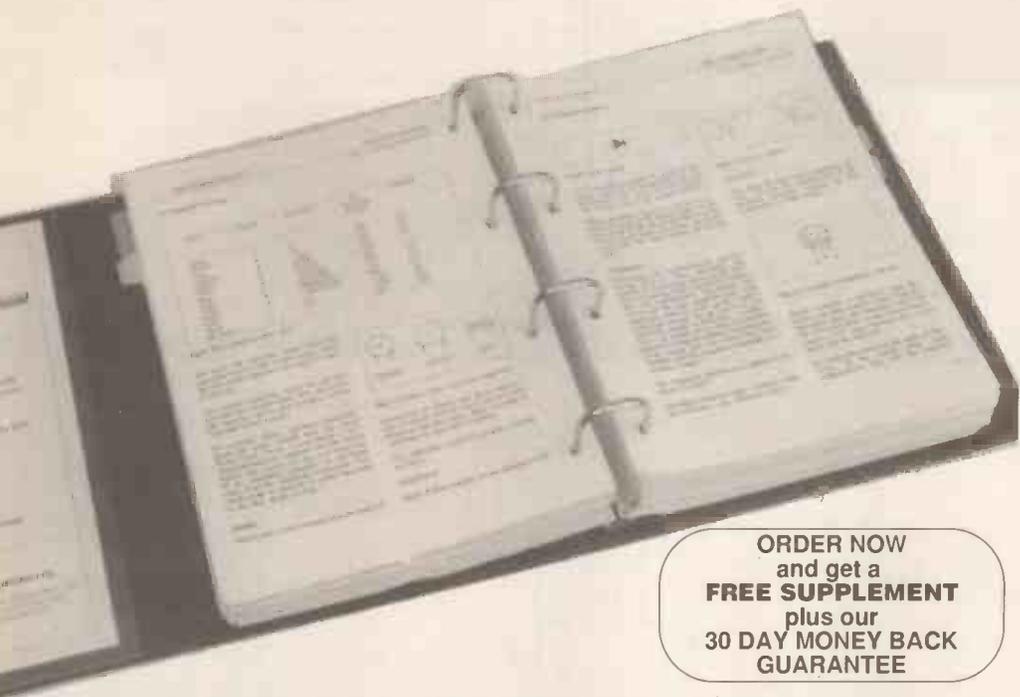
WWW: [www.quickroute.co.uk](http://www.quickroute.co.uk) EMAIL: [info@quicksys.demon.co.uk](mailto:info@quicksys.demon.co.uk)

Quickroute Systems Ltd., 14 Ley Lane, Marple Bridge, Stockport, SK6 5DD, U.K.

Prices and specifications subject to change without notice. All trade marks are acknowledged & respected.

**£149\***

# LEARN ALL ABOUT ELECTRONICS



The essential reference work

- Easy-to-use format
- Clear and simple layout
- Comprehensive subject range
- Regular Supplements
- Sturdy ring-binder
- Projects to build
- Components checklists
- Extensive data tables
- Detailed supply information
- Ready-to-transfer PCBs
- Detailed assembly instructions
- Professionally written

ORDER NOW and get a **FREE SUPPLEMENT** plus our **30 DAY MONEY BACK GUARANTEE**

The revised edition of **The Modern Electronics Base Manual** contains practical, easy-to-follow information on the following subjects:

**BASIC PRINCIPLES:** Symbols, components and their characteristics, active and passive component circuits, power supplies, acoustics and electroacoustics, the workshop, principles of metrology, measuring instruments, digital electronics, analogue electronics, physics for electronics.

**CIRCUITS TO BUILD:** From basic principles to circuit-building, The Modern Electronics Manual and its Supplements describe how to assemble radios, loudspeakers, amplifiers, car projects, computer interfaces, measuring instruments, workshop equipment, security systems, etc.

**ESSENTIAL DATA:** Extensive tables on diodes, transistors, thyristors and triacs, digital and linear i.c.s, microprocessors. The Manual also has an extensive **Glossary**, and covers **Safety, Specialist Vocabulary with Abbreviations and Suppliers**. The most comprehensive reference work ever produced at a price you can afford, the revised edition of **THE MODERN ELECTRONICS MANUAL** provides you with all the essential information you need.

OVER 1,000 A4 loose leaf pages in a sturdy ring binder all for just **£39.95** plus **£5.50** post and packing. Regular Supplements continuously extend the Manual with new material, each Supplement contains approximately 160 pages of information. These are sent about five times a year and cost **£23.50** plus **£2.50** p&p. You can of course return any Supplement (within 10 days) or cancel the Supplements at any time.

## Guarantee

Our 30 day money back guarantee gives you complete peace of mind. If you are not entirely happy with the Manual, for whatever reason, simply return it to us in good condition within 30 days and we will make a full refund of your payment – no small print and no questions asked.

(Overseas buyers do have to pay the postage charge)

Wimborne Publishing Ltd., Dept. Y6  
Allen House, East Borough,  
Wimborne,  
Dorset BH21 1PF  
Tel: 01202 881749 Fax: 01202 841692

**PLEASE** send me **THE MODERN ELECTRONICS MANUAL** plus a **FREE SUPPLEMENT**.

I enclose payment of **£45.45**. I shall also receive the appropriate supplements several times a year. These are billed separately and can be discontinued at any time. Should I decide not to keep the Manual I will return it to you within 30 days for a full refund.

**FULL NAME** .....  
(PLEASE PRINT)

**ADDRESS** .....

..... **POSTCODE** .....

**SIGNATURE** .....

I enclose cheque/PO payable to Wimborne Publishing Ltd.

Please charge my Visa/Mastercard/Access

**Card No.** ..... **Card Ex. Date** .....

## ORDER FORM

Simply complete and return the order form with your payment to the following address:

**Wimborne Publishing Ltd, Dept. Y6  
Allen House, East Borough, Wimborne,  
Dorset BH21 1PF**

**OVERSEAS ORDERS:** All overseas orders must be prepaid and are supplied under a money-back guarantee of satisfaction. If you are not entirely happy with the Manual return it within a month for a refund of the purchase price (you do have to pay the overseas postage). **SEND £39.95 PLUS THE POSTAGE SHOWN BELOW:**

EIRE, SCOTTISH HIGHLANDS and UK ISLANDS	£11
EUROPE (E.E.C. Countries)	AIR MAIL ONLY £20
EUROPE (non E.E.C.)	SURFACE MAIL £20, AIR MAIL £26
U.S.A. & CANADA	SURFACE MAIL £25, AIR MAIL £32
FAR EAST & AUSTRALIA	SURFACE MAIL £31, AIR MAIL £33
REST OF WORLD	SURFACE MAIL £25, AIR MAIL £44

Note surface mail can take over 10 weeks to some parts of the world. Each manual weighs about 4kg including the free supplement when packed.

All payments must be made in £'s Sterling payable to Wimborne Publishing Ltd. We accept Mastercard (Access) and Visa credit cards.

# ELECTRONICS PRINCIPLES 3.0

Electronics Principles 3.0

Basics Dc Theory Ac Theory Transistors Diodes Binary No's Digital Op - Amps

Two's Complement Numbers.

RC Parallel Circuit.

Tri-State Data Latch.

Inverting Operational Amplifier

Resistor 'Rin'.

Resistance

Ohm

kOhm

Mega

Actual Value:

Formatted Value:

Vout = 2V

Rin = 10k  
Rf = 100k  
Gain (Av) = 10

**OP-Amps.**

Inverting

Non-Inverting 1.

Non-Inverting 2.

Dual - Supply.

Differential.

**New Values.**

Vin = 200mV

**Formulae.**

Gain (Av) =  $\frac{R_f}{R_{in}}$

Vout = Input \* Gain (Av)

Calculations Topic Theory Print

Cascade up to sixty-four Windows containing an extended range of 284 interactive analogue and digital electronics topics in full colour. For a demo disk please send £2.00 cheque/postal order or eight first class stamps.

Complete Package Still Only £49.95

## ELECTRONICS TOOLBOX VERSION 3.0

A Windows version of the popular Toolbox Software. Presents over a hundred commonly used formulae in a way that makes calculations easier, thus encouraging experimentation in circuit design. Just select the formula, "pop" in your values and find the result!

Only £19.95

## GCSE MATHEMATICS VERSION 3.0

A series of programs covering all the major topics required by the school syllabus. An easy to use package enabling you to study or revise in what we believe is an interesting and enjoyable way. There are over one hundred and fifty mathematics topics with interactive, full colour graphics, enabling a "learning through doing" approach to encourage experimentation. As used in many schools throughout the UK.

Only £49.95

Also available MATHEMATICS PRINCIPLES 2.0 covers all GCSE topics but without reference to the school syllabus. Particularly useful to mature and overseas students.

EPT Educational Software, Pump House, Lockram Lane, Witham, Essex. UK. CM8 2BJ. Tel/Fax 01376 514008.

E-mail Address, Sales@eptsoft.demon.co.uk. WWW Pages. <http://www.octacon.co.uk/ext/ept/software.htm>

Upgrades, Site Licence details or further information: Please telephone.

Add £2 per order for UK post and packing. Make cheques payable to EPT Educational Software.

Switch, Visa and Mastercard orders accepted - Please give card number, expiry date.

OVERSEAS ORDERS: Add £2.50 postage for countries in the EEC. Outside EEC add £3.50 for Airmail postage.

**MORE AMAZING SURPLUS BARGAINS FROM**

**GREENWELD**  
ELECTRONIC COMPONENTS

27D Park Road  
Southampton SO15 3UQ

Tel 01 703 236363  
Fax 01 703 236307

E-Mail 100014.1463 Internet http://www. herald.co.uk/clients/G/Greenweld.html

Our 200 page 1996 Catalogue is £2.00, but will be sent free with any order.

First time of advertising for all these products - order soon before stocks are sold!

One off and pack prices in bold include VAT; qty prices don't. Number in brackets after order code is approx qty available. P&P £3.00 per order. Pay by cheque, PO, Cash, Book tokens, Visa, Access or Switch. We are open for calls from 8.5.30 Mon-Sat.

**Semiconductors**

**Some 74HC, HCT and F:**

Code	Type	Qty	Price
EX4141	74F157	30	30p
EX4142	74F175	6	35p
EX4124	74HC00	15	15p
EX4125	74HC02	100	15p
EX4126	74HC04	15	15p
EX4127	74HC138	200	19p
EX4128	74HC139	500	19p
EX4129	74HC14	2	16p
EX4130	74HC166	150	50p
EX4131	74HC244	3	30p
EX4140	74HC257	50	36p
EX4132	74HC273	14	30p
EX4133	74HC393	200	24p
EX4134	74HC40106	86	95p
EX4135	74HC4075	25	22p
EX4136	74HC74	300	16p
EX4137	74HC238	2	80p
EX4138	74HC259	65	60p
EX4139	74HC1573	100	50p

**Rectifiers**

EX4108 (300) In line bridge rectifier KBPO4 by G rated 400V 1.5A 3/£1.00; 100+ 2.00

**Transistors**

EX4116 (532) BDX34C Darlington PNP TOP66 case 100V, 10A, 70W. Hfe 750 @ 3A Great Value at 3/£1.00! 100+ 0.20  
EX4120 (800) BC546 NPN TO92 case transistor. Vcb 80V, Ic 100mA, 500mW, 20/£1; Bag of 200 £6.00  
EX4147 (21) TIP135 TOP66 PNP 60V 12A 70W 2/£1.00  
EX4121 (20) 2N3740 TO66 £1.00  
EX4123 (2000) 2N1893 TO39 transistor NPN 120V, 800mW, 0.5A, Hfe 40 @ 150mA List 0.51 Our Price 4/£1.00; 100+ 0.14; 1k+ 0.10

**Triacs**

EX4117 (582) TIC225D 400V 8A TO220 case 4/£2  
EX4118 (500) TIC225M 600V 8A TO220 case 3/£2.00

**Linear ICs**

EX4119 (30) LM2931 TO92 precision voltage reg 5V 150mA 2/£1.00  
EX4122 (1000) LM101AH - TO99 case version of this useful op-amp. List 3.37 With data £1.00  
EX4148 (50) TLC271CP programmable op-amp. 3/£1.00  
EX4114 (47) Z80 DMA £1.00

**Opto**

First, a couple of LCD modules  
EX4096 (29) These are ex-equip. 24x2 dot matrix fitted with short ribbon cable with 14 way header skt. £6.00  
EX4097 (5) As above, but with back light £8.00  
EX4107 (30) BPV14C photodiode £1.00  
EX4113 (500) H11A3 optocoupler. 3/£1.00, 100+ 0.18

**Wire & Cable**

EX6824 (12) Heavy duty (40/0.2) red and black wire about 3m long, fitted one end with bullet plug and receptacle to open end/bullet. There's also another short piece of flex with in-line weatherproof blade fuseholder with 15A fuse. £1.50

**Hardware**

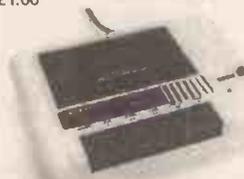
Two large socket head screws  
EX6839 (450) 60mm long (37mm threaded) x 12mm dia (M12) Box of 25 (list 11.74) £4.00  
EX6838 (1375) 25mm long x 12mm dia. (M12) Box of 25 (list 7.36) £2.50

**Voltage Converter**

EX6836 (91) DC-DC voltage converter NMX505.12. Rated 5W in PCB mntg package 50x50x10mm. Input 5V, output 12V 417mA List 22.96. Our Price £5.00

**Protective Covers for Computers**

Although the machines these covers were intended for are probably dead and buried, they could possibly fit other electronic items. Made from leather look fabric backed plastic.  
EX6829 (150) Intelwison 36x22x8cm £1.00  
EX6828 (100) Texas 1199 Size 37x24x6/3cm. £1.00  
EX6830 (40) Sinclair 18x15x3cm, with an all round zip. £1.00



X9092 (20) Computer cassette recorder for the Vx20 or C84 computer. Brand new and boxed with instructions. £3.00

**DYNAMIC MIC**



EX6849 (300) We've had these before - and very popular they were, too! Foster DF-1X, Impedance 50k, FR 100-10,000Hz. Omnidirectional 1.5m cable. Supplied with table stand, holder + adaptor for floor stand and neck cord. £8.00

**Lighting**

EX6827 (5) Outdoor PIR light controller. Fully adjustable directional external PIR detector with time adjustment and sensitivity control. Will switch up to 1.2kW halogen lamp load. £12.50  
EX9091 (5) Auto globe lamp, PIR sensor with 200mm dia globe. Uses 60W ES lamp. £20.00  
EX9090 (5) Classic style lantern with PIR in white. These are good quality lamps with brass fittings. Max 60W ES lamp. £20.00  
EX9089 (5) Daylight sensor classic style lamp. Uses 60W ES lamp £10.00

**Switches**

EX4112 (100) Burgess microswitch 20A 205x19x13 with 1b and 1c/o contacts 2/£1.00

**Capacitors**

EX4111 (100) Variable cap with integral trimmers 20x20x13. Value 300pF 2/£1.00

**Connectors**

EX4109 (1000) 4mm black plug with screw connexion. Pack of 100 £5.00  
EX4115 (73) 44 pin PLCC socket. 50p

**Resistors**

Two high quality precision pots by Bourns. Model 6554S. These are servo mntg 33mm dia and have a rotational life of 20 million revolutions. Linearity 0.5%, Tol 10% List on these is over £40  
EX6841 (150) 2k £5.00; 100+ 3.00  
EX6840 (150) 20k £5.00; 100+ 3.00

**Some more trim pots:**

Code	Qty	Part No	Val.	Price
EX4143	75	64 W	200k	4/£1.00
EX4144	75	43P	500 R	4/£1.00
EX4145	75	43P	5k	4/£1.00
EX4146	75	43P	10k	4/£1.00

**Panel Meter**

EX6833 (10) LED Digital panel meter, Farnell type DPM2C supplied with operating instruction booklet. 3 1/2 digit 12.7mm display. +1.9999V. Needs 5V 150mA supply. Normal and BCD data outputs. 38x63x120mm Last list price £95.17. Our Price £20.00

**Modem**



EX6835 (18) Pace Linnet 1200 PC card - intelligent V21/V22/V23 modem. Auto dial and answer. Supplied with Datatalk software on 3.5" and 5.25" disks, also includes free CompuServe membership with 1hr on line free. All for just £20

EX6834 (240) Black ABS case 220x150x63mm drilled with 115mm dia hole in lid and base for mounting fan, also 28x10 hole for switch and 12.5 dia hole for cable entry. Fitted with rubber feet on long side. £2.00

**Burrs**



A superb selection of parallel sided and tapered burrs, all with 2.3mm dia shaft. The nine different types are available singly or in packs of six. There's also assorted packs.

Code	Type	Dia. (mm)	Qty
EX4098	FFXC <sub>2</sub>	0.8	432
EX4099	FFXC <sub>1</sub>	0.9	1296
EX4100	FFXC <sub>2</sub>	1.0	1728
EX4101	FFXC <sub>3</sub>	1.2	1296
EX4102	FFXC <sub>5</sub>	1.6	432
EX4103	TFXC009	0.9	6264
EX4104	TFXC010	1.0	6256
EX4105	TFXC012	1.2	432
EX4106	TFXC014	1.4	864

Note: EX4098-X4102 are parallel, EX4103-X4106 are tapered.

Prices: 75p each; Pack of 6 of one size £2.50  
EK936 One each of the above types, total 9 £5.00  
EK937 6 each of the above types, total 54 £16.00

**Mobile Battery Chargers**



The electronics of all these quick charger/conditioners is the same - the case size and shape differs to accommodate the battery.

Input voltage is 12V on a 2.5mm power socket (Use lead X6718 to power from car battery). LEDs show charging, 50%, 70% 90% and ready. Battery may be conditioned, too

Code	Qty	Mobile Phone Type	Price
EX6736	275	OKI 900, AT&T 3730	£6.00
EX6737	737	?	£6.00
EX6738	266	NEC P200/300, P201/301 Kenwood KMPH700	£6.00
EX6739	35	Sony CM-H1 CM-H20	£6.00
EX6740	22	GE Pocketphone, Ericsson Hotline or Blaupunkt	£6.00
EX6741	300	Sony HM333	£6.00
EX6742	119	Mitsubishi 3000, DiamondTel 99X	£6.00
EX6743	227	Mitsubishi 4030, DiamondTel 22X	£6.00
EX6745	100	?	£6.00
EX6746	92	OKI	£6.00
EX6747	209	NEC	£6.00
EX6749	19	Technophone PC205A	£6.00
EX6752	51	Panasonic HH-900 or EB-H50	£6.00

**More exciting £9.95 CD-ROMs**

An exciting new range of 'Hotware':  
EHOT001 Family Hobbies and Pastimes: inc guitar tutor, golf, piano, family trees, typing tutor, home contents inventory, screen savers and personal diary.  
EHOT002 Cyber Pup! Airplane designer, cashkids, mathwz, pie chart creator, stones, tangeroos, type, wordwz  
EHOT003 Cyber Student. Europe, Intermezzo, IO test, measurement converter, french verbs, chemical compositions, periodic tables, recorder.  
EHOT004 Cyberleisure. American football, brick, Empire, rats, chessmate, pool, yartzee, table tennis  
EHOT005 Cyberplayground, ABC, Puz, Amnesia, Angela's tunes, Animals, Cays, Colour Me, Dino  
EHOT006 Ultimate Personal Assistance. Software, Smartfont, Flamingo, Virus, Disk Label, Mediator, Spreadsheet, Chamillon  
EHOT007 Psychic Assistant. Fractal, Pheobe, Tarot, Turbo, Time & Chaos, Ouija, ALW, Astrology  
EHOT008 Puzzles and Quizzes. Cubic, Taipei, Xword, Alethic, Bogout, Quiz, Slider, Wordsearch  
EHOT009 Luck & Fortune Enhancer. Backgammon, Horse, Lottery, Poker, Pool/Pan, Roulette, Win Jack, Astrology  
EHOT010 Family Diet & Lifestyle. Bartender, Body insight, Cook, Cholest, Menu, Mindworks, Nutrition, Biograph  
All the above titles are £9.95 each

**...and a couple of other useful titles:**

ETD021 Chessmaster. Happily concurring with our chessboard and pieces offer elsewhere in this advertisement, this superb CDROM contains an amazing amount of material - Interactive tutorial with speech and animation, Teaching Display - graphic illustrations of board coverage.

Features for all levels of players - Multiple Personalities, Time Controls, Tournament Play, Ranking, Notation, Solutions.

Classic games - 150 included; Karpov's favourite Games, Import/Export, Printer support  
Hear each move in any game, multiple perspectives and chess sets, inc design your own! All this for just £9.95

ETD022 Pelmanism - A game of pairs for children 3-6 years. Numerous levels of difficulty. Simple interface. Hear the name of each item! £9.95

**RELAY PANELS**

PLEASE NOTE: On the two panels listed below, one or two relays have been damaged to prevent re-use of the board.



EX6845 (600) This is a great scoop! It seems unlikely you'd find relays at less than 16p each - yet by buying this panel, that's exactly what you will get! 128 miniature BT style DPCO 5V relays + 32 BC337 transistors, 16 x BC327, 4 x NE590 (addressable peripheral driver - 8 open collector darlington outputs cost 6.62 each), 4 x NE591, 4 x LS chips, 128 diodes, Rs, Cs etc. Board value is over £400! Our Price £20.00

EX6846 (200) This one has 32 low profile 4PCO relays with 2A contacts and 24V coil, 64 x 1N4004 and a 64 pin DIN connector. £5.00

**SMPSUs**

EX6843 (12) Made by Skynet measuring 197x108x116/230V ac input, Outputs +5V 8A; +12V 3A. 5V 0.5A -12V 0.5A £7.00

EX6844 (8) Made by Ampercor, this one measures 240x127x63 and includes gold coloured alloy chassis. 115/230V ac input, Outputs +5V 8A; +12V 7.7A. -12V 1.4A. Comes with leads and sockets for fan and PC. £10.00

**Removable Hard Disk Drive**

EX6848 (117) Not too much info on this at present - it's a SyQuest SQ312RD and believed to be in perfect working order, but not new. No hard disks for them, though £20

**SENSATIONAL MAGNET OFFER!**



EX6826 Scoop purchase of 400,000 extremely powerful ferrite magnets, ideal for schools, modellers and hobbyists. They measure 12mm dia x 6mm thick and despite their small size will attract a paper clip from 20mm. If used with our X3545 miniature reed switches they will operate at 10mm and release at 15mm. Separating two takes 300g pull. They have arrived in cartons of 70, so this is the most economical buy. 10 for £1.00; Pack of 70 £3.50

For bulk buyers: (price each) 1400 0.035; 14,000 0.030, 140,000 0.028  
Reed Switches for use with these magnets  
EX3545 Miniature, 20mm long x 2mm dia body 30p each; £20/100  
EW902 Standard, 28mm long x 3.5mm dia body 30p each; £20/100  
EW904 Large, 47mm long x 5mm dia body 40p each; £25/10

**CHESS**



We've purchased a job lot of 'CONCHESS' chess boards intended for use as computerized games so all the squares have an LED showing and a 14mm long miniature reed switch underneath. There's also an interface panel, but the main plug in module is not in place. They're nice quality boards however, and can obviously be utilized for manual chess or draughts etc, after removing the components (if you want/need to). Three sizes of board available:

EX9093 (19) 516mm square with 2" squares. Wood surround with wood grain effect squares. Supplied with a FREE set of chessmen EX6842 £15  
EX9094 (49) 380mm square with 1.5" squares. Although smaller, the board is of a better quality than above - the squares look like a genuine veneer. Supplied with a FREE set of chessmen EX6842 £12  
EX9095 (40) 295mm square with 27mm squares. Bottom of the range, this one is much more basic - its sprayed silver and brown. £6  
Chessmen  
EX6842 (2200) Wooden, with a King height of 83mm, some of the pieces have a magnet in the base covered with a green felt pad. Complete set of 32 pieces £4.00

Loads more bargains in our monthly lists only available to Subscribers - Become one today!

## £1 BARGAIN PACKS - List 2

1,000 items appear in our Bargain Packs List - request one of these when you next order.

30A PORCELAIN FUSE HOLDERS. Make your own fuse board. Pack of 4. Order Ref: 82.  
2 x 6 1/2" METAL FAN BLADES for 3/16 shaft. Order Ref: 86/6 1/2.  
MAINS MOTOR to suit the 6 1/2" blades. Order Ref: 88.  
4-5V 150mA DC POWER SUPPLY. Fully enclosed so quite safe. Pack of 1. Order Ref: 104.  
CROCODILE CLIPS. Small size, 10 each red and black. Order Ref: 116.  
15mm TWIN WIRE, screened. Order Ref: 122A.  
100 PLASTIC HEADED CABLE CLIPS. Nail in type, several sizes. Order Ref: 123.  
MES BATTEN HOLDERS. Pack of 4. Order Ref: 126.  
COMPLETE POCKET SIZE MW RADIO. Believed OK but not tested. Order Ref: 133R.  
2 CIRCUIT MICRO SWITCHES (Licon). Pack of 4. Order Ref: 157.  
13A SWITCH SOCKET. Quite standard but coloured. Pack of 1. Order Ref: 164.  
30A PANEL MOUNTING TOGGLE SWITCH. Double pole, pack of 1. Order Ref: 166.  
NEON NUMICATOR TUBES. Pack of 2. Order Ref: 170.  
3/8 RUBBER GROMMETS. Pack of 100. Order Ref: 181.  
BC LAMP HOLDER ADAPTORS. Pack of 6. Order Ref: 191.  
SUPERIOR TYPE PUSH SWITCHES. Make your own key-board. Pack of 8. Order Ref: 201.  
MAINS TRANSFORMER 8V-0-8V 1/2A. Order Ref: 212.  
SUB MIN TOGGLE SWITCHES. Pack of 2. Order Ref: 214.  
HIGH POWER 3" SPEAKER (11W Bohm). Order Ref: 246.  
MEDIUM WAVE PERMEABILITY TUNER. Its almost a complete radio with circuit. Order Ref: 247.  
SCREW DOWN TERMINALS with through panel insulators. Pack of 6. Order Ref: 264.  
LCD CLOCK DISPLAY. 1/2" figures. Order Ref: 329.  
PUSH ON LONG SHAFTED KNOBS for 1/4" spindle. Pack of 10. Order Ref: 339.  
EX-GPO SPEAKER INSERTS, ref 4T. Pack of 2. Order Ref: 352.  
SUB MIN 1F TRANSFORMERS. Just right if you want coil formers. Pack of 100. Order Ref: 360.  
24V 200mA PSU. Pack of 1. Order Ref: 393.  
HEATING ELEMENT. Mains voltage 100W, brass encased. Pack of 1. Order Ref: 8.  
MAINS INTERFERENCE SUPPRESSOR. Pack of 1. Order Ref: 21.  
ROCKER SWITCHES, 13A mains voltage. Pack of 3. Order Ref: 41.  
MINI UNI SELECTOR with diagram for electronic jigsaw. Pack of 1. Order Ref: 56.  
APPLIANCE THERMOSTATS. Adjustable up to 15A. Pack of 2. Order Ref: 65.  
MAINS MOTOR with gearbox giving 1 rev per 24 hrs. Pack of 1. Order Ref: 89.  
ROUND POINTER KNOBS for flatted 1/4" spindles. Pack of 10. Order Ref: 295.  
CERAMIC WAVE CHANGE SWITCH. 12-pole, 3-way with 1/4" spindle. Pack of 1. Order Ref: 303.  
PLASTIC STETHOSETS. Take crystal or magentic inserts. Pack of 2. Order Ref: 331.  
PRE-SET RESISTORS. Various types and values. Pack of 20. Order Ref: 332.  
CAR TYPE ROCKER SWITCHES. Assorted. Pack of 6. Order Ref: 333.  
LONG SHAFTED KNOBS for 1/4" flatted spindles. Pack of 10. Order Ref: 339.  
REVERSING SWITCH, 20A double pole or 40A single pole. Pack of 1. Order Ref: 343.  
SKIRTED CONTROL KNOBS, engraved 0-10. Pack of 4. Order Ref: 355.  
LUMINOUS PUSH-ON PUSH-OFF SWITCHES. Pack of 3. Order Ref: 373.  
1000W TUBULAR HEATING ELEMENTS with terminal ends. Pack of 2. Order Ref: 376.  
MAINS TRANSFORMER OPERATED NICAD CHARGER. Cased with leads. Pack of 1. Order Ref: 385.  
CLOCKWORK MOTORS. Run for one hour. Pack of 2. Order Ref: 389.  
MULLARD LP65. Almost a complete superhet. Order Ref: 1052.  
SLIDE SWITCHES. Single pole changeover, pack of 10. Order Ref: 1053.  
TELESCOPIC AERIAL. Nickel plated, folds over, just £1. Order Ref: 1051.  
2 CORE MAINS LEAD. Black, 2m long, pack of 4. Order Ref: 1020.  
2M MAINS LEADS. 3 core, black, pack of 3. Order Ref: 1021.  
HEAD CLEANER. For your video or tape, complete with brush, pack of 1. Order Ref: 1026.  
PAXOLIN PANEL. Approximately 12" x 12", just one. Order Ref: 1033.  
6 HOUR CLOCKWORK MOTOR. Just one. Order Ref: 1038.  
VERY THIN DRILLS. 0.4mm, pack of 10. Order Ref: 1042.  
20A TOGGLE SWITCH. Centre off, up is on, down also on but springs back to off. Pack of 2. Order Ref: 1043.  
TUBULAR ELECTROLYTIC CAP. Twin 200uf at 275V, just one. Order Ref: 1046.  
HIGH CURRENT RELAY. 12V DC or 2V AC operates change-over contacts. Just one. Order Ref: 1026.  
FIGURE 8 FLEX. Ideal speaker lead, 12m. Order Ref: 1014.  
6V SOLENOID with good strong pull, pack of 2. Order Ref: 1012.  
1 MEG PRESET POTS. Pack of 4. Order Ref: 998.  
TUBULAR ELECTROLYTICS. Twin 50uf at 350V, pack of 2. Order Ref: 994.  
TUBULAR ELECTROLYTICS. 150uf at 200V, pack of 3. Order Ref: 993.  
MINI RELAY. 5V, coil size 50mm x 15mm x 15mm with closing 5A contacts. Pack of 2. Order Ref: D41.  
MINI RELAY with 5V coil, size 26mm x 19mm x 17mm, 2 sets changeover contacts. Just one. Order Ref: D42.  
BLACK KNOBS. Collet type, pack of 4. Order Ref: D43.  
FERRITE RODS. 3/8" diameter, 7" long, pack of 3. Order Ref: D53.  
ROTARY SWITCH. 9-pole, 6-way, just one. Order Ref: D54.  
PLASTIC HEADED CABLE CLIPS. Tempered nail type, pack of 100, 4 types. Order Ref: ???.

## Smart Kit Electronics

## HIGH QUALITY ELECTRONIC KITS

All kits are complete with PCB and other components in a blister pack. We feel that most readers will know these kits, but if you want more information about them, then we have copies of the illustrated Smart catalogue, this gives full details and circuit diagrams of each kit, price is £1, deductible if you order kits to the value of £20.

CAT. No.	DESCRIPTION	PRICE £	CAT. No.	DESCRIPTION	PRICE £
1002	VU Meter, with l.e.d. display	4.60	1071	4-input Selector	6.90
1003	5W Electronic Siren	2.53	1074	Drill Speed Controller	2.76
1004	Light Switch	3.22	1077	100W HiFi Amplifier	12.50
1005	Touch Switch	2.87	1080	Liquid Level Sensor - Rain Alarm	2.30
1007	Stabilized Power Supply: 3V to 30V at 2-5A	6.90	1082	Car Voltmeter, with l.e.d.s	7.36
1008	SF Function Generator	6.90	1083	Video Signal Amplifier	2.76
1010	5-input Stereo Mixer, with monitor output	19.31	1084	TV Line Amplifier	1.84
1012	Reverberation Unit	5.52	1085	DC Converter, 12V to 6V or 7-5V or 9V	2.53
1016	Loudspeaker Protection Unit	3.22	1086	Music to light for your car	4.60
1023	Dynamic head preamp	2.50	1087	Thyristor/Triac Tester	2.76
1024	Microphone preamp	2.20	1088	Kitt Scanner	10.12
1025	7W HiFi Power Amplifier	2.53	1089	LED Flasher/555 Tester	1.61
1026	Running Lights	4.60	1090	Stress Meter	3.22
1027	NiCad Battery Charger	3.91	1093	Windscreen Wiper Controller	3.68
1029	4 sound electronic siren	3.00	1094	Home Alarm System	12.42
1030	Light Dimmer	2.53	1096	2V-30V 5A Stabilized Variable PSU	11.04
1032	Stereo Tone Control	4.14	1098	Digital Thermometer, with l.c.d. display	11.50
1033	60W HiFi Power Amplifier	7.82	1100	2 x 18W Integrated Amplifier	18.39
1034	Car Battery Checker	1.61	1103	LED Power Meter	1.84
1035	Space Sound Effects	2.30	1106	Thermometer with l.e.d.s	6.90
1038	AM/FM Aerial Amplifier	1.61	1107	Electronics to help win the pools	3.68
1039	Stereo VU Meter	4.60	1109	40W HiFi Amplifier	7.36
1040	10W HiFi Power Amplifier	2.76	1112	Loudspeaker protection, with delay	4.60
1041	25W HiFi Power Amplifier	4.60	1113	2 x 18W Power Amplifier	5.98
1042	AF Generator, 250Hz-16kHz	1.70	1115	Courtesy Light Delay	2.07
1043	Loudness Stereo Unit	3.22	1118	Time Switch with triac 0-10mins	4.14
1045	Sound Effects Generator	3.68	1123	Morse Code Generator	1.84
1047	Sound Switch	5.29	1124	Electronic Bell	2.76
1048	Electronic Thermostat	3.68	1125	Telephone Lock	3.68
1050	3-input HiFi Stereo Pre-amplifier	12.42	1126	Microphone Pre-amplifier	4.60
1051	Touch Dimmer, with memory	4.60	1127	Microphone Tone Control	4.60
1052	3-input Mono Mixer	6.21	1128a	Power Flasher 12V d.c.	2.53
1053	Electronic Metronome	3.22	1131	Robot Voice	3.68
1054	4-input Instrument Mixer	2.76	1133	Stereo Sound-to-Light	5.26
1056	8V-20V 8A Stabilized Power Supply	12.42			
1057	Cassette Head Pre-amplifier	3.22			
1058	Electronic Car Ignition	7.82			
1059	Telephone Amplifier	4.60			
1060	+ 40V 8A Power Supply	8.28			
1062	5V 0-5A Stabilized Supply for TTL	2.30			
1063	12V 2A Power Supply	2.30			
1064	+ 12V 0-5A Stabilized Supply	3.22			
1067	Stereo VU Meter, with l.e.d.s	9.20			
1068	18V 0-5A Stabilized Power Supply	2.53			
1069	Fluorescent Tube Unit from 12V d.c.	2.99			
1070	HiFi Pre-amplifier	7.47			

### TERMS

Send cash, PO, cheque or quote credit card number - orders under £25 add £3 service charge.

## J & N FACTORS

Pilgrim Works (Dept. E.E.)  
Stairbridge Lane, Bolney,  
Sussex RH17 5PA  
Telephone: 01444 881965  
(Also fax but phone first)

# RADIO DATA MODULES MODEM TRANSCIVERS

UK, E.E.C, Scandinavia, Eastern Europe, North & South America, Middle East, South Africa, New Zealand, Far East or Australia. Wherever you are, we have a module on the right frequency for you!

## New !: TXR-XXX-DTR100



Only 55 x 23 x 15mm

**20% Discount On Evaluation Pairs**  
UK, US, EEC or Australian Models

## Low Voltage Transmitters Simplify Interfacing !

- Reduce Component Count, Cost, Size & Power Drain \*
- Twice as fast as the - A version, up to 20,000 bps \*
- Drives directly from a PIC output Port III! \*
- Available UK Approved MPT1340 418MHz \*
- Export I-ETS-300-220, 433.92MHz \*



TXM-418-F Transmitter



SILRX-418-F Receiver

**\* Special UK 40% Off Introductory Offer \***  
**\* Only £29.95 per pair Inc VAT \***

## Exclusive : South African Modules on 403MHz

- TXM-403-A, SILRX-404-A, RXM-403-A \*
- High Quality FM system > 120M Range \*
- Evaluation Kits Available \*
- No Price Surcharge \*
- Eg : 1000 + TXM's Only £5.95 Each \*



RXM-403-A

## VHF Modules for UK, Australia and Beyond !

- UK, 173MHz to MPT1344 & MPT1328 Licence Exempt \*
- Miniature Low Cost 1 & 10mW Transmitters \*
- 173.500MHz Transmitters & Receivers for Australia \*
- PCB mount or canned, Superhet Receivers \*
- Low Cost Meter Reading Transceivers on 183.8875MHz \*
- Prices from < £20.00 to £340.00 each \*



RXM-173/183-4666-60

## World Leading BIM Transceiver £84.95 per pair !



BIM-418-F  
Approved to MPT1340 & I-ETS-300-220

World leading in price, performance and size the BIM high speed transceiver has already found a home around the World in many wire free products from computer networks, hand held terminals to EPOS. Available on 418 and 433.92MHz

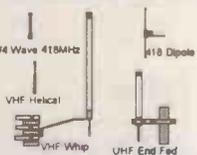
- 5V Operation, PIC Compatible Logic \*
- Exclusive RS232 Serial Version £79.95 \*
- Packet Controller Parallel i/o Board £79.95 \*
- Evaluation Kit with 2 BIM's £149.95 \*
- Volume Discounts Prices Available for OEM's



BIM-433-RPC

## Check our Prices, Now with Free Postage ! \*

Transmitters (1 + Price)	Antennas (1+ price)	Receivers (1+ price)
TXM-418-A 0.25mW .....£12.50	Helical-173MHz .....£ 4.90	SILRX-418-A.....£22.50
TXM-433-A 0.25mW .....£14.75	1/4 Wave 418MHz.....£4.90	RXM-418-A.....£23.95
TXM-418-F 0.25mW .....£14.75	Dipole 418MHz.....£23.50	SILRX-433-A.....£23.95
TXM-433-F 0.25mW.....£14.75	VHF Whip Antenna.....£35.00	RXM-403-A.....£29.05
TXM-403-A 0.25mW.....£14.75	UHF End Fed Dipole.....£35.00	SILRX-418-F.....£23.95
TXM-173-4689 1mW.....£22.50		SILRX-433-F.....£23.95
TXM-173-4689 10mW.....£24.50		RXM-173-60.....£31.62
TXM-184-4689 10mW.....£29.95		RXM-184-60.....£31.62



Credit Card Payments Welcome. Exports 2/4 day delivery by DHL, UPS or Air Express Available. All prices in Pounds Sterling

Radio - Tech Limited, Overbridge House, Weald Hall Lane  
Thornwood Common, Epping, Essex CM16 6NB.  
Sales +44 (0) 181 368 8277 Fax +44 (0) 181 361 3434  
International +44 (0) 1992 57 6107 Fax +44 (0) 1992 56 1994

## SECURITY

### ULTRASONIC MOVEMENT DETECTOR

Xtal controlled oscillator, detector circuits & edge mounted transducers on one PCB just 75x40mm. Detection range 4-7m. Adjustable sensitivity. LED indicator. Outputs to drive external relay/circuits 9V DC operation. 3049-KT. £14.95

### MINI CCTV CAMERA



- FEATURES**
- Compact & light camera PCB module 54Wx38L x30mmH. 33 grams
  - Low power consumption 12V DC, 150mA
  - Low light requirement 0.1 Lux (IR LED on)
  - High quality, high resolution CCD image 512x562 pixels
  - Video output 1Vp-p/75ohm
  - Lens 3.6mm F1.8
  - Field of view 74°H x 55°V
  - Maintenance free
  - Built-in electronically controlled auto-iris
  - Internal synchronisation

ASSEMBLED UNIT: 3047-AS £89.95

## X-FACTOR PUBLICATIONS

### THE EXPERTS IN RARE & UNUSUAL INFORMATION!

Full details of all X-FACTOR PUBLICATIONS can be found in our catalogue. N.B. Minimum order charge for reports and plans is £5.00 PLUS normal P.&P.

**SUPER-EAR LISTENING DEVICE** Complete plans to build your own parabolic dish microphone. Listen to distant voices and sounds through open windows and even walls! Made from readily available parts. R002 £3.50

**TELEPHONE BUG PLANS** Build you own micro-beetle telephone bug. Suitable for any phone. Transmits over 250 metres - more with good receiver. Made from easy to obtain, cheap components. R006 £3.00

**LOCKS - How they work and how to pick them.** This fact filled report will teach you more about locks and the art of lock picking than many books we have seen at 4 times the price. Packed with information and illustrations. R008 £3.50

**RADIO & TV JOKER PLANS** We show you how to build three different circuits for disrupting TV picture and sound plus FM radio! May upset your neighbours & the authorities! DISCRETION REQUIRED. R017 £3.50

**INFINITY TRANSMITTER PLANS** Complete plans for building the famous Infinity Transmitter. Once installed on the target phone, device acts like a room bug. Just call the target phone & activate the unit to hear all room sounds. Great for home/office security! R019 £3.50

**THE ETHER BOX CALL INTERCEPTOR PLANS** Grabs telephone calls out of thin air! No need to wire-in a phone bug. Simply place this device near the phone lines to hear the conversations taking place! R025 £3.00

## GENERAL KITS

**3 DIGIT LED COUNTER** 2 board basic event counter. Main board has 3 digit counter circuit. 2nd board has Count & Reset switches & debounce circuit. Cascaded with other boards to provide more digits. Box & battery holder provided. 9V battery. 78x50x25mm. 3001-KT. £14.95

**OP-AMP FUNCTION GENERATOR** Quad Op-Amp connected as oscillator & wave shapers to generate audio range wave-forms. Oscillator generates Square Wave from 6Hz to 6KHz. Other amps produce Triangle & pseudo Sine outputs. Solder pad outputs. 9V powered. 47x40x22mm. 3023-KT. £4.95

**LOGIC PROBE** Original, modern design tests both CMOS & TTL circuits as well as detecting fast pulses. Gives visual & audio indication of logic states found. Powered from circuit under test. It's operation is fully explained. 3024-KT. £7.95

**ROULETTE LED** A great introduction to gambling... an electrical 'Watch the ball' spin round the roulette wheel, slow down & drop into slot. Uses 10 LEDs, a CMOS decade counter & Op-Amp to teach Voltage Control Oscillator (VCO) principles. 9V powered. Educational & fun! 3006-KT. £12.95

**PELTIER JUNCTION HEAT PUMP** Boil or freeze water instantly! Use for regulated cooling of temperature sensitive components and much more. 3066-KT. £21.95

**XENON TUBE FLASHER** This powerful high voltage xenon flasher runs off a simple 9V battery. A transformer is used to step up the 9V supply voltage to the high voltage required to flash the 25mm long tube. Flash rate adjustable between 0.25 to 2 second intervals. 3022-KT. £11.95

**LM383 AMPLIFIER MODULE** Proven, popular building block for use in any audio project where general amplification required. Power output dependent on supply voltage & load resistance. Typical ratings: Over 10W for 16V supply & 2W speaker, 1W for 9V supply & 6W speaker. 3047-KT. £9.95

## plus AUDIO • EDUCATIONAL • LASER • SECURITY • TEST GEAR • BOOKS • more

Our high quality project kits are supplied with all components, fibre glass PCB's & comprehensive instructions. FREE CATALOGUE with order or send 2 x 1st Class stamps (refundable) for details of over 1000 kits & publications. Mail order only. Please ADD £2.00 P. & P. (Europe £3, Rest of World £5) & make cheques/PO's payable to Quasar Electronics. Goods normally despatch within 5 working days. Please allow 28 days for delivery. Prices include VAT at 17.5%. For safety send cash by recorded delivery.

Quasar Electronics Unit 14 Sunningdale BISHOP'S STORTFORD Herts CM23 2PA  
E-mail: 101364.3510@compuserve.com

# Quasar Electronics

**COMBINATION LOCK** Versatile electronic lock comprising main circuit & separate 8 key touch-pad for remote opening of lock. 120VAC/110A relay supplied. 9-12V. 3029-KT. £9.95

**LIGHT ALARM** Protect your valuables with this practical, clever little circuit. Alarm sounds if even the smallest amount of light falls on the circuit. Place in cash box etc. 3008-KT. £4.95

**THE SCREAMER!** Alarm alarm siren gives out a massive 110db of ear piercing noise. Box supplied with two 35mm piezo elements already built into their own resonant cavity. PCB fits inside box to give a neat, compact unit. Use as part of an alarm circuit or just for the fun of it! 6-9V operation. 3015-KT. £9.95

## SURVEILLANCE

High performance surveillance kits Room transmitters supplied with sensitive electret microphones & battery holders/clips. All transmitters can be received on an ordinary VHF FM radio.

**MTX - Miniature 9V Transmitter** Easy to build & guaranteed to transmit 500 metres (over 1000m possible with higher voltage & better aerial) 3-9V operation. Only 45x18mm. 3007-KT. £4.95

**MRTX - Miniature 9V Room Transmitter** Best selling 'bug'. Super sensitive, high power (1000m range (Up to 2 miles with 18V supply & better aerial)), 9V operation. 45x19mm. 3018-KT. £5.95

**HPTX - High Power Room Transmitter** High performance, 2 stage transmitter gives greater stability & high quality reception. 1000m range with 9V battery. 6-12V operation. On/off switch. Size 70x15mm. 3032-KT. £6.95

**VTX - Voice Activated Transmitter** Powerful 2 stage voice activated transmitter. Only operates when sounds are detected. 1km range. Low standby current - conserves battery power. Adjustable sensitivity & turn-off delay. Only 63x38mm. 3028-KT. £8.95

**TRI - Telephone Recording Interface** Connect between phone line & cassette recorder. Automatically switches on tape when phone is used. Records all conversations. Powered from line. 48x32mm. 3033-KT. £8.50

**TRVS - Tape Recorder Vow Switch** sensitive, voice activated switch - automatically turns on cassette recorder when sounds are detected. Adjustable sensitivity & turn-off delay. 15x19mm inc. mic. 3013-KT. £7.50

**MTTX - Miniature Telephone Transmitter** Attaches anywhere to phone line. Transmits only when phone is used. Uses phone line as aerial & power source. 500m range. 45x15mm. 3016-KT. £5.50

**Two Station Intercom/Hard Wired Bug** Each unit has its own speaker, microphone & amplifier (LM386). Turn into a hard wired bug by using 4 stand ribbon cable supplied to send power from the receiving unit to the remote 'bug' unit. 9V. 3021-KT. £12.95

**Telephone Amplifier Kit** Pick-up coil & sensitive amplifier let you hear conversations without even holding the phone! Can be used for surveillance purposes. 3055-KT. £9.95

**LED SEQUENCE/RANDOM FLASHER.** 5 ultra bright red LED's flash in sequence or random. Ideal for model railways. On/off switch. COB PCB 15x8mm (space provided). 3V powered. 3003-KT. £3.95

**LED DICE** The classic electronic project that never loses its popularity. Combines a great game with an easy introduction to electronics & simple circuit analysis. 7 LED's simulate a real dice face. The dice rolls, slows down, stops on a number at random. Uses a 555 timer & counter IC. Box included. 9V operation. 3003-KT. £8.95

**STAIRWAY TO HEAVEN GAME** This game of skill tests your hand-eye co-ordination. If you press the switch each time the green part of the bi-polar LED lights you climb higher up the stairway - but miss & you start again! Introduces you to several basic electronic circuits. Box provided. 9V operation. 78x50x19mm. Rolfe Harris NOT included. 3005-KT. £8.95

**DC MOTOR SPEED CONTROLLER** Control the speed of any common DC motor rated up to 100W (5A). Operates on 5-15V. Uses NE555 IC to pulse-width modulate a TIP122 high current, switching power transistor. In this way torque of the motor is not lowered. Box mounted. 3067-KT. £19.95

**SWITCHING POWER SUPPLY** Replace expensive 9V batteries with cost-efficient 1.5V cells. IC based circuit acts as a step-up switching power supply. Selectable 1.5 or 3V DC inputs. Gives a fixed output of 9V @ 18mA from a 1.5V "AA" cell. Solder pads for input/output. 1 cell & 2 cell "AA" holders & jumper switches supplied. 40x15x12mm. 3035-KT. £4.95

**SINGLE CHIP AM RADIO** Complete mini sized AM radio on a PCB. Tuned Radio Frequency front-end. AM Radio IC & 2 stages audio amplification. All components supplied inc. prewound coil & speaker. 32x102mm. 3063-KT. £9.95

**TRAIN SOUNDS** 4 selectable sounds - Whistle Blowing, Level Crossing Bell, Chugging & 'Clickety-Clack'. 2.5-6V. Supplied with all components inc. speaker, 18 x 25mm COB PCB, switches & 2x "AA" battery holders. SG1. £4.95

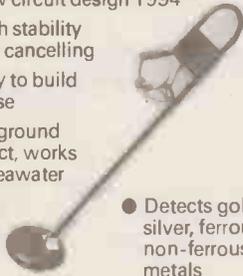


## MAIL ORDER ONLY • CALLERS BY APPOINTMENT

### EPE MICROCONTROLLER P.I. TREASURE HUNTER

The latest MAGENTA DESIGN - highly stable & sensitive - with  $\mu$ C control of all timing functions and advanced pulse separation techniques.

- New circuit design 1994
- High stability drift cancelling
- Easy to build & use
- No ground effect, works in seawater



- Detects gold, silver, ferrous & non-ferrous metals

- Efficient quartz controlled microcontroller pulse generation.
- Full kit with headphones & all hardware

KIT 847.....£63.95

### DIGITAL LCD THERMOSTAT

A versatile thermostat using a thermistor probe and having an LCD display. MIN/MAX memories, -10 to 110 degrees Celsius, or can be set to read in Fahrenheit. Individually, settable upper and lower switching temperatures allow close control, or alternatively allow a wide 'dead band' to be set which can result in substantial energy savings when used with domestic hot water systems. Ideal for greenhouse ventilation or heating control, aquaria, home brewing, etc. Mains powered, 10A SPCO relay output. Punched and printed case.

KIT 841.....£29.95

### PORTABLE ULTRASONIC PEST SCARER

A powerful 23kHz ultrasound generator in a compact hand-held case. MOSFET output drives a special sealed transducer with intense pulses via a special tuned transformer. Sweeping frequency output is designed to give maximum output without any special setting up.

KIT 842.....£22.56

### DIGITAL CAPACITANCE METER

A really professional looking project. Kit is supplied with a punched and printed front panel, case, p.c.b. and all components. Quartz controlled accuracy of 1%. Large clear 5 digit display and high speed operation. Ideal for beginners - as the  $\mu$ F, nF and pF ranges give clear unambiguous read out of marked and unmarked capacitors from a few pF up to thousands of  $\mu$ F.

KIT 493.....£39.95

### ACOUSTIC PROBE

A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. Sounds from engines, watches, and speech travelling through walls can be amplified and heard clearly. Useful for mechanics, instrument engineers, and nosy parkers!

KIT 740.....£19.98

### WINDICATOR

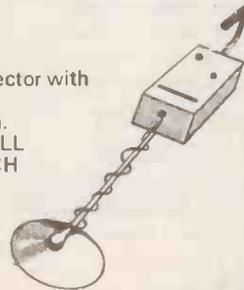
A novel wind speed indicator with LED read-out. Kit comes complete with sensor cups, and weatherproof sensing head. Mainspower unit £5.99 extra.

KIT 856.....£28.00

### BUCCANEER I.B. METAL DETECTOR

An Induction Balance (I.B.) detector with audible output. Providing good sensitivity and easy construction. COMPLETE KIT - INCLUDES ALL HARDWARE, HANDLE, SEARCH HEAD, PCB etc. CIRCUIT REJECTS IRON WHILST PICKING UP GOLD, SILVER, COPPER etc. A SOLID RELIABLE DESIGN.

KIT 719.....£54.99



### 1000V & 500V INSULATION TESTER

Superb new design. Regulated output, efficient circuit. Dual-scale meter, compact case. Reads up to 200 Megohms.

Kit includes wound coil, cut-out case, meter scale, PCB & ALL components.

KIT 848.....£32.95



### MOSFET MkII VARIABLE BENCH POWER SUPPLY 0-25V 2.5A.

Based on our MkI design and preserving all the features, but now with switching pre-regulator for much higher efficiency. Panel meters indicate Volts and Amps. Fully variable down to zero. Toroidal mains transformer. Kit includes punched and printed case and all parts. As featured in April 1994 EPE. An essential piece of equipment.

KIT 845.....£64.95



### ULTRASONIC PEST SCARER

Keep pets/pests away from newly sown areas, fruit, vegetable and flower beds, children's play areas, patios etc. This project produces intense pulses of ultrasound which deter visiting animals.

- KIT INCLUDES ALL COMPONENTS, PCB & CASE
- EFFICIENT 100V TRANSDUCER OUTPUT
- COMPLETELY INAUDIBLE TO HUMANS

KIT 812.....£14.81



### SPACEWRITER

An innovative and exciting project. Wave the wand through the air and your message appears. Programmable to hold any message up to 16 digits long. Comes pre-loaded with "MERRY XMAS". Kit includes PCB, all components & tube + instructions for message loading.

KIT 849.....£16.99

### 12V EPROM ERASER

A safe low cost eraser for up to 4 EPROMS at a time in less than 20 minutes. Operates from a 12V supply (400mA). Used extensively for mobile work - updating equipment in the field etc. Also in educational situations where mains supplies are not allowed. Safety interlock prevents contact with UV.

KIT 790.....£28.51

### MOSFET 25V 2.5A POWER SUPPLY

High performance design has made this one of our classic kits. Two panel meters indicate Volts and Amps. Variable from 0-25 Volts and current limit control from 0-2.5A. Rugged power MOSFET output stage. Toroidal mains transformer.

KIT 769.....£56.82

### INSULATION TESTER

A reliable and neat electronic tester which checks insulation resistance of wiring and appliances etc., at 500 Volts. The unit is battery powered, simple and safe to operate. Leakage resistance of up to 100 Megohms can be read easily. A very popular college project.

KIT 444.....£22.37

### DIGITAL COMBINATION LOCK

Digital lock with 12 key keypad. Entering a four digit code operates a 250V 16A relay. A special anti-tamper circuit permits the relay board to be mounted remotely. Ideal car immobiliser, operates from 12V. Drilled case, brushed aluminium keypad.

KIT 840.....£19.86

### E.E. TREASURE HUNTER P.I. METAL DETECTOR MKI

Magenta's highly developed & acclaimed design. Quartz crystal controlled circuit MOSFET coil drive. D.C. coupled amplification. Full kit includes PCB, handle, case & search coil.

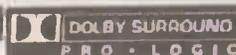
- KIT INC. HEADPHONES
- EFFICIENT CMOS DESIGN
- POWERFUL COIL DRIVE

- DETECTS FERROUS AND NON-FERROUS METAL - GOLD, SILVER, COPPER ETC.
- 190mm SEARCH COIL
- NO 'GROUND EFFECT'

KIT 815.....£45.95



## DOLBY PRO-LOGIC DECODER



Experience the delight of SURROUND SOUND in your own home. This project brings full Genuine PRO-LOGIC surround sound to you at a fantastic price. The circuit meets all \*Dolby specifications, with "Stereo", "3-Stereo" and "Surround Sound" selections. Exactly as described in this booklet.

For minimum cost the "Short Form Kit" is ideal. This is complete except for the case and power transformer. It includes the switches, sockets, and pots, and is ideal for building into a custom set-up with pre-amp and power-amp modules, where power is available.

The alternative "Full Kit" gives the best value option. With a printed front panel, punched rear panel, power transformer and mains lead and black brushed aluminium knobs. This kit produces a complete stand-alone decoder that can be used with any audio.

Short Form KIT, Kit Ref: 858 £99.00 Kit with case and transformer, Kit Ref: 869 £124.99

\*DOLBY and the double D symbol are trademarks.



### DC Motor/Gearboxes

Our Popular and Versatile DC motor/Gearbox sets. Ideal for Models, Robots, Buggies etc. 1.5 to 4.5V Multi ratio gearbox gives wide range of speeds.

LARGE TYPE - MGL £6.95

SMALL - MGS - £4.77



### Stepping Motors

MD38...Mini 48 step...£8.65

MD35...Std 48 step...£12.98

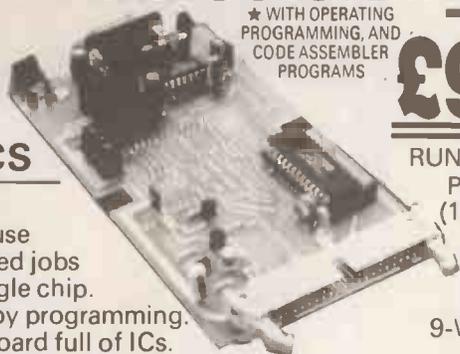
MD200...200 step...£16.80

MD24...Large 200 step...£22.95

# PIC DEVELOPMENT & TRAINING SYSTEM PIC

**YOUR KEY TO ANOTHER NEW AGE OF ELECTRONICS**

PICs are being used more and more because they allow complicated jobs to be done with a single chip. All the work is done by programming. One PIC replaces a board full of ICs. Saving time, space, power, and MONEY.



★ WITH OPERATING PROGRAMMING, AND CODE ASSEMBLER PROGRAMS

**£99** INCLUDING VAT

+ £3.00 p&p

RUNS WITH ANY PC POWER SUPPLY (12V at 200mA)

**£8.99**

PC LEADS

9-WAY **£6.00**

25-WAY **£7.00**

## HOW DO I START WITH PICs?

**STEP 1** – Buy the PIC-DATS Development & Training System

Development & Training System

**STEP 2** – Follow May & June '95 EPE Series – showing how to program for practical applications

**STEP 3** – Start writing and testing your own programs

## PIC PROJECT – LIGHT CONTROLLER DEVELOPMENT SYSTEM (NO SOFTWARE)

A real-world application for a PIC microchip. This project can be made to do just what you chose by writing your own software. It can be programmed to work as a 4-Channel Light Chaser or a simple controller for domestic lighting. Zero volt crossing signal is provided and there is a 4x3 matrix keypad. (Less case).

Kit 855.....**£35.95**

## PIC 16C84 DISPLAY DRIVER

**NEW!**

USES PIC16C84 to drive a 2 LINE x 16 LCD Display.

Another **NEW** PIC project from Magenta. Supplied with PCB, industry standard 2 line x 16 character display, PIC16C84, components, and software to include in your own programs. Full display data and program service code is applied. Ideal development base for meters, terminals, calculators, counters, timers etc. Just waiting for your application.

KIT Ref. 860.....**£17.99**

## SIMPLE PIC16C84 PROGRAMMER

**NEW!**

Based on the design in February '96 EPE. Magenta have made a proper PCB for this circuit and a full kit of parts.

The PCB eliminates the risk of layout errors. Additional contact points are provided to allow connection to RA and unused RB pins when testing programs.

Kit includes 1 – PIC16C84 chip, lead, connector and all software.

Programmer Kit – with software disk, lead, connector and PIC16C84 chip, including PCB.

Kit 857.....**£12.99**

Power Supply Unit 12V-14V.....**£3.99**

Extra PIC16C84 Chips.....**£7.36**

## KIT HIGHLIGHT

We have noticed a number of customers buying the PIC 16C84 Programmer and Kit 855. This is an ideal combination. Kit 855 allows Mains Power to be controlled safely using a PIC16C84. Experiment with chaser patterns and dimming using phase control. Special kit with all components and blank PIC16C84 and reprints.

Kit 855/16C84.....**£39.95**

## 68000 DEVELOPMENT AND TRAINING SYSTEM

Never before at this price! Our own 68000 board kit. Used all over the world in schools and universities. Double Eurocard PCB with RAM, ROM, and I/O. Full featured MONITOR and LINE BY LINE ASSEMBLER ON BOARD. Just needs power, and a serial link to your PC. Supplied with full data and applications course. Use to learn, or as a stand-alone computer board.

**£55.00!**

Kit Ref 601



## BAT DETECTOR



An excellent circuit which reduces ultrasound frequencies between 20 and 100 kHz to the normal (human) audible range. Operating rather like a radio receiver the circuit allows the listener to tune-in to the ultrasonic frequencies of interest. Listening to Bats is fascinating, and it is possible to identify various different types using this project. Other uses have been found in industry for vibration monitoring etc.

KIT 814.....**£21.44**

## Mini-Lab & Micro Lab Electronics Teach-In 7

As featured in EPE and now published as Teach-In 7. All parts are supplied by Magenta. Teach-In 7 is £3.95 from us or EPE Full Mini Lab Kit – £119.95 – Power supply extra – £22.55 Full Micro Lab Kit – £155.95 Built Micro Lab – £189.95

# MAGENTA

Tel: 01283 565435 Fax: 01283 546932

All prices include VAT. Add £3.00 p&p.



Tel (0191) 251 4363  
 Fax (0191) 252 2296  
**ESR**  
**ELECTRONIC COMPONENTS**  
 Station Road, Cullercoats,  
 Tyne & Wear  
 NE30 4PQ  
 U.K.

AD847JN	£6.50	TBA800	£0.70	BY127	£0.18	AC187	£0.48	BC338-25	£0.10	BDX54C	£0.50
AD9696KN	£7.73	TBA810S	£0.64	BY133	£0.10	AC188	£0.48	BC348B	£0.14	BF180	£0.31
ADEL2020AN	£5.06	TBA820M	£0.39	OA47	£0.28	AC189	£3.84	BC348B	£0.25	BF182	£0.31
ADM222AH	£3.55	TDA1024	£1.49	OA90	£0.07	AD149	£1.67	BC393	£0.73	BF185	£0.58
ADM232AA	£3.55	TDA1170S	£2.48	OA91	£0.10	AD161	£0.92	BC414C	£0.13	BF194	£0.31
ADM485JN	£2.97	TDA2002	£1.04	OA200	£0.56	AD162	£0.92	BC441	£0.40	BF194B	£0.19
ADM690AN	£5.13	TDA2004	£3.11	OA202	£0.29	BC107	£0.16	BC461	£0.40	BF195	£0.19
ADM691AN	£6.48	TDA2030	£1.18	Generators 2.7 to 33V		BC107B	£0.17	BC463	£0.29	BF234	£0.35
ADM695AN	£6.48	TDA2050V	£3.98	400mW	£0.08	BC108	£0.14	BC478	£0.32	BF244B	£0.40
ADM699AN	£3.58	TEA5113	£1.11	3.11W	£0.14	BC108A	£0.14	BC479	£0.32	BF244C	£0.35
AMP04FP	£10.94	TL061CP	£0.35	5W		BC108C	£0.16	BC490	£0.24	BF257	£0.33
BUF04GP	£8.56	TL062CP	£0.60	Bridge Rectifiers		BC109	£0.17	BC516	£0.22	BF259	£0.33
CA741CE	£0.26	TL064CN	£0.72	W02 1.5A 200V	£0.20	BC109C	£0.18	BC517	£0.20	BF337	£0.40
CA747CE	£0.39	TL071CP	£0.48	W04 1.5A 400V	£0.22	BC114	£0.41	BC527	£0.20	BF355	£0.38
CA3046	£0.37	TL072CP	£0.50	W06 1.5A 600V	£0.22	BC115	£0.41	BC528	£0.20	BF423	£0.13
CA3059	£1.16	TL074CN	£0.58	W08 1.5A 800V	£0.27	BC116	£0.41	BC537	£0.20	BF451	£0.19
CA3080E	£0.73	TL081	£0.33	W010 1.5A 1kV	£0.24	BC118	£0.41	BC546B	£0.08	BF459	£0.33
CA3130E	£0.98	TL082CP	£0.50	BR32 3A 200V	£0.36	BC132	£0.36	BC547C	£0.08	BF469	£0.36
CA3140E	£0.51	TL084CN	£0.63	BR34 3A 400V	£0.40	BC134	£0.36	BC547C	£0.09	BFX29	£0.31
CA3189E	£1.22	TL494CN	£1.49	BR36 6A 600V	£0.33	BC135	£0.36	BC547C	£0.09	BFX84	£0.31
CA3240E	£1.12	TL770SACP	£1.62	BR62 6A 200V	£0.70	BC140	£0.25	BC548C	£0.08	BFX85	£0.32
DG211CJ	£1.55	TLC271	£0.54	BR68 6A 800V	£0.59	BC141	£0.27	BC549C	£0.10	BFY50	£0.20
DG212CJ	£1.55	TLC272	£0.88	100A 10A 400V	£1.39	BC142	£0.31	BC550C	£0.10	BFY51	£0.25
DG411DJ	£3.11	TMPO1FP	£5.60	2502 25A 200V	£1.68	BC143	£0.34	BC556A	£0.08	BFY52	£0.28
DG412DJ	£4.19	ULN2003	£0.52	2506 25A 600V	£1.75	BC149	£0.21	BC557B	£0.08	BS107	£0.21
EL2020CN	£4.99	ULN2004A	£0.48			BC154	£0.36	BC557C	£0.08	BS170	£0.23
EL2030CN	£5.67	ULN2608	£1.20			BC157	£0.12	BC558C	£0.08	BSW66	£1.35
ICL7106	£2.80	ULN2803	£0.90	TIC106D	£0.36	BC159	£0.17	BC559C	£0.08	BU126	£1.32
ICL7611DCPA	£1.06	ZN409CE	£1.89	TIC116D	£0.66	BC160	£0.28	BC560A	£0.09	BU205	£1.41
ICL7621	£1.70	ZN414Z	£1.16	TIC126D	£0.77	BC170	£0.16	BC560B	£0.09	BU208A	£1.24
ICL8038	£5.25	ZN416E	£1.99	Triacs		BC170B	£0.16	BC637	£0.21	BU208A	£1.24
ICN17555	£0.36	ZN416E	£3.11	TIC206D	£0.65	BC171	£0.11	BC638	£0.21	BU500	£1.54
ICN17556	£0.36	ZN416E	£3.11	TIC206D	£0.65	BC171B	£0.11	BC638	£0.21	BU508A	£1.44
LM65V	£2.63	2N116	£5.50	TIC226D	£0.73	BC172	£0.13	BC640	£0.21	BU508D	£1.44
LM72M	£1.89	2732	£4.84	BT408-600B	£0.99	BC172B	£0.13	BCY70	£0.22	BU526	£1.74
LM797	£6.37	2764-25	£4.20	TIC236D	£0.96	BC177	£0.18	BCY71	£0.20	BU806	£1.06
LM93	£6.99	2764-25	£4.20	Diag. Si. Switch		BC178	£0.18	BCY72	£0.20	BUT11A	£1.30
LM347N	£0.46	27C60-25	£3.44	DB3, 32V	£0.20	BC179	£0.18	BD124P	£6.86	BUT11AF	£1.30
LM351N	£0.43	27C101	£5.74	DRY39	£1.30	BC179A	£0.17	BD135	£0.21	BUX84	£0.78
LM353N	£0.42	27128-20	£4.08	27128-20	£4.08	BC182	£0.11	BD136	£0.21	IRF540	£1.60
LM355	£0.84	27256-20	£4.85	27256-20	£4.85	BC182A	£0.11	BD137	£0.23	IRF740	£1.80
LM301A	£0.25	27256-20	£3.68	RAM		BC182B	£0.12	BD138	£0.22	MJ2501	£1.60
LM308N	£0.58	27256-20	£3.42	2N2218A	£0.28	BC182L	£0.08	BD139	£0.26	MJ3001	£1.80
LM311N-8	£0.32	4164-15	£1.78	2N2219A	£0.25	BC182LB	£0.08	BD140	£0.25	MJ11015	£2.11
LM318	£0.98	6116-10	£0.96	2N2222A	£0.18	BC183	£0.08	BD150C	£0.82	MJ11016	£2.56
LM319N-14	£0.30	6264-10	£1.53	2N2646	£0.86	BC183B	£0.08	BD165	£0.35	MJF340	£0.40
LM324	£0.26	41256-10	£2.80	2N2904A	£0.25	BC184	£0.08	BD187	£0.39	MPSA05	£0.14
LM335Z	£1.52	62256-10	£5.35	2N2905A	£0.25	BC184L	£0.08	BD201	£0.40	MPSA06	£0.12
LM339N	£0.24	511000-8	£8.54	2N2907	£0.20	BC184C	£0.08	BD202	£0.40	MPSA13	£0.12
LM348N	£0.31	514256-8	£6.88	2N2907A	£0.20	BC204	£0.72	BD203	£0.40	MPSA42	£0.17
LM358N	£0.27			2N2926	£0.16	BC206B	£0.72	BD204	£0.40	MRF475	£7.28
LM377	£2.57			2N3053	£0.27	BC207B	£0.74	BD222	£0.58	TIP29C	£0.31
LM380N-14	£1.12			AD420AN	£25.38	BC208	£0.72	BD225	£0.42	TIP30C	£0.41
LM381N	£2.64			AD557JN	£8.75	BC209A	£0.72	BD232	£0.50	TIP31C	£0.31
LM386	£0.79			AD674JN	£18.48	BC212	£0.08	BD237	£0.32	TIP32C	£0.41
LM392N	£0.79			AD767JN	£20.88	BC212L	£0.08	BD238	£0.32	TIP33C	£0.72
LM393N	£0.21			AD775JN	£18.48	BC212LB	£0.08	BD240C	£0.37	TIP41A	£0.48
LM709T	£0.09			AD7226KN	£25.69	BC213	£0.08	BD243B	£0.50	TIP42C	£0.52
LM733	£1.04			AD7528JN	£8.63	BC213B	£0.08	BD244A	£0.53	TIP47	£0.48
LM748CN-8	£0.37			AD7545AKN	£14.04	BC213C	£0.08	BD244C	£0.53	TIP48	£0.48
LM759CP	£3.38			AD7581JN	£25.80	BC213LC	£0.08	BD245C	£1.18	TIP48	£0.48
LM1458	£0.37			AD7828KN	£20.33	BC214	£0.08	BD246C	£1.18	TIP21	£0.48
LM1881	£3.92			AD7845JN	£14.04	BC214L	£0.08	BD246	£1.18	TIP22	£0.48
LM2917N8	£3.10			ICL7109CPL	£7.75	BC225	£0.15	BD246C	£1.18	TIP22	£0.48
LM3900N	£0.72			ICL7549JP	£3.51	BC237B	£0.09	BD283	£0.61	TIP25	£0.46
LM3909N	£1.76			ZN425E	£5.94	BC238	£0.09	BD284	£0.61	TIP27	£0.40
LM3911	£2.56			ZN426E	£3.13	BC238C	£0.09	BD400	£0.79	TIP32	£0.46
LM3914	£2.30			ZN427E	£8.78	BC239C	£0.10	BD441	£0.41	TIP37	£0.56
LM3915	£2.70			ZN428E	£5.94	BC250A	£0.15	BD442	£0.47	TIP42	£1.08
LM13600	£1.66			ZN439E8	£7.13	BC251	£0.13	BD535	£0.37	TIP47	£1.12
LMC3600CN	£2.16			ZN448E	£7.02	BC252	£0.13	BD535	£0.50	TIP2955	£0.97
LMC6032IN	£1.55			7805	£0.44	BC261B	£0.30	BD536	£0.65	TIP3055	£0.63
LMC6042IN	£1.82			7808	£0.50	BC262B	£0.24	BD581	£0.62	VN10KM	£0.48
LP311N	£0.24			7812	£0.50	BC267B	£0.30	BD597	£0.92	ZTX300	£0.16
LP324N	£0.74			7815	£0.38	BC307	£0.10	BD646	£0.52	ZTX500	£0.16
LP339N	£0.74			7818	£0.50	BC308	£0.10	BD648	£0.52		
MAX202CPE	£2.93			7819	£0.38	BC319C	£0.13	BD650	£0.53		
MAX208CNP	£6.99			7819	£0.38	BC327	£0.10	BD707	£0.42		
MAX220CPE	£5.06			7905	£0.40	BC327-16	£0.10	BD708	£1.04		
MAX222CPE	£5.06			7912	£0.38	BC328	£0.10	BD807	£0.80		
MAX232CPE	£2.16			7915	£0.38	BC328-16	£0.10	BDX32	£1.48		
MAX238CNP	£6.88			7924	£0.38	AC126	£0.44	BC337	£0.10	BDX33C	£0.49
MAX242CPE	£2.63			78L05	£0.26	AC127	£0.50	BC337-25	£0.10	BDX35C	£0.50
MAX631ACP	£4.99			78L08	£0.23	AC128	£0.40	BC338	£0.10	BDX53C	£0.47
MAX635ACP	£4.99			78L12	£0.23						
MC1488	£0.39			78L15	£0.24						
MC1489	£0.39			78L24	£0.39						
MC3302	£0.56			7910S	£0.28						
MC3340P	£1.60			79108	£0.28						
MC3458P	£0.36			79112	£0.23						
MV600DP	£2.93			79115	£0.28						
NE531	£1.47			79124	£0.27						
NE555N	£0.25			AD6666AN	£5.11						
NE556N	£0.36			L2000VC	£1.24						
NE565	£1.84			L296	£8.13						
NE566N	£0.90			L387A	£3.24						
NE567N	£0.39			LM2940CT	£2.20						
NE571N	£2.47			LM317T	£2.84						
NE572N	£0.62			LM323K	£2.84						
NE583N	£0.80			LM334Z	£1.32						
NE5832N	£0.64			LM384	£5.52						
OP07CN	£1.42			LM723	£0.29						
OP27CN	£2.90			LP2950CZ	£2.97						
OP27GP	£2.36			REF01CP	£3.44						
OP90GP	£3.11			REF02CP	£4.66						
OP13GP	£2.43			REF12Z	£1.28						
OP17GP	£1.89			REF195GP	£4.72						
OP183GP	£3.44										
OP200GP	£5.60										
OP213FP	£2.00										
OP275GP	£2.57										
OP282GP	£2.27										
OP283GP	£5.20										
OP290GP	£5.40										

# EVERYDAY PRACTICAL ELECTRONICS

VOL. 25 No. 6

JUNE '96

**Editorial Offices:**  
EVERYDAY PRACTICAL ELECTRONICS EDITORIAL  
ALLEN HOUSE, EAST BOROUGH, WIMBORNE  
DORSET BH21 1PF  
Phone: Wimborne (01202) 881749  
Fax: (01202) 841692.  
**Due to the cost we cannot reply to orders or queries by Fax.**

See notes on Readers' Enquiries below - we regret lengthy technical enquiries cannot be answered over the telephone.  
**Advertisement Offices:**  
EVERYDAY PRACTICAL ELECTRONICS  
ADVERTISEMENTS  
HOLLAND WOOD HOUSE, CHURCH LANE  
GREAT HOLLAND, ESSEX CO13 0JS  
Phone/Fax: (01255) 850596

## SEMI-ILLEGITIMATE

I suppose I consider myself to be computer semi-illegitimate - I was educated before PCs married themselves into everyday life. But I can sort out some of the problems we have with the everyday glitches that present themselves on our various office software packages; however, the typesetting scanners, processors and image setters are another ball game.

I'm the sort of person who likes to know how things operate and to be able to put them right when they don't, but I don't mind admitting that there is no way I would ever try to delve into our various computer systems. However, PCs are incredibly useful and I wonder how we would cope without them now.

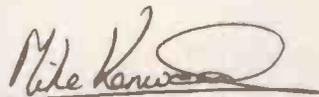
I well remember the then managing director of IPC magazines turning down my idea for a hobby computing magazine in the late seventies because he could "see no reason for anyone to want a computer in their home"! Within a few months *Personal Computer World* and *Practical Computing* had been launched by other publishers and their success is now obvious to all.

## FACT OF LIFE

Like them or not, computers are now a fact of life and it is in everyone's interest to use these tools to their advantage. When it comes to project building you can design and test your own circuit "on screen" without ever seeing a real component. You can design and layout a p.c.b. for the project and you can program your own PIC (or similar) chip, dedicated to your project design; and there is no doubt that the use of PICs can simplify construction - see the PulStar article on page 456.

The other interesting area of computing relating to electronics is as an educator and information supplier. Teach yourself electronics theory using your PC, or plug into millions of data sources around the world via the Internet. Next month our own Internet expert, Alan Winstanley, will blast apart the jungle of computerspeak and hype that surrounds The Net to put you in the picture on the how, why, where, what and when of this global communications network.

Even if you detest PCs you should read this article. The Internet is beginning to have a significant effect on all sorts of areas of life, its uses and users are mushrooming and we believe that everyone should know what it's all about. Even if you are already aware and "On The Net" we are sure, as an electronics enthusiast, that you will find some interesting information in Alan's article.



## SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £24. Overseas: £30 (£47.50 airmail). Cheques or bank drafts (in £ sterling only) payable to *Everyday Practical Electronics* and sent to EPE Subscriptions Dept., Allen House, East Borough, Wimborne,

Dorset BH21 1PF. Tel: 01202 881749. Subscriptions start with the next available issue. We accept Access (MasterCard) or Visa. (For past issues see the *Back Issues* page).

## BINDERS

Binders to hold one volume (12 issues) are available from the above address. These are finished in blue p.v.c., printed with the magazine logo in gold on the spine. Price £5.95 plus £3.50 post and packing (for overseas readers the postage is £6.00 to everywhere except Australia and Papua New Guinea which cost £10.50). *Normally sent within seven days but please allow 28 days for delivery - more for overseas orders.*

*Payment in £ sterling only please. Visa and Access (MasterCard) accepted, minimum credit card order £5. Send or phone your card number and card expiry date with your name, address etc.*



**Editor:** MIKE KENWARD  
**Secretary:** PAM BROWN  
**Deputy Editor:** DAVID BARRINGTON  
**Technical Editor:** JOHN BECKER  
**Business Manager:** DAVID J. LEAVER  
**Subscriptions:** MARILYN GOLDBERG  
**Editorial:** Wimborne (01202) 881749  
**Advertisement Manager:**  
PETER J. MEW, Frinton (01255) 850596  
**Advertisement Copy Controller:**  
DEREK NEW, Wimborne (01202) 882299

## READERS' ENQUIRIES

We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply *must* be accompanied by a stamped self-addressed envelope or a self-addressed envelope and international reply coupons. **Due to the cost we cannot reply to queries by Fax.**

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it.

## COMPONENT SUPPLIES

We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers.

We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

We regret that we cannot provide data, or answer queries, on projects that are more than five years old.

## ADVERTISEMENTS

Although the proprietors and staff of EVERYDAY PRACTICAL ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or in inserts.

The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should first address them to the advertiser.

## TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

We advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the UK. Readers should check the law before buying any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use or ownership. The laws vary from country to country; overseas readers should check local laws.

# SARAH'S LIGHT

STEVE AZE



*Banish the fears of darkness with this toddler's cot light. So simple, a one year old can use it!*

**S**O YOU'RE not afraid of the dark? Imagine the scene: It's the middle of a winter's night when you're woken up by the sound of a creaking floorboard. Pulse racing, you try to get out of your bed, but find that you can't.

The hairs on the back of your neck stand up as you consider that from where you are there's no way you can turn on the light. So you crouch, trapped, staring into the darkness while your imagination parades a host of outlandish possibilities for your terror.

Sounds like a nightmare? It's a situation faced nightly by children who sleep in a cot – and then we wonder why kids are afraid of the dark! So the idea for Sarah's Light was born, to banish fears of the dark by giving the child control over it.

## SARAH'S LIGHT

The specification was for a bedside light that could be operated by a seventeen month-old baby. A standard bedside light was dismissed right away on safety grounds: mains voltages, hot bulbs and breakable glass do not mix well with unsupervised children.

Sarah's Light would have to be intrinsically very safe – no high voltages, no hot areas, and no small pieces that could choke a child. It would have to be push-button operated, as rocker switches are a bit tricky for little fingers, but my daughter has been adept at using pushbuttons from as soon as she could make her own way to the hi-fi. The switches for this project would also have to "glow" so that they could be easily found in the dark.

As it's easy to fall asleep with a light on, particularly when reading before bedtime, the lamp would have to turn itself off after a while. However, as any parent will tell you, a lamp suddenly turning off can as easily wake a small child as one turning on, so a slow fade is needed.

This also helps when the light is used by an adult or older child; it fades out gently after a while if you've fallen asleep, but won't plunge you into darkness without warning just as you're coming to the end of a chapter.

## CIRCUIT DESCRIPTION

The main circuit diagram for Sarah's Light is shown in Fig. 1. The power supply regulation and smoothing is shown in Fig. 2.

At the heart of the circuit are two 4526 CMOS programmable 4-bit binary down-counters, IC1 and IC2. When the "load" input (pin 3) on the 4526 is taken high, the binary-format numerical value on the four parallel inputs P0 to P3 (pins 5, 11, 14, 2) is loaded into the counter.

With each low/high transition on the clock input (pin 6) the count decreases by one, with the counter value appearing on outputs Q0 to Q3 in binary format. A high on the Reset pin (10) will take the count to zero.

The 4526 features a useful "zero detect" (ZD) pin which goes high when the counter value is zero. Note that when the counter is at zero, the next clock pulse takes the count around to binary 1111 (decimal 15).

To get what is effectively an 8-bit programmable down-counter, IC1 and IC2 are linked by connecting the Q3 output (pin 1)

of IC2 to the clock input (pin 6) of IC1. In this format IC1 shows the four most significant bits of the combined 8-bit counter.

At power on, one of the gates of a 4093 quad 2-input NAND Schmitt trigger, IC5a, temporarily takes the Reset pins of the counters high, resetting the combined count to zero. The ZD pins of both i.c.s will then be high, so the output of NAND gate IC5c is low, inhibiting the system oscillator IC5b, so that the whole circuit is in a static condition.

Pressing the On button of switch S1 loads the value 11111111 binary (255 decimal) into the combined counter (IC1, IC2), as programmed by the P0 to P3 data input pins of both i.c.s. IC1 ZD goes low (no longer zero count on IC1), so IC5c output goes high, enabling the oscillator formed around IC5b. This oscillates at about one kiloHertz (1kHz), which we'll call 1024Hz as it makes the maths easier(!).

A 12-bit binary counter, IC4, produces a square wave; with the output on Q12 being a square wave of  $\frac{1}{2^{12}}$  (1/4096) of the frequency of the clock input. In this case this is 0.25Hz (1024/4096), or four seconds for each complete cycle. So the count on the combined 8-bit counter, which was initially set to 255 decimal by pressing the "on" switch, will now decrement by one every four seconds.

## LAMP DRIVER

The main illuminating lamp(s) LP3/4 is driven by transistor TR1, which is a power MOSFET device chosen because it is easy to interface to CMOS outputs, and is a cost-effective way of handling the required current. TR1 is controlled by the output of NAND gate IC5d, which acts here as an inverse logic OR gate, so that if either input is low, its output is high and TR1 is on.

Whilst the 8-bit counter value is in the range binary 11111111 down to 00010000 (decimal 255 to 16), IC1 has a count of greater than zero, so the zero detector of IC1 is low, causing IC5d output to be high, switching TR1 and the main lamp(s) on.

After a period of about four seconds  $\times$  240 (about 16 minutes) following pressing the On switch, the count eventually falls to binary 00001111 (15 decimal). The zero detector (ZD), pin 12 of IC1, then goes high (zero count on IC1), and the output of IC5d becomes conditional on the A<=B output of IC3 pin 7.

When this is high, with IC1 ZD also being high, the output of IC5d will be low and TR1 will be off. Conversely, when the



$A <= B$  output of IC3 is low, the output of IC5d will be high and TR1 will be on.

IC3 is an arithmetic comparator which compares two 4-bit words. The outputs of this device indicate the relative magnitudes of the two words.

Pin 7 output of IC3 is given as an  $A <= B$  output. This means it is high when word A is smaller than word B, but by configuring the cascade inputs (pins 2, 3, 4) as shown, it becomes an  $A <= B$  output. This means that it is high when A is less than or equal to B.

## COUNTING

When the oscillator IC5b is running, word B presented to IC3 is constantly counting from 0 to 15 decimal and then back to 0 again. It goes through this cycle 128 times a second (clock frequency 1024Hz divided by  $2^3$ ).

When the word at A (the outputs of IC2) is 15 decimal, the  $A <= B$  output will be high while word B is 15 decimal (the condition "Is A less than or equal to B?" is satisfied). IC1 ZD is also high (as IC1 is at zero), so IC5d output is low and TR1 is off.

For the rest of the word B cycle (values 0 to 14 decimal at word B), IC3  $A <= B$  output will be low (A is not less than or equal to B), causing IC5d output to be high and TR1 to be on. Thus the lamp is driven by a 128Hz square wave with a mark:space ratio of 15:16 (i.e. it is on for 94 per cent of each cycle), and so glows with a slightly reduced intensity.

Four seconds later, the next low-to-high transition at the clock input to IC2 pin 6 will cause the word at A to decrease by one. The word at A is now 14, so the mark:space ratio of the pulse output of IC5d will be 14:16, so that TR1 is now on for only 88 per cent of the time and the lamp glows a bit dimmer still.

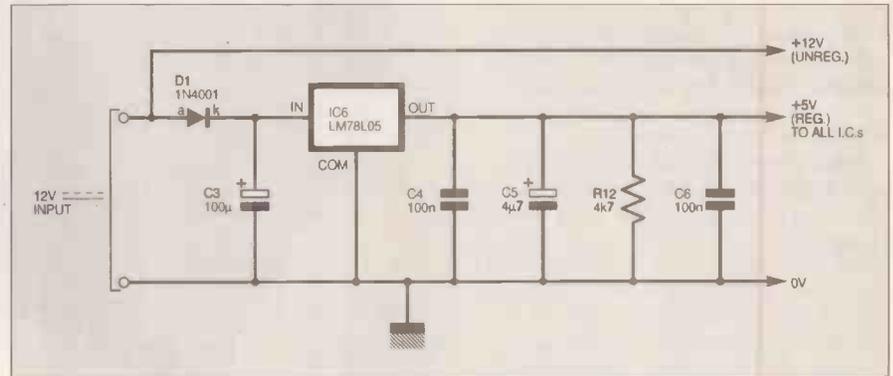


Fig. 2. Supply voltage regulation circuit for the i.c.s.

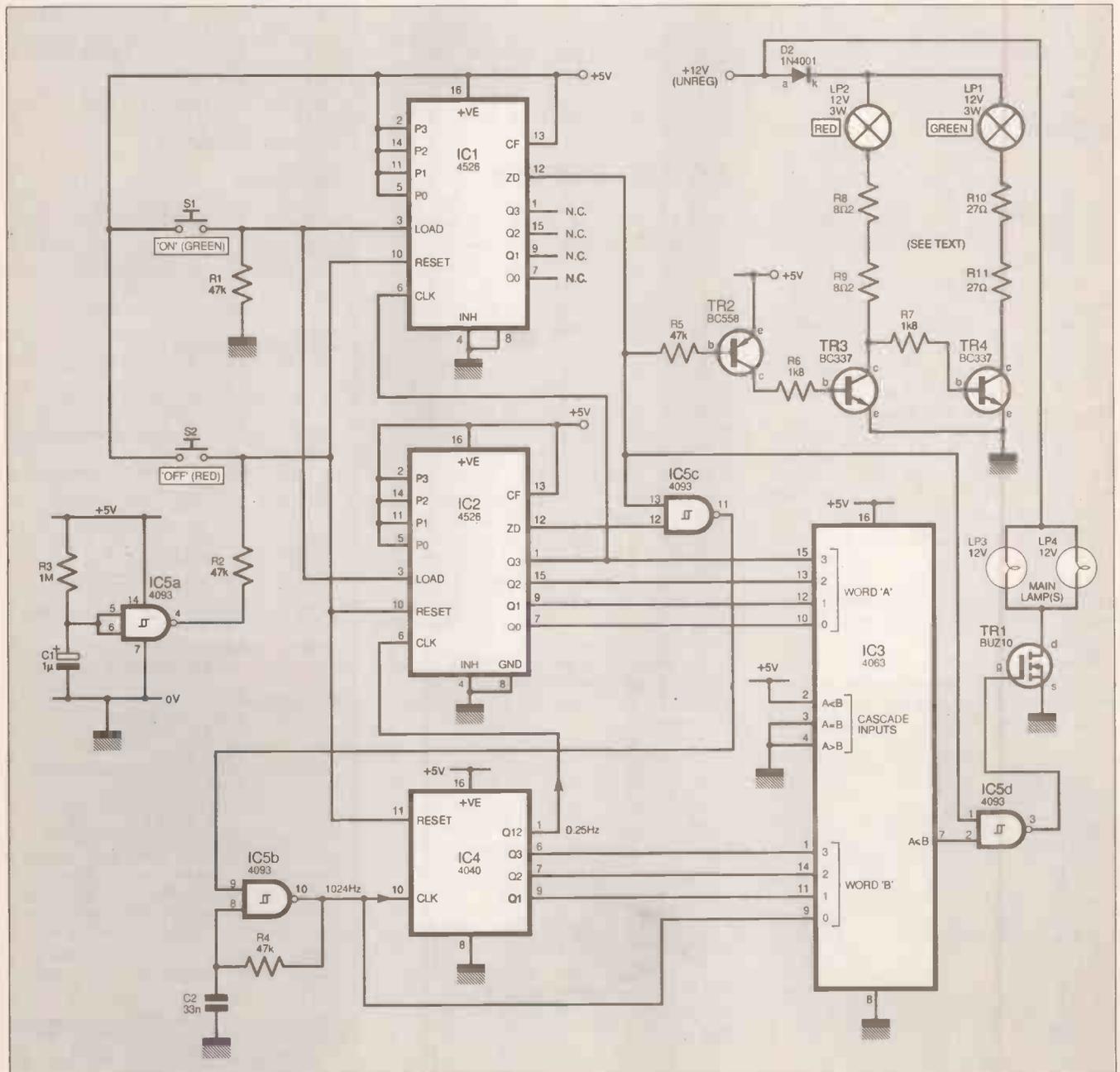


Fig. 1. Main control circuit diagram for Sarah's Light. Switches S1 and S2 are combined with indicator lamps LP1 and LP2.

In this way the brightness of the bulb decreases in 16 four-second steps, as the count on the 8-bit combined IC1/IC2 counter counts down from decimal 16 down to zero. When the IC1/IC2 combined count is zero, the action of IC5c then stops oscillator IC5b (IC1 and IC2 ZDs both high, so IC5c output goes low), and the circuit halts.

Word A at IC3 is now zero, which has to be less than or equal to word B, so IC3  $A \leq B$  output is high. IC1 ZD is also high, so IC5d output is low and TR1 is off. The dimming process therefore takes approximately four seconds  $\times$  16 (about a minute) from full brightness to fully off.

This pulse-width modulation or "chopper" action by transistor TR1 when dimming is preferable to that of a simple voltage follower with a decaying voltage, as the latter would cause a higher dissipation in the output transistor. This would then require heatsinking, leading to constructional complication and expense.

In the chopper circuit given here the MOSFET TR1 is only ever fully on or fully off, so the dissipation is kept low. The on-state resistance of the BUZ10 (TR1) is given as 0.08 ohms, so calculating the dissipation in TR1 as  $I^2R$ , it can be seen that moderately large currents can be handled with little or no heatsinking.

## LIGHT TIME

The indicator lights, LP1 and LP2, for the On and Off switches are driven from the zero detection (ZD) output of IC1 via transistors TR2 to TR4, such that the Red light LP2 is on when the main lamp LP3/4 is at full brightness.

The Green light LP1 comes on at the beginning of the final countdown period, and remains on when the circuit is parked in the fully-off mode. Note that as TR4's base (b) current comes through the filament of the Red light, this bulb must be in place for the Green light to operate.

Ordinarily, pushbuttons are arranged so that they light up when pressed, but here they go off when pressed. This is so that when the main lamp LP3/4 is off and all is in darkness, the button to switch the lamp on is illuminated and so can be found in the dark. It also seems to make good sense to a one year old, who understands that to make something happen she/he needs to press the button that is glowing.

Resistors R8 to R11 adjust the brightness of the switch-illuminating bulbs to the desired level. The Green light shows when all is dark, so should be set up to glow



Completed Light unit showing the main lamps and pushbuttons.

very dimly, unless it is to double as a "nightlight" to light-up the whole room.

Running the lamp at a reduced power also greatly increases the bulb life, which is no bad thing as this bulb will be on for most of the time.

## POWER SUPPLY

The 12V needed to power the unit doesn't need to be particularly smooth, so a straightforward bridge rectifier and capacitor arrangement can be used to provide the d.c. with maximum efficiency. A suggested circuit diagram for a suitable power supply arrangement is shown in Fig. 3.

Diodes D1 and D2, in Fig. 1 and Fig. 2, give reverse polarity protection against the possibility of a wrong connection between PSU and lamp controller.

The voltage to the power MOSFET TR1 is picked off before diode D1, to avoid losing another 0.7V forward drop. The voltage by the time it gets to the bulbs is about 11V (9V transformer output  $9V \times \sqrt{2}$ , less two diode forward drops and a bit for ripple). When driving a 10W main lamp, the MOSFET drops less than 0.1V, compared to 0.7V for a bipolar device, so that helps.

The logic is a bit more fussy about ripple on the power supply, so it gets a stabilised 5V courtesy of voltage regulator IC6. See Fig. 2.

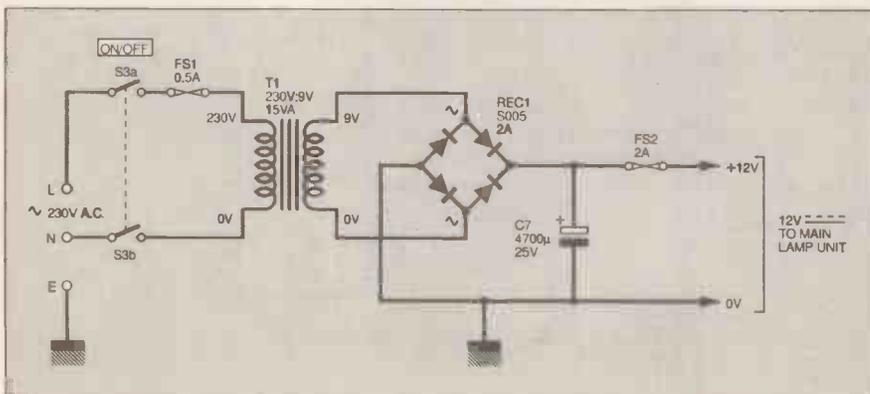


Fig. 3. Circuit diagram for a suggested mains driven power supply.

## COMPONENTS

### Resistors

R1, R2,	47k (4 off)
R3	1M
R6, R7	1k8 (2 off)
R8, R9	8 $\Omega$ 2 (2 off - see text)
R10, R11	27 $\Omega$ (2 off - see text)
R12	4k7

All 0.6W 1% metal film

See  
**SHOP  
TALK**  
Page

### Capacitors

C1	1 $\mu$ radial elect. 16V
C2	33n resin-dipped plate ceramic
C3	100 $\mu$ radial elect. 35V
C4, C6	100n resin-dipped plate ceramic (2 off)
C5	4 $\mu$ 7 radial elect. 63V

### Semiconductors

D1, D2	1N4001 50V 1A rec. diode (2 off)
TR1	BUZ10 <i>n</i> -channel power MOSFET
TR2	BC558 <i>npn</i> silicon transistor
TR3,	
TR4	BC337 <i>npn</i> silicon transistor (2 off)
IC1, IC2	4526 4-bit programmable binary down-counter
IC3	4063BE 4-bit magnitude comparator
IC4	4040BE 12-stage binary counter
IC5	4093BE quad 2-input NAND Schmitt trigger
IC6	LM78L05 +5V 100mA voltage regulator

### Miscellaneous

S1/LP1	Green illuminated pushbutton switch (see text)
S2/LP2	Red illuminated pushbutton switch (see text)
LP3, LP4	main lamp unit, 12V 3W bulb, (see text - 2 off)

Printed circuit board available from EPE PCB Service, code 996; plastic case, size to choice; 14-pin d.i.l. socket; 16-pin d.i.l. socket (4 off); strain-relief cable grommet; multistrand connecting cable; solder terminal pins; solder etc.

Note: components have not been included for the suggested power supply (P.S.U.) - see text.

Approx Cost  
Guidance Only

**£25**  
excluding P.S.U.

## CONSTRUCTION

Please keep safety in mind throughout the construction. There must be no small parts that could become detached and present a possible choking hazard to young children.

The switches and lamps **MUST** have securely attached lenses that cannot be prised off, and the lamp(s) should be checked to make sure that no accessible parts become too hot to the touch. The unit should be immovably fixed to the child's cot or wall, and the cabling carefully secured so that there are no loops that could be hazardous.

## CIRCUIT BOARD

The circuit for Sarah's Light is accommodated on a single-sided printed circuit board (p.c.b.). The only off-board wiring being to the combined On/Off switch/indicator lamps, main illuminating lamps and low voltage supply leads.

Topside p.c.b. component layout and full size underside copper foil master are shown in Fig. 4. This board is available from the *EPE PCB Service*, code 996.

Building the p.c.b. is straightforward enough. But normal CMOS handling precautions should be observed while handling any of the i.c.s. It is suggested that d.i.l. sockets be used for the i.c.s.

Depending upon the rating of lamp(s) to be used, it may be as well to build up the main current-carrying areas of the p.c.b. track with solder. These being: those areas of track interconnecting the power MOSFET TR1, the power supply input pins and main illuminating lamp output pins.

Commence construction of the p.c.b. by inserting the eight link wires, 12 solder pins and the five d.i.l. sockets. Do not insert any i.c.s until the board construction has been completed and checked for wiring faults or solder "bridges" across tracks.

Next, the resistors and capacitors should be mounted, in ascending size. Finally, the transistors should be soldered in place. Be extra careful to get the orientation of the transistors and i.c.s, plus the polarities of the electrolytic capacitors the correct way round.

The main output MOSFET TR1 does not need any heatsinking with lamps of up to 20W or so, as its low "on" resistance (about 0.1 ohms) and the chopper action of the lamp driver circuit keep heat losses very low.

Transistor TR1 is rated at 20A, so the circuit as shown can be used to drive quite a large load if a heatsink is used for it. Even if a 60W car headlight-sized bulb were to be used (more of a floodlight than

a reading light), the dissipation in TR1 would be less than 3W, so a quite modest heatsink would suffice.

## LAMP UNIT

In choosing a suitable 12V lamp unit, it was found that 3W is sufficient to see by, but if the unit is to be used by an adult or older child as a reading lamp, a reasonably focussed 10W is needed.

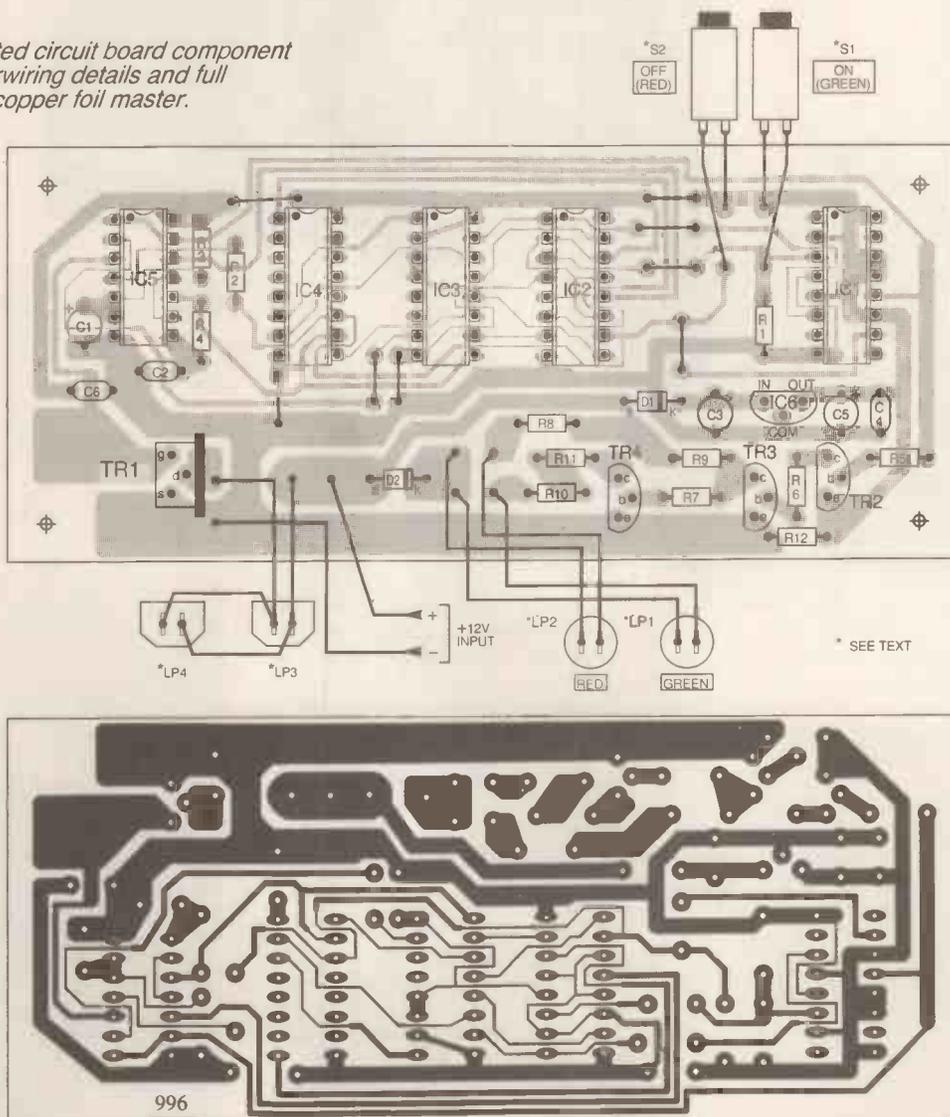
Finding a suitable 10W 12V lamp unit can be a problem, as most automotive lamps that could be used for this purpose (interior lights, number plate lamps, etc.) use 5W bulbs. Some trailer number plate lamps use 10W bulbs, but these can become rather hot to the touch.

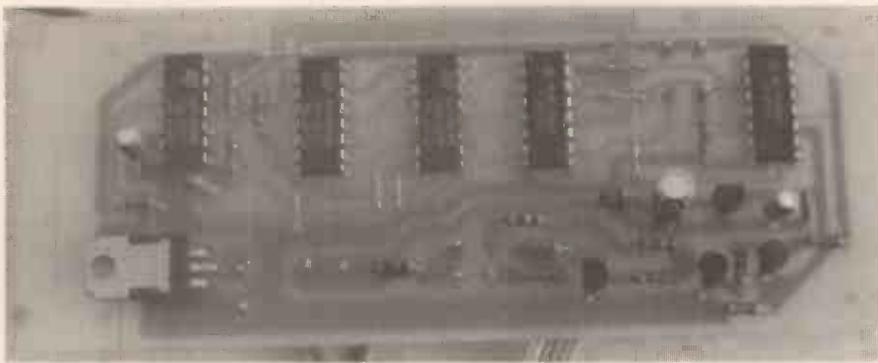
This problem was finally settled by using two 5W units. The author found that number plate lamps from a Fiat Uno give just the right pattern of illumination and are easy to mount.

They can be used with 5W or 3W capless bulbs. However, with the 5W bulb for which it is designed, the lens becomes quite warm to the touch, although not hot enough to burn.

The Fiat Uno lamps need to be adapted to fulfil the criterion of being secure against dismantling from the front of the panel. By taking off the spring mounting-lugs on the body and fixing the lamps into

Fig. 4. Printed circuit board component layout, interwiring details and full size p.c.b. copper foil master.





Component layout on completed circuit board. The power MOSFET TR1 has been carefully bent horizontally with the p.c.b.

the case cut-outs using screws, they are proofed against being prised out by little fingers.

On the prototype, the two lamps are mounted side by side and look like a scary pair of glowing eyes, but the author's daughter seems unperturbed.

### INDICATOR LAMPS

Finding the right series resistance to make LP1, the Green switch indicator lamp, glow gently in the dark is largely a matter of trial and error. The most efficient approach

series resistors for each lamp, so a pair of 0.6W metal film miniature resistors will be adequate to cope with the required dissipation in most applications.

The mains power supply unit should be kept completely separate from the lamp unit and tucked away out of reach of little hands, so that only low voltage cables are run to the lamp unit site. The cable *must* be

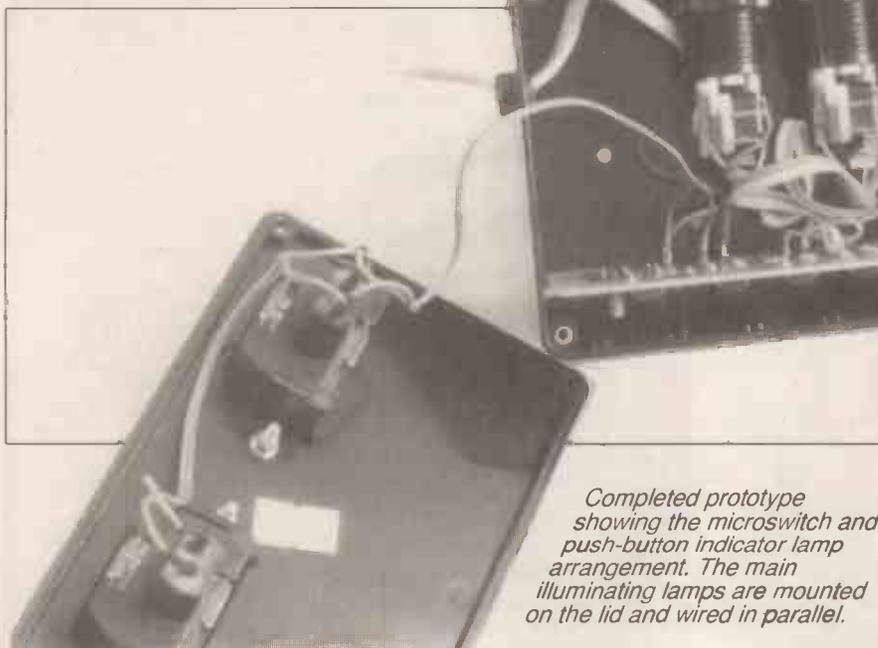
R5 from the rest of the circuit and using it to look at what is going on. The Green light will show for no connection or high, and the Red light will show for low.

Remember that if using the suggested switches and series resistors for the indicator lamps LP1 and LP2, the Green light is intended to be seen to glow dimly in conditions of darkness, and so may not seem to glow at all when viewed in bright conditions.

### VARIATIONS

The delay period before turning off can be changed by varying the values of resistor R4 or capacitor C2 to give a different oscillator frequency. Doubling the value of either would halve the oscillator frequency and so double the delay time, producing a delay of about half an hour before turning off (with a two minute dimming period). The delay time could be increased up to about 45 minutes before the chopper action of TR1 produces a noticeable flicker during dimming due to the slower running of the oscillator.

For a delay of less than 15 minutes, but still with a one minute dimming period, the initial count loaded into IC1 could be made smaller. For example, taking IC1 P3 (pin 2) low (0V) instead of high would give a delay of about eight minutes (countdown from 01111111 binary, 127 decimal) before a one minute dimming period.



Completed prototype showing the microswitch and push-button indicator lamp arrangement. The main illuminating lamps are mounted on the lid and wired in parallel.

is to use a 24V bulb, if available, which seems to give about the right amount of light for use under dark conditions when driven by a 12V supply. Otherwise, if using a 12V bulb, a series resistance of about the same value as the resistance of the bulb when hot is a good starting point.

The combination switch/lamp used in the prototype is an RS type (see *Shoptalk*) and is continuously rated for bulbs of up to 2W only. Unhelpfully, this is rather less than the smallest bulb (2.4W) which will fit them, so a series resistance is needed for the Red bulb as well.

With these switches, suitable series resistor values for the red bulb were found to be 8.2 ohms for R8 and R9 (total 16.4 ohms). If using a 12V 3W bulb for the Green indicator lamp, values for resistors R10 and R11 of 27 ohms (total 54 ohms) give the desired dim glow, or 10 ohms each (total 20 ohms) with a 24V 3W bulb.

Provision is made on the p.c.b. for two

permanently attached at the lamp end (to avoid it being pulled out), and connected at the other end to the power supply by some type of adequately rated plug-in connector. Also, where the cable runs from the lamp unit it should be hidden away and firmly secured down the *outside* of the child's cot, away from inquisitive fingers.

*Double check to satisfy yourself that the unit does not present any hazard before leaving it with unattended children.*

### TESTING

If the circuit doesn't work when first switched on, a good initial check is to use a logic probe to look at the Q12 output on pin 1 of IC4. When the circuit is counting down, this output should be changing state every two seconds.

Trouble-shooting for the hard-up constructor without a logic probe of their own could be carried out by temporarily breaking-away the "ZD" side of resistor

### CONCLUSION

Sarah thinks her light is wonderful. On a dark winter's morning she now chases to turn the light on and look through her picture books when she wakes up, instead of bawling until someone comes to her.

Mum and Dad can now use the extra time in bed in the morning to do what they used to do a lot more of before they had children – sleep!



# HART

## HART AUDIO KITS – YOUR VALUE FOR MONEY ROUTE TO ULTIMATE HI-FI

HART KITS give you the opportunity to build the very best engineered hi-fi equipment there is, designed by the leaders in their field, using the best components that are available.

Every HART KIT is not just a new equipment acquisition but a valuable investment in knowledge, giving you guided hands-on experience of modern electronic techniques.

In short HART is your 'friend in the trade' giving you, as a knowledgeable constructor, access to better equipment at lower prices than the man in the street.

You can buy the reprints and construction manual for any kit to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.

Our list will give you full details of all our Audio Kits, components and special offers.

### INTRODUCING The Hart "Chiara"

#### Single-Ended Class "A" Headphone Amplifier.

Most modern high fidelity amplifiers either do not have a headphone output facility, or this may not be up to the highest standard.

The new Hart "Chiara" has been introduced as an add-on unit to remedy this situation, and will provide two ultra high quality headphone outlets. This is the first unit in our 2000 Range of modules to be introduced through the year. Housed in the neat, black finished, Hart Minibox it features the wide frequency response, low-distortion and "musicality" that one associates with designs from the renowned John Linsley Hood.

Both outputs will drive any standard high quality headphones with an impedance greater than 30 ohms and the unit is ideal for use with the Sennheiser range. A signal link-through makes it easy to incorporate into your system and two extra outputs, one at output level and one adjusted by the Volume control are available on the back panel. The high level output also makes a very useful long-line driver where remote mounted power amplifiers are used. Power requirements are very simple and can be provided by either of our new "Andante" power supplies. Use the K3565 to drive the "Chiara" on its own, K3550 if driving other modules as well.

Volume and Balance controls are provided and as befits any unit with serious aspirations to quality these are the ultra high quality Alps "Blue Velvet" components.

Very easily built, even by beginners, since all components fit directly on the single printed circuit board and there is no conventional wiring whatsoever. The kit has very detailed instructions, and even comes with a roll of Hart audiograde silver solder. It can also be supplied factory assembled and tested.

Selling for less than the total cost of all the components, if they were bought separately, this unit represents incredible value for money and makes an attractive and harmonious addition to any hi-fi system.

**K2100** The total cost of a complete set of all components to build this unit is £126.37. Our special discount price for all parts bought together as a kit is **£109.50**

**K2100SA** Series Audiophile, with extra selected components.....**£112.46**

#### HART TC1D Triple Purpose TEST CASSETTE

Now available again and even better than before! Our famous triple purpose test cassette will help you set up your recorder for peak performance after fitting a new record/play head. This quality precision Test Cassette is digitally mastered in real time to give you an accurate standard to set the head azimuth, Dolby/VU level and tape speed, all easily done without test equipment.

TC1D Triple Purpose Test Cassette.....**£9.99**

Send or phone for your copy of our FREE List of these and many other Kits & Components. Enquiries from Overseas customers are equally welcome, but PLEASE send 2 IRCs if you want a list sent surface post, or 5 for Airmail.

Ordering is easy. Just write or telephone your requirements to sample the friendly and efficient HART service. Payment by cheque, cash or credit card. A telephoned order with your credit card number will get your order on its way to you THAT DAY.

Please add part cost of carriage and insurance as follows:—INLAND Orders up to £20 - £1.50,

Orders over £20 - £3.50. Express Courier, next working day £10.

OVERSEAS - Please see the ordering information with our lists.

### NEW BOOK

#### "Audio Electronics"

And now, hot off the press, yet another classic from the pen of John Linsley Hood. Following the ongoing enormous success of his "Art of Linear Electronics" the latest offering is the all-new edition of "Audio Electronics", now entirely re-written by the master himself.

Underlying audio techniques and equipment is a world of electronics that determines the quality of sound. For anyone involved in designing, adapting or using digital or analogue audio equipment understanding electronics leads to far greater control over the reproduced sound.

The subjects covered include tape recording, tuners, power output stages, digital audio, test instruments and loudspeaker crossover systems. John's lifetime of experience and personal innovation in this field allow him to apply his gift of being so familiar with his subject that he can write clearly about it and make it both interesting and comprehensible to the reader.

Containing 240 pages and over 250 line illustrations this new book represents great value for money at only £18.99 plus £2.50 postage. Send or telephone for your personal copy now.

### ALPS "Blue Velvet" Precision Audio Controls



To fulfil the need for ultra high quality controls we import a special range of precision audio pots in values to cover most quality amplifier applications. All in 2-gang stereo format, with 20mm long 6mm diam. steel shafts, except for the 50K Log which is 25mm x 6mm. Overall size of the manual pot is 27W x 24H x 27D deep, motorised versions are 72-4mm Deep from the mounting face. Mounting bush for both types is 8mm diameter.

Now you can throw out those noisy ill-matched carbon pots and replace with the real hi-fi components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability.

The motorised versions use a 5V DC motor coupled to the normal control shaft with a friction clutch so that the control can be operated manually or electrically. The idea of having electrically operated pots may seem odd, archaic even, but it is in fact the only way that remote control can be applied to any serious Hi-Fi system without loss of quality. The values chosen are the most suitable available for a low loss passive volume and balance control system, allowing armchair control of these two functions.

Our prices represent such super value for pots of this quality due to large purchases for our own kits.

#### MANUAL POTENTIOMETERS

2-Gang 100K Lin.....**£15.67**  
2-Gang 10K, 50K or 100K Log.....**£16.40**  
2-Gang 10K Special Balance, zero crosstalk and zero centre loss.....**£17.48**

#### MOTORISED POTENTIOMETERS

2-Gang 20K Log Volume Control.....**£26.20**  
2-Gang 10K RD Special Balance, zero crosstalk and less than 10% loss in centre position.....**£26.98**

#### REEL TO REEL HEADS

999R 2/4 R/P 100mH.....**£16.84**  
We have a few erase heads to suit which can only be supplied when 2 R/P heads are purchased **£36.80**

#### TAPE RECORDER CARE PRODUCTS

DEM1 Mains Powered Tape Head Demagnetizer, prevents noise on playback due to residual head magnetisation.....**£4.08**  
DEM115 Electronic, Cassette Type, demagnetizer.....**£8.61**

### LINSLEY HOOD 'SHUNT FEEDBACK' RIAA MOVING COIL & MOVING MAGNET PICKUP PREAMPLIFIERS



The HART K1450 Magnetic pickup preamplifier kit features a totally discrete component implementation with a specially designed low input impedance front end and the superior sound of the Shunt Feedback circuitry. High quality components fitting to an advanced double-sided printed circuit board make this a product at the leading edge of technology that you will be proud to own. Nevertheless with our step by step Instructions it is very easy and satisfying to assemble. The higher current consumption of this unit means that it is best powered by our new Andante Audio Power Supply, itself an advanced piece of technology in a matching case. This supplies the superbly smoothed and stabilised supply lines needed by any sensitive preamplifier and features a fully potted hi-grade toroidal transformer along with a special limited shift earth system for hum free operation. The K1450 is suitable for all moving coil and moving magnet transducers this unit is especially recommended for, and will extract the very best from the modern generation of low output high quality moving coil transducers.

K1450 Kit, complete with all parts ready to assemble inside the fully finished 228mm x 134mm x 63mm case. Kit includes full, easy to follow, assembly instructions as well as the Hart Guide to PCB Construction, we even throw in enough Hart Audiograde Silver Solder to construct your kit!

K1450SA Series Audiophile version with selected components.....**£111.58**  
.....**£133.94**

### HIGH QUALITY REPLACEMENT CASSETTE HEADS



Do your tapes lack treble? A worn head could be the problem. For top performance cassette recorder heads should be replaced every 1,500 hours. Fitting one of our high quality replacement heads could restore performance to better than new! Standard Inductances and mountings make fitting easy on nearly all machines (Sony are special dimensions, we do not stock) and our TC1 Test Cassette helps you set the azimuth spot on. As we are the actual importers you get prime parts at lower prices, compare our prices with other suppliers and see! All our heads are suitable for use with any Dolby system and are normally available ex-stock. We also stock a wide range of special heads for home construction and industrial users.

HC80 NEW RANGE High Beta Permalloy Stereo head. Modern space saver design for easy fitting and lower cost. Suitable for chrome, metal and ferric tapes, truly a universal replacement head for everything from hi-fi decks to car players and at an incredible price too!.....**£11.70**  
HRP373 Downstream monitor combi head.....**£62.59**  
HQ551A 4-Track R/P.....**£8.75**  
HQ551S Sony Mount 4-Tr. R/P.....**£14.90**  
HQR560 Rotary Base 12.5mm R/P/E.....**£21.90**  
HQR570 Rotary Base 15mm R/P/E.....**£22.59**  
HQR580 Rotary Base 12.5mm R/P.....**£14.29**

### HART Classical CD's.

Top quality, Full Digital (DDD), over 100 titles from only **£1.99** Ring or send for your list!

### TECHNICAL BOOKSHELF

We stock a good range of books of interest to the electronics and audio enthusiast, including many reprinted classics from the valve era. Some were in last month's advertisement, but see our list for the full range.

New this month is the GEC Valve designs book at **£18.95**, and the VTL Book, a modern look at valve designs, **£17.95**.

QUALITY  
AUDIO KITS

24 hr. SALES LINE  
(01691) 652894

ALL PRICES  
INCLUDE  
UK/EC VAT

# HART

HART ELECTRONIC KITS LTD  
6 PETER LANE MILL  
OSWESTRY, SHROPSHIRE  
SY10 2AF

# New Technology Update

Ian Poole investigates an exciting new polymer-based display technology.

**S**EMICONDUCTOR technology is moving in many new directions. Although the well known semiconductors like silicon, germanium and gallium arsenide are likely to remain as the most widely used materials for the time being, many new and interesting materials are beginning to appear. These have some very useful properties and are likely to change the face of electronics in many areas.

In one development a British company is leading the way. Called Cambridge Display Technology, it has developed a polymer material which promises to give an inexpensive method of manufacturing colour light emitting displays. This could make major inroads into the display market which was worth around 25 billion pounds in 1994 and is still growing fast.

Even though liquid crystal and other forms of technology are available, they are still very expensive and not suitable for applications like television because their response time is too slow. The new displays could overcome these problems and have a great chance of cornering a large section of the market.

## Polymer Displays

The technology is based around a light emitting polymer material (l.e.p.), which is made from a derivative of poly-phenylene vinylene. The material exhibits semiconductor properties, even though it is not a traditional semiconductor material. The main differences occur because of the method of charge transportation.

The similarities mean that many of the lessons learned on traditional light emitting substances, like gallium arsenide, have been passed onto the new displays and development is progressing very swiftly. Already colours can be produced and switching speeds are very high.

To make the display, two 0.1 $\mu$ m layers of l.e.p. material are sandwiched between negative and positive electrodes as shown in Fig. 1. To obtain the p-n junction equivalent one layer is of poly-phenylene vinylene and the other is a cyanopoly-phenylene vinylene. With this structure efficiencies of over one per cent have been achieved from blue to near infra-red.

It is found that the l.e.p. material is intrinsically non-conducting laterally. This means that different pixels on the display do not need to be fabricated separately. All that is required is that the patterns of the display are defined by the conducting layers which are deposited on the top and bottom of the display.

This means that the size of the pixels and hence the definition is limited only by the capabilities of the deposition equipment. For future displays very high levels of definition will be available, far greater

than anything which is currently on the market.

To fabricate the electrodes aluminium is used for the driving side of the display. However, for the viewing side it is necessary to have a transparent layer to allow the light through. This is achieved by using a transparent indium-tin layer.

## Advantages

Displays using l.e.p. technology have a number of advantages over other types which are currently available. The first is their low power consumption. They can be run from a 3V supply and require only about 1mA for every square centimetre to give a light output of 10 candelas per metre squared.

Furthermore, they are light emitting unlike liquid crystal displays which need an additional light source, either from front or back-lighting. They also have a wide angle of view, again scoring over liquid crystal displays.

Whilst it is possible to have a matrix of pixels giving very high degrees of resolution, the displays can also be made with defined patterns. This aspect is useful for applications where a limited number of digits or patterns need to be displayed, as on a watch or radio display.

Another advantage is that the drivers required for the displays are cheap and easy to produce. Unlike electroluminescent displays or cathode ray tubes which need high voltages, l.e.p. displays are low voltage devices making the on-board electronics much simpler.

They also do not need an alternating drive voltage like liquid crystal displays. This gives significant advantages in terms of electromagnetic compatibility and general radio frequency interference in radio based systems. This makes them ideal for use in the growing mobile phone market.

The fact that the display is based on a polymer has several mechanical advantages. It is very rugged and can also be deformed without damage. It is even

possible to have the displays formed to a particular shape during manufacture – a factor which could give some very interesting possibilities.

The fact that they have fast response times is a further advantage. As they can handle the speeds required for video applications this is likely to open a large market very quickly.

Finally, they are easy to manufacture. They have a monolithic construction and the techniques required for manufacture do not present any major difficulties. This means the processes will be relatively low cost.

## Developments

The development of these devices shows a great degree of promise, but like all new developments there are a number of hurdles which still need to be overcome.

One problem which is being addressed is that the displays have a limited life. This is brought about by the fact that the poly-phenylene vinylene is susceptible to oxidation. If the material is exposed to oxygen under power then the display will become less bright. Significant development is being undertaken to improve the material lifetimes through the use of improved materials, and through improved encapsulation. Currently sufficient lifetimes have been obtained to allow for them to be used commercially, but further improvements are still being sought.

## Summary

L.E.P. development is progressing swiftly, and it promises to be one of the most revolutionary display technologies to appear in many years. It fulfils the major requirements to enable it to challenge the cathode ray tube for dominance of the market.

It will be cheap, have a colour capability, have a fast response time, and be capable of high levels of definition. This should make it a market winner. For further information contact Mark Gostick at CDT on 01223 (44 1223) 276351 and please mention EPE.

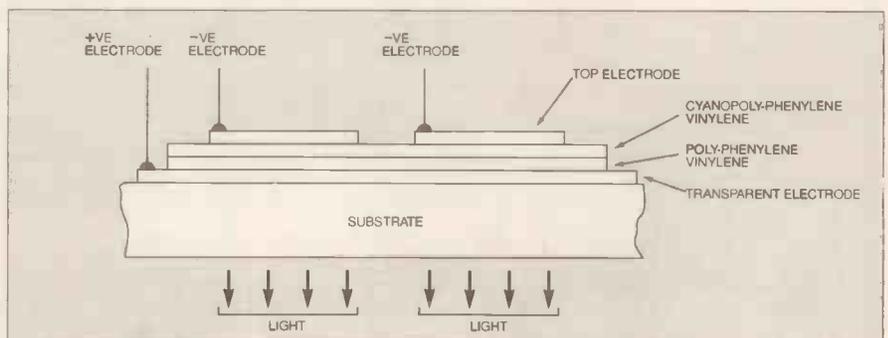


Fig. 1 The structure of a light emitting polymer display.

BTEC  
Certificated



TUTOR  
Supported

NATIONAL  
COLLEGE OF  
TECHNOLOGY

### DISTANCE LEARNING COURSES

The National College of Technology offer a range of packaged learning short courses for study at home or in an industrial training environment which carry modular BTEC awards leading to a higher BTEC certificate. Study can commence at any time and at any level enabling you to create a study routine to fit around existing commitments. Courses on offer include:

- Analogue Electronics
- Digital Electronics
- Fibre/Optoelectronics
- Mechanics & Mechanisms
- Programmable Logic Controllers
- Electronic Testing & Fault Diagnosis

Tutor support and BTEC certification are available as options with no travelling or college attendance required. These very popular courses which are ideal for vocational training contain workbooks, audio cassette lectures, PCB's, instruments, tools, components and leads as necessary to support the theoretical and practical training. Whether you are a newcomer to electronics or have some experience and simply need an update or certification, there is probably a distance learning course ready for you. Write or telephone for details to:

National College of Technology  
NCT Ltd., PO Box 11  
Wendover, Bucks  
Tel: (01296) 624270

## JCG ELECTRONIC PROJECTS

PO BOX HP79 WOODHOUSE STREET HEADINGLEY LEEDS LS6 3XN

### KITS

#### RADIO KITS/TRANSMITTERS/ REMOTE CONTROL

- MICRO FM (a). 1km range transmitter, 80-100MHz preset. Received on any FM Radio. 2 x 3cm. £6.95
- MICRO FM (b). Variable mic. sensitivity. Tuneable 80-110MHz. 1km range, 2 x 3.5cm £7.95
- ULTRA MINI FM. 200mtrs range. 80-100MHz, runs off watch battery (inc.), only 1 x 2cm £8.95
- FM TRACKER. Transmits a constant tone for direction finding, tracking etc. 80-110MHz £8.95
- FM RECEIVER (a). Small high quality FM receiver. Covers standard FM broadcast bands. Will drive headphones (not inc.) £10.90
- FM RECEIVER (b). As (a) but with 3 watt audio power amplifier and tuning LED £13.50
- CRYSTAL RADIO. Great introduction to radio electronics. Includes tuner, ferrite aerial and earphone £8.50
- AM RADIO. Single chip radio for use with headphones, (not inc.) or an external amplifier £9.90
- I.R. REMOTE CONTROL. Single channel for lights, garage doors etc. Transmitter - £6.95 Receiver (with mains relay) - £12.20
- 27MHz RADIO CONTROL. Single channel, XTAL controlled Transmitter - £9.50 Receiver (with mains relay) - £15.45

#### PREAMPS/AUDIO

- AU10 GENERAL PURPOSE PREAMP for audio applications where low noise isn't a priority - guitar amps etc. 9V-15V, variable gain and high output £4.20
- AU11 LOW NOISE PREAMP for more critical input stages. Ideal for mixers etc. 9V-15V, variable gain £4.50
- AU12 ULTRA LOW NOISE PREAMP. Professional standard. Uses an NE5534 i.c. 9V-15V, variable gain £5.99
- AU14 SMALL SIG + EQ. Preamp with a simple three-band passive EQ circuit. Designed for piezo pu's £6.90
- AU15 SINGLE TRANSISTOR. Low noise preamp for electric guitars etc. Preset gain. BC184L £3.90
- AU16 ACTIVE TONE CONTROL. 12dB cut and boost, bass and treble with preamp. Includes pots. £9.95
- AU17 7-BAND EQ board for graphic/tone control applications. Pots Included £14.95
- AU19 ANALOGUE DELAY. "Bucket brigade" delay line. Variable clock frequency for producing double track and echo effects etc. Delay times from 2.5 to 51ms. £18.50
- AU21/22 DIGITAL DELAYS. 200ms and 800ms digital delay lines with 10-bit A/D-D/A. Variable sample rate (25-50kHz). Variable delay time. 200ms £20.40, 800ms £24.95

### SEND STAMP FOR LATEST CATALOGUE

- ★ SURVEILLANCE
- ★ KITS
- ★ SECURITY
- ★ AUDIO
- ★ RADIO

#### U.H.F. TX/RX

D.T.I. approved key fob transmitter and receiver kit. 200mts. range. Ideal for alarms, remote control, pagers etc. Exceptional value. Transmitter £13.95 Receiver £25.50

## MICRO TRANSMITTERS GUIDE

★ Only £3.95

★ Easy to follow guide to building short range F.M. transmitters and surveillance devices. Packed with useful information and circuits.

(Some of the circuits included cannot be used legally in the UK)



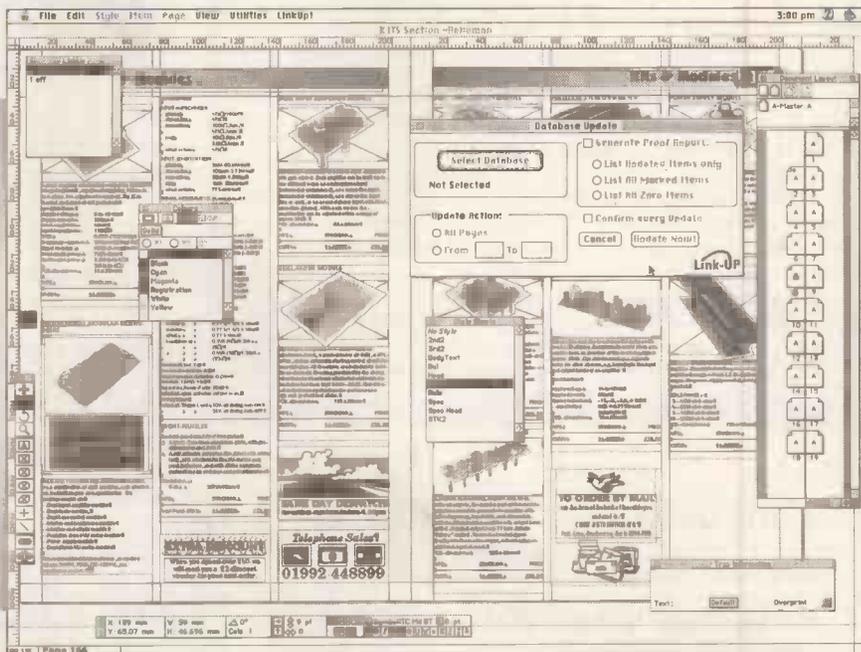
ALL KITS COME COMPLETE WITH PRE-DRILLED P.C.B.'S, HIGH SPEC COMPONENTS AND FULL INSTRUCTIONS - MAIL ORDER ONLY - MAKE CHEQUES/PO'S PAYABLE TO J.C.G. PLEASE ADD 50p POSTAGE AND PACKING.

# Summer '96 Cirkit Catalogue now in preparation...

The summer 1996 catalogue has 280 pages packed with over 4000 products.

- ▶ New Multimedia CD ROM titles
- ▶ New radio amateur equipment
- ▶ Even further additions to our Computer section
- ▶ PIC Microcontroller projects and modules
- ▶ Hundreds of new products including Books, Computers, Rigs & receivers, Semiconductors and Test Equipment
- ▶ 280 pages, 25 sections and over 4000 products from some of the worlds finest suppliers

£1.95  
+30p P&P



# Cirkit

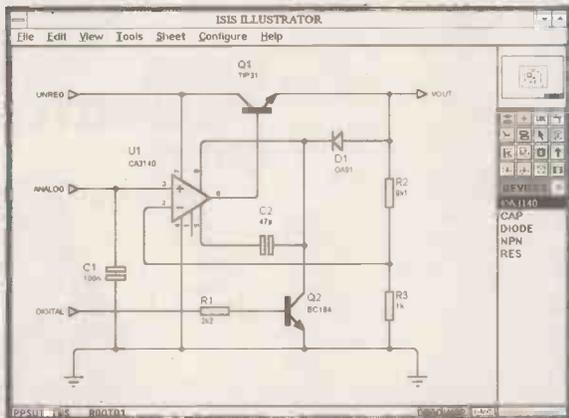
Tel: 01992 448899 Fax: 01992 471314



Cirkit Distribution Ltd ▶ Park Lane ▶ Broxbourne ▶ Herts ▶ EN10 7NQ

## CADPAK for Windows

CADPAK is especially suited to educational, hobby and small scale schematic and PCB design. CADPAK includes both schematic drawing and 32-bit PCB drafting tools but as an entry level product, there is no netlist link between them.



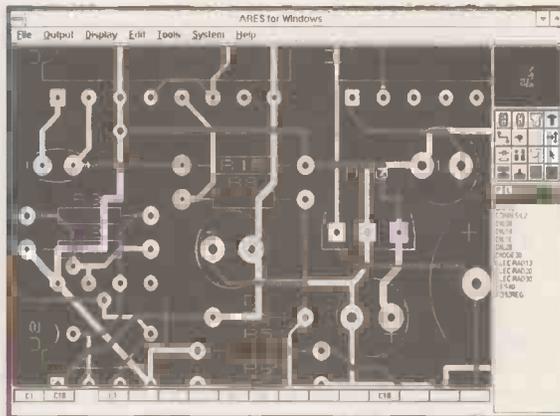
The schematic drawing module of CADPAK, ISIS ILLUSTRATOR, enables you to create circuit diagrams like the ones in the magazines.

- Runs under Windows 3.1 making full use of Windows features such as on-line help.
- Full control of appearance including line widths, fill styles, fonts, colours.
- Automatic wire routing & dot placement.
- Fully automatic annotator.
- Complete with device and comprehensive package libraries for both through hole and SMT parts.
- Advanced route editing allows deletion or modification of any section of track.
- Gerber, Excellon and DXF outputs as well as output via Windows drivers. Also includes Gerber viewer.
- Exports diagrams to other applications via the clipboard.
- CADPAK is also available for DOS.

**CADPAK FOR WINDOWS ..... £ 149**  
**CADPAK FOR DOS ..... £ 79**

## PROPAK for Windows

PROPAK has all of the features in CADPAK plus netlist based integration, automatic power plane generation and a powerful auto-router. PROPAK includes enough schematic capture and PCB design functionality for all but the most demanding applications.



PROPAK's schematic drawing editor ISIS ILLUSTRATOR+ includes even more features than ISIS ILLUSTRATOR. PROPAK's 32-bit PCB design tool, ARES for Windows, is our most powerful and easy to use yet.

- Multi-sheet and hierarchical designs.
- Netlist link between modules guarantees consistency between schematic and PCB.
- Netlists are also compatible with SPICE-AGE and most other electronics CAD packages.
- Generates a full bill of materials.
- ASCII data import facility.
- Electrical rules and connectivity checkers.
- Ratsnest display with automatic update during placement and routing.
- Multi-strategy autorouter gives high completion rates.
- Power plane generator creates ground planes with ease.
- PROPAK is also available for DOS.

**PROPAK FOR WINDOWS ..... £ 495**  
**PROPAK FOR DOS ..... £ 395**

**Call or fax us today for a demo pack. Please state whether you would like a DOS or Windows pack.**

Prices exclude postage (£5 for UK) and VAT. ISIS ILLUSTRATOR and ARES for Windows are also available separately. All manufacturers trademarks acknowledged.

**abcenter**  
**Electronics**  
 53-55 Main St. Grassington, N. Yorks. BD23 5AA  
 Tel: 01756 753440 Fax: 01756 752857

## PROGRAMMABLE HEARING

Pushbutton programming sets the new hearing aid to the response range preferred by the wearer for different acoustic situations

by Hazel Cavendish

A NOVEL electronic development for people with impaired hearing has been introduced to Britain by the multinational giant 3M. Through a firm in Devon, 3M is marketing a Swedish-designed programmable hearing aid with eight programs and multiple memories.

Hearing and Medical Appliances of Bradworthy in Devon have been training a team of Dispensers to teach clients how to use this revolutionary two-channel sound processing system, with its high performance circuit separating input sounds into high frequency and low frequency channels.

Digitally controlled analogue signal processing is used in the 3M Model 8200 hearing instrument, which stores eight settings in an integrated circuit which includes memory, control logic and a data-logging feature. The hard-of-hearing user can select any of the eight settings via pushbuttons on the instrument. Originally christened the *Memory Mate*, the concept was researched and developed in the Audiology Department of Gothenberg University.

### DISPENSING AID

Paul Lavis, MD of the Devon company, says that although the hearing aid was introduced in Britain last year, the first priority for his company has been the training of the first 20 human Dispensers.



The hearing instrument worn behind the ear (BTE) has two controls to select the user's required programme needs. The inset shows how small the unit's control boards are.

"It has taken a lot of detailed training to prepare our team," he says, "which will be followed by another 20 to 25 trainees, all of whom have to be thoroughly computer literate to teach the new system. In the last three months our Dispensers have been helping over 1,000 clients and sales are escalating fast now." The clients, though, need know nothing of the interior workings of the hearing aid. Once the Dispenser has set it up to suit a particular individual, all the latter needs to do is press the buttons to get the best sound out of it.

### NOISE IMMUNITY

The main advantage of the new system is that it overcomes the problem of the crowded room - always an anathema to people with hearing difficulties. A conventional hearing aid has a frequency response that does not change much at normal listening levels. This makes it difficult for speech intelligibility and optimal listening comfort to be achieved simultaneously, particularly in different listening environments. By using a programmable hearing aid with multiple memories, the listener can choose between a range of sound pictures, which increases the chance of finding a suitable frequency curve for each listening situation.

The characteristics of the two-channel sound compression system are unlike others available in a programmable instrument. Most

other systems operate according to a fixed logarithmic compression ratio.

Once the threshold of compression is reached, all input levels above this value (and below the threshold level of a front end limiter) are compressed at the same ratio. Low level sounds are compressed at the same ratio as high level sounds. Even if this ratio is "variable" (i.e. programmable), it remains fixed once the hearing instrument has been programmed.

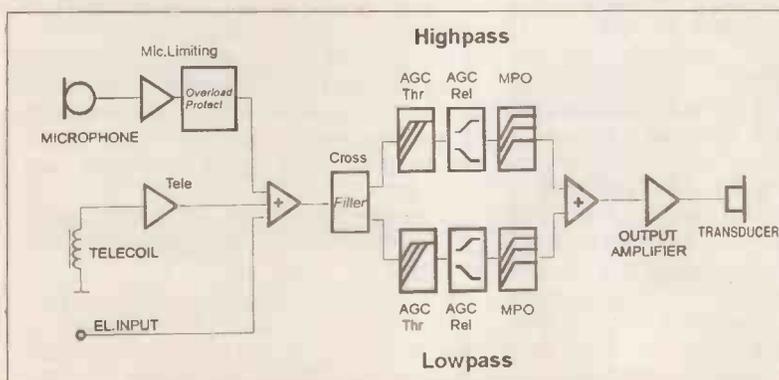
On the other hand, the intensity-proportionate design of the 3M compression system automatically adjusts the compression ratio in real time, depending upon the level of the input. Sounds which are slightly above the compression threshold are compressed at a very low ratio, while loud sounds are compressed at a much higher ratio. The compression ratio varies in a curvilinear fashion over the operating range of the circuit. This design allows weaker sounds to be adequately amplified, while the loudest sounds are maximally compressed. Several advantages can be realised through this approach to compression.

Two-channel compression, also known as two-frequency band-separation, is a significant improvement over single channel instruments and deals effectively with 95 per cent of hearing losses. The other five per cent might find advantage in a design having three or more channels, but the performance trade-offs are significant.

### ANALOGUE FILTERING

Current technology allows designers who require three or more frequency channels to use switched capacitor filters. However, because these chop the signal at a high rate, they generate noise which in turn needs to be filtered out.

Dr Stephen Mangold, however, who is the inventor of the new hearing aid



Functional block diagram for the programmable Hearing Aid.

compression technology, as well as being R&D Manager at 3M's Diaphon facility in Gothenberg, has chosen to use analogue (RC) filters as an alternative to switched capacitors because they are continuous and therefore very quiet.

He has worked out a novel method of incorporating these filters within the signal processing circuitry. Three different inputs are available in the hearing aid: microphone, telecoil and direct electrical input. Transients in the input signal are suppressed by a soft clipper and the signal is then split by the filters into lowpass and highpass channels. Each channel has an independent automatic gain control circuit, after which the signals are recombined and fed to an output amplifier and transducer.

Two-channel sound Processing is available in many

different 3M hearing instruments ranging from "behind-the-ear" (BTE) to "in-the-canal" (ITE) models. They have eight individual memories, and a total of ten parameters can be programmed into each of the eight.

The hearing aid also has data-logging capabilities which represent a novel concept in hearing instrument fitting and adjustment. Registers provide the Dispenser with information about the total time spent listening via each of the eight programmed memory modes, the total time the hearing aid has been switched on, and the number of switchings from one memory mode to another.

### HEARING TRIALS

Twenty-two experienced hearing aid users of both sexes, aged from 22 to 77 agreed to take part in trials in Sweden before the invention was

released. The volunteers compared the new programmable hearing aid with their own well-fitted conventional aids (the latter having been carefully checked for efficiency by the Institute for the Handicapped in Stockholm).

When the results were announced, seventeen members of the team found that the use of different frequency responses for acoustically different characteristics was beneficial. In direct paired comparisons with their personal aid, in six specified domestic situations, the programmable hearing aid was selected with confidence in 81 test situations out of 120. Speech discrimination scores were significantly better with the new aid. All but two of the team preferred the programmable aid, mainly because of its better sound quality and extended adjustment possibilities.

The University researchers had expected to find some resistance from "experienced" hearing aid users against using pushbuttons to adjust the aid. They were surprised to find that 67 per cent accepted them, with the unexpected reason for preferring the pushbuttons being a feeling of security in finding the amplification wanted.

Because the user had full control over amplification in distinct steps, he or she was easily able to avoid acoustic feedback. The result was generally more favourable than had been expected because the team were experienced wearers of carefully fitted hearing aids, and therefore expected to express more conservative opinions.

The cost of the hearing aids varies from £1,700 to £1,950, the in-the-ear model being the most expensive of the two.

## Honouring Willy Johnson

**W**ILLY JOHNSON, the prolific inventor whose imaginative creations have been mentioned in these pages from time to time, is to be awarded an Honorary Doctorate in Design (D.Des) by Southampton University, which describes him as "an internationally acclaimed inventor who has successfully combined academic research ideas with industrial development".

Southampton University points to Willy's work on improving the clarity of television and computer screens as being the main source of his new international recognition, a reference to his Microsharp technology sold to America two years ago and reported in *EPE* May '94 issue.

When ten honorary degrees are presented at ceremonies in July this year, and in Spring 1997, Willy Johnson will find himself in good company. Dr Tim Berners-Lee, involved in the creation of the World Wide

Web, described by the University as one of the great pioneers of computing, and Professor George Gray, who received the international Kyoto Prize from the Emperor of Japan for his contribution to the science of liquid crystals, have been created Doctors of Science by Southampton. Both the latter worked in Poole, Dorset, respectively for Plessey Telecommunications and Merck Ltd.

*Hazel Cavendish*



## PC-BASED STORAGE SCOPE

A NEW PC-based storage oscilloscope has been introduced by Pico Technology, who describe their ADC-200 as a high-speed Virtual Instrument. Together with PicoScope software (Windows and DOS versions included in the price), your PC-compatible computer can be used as a 50MSPS (million samples per second) digital storage oscilloscope (DSO), a spectrum analyser, frequency meter or voltmeter.

Pico believe that the ADC-200 breaks the price/performance barrier for DSO products. For less than half the price of the cheapest benchtop instrument you get a fully featured scope with such options as FFT (Fourier Fast Transform) analysis and waveform storage/printing normally only found on the most expensive models.

Not only does this design offer all the usual advantages that DSOs have over analogue scopes, but also takes things one step further. By making full use of the Windows environment, it is possible to view a signal in several ways simultaneously. The screen shows four different views of the same input signal. The scope shows the actual waveform, the spectrum of its frequency components, and the two meters show its a.c. voltage and frequency.

The 50MSPS version of the ADC-200 is priced at £459, and the 20MSPS unit is just £359.

For more information, contact Pico Technology Ltd., Dept. EPE, Broadway House, 149-151 St Neots Road, Hardwick, Cambridge CB3 7JQ. Tel: 01954 211716.



*Willy Johnson displaying the Elarm featured in EPE February '96.*

# Blooming Spoofy Times

It is a curious time-honoured tradition in Britain (do other countries have similar ones?) that the First of April should be commemorated by all manner of scams, spoofs, hoaxes and practical jokes. Such classics as well-documented reports about spaghetti that grows on trees, sheep dogs that drive cars, and the mining of silicon from Welsh beaches, all spring to mind. No doubt you've each got your own particular favourites.

This year a certain Zola McMalcolm hit the headlines by reporting in the April issue of *EPE* that her research laboratory had evolved the electronic technique of Chromo-floristics, a method by which flower colourings could be selectively modified through using light emitting diodes to irradiate plants. It was a technique which could have profound significance for floral culturists world-wide. Truth, though, had been hybridised, pruned and nurtured in prime mendacity!

It was a well-reasoned and plausible argument, the hall-mark of any good April spoof, and a circuit diagram and software program provided further authenticity to the report. Moreover, both the latter *do* actually work, although not in the botanical application quoted.

So, how many of you were persuaded by the argument? Many, we suspect - go on, admit it, and that you ran the program! Well, you are in good company: two of Britain's top media sources were convinced of the technique's genuineness, BBC's *Tomorrow's World* and *The Times* newspaper, both of whose technical researchers rang us wanting interviews with Zola!

Wickedly, our Technical Editor strung along *TW*'s lady researcher for a while before revealing the nature of the report, much to her dumbfounded disbelief. Equally jocular, our MD similarly chatted with *The Times'* charming columnist who, as was eventually disclosed to her, had rung up on *The Right Day* - April 1st!

To her credit, though, Ms Anjana Ahuja became even more impressed by Zola's fantasy and proceeded to write a lengthy feature about the root of the floral tale, which was published in *The Times* on April 3rd. Fame for us all!

However, she also revealed Zola's hitherto secret but true identity - none other than our *previously* respected Technical Editor, causing a flurry of conversation here at *EPE* HQ when *The Times* was circulated round the office:

"But Tech Ed's the *real* April Fool", proclaims Adverts, promotionally.

"Mad as a March Hare", outlines Art Tart, pictorially.

"More like he's Nuts in May", cracks MD, managerially.

"Two chips short of a circuit", defines Deputy Editor, analytically.

"A character short of a sentence", inputs Typesetting, typically.

"The longer his Sentence the better", advances Subscriptions, committedly.

"He must be made accountable", adds Finance, summarily.

"Send him packing", raps Dispatch, expeditiously.

"Perhaps we can sell him", counters Sales, monetarily.

The phone rings:

"I think it's Kew Botanical Gardens - where can they get a bushel of l.e.d.s?", illuminates Secretarial, pam-purringly.

"Tell them to read *Shoptalk*", deputises Dep Ed, chattily.

"Oh, ain't it all Super-chromofloralisticprimoapril-ocious!", quips Tech Ed, quite logically.

# RADIO WITHOUT HASSLE

OFF-THE-SHELF pre-approved and aligned radio data transceiver modules are at last a reality! One company who can now supply such equipment are Radio-Tech, who have published a *free* catalogue listing over 60 licence-exempt module types.

These modules are suitable for a diverse range of applications, from simple remote controls, telemetry, temperature monitoring, and free-wire LANS, to rocket flight system monitoring. In effect, the modules can be treated as i.c.s and include everything you would expect for a radio system, from FM modulator to RF amplifier and filters. Frequencies are available covering over 95 per cent of the world. Transmission data is entered serially and at the receiver is again recovered as a serial data stream.

To assist first time users, evaluation kits are available. Not only that, and ideal for PIC microcontroller users, Radio-Tech have a unique range of low-voltage transceivers that can be driven directly from a PIC I/O port.

Prices of the various transceivers range from a mere £5 to £480, exclusive of VAT and carriage. Export enquires are welcome.

For more information, contact Radio-Tech Ltd., Dept. EPE, Overbridge House, Weald Hall Lane, Thornton Common, Epping CM16 6NB. Tel: 0181 368 8277.

## THIN LITHY

PRODUCTION of the world's thinnest Lithium primary cell begins in May. So announces Yuasa, a world-leading battery manufacturer who first started producing batteries in the 1920s. The Yuasa "PowerFilm" is a Lithium 3V cell that is only 0.2mm thick and uses solid polymer electrolyte (SPE). The other measurements are only 29.3mm x 22.3mm.



The cell incorporates a Lithium anode and a manganese dioxide cathode separated by a solid polymer electrolyte. These are encased between two micro-thin metal foils that also act as an external case and the positive/negative collector.

A significant development is the sealing of the outer edges of these collectors using a sealing compound that also provides the electrical insulation between the two polarities of the current collectors. This, claims Yuasa, makes the PowerFilm the safest and highest power-density SPE Lithium primary cell available.

For more information, contact Yuasa Battery Sales (UK) Ltd., Hawksworth Industrial Estate, Swindon, Wilts SN2 1EG. Tel: 01793 612723.

## Lazerlyte

SIZED just slightly larger than a pen, the Lazerlyte pointer has been introduced into the UK. Apparently, this laser pointer is the market leader in America and is becoming one of the top selling electronic toys there.

Lazerlytes have been on trial by Dixons' new stores and have sold so well that they are now stocking them all over the UK. Other retail groups, including Rymans, Viking, Globus/Office World and Techno, also stock them.

These pointers project a dot of laser light over a considerable distance and are both useful and fun. From company and conference presentations, to school blackboards and slide shows, from computer screens to atlases, indeed in a host of business and leisure environments, these pointers have thousands of uses.

Lazerlytes are available which have different brightnesses and distance coverage, the recommended retail prices range from £29.99 for the model 100, to £74.99 for the executive version. Try one, you'll like it!

## BASiCALLY NOISY

BASiCS UK Ltd. has launched the first in a range of innovative standard i.c. products. The device, a high performance tone generator chip, is said to lead the market through its broad range of available tones - 27 in all. Sounds available include sweeping, whooping, continuous and intermittent tones, at a range of frequencies.

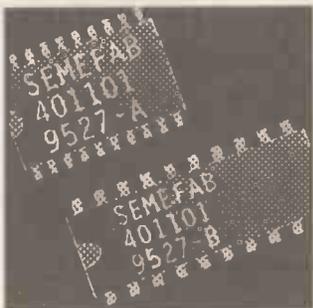
The range of applications must be almost infinite, but certainly embraces situations in which an audible alarm is needed, such as for vehicle and premises security, smoke, gas and personal safety, system condition and status

monitoring, including level detection. Plus, of course, numerous applications for use with toys.

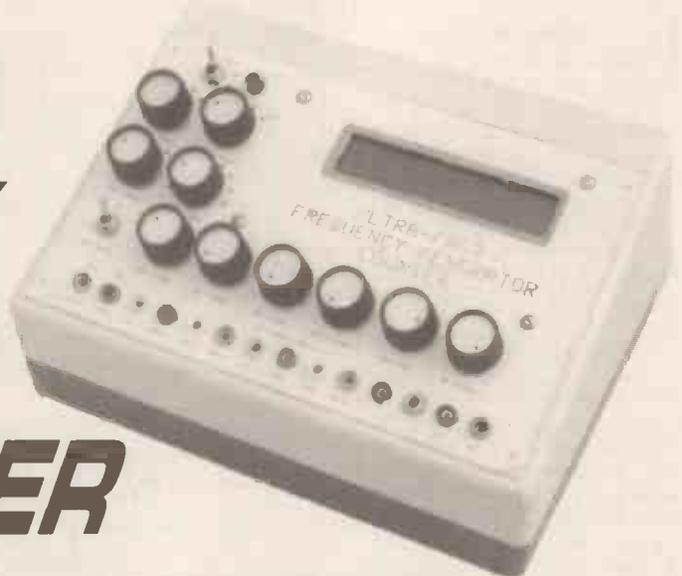
Whilst the chips do not include their own amplifiers or speakers, they are very easy to build into a system, requiring only a 5V d.c. power source, a 4MHz crystal and a suitable amplifier.

We are actively looking further into these chips for possible use in a future constructional project.

For more information, contact BASiCS UK Ltd., Cheapside Court, Buckhurst Hill, Ascot, Berks, SL5 7RF. Tel: 01344 874442.



# ULTRA-FAST FREQUENCY GENERATOR AND COUNTER



JOHN BECKER

Part One

Improve your workshop facilities with this high-speed, multi-frequency item of test gear - it's a real freq-out!

**T**HIS item of workshop test equipment was designed in response to the need for a frequency generator and 8-digit counter which could cope with frequencies well in excess of 40MHz and which had more than one signal generator.

The main features of the Ultra-Fast Frequency Generator/Counter are outlined in the "Specification" panel. The block diagram in Fig. 1 shows the basic function configurations for the unit.

## OSCILLATOR-1

Circuit diagram details for Oscillator-1, the wide range square wave generator (0.05Hz to >40MHz), are shown in Fig. 2. The oscillator is formed around the Schmitt trigger inverter IC12a. Frequency is determined by the total feedback resistance formed by resistor R14 and potentiometers VR1 and VR2, in conjunction with the total capacitance, via switch S5, between IC12a pin 13 and ground (0V).

Potentiometer VR1 gives a rough or "coarse" setting of the required frequency and VR2 "fine" tunes it. Be aware, though, that VR2 only has a significant effect when VR1 is set to its lower resistance values.

Nine capacitance values can be selected by switch S5, as provided by C17 to C25, the largest value setting the slowest frequency range. They are arranged in ascendant decade steps, so that at each step the frequency range controllable is, theoretically, ten times slower than the previous one.

In practice, the actual range is slightly less well-defined since the tolerance factors for the capacitors will affect their precise values.

Additionally, for the highest frequency range available, it is not only the value of C17 which affects the range. The gate capacitance of IC12a and the stray capacitance caused by the surrounding components on the printed circuit board, plus that of the wiring to the potentiometers, become significant. Indeed, it is likely that the total additional capacitance will exceed the value of C17 which may, therefore, be omitted if preferred.

From IC12a pin 12, the frequency is buffered by Schmitt inverter IC12b and

output through socket SK6. It is additionally routed to the frequency counter via switch S3 (discussed later). IC12e and IC12f in the drawing are unused inverters from the same hex package.

## OSCILLATOR-2

Details of Oscillator-2, its frequency divider, and the sinewave filter are shown in Fig. 3.

This oscillator is formed around IC12c and functions in the same way as Oscillator-1, except that different frequencies (0.01Hz to 1.6Mhz) are available. Five capacitance ranges, set by C10 to C14, are selectable by switch S7.

Each ascending switched range is nominally ten times lower in frequency than the preceding one. Coarse and Fine tuning are carried out by potentiometers VR3 and VR4.

From IC12c pin 4, the frequency is output via socket SK7, routed to the

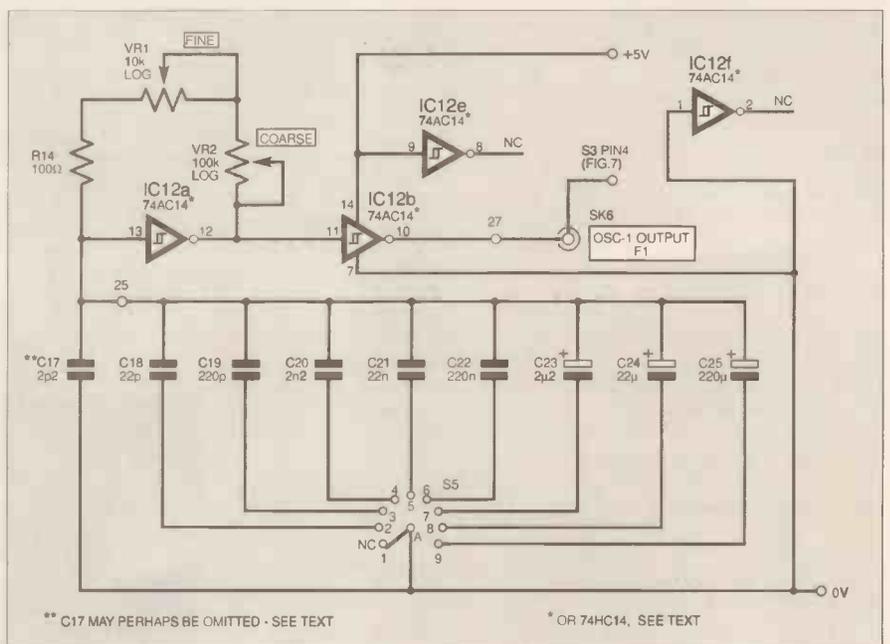


Fig. 2. Circuit diagram for Oscillator-1.

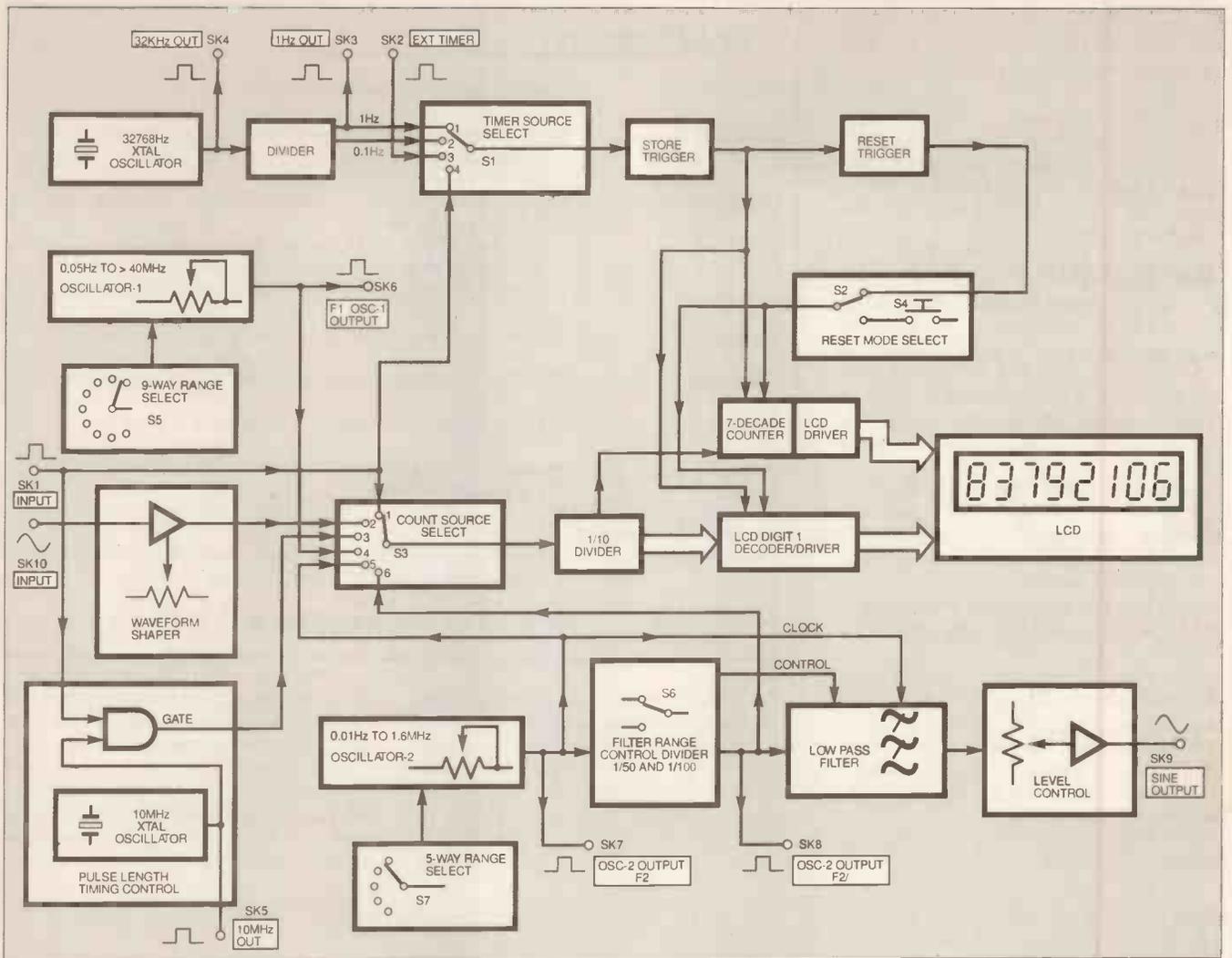


Fig. 1. Block diagram for the Ultra-Fast Frequency Generator and Counter.

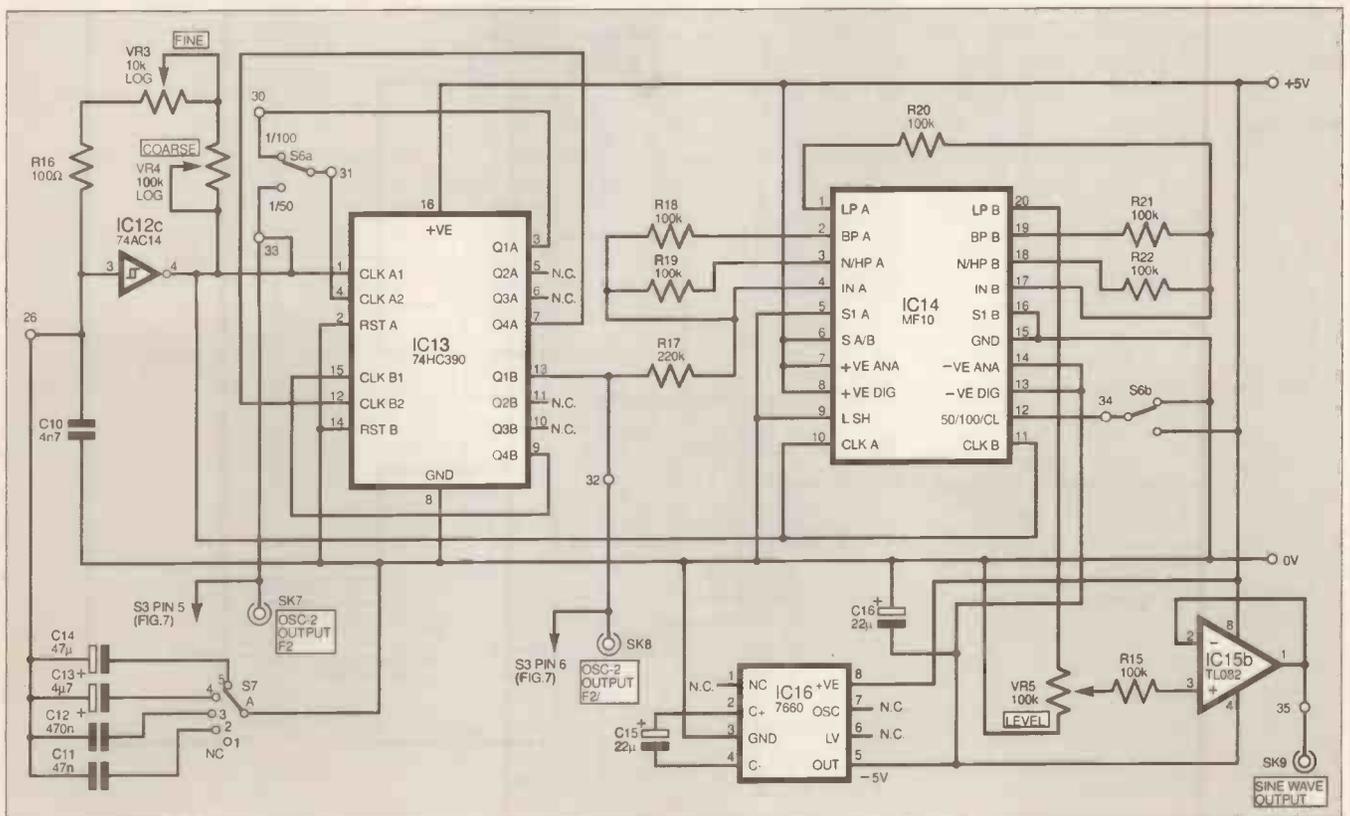


Fig. 3. Circuit diagram for Oscillator-2 and Sinewave filter stages.

frequency counter via switch S3, and is also fed into binary counter IC13. This counter consists of several stages which are connected so that the output at IC13 pin 13 can be switched by S6a for either 1/50th or 1/100th of the input frequency.

The divided square wave output frequency at IC13 pin 13 is fed to output socket SK8. It is also fed into the filter chip IC14 via resistor R17.

### SINEWAVE FILTER

The square wave from IC13 pin 13 is converted into a sinewave by the switched capacitor filter chip IC14. The sinewave is generated in response to a controlling clock frequency which is either 1/50th or 1/100th of that of the input signal frequency. The 1/100 ratio results in a better shaped sinewave.

Here, the clock frequency is supplied direct from IC12c pin 4. As the filter's input frequency is always either 1/50th or 1/100th of the clock rate, filter precision, and thus sinewave shape, is assured. Switch S6b sets the correct control voltage on IC14 pin 12 to suit the clock/signal ratio.

The filter IC14 requires a positive and negative supply voltage. The latter is generated by the voltage inverter IC16. This is the familiar type 7660 device and is conventionally connected. Two filter circuits are contained within IC14. Both are configured as low-pass filters.

The signal from IC13 pin 13 is fed, via resistor R17, into IC14 pin 4. As set by the

<b>Specification . . .</b>	
<b>Display:</b>	8-digit liquid crystal display (l.c.d.)
<b>Oscillator-1:</b>	Square wave output; 9 switched ranges; variable from 0.05Hz to over 40MHz
<b>Oscillator-2:</b>	Square wave output; 5 switched ranges; variable from 0.01Hz to 1.6MHz. Switched f/50 or f/100 square wave output. Switched f/50 or f/100 sinewave output. Sinewave amplitude variable from 0V to 2.5V peak max.
<b>Oscillator-3:</b>	10MHz fixed rate; crystal controlled square wave output
<b>Oscillator-4:</b>	32768Hz fixed rate; crystal controlled square wave output
<b>Input 1:</b>	Digital input; 0V to 5V logic; range to over 40MHz
<b>Input 2:</b>	Analogue input 2.5V peak-to-peak; range to over 400kHz; variable trigger level
<b>Counter Reference Timing Options:</b>	1Hz; 0.1Hz; external timer input logic 1, pulse length referenced to 10MHz; event counting
<b>Power Supply:</b>	7V to 12V d.c. from external source; 5V d.c. output

value of R17, the first stage attenuates the signal amplitude by a factor of two. Then, via resistor R20, the first stage low-pass output (LP A) signal at pin 1 is coupled into the second stage, where the resistor ratios maintain the same signal level.

From IC14's final low-pass (LP B) output pin 20, the sinewave signal is routed

via Level control VR5 to the non-inverting buffer formed by op.amp IC15b. From here, it is output to socket SK9.

Up to about 100kHz, the maximum peak amplitude is about 2.5V. Above 100kHz, the maximum amplitude drops progressively to about 1.5V at the maximum frequency available.

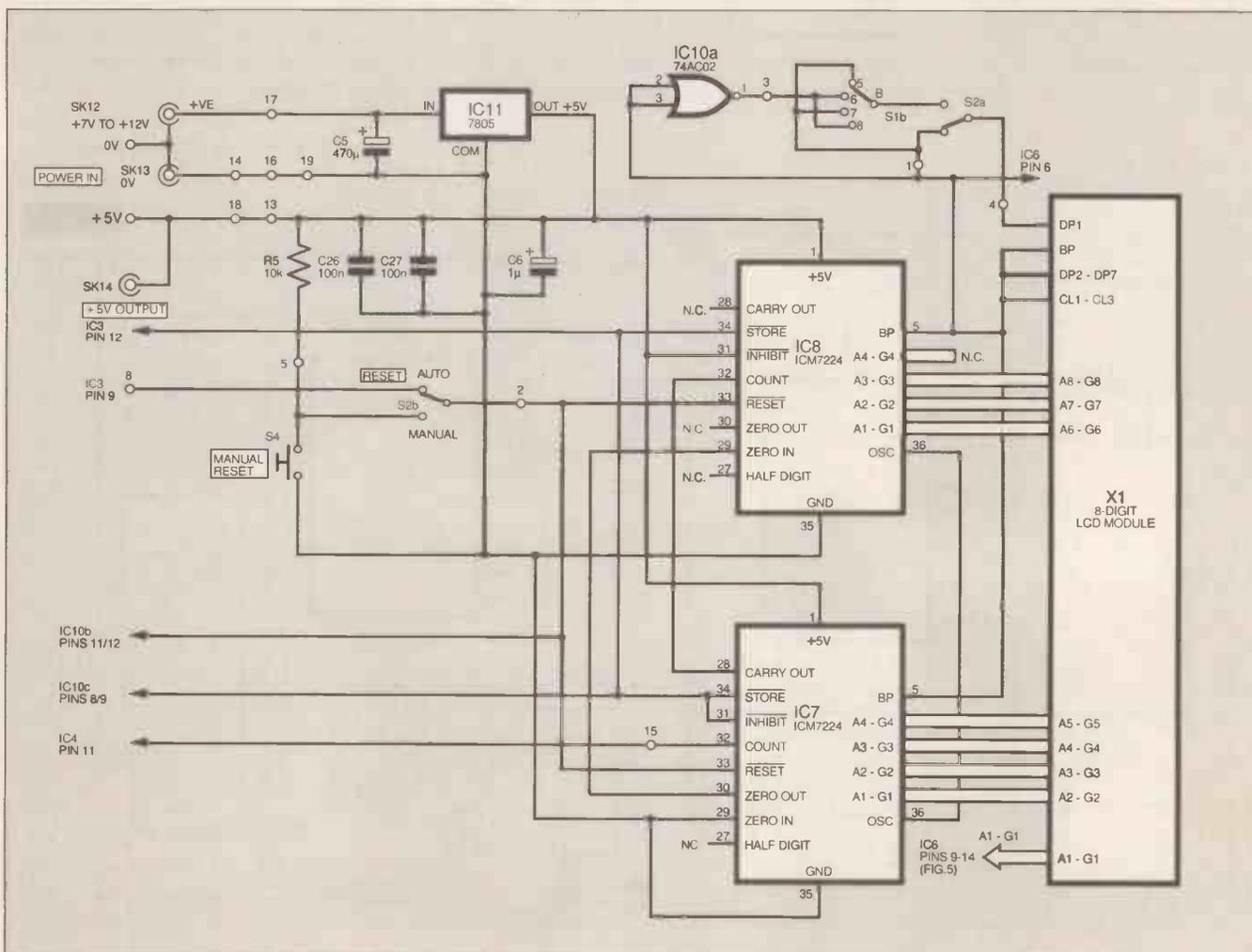


Fig. 4. Circuit diagram for l.c.d. digits 2 to 7 counter/driver, display and power supply.



## FREQUENCY COUNTER

The story now becomes a bit complicated! Refer jointly to Fig. 4 and Fig. 5.

The Frequency Counter consists of eight cascaded decade counters whose contents are periodically output to an 8-digit display and then reset. The rate at which the display is normally one Hertz (1Hz), so that the display shows the frequency of the input signal in Hertz. As will be seen, other reset periods can be selected.

Seven cascaded decades are counted by IC7 and IC8 in Fig. 4. IC7 counts four of them and IC8 counts the other three. Each of these chips decodes the count into a format suitable for outputting to the l.c.d. module X1.

It might seem that all eight decades could be handled by these two chips, which are type ICM7224 4-digit l.c.d. counter/drivers. However, the maximum input frequency the ICM7224 can accept is

15MHz, whereas the counter is required to handle rates of at least 40MHz, and possibly more.

Consequently, a preliminary decade counting stage is required which will handle the higher rates. Its output, which is at a rate ten times lower than the original signal, is then cascaded into IC7.

The circuit diagram for this preliminary stage is shown in Fig. 5. The signal to be counted is input to the frequency divider IC4, whose Q3 output at pin 11 is fed to IC7 pin 32 in Fig. 4.

An additional design problem arose here in that the AC series (Advanced CMOS, very high speed) of logic chips did not include a decade counter, or a counter which can output to an l.c.d., or one which contains a latch. (When this unit was being designed, the AC series was very limited

in its range – it still is, for that matter!) Consequently, as seen in Fig. 5, IC4 has to be fed into a latch, IC5, which then feeds into an l.c.d. driver, IC6, to control the digit 1 display.

The counter chosen for IC4 is a type 74AC161 4-bit binary counter. It is configured as a decade counter by taking its Q1 and Q3 outputs into NAND gate IC9a, whose output is inverted by IC9b and then, via NOR gate IC10d, passed to the Reset input at IC4 pin 1.

All three counter blocks, IC4/IC5 plus IC7 and IC8, need latching (Store) and resetting signals. There are several sources for these, as will be seen, but the result is that the Store signal comes to IC7/IC8 pins 34 (Fig. 4), and then (Fig. 5) is inverted by IC10c before going to IC5 pin 9, its clock input.

The Store signal causes the count value contained in IC5, IC7 and IC8 to be "frozen" and held until the next Store signal is received. Immediately the count values have been stored, the counters can be reset.

There are several sources for the Reset signal, as again will be seen. Referring to Fig. 4, whatever the source, from the pole of switch S2b, the Reset signal is fed to IC7/IC8 pins 33, and to IC10b pins 11 and 12 (Fig. 5). It is inverted by IC10b and then passed via NOR gate IC10d to IC4 pin 1. These Store and Reset arrangements keep the three counter chips synchronised.

Switch S2b is used to switch the counter resetting source from Automatic operation to Manually controlled by S4. This allows counts to be made over extended periods of time under user control. In other words, it allows the unit to be used as an event counter.

## COUNTER TIMING

The normal counter Store and Reset sequence is required to operate at one second intervals, i.e. at 1Hz, so that the display shows the frequency rate in Hertz. Refer now to Fig. 6.

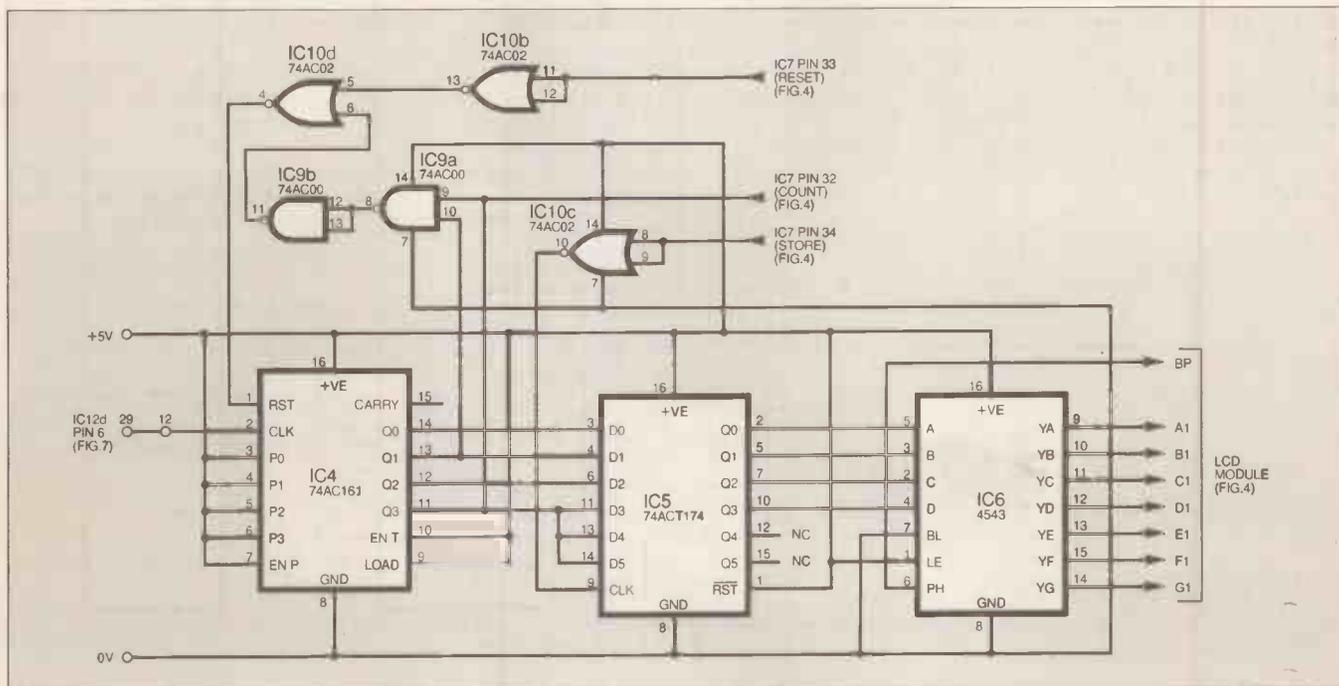


Fig. 5. Circuit diagram for l.c.d. digit 1 counter/driver.

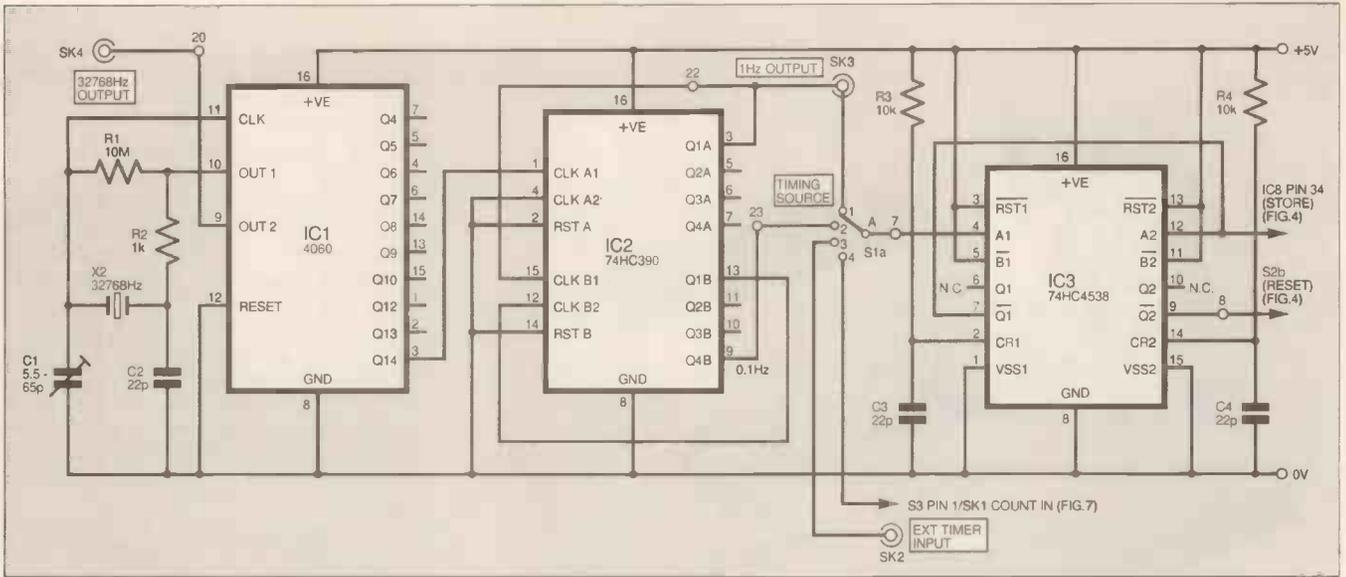


Fig. 6. Circuit diagram for timing period control and selection.

A crystal controlled oscillator and counter is formed around IC1. The basic crystal rate of 32768Hz is divided internally by IC1 so that a frequency of 2Hz is output from pin 3 (output Q14). The 32768Hz signal is also available as a signal source output via socket SK4.

From IC1 pin 3, the 2Hz signal is fed into counter IC2 at pin 1. The A1 stage of this counter divides the signal rate by two, outputting a 1Hz rate at pin 3. This 1Hz signal is made available to the outside world via socket SK3.

The 1Hz signal is now divided by stages B1 and B2, resulting in a 0.1Hz rate being output at pin 9. Both signals, 1Hz and 0.1Hz, are routed to switch S1a, as are other timing signal sources.

Which ever source is chosen, S1a (pole A) routes the timing signal to the dual monostable IC3, at pin 4. The first monostable has its pulse length set by resistor R3 and capacitor C3. Negative-going pulses output from pin 7 are the Store signals sent to the counters IC7 and IC8 (Fig. 4) and the latch IC5 (Fig. 5).

Negative-going pulses from IC3 pin 7 are also fed into the second monostable at IC3 pin 12. The pulse length of this stage is set by resistor R4 and capacitor C4. This monostable is triggered at the end of each Store pulse from pin 7. The negative going pulse output at pin 9 is the Reset pulse supplied to counters IC7 and IC8 (Fig. 4) and IC4 (Fig. 5).

The result is that each of the eight cascaded counters have their count values stored and output to the l.c.d. and are then immediately reset, allowing the counting to restart. As the previous count value has been stored, the l.c.d. only shows the final answer.

Selection by switch S1a of the 0.1Hz rate instead of 1Hz, relates the count to periods of ten seconds rather than one second. When this mode is selected, a decimal point is suitably turned on in the l.c.d. by switch S1b in conjunction with NOR gate IC10a, as shown in Fig. 4. Switch S2a turns off the decimal point when the unit is being used as an Event Counter.

### COUNT SOURCES

Referring now to Fig. 7, signals to be counted, or pulses whose lengths are to be measured, first need buffering. Switch S3 selects the source which is routed to the buffering Schmitt inverter IC12d, from where they are fed to the display counter input at pin 2 of IC4 in Fig. 5.

Digital signals whose logic levels swing between 0V and 5V are brought into the Logic Input at socket SK1, then going via S3/1 directly to IC12d.

Signals whose peak voltage levels do not swing between 0V and 5V are brought in via the A.C. Input, SK10. Such signals include those whose swings contain a negative voltage, or are greater than or less than the 0V to 5V logic range.

Capacitively coupled by C7 and mid-way biased by resistors R6 and R7, these "non-conformant" signals are fed via resistor R8 to op.amp IC15a. This is configured as a comparator whose reference voltage is set by potentiometer VR6. Resistors R9 and R10 limit the reference level extremes.

Each time the input voltage swings above and below the reference level, the output at IC15a changes state, switching between the op.amp's saturation output voltage extremes, just less than the power line voltage levels. Since the latter includes the -5V rail, resistor R11 and diode D1 are added to keep the minimum voltage fed via S3 to IC12d close to 0V.

Also fed to S3 are signals from Oscillator-1 and Oscillator-2, including the latter's 1/100 and 1/50 signals.

### 10MHz REFERENCE GENERATOR

Additionally Fig. 7 shows the 10MHz reference oscillator which is used for timing external pulse lengths. Pulse length is taken as the time that the pulse is high (logic 1).

Formed around IC9c, the 10MHz oscillator is output to the 2-input NAND gate IC9d. To the other input of IC9d is fed the input logic signal. Consequently, the output from IC9b only passes the 10MHz pulses when the input signal is high. These

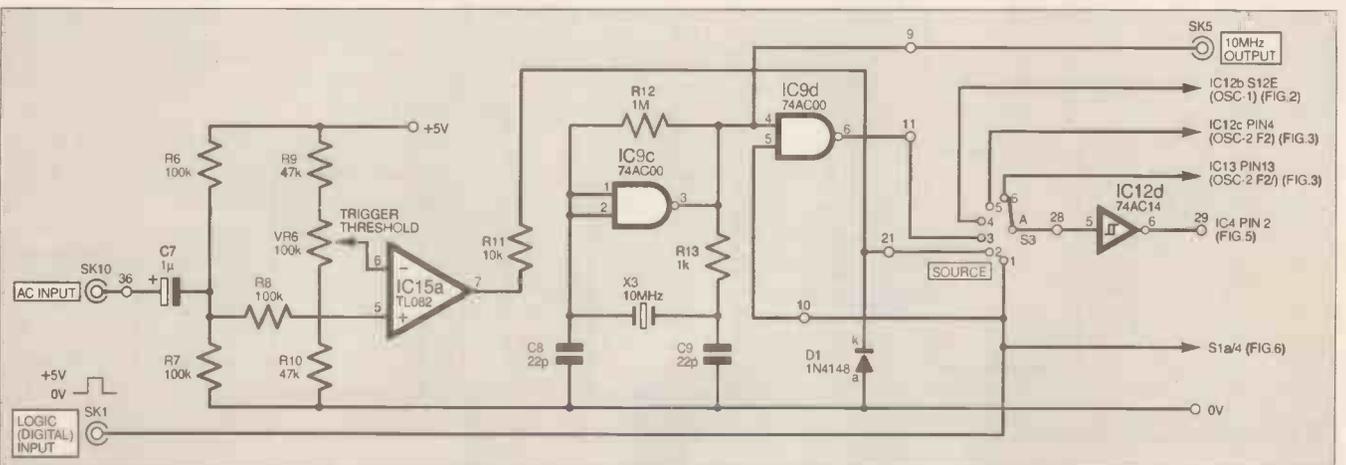


Fig. 7. Circuit diagram for a.c. input, 10MHz timing reference generator, and count source selection.

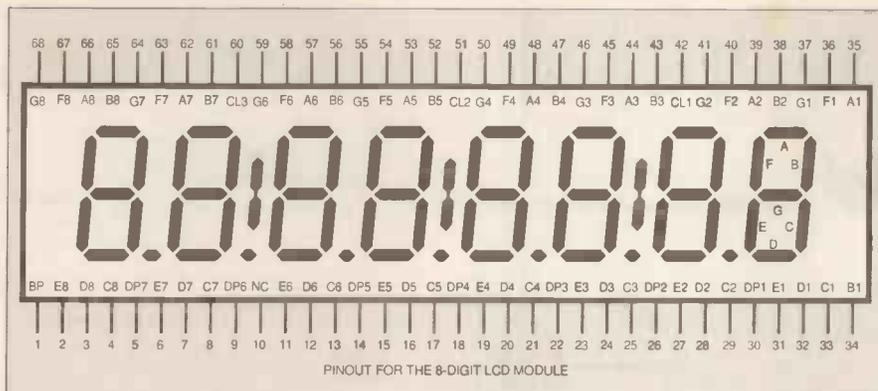
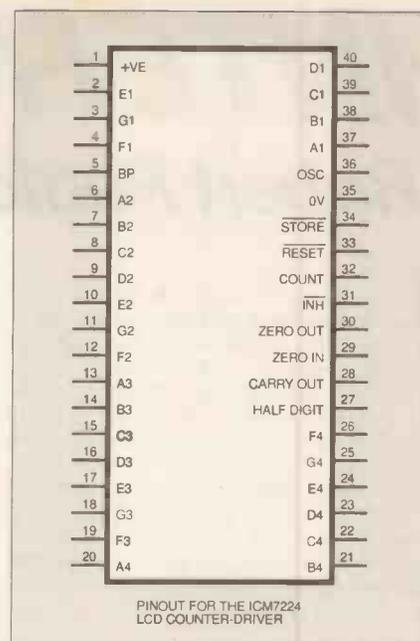


Fig. 8. Pinouts for the 8-digit l.c.d. module and (right) the ICM7224 counter/driver.



signals are fed to switch S3 from where they can be counted.

To measure the length of an input pulse period, the pulse itself is used as the timing source which controls the Store and

Reset routines of the frequency counters (switch S1 in position 4). Using the 10MHz frequency as the signal source (switch S3 in position 3), the number of its pulses which are counted during the input

pulse width represent the latter's duration in 0.1µs (i.e. ten oscillator pulses counted equals an external pulse length of one microsecond).

### POWER SUPPLY

Returning once more to Fig. 4, the complete unit can be powered from a d.c. supply between 7V and 12V. It is brought in via socket SK12 and regulated down to 5V by IC11.

This voltage supplies all parts of the circuit. It is also available as an output voltage at socket SK14. The external 0V (common ground) socket is SK13.

Capacitors C5, C6, C26 and C27 provide power line decoupling.

### SEMICONDUCTORS

Although IC12 is specified as a 74AC14, at the time of designing, these chips were in extremely short manufacturing supply. Consequently, the 74HC14 was used in the prototype. Both versions have the same pinouts, but the AC version can operate at higher frequencies than the HC (High-speed CMOS).

If the AC version can be obtained, using it may result in a higher maximum frequency available from Oscillator-1, although this has not been confirmed. With the HC version, the prototype's maximum frequency was about 46MHz.

Whether or not IC12 is obtainable as an AC type, with the other chips it is still worth while trying to get AC versions wherever these are specified (see *Shop Talk*).

If AC versions cannot be obtained, the HC versions may be substituted, though at a risk of reduced upper frequency handling range. Where HC versions are specified, there is nothing to be gained by substituting the AC types. Note that the LS and standard TTL versions are NOT suitable for this unit.

Pinouts for the 8-digit display and the ICM7224 counter/driver, are shown in Fig. 8.

**Next Month:** Circuit board construction, interwiring, case details and final testing.

## COMPONENTS

### Resistors

R1	10M	R9, R10	47k (2 off)
R2, R13	1k (2 off)	R12	1M
R3 to R5, R11	10k (4 off)	R14, R16	100Ω (2 off)
R6 to R8, R15,		R17	220k
R18 to R22	100k (9 off)		

All 0.25W 5% carbon film or better.

### Potentiometers

VR1, VR3	10k rotary carbon, log. (2 off)
VR2, VR4	100k rotary carbon, log. (2 off)
VR5, VR6	100k rotary carbon, lin. (2 off)

All are p.c.b. mounting types (see text).

### Capacitors

C1	5.5p to 65p trimmer	C14	47µ radial elect., 10V
C2 to C4,		C15, C16,	
C8, C9,		C24	22µ radial elect., 10V (3 off)
C18	22p polystyrene (6 off)	C17	2p2 ceramic plate (see text)
C5	470µ radial elect., 16V	C19	220p polystyrene
C6, C7	1µ radial elect., 10V (2 off)	C20	2n2 polystyrene
C10	4n7 polystyrene	C21	22n polyester
C11	47n polyester	C22	220n polyester
C12	470n polyester	C23	2µ2 radial elect., 10V
C13	4µ7 radial elect., 10V	C25	220µ radial elect., 10V
		C26, C27	100n polyester (2 off)

All voltages are minimum values.

### Semiconductors

D1	1N4148 signal diode	IC9	74AC00 quad 2-input NAND gate
IC1	4060 14-bit counter with oscillator	IC10	74AC02 quad 2-input NOR gate
IC2, IC13	74HC390 dual 4-stage counter (2 off)	IC11	7805 5V 1A regulator
IC3	74HC4538 dual monostable	IC12	74AC14 hex Schmitt inverter
IC4	74AC161 4-bit binary counter	IC14	MF10 switched capacitor filter
IC5	74ACT174 Hex D-type flip-flop	IC15	TL082 dual f.e.t. op.amp
IC6	4543 l.c.d. driver		
IC7, IC8	ICM7224 4½ digit counter/driver (2 off)		
IC16	7660 voltage inverter		

See text regarding AC types.

### Miscellaneous

S1	3-pole 4-way rotary switch
S2, S6	min. d.p.d.t. toggle switch (2 off)
S3, S7	2-pole 6-way rotary switch (2 off)
S4	min. s.p. push-to-make switch
S5	1-pole 12-way rotary switch
SK1 to SK11, SK13, SK14	2mm single socket (13 off) (see text)
SK12	min. power socket
X1	8-digit l.c.d. module
X2	32768Hz crystal
X3	10MHz crystal

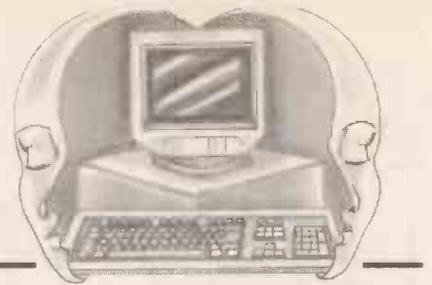
Printed circuit boards (2 off), available as a pair from the *EPE PCB Service*, codes 994 (Osc.) and 995 (L.C.D. Driver); knob, screw-fix, with pointing mark (10 off); plastic case, 2-tone, sloped metal panel, 216mm x 155mm x 100mm (max. height); 8-pin d.i.l. socket (2 off); 14-pin d.i.l. socket (3 off); 16-pin d.i.l. socket (7 off); 20-pin d.i.l. socket; 34-pin s.i.l. socket (4 off) (see text); 40-pin d.i.l. socket (2 off); nuts (12 off) and bolts (4 off) to suit; cable ties; 1mm terminal pins; connecting wire; solder, etc.

**Approx Cost**  
Guidance Only

**£79** excluding case

# INTERFACE

Robert Penfold



LAST month's *Interface* article covered simple circuits based on the 6402 UART which enable serial data from an RS232C port to be converted into bytes of parallel data. This month we progress to the transmitter circuits, and getting parallel data into a computer via the serial port. With the aid of a 6402 UART this is fairly simple, but it is not quite as straightforward as decoding serial information into bytes of parallel data. Some control logic may be needed with the receiver circuit, but for a serial transmitter circuit it is obligatory.

## Self-Service

The receiver section of the UART places fresh bytes of data onto its parallel outputs as and when they become available from the decoder section. Often this is all that is needed, but if necessary the UART can be made to generate a strobe pulse each time a fresh byte of parallel data is made available.

This is just a matter of getting the Data Ready output at pin 19 to reset itself via the Data Ready Reset input at pin 18. Pin 19 goes high when a new byte of data is placed onto the parallel outputs, and it is reset by taking pin 18 low. The Data Ready output will therefore reset itself if it drives the Data Ready Reset input via an inverter.

In practice, it is often necessary to include a delay circuit in order to ensure that the output pulse is long enough to drive the peripheral circuit reliably. Experience has shown that a simple common emitter switching stage is adequate, and a circuit of this type is provided in Fig. 1. This type of circuit provides the required inversion. The delay is provided by capacitor C1 in conjunction with base feed resistor R1.

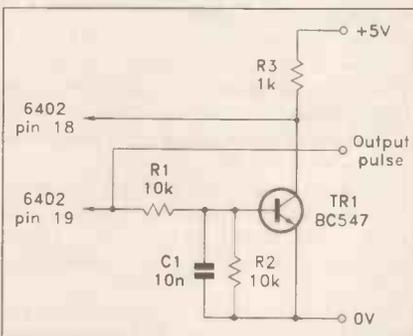


Fig. 1. Circuit which generates a strobe pulse each time a fresh byte of data is available.

Pin 19 of the UART goes high when a fresh byte of data becomes available, but even with C1 included the pulse duration will only be a few tens of microseconds. This is a fairly long duration by the standards of logic circuits, and it should be sufficient to activate the peripheral circuit properly. However, if necessary the pulse length can be increased by raising the value of C1.

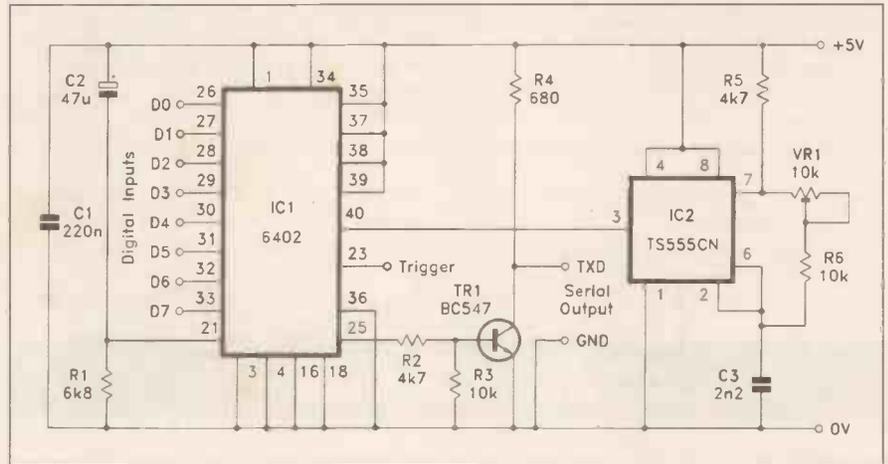


Fig. 2. The serial transmitter circuit. The trigger input is pulsed low to transmit a byte of data.

## Transmitter Circuit

In Fig. 2 is shown the circuit diagram for a unit that provides basic parallel-to-serial conversion. Some of this circuit is much the same as the receiver circuit, with the control inputs again being connected to provide a word format of one start bit, eight data bits, one stop bit, and no parity.

The reset circuit connected to pin 21 is also the same, but note that in last month's receiver circuit resistor R4 and capacitor C1 were shown the wrong way round. The capacitor must go to the positive supply and the resistor to the negative supply, as shown in Fig. 2 here. This gives the required positive reset pulse at switch-on.

The clock circuit is the same as the one used in the receiver circuit, and correct adjustment of potentiometer VR1 should provide operation at 1200 baud. Adjusting VR1 is just a matter of using trial and error to locate a setting that enables the computer to reliably decode the serial data. If a frequency meter is available, adjust VR1 for an output frequency of 19.2kHz at pin 3 of IC2.

Of course, if preferred, the crystal controlled clock circuit provided last month can be used in place of the 555 astable. This avoids the need for any setting up adjustments. If both the transmitter and receiver sections of the 6402 are to be used, and the two sections will be run at the same baud rate, it is perfectly all right to drive both sections from the same clock circuit.

The bytes of parallel data are fed to the eight inputs at pins 26 to 33, and the serial data is transmitted from pin 25. The signal from pin 25 is at standard 5V logic levels, whereas an RS232C input requires nominal signal levels of plus and minus 12 volts. Also, the output from the UART is of the wrong polarity, and must be inverted before it can drive an RS232C input properly.

In practice, it is usually satisfactory if an RS232C port is driven with a 5V

logic signal, provided a short connecting cable is used, preferably together with a baud rate of about 1200 or less. In most general interfacing applications, it is only necessary to use a short connecting cable of a metre or two in length, and a baud rate of about 1200 is adequate. This enables a simple common emitter switching stage to be used as the line driver.

In this circuit transistor TR1 is used as the inverter/driver. There are special RS232C driver chips available, and the MC1488P quad driver seems to be the "standard" device of this type. Pinout details for this chip are provided in Fig. 3. It has four drivers, which enable it to act as the line driver for any handshake outputs, and (or) to be used with more than one UART.

One of the line drivers is perfectly straightforward, but the other three provide a two input NAND gate function. In other words, the output of the driver goes low if both inputs are high, but is high if either or both inputs are low.

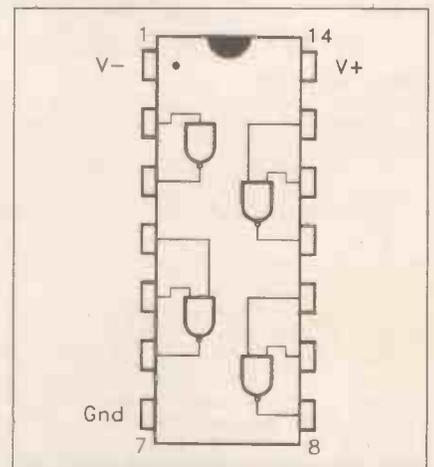


Fig. 3. Pinout details for the MC1488P quad line driver.

This effectively enables one input to be used to cut off the serial signal fed to the other input, but this facility is of little value in most practical applications.

If the two inputs of each NAND gate driver are wired together, they will operate as simple inverter/drivers, but may excessively load the serial output of the UART. It is safer if one input is connected to the +5V rail and the other input is fed with the serial output signal of the UART.

Connection details for both types of driver in the MC1488P are shown in Fig. 4.

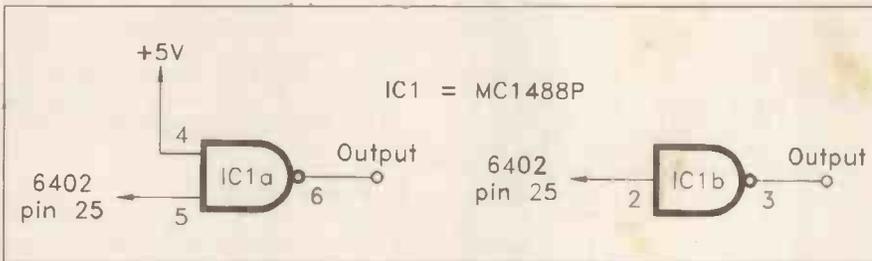


Fig. 4. Using the driver in the MC1488P.

A slight drawback of simple line driver chips such as the MC1488P is that they require dual balanced supplies of about  $\pm 12V$  (a maximum of  $\pm 15V$  for the MC1488P). Some of the more modern drivers generate their own dual balanced supplies from a +5V supply. These "do-it-yourself" driver chips have the drawback of being relatively expensive, but in some cases could effectively pay for themselves by avoiding the cost of an additional power supply. Unfortunately, I have not yet had a chance to try one of these chips with the 6402 due to supply difficulties, but I will pursue this matter.

### In Control

As pointed out previously, a control circuit cannot be regarded as an "optional extra" when using the 6402 to transmit data. As it stands, this serial transmitter circuit will simply sit there doing nothing, ignoring the bytes of data fed to its inputs!

In order to transmit a byte of data it is necessary to briefly pulse pin 23 of the UART low. Data is loaded into the transmitter-holding register on the falling edge of the pulse, and transmission commences on the rising edge.

When initially testing the circuit, it can be helpful to have the UART send a regular stream of bytes. One way of achieving this is to simply connect pin 23 to the clock input at pin 40. Obviously the clock will provide pulses at a much higher rate than the UART can transmit full bytes of data, but the UART seems to ignore any extra trigger pulses. This results in bytes of data being transmitted virtually end-to-end.

This method is simple, but it provides a rapid and continuous flow of data which the computer might find it difficult to digest, particularly if a high

operating frequency of the circuit is inversely proportional to the value of this capacitor. A value of  $1\mu F$  for example, would result in bytes of data being sent at about 10 per second.

Although at first sight this method of control may seem to be valid for general use, it does have a major problem. The data on the parallel inputs must be stable during the pulse on pin 23. With this simple asynchronous method of control, the stability of the data cannot be guaranteed, and invalid data might be transmitted.

In an application where the data changes very slowly this might not matter, though. For example, a temperature interface could be designed to take readings at one second intervals. There would be little or no change from one reading to the next, and a software filter could be used to remove any erroneous results that occurred from time to time.

### Running Free

The free-running method might also be usable in something like an alarm application where the binary input pattern would normally be the same for hours or even weeks at a time. The software would show the states of the sensors, and sound an alarm if a change was detected.

It is unlikely that a reading glitch as the system was triggered would prevent it from working properly anyway, but this is something that could easily be avoided by using appropriate software methods.

In applications where the data is constantly changing, it is essential to use a proper control logic circuit. Basically, all this has to do is latch each new byte of data into an 8-bit latch, and then trigger the 6402 UART.

Latching data using the 74LS273, etc. is a subject that has been covered in previous *Interface* articles and is not something we will consider again here. Some peripheral circuits, including most analogue-to-digital converters, have a built-in data latch, and also have a status output that can be used to provide the UART with a suitable trigger pulse. Circuits of this type can usually be interfaced to a serial transmitter with little difficulty.

Next month we will conclude our investigation of basic serial interfacing techniques.

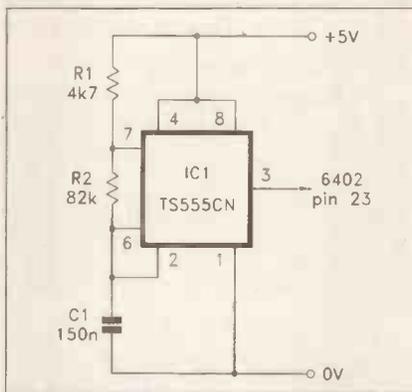


Fig. 5. A circuit which provides regular triggering to the 6402 UART.

baud rate is used. The 555 oscillator circuit of Fig. 5 provides a simple alternative that enables the data rate to be set at practically any desired figure.

Using the specified timing component values, the UART will be triggered at approximately 10ms intervals (i.e. at about 100Hz). A lower rate can be obtained by using a higher value for timing capacitor C1, and the

## RING BINDERS FOR EPE

This ring binder uses a special system to allow the issues to be easily removed and reinserted without any damage. A nylon strip slips over each issue and this passes over the four rings in the binder, thus holding the magazine in place.

The binders are finished in hard wearing royal blue p.v.c. with the magazine logo in gold on the spine. They will keep your issues neat and tidy but allow you to remove them for use easily.

The price is £5.95 plus £3.50 post and packing. If you order more than one binder add £1 postage for each binder after the initial £3.50 postage charge, (for overseas readers the postage is £6.00 each to everywhere except Australia and Papua New Guinea which costs £10.50 each).

Send your payment in £'s sterling cheque or PO (Overseas readers send £ sterling bank draft, or cheque drawn on a UK bank or pay by credit card), to Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Fax: 01202 841692 (We cannot reply to queries or confirm orders by Fax due to the cost).

We also accept credit card payments. Mastercard (Access) or Visa (minimum credit card order £5). Send your card number and card expiry date plus cardholders address (if different to the delivery address).





# FOX

## REPORT

by Barry Fox

### Tandy Syndrome

At the knowledgeable end of the computer trade, they call it the "Tandy Syndrome". Someone buys a modem which, like all modern modems, has a US phone socket on the rear. For one reason or another they need a new lead, perhaps longer or perhaps because the original lead has American plugs on both ends.

The lead hunter goes to Tandy, because that is the only shop on the High Street that can be relied on to stock a good range of connectors. They buy a lead with an American plug at one end and a British BT plug at the other, plug it between the wall and the modem and try to send electronic mail or surf the Internet. But the modem sits resolutely dead. Exactly the same death is likely to afflict phones or fax machines.

### Hell of a Hot-line

It is pure luck whether this happens or not, and Devilish hard to resolve because there is a conspiracy of silence inside the phone industry. By providing only inadequate or obscure explanations and instructions, the companies can so confuse the public that it is easier for people to buy new equipment.

Both the US and UK telephone systems rely on two wires to carry phone signals into the house. The house plugs and sockets have space for six pins but only four are used, numbered 2 to 5.

In the US system, the two "hot" wires go to the two centre pins of the small four-pin plugs and sockets. In the UK, the two hot wires go to the outer pins (2 and 5) of the larger four-pin plugs and sockets that BT uses.

So if a modem is wired for the US system, any lead which connects it to a UK socket must have the centre pins hot at the modem end, and the outer pins hot at the British plug and socket end. But for two reasons it is not that simple.

Some modem and phone manufacturers wire their rear panel US standard sockets in a non-standard way, with the outer pins hot. This way, when the equipment is used in the UK, the connecting lead uses straight through wiring without any need to swap the signal from centre to outer pins.

### Leading Question

The trick is in knowing how the modem sockets are wired, because it is very difficult to tell by looking, especially if the socket has all four contacts present. This is one of the reasons for that Tandy Syndrome. The shop staff are unlikely to understand the problem, let alone offer help. You might as well toss a coin before buying a lead which may be straight through, outer to outer, or cross-over,

centre to outer. You can also toss a coin over which leads your equipment needs.

And it gets worse. The US phone system works through the home on two wires but the British system needs a third wire to make the phones ring. More accurately, phones which are approved for use in the UK need the third wire to ring. Phones from the US will ring in British homes with only two wires. With only two wires you can make calls and talk on three wire UK phones but you won't know when there is an incoming call.

### French Connection

UK fax machines also need the ringing tone if they are to auto-answer. Without it the machine can only send or receive faxes manually. People with holiday homes in France find this out to their cost when they take their British fax machine over the Channel. When plugged into a French phone line it stubbornly refuses to answer incoming faxes.

If only two wires come into the house, where does the third wire signal come from? It is derived from hot wires 2 or 5 by a capacitor. This passes the a.c. ringing tone to wire 3. The capacitor is built into the master socket at the point where the two incoming wires enter the house.

It is missing from the extension sockets which are then used all round the house. Wire 4 may provide an earth recall connection. Hence the need to use four wire cabling to connect the master socket to the extensions.

### Golden Rule

After years of messing around with different phones, fax machines and modems, bought in a variety of countries and then used in a variety of countries, I can pass on only one golden rule. Whenever you buy any piece of telephone equipment, mark the lead which comes with it. That way you can always go back to first principles and use the original lead as a reference point.

This is a life-saver with equipment such as faxes and fax switches which will often leave the factory with US line sockets and connector leads which are wired with such wholly illogical configurations that they are completely useless once the original leads have been removed and mislaid.

The principle is the same as that of noting original computer software settings, or electronic hardware adjustments, before making any alterations. That way when you get in a mess, you can always go back to the original setting and start again.

## Going . . . Going . . . Gone!

Gradually it all slips away. In 1991 the Government sold off the national research laboratories in Winchester which had been owned by the Independent Broadcasting Authority. Over the years the IBA pioneered digital video recording, and advances in analogue television, such as the clever but ill-fated MAC system.

The IBA's labs were bought for the knock-down price of £70 million by investment firm Mercury Asset Management. The privatised labs were re-named National Transcommunications Ltd and the IBA's successor, the Independent Television Commission, employed NTL to research digital television. NTL also diversified into satellite transmission and mobile radio. As Ian Armitage of Mercury said recently "The investment has proved to be outstanding".

Armitage was speaking as MAM sold off the last chunk of its hugely profitable investment.

Last year Rupert Murdoch's News International bought the section of NTL that had been employed by the ITC to develop digital television. It was hived off staff, stock and barrel, and re-named Digi-Media Vision.

In late March, Mercury flogged the remaining staff and stock to cable TV company CableTel. Although the official announcement makes much of the fact that CableTel is "Britain's third largest cable communications operator", the truth of the matter is that CableTel is an American company.

Although Rupert Murdoch never said how much he paid for the DMV share of NTL, CableTel is paying a total of £235 million, for a company that is earning over £100 million a year.

So research labs that were built to serve the British public, and transmit British TV and radio programmes, have now made the Government a piddling £70 million and earned the Mercury money men literally hundreds of millions.

The final sale negotiations were protracted, and the final deal was not signed until the small hours of the morning. By then the two companies had already kitted out a conference hall in London to puff the sale to city analysts. After the analysts had heard the news, NTL and CableTel held a joint press conference. It started at 11.30am. By the time 280 faxes had gone out inviting journalists to attend and ask questions, it was well into the afternoon and the conference was finished.

There would not have been much point in going anyway. MAM is in business to buy cheap and sell high. The culprits are the British government ministers who, in 1991, sold the IBA's labs cheap and so gave MAM the chance to make a small fortune.

The sting may be in the tail. If the BBC now goes ahead and sells its transmitter network to raise money, NTL is the most likely buyer. The transmission of all British radio and TV will then be controlled from America.

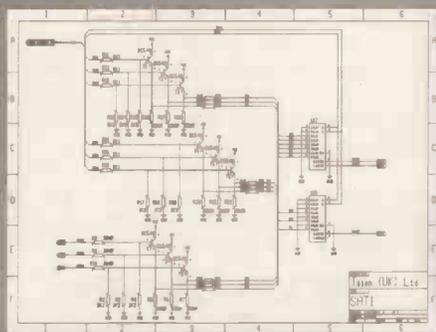
**Is your PCB design package not quite as "professional" as you thought? Substantial trade-in discounts still available.**

## Board Capture

*Schematic Capture Design Tool*

- Direct netlist link to BoardMaker2
- Forward annotation with part values
- Full undo/redo facility (50 operations)
- Single-sheet, multi-paged and hierarchical designs
- Smooth scrolling
- Intelligent wires (automatic junctions)
- Dynamic connectivity information
- Automatic on-line annotation
- Integrated on-the-fly library editor
- Context sensitive editing
- Extensive component-based power control
- Back annotation from BoardMaker2

**£395**



## BoardMaker

*BoardMaker1 - Entry level*

- PCB and schematic drafting
- Easy and intuitive to use
- Surface mount and metric support
- 90, 45 and curved track corners
- Ground plane fill
- Copper highlight and clearance checking

**£95**

*BoardMaker2 - Advanced level*

- All the features of BoardMaker1
- Full netlist support- BoardCapture, OrCad, Schema, Tango, CadStar
- Full Design Rule Checking both mechanical and electrical
- Top down modification from the schematic
- Component renumber with back annotation
- Report generator- Database ASCII, BOM
- Thermal power plane support with full DRC

**£395**

## BoardRouter

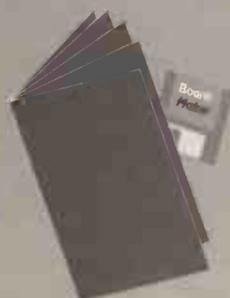
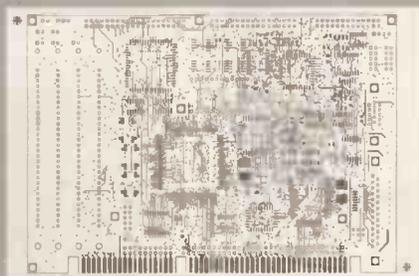
*Gridless re-entrant autorouter*

- Simultaneous multi-layer routing
- SMD and analogue support
- Full interrupt, resume, pan and zoom while routing

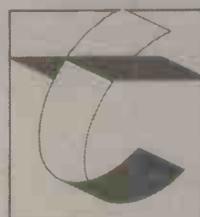
**£200**

*Output drivers - Included as standard*

- Printers - 9 & 24 pin Dot matrix, HPLaserjet and PostScript
- Penplotters - HP, Graphtec & Houston
- Photoplotters - All Gerber 3X00 and 4X00
- Excellon NC Drill and Annotated drill drawings (BM2)

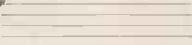
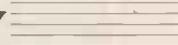


For further information contact  
**Tsien (UK) Limited**  
 Aylesby House  
 Wenny Road, Chatteris  
 Cambridge, PE16 6UT  
 Tel 01354 695959  
 Fax 01354 695957  
 E-mail [Sales@tsien.demon.co.uk](mailto:Sales@tsien.demon.co.uk)



**tsien**

# VU DISPLAY AND ALARM

MAX HORSEY  PCB DESIGN BY DAN RUSBY 

*Bargraph I.e.d.s and a buzzer give audio-visual warning of signal overloads.*

**B**ASED on the information provided in *Teach-In Part 8*, this article shows how modules may be selected and combined to produce a working project.

The VU (Volume Units) Display and Alarm has two distinct functions:

1. A set of I.e.d.s (light emitting diodes) which pulse according to the level of sound received by a built in microphone.
2. A stereo line input which may be connected to the output from an audio source, such as an amplifier, cassette recorder or video recorder, to monitor the sound level being recorded.

In both situations, if the level becomes too high, a buzzer sounds a warning.

The first application is mainly for display purposes, although if the buzzer is replaced by a lamp or I.e.d. the circuit could also warn of excessive noise level.

Note that the buzzer cannot be used as a warning device when the internal microphone is in use, since the buzzer's own sound will be picked up by the microphone and cause the circuit to latch.

The second application is particularly useful when recording cassettes or video tapes. In the author's experience, automatic sound level controls never produce good results, but it can be quite tedious watching the recording level indicators in case an unexpected sound peak makes the system over-record.

This circuit enables the user to relax, read, sunbathe etc., safe in the knowledge



that the device will buzz or bleep if an excessive sound peak occurs (but it could still be necessary to start over again if it does!).

The circuit is designed to be connected either between, say, an amplifier "record output" and the cassette recorder or video recorder, or to the line output of the recorder.

The two stereo channels are mixed to produce a single signal for the circuit, but the separate stereo channels are sent on to the recorder. In other words, stereo channel source separation is not compromised.

## BLOCK DIAGRAM

As seen in the block diagram of Fig. 1, the concept is achieved by using two input modules, namely the sound input circuit and the mixer circuit, selecting between them by means of a switch.

The signal is then processed by an integrated circuit (i.c.) and associated components which convert a rising and falling voltage into a rising and falling I.e.d. display.

The buzzer output module is connected so that when the appropriate I.e.d. lights, the buzzer sounds, indicating the excess level warning.

## CIRCUIT DESIGN

Studying Fig. 2 reveals that the final circuit is a fairly close copy of modules discussed in *Teach-In Part 8*.

Op.amp IC1 is connected as a non-inverting amplifier with a gain of about 471 (i.e.  $R4/R5 + 1$ ). This part of the circuit provides a high gain suitable for a microphone, which should be an *electret* type. If a *dynamic* microphone is used, then remove R1 so that there is no connection between the microphone and positive rail. The signal level delivered to bargraph driver IC3 is set by potentiometer VR1.

Op.amp IC2 is connected as an inverting amplifier and is used as a mixer stage. It is intended for "line level" input signals – the type of signal associated with the outputs from cassette recorders and video recorders. It cannot be used with microphones.

As discussed in Part 8, the inverting input (pin 2) is a "virtual earth", which ensures that the signal arriving from one source cannot interfere with the other, and vice-versa.

The two stereo halves of the audio signal are mixed and, if necessary, amplified a little, but the separation between them on the source (input) side is retained. Both channels are given the same amount of

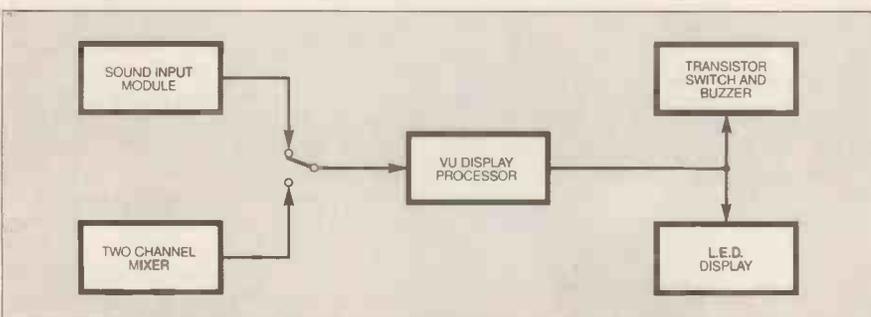


Fig. 1. Block diagram for the VU Display and Alarm.

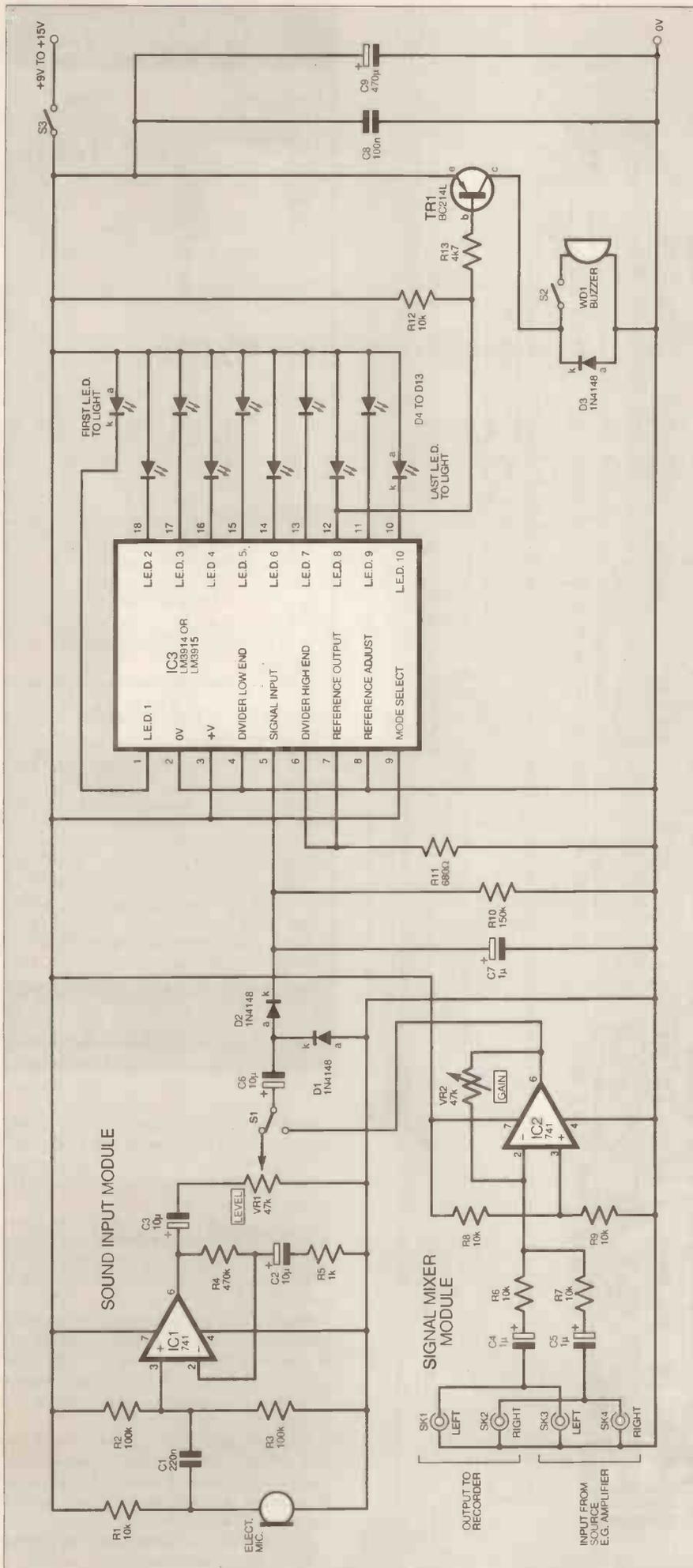


Fig. 2. Complete circuit diagram for the VU Display and Alarm.

gain since their input resistors, R6 and R7, have equal values.

The overall gain of this stage is variable from nil to about 4.7 times by potentiometer VR2, which is wired as a variable resistor.

Switch S1 selects between the audio input module and the signal mixer. Both modules require a d.c. blocking capacitor in series with their outputs, and so a single capacitor C6 is provided after the switch. Likewise, both circuits require an a.c. to d.c. converter (as within the dotted lines in Part 8 Fig. 8.4).

Here, in Fig. 2, the converter consists of diodes D1 and D2, capacitor C7 and resistor R10. The resulting d.c. voltage, which rises and falls according to the a.c. signal strength, is supplied to IC3 pin 5, to control the l.e.d. display, D4 to D13.

Note that each output at IC3 is "active low", therefore each l.e.d. is connected between the positive power line and the appropriate output. Resistor R11 sets the brightness of the display.

The eighth output was chosen as the "overload" warning source, and so pin 12 is used to control the buzzer WD1 via transistor TR1. Resistor R12 was added to ensure that the transistor turns off completely when pin 12 is not active. Switch S2 turns off the buzzer when not required.

Finally, decoupling is provided by capacitors C8 and C9, whilst S3 is the power on/off switch.

## OMITTING MODULES

If either of the two input stages in Fig. 2 is not required, simply leave out the appropriate components. For example if the circuit is to be used only as a recording signal warning device, omit the microphone input stage, comprising IC1, R1 to R5, C1 to C3, VR1, S1 and the microphone.

When switch S1 is omitted, the positive side of capacitor C6 should be connected directly to the output of the retained input stage (i.e. to IC2 pin 6, or the wiper of VR1, as appropriate).

## POWER SUPPLY

Although the circuit will operate from a PP3 (9V) battery for several hours, if it is likely to be used for considerably longer periods a mains power adaptor is recommended. A small regulated type offering 9V or 12V d.c. at up to 300mA is ideal.

## HOUSING BENEFITS

Since the circuit is designed for producing a display, some thought should be given to housing the unit in a suitable case before starting. The printed circuit board (p.c.b.) is designed to allow a set of l.e.d.s to be inserted directly. The larger rectangular types (i.e. 7mm x 2.5mm) will fit exactly end to end.

If the l.e.d.s are to be mounted directly into the board, then decide at this stage how the p.c.b. will fit into the case, and whether a long slot will be cut (quite a difficult operation) or whether a case with a transparent top will be used.

Alternatively, a "normal" case can be used and holes made in the front for standard round l.e.d.s, connecting them back to the p.c.b. via wires. Note that only 11 wires are required (not 20); in other words, one for each l.e.d. cathode (k), plus one lead connected to all the l.e.d. anodes (a).

# COMPONENTS

## Resistors

R1, R6 to R9, R12	10k (6 off)
R2, R3	100k (2 off)
R4	470k
R5	1k
R10	150k
R11	680Ω
R13	4k7

All 0.25W 5% carbon film, or better

## Potentiometers

VR1, VR2	47k rotary lin. (2 off)
----------	-------------------------

## Capacitors

C1	220n ceramic disc
C2, C3, C6	10μ elect. radial, 16V (3 off)
C4, C5, C7	1μ elect. radial, 16V (3 off)
C8	100n ceramic disc
C9	470μ elect. radial, 16V

Voltages are *minimum* values

## Semiconductors

D1 to D3	1N4148 signal diode (3 off)
TR1	BC214L <i>pnp</i> transistor
IC1, IC2	741 op.amp (2 off)
IC3	LM3915 logarithmic bargraph driver
D4 to D10	green l.e.d., rectangular, 7mm x 2.5mm (7 off)
D11 to D13	red l.e.d., rectangular, 7mm x 2.5mm (3 off)

## Miscellaneous

WD1 solid state buzzer, 6V to 12V  
 S1 s.p.d.t. min. toggle switch  
 S2, S3 s.p.s.t. min. toggle switch  
 Printed circuit board, available from the *EPE PCB Service*, code 999; electret microphone insert; 8-pin d.i.l. socket (2 off); 18-pin d.i.l. socket; phono socket, red (2 off), phono socket, black (2 off); knob (2 off); plastic case 150mm x 80mm x 75mm, with transparent lid (see text); power input socket; 12V power supply (see text); terminal pins; wire; solder, etc.

Approx Cost  
 Guidance Only

**£22**

excl. case and PSU

Note that the p.c.b. is mounted in the case with the l.e.d.s on the left hand side. This is to ensure that the last l.e.d. to light will be at the top when the project is standing upright.

## CONSTRUCTION

Details of the p.c.b. are shown in Fig. 3. This board is available from the *EPE PCB Service*, code 999.

Begin p.c.b. assembly with the smallest components and i.c. sockets, building up in size and finishing with the off-board connections. As usual, check the polarity of electrolytic capacitors, diodes and transistor TR1.

When connecting the l.e.d.s, also check their polarity carefully. Remember that the shorter l.e.d. lead (normally) represents its cathode (k), and is connected to the respective output of IC3.

Rectangular l.e.d.s may not be clearly marked with regard to polarity, and once the wires have been cut it may be difficult to fit them the correct way round.

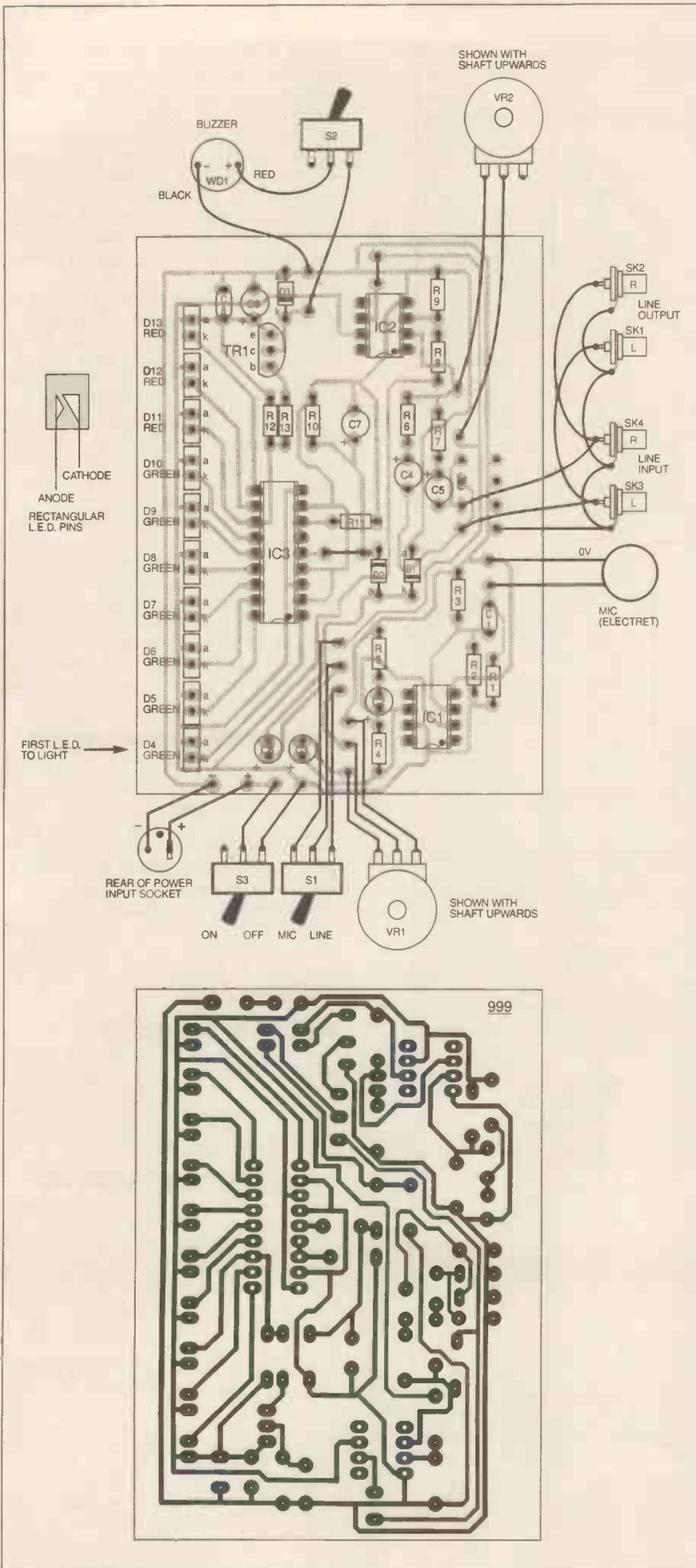


Fig. 3. Printed circuit board component layout and full-size underside copper foil track master pattern.

However, by comparing them carefully, it is possible to work out the polarity by checking the shape of the metal parts inside the body.

## TERMINAL PINS

If the p.c.b. is to be fitted in a transparent case, it is better to fit all the wires for connecting to off-board components on the *track* side of the board so that they are hidden from view. They are best connected by means of terminal pins, which, in this instance, should be inserted with their heads on the *component* side.

Next, connect the electret microphone, taking great care with its polarity. The polarity is not always obvious and the catalogue from which the microphone was purchased may have to be consulted. Some suppliers sell microphone inserts with screened wires already connected, in which case the outer part of the cable is the negative (0V) side.

If wires are not already connected to the microphone insert, use normal wires (rather than screened cable) to make the connections if they are only a few centimetres long.

## AUDIO LEADS

The circuit diagram, Fig. 2, shows how the audio line level signal can be routed through the project. This means that, for example, the output from an amplifier to a cassette recorder can be connected to the project, and another lead used from the project to the recorder. This method is shown in the wiring block diagram in Fig. 4a, but note that the gain setting on the recorder will not change the level of signal reaching the project.

If the connection method shown in Fig. 4b is used, then any changes made to the gain setting on the recorder will cause a change of signal at the project.

There is provision on the p.c.b. for routing the audio signal in and out via wires connected directly to it. However, it

may be more convenient to just use three connections to the p.c.b. and connect the phono sockets, Left with Left, and Right with Right with short insulated wire links, as shown in Fig. 3. Since the two sockets are connected in parallel it is immaterial which are called "input" or "output".

Complete all the other connections to the potentiometers and switches.

When inserting the i.c.s, check carefully that the notch on each one lines up with the layout. Although they are not prone to static damage in the same way that CMOS i.c.s are, it is still sensible to handle them with respect.

## TESTING

A 12V 100mA regulated supply is ideal for testing the circuit. If powered by a

battery, or an ordinary 9V to 12V power supply, check that components, the i.c.s in particular, do not become hot due to faulty wiring.

Switch S1 to "microphone", then wait for about 15 seconds for the capacitors to charge. Adjust VR1 until one or more of the l.e.d.s light, pulsing with sounds received by the microphone.

Now set S1 to "mixer" and connect the input to a cassette recorder output, or an amplifier line output. Adjust VR2 until the l.e.d.s again pulse with changes in the signal level.

If the circuit is functioning properly, the buzzer should sound (if switch S2 is on) when l.e.d. number eight lights up (the first of the reds). Failure in this area indicates that TR1 may be connected the wrong way round.

## FAULT FINDING

Failure of one or other test should indicate the area of the circuit to check first. Read the fault finding guide provided in *Teach-In Part 1* for general help.

An oscilloscope connected to output pin 6 of IC1 or IC2 should indicate a signal, but do not expect to trace a signal at pin 2 of IC2. Even though this is the input pin, there will not be any measurable signal present (see comments in Part 8 about "virtual earth").

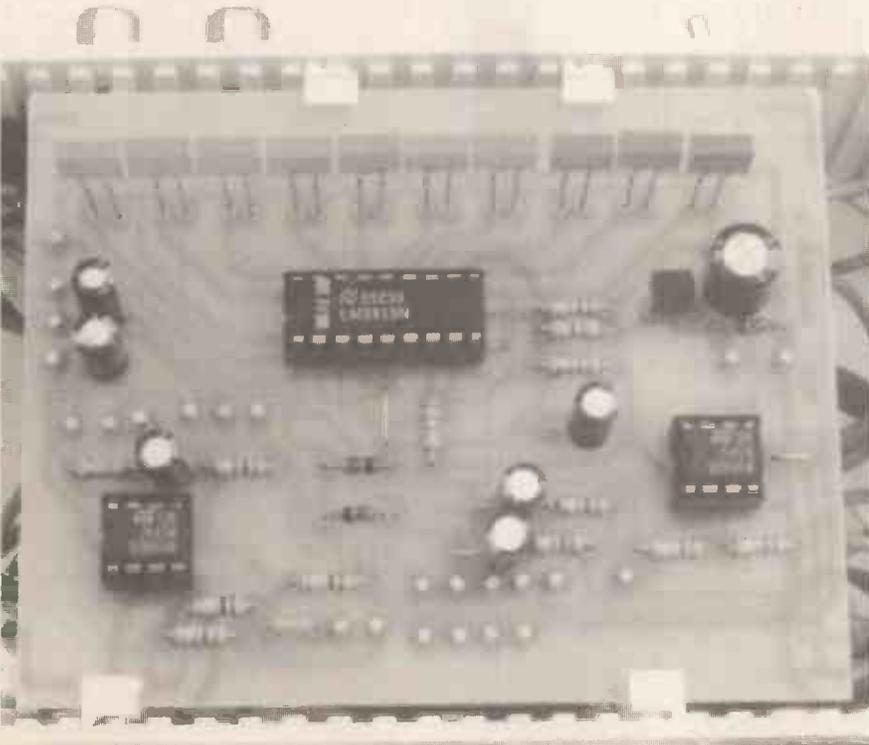
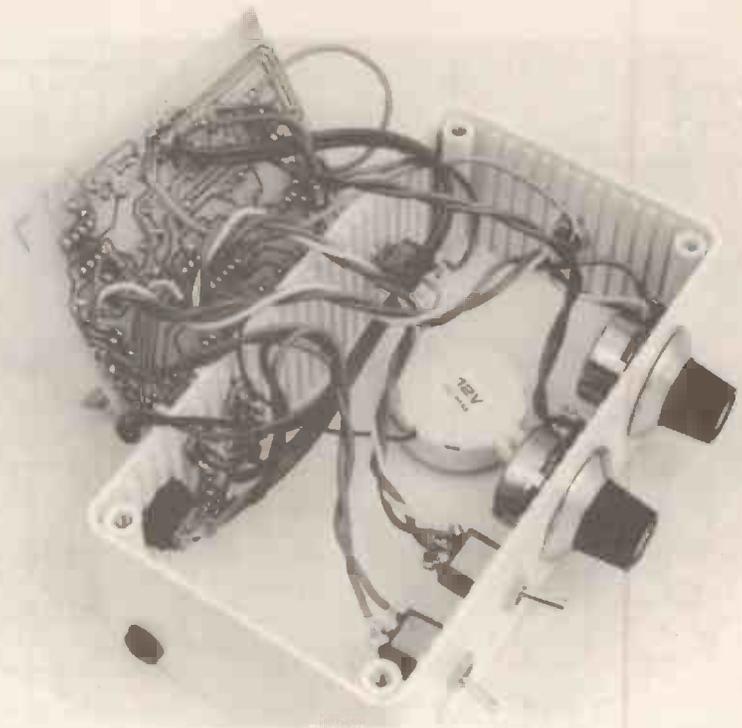
A voltmeter should reveal a signal (i.e. a fluctuating d.c. voltage) at the cathode (k) of diode D2.

Check that the l.e.d.s are connected the correct way round.

## THE CASE

Studying the photographs, prepare the case. Begin by drilling the holes for the power input socket, line input/output sockets, potentiometers and switches.

Phono sockets should be used so that the line input and output system is compatible with the majority of commercial equipment. Note that the retaining nuts on the phono sockets are responsible for holding the 0V connections securely, therefore they should be screwed very firmly.





EVERYDAY

PRACTICAL

# ELECTRONICS

# BACK ISSUES

We can supply back issues of *EPE* by post, many issues from the past five years are available. An index for each year is also available - see order form. Alternatively, indexes are published in the December issue for that year. Where we are unable to provide a back issue a photostat of any *one article* (or *one part* of a series) can be purchased for the same price.

## DID YOU MISS THESE?

### DEC '94

**PROJECTS** ● Spacewriter Wand ● *EPE* Fruit Machine ● Universal Digital Code Lock ● Video Modules, Part 2 (Horizontal Wiper, Vertical Wiper, Audio Mixer) ● Rodent Repeller.  
**FEATURES** ● Electronics from the Ground Up, Part 3 ● Embedded Controllers ● Index for Volume 23.

### JAN. '95 Photostats Only (see below)

**PROJECTS** ● Magnetic Field Detector ● Moving Display Metronome ● Model Railway Track Cleaner ● Beating the Christmas Lights ● *EPE* Fruit Machine, Part 2 ● Video Modules, Part 3 (Dynamic Noise Limiter, System Mains Power Supply).  
**FEATURES** ● Electronics from the Ground Up, Part 4 ● Electromagnetic Compatibility ● Checking Transistors.

### FEB. '95

**PROJECTS** ● 12V 35W PA Amplifier ● Foot-Operated Drill Controller ● The Ultimate Screen Saver ● MIDI Pedal Board ● Model Railway Signals.  
**FEATURES** ● Electronics from the Ground Up, Part 5 ● Transformerless Power Supplies ● Quickroute 3.0 Review.

### MARCH '95

**PROJECTS** ● Multi-Purpose Thermostat ● Name of the Game-1 Counterspell ● Sound Activated Switch ● Audio Amplifier ● Light Beam Communicator.  
**FEATURES** ● Electronics from the Ground Up, Part 6 ● Understanding PIC Microcontrollers ● Visio Graphics Software Review.  
**FREE** Multi-Project PCB with this issue.



### APRIL '95

**PROJECTS** ● National Lottery Predictor ● Auto-Battery Charger ● Light-Activated Switch ● Switch On/Off Timer ● Continuity Tester ● Name of the Game-2 Counterspin.  
**FEATURES** ● Electronics from the Ground Up, Part 7 ● Circuit Surgery ● The Hard Cell (Mobile Telephones).

### MAY '95 Photostats Only (see below)

**PROJECTS** ● PIC-DATS-1 (PIC Development and Training System) ● R.F. Signal Generator - 1 ● MIDI Pedal ● Club Vote Totaliser ● Name of the Game-3, On Your Marks and Games Timer.  
**FEATURES** ● Electronics from the Ground Up, Part 8 ● Las Vegas Show Report.

### JUNE '95 Photostats Only (see below)

**PROJECTS** ● PIC-DATS-2 (PIC controlled 4-Channel Light Chaser) ● *EPE* HiFi Valve Amplifier - 1 ● R.F. Signal Generator - 2 ● AA to PP3 Converter ● Name of the Game - 4, Star-Struck!, Six-Shot Light Zapper, Wander Wands.  
**FEATURES** ● Electronics from the Ground Up, Part 9 ● Smart Cards.

### JULY '95

**PROJECTS** ● Windicator ● Curtain Winder ● Ramp Generator - 1 ● High Voltage Capacitor Reformer ● *EPE* HiFi Valve Amplifier - 2  
**FEATURES** ● Bridge Rectification Enhanced ● Ingenuity Unlimited.

### AUG '95

**PROJECTS** ● Solar Seeker ● Personal Practice Amplifier ● Infra-Red Remote Control Unit ● Versatile Microcontrolled 3-Digit Timer ● Ramp Generator - 2.  
**FEATURES** ● Static ● Circuit Surgery.

### SEPT '95 Photostats Only (see below)

**PROJECTS** ● Simple Theremin ● Low Range Ohmmeter Adaptor ● Comprehensive Security System ● Vandata ● Hum-Free Battery Eliminator.  
**FEATURES** ● Cave Radio ● Ingenuity Unlimited.



### OCT '95

**PROJECTS** ● Ginormous VU Meter ● Sound Switch ● Audio Sinewave Generator ● Treble Booster ● Infra-Red Controller/Alarm ● Capacitor Check ● Experimenter's Bargraph Test Board.  
**FEATURES** ● Circuit Surgery ● Security Tagging ● Using Bargraph Displays.  
**FREE** Multi-Project PCB with this issue.

### NOV '95 Photostats Only (see below)

**PROJECTS** ● Digital Delay Line ● Video Enhancer ● 50Hz Field Meter ● Temperature Warning Alarm ● Current Tracer ● Distortion Effects Unit.  
**FEATURES** ● Teach-In '96 Part 1 ● Developments in Radio Broadcasting Technology ● Turnpike for Windows Review ● Ingenuity Unlimited.

### DEC '95 Photostats Only (see below)

**PROJECTS** ● Light Operated Switch ● Stereo "Cordless" Headphones ● *EPE* Met Office - 1 ● Modular Alarm System ● Audio Meter and Amplifier.  
**FEATURES** ● Teach-In '96 Part 2 ● Circuit Surgery ● Index for Volume 24.

## URGENT?

NEED AN ARTICLE TODAY? TRY

OUR NEW FAX ON DEMAND SERVICE

- see page 475 for details

### JAN '96

**PROJECTS** ● Printer Sharer ● Mains Signalling Unit ● Automatic Camera Panning System ● Audio Signal Generator ● *EPE* Met Office - 2.  
**FEATURES** ● Teach-In '96 Part 3 ● Ingenuity Unlimited ● European Consumer Electronics Show ● Techniques - Actually Doing It ● Maths Plus Review ● Decibels and dBm Scale.

### FEB '96

**PROJECTS** ● Simple PIC16C84 Programmer ● Mains Signalling Unit - 2 ● PIC Electric Meter - 1 ● Vari-Speed Dice ● Analogue Frequency Meter.  
**FEATURES** ● Teach-In '96 Part 4 ● Circuit Surgery ● Making Your Own P.C.B.s ● Techniques - Actually Doing It.

### MARCH '96

**PROJECTS** ● Mind Machine Mk III Part 1 ● High Current Stabilized Power Supply ● Multi-Purpose Mini Amplifier ● Infra-Zapper ● PIC-Electric Meter - 2.  
**FEATURES** ● Teach-In '96 Part 5 ● Ingenuity Unlimited ● Flight PAL Trainer Review.  
**FREE** ● Headphones (UK copies only).

### APRIL '96

**PROJECTS** ● Dolby Pro-Logic Decoder (Free Booklet) ● Bat-Band Converter ● Event Counter ● Mind Machine Mk III Part 2 - Programmer ● Hearing Tester.  
**FEATURES** ● Teach-In '96 Part 6 ● Circuit Surgery ● Thermionic Valves Part 1.

### MAY '96

**PROJECTS** ● Midi Analyser ● Mind Machine Mk III Part 3 - Tape Controller ● Versatile PIR Detector Alarm ● Countdown Timer ● Bat Band Converter B.F.O.  
**FEATURES** ● Teach-In '96 Part 7 ● Ingenuity Unlimited ● Thermionic Valves Part 2 - The C.R.T.

## BACK ISSUES ONLY £2.50 each inc. UK p&p.

Overseas prices £3.10 each surface mail, £4.10 each airmail.

We can also supply issues from earlier years: 1990 (except March), 1991 (except May, June, Aug., Sept. and Nov.), 1992 (except April and Dec.), 1993 (except Jan., Feb., March and April), 1994 (except April, June and Nov.), 1995 (except Jan., May, June, Sept., Nov. and Dec.). Please note we are not able to supply copies (or 'stats of articles) of *Practical Electronics* prior to the merger of the two magazines in November 1992.

Where we do not have an issue a photostat of any *one article* or *one part* of a series can be provided at the same price.

### ORDER FORM - BACK ISSUES - PHOTOSTATS - INDEXES

Send back issues dated .....

Send photostats of (article title and Issue date) .....

Send copies of last five years indexes (£2.50 for five inc. p&p - Overseas £3.10 surface, £4.10 airmail)

Name .....

Address .....

I enclose cheque/PO./bank draft to the value of £.....

Please charge my Visa/Mastercard £.....

Card No. .... Card Expiry Date .....

Note: Minimum order for credit cards £5. Please supply name and address of cardholder if different from that shown above.

SEND TO: Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF.

Tel: 01202 881749. Fax: 01202 841692. (Due to the high cost we cannot reply to queries or orders by Fax.)

Payments must be in £ sterling - cheque or bank draft drawn on a UK bank.

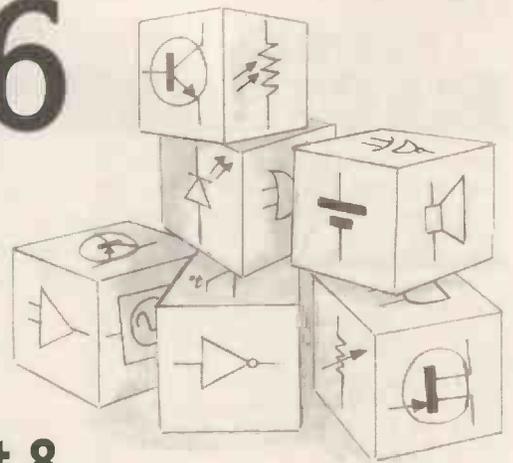
Normally supplied within seven days of receipt of order.

Send a copy of this form, or order by letter if you do not wish to cut your issue.

M6/96

# TEACH-IN '96

## A Guide to Modular Circuit Design



Max Horsey

Part 8

**D**URING this series of articles, a range of circuit modules is examined, divided into Input, Processor and Output sections. Where possible a choice of module is offered within each section.

Each of the ten Parts of the Series is accompanied by a constructional article explaining how a complete project may be devised by employing the modules described, together with a p.c.b. design. Each project will be one of many possible ideas that could be

implemented and it is hoped that readers will design for themselves a variety of circuits by combining modules provided in the whole series.

The proposed range of modules covered by the Series is detailed in Part 1, Table 1.1. Each module is chosen to link easily with adjacent modules in the same Part, but modules may also be linked with modules in other Parts of the Series.

Max Horsey is Head of Electronics at Radley College.

**H**ERE in this eighth Part of *Teach-In* the following Input, Processor and Output modules are examined:

**INPUT MODULES:** Audio input, signal mixer, position to voltage sensor

**PROCESSOR MODULE:** VU display

**OUTPUT MODULE:** Single *pn*p transistor output

The project associated with this part is a VU Display and Alarm, which provides a pleasing visual display, and an audible over-level alarm buzzer.

### AMPLIFIER CIRCUITS

The amplifier modules are based around an op.amp, such as the type 741. Op.amps were encountered in Part 1 of the series, where one was being used as a comparator. A comparator circuit, as the name suggests, compares the voltage at its two inputs and causes the output to switch between positive and negative (or 0V) according to their voltage levels.

The key point about a comparator is that its output *switches* "instantaneously", there is no half-way stage.

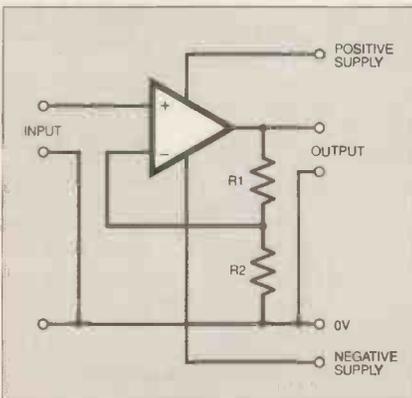


Fig. 8.1. Circuit diagram for an op.amp non-inverting amplifier.

An audio amplifier needs to provide an output waveform which is a faithful copy of the input waveform, even though it may be greater in magnitude (i.e. amplified). This is achieved by means of *negative* feedback. Not surprisingly, this is the opposite of *positive* feedback (discussed in Part 1, in which it was used to create a Schmitt trigger – a circuit with a particularly abrupt switching action).

The op.amp can be connected in two principle amplifying configurations, both with negative feedback. These are known as:

1. Non-inverting amplifier
2. Inverting amplifier

### NON-INVERTING AMPLIFIER

The basic arrangement for a *non-inverting* amplifier working on a dual-rail supply is shown in Fig. 8.1. Note that the inverting input is denoted by a minus sign, and that the non-inverting input is denoted by a plus sign.

Feeding the signal into the non-inverting input, the output provides a signal which is exactly *in phase* (in step) with the input.

Resistor R1 is connected from the output to the inverting input and provides negative feedback. If the *full* output voltage were to be returned to the inverting input, the circuit would not amplify the signal, but merely "buffer" it, producing an output voltage of the same level as that at the input.

An amplifier in this configuration has what is known as "unity gain", i.e. a gain of one. To provide amplification (a gain greater than one), the feedback voltage is reduced by resistor R2.

Resistors R1 and R2 act as a potential divider, reducing the feedback voltage and allowing the circuit to amplify.

The gain of the circuit, i.e. the amount by which it amplifies, is set by the ratio of R1 and R2 according to the formula:

$$\text{Gain} = (R1 / R2) + 1$$

Typical values for the resistors might be, for example, 100k $\Omega$  for R1 and 10k $\Omega$  for R2. This would provide a gain of:

$$\text{Gain} = (100k / 10k) + 1 = 11$$

This means that if the input signal has a peak voltage of, say, 20mV, the output voltage will have a peak of:

$$20 \times 11 = 220\text{mV}$$

The non-inverting op.amp input has a very high input impedance. In other words, it only requires a very small current. Therefore, amongst many possible applications, it is useful as a microphone amplifier.

### DUAL-RAIL SUPPLY

The circuit in Fig. 8.1 is powered by what is known as a *dual-rail* supply. This may seem strange since there are, in fact, *three* supply lines: positive, 0V and negative. The term *dual* means that there are two rails in addition to the 0V rail to which they are referenced.

Virtually all professionally constructed amplifiers use this dual-rail system. The reason is that amplifiers are normally designed for amplifying alternating signals i.e. signals whose voltages *swing*

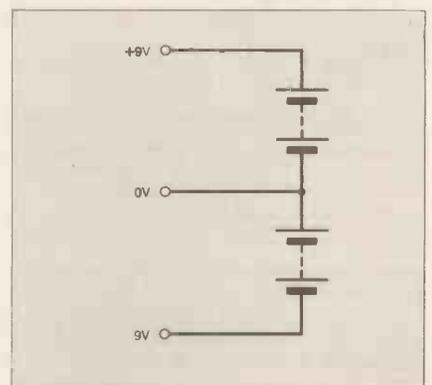


Fig. 8.2. A dual-rail supply formed from two batteries.

between positive and negative with reference to the 0V (ground or earth) line.

An amplifier without a negative supply cannot handle a negative signal. Referencing signals to the 0V (ground) rail also helps to reduce mains hum from being picked up by the circuit when it is powered by a mains driven power supply.

A dual-rail supply can also be produced using two batteries, as shown in Fig. 8.2. Note how the two 9V batteries in series can be regarded as supplying voltages which can be labelled +9V, 0V and -9V. (They could also be labelled as +18V, +9V and 0V, or other similar variants, depending on which terminal is regarded as the 0V reference point.)

Such a supply is rather cumbersome and in practice it is easier to modify the amplifier circuit so that it will operate on a single-rail supply (i.e. a "normal" 0V and positive supply). This is achieved by moving the average value of the alternating signal being amplified up from 0V to half the single supply voltage. (An example of this technique is shown later in Fig. 8.4.)

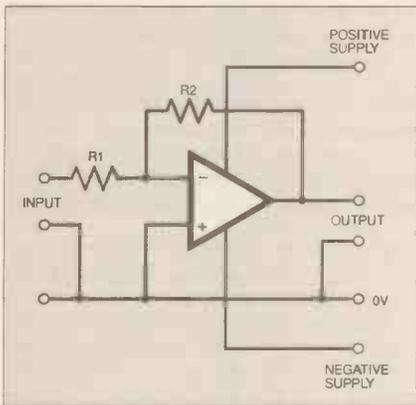


Fig. 8.3. Circuit diagram for an op.amp inverting amplifier.

## INVERTING AMPLIFIER

An *inverting* amplifier circuit is shown in Fig. 8.3. It too can be powered by a dual-rail or single-rail supply.

The source signal is fed to the inverting input, making the output signal 180 degrees out of phase (i.e. exactly out of step) with it. This is sometimes known as "signal inversion". In many audio amplifier circuits, although not all, it is of no consequence.

The gain of the circuit is set by the ratio of the feedback resistor (R2) and the input resistor (R1):

$$\text{Gain} = -(R2 / R1)$$

Note the minus sign which indicates that a positive-going input signal will produce a negative-going output signal and vice-versa, i.e. 180° out of phase.

Typical resistor values might be, for example, 100kΩ for R2, and 10kΩ for R1. The gain would then be:

$$\text{Gain} = -(100k / 10k) = -10$$

Thus an alternating input signal with a peak voltage of 50mV would result in an output with a peak of -500mV.

The input impedance of this circuit is the value of resistor R1. This is generally much lower than the input impedance of the non-inverting amplifier.

However, the circuit has a particularly useful property in that the voltage at the inverting input is always "virtually" equal

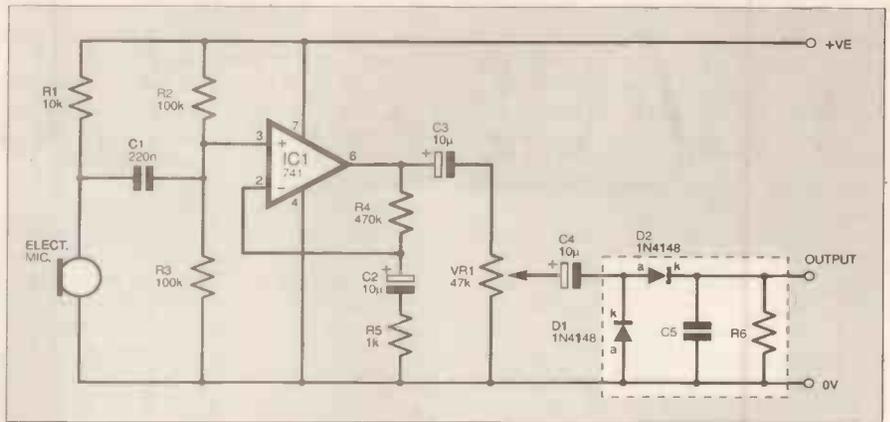


Fig. 8.4. Circuit diagram for the audio input module which produces a d.c. output voltage relative to the input signal amplitude.

to the voltage at the non-inverting input. The inverting input can therefore be regarded as a *virtual earth* - a very valuable asset if the circuit is used as an audio mixer.

Many signals can be directed simultaneously into a virtual earth input without any of the signal sources interfering with each other. In other words, signals can be *mixed* at a virtual earth input, as will be seen shortly.

## AUDIO INPUT MODULE

The audio input module shown in Fig. 8.4 is based on the non-inverting amplifier in Fig. 8.1.

The circuit shown is designed to switch its output from low (a bit higher than 0V) to high (a bit lower than the positive supply line voltage) whenever the microphone picks up a sufficiently loud sound.

The module is based around a single op.amp, IC1, and the familiar type 741 works well in this application. The circuit may not be easy to recognise due to the components required to make the i.c. work on a single-rail supply. However, if you imagine the circuit with components R2, R3, C1 and C2 removed, it looks more like the arrangement shown in Fig. 8.1.

The circuit has been designed on the assumption that an *electret* (i.e. capacitive) microphone will be used. Such microphones require a constant d.c. supply, and this is provided via R1. If a *dynamic* microphone is used, R1 should be removed.

Resistors R2 and R3 maintain a steady d.c. supply equal to half the supply voltage at IC1 pin 3, the non-inverting input. In the absence of an input signal, this causes the op.amp's inverting input at pin 2, and its output at pin 6, to be held at the same voltage. Capacitor C1 prevents any flow of d.c. which could upset this voltage, but it allows the a.c. audio signal from the microphone to reach pin 3.

The gain of the circuit is set to about 470 by the ratio of resistors R4 and R5. The formula is as before:

$$\text{Gain} = (R4 / R5) + 1$$

In practice, the gain may be less than this figure, particularly at higher frequencies, but it is more than adequate in this application.

The d.c. output level normally rests at half the supply voltage (about 6V assuming a 12V supply). The amplified audio signal is superimposed on this d.c. level.

Capacitor C3 blocks the passage of d.c. but allows the a.c. signal to flow into potentiometer VR1, which allows its output level to be varied as required. As one end of VR1 is connected to the 0V line, the a.c. signal swings above and below this voltage.

Notice the importance of the three capacitors C1, C2 and C3 in preventing the flow of d.c. voltage at three strategic points in the circuit, and therefore allowing the op.amp to work at an average of half the supply voltage.

If just an amplified version of the input signal is required, then ignore the components shown within the dotted line, and take the output from the wiper of potentiometer VR1.

## A.C. TO D.C. CONVERSION

When the components within the dotted box in Fig. 8.4 are included, the varying a.c. signal output from the wiper of VR1 is passed through capacitor C4 and into the diode "pump" comprising diodes D1 and D2, plus capacitor C5. The circuit is a type of rectifier which produces a d.c. output voltage relative to the peak-to-peak voltage across the a.c. waveform.

Ignoring for the moment normal voltage drops across the diodes, it works as follows:

At the wiper of VR1, the a.c. signal swings above and below the 0V level. If C4 and D1 were omitted, with D2 connected to the wiper, the voltage pumped into C5 would be that portion of the signal above 0V. The voltage below 0V would be ignored.

With C4 included, the full a.c. waveform is transferred across it, but the midway level is still the same and so only the voltage above 0V passes through D2.

However, with D1 included as well, when the waveform on the output side of C4 tries to go below 0V, current is "sucked" from the 0V line via D1. Consequently, this side of C4 *never* can go lower than 0V (still ignoring diode voltage drop).

Moreover, next time the waveform output from C4 rises, the rise is now from the minimum level imposed via D1, i.e. from 0V upwards. Since the waveform itself is unchanged, the total voltage between its upper and lower peaks is now pumped through D2 into C5.

In reality, of course, the actual d.c. voltage will be less than the full peak-to-peak voltage due to the forward voltage drop across the diodes.

Capacitor C5 is included to store the pumped peak voltage and prevent it from

simply rising and falling in step with the amplitude of the a.c. signal. Since it is usually desirable to allow the peak voltage to eventually die away, resistor R6 is included through which it can flow.

During loud sounds, a steady voltage builds up on C5, but during a quiet moment current flows through R6 causing the voltage to fall slowly. In other words, and with the correct component values chosen, the voltage on the capacitor represents the average sound level received.

The values of the capacitor and resistor both determine the rate at which the stored voltage decays. The optimum values depend upon the effect required and the current used by the next stage of the circuit. As a rough guide, try a capacitor value of 1µF (positive end connected to D2) and a resistor of 22kΩ.

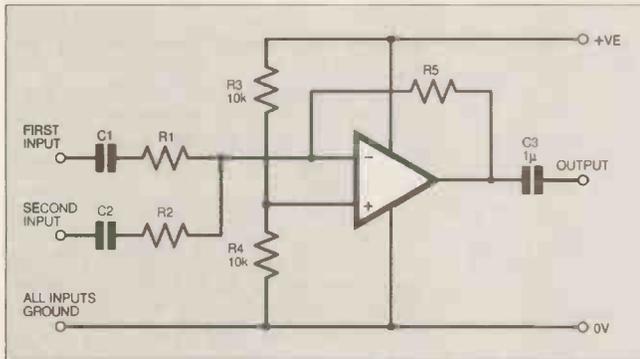


Fig. 8.5. Basic 2-channel op.amp mixer circuit.

## MIXER MODULE

There are situations when a circuit requires two or more a.c. signals to be combined into one output channel.

Obviously, the input channels cannot be merely joined together – this would adversely affect their source circuits. Diodes in series with each signal cannot be used either, since the signals are likely to be alternating and one side of their waveform would be lost.

However, by capacitively coupling the signals into a virtual earth input via separate resistance paths, the signals can be *mixed* without affecting their source stages (providing the path resistance values are sufficiently great).

One way of doing this is to use an op.amp in its inverting mode, as illustrated in Fig. 8.5. This circuit is for mixing two a.c. signals, but, by similarly adding further resistors and capacitors in series at the inverting input, more channels can be brought in and mixed.

This circuit also operates on a single-rail supply. The "central" or reference voltage is supplied from the junction of the potential dividing resistors R3 and R4. Capacitors C1 and C2 isolate the a.c. signal from any preceding d.c. voltage. Similarly, C3 allows only a.c. signals to pass from the op.amp's output.

Each of the signals can be amplified individually. The amount of amplification or gain is governed by the ratio of the signal's input resistance value (either R1 or R2 as appropriate) to the value of the feedback resistor, R5. In this instance:

$$\text{Input 1 gain} = -(R5 / R1)$$

$$\text{Input 2 gain} = -(R5 / R2)$$

As commented earlier, the signal inversion (and its minus sign in the formula) can often be ignored.

A greater number of inputs may be used if required, even though only two are

shown. In each case, the input resistor value should be calculated for the gain required for that input signal path. Quite likely, the gain required will just be one (i.e. no amplification), so all input resistors will have the same value as the feedback resistor R5. Suggested values are between about 10kΩ and 100kΩ. A series capacitor is necessary for each input.

Note that when two or more signals are mixed, the total maximum peak voltage at the mixer's output is the instantaneous sum of the amplitudes of each signal. In some cases, this can result in a *reduction* of output amplitude if the signals have opposing phases. In other cases, there can be an *increase* when the signals are fully in phase.

In practice, this means that if many signals are being mixed, it may

be necessary to decrease their individual levels to avoid overdriving the op.amp, which would cause output signal distortion.

With an op.amp in an inverting configuration, signal reduction (gain less than one) can be achieved by making the input resistance *greater* than that of the feedback, as can be proved using

the above formula. (Note that with a *non-inverting* op.amp configuration, the gain cannot be set for less than one.)

If conversion of the a.c. output from the mixer to a d.c. voltage is required, the components shown within the dotted line in Fig. 8.4 should be added. It would also be wise to increase the output capacitor from 1µF to about 10µF, so increasing the output current transferred. Use an electrolytic with its positive side towards the i.c.

## POSITION SENSOR

As shown in Fig. 8.6, using a potentiometer, VR1, a position-to-voltage sensor can be created. The method shown is a very simple idea, but it can be very effective when linked to the I.e.d. VU display processor discussed later.

The two ends of VR1 are connected across the power supply. Consequently, when the pot shaft is turned, there is a voltage change on its wiper relative to the rotation. In other words, the position of

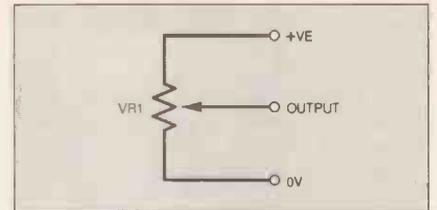


Fig. 8.6. A potentiometer can be used for position-to-voltage sensing.

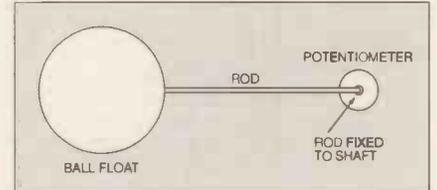


Fig. 8.7. Using a potentiometer to sense water level changes.

the shaft determines the output voltage. The value of VR1 will depend on other circuit aspects, but may typically be between 10kΩ and 100kΩ.

If the output from the wiper is connected to the input of the VU display processor, the movement of the shaft will be displayed on the row of I.e.d.s.

This device can form the basis of, for example, a water level controller. A float may be connected to the shaft, via a rod as shown in Fig. 8.7, so that as the water level changes the pot turns. It will be seen later how a warning device could be added to indicate a dangerously high or low water level.

It may be necessary to "tune" the output voltage to a desired range, and two possible circuits are shown in Fig. 8.8.

The circuit in Fig. 8.8a shows how the output voltage can be restricted to within a limited range set by the presets VR2 and VR3. The circuit in Fig. 8.8b pulls the maximum output voltage down to any required level, determined by the setting of VR2.

The circuits may be combined, and/or the values of the presets may be changed according to the application required.

## BARGRAPH DISPLAY

The VU Display Module shown in Fig. 8.9 is based on the LM3914 or LM3915 bargraph i.c.s. These i.c.s switch on their ten outputs in relation to the voltage at the input, pin 5. With the devices wired as shown, if the input voltage is zero, no outputs switch on, but as the input voltage rises, the outputs switch on progressively in ascending order.

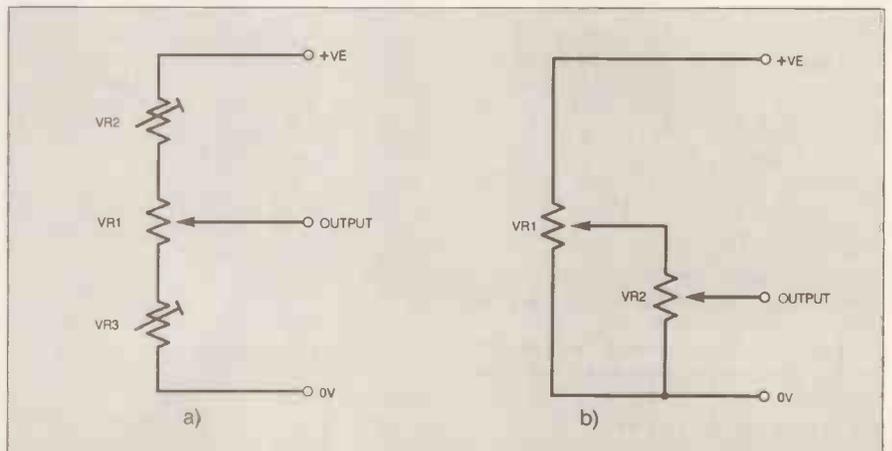


Fig. 8.8. Two methods for restricting the output voltage range from a potentiometer.

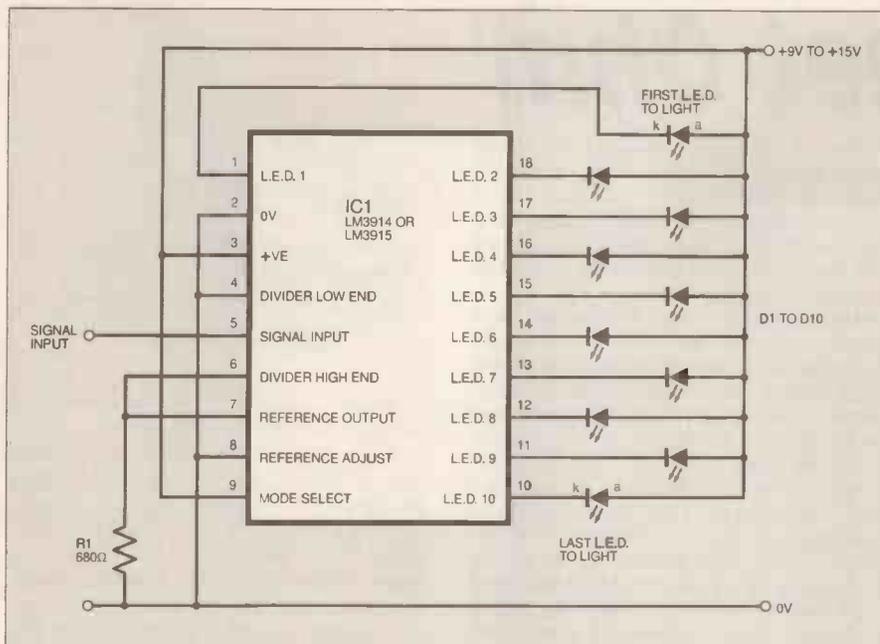


Fig. 8.9. Basic circuit diagram for a bargraph display.

The outputs are shown connected to a set of l.e.d.s for display purposes (e.g. like the sound level display on audio equipment). They can also be used in other ways - for example to trigger a warning device if a particular input voltage level is too high.

Note that the outputs are "active low". In other words, they are normally held high (positive) and switch to 0V when active.

## LINEAR OR LOGARITHMIC

The LM3914 device features a linear scale, where each rise of 125mV at the input (pin 5) will cause another l.e.d. to light. Since there are ten outputs, the whole scale is covered by a rise of 1.25V. This assumes the connections are as shown in Fig. 8.9.

Type LM3915 has a logarithmic scale where each l.e.d. represents a 3dB change in input voltage level. This is ideal for monitoring sound levels since the human ear responds to sound in a similar way.

The simple circuit arrangement in Fig. 8.9 applies to both i.c. versions and shows the outputs connected to l.e.d.s. Note the absence of series resistors. This i.c. regulates the l.e.d. current automatically, according to the value of resistor R1.

(More information on these chips was published in the feature "Using Bargraph Displays" in EPE October '95. Ed.)

## OUTPUT CURRENT

The current flowing from pin 7 through resistor R1 to 0V determines the l.e.d. current, which is about ten times that through R1. Since pin 7 is a voltage reference source and is set to 1.25V, a value of 680Ω for R1 will allow a maximum current of just over 15mA to flow through each l.e.d.

In practice, the current is likely to fluctuate, making the display less bright than expected.

## RESISTOR CHAIN

Divider High End pin 6 is connected to the high end of the chain of resistors

inside IC1, and pin 4 is at the low end. The voltages at these two pins determine the range of voltage at pin 5 to which the outputs respond.

In Fig. 8.9, the low end (pin 4) is connected to 0V and the high end (pin 6) to the 1.25V reference (pin 7). This sets the input range from 0V to 1.25V.

## DOT/BAR MODE

Mode Select pin 9 is shown connected to positive. This causes the display to cascade in bar mode like the display on a tape recorder. The circuit can be changed to dot mode (i.e. only one output active at one time) by disconnecting pin 9 from the positive rail, and leaving it open circuit (i.e. not connected to anything).

## OUTPUTS

The outputs are shown connected to single l.e.d.s. Two or three l.e.d.s may be connected in series with each output if required. The output pins can also be connected to other devices - for example transistors, or Darlington pairs, if you wish to drive larger lamps etc.

Remember, though, that the outputs are active low, in other words, when an output switches on, its voltage falls. This is the opposite of many of the outputs

that have previously been discussed in this series.

Consequently, if the output pins of these bargraph i.c.s are to drive transistors, *pn*p types must be used (such as BC214L).

## PNP SWITCH

*PNP* transistors have already been encountered in this series. For example, they were used in the Fail-Safe Siren module of Part 2 (Fig. 2.14) and the Motor Direction Control in Part 3 (Fig. 3.13). They work in the opposite way to *npn* types, and are therefore very useful if an output device, such as a buzzer, is to be turned on when the voltage of the controlling signal falls.

A single *pn*p transistor circuit is shown in Fig. 8.10a. Here, if the input is left open circuit (unconnected), or connected to positive, no current will flow through any device connected to the output shown.

If the input voltage is made lower than the positive supply, by about 0.7V or more, the transistor will turn on and current will flow through any output device connected across the arrowed points.

The circuit in Fig. 8.10b is similar except that a second *pn*p transistor (TR2) is used, forming a Darlington pair, so allowing a greater current to be switched. The dotted box indicates that a single *pn*p Darlington transistor could replace the two separate transistors shown.

If two transistors are used, TR1 should be a high gain low power *pn*p type, such as BC214L, and TR2 should be a higher power *pn*p transistor, such as TIP42A.

Alternatively, the single Darlington equivalent could be TIP127. See Part 1 Fig. 1.14 for the pin connections.

In both modules, a diode (D1) is shown connected across the output points to guard against voltage spikes which may be produced by relays, motors and other inductive devices (devices with electrical coils in them). The diode may be omitted if a non-inductive device, such as an l.e.d. (with suitable series resistance) is connected.

## EXAMPLE PROJECT

The VU DISPLAY and Alarm unit elsewhere in these pages is the example project which shows how the modules in *Teach-In* Part 8 can be combined in a practical application.

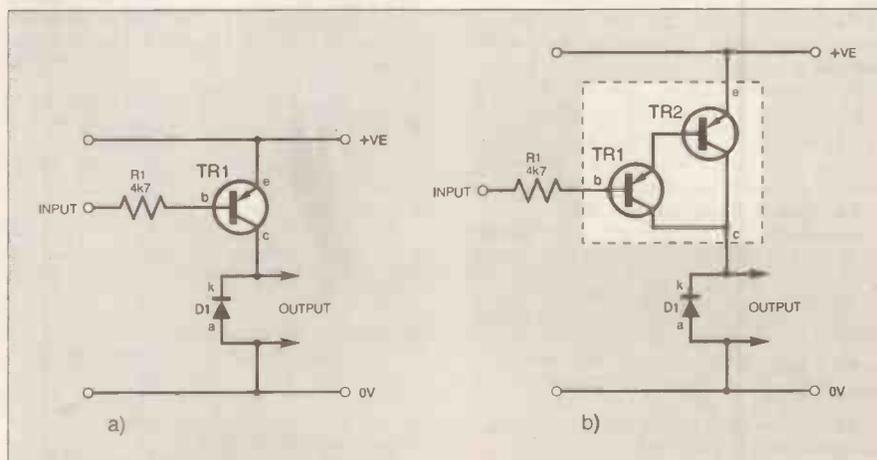


Fig. 8.210. Two examples of a *pn*p switch: (a) a single transistor and (b) a Darlington transistor.

# Ohm Sweet Ohm

## Max Fidling

### Happy Holiday

Glancing at my 1996 calendar dangling from a nail I'd bashed in over the bench, today was a public holiday, and I'd planned to have the day to myself, rummaging in the shack. I'd hoped to tackle the construction of my newest brainchild, inspired by a magazine project. Unfortunately, some things never go to plan...

Being known as the one in the street who potters with electrical gadgets and stuff of a similar ilk, I've gained a reputation for repairing all manner of domestic appliances (or not), from toasters to TV's to washing machines. The trouble is, folks generally expect repairs doing for next to nothing and they want a lifetime's guarantee thrown in as well!

It would be nice, I often reflect, if I could make a decent living at this job like the professionals do. After all, I've got all the kit, including an array of tools and equipment, all carefully colour co-ordinated just as a real engineer's would be. Plus, of course, I've now got my yellow multimeter with the added ability to speak when called upon to pass judgment!

"ZERO VOLTS!" - I had left the talking meter switched on, so I prodded a rubbery button on it to silence the mechanically-voiced instrument. Piddles, my feline friend and general smart Alec, was nearby, munching and noisily clattering his bowl of cat food, which I'd recently refilled in an attempt to keep him occupied and out of my hair. (I failed.)

### Calling the Tune

Just as I started to "paw" over the text of the magazine project, my neighbour

waltzed in, carrying an ominous-looking bit of kit. Beware of neighbours bearing electrical goods, I always say!

A mains lead dangled from the gadget onto the floor, the plug batting the cat on the head. Piddles looked up temporarily before tucking in again, undeterred.

My neighbour, Albert, had brought in a very old stereo music centre - you know, one of those almighty wooden boxes with a large Perspex lid, containing a record deck, tape cassette and stereo tuner. Apparently the stereo amplifier had failed on one channel, Albert explained.

My eyes rolled upwards as I guessed what was coming next! I sensed a feeling of blackmail coming on - because having indirectly ruined Albert's croquet lawn with my electronic garden mole deterrent, it had taken me a week or two to patch things up and so, diplomatic relations restored, I guess I felt duly obliged to lend a hand.

### Sonic the Edgy Mog

Waving Albert away cheerfully whilst expressing my gratitude at being presented with this "ever-so-exciting" challenge, I started to take the vintage stereo apart. Piddles jumped up onto the bench and starting nosing this latest addition.

Out came my multi-coloured screwdriver set, on went the iron and I soldered up my pair of surplus 8 ohm loudspeakers to the DIN sockets on the back of the cabinet. I plugged the lot into the mains and switched on, expectantly.

BZZZT! SSSHHHST!! A cacophony exploded from one speaker. Well, one channel worked anyway! Taken aback, the cat leapt off the worktop and hid behind my pile of washing machine spares.

The unforgettable smell of burning soon started to fill the workshop, though, followed by a "Phut!" as I switched off just in time



to witness a plume of blue smoke curling out from the innards of the stereo.

A few twirls of the screwdriver revealed that a resistor on the main board had become CBB (Charred Beyond Belief), and even an attempt by the talking multimeter to establish its value failed dismally. "ZERO OHMS!" it burbled, when prompted. *Marvellous*, I muttered.

I spotted a similar-looking resistor on the other half of the amplifier board, and guessing that the two channels were the same I de-coked the p.c.b. and stuffed in a new component. A quick re-test confirmed my worst fears - one channel was still struck dumb! The new resistor started to smoulder ominously. I could feel a replacement output transistor coming on!

### Fast Food

The moggie jumped up again and peered at the smoking stereo whilst I rummaged through my rusty tin of surplus semiconductors. *Please let me have an AD162*, I prayed. No joy...

Ah, well, whilst putting my feet up and checking through my transistor equivalents book, I placed a few cat food treats on the whirring record deck and amused myself by watching Piddles trying to snaffle them whilst doing 33 r.p.m. What a way to spend a holiday!

## SHOP TALK

with David Barrington

### PulStar

Not too many problems should be encountered by the Radio Control enthusiast who wishes to build the *PulStar* project to aid with the setting up and alignment of their models. The 16-character by 2-line display module type LM016L is currently being sold at the bargain price of £6 by **Greenweld Electronics** (Tel: 01703 236363).

A ready-programmed PIC 16C54 microcontroller is obtainable (Mail Order ONLY) from the designer, Phil Green, for the sum of £12 including postage. Overseas readers should add £2 to the order. All orders should be sent to: **Phil Green, 6 Yews Close, Worral, Sheffield, S30 3BB**.

The 3-terminal 4MHz resonator should be generally available from our advertisers. The one in the prototype came from **HB Electronics** (Tel: 01204 525544). Servo leads should be carried by model shops, **Magenta Electronics** and **Maplin**.

For those wishing to do their own programming, the software is obtainable on a 3.5in. disk from the Editorial Offices (see page 421) for the sum of £2.50 (overseas - surface £3.10; airmail £4.10).

### Sarah's Light

Special care needs to be taken with respect to components for *Sarah's Light* to

ensure the child safety aspect of the project. Illuminating switches/lamps with caps which cannot be prised off may be hard to find.

The ones in the model are RS type illuminating actuators, which also take the microswitches, and can be ordered through **Electromail** (Tel: 01536 204555), codes 335-075 and 335-069 for pushbutton actuator and 159-4534 for the microswitches.

The power MOSFET BUZ10 came from **Maplin**, code UJ32K. Not everyone stocks the 4526 4-bit programmable binary down-counter, but **Farnell** (Tel: 0113 263 6311), code CD4526BCN, and **Electromail**, code 641-083, do.

A trip down to your local car breakers yard should unearth the Fiat Uno number plate lamps and should set you back about £2 to £5 each.

### Home Telephone Link

Just a couple of items need highlighting for the *Home Telephone Link* project. The electret microphone insert is the omnidirectional type and stocked by most of our component advertisers.

The specified case, with transparent lid, and 38mm dia. "Lo-Z" loudspeakers came from **Maplin**, codes YU94C and W04E respectively. Strangely, you will not find

any entry for the miniature speaker range in their current catalogue. However, we can confirm that these items are still in stock.

The lever-operated microswitch also came from the same source, code GW67X. If another microswitch is used, it is important to check for the pole contact as this *must* go to the "Line B" track on the p.c.b.

### VU Meter and Alarm (Teach-In '96)

We do not expect any buying problems to arise with the *VU Meter and Alarm*, this month's *Teach-In* project.

When ordering the bargraph driver i.c., be sure to specify the "log." type LM3915. The case, with a screw-down transparent lid, came from **Electromail**, (Tel: 01536 205444), code 507-674.

### Ultra-Fast Frequency Generator and Counter

The latest 74AC advanced CMOS logic range of i.c.s used in the *Ultra-Fast Frequency Generator and Counter* are stocked by **Farnell** (Tel: 0113 263 6311) and **Electromail** (Tel: 01536 204555). They also list the 4543 l.c.d. driver (codes F-386-390 and E-641-207) and the 8-bit l.c.d. display (codes F-491-287 and E-589-294). *The LS and standard TTL versions are NOT useable in this circuit.*

For the MF10 active filter we came up with **Maplin**, code QY35Q. They also stock the 4½ digit counter/driver, code FP62S.

Details and prices for all of this month's p.c.b.s can be found on page 483.

## VARIABLE VOLTAGE TRANSFORMERS

INPUT 220V/240V AC 50/60  
OUTPUT 0V-260V

	Price	P&P
0.5KVA 2.5 amp max	£31.90	£8.00
	(£44.53 inc VAT)	
1KVA 5 amp max	£41.15	£7.00
	(£56.58 inc VAT)	
2KVA 10 amp max	£59.40	£8.50
	(£79.78 inc VAT)	
3KVA 15 amp max	£78.65	£8.50
	(£102.40 inc VAT)	
5KVA 25 amp max	£139.15	

(Plus Carriage)  
Buy direct from the Importers. Keenest prices in the country  
**COMPREHENSIVE RANGE OF TRANSFORMERS-LT-ISOLATION & AUTO**  
110V-240V Auto transformer either cased with American socket and mains lead or open frame type. Available for immediate delivery.

## WIDE RANGE OF XENON FLASHTUBES

Write/Phone your enquiries

### ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft 40 watt £14.00 (callers only)	(£16.45 inc VAT)
2ft 20 watt £9.00 (callers only)	(£10.58 inc VAT)
12in 8 watt £4.80 + 75p p&p	(£5.52 inc VAT)
9in 6 watt £3.96 + 50p p&p	(£5.24 inc VAT)
6in 4 watt £3.96 + 50p p&p	(£5.24 inc VAT)

**230V AC BALLAST KIT**  
For either 6in, 9in or 12in tubes £6.05 + £1.40 p&p  
(£8.75 inc VAT)

The above Tubes are suitable for Forged Bank Note detection, security marking etc.  
Other Wavelengths of U.V. TUBE available please telephone your enquiries.

**400 WATT UV LAMP**  
Only £38.00 + £4.00 p&p (£49.35 inc VAT)

**160 WATT SELF-BALLASTED BLACK LIGHT MERCURY BULB**  
Available with E.S. fitting.  
Price inc VAT & p&p £25.55



**12V D.C. BILGE PUMPS**  
500 GPH 15ft head 3 amp £19.98  
1750 GPH 15ft head 9 amp £34.55

Also now available:  
24V D.C. 1750 GPH 15ft head 5 amp £35.55  
All designed to be used submerged.  
PRICES INCLUDE P&P & VAT

**SUPER HY-LIGHT STROBE KIT**  
Designed for Disco, Theatrical use etc.  
Approx 16 joules. Adjustable speed £50.00 + £3.00 p&p  
Case and reflector £24.00 + £3.00 p&p (£31.73 inc VAT)  
SAE for further details including Hy-Light and Industrial Strobe Kits.



## SERVICE TRADING CO

57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB  
TEL: 0181-995 1560 FAX: 0181-995 0549  
ACCOUNT CUSTOMERS MIN. ORDER £10



## 5 KVA ISOLATION TRANSFORMER

As New Ex-Equipment, fully shrouded, Line Noise Suppression, Ultra Isolation Transformer with terminal covers and knock-out cable entries. Primary 120V/240V, Secondary 120V/240V, 50/60Hz, 0-005pF Capacitance. Size, L 37cm x W 19cm x H 16cm, Weight 42 kilos. Price £120 + VAT. Ex-warehouse. Carriage on request.

**24V DC SIEMENS CONTACTOR**  
Type 3TH8022-05 2 x NO and 2 x NC 230V AC 10A. Contacts. Screw or Din Rail fitting. Size H 120 x W 45 x D 75mm. Brand New Price £7.63 incl. P&P and VAT.

**240V AC WESTCOOL SOLENOIDS**  
TT2 Mod. 1 Rat. 1 Max. stroke 3/16in. Base mounting 1/2in. stroke 5lbs pull approx. TT6 Mod. 1 Rat. 1 Max. stroke 1 in. Base mounting 1/2in. stroke 15lbs pull approx. SERIES 400 Mod. 1 Rat. 2 Max. stroke 1/2in. Front mounting 1/2in. stroke 15lbs pull approx. Price incl. p&p & VAT. TTS £5.88, TT6 £8.81, SERIES 400 £7.64.

**AXIAL COOLING FAN**  
230V AC 120mm square x 38mm 3 blade 10 watt Low Noise fan. Price £7.29 incl. P&P and VAT.  
Other voltages and sizes available from stock. Please telephone your enquiries.

**INSTRUMENT CASE**  
Brand new. Manufactured by Imhof. L 31 x H 18 x 19cm Deep. Removable front and rear panel for easy assembly of your components. Grey textured finish, complete with case feet. Price £16.45 incl. P&P and VAT. 2 off £28.20 inclusive.

**SEWING MACHINE MOTOR**  
Brand new 220V/240V AC/DC, SEW-TRIC 2 lead Brush Motor. Size L: 100mm x H: 70mm x W: 55mm. Spindle 1/4 in. dia. x 1 in. long. Price £14.10 inc p&p & VAT.

**GEARED MOTORS**  
71 RPM 20lb/inch torque reversible 115V AC input including capacitor and transformer for 240V AC operation. Price inc VAT and p&p £27.73.

**SOLID STATE EHT UNIT**  
Input 230V/240V AC, Output approx 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec, 30 sec to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, e.g. supplying neon or argon tubes etc. Price less case £8.50 + £2.40 p&p (£12.81 inc VAT) NMS.

**EPROM ERASURE KIT**  
Build your own EPROM ERASURE for a fraction of the price of a made-up unit. Kit of parts less case includes 12in 8 watt 2537 Angst Tube Ballast unit, pair of telen leads, neon indicator, on/off switch, safety microswitch and circuit £15.00 + £2.00 p&p (£19.98 inc VAT)

**WASHING MACHINE WATER PUMP**  
Brand new 240V AC fan cooled. Can be used for a variety of purposes. Inlet 1 1/2in., outlet 1in. dia. Price includes p&p & VAT. £11.20 each or 2 for £20.50 inclusive.

## PIC EEZE

This is the easiest way to start using PIC microcontrollers. PIC EEZE is a powerful and versatile development system that allows a cheap entry level into the world of PIC programming. Can be upgraded whenever you're ready. Upgrading is easy (plug in).

**PIC EEZE-1** Built and tested £44.95  
supports: 16C61/62/63/64/65/71/73/74/84/620/621/622/Serial EEPROMs.

**PIC EEZE-2** Built and tested £52.95  
supports: as PIC EEZE-1 plus 16C54/55/56/57/58.

**PIC EEZE-3** Built and tested £72.95  
supports: as PIC EEZE-2 plus In Circuit Emulation (even A to D on 71)

All systems have high quality PCB with a quality universal ZIF socket (so you don't have to spend any more money to get an easy to use system), on board regulation, expansion port and when new PIC versions are released the system can be software upgraded. All software is FREE so you won't have to keep spending to keep up. Microchip's Assembler and simulator along with our own programming software and PIC examples are supplied on disk. New Windows integrated development environment. Connects to PC via parallel port. A serial version will be available soon (Please ring or write as it may already be available). A suitable PSU and Lead are required, which we can supply if needed.  
Interface Lead £4.00. PSU £4.95.

**LPAK** £28.00  
An introduction to PIC programming. The board plugs into any PIC EEZE system expansion port and has on board 7-segment displays, LEDs button and switches which can be controlled via software to show simple PIC programming for beginners.

**DPAK** £28.00  
Demonstration boards (2) for 18/28 pin PICs. The first board is a stand alone PCB c/w ready-made oscillator, regulation, etc, and it can be used with breadboards, i.e. sockets, etc, or it can be used with the second board which is a version of LPAK.

Compiler to create your own BASIC PICs - ring for availability.

**SUPPORT**  
We will give continuing support to users of our systems with their PIC projects/problems. Further expansion of the system is planned which includes - a 17CXX Adapter, Smart Card Reader and FREE software to allow the system to be used for data logging and PC I/O port control.



Please add £2.00 P&P and make cheques payable to LENNARD RESEARCH

29 Lavender Gardens, Jesmond, Newcastle upon Tyne, NE2 3DD.  
Telephone (0191) 281 8050.

# SEETRAX CAE RANGER PCB DESIGN

## WITH COOPER & CHYAN AUTOROUTER

**RANGER3 - DOS £2500**  
**- Windows\NT £2900**

Hierarchical or flat schematic linked to artwork.

Unlimited design size, 1 micron resolution

Any shaped pad, definable outline library

Pin, gate & outline swapping - auto back annotation

Split power planes, switchable on - line DRC

### COOPER & CHYAN SPECCTRA

autorouter (SP2)

Inputs: OrCAD, Cadstar,

PCAD, AutoCAD DXF

Outputs: Postscript, Windows bit map

R2 & R3 Outputs: 8/9 & 24 pin printers, HP

Desk & Laser Jet, Cannon Bubble Jet,

HP-GL, Gerber,

NC Drill, AutoCAD DXF

**RANGER2 £150**

Upto 8 pages of schematic linked to artwork  
Gate & pin swapping - automatic back annotation  
Copper flood fill, Power planes, Track necking,  
Curved tracks, Clearance checking,  
Simultaneous multi-layer auto-router

**RANGER2 UTILITIES £250**

COOPER & CHYAN SPECCTRA auto-router (SPI)  
Gerber-in viewer, AutoCAD DXF in & out

**UPGRADE YOUR PCB PACKAGE TO RANGER2 £60**

## TRADE IN YOUR EXISTING PACKAGE TODAY

Seetrax CAE, Hinton Daubnay House, Broadway Lane, Lovedean, Hants, PO8 0SG

Call 01705 591037 or Fax 01705 599036 + VAT & P.P

All Trademarks Acknowledged

# PULSTAR

PHIL GREEN

*Servo motor pulse width alignment without tears!*

ANYONE who has built a Radio-Control system will appreciate how much time and effort goes into setting up and alignment. Sheer determination keeps the R-C constructor going long enough to see the gear make its maiden flight!

Most critical are the radio frequency (r.f.) stages – a poorly aligned receiver could be pretty dangerous in a fast aircraft, and a spluttering transmitter down at the local flying club might well result in several splattered models!

The digital timing section of a transmitter is less critical, but to ensure the system is compatible with other outfits, channel pulses have to be precisely set for Neutral and Throw.

Servos are also making appearances outside the modelling world, in robotics and animation projects, especially since they are so easy to interface. A simple insect-style robot, for example, might use six servos and, for each channel, pulses generated by the controlling program need tuning to give precise positioning.

## SERVO ACCURACY

Channel pulse setting normally involves borrowing a "standard" servo, which was

hopefully set up to a nominal spec at the factory. Each transmitter channel is tweaked to give Neutral on the standard servo, and this then becomes the standard channel setting for Neutral. Other servos can then be centralised, using just one channel to avoid compounded errors.

Once this tedious operation is complete, the system works, but the precise channel timings are still unknown. If no standard servo is available, the operation becomes even more hit and miss.

If only this finicky alignment could be done "off-line" . . . Well, it can, read on!

## PIC CONTROL

Enter PulStar, which is a precision channel measuring device and pulse generator,



## SPECIFICATIONS

Microcontroller operation  
Alphanumeric display  
Pushbutton setting

Triple mode:

GEN – generate (servo test)  
READ – measure Receiver output  
SWEEP – end-to-end travel

Channel pulse range 0.01 ms to 2.55 ms.  
Frame rate range: 1 ms to 255 ms

Resolution:

Channel 0.01 ms  
Frame 1 ms

Error detection:

Channel > 2.55 ms  
Frame > 255 ms

Consumption 5 mA typical from Receiver battery.

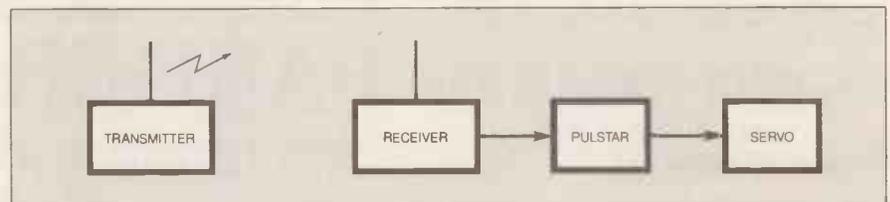
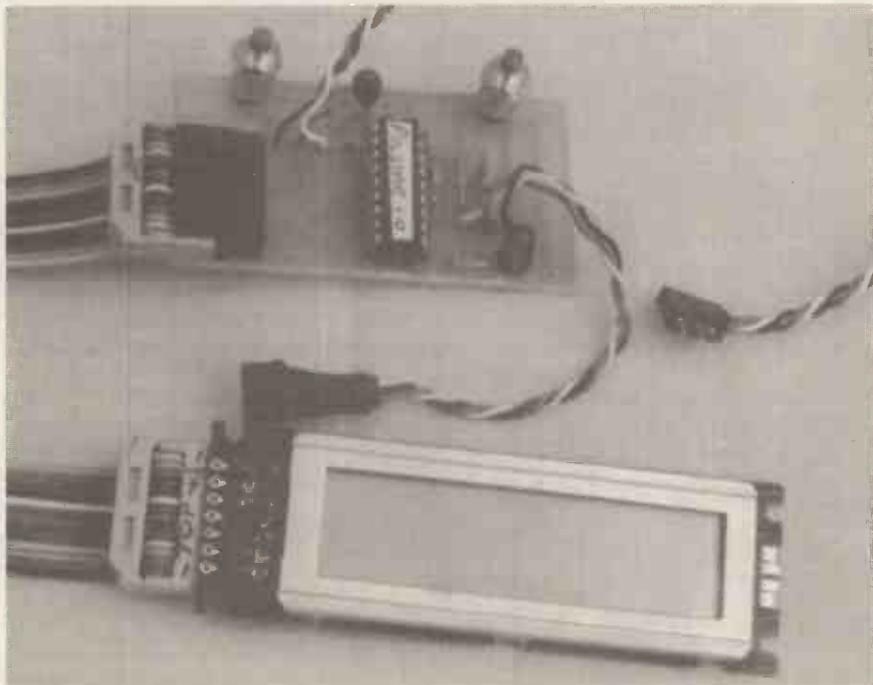


Fig. 1. Block diagram showing how PulStar fits into an R-C system.



PulStar basically consists of a simple printed circuit board and an "intelligent" display module.

built around one of the new generation of embedded controllers, the PIC16C54 microcontroller, with which many EPE readers will now be familiar. Being crystal or resonator controlled, this "computer-on-a-chip" provides spot-on timing, without any calibration.

Using a microcontroller means that rather than using lots of integrated circuits (i.c.s), we can do all the clever stuff in software, whilst keeping the hardware design down to just the one chip. Construction is therefore very simple (it's the software designer who does all the work!).

PulStar cannot help with setting up the r.f. section of an outfit (kit manufacturers often provide an alignment service), but it has proven to be invaluable when setting up mixers, speed-controllers, switches, and recalibrating old servos which were set to some non-standard pulse width.

Software details are given at the end of the article.

The block diagram in Fig. 1 shows how PulStar fits into the system.

## CIRCUIT DIAGRAM

As can be seen from the photograph and the circuit diagram in Fig. 2, there is not much to PulStar, just the microcontroller

IC1, the display X2 and a few additional components.

The display is a 16-character by 2-line liquid crystal display (l.c.d.) which has some intelligence in itself. This simplifies the software in that it is not necessary to worry about which dots form the letter "A", for example. Thankfully, we just send the code for each character and let the display electronics do the rest.

The integral l.c.d. controller can operate by transferring eight bits at a time (i.e. a full ASCII character) or in 4-bit mode, whereby two transfers are needed to send a character. The 4-bit mode is slower, but has the advantage of using fewer interface connections.

In addition to the four or eight data lines, a few control lines are necessary: Line "E" strobes data into the display, and "R/S" selects whether the data is a character for display, or a command, such as "blink", for example.

Line "R/W" normally selects Read or Write to the display. In this application, though, it is not necessary to read from the display, and so the line is held at 0V.

One further control line is Contrast on pin 3 (V<sub>0</sub>). Grounding this pin gives good readability in average lighting. (If readers want to experiment with varying the contrast voltage, this pin could be taken to the wiper of a potentiometer connected across the 5V power lines.)

Intelligent liquid crystal displays were once very expensive. However, mass-production now means that they can be bought quite cheaply from many outlets. Second-hand ones are also available from some surplus dealers (see *Shoptalk*). Amateur radio rallies are also a likely source. Two display lines are necessary, but 16, 20, 32 or 40 character types should work equally well, in a larger case.

## CONTROLLER COMPONENTS

The microcontroller is IC1 and it operates at a basic clock speed of 4MHz, as set by the ceramic resonator X1.

For this application, the use a ceramic resonator instead of a crystal seemed acceptable. They are more durable, cheaper, and include damping capacitors. (In some other designs, though, they may be less satisfactory than crystals since their frequency can drift with temperature. Ed.)

If a 4MHz crystal is already available in the junk-box, by all means use it in place of the resonator, but also add a 33pF polystyrene capacitor between each of its leads (on IC1 pins 15 and 16) and ground (0V).

Signals from the receiver are brought into IC1 pin 2 (RA3) via plug PL1. Signals are output to the servo from IC1 pin 13 (RB7) via socket SK1. These connectors also supply power (5V) from the receiver to the circuit and to the servo.

Switches S1 and S2 are used to tell the microcontroller which mode it is to assume, Read or Generate.

Light emitting diode D1 indicates if the microcontroller thinks it has received an incorrect code from the receiver.

## CONSTRUCTION

Details of the printed circuit board (p.c.b.) are shown in Fig. 3. This board is available from the EPE PCB Service, code 998.

## RADIO CONTROL PRIMER

The very first radio control systems had a single pushbutton control, and used the presence or absence of a carrier wave to operate a clock-work actuator inside the model. Each press of the transmitter button gave only sequential left-right-left-right control, although many ingenious schemes evolved to give more complex functions, and experimentation was the order of the day.

In the first true multi-channel radio control systems, the carrier was amplitude modulated by an individual audio tone for each channel. As a result, a 10-channel transmitter, for example, behaved something like a 10-note piano keyboard. The receiver had either tuned filters, or more often a reed bank, like miniature tuning forks, each of which vibrated in sympathy with a particular tone.

This would be detected, amplified, and used to drive a motorised servo mechanism, which in turn moved the control surfaces of the model. This type of control was nicknamed "bang-bang" since each servo switched between extremes of movement – all or nothing, rather like driving a car with a foot hard on the accelerator, using the ignition switch to control the speed! For many years however, these systems were extremely successful.

## PROPORTIONAL CONTROL

Little has changed in the field of digital proportional radio control since its arrival in the sixties, although it is now described more appropriately as Pulse Position Modulation (PPM). The term "digital" also now applies more realistically to modern Pulse Code Modulation (PCM) systems which make extensive use of microcontrollers such as the PIC.

In either case, PPM or PCM, the output from the receiver takes the form of a 3-wire connection for each

servo, two carrying power (usually from a 4.8V Nicad battery) and one for the channel signal. Movement of a transmitter joystick controls the width of the corresponding receiver pulse, which is repeated about 50 times per second, i.e. a 20-millisecond frame rate.

One extreme of motion equates to a pulse width of 1.00ms, the other extreme to 2.00ms, with a smooth variation throughout the range, and neutral at 1.50ms. The period between pulses (about 8ms to 16ms) is used to synchronise the receiver to ensure that each output relates to the correct joystick.

Proportional control gave many advantages, including "trimming" an aircraft in flight, something which was impossible using "bang-bang" techniques.

Each proportional servo contains a monostable multivibrator or timer, the period of which is governed by the current position of the servo. This monostable is triggered by the arrival of a new pulse from the receiver, and the difference between the receiver pulse width and that of the monostable is used to drive the servo to correct the difference. The result is that the servo smoothly follows the position of the transmitter control.

## MULTI-CHANNEL

Two-channel sets are common in buggies and model boats. These use Amplitude Modulation (AM) of a 27MHz or 40MHz carrier wave. For model aircraft using ailerons (roll), elevators (pitch), rudder (yaw), throttle, and optionally retracting undercarriage and flaps – four or six channels are common on the 35MHz band using Frequency Modulation (FM). The difference in the two signal patterns is shown in Fig. 6.

Regardless of the system or frequency, however, generally speaking, a servo is a servo is a servo.

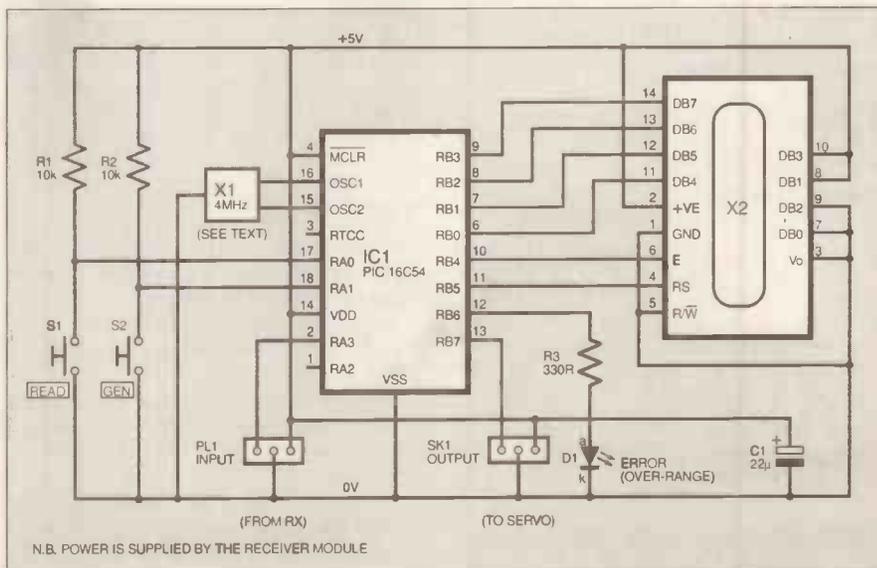


Fig. 2. Complete circuit diagram for PulStar.

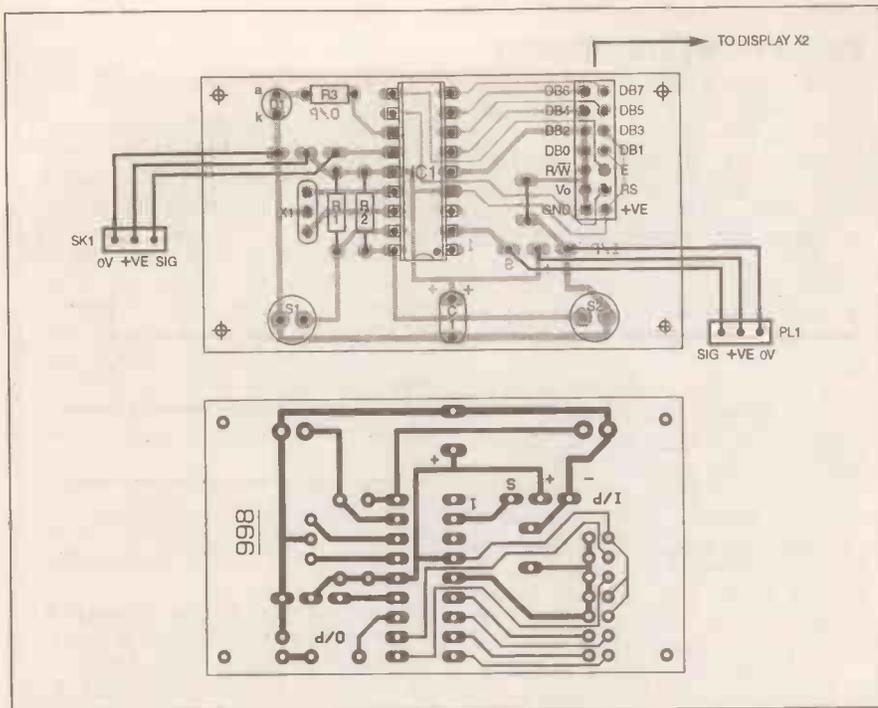


Fig. 3. Printed circuit board component layout and full size copper foil master track pattern for PulStar.

Using the printed circuit board makes the job simpler and neater, although Veroboard is equally suitable and was used for preliminary trials. The recommended p.c.b. has one short strap (on-board link wire), fit this first.

A d.i.l. (dual-in-line) socket must be used for IC1 as it can be damaged by static electricity, reverse polarity, or excess heat, any of which could, at the very least cause loss or corruption of the software programmed into it.

Switches S1 and S2 can be wired or mounted directly on the board, in which case they will also provide mechanical

support. Watch the polarity of the Tantalum bead capacitor (C1), the display connector and the l.e.d. D1. Double check the correctness of the wiring to connectors PL1 and SK1 since errors could be expensive!

Be especially careful when connecting the display. Ribbon cable and IDC connectors were used for the display connections in the prototype. These make a robust, if bulky job.

Alternatively, thin, flexible hook-up wire (servo wire is ideal), could be soldered into the p.c.b. Connectors, though, certainly ease fault-finding and are a boon when testing second-hand displays. The display pinout details are shown in Fig. 4.

Do not connect the display or the servo to the p.c.b., until preliminary testing has been done.

The prototype was not mounted in box but used in its "naked" state. However, if it is preferred to house the completed board and display in a suitable case, ensure that nothing can short-circuit.

If the switches are not mounted on the p.c.b. but are wired back to it, fit them into the case beneath the display so that the READ and GEN legends which it generates at switch-on (see Fig. 5a) apply correctly.

### TESTING

For the preliminary tests, first plug the input lead (PL1) into a suitable +5V power source or your R-C receiver.

Switch on, and check that the l.e.d. flashes once. This proves that the controller is running.

Any problems at this stage will be down to poor soldering – most likely around the display connector or on tracks between the chip leads.

Switch off, plug in the display, and switch on. Check that the sign-on message "PulStar" appears. If all is well, congratulations! You have a very useful addition to your toolkit!

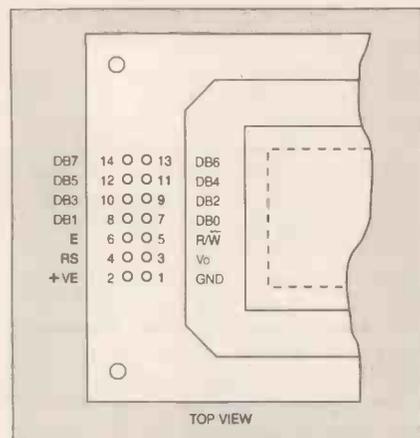


Fig. 4. Pinouts for the l.c.d. module.

### USING PULSTAR

To use PulStar in a real situation, plug PL1 into your receiver just as you would a servo, and connect the servo to socket SK1.

On switching on, you will see a prompt to select which operating mode is required, with READ and GENERate legends above the two switches, as in Fig. 5a. Press READ (S1) and the display changes to show the current pulse width and frame rate. If no signal is being sent by the transmitter, the display in Fig. 5b will be seen. When a transmitter signal is being received, the display will be similar to that in Fig. 5c.

Switch off, pause to let the power supply line voltage drop back to 0V, and then switch on again. This resets the program back to the Mode Select option. Press GEN (S2) and PulStar will begin sending a continuous stream of pulses to the servo. The display will show the current pulse width, with the legends UP and DOWN above the two switches (Fig. 5d).

On start-up, the pulse width is set to 1.5 milliseconds, which is a common standard

## COMPONENTS

### Resistors

R1, R2 10k (2 off)  
R3 330Ω

All 1/8W 5% carbon film, or better

### Capacitor

C1 22μ tantalum bead, 10V

### Semiconductors

D1 red l.e.d.  
IC1 PIC16C54 microcontroller (pre-programmed, see text)

### Miscellaneous

S1, S2 min. push-to-make switch (2 off)  
X1 3-terminal 4MHz ceramic resonator (see text)  
X2 16-character x 2-line l.c.d. module

Printed circuit board, available from the EPE PCB Service, code 998; 18-pin d.i.l. socket; 3-way socket and plug suitable for R-C receiver and servo coupling; 14-way IDC socket (optional) (2 off); 14-way IDC connector, p.c.b. mounting (optional) (2 off); 14-way ribbon cable; 3-way stranded cable; solder, etc.

See  
**SHOP  
TALK**  
Page

Approx Cost  
Guidance Only

**£25**

### DISPLAY SCREENS

At switch-on:

a) PulStar\* v1.0  
READ <mode> GEN

Read mode, awaiting signal:

b) ? ms pulse  
? ms frame

Read mode, typical signal:

c) 1.73 ms pulse  
018 ms frame

Generate mode:

d) 1.50 ms pulse  
DOWN SWEEP UP

Generate mode: (sweep)

e) Generate: SWEEP

Error condition: (also l.e.d. flashes)

f) Over-range I

Fig. 5. The six basic screen display modes

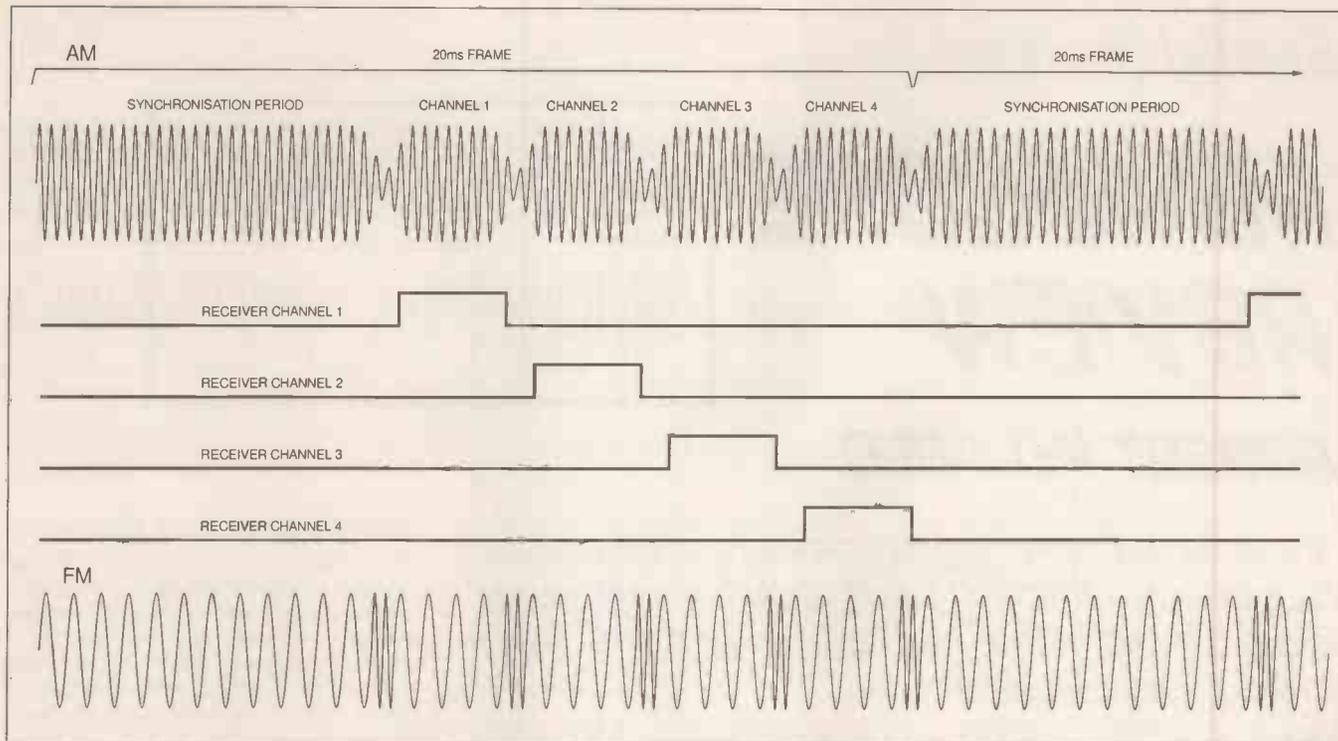


Fig. 6. Comparative waveforms generated by AM and FM systems to control four receiver channels.

for the Neutral position. Pressing UP will increase the pulse width steadily towards a maximum of 2.55ms, whilst pressing DOWN will narrow the pulse towards 0.01ms. Note that these values are extremes, beyond the ranges normally used by model servos, which have a useful range of about 0.8ms to 2.2ms maximum. If a servo is connected to the output lead, its shaft position will follow the internal pulse generator.

Between the UP and DOWN legends is the option SWEEP, activated by pressing both buttons together, resulting in the

display shown in Fig. 5e. This function will sweep the servo side to side from its current position (use UP and DOWN to select neutral first).

The idea is that by connecting two servos via a "Y" lead, transit times can be compared. In a set of four servos, one will be slowest and can be used for throttle; and the fastest used for a more critical function such as ailerons.

(Note that data pin RB7 of the PIC16C54 (the pin which supplies current to the servo) can sink a maximum of 25mA, and source a maximum of

20mA. These maximum currents must not be exceeded.)

If pulses having a width outside that catered for are received, the error condition signal shown in Fig. 5f will appear.

### SOFTWARE

For readers who wish to program their own PIC16C54, the software for PulStar is available on 3.5in disk for £2.50 from the Editorial office. Pre-programmed PIC16C54 chips are available from the author. For more details see *Shoptalk* page.

**NEXT MONTH \* GAMES COMPENDIUM \* TWIN-BEAM  
INFRA-RED ALARM \* ADVANCED NiCAD CHARGERS \***

**PLUS - Special Feature -**

**INTERNET and the WORLD WIDE WEB**

**DON'T MISS OUT - ORDER YOUR COPY NOW!**

**EVERYDAY**

**PRACTICAL**

**ELECTRONICS**

**NEWSAGENTS ORDER FORM**

Please reserve/deliver a copy of **Everyday Practical Electronics** for me each month

Signed .....

Name and Address .....  
(BLOCK CAPITALS PLEASE)

.....

.....

..... Post Code .....

*Everyday Practical Electronics* is published on the first Friday of each month and distributed S.O.R. by Seymour  
Make sure of your copy of EPE each month - cut out or photostat this form, fill it in and hand it to your newsagent.

# MINISCOPE REVIEW

ROBERT PENFOLD

Tests show that the Miniscope I.c.d. oscilloscope/logic analyser has much to recommend it to the home user.

WHEN I first became interested in electronics, which I suppose was about 30 or so years ago, the average oscilloscope was pretty huge. In fact most oscilloscopes actually weighed so much that the average table or bench could not be relied upon to carry one! Instead, they were mounted on custom made trolleys that were usually of heavy steel construction.

## Scope for Improvement

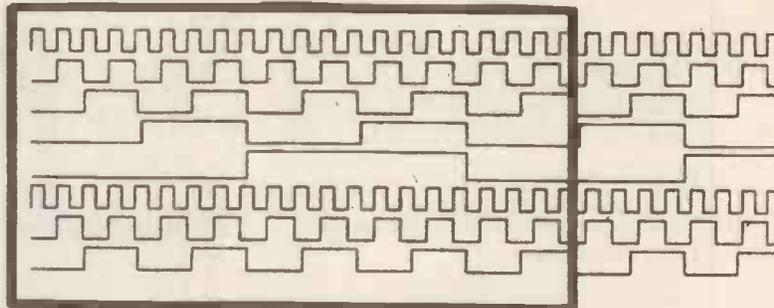
Technology has moved on, and oscilloscopes no longer strain the floorboards. In fact truly portable oscilloscopes have been available for some years now. The original units were based on miniature cathode ray tubes (c.r.t.s), but many of the more recent portable oscilloscopes have been based on liquid crystal displays (l.c.d.s). The low power consumption and small size of a liquid crystal display makes it the obvious choice for a portable oscilloscope.

The unit reviewed here is the *Miniscope MS10* I.c.d. digital storage oscilloscope from Audon Electronics. In fact this is a two-in-one instrument that can act as a portable storage oscilloscope or eight

channel logic analyser. It will be of interest to many *EPE* readers as it is designed specifically for electronics hobbyists. It is relatively simple and straightforward to use, and costs just £199-00 plus V.A.T.

The *Miniscope* is genuinely portable, with approximate dimensions of 198mm x 178mm x 108mm, and without the batteries installed it weighs in at just 0.5kg. It can be powered from six "C" size batteries, or from an optional mains adaptor. The mains adaptor is the best choice unless the complete portability of battery operation is essential, since using batteries is likely to be quite expensive in the long term.

The screen is quite small, with an active area that measures approximately 57mm x 39mm. Its resolution is 64 x 128 pixels, which gives far less resolution than a conventional c.r.t. oscilloscope screen, but it is substantially better than simple l.e.d. oscilloscopes. The right hand 25 per cent of the screen is used to display information such as the sweep speed and the mode in use, which somewhat reduces the effective size and resolution of the screen.



However, in use the screen seems to show plenty of detail, and it will accurately display overshoot and "ringing" on squarewaves and the shape of complex speech waveforms, etc. The contrast is relatively low unless you view the screen from almost directly in front of it, but this seems to be a problem with all liquid crystal displays.

## In-Store

If we consider the *Miniscope* in its storage 'scope guise first, it has switchable a.c./d.c. coupling, and can sample at up to 10MHz. It has to be borne in mind here, that a sampling rate of 10MHz does not mean that it has a bandwidth of 10MHz. In order to obtain a reasonably accurate display it is necessary to have a sampling rate at least two to three times higher than the maximum input frequency.

Clearly, the sampling rate easily accommodates audio waveforms, which is likely to be the main area of application for a unit such as this. The *Miniscope* can just about handle a PAL composite video signal.

The sweep time is variable from 200ms to 10µs in the usual 1 - 2 - 5 - 10 sequence. Two pushbuttons are used to increment and decrement the sweep time, and the selected time is displayed on the screen, together with the sampling rate.

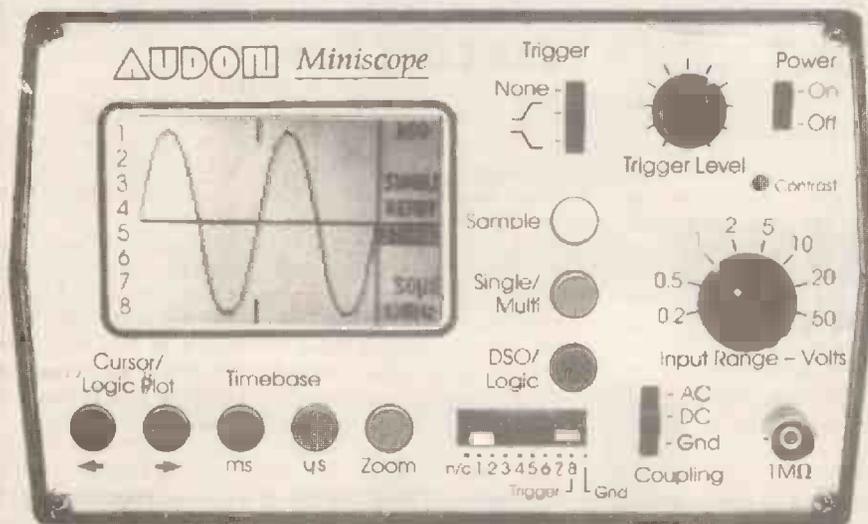
The latter is 10MHz for sweeps of 2ms or less, or 100kHz for sweeps of more than 2ms. The sweep time is the time for a complete sweep, incidentally, and not the time per cursor division. In fact there is no screen grid of any kind, just a line across the screen which indicates the 0V axis.

At most sweep speeds the unit takes in many more samples than the screen can display properly. The extra samples can be fully utilized by zooming in and displaying a selected section of the waveform.

Two pushbuttons permit a cursor to be positioned beneath the desired section of the waveform, and the Zoom button is then repeatedly pressed to cycle through the available zoom levels. This system works quite well, and at most sweep speeds effectively gives greatly boosted screen resolution.

## Finger on the Trigger

The *Miniscope* can operate in single-shot mode or a form of free-running operation. In the free-running mode the repetition rate seems to be rather slow in comparison to a conventional oscilloscope.



## Specifications

### DSO

10 Mega-samples per second  
0.2V-50V input range  $\pm 5\%$   
200ms-10 $\mu$ s timebase  $\pm 0.1\%$   
1MHz bandwidth ( $-3$ dB)  
6 bit ADC resolution  
1 Meg Ohm input impedance

### Logic Analyser

10 Mega-samples per second  
8 Channel inputs  
5V TTL and 4.5-15V CMOS

### General

64 x 128 pixel L.C.D. screen  
Dimensions 198mm x 178mm x 108mm  
Weight approx 0.5Kgs (excl. batteries)  
Power Supply internal 6 x C batteries  
Power supply external 7V-15V @ 300mA  
via 3.5mm jack

Triggering can be either Positive or Negative, or None. The latter provides arbitrary sampling in the free-running mode.

In the single-shot mode it results in a sample being taken when the Sample button is pressed. One disappointing omission is a lack of any facility for external triggering. A trigger level control enables the trigger point to be set when using positive or negative triggering.

There are eight switched sensitivities from  $\pm 0.2$  volts to  $\pm 50$  volts, again with the usual 1 - 2 - 5 - 10 sequence. The maximum sensitivity may seem rather low, but the quoted figures are those needed to provide a full height display, not the normal volts-per-scale division. The maximum sensitivity is still lower than that of most other oscilloscopes, but it is sufficient for the majority of applications.

### Logic Analyser

The logic analyser has eight channels, and it can handle normal 5V TTL levels, or CMOS levels with a supply in the range 4.5V to 15V. Sample rates and sweep times are the same as those in the oscilloscope mode. The 10MHz sampling rate is a bit limiting, since the displayed waveforms will only have accurate timing if the sampling rate is much higher than the maximum input frequency.

A 10MHz sampling rate gives good results with input frequencies of up to about 1MHz or so, and with pulses of around 1 $\mu$ s or less, but with higher frequencies or shorter pulse durations the accuracy soon starts to fall away.

The logic analyser is clearly unsuitable for use with high speed TTL circuits, but it is usable with most circuits based on 4000 series CMOS chips, or TTL circuits operating at a few megahertz or less.

In the logic analyser mode, only single sweep operation is available. This is presumably a deliberate omission, since repetitive triggering would serve no obvious purpose in a logic context. With the trigger switch set to the None position the unit is triggered by pressing the Sample button.



With positive or negative triggering selected, the sweep commences when the appropriate type of transition is detected on the Channel 8 input. However, trigger pulses are ignored until the unit has been "cocked" by pressing the Sample button. This avoids unwanted multiple triggering of the unit.

As in the storage oscilloscope mode, at most sweep speeds the unit takes samples at a rate which is higher than the minimum needed to produce the display. At most sweep speeds this over-sampling enables the display to be "zoomed" to expand a selected section.

It is also possible to select a "scroll" mode when the unit is used as a logic analyser. The screen can then be scrolled sideways to effectively extend the display to the left. This is a useful feature, but it only works on a few sweep speeds, and the amount of scroll available is quite limited.

### General

The *Miniscope* is supplied with a rather basic 16-page A4 manual. This is very brief and to the point, but it tells you everything you need to know in order to access all the available facilities. It does not provide a general introduction to oscilloscopes and their uses, so you will need a book or two on the subject if your knowledge of oscilloscopes is a bit sketchy.

The standard of construction is not equal to that of high quality professional equipment, but it is still quite well made and it looks quite tough. It should stand up to many years of use by an enthusiastic electronics hobbyist.

A standard BNC oscilloscope test lead is supplied with the unit, and this is terminated with a pair of crocodile clips. A "professional" probe lead having an  $\times 1/\times 10$  facility is available as an optional extra, but the standard lead is perfectly adequate for most purposes. The unit is also supplied with a short 9-way test lead for the logic analyser port. This is terminated with miniature probe clips.

### Summary

First and foremost the *Miniscope* is a digital storage oscilloscope. The logic analyser is something of an afterthought, but it is certainly an extremely useful

storage oscilloscope and logic analyser at a bargain price. It was not designed as such, and is not put forward by the manufacturers in this guise. It is designed specifically for the home user, with a price and specification that should appeal to many in this target group.

The *Miniscope* has definite limitations. The screen size and resolution is limited but adequate, as is its bandwidth. The lack of a graticule plus the limited screen size make it impossible to measure time, frequency, or voltage very accurately. It also lacks a dual trace facility, and is not at its best when used with constantly changing waveforms in the free-running mode.

For most potential users these factors will be easily outweighed by its small size and relatively low cost. This unit is well suited to "kitchen table" project construction, which is not really true of conventional oscilloscopes, even the modern ones.

The *Miniscope* is also very simple and straightforward to use, which is another plus point for the home user. It is very different to any oscilloscope that I have used before, but I soon became accustomed to using it.

Last, and by no means least, this is a proper storage oscilloscope, which will catch fleeting one-off waveforms, and display them in a clear and unambiguous fashion. The test period was something less than extensive, but the *Miniscope* always performed flawlessly each time that I used it.

### Conclusion

The *Miniscope* is a very impressive instrument which can certainly be recommended, particularly to those who are interested in audio and (or) low to medium frequency logic circuits.

Its £199.00 price tag is boosted to £247.92 when the optional mains adaptor (£6.00), postage (£6.00), and V.A.T. have been added, but it still represents very good value for money at this price. For experienced constructors a kit version is available at £169.00 plus V.A.T., but this version was not reviewed.

For further details contact: Audon Electronics, 36 Attenborough Lane, Chilwell, Nottingham, NG9 5JW. Phone/Fax 0115 925 9737. □

# MORE SCOPE FOR GOOD MEASUREMENTS

ROY BEBBINGTON

Part 1

*Using an oscilloscope to examine an electronic circuit is like having a blindfold removed – you can really see what is happening, if you know how to look properly.*

EVERY picture tells a story, and the more detailed the picture, the better the story. Generally, we all think in pictures, and this also applies when we measure physical or electrical signals. For example, we observe the analogue indication of the hands of a watch, or a pointer on a meter.

Electrical quantities, voltage, current or resistance, can be measured by using the heating and magnetic effects of an electric current to indicate their strength by deflecting a pointer over a meter scale. Although such meters are in common use, the visual indication of the pointer may tell only half the story (0.707 of peak for sinewaves!), and one that is not entirely true. For instance:

- reading errors occur if the meter takes power from the circuit under test
- problems arise when the quantities on test vary with time, especially at speed
- mechanical pointers are easily damaged by an overload signal and, moreover, give no mental image of its actual waveshape

The need to visualise waveforms pictorially is evident by the numerous graphs that are drawn to illustrate electrical signals. Fortunately, the oscilloscope (scope) can provide an automatic trace of that picture for us!

With a scope we can check the history of a signal and observe the shape of things to come if we leave it to “baby-sit” the circuit of interest. Whereas a voltmeter generally shows root-mean-square (r.m.s.) values and is restricted to one signal, an oscilloscope shows the signal variations with time – peaks, troughs, transients, distortion, warts and all! And, for good measure, it usually compares two or more signals at the same time.

Unlike the voltmeter pointer or display, the cathode ray oscilloscope (c.r.o.) employs an almost weightless beam of electrons that can easily follow a rapidly varying analogue signal and display it in graphical form – in short, a voltmeter with pictures!

## SCOPES AVAILABLE

Analogue scopes are widely used to troubleshoot and calibrate all manner of repetitive signals, and cathode ray tubes (c.r.t.s) with long-persistence phosphors enable viewing times to be extended for a

few seconds to view low-frequency and once-only events.

The advent of *storage* scopes meant that waveforms could be displayed long after they had disappeared from the input sockets. Analogue storage scopes considerably extend the viewing period by using special storage tubes with extremely high writing speeds.

Digital storage scopes (d.s.o.s) offer the greatest benefits in terms of flexibility in capturing and storing signals. As its name implies, a d.s.o. stores signals in a digitally-coded form – which is available indefinitely.

Although most scopes are built around a cathode ray tube, a recent breakthrough in design is the liquid crystal display (l.c.d.) which, when combined with large-scale integration techniques, provides a handheld scope.

## C.R.T. DISPLAYS

The simplified layout of a cathode ray tube is shown in Fig. 1. The cathode of the electron gun, coated with barium sulphate

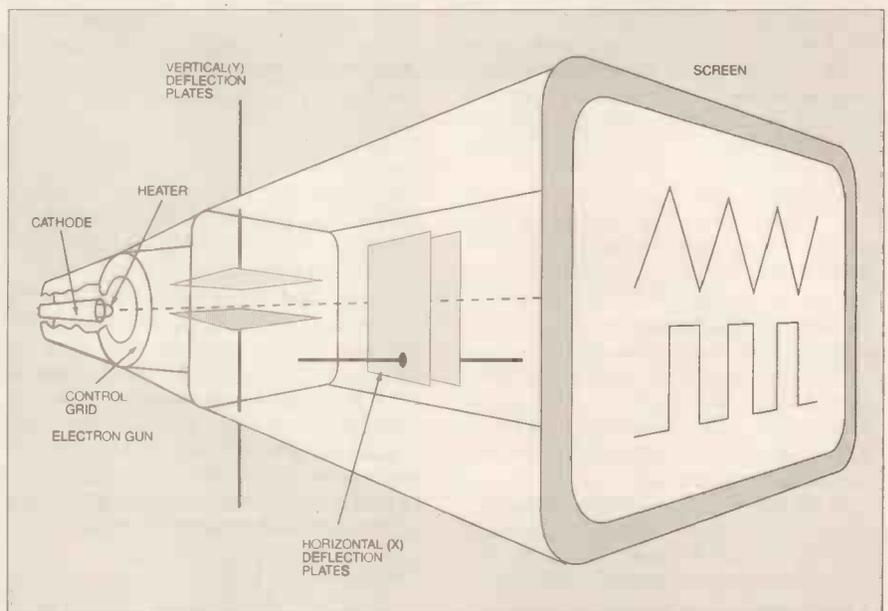
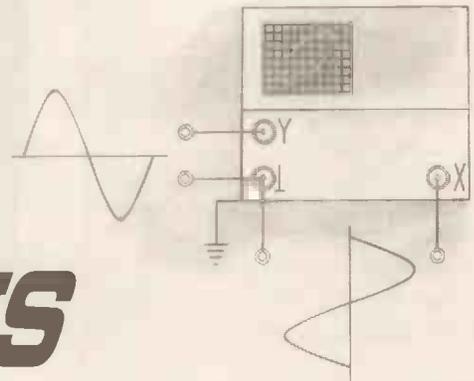


Fig. 1. Basic details of a cathode ray tube as used in an oscilloscope, excluding focussing and acceleration anodes.

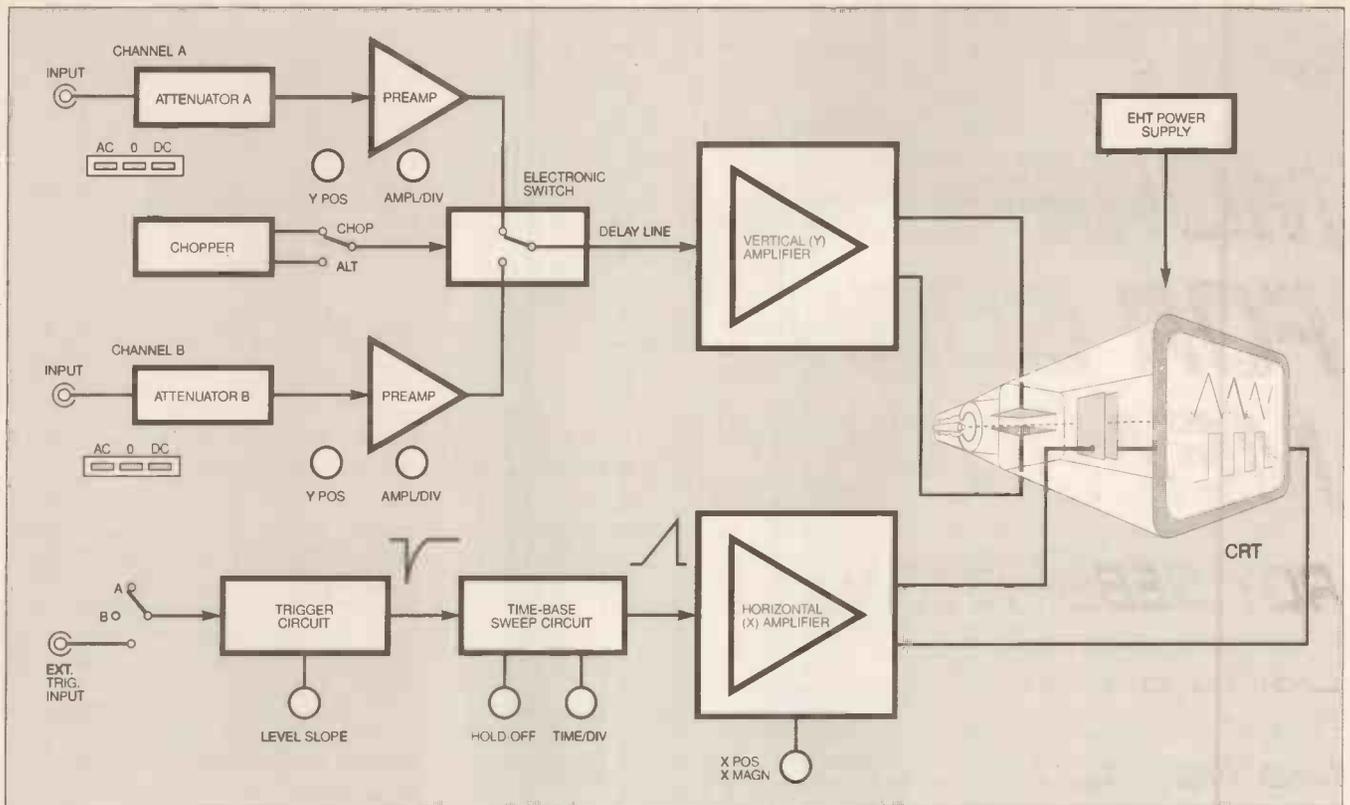


Fig. 2. Block diagram of an analogue dual-trace oscilloscope, excluding focus and brilliance controls.

similar to that in a "normal" thermionic valve, emits electrons that pass through a series of electrodes towards the screen.

The electrons are focussed into a beam to form a spot in the centre of the screen. As with a TV, the surface of this screen has an inner coating of a luminescent layer that emits light, usually green, when struck by electrons.

#### Focus

To obtain a sharp trace on the screen, the focus electrodes, supplied with positive and negative voltages to create a lens effect, control the beam spot size so that it remains sharp for different intensities and sweep speeds. A manual focus control is also included.

#### Deflection Plates

The two pairs of deflection plates can shift the electron beam, moving the spot on the screen by electrostatic deflection when voltages are applied. These are known as the X (horizontal) and Y (vertical) deflection plates.

As you would expect from these graphical expressions, the Y plates are controlled by the signal voltage to be measured, and the X plates are usually controlled by a timebase (Y-T displays).

#### Intensity

Anodes at positive potentials control the speed of the electron beam and therefore the trace intensity. At very fast sweep speeds, the phosphor coating of the screen is energised for a shorter period, so the intensity needs to be increased, otherwise the trace will not be seen.

Conversely, at slow sweep speeds, the intensity needs to be reduced to prevent "burn-in" of the phosphor.

Fortunately, most modern oscilloscopes have automatic adjustment of intensity to compensate for different sweep speeds. For high frequency inputs, i.e. high writ-

ing speeds, post-deflection acceleration is applied by a voltage of 10kV or more in the area of the screen.

#### Screen

On striking the flat inner surface of the c.r.t., the energy of the electron beam is converted into light by the phosphor coating. Unlike a graph plotter with its continuous roll of paper, the c.r.t. has a screen of limited width. Consequently, a continuous time axis has to be represented by repeatedly sweeping the X trace from left to right of the screen as a timebase.

To be able to measure the waveforms on the screen, some form of scale is necessary. A graticule can be affixed externally in front of the screen, but most modern oscilloscopes have internal graticules in the same plane as the phosphor, to avoid errors due to parallax.

### OSCILLOSCOPE CIRCUIT BLOCKS

When a c.r.t. is used at the heart of an oscilloscope, as is usually the case, what are the circuit blocks that make it "tick"? If we take the power supplies for granted, the basic blocks for a two-channel analogue oscilloscope are as shown in Fig. 2.

#### Vertical Deflection

Two identical Y (vertical) channels allow two input signals, A and B, to be compared simultaneously on the screen by a dual-trace technique using electronic switching.

Each signal input has an input attenuator and a pre-amplifier with a manual control (AMPL/DIV), calibrated in mV/div and V/div to adjust the amplitude of the signals to suit the required display size.

Channel A and B waveforms, suitably conditioned, can be selected manually and displayed in either the chopped (CHOP) or the alternate (ALT) mode. In the chopped

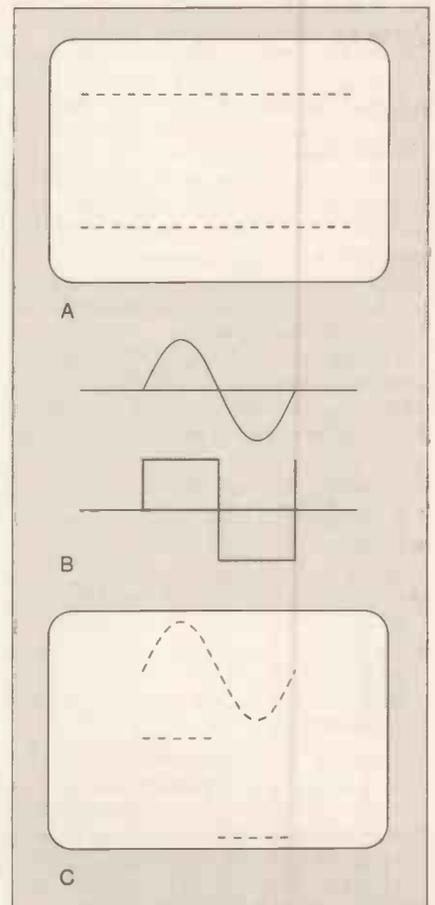


Fig. 3. Timebase presentation of signals on a dual-trace oscilloscope.

mode, a pulse from a free-running multi-vibrator (astable) chops at a rate of 200kHz or more between the two input signals. At time coefficients lower than about 0.1ms/div, each trace appears to be continuous, but for higher sweep speeds

the traces will appear as dashed lines (Fig. 3), so imposing an upper limit for the CHOP mode.

In the ALT mode, pulses are derived from the timebase circuits, synchronised with the end of successive sweeps; i.e. one channel signal is traced per sweep. As shown, the electronic switch then changes over to trace the other channel signal.

With ALT selected, at slow sweep speeds the traces appear to be written one after the other and are therefore difficult to compare.

From the foregoing, it will be realised that the ALT mode is more suitable for faster sweep speeds, whilst the CHOP mode is better for slower sweep speeds and single-shot events.

### Delay Line

A built-in delay line might be included in the vertical channel of some scopes to compensate for the longer delays introduced by the electronic circuits of the horizontal channel. This ensures that the X and Y signals arrive together so that leading edges of waveforms can be viewed on the screen.

A final vertical deflection amplifier provides sufficient output to the Y deflection plates to allow a sizeable vertical trace capable of being shifted to show signal details of interest without distortion. Typically, the maximum deflection might be the equivalent of 24 divisions (three screens).

Each trace can be centred or positioned as desired on the vertical axis of the screen by means of a manual control (Y POS).

### Input Coupling Switch

Each channel has an input coupling switch, often labelled AC-0-DC. By selecting "0", the channel can be switched to the 0V (ground) level. This facility allows the channel reference levels to be adjusted individually or in respect to one another.

The AC setting is used to block a d.c. component in a signal that would otherwise form the major part of the signal. This position allows you to see more of an

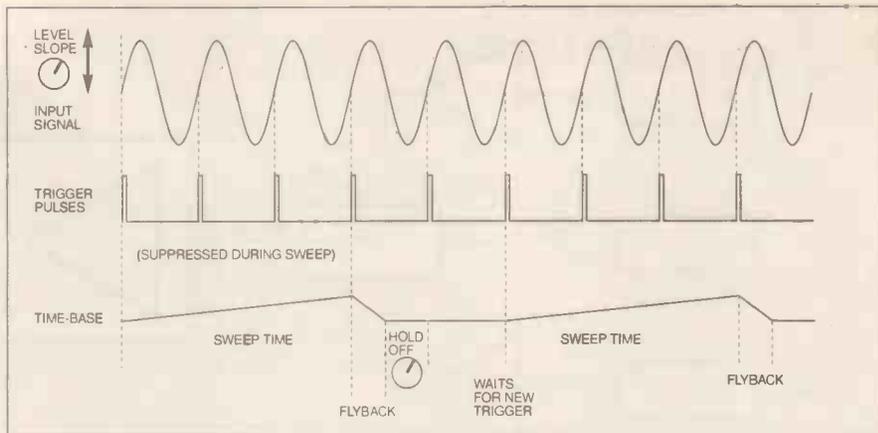


Fig. 4. Timebase generator output waveforms.

a.c. transient that is of interest, adjusting the respective controls accordingly. However, remember that no d.c. level with respect to ground is seen, and low-frequency components in a signal may show distortion.

The DC setting allows measurements of d.c. voltage levels to be taken.

In some scopes, signals from the two vertical channels can be added (ADD), or inverted to give subtraction. These options are useful for removing hum, or for differential measurements.

### Horizontal Deflection

Horizontal (X) deflection represents the time axis, against which the signals on the vertical channels are plotted. An internal timebase supplies the horizontal information by means of an accurate sweep generator at user-selectable speeds.

Sweep speed (TIME/DIV) is measured in  $\mu\text{s}/\text{div}$  to  $\text{s}/\text{div}$ . The timebase generator provides a sawtooth signal, a linear positive-going ramp that deflects the spot from left to right on the screen at a speed determined by the TIME/DIV setting. The timebase generator waveforms are indicated in Fig. 4.

On reaching the right-hand side, the sawtooth waveform drops sharply to return the spot quickly to the left-hand side, from where it starts the next trace. This

rapid return path, known as "flyback", is suitably blanked to prevent any confusion with the trace. By selecting different sweep periods, with a continuously variable timebase control it is possible to view one or more periods of a waveform across the screen, or zoom in on a point of interest (X MAGN).

The trace can be moved horizontally by a control (X POS) to coincide with a graticule line for measurement purposes.

### Triggering

For the electron beam to return repeatedly to the same point on the screen, and to follow exactly the same path each time, accurate timing is required. This is the task of the trigger circuit. It ensures that the timebase starts each time at a pre-determined point on the input signal, to obtain a stable waveform that is traced repeatedly without jitter.

A hold-off pulse prevents extra trigger pulses from interfering with the start of the sweep and causing "double-writing".

The trigger controls are typically SOURCE, LEVEL and SLOPE. Often the trigger source is from the signal itself, or from an external trigger. A trigger LEVEL control determines at which voltage level the timebase will start. SLOPE selects whether the trigger is positive- or negative-going.

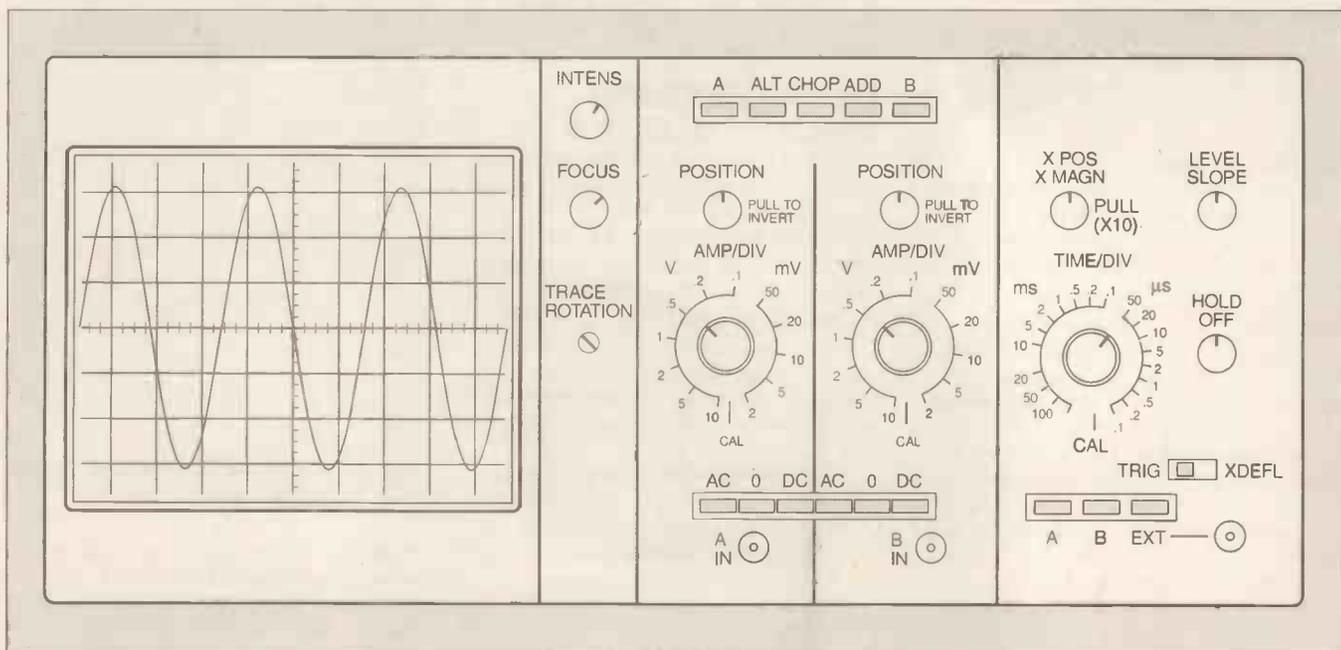


Fig. 5. Stylized layout of the basic controls on a typical dual-trace oscilloscope.

A horizontal deflection amplifier feeds the timebase waveform to the X deflection plates at the requisite level.

An example of a typical front panel layout for an analogue dual-trace scope is shown in Fig. 5.

## ADDITIONAL FEATURES

As discussed above, in addition to the X and Y sections, scopes have a third section which controls the electron gun, allowing brilliance and focus of the beam spot to be varied, and is known as the Z-axis.

Normally, the spot is blanked during the flyback time, but in some scopes this blanking can be usefully controlled via an external signal, e.g. to provide time markers from clock pulses, via a Z-input. This facility is known as Z-modulation.

For detailed study of complex waveforms, scopes having dual timebases become necessary: a main timebase (MTB) and a delayed timebase (DTB). Part of the MTB can be displayed more brightly to indicate the start of a DTB that has a much faster sweep speed in order to expand the point of interest.

So far, only the built-in timebase (Y-T mode) has been discussed for the horizontal deflection system. However, with many scopes an external signal can be substituted to deflect the signal along the X-axis, referred to as the X-Y mode. This allows two signals to be plotted simultaneously to see their relationship.

## COMMON WAVEFORMS

Perhaps the most familiar standard waveforms are the sinewave, the triangular waveform and the square wave. In the timebase generator we also met the sawtooth waveform, a variant of the triangular waveform. The ramp waveform is a special case variant of the sawtooth,

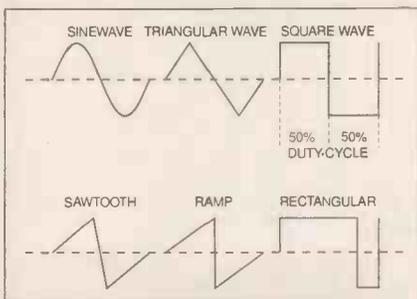


Fig. 6. Idealised standard waveforms.

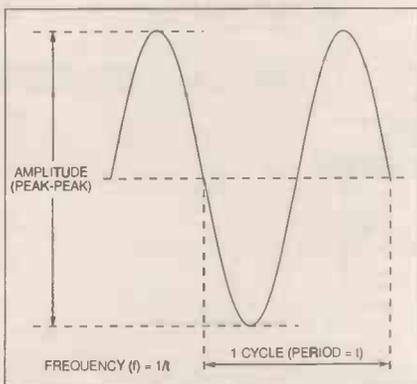


Fig. 7. Sinewave parameters.

with the fastest possible transition between the voltage extremes at the end of the ramp period. Examples of these waveforms are shown in Fig. 6.

Similarly, the rectangular wave is a variant of the squarewave, i.e. when the duty-cycle is not 50 per cent. Both these waveforms can also be referred to as pulse waveforms.

The frequency and amplitude of a sinewave are represented as shown in Fig. 7, from which it will be seen that the time taken between the same point on successive waveforms is known as one cycle or period.

The number of complete cycles occurring in one second, i.e. the frequency, is expressed in Hertz (Hz). Therefore, for example, if the period of a waveform is 20ms, its frequency is calculated as:

$$f = 1/(20 \times 10^{-3}) = 50\text{Hz.}$$

Next to frequency, the amplitude or peak-to-peak voltage is the next most common parameter that is checked.

Repetitive waveforms are the easiest to measure on an oscilloscope since single or infrequent waveform occurrences may happen too fast to be seen.

## BANDWIDTH

An oscilloscope's most important specification is, perhaps, the frequency response, or *bandwidth*, of its vertical system. As shown in Fig. 8, this is expressed as the maximum frequency that can be displayed on the screen with an amplitude that is not more than 3dB below the signal under test (71 per cent of the input signal).

From the graph in Fig. 8, it can be seen that an oscilloscope used towards its upper frequency limit will give misleading results. High-frequency amplitude measurements can be up to 30 per cent less than those of low-frequency signals.

Also, as high-frequency pulses are formed from a fundamental sinewave and its harmonics, a 10MHz squarewave displayed on a 10MHz bandwidth scope, as shown, would appear as a sinewave, since all harmonics higher than the first would be heavily attenuated by the high-frequency roll-off. The solution is to keep well within the upper frequency limits of your scope, or to use one with a wider bandwidth for making high-frequency measurements.

## PULSE PITFALLS

Because pulses do not change from one level to another in zero time (nothing in nature is truly "instantaneous"), then their shapes will not conform to the idealised square wave shown in Fig. 6. Some of the imperfections that might occur are illustrated in Fig. 9 and should be recognised if oscilloscope measurements are to be meaningful.

The finite time taken for a pulse to attain a higher level is known as its *risetime*; the time taken for a pulse to fall to its lower level is known as its *falltime*. These parameters are defined as the transition time between the 10 per cent and 90 per cent levels of the pulse amplitude value – in theory, the fastest transition the scope can display.

There is a direct relationship between risetime and bandwidth, stated as:

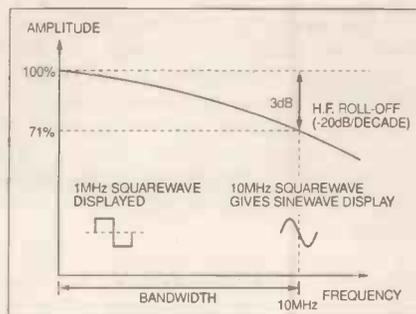


Fig. 8. Frequency response of a 10MHz oscilloscope.

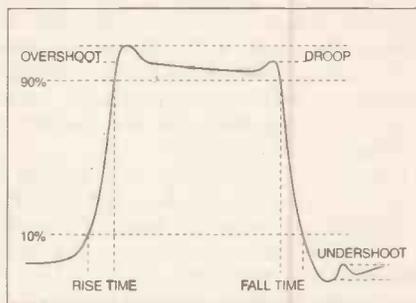


Fig. 9. Pulse imperfections.

$$\text{bandwidth (Hz)} \times \text{risetime (s)} = 0.35$$

Thus, the risetime of a 15MHz oscilloscope is equal to:

$$0.35 / 15 \times 10^6 = 23\text{ns}$$

For a 50MHz scope, the risetime is 7ns.

Graticules are usually calibrated so that the top and bottom of signals can be aligned against zero per cent and 100 per cent marks to allow risetime to be read along the X-axis against the 10 per cent and 90 per cent verticals, in conjunction with the TIME/DIV control.

If the risetime of your scope is comparable with that of the signal, then substantial reading errors will occur; e.g. a 1:1 ratio of signal-to-scope risetime gives a 40 per cent error. In comparison, a scope risetime that is ten times faster than the signal reduces the error to a negligible 0.5 per cent.

An amplifier system that can reproduce more harmonics, linearly and in phase, will give shorter risetimes, higher bandwidths and better results. Other effects such as overshoot, undershoot and droop may be caused by capacitive coupling and stray capacitances in amplifier stages.

## PROBES

The connecting lead between a circuit under test and the oscilloscope forms an important link in the quest for meaningful measurements. Because they are used to probe about in the circuit under test, these leads are generally called "probes".

Passive probes incorporate only passive components such as capacitors and resistors and usually attenuate the incoming signal. On the other hand, there are active probes that provide amplification. If d.c. voltages are being measured, the input connection gives no problem provided the scope input impedance (often standardised at 1MΩ) is much greater than that of the signal source.

However, when a.c. voltages are being measured, stray capacitances, in the

coaxial cable for instance, will heavily load the signal, especially at high frequencies. If possible, it is better to measure at a low-impedance point in a circuit to reduce the load on the input of the oscilloscope. When this is not feasible, then a 10:1 passive probe can be used to compensate for the cable capacitance.

It is important that screened cable is used for the probe connection, otherwise interference, such as mains hum, radio signals or the local taxi service, could play havoc with your measurements.

Always check the specifications of the probe carefully to see that it is suitable for the task in hand. Remember that a 50MHz probe used with a 50MHz scope gives a combined bandwidth that is less than 50MHz - the probe capacitance is added to that of the scope and the combined risetime will be increased.

For higher frequencies, up to 650MHz, f.e.t. (field effect transistor) probes are available with very low input capacitance (1.5pF), suitable for measuring fast transients in high impedance circuits.

Current probes, using sensing transformers in the probe tip, are also available to enable current measurements to be made without the need to break into a circuit.

## LOOKING FOR DETAIL

Earlier, the X MAGN control was mentioned. This magnifier enables the signal detail to be enlarged by a factor of ten. In

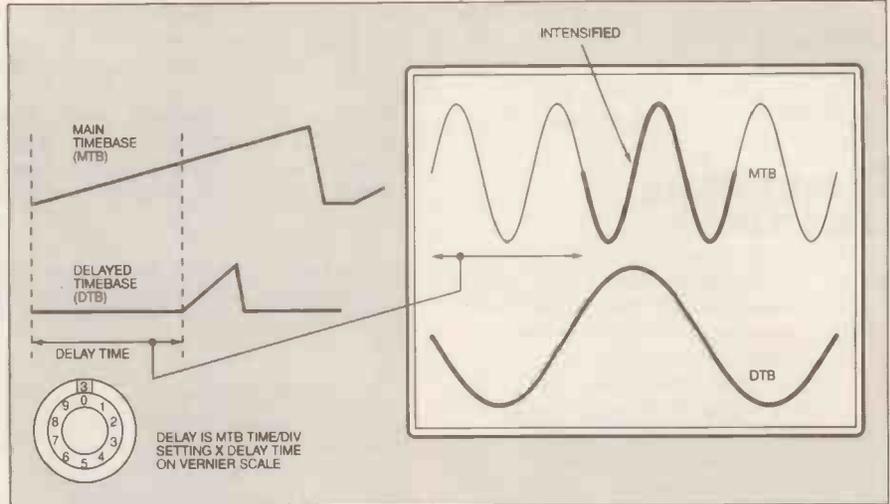


Fig. 10. Delayed timebase showing expanded display of main timebase.

addition to this facility, many scopes have a delayed timebase (DTB) that enables parts of the main timebase (MTB) sweep to be selected and amplified to show even greater signal detail.

The controls are similar to those shown in the X section of the basic controls diagram in Fig. 5, but also includes a DELAY TIME control with a vernier scale for accurate location of the point on the MTB at which the DTB starts (see Fig. 10).

The length of the MTB part to be expanded for examination is determined by the setting of the DTB TIME/DIV setting.

This part is intensified by the electron beam. A d.c. voltage set by the DELAY TIME control generates the DTB by comparison with the MTB sweep voltage. The DTB starts when the two voltages are equal. By means of the ALT-mode, the intensified part of the MTB trace and its expanded form, the DTB trace, can both be displayed, as shown.

## NEXT MONTH

In the concluding part of this article next month, we discuss oscilloscope applications and experiments, and take a look at storage scopes.

# FREE CATALOGUE

THINK COMPONENTS - THINK CRICKLEWOOD

- TELEVISION & VIDEO SPARES ● RESISTORS & CAPACITORS ● HI-FI GADGETS & SPEAKERS
- TRANSISTORS & I.C.'s ● AUDIOPHILE CAPACITORS
- IN CAR AUDIO ● COMPUTER BOARDS ● TOOLS & TEST EQUIPMENT ● PLUGS SOCKETS & LEADS



PLEASE SEND ME A COPY OF THE CRICKLEWOOD CATALOGUE.

Name.....

Address.....

EPE

PRICES HELD INTO 1996

Cricklewood Electronics Ltd, 40-42 Cricklewood Broadway, London NW2 3ET. Tel: 0181-450 0995 Fax: 0181-208 1441

## WE HAVE THE WIDEST CHOICE OF USED OSCILLOSCOPES IN THE COUNTRY

PHILIPS PM3295 Dual Trace 350MHz Delay. Cursors.	£2000
H.P. 54200A Digitizing Oscilloscope 50MHz.	£500
TEKTRONIX 485 Dual Trace 350MHz Delay Sweep	£750
TEKTRONIX 475 Dual Trace 200MHz Delay Sweep	£500
TEKTRONIX 465 Dual Trace 100MHz Delay Sweep	£400
TEKTRONIX 3530A Dual Trace 30MHz In TMSOS.	£400
TEKTRONIX 2215 Dual Trace 60MHz Delay Sweep.	£400
TEKTRONIX 2213 Dual Trace 60MHz	£350
HAMEG 705 Dual Trace 70MHz Delay Sweep	£375
HAMEG 605 Dual Trace 60MHz Delay Sweep Component Tester	£450
TEKTRONIX 455 Dual Trace 50MHz	£375
PHILIPS PM3277 Dual Trace 50MHz Delay Sweep.	£400
KILUSI 5530A Dual Trace 35MHz	£220
COULD 051100S1 Dual Trace 30MHz	£200
WATSU S55702 Dual Trace 20MHz	£200
COULD 05300 Dual Trace 10MHz Delay Sweep.	£200
HITACHI V109 Dual Trace 20MHz Mono/Battery	£400
PHILIPS PM497 Dual Trace 50MHz SCOPEMETER Dig. Storage	£400
25M/Samples	£1000
LEADER LCD100 DMM/SCOPE 200kHz Digital Storage LCD	£450
TEKTRONIX 468Dual Trace 100MHz Delay Sweep Digital Storage	£750
HITACHI VC6041 Dual Trace 40MHz Dig. Storage	£650
COULD 1425 Dual Trace 20MHz Digital Storage Cursors/Interface	£450
H.P. 1741A Dual Trace 100MHz Analogue Storage.	£400
TEKTRONIX 434 Dual Trace 25MHz Analogue Storage	£250

### THIS IS JUST A SAMPLE - MANY OTHERS AVAILABLE

H.P. 8620C Sweep Oscilloscope with 86290B 2-18GHz	£2000
H.P. 8655A Syn. Sig. Gen. 0-1-390 MHz	£90
MARCONI 2022 AM/FM Sig. Gen. 10kHz-1GHz	£1600
MARCONI 2019 Synthesised AM/FM Sig. Gen. 80kHz-1040MHz	£1900
H.P. 8640A AM/FM Sig. Gen. 80kHz-1040MHz	£750
H.P. 8620C Sweep Oscillator Main Frame only	£200
RACAL 9081 Syn. AM/FM Sig. Gen. 5MHz-520MHz	£450
MARCONI TF237A Dig. Fct. Meter 20Hz-20kHz 0.05% un-used	£225
MARCONI TF893B Audio Power Meter Snad.	£250
MARCONI TF2163 Attenuator DC-1GHz	£100
H.P. 8495B Attenuator DC-18GHz-0.70dB in 100B Steps	£350
HATFIELD 2105 Attenuator 50 Ohm	£75
MARCONI 2305 Modulation Meter.	£2250
R.S. 51000 Noise Meter UPSF2 with UPSF2E2 40Hz-10MHz	£1500
WITRON 6E10A Programmable Sweep Gen. 1kHz-2GHz	£1500
W&G Selective Level Meter SPV411 with PSE11	£90
H.P. 4277A LCZ Meter with Test Fixture.	£90
R&S VHF Field Strength Meter type HFV 25MHz-300MHz	£250

### BRUEL & KJOER EQUIPMENT AVAILABLE - PLEASE ENQUIRE

SPECTRUM ANALYSERS	
H.P. 8556A 0.015GHz-22GHz	£4000
TAKEDA RIKEN CR4122B 100kHz-1500MHz	from £3000
H.P. 182 with 8558B 100kHz-1500MHz	from £1700
H.P. 1411 with 8555A & 8552B 10kHz-180kHz	£1500
H.P. 1411 with 8554B & 8552B 500kHz-1250MHz	£1200
H.P. 1411 with 8553B & 8552A 1kHz-110MHz	£900
H.P. 3580A SHZ-50kHz	£800
MARCONI TF2370 30Hz-110MHz	£1000
MARCONI 82 100kHz-400MHz	£90A

Used Equipment - Guaranteed. Manuals supplied if possible. This is a VERY SMALL SAMPLE OF STOCK. SAE or telephone for lists. Please check availability before ordering. CARRIAGE all units £16. VAT to be added to Total of Goods and Carriage.

**STEWART OF READING**  
110 WYKHAM ROAD, READING, BERKS RG6 1PL  
Tel: 01734 268041 Fax: 01734 351696

### STABILOCK 4021 RADIO TEST SET ONLY £800

H.P. 5342A Counter 24GHz HP/B	£1750
H.P. 5340A Counter 10Hz-18GHz	£750
MARCONI 2435 Frequency Meter 10Hz-2GHz	£500
RACAL 1998 Freq. Counter 13GHz (optons GPIB & High Stab)	£900
RACAL/DANA 1991 Universal Counter/Timer 160MHz 9 digit.	£800
MARCONI 2437 Universal Counter/Timer DC - 100MHz 8 digit.	£175
RACAL 9916 Frequency Counter 10Hz-520MHz	£175
RACAL 9905A Universal Counter/Timer 10Hz-200MHz	£250
SOLARTRON 7150 6 1/2 digit DMM with REC.	£350
SOLARTRON 7045 4 1/2 digit Multimeter Volts/Amms/Ohms	£80
FLUKE 8842A Digital Multimeter	£700
FLUKE 45 Digital Multimeter	£375
FLUKE 77 Handheld DMM 3 1/2 digit with case	£100
FLUKE 8050A Bench/Portable DMM 4 1/2 digit True RMS	£225
FLUKE 8010A Bench/Portable DMM 3 1/2 digit True RMS	£150
COULD J38 Sine/Square Oscillator 10Hz-100kHz	£150
FEEDBACK FG600 Sine/Sq/Tri	£60
FARNELL LF1 Sine/Square Osc. 10Hz-1MHz	£75
FARNELL LMF1 Sine/Square Osc. 10Hz-1MHz	£50
THANDER TC501 Func. Gen. 0.005Hz-5MHz Sine/Sq/Tri/Ramp/Pulse/etc	£175
THANDER TC502 as TC501 with Sweep Facilities.	£275
UNAD-AM EP501 Audio Analyser	£350
PHILIPS PM5555 Waveform Monitor	£200
PHILIPS PM6917 Video Line Selector	£200
FERRORGRAPH RT52 Recorder Test Set	£250
AWA F242A Distortion Noise Meter	£400
LEADER LSC216 Standard Signal Generator	£450
KEMO Dual Variable Filter V97/B 0-1Hz-10kHz	£200
MARCONI TF2700 Universal Bridge. Battery Operated	from £150
WAYNE KERR 6424 Digital Component Meter LDR	£200
SORENSEN DCR600-4.5B 0-800V. 0-4-5A	£700
H.P. 8268 0-40V. 0-30A	£500
THURLEY PL320 0-30V. 0-2A Digital	£100
FARNELL L30-5 0-30V. 0-2A Two Meters	£150
FARNELL L30-2 0-30V. 0-2A Twice	£160
FARNELL L30-1 0-30V. 0-1A Twice	£80
FARNELL L30-1 0-30V. 0-1A Metered	£150
FARNELL L30-1 0-30V. 0-1A Metered	£85
BRANDENBURG Model 472R +/- 2kV Metered	£200

### MANY OTHER POWER SUPPLIES AVAILABLE

### NEW EQUIPMENT

HAMEG OSCILLOSCOPE HM1005 Tripe Trace 100MHz Delay Timebase	£847
HAMEG OSCILLOSCOPE HM604 Dual Trace 60MHz Delay Sweep	£653
HAMEG OSCILLOSCOPE HM303 Dual Trace 30MHz Comp. Tester	£492
HAMEG OSCILLOSCOPE HM205-3 Dual Trace 20MHz Digital Storage	£653
All other models available - all oscilloscopes supplied with 2 probes	
BLACK STAR EQUIPMENT (P&P all units ESI)	
APOLLO 10 100MHz Counter/Timer Ratio/Period/Time Int. etc.	£284
APOLLO 100 100MHz as above with more functions.	£332
1325 FREQUENCY/PERIOD COUNTER 1-3GHz	£149
JUPITOR 500 FUNCTION GEN. 0-1Hz-500kHz Sine/Sq/Tri	£125
ORION COLOUR BAR GENERATOR Pal/TV/Video	£243
All other Black Star equipment available	
OSCILLOSCOPE PROBES Switched X10 (P&P ESI)	£15

# SURVEILLANCE

## PROFESSIONAL QUALITY KITS

# No. 1 for Kits

Whether your requirement for surveillance equipment is amateur, professional or you are just fascinated by this unique area of electronics SUMA DESIGNS has a kit to fit the bill. We have been designing electronic surveillance equipment for over 12 years and you can be sure that all our kits are very well tried, tested and proven and come complete with full instructions, circuit diagrams, assembly details and all high quality components including fibreglass PCB. Unless otherwise stated all transmitters are tuneable and can be received on an ordinary VHF FM radio.

**Genuine SUMA kits available only direct from Suma Designs. Beware inferior imitations!**

### UTX Ultra-miniature Room Transmitter

Smallest room transmitter kit in the world! Incredible 10mm x 20mm including mic. 3V-12V operation. 500m range..... £16.45

### MTX Micro-miniature Room Transmitter

Best-selling micro-miniature Room Transmitter. Just 17mm x 17mm including mic. 3V-12V operation. 1000m range..... £13.45

### STX High-performance Room Transmitter

High performance transmitter with a buffered output stage for greater stability and range. Measures 22mm x 22mm, including mic. 6V-12V operation, 1500m range. £15.45

### VT500 High-power Room Transmitter

Powerful 250mW output providing excellent range and performance. Size 20mm x 40mm. 9V-12V operation. 3000m range..... £16.45

### VXT Voice-Activated Transmitter

Triggers only when sounds are detected. Very low standby current. Variable sensitivity and delay with LED indicator. Size 20mm x 67mm. 9V operation. 1000m range. £19.45

### HVX400 Mains Powered Room Transmitter

Connects directly to 240V A.C. supply for long-term monitoring. Size 30mm x 35mm. 500m range..... £19.45

### SCRX Subcarrier Scrambled Room Transmitter

Scrambled output from this transmitter cannot be monitored without the SCDM decoder connected to the receiver. Size 20mm x 67mm. 9V operation. 1000m range..... £22.95

### SCLX Subcarrier Telephone Transmitter

Connects to telephone line anywhere, requires no batteries. Output scrambled so requires SCDM connected to receiver. Size 32mm x 37mm. 1000m range..... £23.95

### SCDM Subcarrier Decoder Unit for SCRX

Connects to receiver earphone socket and provides decoded audio output to headphones. Size 32mm x 70mm. 9V-12V operation..... £22.95

### ATR2 Micro-Size Telephone Recording Interface

Connects between telephone line (anywhere) and cassette recorder. Switches tape automatically as phone is used. All conversations recorded. Size 16mm x 32mm. Powered from line..... £13.45

### UTLX Ultra-miniature Telephone Transmitter

Smallest telephone transmitter kit available. Incredible size of 10mm x 20mm! Connects to line (anywhere) and switches on and off with phone use. All conversation transmitted. Powered from line. 500m range..... £15.95

### TLX 700 Micro-miniature Telephone Transmitter

Best-selling telephone transmitter. Being 20mm x 20mm it is easier to assemble than UTLX. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. 1000m range..... £13.45

### STLX High-performance Telephone Transmitter

High performance transmitter with buffered output stage providing excellent stability and performance. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. Size 22mm x 22mm. 1500m range..... £16.45

### TKX900 Signalling/Tracking Transmitter

Transmits a continuous stream of audio pulses with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m. Size 25mm x 63mm. 9V operation..... £22.95

### CD400 Pocket Bug Detector/Locator

LED and piezo bleeper pulse slowly, rate of pulse and pitch of tone increase as you approach signal. Gain control allows pinpointing of source. Size 45mm x 54mm. 9V operation..... £30.95

### CD600 Professional Bug Detector/Locator

Multicolour readout of signal strength with variable rate bleeper and variable sensitivity used to detect and locate hidden transmitters. Switch to AUDIO CONFORM mode to distinguish between localised bug transmission and normal legitimate signals such as pagers, cellular, taxis etc. Size 70mm x 100mm. 9V operation..... £50.95

### QTX180 Crystal Controlled Room Transmitter

Narrow band FM transmitter for the ultimate in privacy. Operates on 180MHz and requires the use of a scanner receiver or our QRX180 kit (see catalogue). Size 20mm x 67mm. 9V operation. 1000m range..... £40.95

### QLX180 Crystal Controlled Telephone Transmitter

As per QTX180 but connects to telephone line to monitor both sides of conversations. 20mm x 67mm. 9V operation. 1000m range..... £40.95

### QSX180 Line Powered Crystal Controlled Phone Transmitter

As per QLX180 but draws power requirements from line. No batteries required. Size 32mm x 37mm. Range 500m..... £35.95

### QRX 180 Crystal Controlled FM Receiver

For monitoring any of the 'Q' range transmitters. High sensitivity unit. All RF section supplied as pre-built and aligned module ready to connect on board so no difficulty setting up. Output to headphones. 60mm x 75mm. 9V operation..... £60.95

**A build-up service is available on all our kits if required.**

UK customers please send cheques, POs or registered cash. Please add £1.50 per order for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send Sterling Bank Draft and add £5.00 per order for shipment. Credit card orders welcomed on 01827 714476.

**OUR LATEST CATALOGUE CONTAINING MANY MORE NEW SURVEILLANCE KITS NOW AVAILABLE. SEND TWO FIRST CLASS STAMPS OR OVERSEAS SEND TWO IRCS.**

## ★★★ Specials ★★★

### DLTX/DLRX Radio Control Switch

Remote control anything around your home or garden, outside lights, alarms, paging system etc. System consists of a small VHF transmitter with digital encoder and receiver unit with decoder and relay output, momentary or alternate, 8-way d.i.l. switches on both boards set your own unique security code. TX size 45mm x 45mm. RX size 35mm x 90mm. Both 9V operation. Range up to 200m.

Complete System (2 kits)..... £50.95  
Individual Transmitter DLTX..... £19.95  
Individual Receiver DLRX..... £37.95

### MRX-1 Hi-Fi Micro Broadcaster

Not technically a surveillance device but a great idea! Connects to the headphone output of your Hi-Fi, tape or CD and transmits Hi-Fi quality to a nearby radio. Listen to your favourite music anywhere around the house, garden, in the bath or in the garage and you don't have to put up with the DJ's choice and boring waffle.

Size 27mm x 60mm. 9V operation. 250m range..... £20.95

**SUMA  
DESIGNS**

DEPT. EE  
THE WORKSHOPS, 95 MAIN ROAD,  
BAXTERLEY, NEAR ATHERSTONE,  
WARWICKSHIRE CV9 2LE  
VISITORS STRICTLY BY APPOINTMENT ONLY



**Tel/Fax:  
01827 714476**

# HOME TELEPHONE LINK

MICHAEL McLOUGHLIN



A low-cost "personal" home phone-link, with a range of up to one kilometre.

Nowadays, the earphone is usually a small loudspeaker, with an impedance of anything up to 200 ohms. We shall use a small speaker, but stick to 8 ohms impedance, to assist with availability.

**A** TELEPHONE is a fairly easy thing to make. An exchange is more complicated, but to start with, you don't need one!

Two telephones will talk to each other quite happily without an exchange. Such an arrangement is called a telephone link. This article will describe suitable telephones, and show how to link two of them together.

The microphone has always been the critical component in the telephone. For 100 years the carbon type was used. This relies on carbon granules (fine grains), packed between two electrodes. The granules are compressed and released by sound waves, and the resistance between the electrodes varies accordingly.

Connect this type of microphone in series with a magnetic earphone, and you have a telephone. To use it, see Fig. 1.

- Microphone • Earphone • Bell (or other sounder) • Dial (or other signalling device) • Switch, to control d.c. supply.

## MICROPHONE

The modern electronic telephone uses the 10mm diameter condenser microphone (mic.). (Condenser is the old word for capacitor). This mic. is small, sensitive, well shielded, and requires little power. It is also cheap, and readily available.

It works on the electret principle, but to lower the output impedance a f.e.t. (field effect transistor) has been incorporated. This has three consequences. First, polarity has to be respected. Second, the current drawn is not greatly affected by voltage applied, so long as this is in the permitted range of 1.5V to 9V. Finally, the mic. constant current shows considerable variation from one specimen to another. It can be anything from 100µA to 400µA.

Normal speech originating 50mm (2in.) from the mic. superimposes on this a signal current with peaks of ±5µA, producing ±50mV peaks if the series resistor, as shown in Fig. 2, is 10 kilohms. The

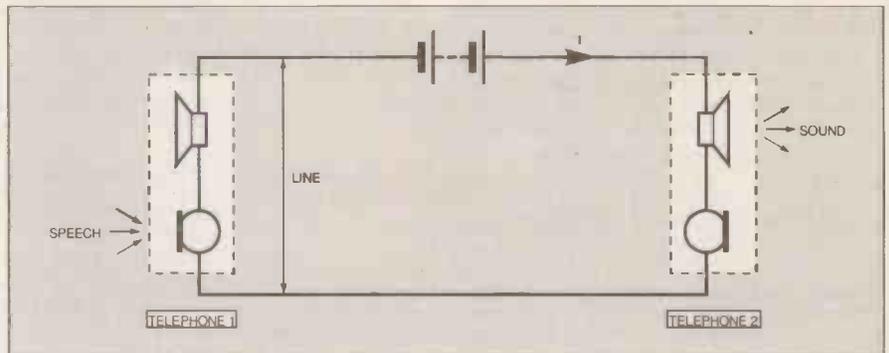


Fig. 1. Simultaneous two-way communication. Speech at either microphone modulates the circulating current, reproducing the sound in both earphones.

condenser mic. is robust, but it has to be handled with care when attaching leads to it, as in Fig. 2.

Output impedance of the circuit in Fig. 2 is just the 10k resistor. When connected correctly, the traditional carbon mic. produces about ten times the output voltage, with only one hundredth of the output impedance. This means ten thousand times more signal power! Plainly, the electret mic. will need an amplifier, to boost output.

The chosen speaker requires an audio signal of ±50mV on peaks, to deliver good telephone sound. That is just the voltage produced by the condenser mic. But try driving 8Ω from a 10k source impedance!

In a "two-station" telephone link the destination of the call is obvious, so the dial is unnecessary. The bell can be replaced by a buzzer, and the cheapest type is an electromechanical type.

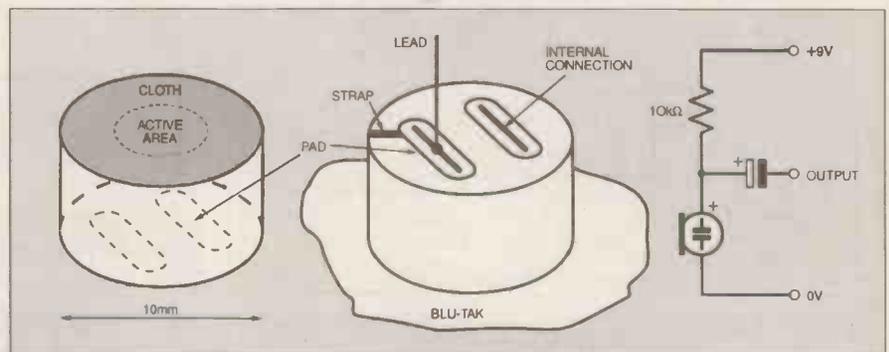


Fig. 2. Condenser (electret) microphone. The negative terminal is identified by the strap which connects it to the case. Two pads are provided for leads. These are loaded with solder, which conceals the internal connections shown. To solder a lead, press the mike into some Blu-tack. Then melt the solder on the pad, and stand a vertical wire outside the internal connection, as drawn. To lift the mic. from the Blu-tack, rock gently. Output is taken from a series resistor, as indicated.

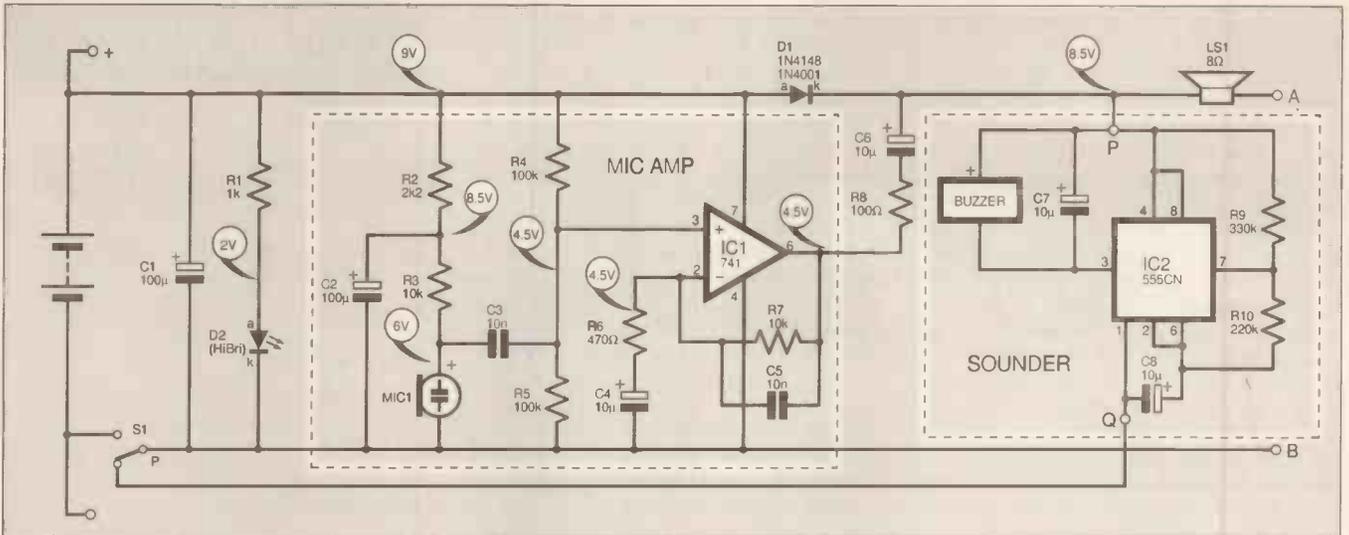


Fig. 4. Complete Home Telephone link Circuit diagram. The voltages marked should appear when the phone is lifted, if the test meter negative lead is connected to the B wire. Nothing should be attached at A and B. Speaking into the mic. should raise the voltage at P.

This buzzer produces the sound by hammering, in the traditional manner, but an internal transistor replaces the usual contact breaker. As a result, polarity is again important, and the positive lead is red.

### SWITCHING

As the telephone link will only be used occasionally, and there should be no standby current, operation from a 9V battery is convenient. This suggests a 6V buzzer, as its permitted supply voltage is anything from 4.5V to 9V. But a switch will be needed to control the supply.

In early phones the user operated this switch, but that is a recipe for disaster. It is much too easy to forget to switch off, and that soon leaves a dead phone.

So the gravity switch was invented: when the phone is hung up or laid down, its weight automatically switches off the power. Nowadays every phone has a gravity switch.

A microswitch can do this job very well and was adopted in this design. But its operation is still checked by including an l.e.d. As dialling is superfluous, picking up your phone ought to sound the far buzzer at once. In fact, a single microswitch can

control both the d.c. power and the buzzer, as in Fig. 3.

### CIRCUIT OPERATION

Suppose that the phone shown in Fig. 3 is lifted, altering the position of the micro-switch S1. Then d.c. is applied to the line via the diode, and the distant phone buzzer sounds. The pulses of current drawn by that buzzer flow through the local speaker, producing a useful ringing tone.

When the distant phone is lifted, its buzzer is disconnected. The stronger battery then takes control of the voltage on the A wire, biasing the remote diode into non-conduction. Speech voltages are rectified by the remaining diode, and promptly bias it out of conduction also, leaving the line as the only circuit left open for speech currents.

Because of its negative feedback the mic. amplifier will have a very low output impedance (milliohms). Thus the output voltage delivered by the amplifier has no difficulty driving signal current down the line and through both speakers. At the far end the signal current flows easily to ground, via the low output impedance of the local amplifier.

### PRACTICAL CIRCUIT

The full circuit diagram for the Home Telephone Link is shown in Fig. 4. This circuit is repeated for the distant phone.

The loudspeakers need 50mV on peaks, which requires only 6mA of signal current. That is well inside the 10mA current limit of the ever popular 741 op.amp, so it can be used to drive the speakers!

However, there is a snag. In the circuit of Fig. 3, just 16 ohms of line resistance is enough to cut the received signal voltage in half. Standard indoor telephone cable has a loop resistance (there-and-back) of 20 ohms per 100 metres, so that is about the maximum range.

Spectacular improvement occurs if a 100 ohms resistor is inserted in series with capacitor C6. To deliver the same signal current the 741 has now to produce 13½ times as much output voltage, but that only requires a gain adjustment.

With the 100 ohm resistor in place, the loop line resistance must now be twice 108 ohms to divide the received voltage by two. This gives a line length of 1.1km. By improving line matching, the extra resistor has multiplied the range of the Telephone Link by 13½ times.

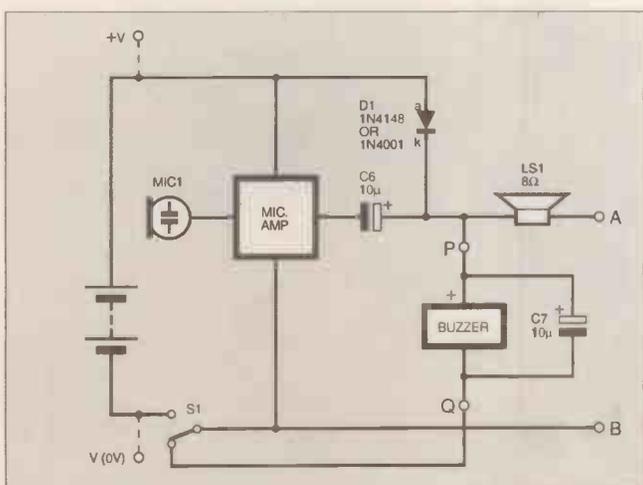


Fig. 3. Telephone with automated calling. The line connects A and B to the same points on the distant phone. When the phone is not in use, the gravity switch S1 adopts the position shown. For the dotted connections see the text.



The completed prototype phone, built on stripboard.

It is tempting to insert a larger resistor, but then the 741 output voltage starts to approach its limits, at least if the battery is getting old. A weaker speech signal could of course be heard over much longer distances. But the buzzer used here sets a definite limit: with a 9V supply it fails at line lengths over 1km.

The buzzer in Fig. 3 has capacitor C7 in parallel. This helps to provide the 60mA current pulses required, particularly if the battery is old or the line is long.

However, it is clear that the two components between P and Q could be replaced by any other calling system that works on d.c. For example, a 555 and buzzer could be inserted here, to simulate the international ringing cadence. This is one second of sound, followed by three seconds of silence, and it is also used in the UK on internal exchanges.

Generating a ringing cadence allows the caller to listen to the ringing tone, instead of having to control the ringing on his microswitch. More decisively, inclusion of the 555 also deals with the following difficulty.

Refer to the circuit of Fig. 3. When the conversation is finished, one user will put down their phone before the other. This reproduces the calling situation (one phone lifted and one not). The result is that the first person to put down the phone receives a loud buzz, which lasts until the other phone is put down.

This could be tolerated, because the users know each other. But using the 555 to generate a ringing cadence eliminates the difficulty. There is a five second delay between applying voltage to the 555 and the buzzer sounding, and that interval is more than sufficient to allow both parties to lay down their phones. Unexpected final buzzes disappear.

## ON-LINE

The most expensive part of a telephone system is the line to the user. So this is rarely more than two wires. However, 2-wire indoor cable is not so easy to buy,

and anyway it is not much cheaper than the standard 4-wire cable. If 4-wire cable is used, paralleling of conductors would double the range.

A more interesting possibility is to use the extra pair to carry the battery supply from one telephone to the other. Then only one phone need carry a battery.

If the line is less than 500 metres in length, 4-wire cable should be considered. It confers a repetitive saving on batteries, at the cost of a comparable one-off additional sum spent on the cable.

To use 4-wire cable, find the terminals, plus (+) and minus (-) which are shown dotted in Fig. 3, and use the extra pair to connect these terminals to their mates on the other phone (+ to +). Either phone can carry the single battery required.

This brings us to the final circuit of Fig. 4, which includes the 555 timer IC2.

## CONSTRUCTION

You will need to make two phones, but the work is light. Many things take longer to describe than to carry out. A basic method of construction is given as a guide.

The construction of the Telephone Link requires two identical printed circuit boards (p.c.b.s), one for each phone. This p.c.b. is available from the *EPE PCB Service*, as a pair, code 997.

The topside p.c.b. component layout and full size copper foil master pattern are shown in Fig. 5. The lever-operated microswitch S1 is mounted on the board trackside, as can be seen in the photographs.

Commence construction by first carefully cutting the p.c.b. to the shape indicated in Fig. 5 – the larger cutout is to locate the battery in the box and the two smaller ones aid wiring and provide some “elastic” support for the speaker when finally shutting the case on completion.

For the “handset” enclosure a box with a transparent lid was used, this allowed the operating l.e.d. to be seen without having to drill any holes in the lid. To slide this box open, apply end-to-end finger pressure on the upper and lower faces.

# COMPONENTS

## Resistors

R1	1k
R2	2k2
R3, R7	10k (2 off)
R4, R5	100k (2 off)
R6	470Ω
R8	100Ω
R9	330k
R10	220k

All 0.25W 5% carbon film

## Capacitors

C1, C2	100μ axial elect. 10V (2 off)
C3, C5	10n disc ceramic, lead pitch 5mm (2 off)
C4, C6, C7, C8	10μ axial elect. 10V (4 off)

## Semiconductors

D1	1N4148 signal diode or 1N4001 rec. diode
D2	5mm high brightness red l.e.d.
IC1	741 op.amp
IC2	555CN timer

## Miscellaneous

MIC1	electret microphone insert, 10mm dia.
LS1	8 ohm 38mm dia. moving coil loudspeaker
S1	lever-operated sub-miniature microswitch
WD1	6V electromechanical buzzer
B1	9V PP3 type battery, with clips

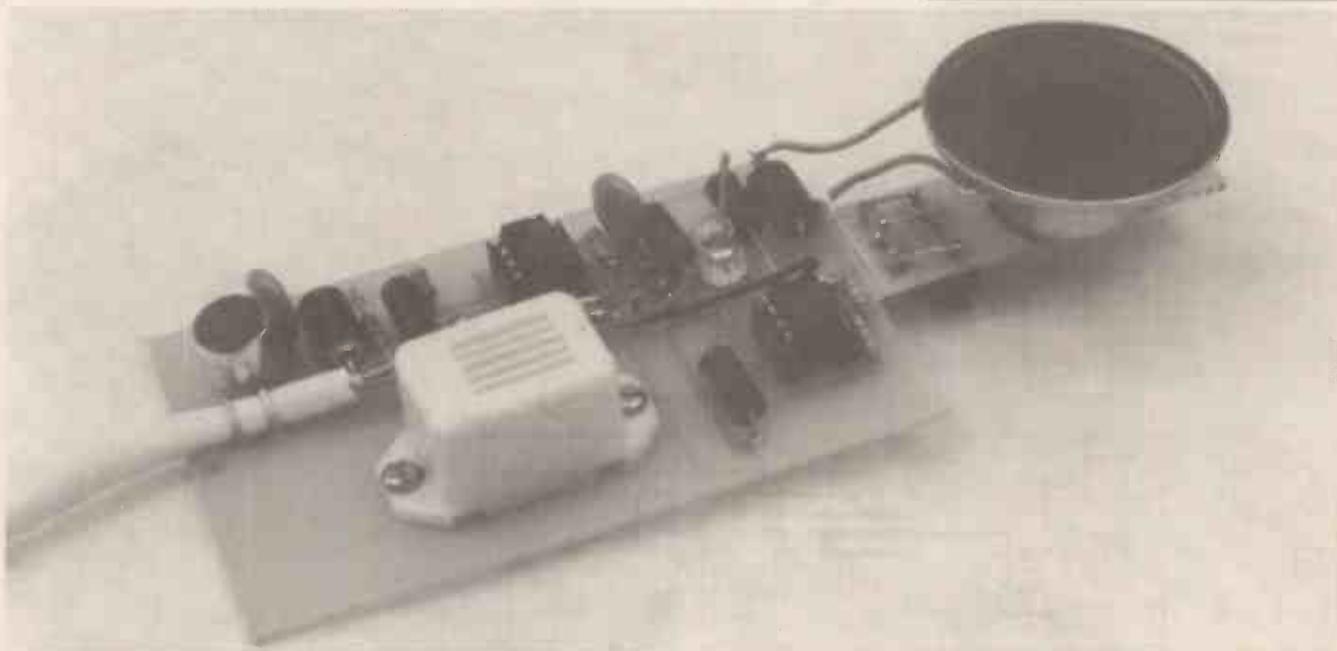
Printed circuit board available as a pair from *EPE PCB Service*, code 997; plastic case, with transparent lid, size approx. 141.5mm x 57mm x 23.5mm; 8-pin d.i.l. socket (2 off); 4-way terminal block; 4-way (or 2-way) indoor telephone cable; M2.5 screws 12mm (2 panel and 2 cntsk); M2.5 nuts (4 off); M2.5 washers (2 off); aluminium strip; solder pins; solder etc.

(2 sets required – one for each phone)

Approx Cost  
Guidance Only

# £21

per phone (excluding cable)



The first prototype phone built on a printed circuit board. This prototype was not intended to be housed in a case so the microphone and buzzer were mounted directly on the p.c.b. When inserted in the case, the p.c.b. has to be cut to take the battery, the microphone mounted inside the lid and the buzzer on the outside of the case.

The base section has a 1mm rail on each side intended to support the circuit board about 1mm above the box floor. You may need to rub down the edges of the p.c.b., with fine sandpaper, to obtain a snug fit on the support rails.

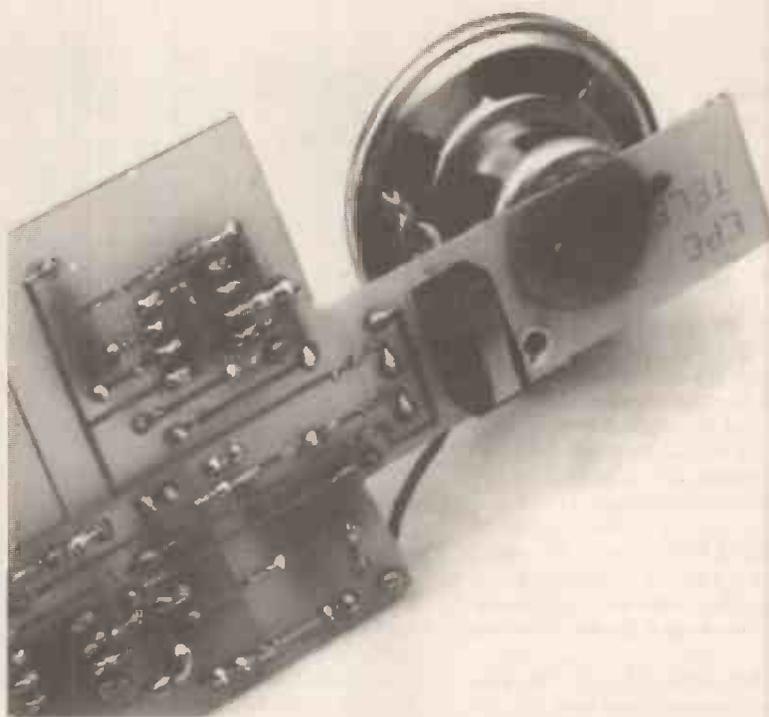
Identify the two blind holes nearest to the right hand edge on the p.c.b. and drill them out to 3mm diameter. Rest the p.c.b. on its support rails in the base of the box, and use the same drill to make two holes in the base of the box, directly beneath the p.c.b. holes. Before drilling, back the box with a wooden strip to prevent sudden breakthrough damaging the box.

Back to the p.c.b. Position the link wires and two d.i.l. sockets and solder in place. Next, the resistors and two disc ceramic capacitors should be mounted on the board.

The axial type electrolytic capacitors, diode and the l.e.d. should follow next. Particular care should be taken to get their polarities the right way round. The cathode (k) of the l.e.d. is indicated by a "flat" on its body, and it is the shorter lead.

Use clear glue to stick the microswitch to the copper track side, at the "flexi" end, of the board with the actuating lever pointing down. On the component side, solder short insulated connecting leads to microswitch pins and take the "free" ends to the required copper pads on the p.c.b.

Glue the loudspeaker in position, with its connections as indicated in Fig. 5. Be sure that the speaker does not overhang the right hand edge of the p.c.b. or it will not fit into the case.



The lever-operated microswitch is mounted on the copper track side of the p.c.b. The pole (p) of the switch connects to line B. Note the position of the loudspeaker.

Next, cut and strip a 20cm length of indoor telephone cable, to provide a supply of fine wire. Cut a two metre length of cable, connect its wires according to the colours suggested, and then tie it to the

board with the fine wire as indicated in Fig. 5. Cut the leads on the battery clip to 5cm length, and fix it.

Referring back to Fig. 2, solder to the microphone two fine wires 10cm in length

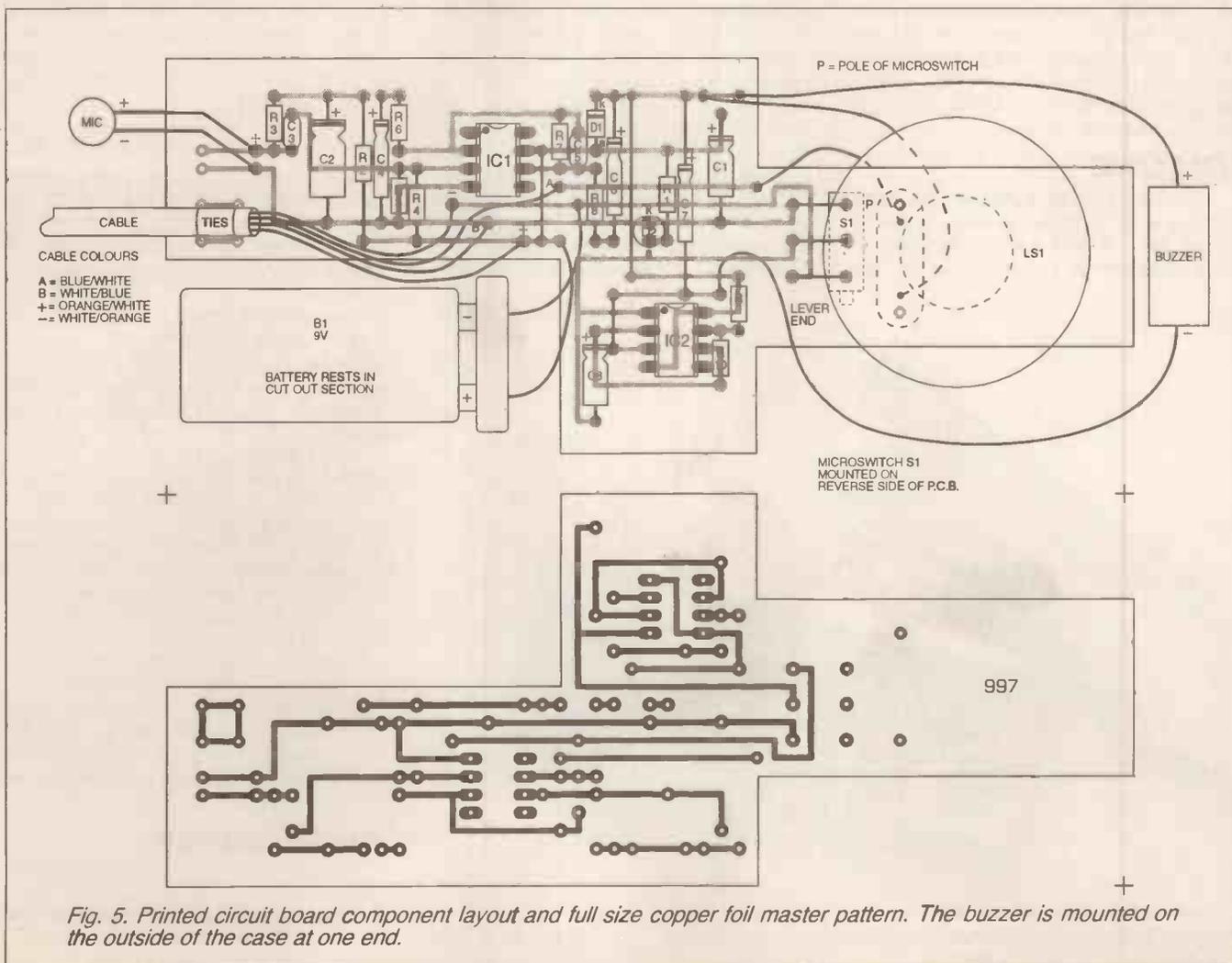


Fig. 5. Printed circuit board component layout and full size copper foil master pattern. The buzzer is mounted on the outside of the case at one end.

respecting polarity, solder these wires to their copper pads on the p.c.b. Temporarily connect the buzzer.

## TESTING

Before boxing your phone, you can test it as follows. Connect the four wires of its cable to a piece of terminal block, and at the block add a 10 $\mu$ F capacitor from the A wire to the B wire (+ goes to A).

Connect the battery, in series with a current meter. When the phone is lifted, the l.e.d. should light. Current should be around 10mA, and fingering the pad on the mike should produce noises in the speaker.

Whether the phone is lifted or not, joining the two lower connections on the microswitch should cause the buzzer to sound, after a five-second delay. It draws an average current of 30mA. Disconnect the battery before proceeding.

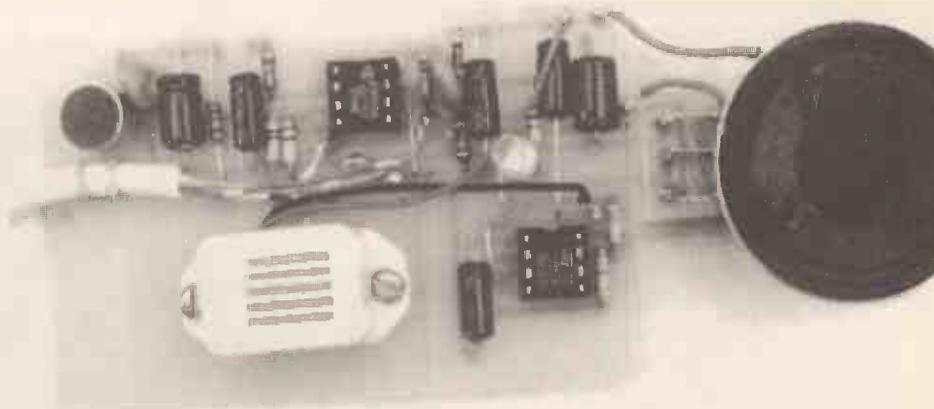
## BOXING-UP

When working on the box, remember: Before drilling, back the box with wood, to prevent sudden breakthrough. Do not use a punch to start holes! Use a compass point, or a track-break tool, used for cutting copper tracks on stripboard.

Rest the board on the rails, with its two holes lined up against those in the box. Use a marker pen to draw on the outside of the box the outline of the microswitch. Now use drills and files to produce a rectangular aperture for the microswitch, leaving about 1mm clear all round to assist later assembly.

Use screws to fix the buzzer on the outside end of the box, symmetrically between the two holes in the box floor. Fix it as near to the floor as possible, to prevent fouling of its leads as they enter the box through a third hole near the rim of the loudspeaker. Holes of 3mm diameter are suitable, with M2.5 screws. It is helpful to drill out to 4mm the holes in the buzzer.

Now start work on the upper section of the box (the lid). Draw on paper a square of 10mm, and cut it out. Use Blu-tack to fix it centrally on the outside of the lid,



*The microphone insert and buzzer are not mounted on the p.c.b. in the final version. The board is carefully cut to make space for the battery and the microphone is glued to the inside lid of the case – see below.*

with its edge 15mm from the open end. Mark the box at each corner of the square.

Remove the paper, and add by eye a mark at the centre of the square. Drill 3mm diameter holes at all five points, to allow sound to escape from the loudspeaker. Then drill a 3mm hole in the end wall of the lid, and enlarge it to 5mm to carry the external cable.

## MICROPHONE

Drill a 3mm hole in the lid for the mic., centred 10mm from the insides of the nearby walls. Unsolder the microphone leads from the board, used when "testing", and straighten them to serve as a handle. Make a small pool of clear glue, and rotate the microphone in it so that just the side walls are generously covered.

Place the microphone centrally on the prepared hole, and use a matchstick to push the glue down to meet the box material. You can bring up extra glue on the match. There must be a complete seal all round, to prevent audio feedback.

Place the board on its rails, so that the microswitch drops through its hole. Remove the terminal block, and thread the "line" cable through the 5mm hole in the side.

Solder the mic. leads back on to their connecting pins (+ to +), in such a way that they will not tangle with the cable when the box is closed. Solder the buzzer to its pins.

Connect the cable once more to the terminal block. After that is safely done, connect the battery, fold its leads, and place it in the box. To extinguish the l.e.d., rest the phone on the table.

If you wish to hang the phone on the wall rather than rest it on a table, cut a strip 10mm by 86mm from 16s.w.g. aluminium sheet. Use two countersunk 12mm screws M2.5 to attach this strip to box and circuit board, using the holes already prepared.

The phone will now hang on two panel pins driven into the wall at 30 degrees to the horizontal, centred exactly 70mm apart. Alternatively, cut a strip 35mm high from an unwanted plastic card in your wallet, and use that.

Now prepare to close the box. To do this, it is necessary to depress the speaker. The resultant pressure between speaker and lid produces a partial seal when the box is closed, providing good audio coupling to the ear. The depression required is easy to achieve, if the specified 38mm dia. loudspeaker is used. The 40mm diameter speaker supplied by RS is less suitable, as it has an additional 1mm depth.

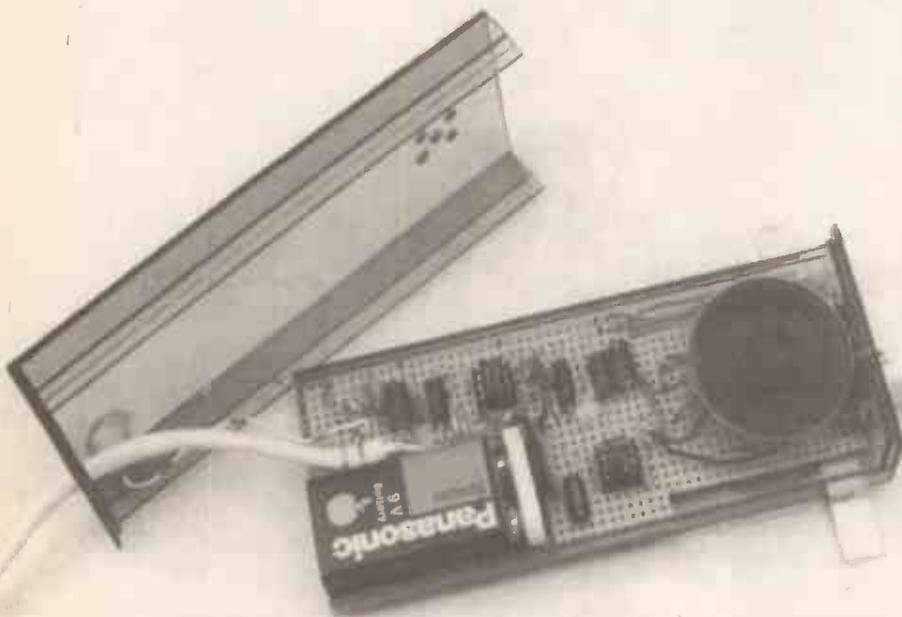
Do not slide the lid shut, as its leading edge may catch the speaker cone, and strip it from the metal rim. To close the box, proceed more carefully, as follows.

Lower the lid slowly towards the base section, so that the box will be mostly closed when lid and base meet. Aim to leave uncovered just one quarter of the speaker cone. While the two sections are approaching, encourage the 10cm microphone leads to fold tidily down the side of the box, and gradually extract the surplus of telephone cable.

Continue to press down on the lid, keeping one quarter of the speaker uncovered, until the lid clicks into place. Carefully slide the box shut. To open the box, cautiously slide open the lid, as far as the mic. leads permit, and then gently prise it upwards at its leading edge.

## INSTALLATION

The terminal block on the cable can be attached to the skirting board, and the fixed line can run from there, with the cable held by clips at 230mm (9in.) intervals. Where a portable link is desired, a simpler arrange-



*Prototype stripboard version mounted inside the specified case, with transparent lid. Note the positions of the microphone and buzzer.*

ment is allowable – wire both phones directly to a 100 metre drum of cable.

If 4-wire cable is used, the second phone does not need a battery or clip, and its board does not need a cut-out for the battery. If the phone is not to hang on the wall, omit the two holes in the board and the box floor.

## STANDARD TELEPHONES

Standard (BT) telephones derive their operating current from the exchange battery, and use different voltage parameters, and include a tone-based signalling system. Further, they are superior to those described here in three other ways. Their range is greater. This is because line matching is more sophisticated, and because the sounders used need much less current than our buzzer. Second, sidetone (what you hear of your own voice) is reduced, for your comfort, and to make you speak up. Thirdly, the phone senses the length of the line to the exchange, by noting how much current it is receiving, and the output signal is adjusted accordingly.

To produce a similar ringing cadence to a standard phone, the circuit diagram shown in Fig. 6 can be used. This replaces the components between points P and Q in Fig. 4. You will, of course, have to design your own small circuit board to take the components.

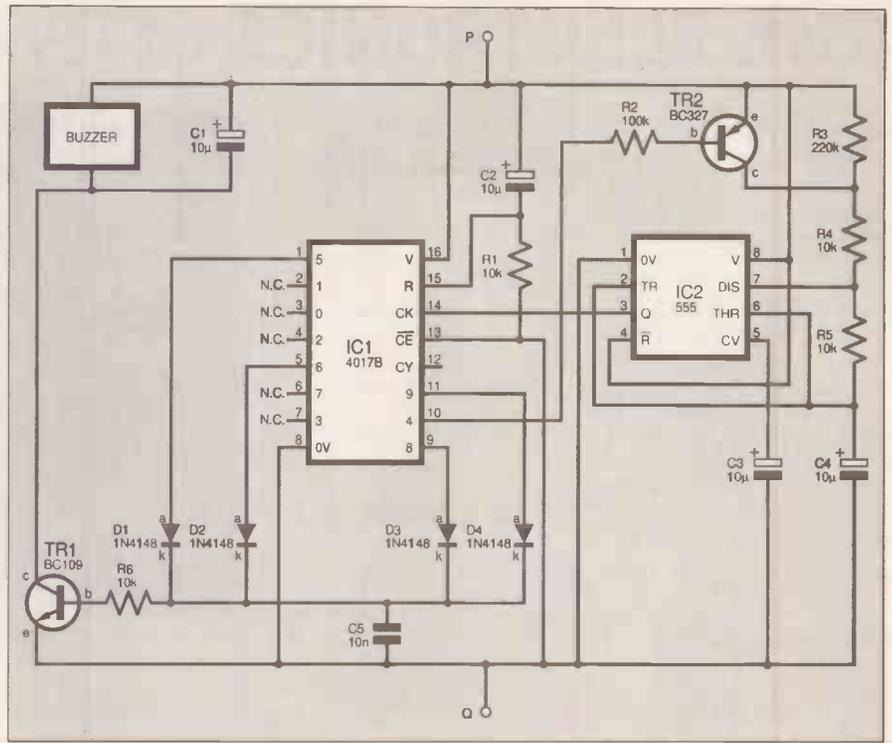


Fig. 6. Circuit for producing the familiar BT ringing cadence. The 555 timer period is 0.2 sec., and the 4017 IC1 sounds the buzzer at counts 5 + 6 and 8 + 9. Count 4 is stretched. This circuit replaces components between points P and Q in Fig. 4 if required.



## IF AN ADVERT IS IN PRINT, IS IT PROPER?

Most advertisements are legal, decent, honest and truthful. A few are not, and, like you, we want them stopped.

If you would like to know more about how to make complaints, please send for our booklet: 'The Do's and Don'ts of Complaining'. It's free.

The Advertising Standards Authority.

We're here to put it right. ✓

ASA Ltd., Dept. Z., Brook House, Torrington Place, London WC1E 7HN.  
This space is donated in the interests of high standards of advertising.

## SHERWOOD ELECTRONICS

### FREE COMPONENTS

Buy 10 x £1 Special Packs and choose another one FREE

SP1	15 x 5mm Red Leds	SP118	2 x Cmos 4047
SP2	12 x 5mm Green Leds	SP119	4 x Cmos 4072
SP3	12 x 5mm Yellow Leds	SP124	20 x Assorted ceramic disc caps.
SP6	15 x 3mm Red Leds	SP125	10 x 1000/16V radial elect caps.
SP7	12 x 3mm Green Leds	SP130	100 x Mixed 0.5W C.F. resistors
SP8	10 x 3mm Yellow Leds	SP131	2 x TL071 Op.amps
SP10	100 x 1N4148 diodes	SP135	6 x Min. slide switches
SP11	30 x 1N4001 diodes	SP137	4 x W005 1.5A rectifiers
SP12	30 x 1N4002 diodes	SP138	20 x 2.2/50V rad. elect. caps.
SP13	20 x Assorted radial elect. caps.	SP142	2 x Cmos 4017
SP18	20 x BC182 transistors	SP144	3 x TIP31A transistors
SP19	20 x BC183 transistors	SP145	6 x ZTX300 transistors
SP20	20 x BC184 transistors	SP147	5 x Stripboard 9 strips/25 holes
SP21	20 x BC212 transistors	SP151	4 x 8mm Red Leds
SP22	20 x BC214 transistors	SP152	4 x 8mm Green Leds
SP23	20 x BC549 transistors	SP153	4 x 8mm Yellow Leds
SP24	4 x Cmos 4001	SP156	3 x Stripboard, 14 strips/27 holes
SP25	.4 x 555 timers	SP160	10 x 2N3904 transistors
SP26	4 x 741 Op.amps	SP161	10 x 2N3906 transistors
SP28	4 x Cmos 4011	SP162	10 x 100K hor. trimpots
SP29	4 x Cmos 4013	SP165	2 x LF351 Op.amps
SP33	4 x Cmos 4081	SP167	6 x BC107 transistors
SP36	25 x 10/25V radial elect caps	SP168	6 x BC108 transistors
SP37	15 x 100/35V radial elect caps	SP173	10 x 220/25V rad. elect. caps
SP39	10 x 470/16V radial elect caps	SP175	20 x 1/63V radial elect caps
SP41	20 x Mixed transistors	SP182	20 x 4.7/50V radial elect caps
SP42	200 x Mixed 0.25W C.F. resistors	SP183	20 x BC547 transistors
SP47	5 x Min. pushbutton switches	SP187	15 x BC239 transistors
SP48	12 x Assorted axial elect. caps.	SP192	3 x Cmos 4066
SP102	20 x 8-pin DIL sockets	SP193	20 x BC213 transistors
SP103	15 x 14-pin DIL sockets	SP194	10 x OA90 diodes
SP104	15 x 16-pin DIL sockets	SP195	3 x 10mm Yellow Leds
SP105	5 x 74LS00		
SP106	5 x 74LS02		
SP112	4 x Cmos 4093		
SP115	3 x 10mm Red Leds		
SP116	3 x 10mm Green Leds		
SP117	15 x BC556 transistors		

### RESISTOR PACKS – C.Film

RP3	5 each value – total 365 0.25W	£2.40
RP7	10 each value – total 730 0.25W	£3.75
RP10	1000 popular values 0.25W	£6.00
RP4	10 5 each value-total 365 0.5W	£3.40
RP8	10 each value-total 730 0.5W	£6.00

Catalogue £1 inc. P&P or FREE with first order.

P&P £1.25 per order. NO VAT.

Orders to:  
**Sherwood Electronics,**  
7 Williamson St., Mansfield,  
Notts. NG19 6TD.

# THE ELECTRONICS SERVICE MANUAL

ESM

## ESM IS ABOUT ELECTRONICS AND ELECTRONIC EQUIPMENT, EXPLAINING:

- What it is • How it works • How to test it • How to take it apart
- How to find faults • How to fix it

## OFFERING:

- Down to earth advice • Vital data • Facts to feast on
- Knowledge at your finger-tips

T

## TOPICS COVERED:

- TV • Audio • Video • Computers • Disk drives • Techniques
- Test gear • Workshops • Addresses • Pinouts • Symbols • Safety
- Logos • Tools • Data • etc

W

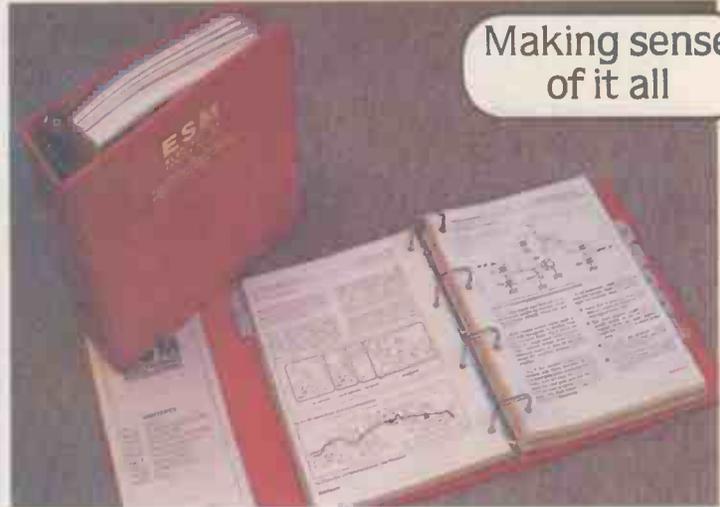
## WHO IT'S FOR:

- Across the board appeal!
- Ideal for: Technicians • Engineers • Students • Hobbyists

L

## LITERARY MERIT:

- Authoritatively written • Clearly presented • Highly readable
- A living library in words, drawings and photographs



S

## SUPPLEMENTS

Detailed technical servicing notes on various types of equipment are covered in the quarterly Supplements, plus additional valuable information for other sections of the Manual

F

## FREE

We will send you the latest Supplement FREE with your Manual

P

## PRICES

Manual only £39.95 plus P&P  
Over 850 A4 pages edited by Mike Tooley. Supplied in robust ring binder. Latest Supplement included FREE. 24-hour despatch  
Supplements £23.50 plus P&P  
Approximately 160 pages of facts and data in each Supplement

G

## GUARANTEE

Our NO-QUIBBLE MONEY-BACK GUARANTEE gives you *complete peace of mind*. If you are not entirely happy with the Manual or its Supplements, for whatever reason, simply return to us in good condition (within 30 days for the Manual, 10 days for Supplements) and we will make a FULL REFUND of your payment. (Overseas buyers do have to pay the postage charge.)

H

## HOW TO OBTAIN ESM

Order now! – just fill in the order form.  
Or, to find out more about ESM, ring, fax or write to:

**Wimborne Publishing Ltd, Dept. Y6**  
**Allen House, East Borough, Wimborne,**  
**Dorset BH21 1PF**

Tel: 01202 881749 Fax: 01202 841692

## ELECTRONICS SERVICE MANUAL COVERAGE AND CONTENTS

### SAFETY

Safety practices, life-saving techniques, legal requirements

### UNDERPINNING KNOWLEDGE

Electronics theory, component theory & functions, circuit techniques, fault diagnosis, detailed equipment principles

### PRACTICAL SKILLS

Component identification, avoiding static, soldering & component replacement techniques

### TOOLS AND EQUIPMENT

Choosing tools & test gear, workshop practice, optimising test equipment

### SERVICING TECHNIQUES

The Supplements include detailed guidelines on how to service specific types of electronic equipment

### TECHNICAL NOTES

Detailed examination of how specific types of electronic equipment work

### REFERENCE DATA

Detailed tables of specifications for semiconductors, including pinouts

### USEFUL ADDRESSES

Manufacturers' & suppliers' addresses, including logos

### INDEX

Itemised key subjects in the Manual and individual Supplements

## PRIORITY ORDER FORM

## PLEASE URGENTLY SEND ME

Item	Cost	Postage	Total
ESM Manual	£39.95	£	£
One Supplement free with Manual	FREE	FREE	£0.00
Payment in £ Sterling only		Total	£

## POSTAGE CHARGES

Postal Region	Manual	
	Surface	Air
UK	£5.50	–
Eire, Scottish Highlands and UK Islands	–	£11
Europe (EEC)	–	£20
Europe (Non-EEC)	£20	£26
USA & Canada	£25	£32
Far East & Australia	£31	£33
Rest of World	£25	£44

Note: Surface mail can take over 10 weeks to some parts of the world. Each Manual weighs about 4kg when packed.

Full name: .....

(BLOCK CAPITALS PLEASE)

Address: .....

.....

.....

..... Post code: .....

Telephone Number: .....

I enclose cheque/PO payable to WIMBORNE PUBLISHING LTD

Please charge my Access (Mastercard)/Visa card. Expiry date.....

Card No: .....

(Please advise cardholder's address if different from above)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Please send this form (or copy) to: Wimborne Publishing Ltd, Dept. Y6, Allen House, East Borough, Wimborne, Dorset BH21 1PF

# FAX ON DEMAND

**EVERYDAY**

**PRACTICAL**

# ELECTRONICS

# ON FAX

## WHY WAIT?

**We Give You The Fax!**

Projects and Series  
From the Past Year's  
Issues of *EPE*

**AVAILABLE INSTANTLY!  
24 HOURS A DAY!**

## WHAT IS EVERYDAY PRACTICAL ELECTRONICS ON FAX?

**H**AVE you ever wanted to get hold of past project or part of a Teach-In series fast? *EPE ON FAX* is a new service aimed at providing you with the article you need on-demand, seven days a week, 365 days a year, 24 hours a day.

All the projects and major series from the past year have been stored on computer and linked to a sophisticated selection system that uses the latest voice and Fax technology. You can select the article you require from a menu and have it downloaded to your Fax machine on demand.

The service will be constantly updated with new material as each issue is published, thus providing a live, instantly available, resource covering the latest *EPE* articles.

- 1 Call the *EPE ON FAX* system from the handset of your Fax machine. The handset must be switched to "tone".
- 2 Following voice prompts, select either an index of articles, or a specific article by known article number (if you have previously received the index), from the keypad on your Fax machine or connected handset.
- 3 *EPE ON FAX* delivers your choice of article to your Fax machine, complete with cover sheet, while you wait.



## HOW TO USE *EPE ON FAX*

- From your Fax machine call 0897 124 125, making sure that your handset is switched to "tone". You will then hear a series of messages, which will help to guide you through the system.
- For one of the available indexes, which contain the document numbers and the number of pages of each article, press "1" when prompted.
- To obtain a particular document, press "2" when prompted and, when requested, enter the document number you want from the keypad on your Fax machine. The system will then confirm your selection.
- When you have selected the document that you require, you will then be prompted to press the Start or Receive button on your Fax machine. Please make sure that you hear a definite Fax squeal before you press Start.

## HOW MUCH WILL IT COST?

*EPE ON-FAX* service is a higher rate premium line phone service. Calls cost £1.50 a minute.

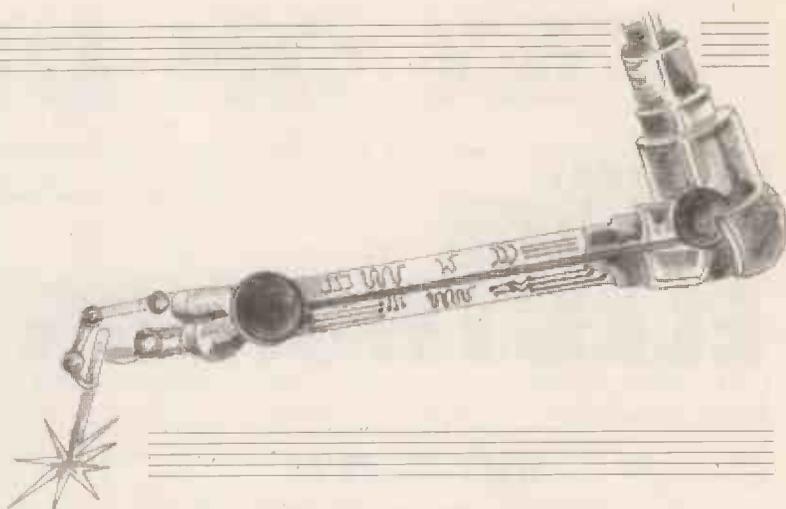
## FURTHER INFORMATION

If you would like further information about how this project was put together, ring Starcomm Limited on (0113) 2940600.

**TRY IT NOW! CALL 0897 124 125**

# CIRCUIT SURGERY

ALAN WINSTANLEY



Hot on the heels of the last Surgery, we follow up with more analysis of the "single resistor" 555 astable, we take the lid off R-C snubbers and look at suppressor capacitors, too.

## 555 Astable – Fun With!

IN April's *Circuit Surgery* I made a minor but obvious blooper, which I attribute to a memory parity error on my part! My thanks to regular reader *Barry Taylor* of Rickmansworth who sets the record straight, keeps me on my toes and adds several very interesting extras. I've redrawn the astable oscillator circuit in question, see Fig. 1. Mr. Taylor writes:

*I was pleased to see your note that a bipolar 555 configured as in April's Fig. 3b cannot give a 50 per cent duty cycle. This will probably surprise many readers because a few other texts insist that this type of astable will indeed give an equal mark-to-space ratio.*

*The problem is that although the low period is 0.693RC (usually quoted as 0.7RC), the "high" period is longer in this circuit because the voltage available to charge the capacitor is less than the full supply voltage. Thus the capacitor takes longer to charge from 1/3 Vcc to 2/3 Vcc than it would with the CMOS version. The voltage drop is due to the Darlington pair used in the upper half of the 555 output stage, and a figure of 1.35V drop is reasonable.*

*Calculator ready, here's how the "high" period for this circuit is figured out:*

$$T_{HIGH} = -RC_{LN} \left[ \frac{\frac{2V_{cc}}{3} - (V_{cc} - 1.35)}{\frac{V_{cc}}{3} - (V_{cc} - 1.35)} \right]$$

( $T_{HIGH}$  being the high period,  $LN$  being the natural log,  $V_{cc}$  is the supply rail voltage).

For  $V_{cc}$  of +5V, I calculate  $T_{HIGH}$  is 1.83 RC, duty cycle 72.5 per cent and the frequency is  $0.396 \div RC$ . For a 15V rail,  $T_{HIGH}$  is 0.863 RC and yields a 55.5 per cent duty cycle.

However, I didn't follow your note regarding how the CMOS 7555 high-input impedance allows a 50 per cent duty cycle to be generated (p.268). Surely the reason is that the 7555 output "high" voltage is equal to  $V_{cc}$ ?

Many thanks for the lucid explanation, and you're right of course – the input impedance has little influence on the duty

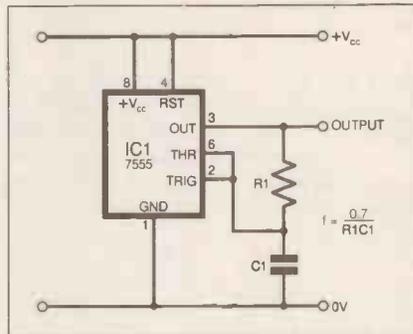


Fig. 1. A CMOS 555 astable.

cycle obtained; sorry about the blooper. An important feature of the CMOS 7555 chip is that its output switches from rail to rail.

The bipolar type is handicapped by the fact that, due to its internal circuitry, its "high" output is always two diode drops below the positive supply rail. So the *most* you'll get out of a vanilla 555 with a 5V rail is typically about +3.8V. A 7555 will offer +4.5V or more.

Referring to Fig. 2, if you use the bipolar 555 in the "single resistor" astable circuit, you can't get a 50 per cent duty cycle (if it matters) for this reason: the chip has a threshold voltage (which pin 6 looks for) of two-thirds  $V_{cc}$ . When the capacitor's charging up, the output is high for this period.

In a classical two-resistor 555 astable, the capacitor charges from the full supply

rail voltage. If you have a 10V rail, say, the threshold voltage is +6.66V; so when this voltage is reached, the chip switches over internally and its output goes low.

## Different Strokes

Now, if you're charging the capacitor  $C1$  from the *output* pin instead, in the bipolar's case this is always *lower* than the supply rail by about 1.4V. But the chip's threshold voltage is still the *same*, +6.66V.

Because the capacitor charges exponentially (on a curve), it must take progressively longer for it to charge up to +6.66V from a 8.6V rail (i.e. 77 per cent of the applied voltage) than it does from a 10V rail (66 per cent). Hence, the output high time is longer for a bipolar than a CMOS 7555 and you can never achieve a 50 per cent duty cycle. That's why the CMOS 7555 is sometimes a better bet.

There are times when the CMOS and the bipolar 555 timer chips do behave as quite different animals. When launched, the CMOS timer was claimed to be a direct plug-in replacement for the bipolar version.

This proved not to be so, and the fact that the NE555 is still soldering on means that there's plenty of life yet in the old warhorse. One key area concerns the amount of "clout" a 555 chip can deliver.

I remember using the CMOS 7555 for the first time in the mid 1980s and it soon became apparent that in my own circuits, all was not well. The CMOS chip had

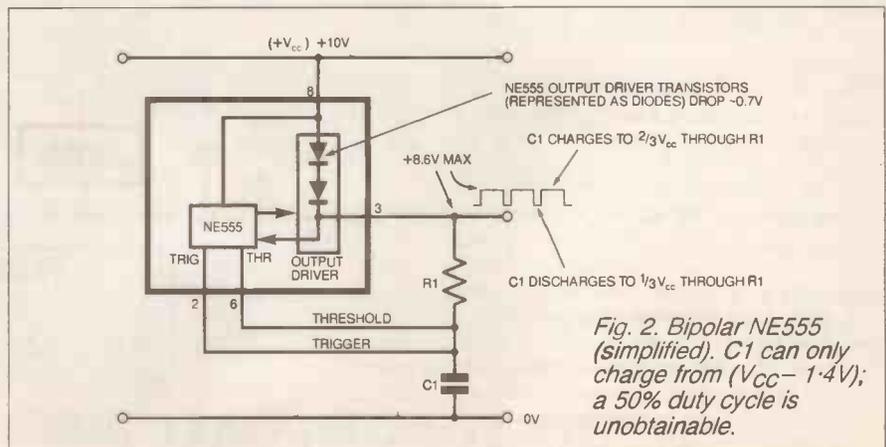


Fig. 2. Bipolar NE555 (simplified).  $C1$  can only charge from  $(V_{cc} - 1.4V)$ ; a 50% duty cycle is unobtainable.

a worse specification for output current sourcing, and I found bizarre behaviour such as the output voltage dropping if I tried to draw anything more than a few tens of milliamps.

It wouldn't drive relays very well. It really needs buffering with a driver transistor (or driver i.c.) on the output if you plan to do spectacular things with it. The bipolar type is more useful in this respect and can sink or source up to 200mA.

Of course, the CMOS type can operate reliably at higher frequencies (2MHz compared with a few hundred kHz) and it has a lower supply current than its bipolar brother (about 0.3mA compared with the bipolar's 6.0mA). It's horses for courses, but at least you now know why they're a bit different.

## Wheatstone's Origins

Also following on from April's issue, Mr. Taylor adds: "It is often forgotten that Wheatstone did not invent the arrangement which bears his name. S.H. Christie described it in 1833 and it was used by Wheatstone with improvements in 1847."

My thanks to Mr Norman Spivey of the University of York who sent the following E-mail:

Dear Alan, I am very grateful for the CMOS 555 astable circuit in your article. I like circuits which do the same for less! I found that it modulated an LC v.h.f. oscillator just by connecting it to the same battery - no need to use the output pin!

Also, your UK Sources FAQ is an excellent source of addresses etc. which I am now storing on my PC, using a text editor to search for names when necessary.

Thanks! Several readers asked for the document to be E-mailed and we happily obliged. It can be stored on hard disk for future reference, or it prints out at over 20 pages.

By the way, April's issue contains ordering details for those wishing to purchase a printed copy. The UK Sources FAQ (Frequently Asked Questions) is also posted into the Internet newsgroup sci.electronics.components quarterly. The next one is due in June 1996.

## Relay Contact Suppression

I know that several G.P.O. (for younger readers, General Post Office - BT's predecessor) engineers read this column and my item on "contact suppressors" (April 1996 issue) prompted the following from Mr. A. Malcolm of Bromsgrove.

I'd like to point out that the practice of fitting RC filters across the contacts can be quite dangerous! It could cause delayed release of relays, for example.

The solution I was taught (G.P.O. RIS.) was to always fit the suppressor across the inductive load. This should "fail safe", i.e. the resistor will go open circuit if the capacitor fails as the resistor can only dissipate a fraction of a watt.

As a matter of interest the suppressor as supplied by the old G.P.O. (Type FS44) was 100 ohms in series with 0.035µF, sealed in a resin pot. This proved very effective in the hundreds of applications I fitted them over the years.

Thank you for your letter, Mr. Malcolm. I hadn't personally experienced any problems in the past by placing these snubbers across relay contacts (which is, after

all, one of their specified applications), and the time constant of the suggested standard RC network (100 ohms and 100nF) is very low indeed - 10µs - so I'd be rather surprised if this delay had any detrimental effect on external circuitry.

There are a few examples where suppressors have to be placed directly across contacts, though - such as audio equipment, switches controlling large inductive loads and certain test equipment. Fig. 3 shows a few applications.

Your point is taken though that it is wise to suppress the source of the interference first, rather than the contacts. One must always be mindful of "worst case" conditions, especially when parts are connected directly across the mains.

## Class Act

Mains-rated capacitors intended for suppression purposes are generally classified as one of two types, see Fig. 4.

- Class X - designed for direct connection across the mains, between Live (Line) and Neutral.

- Class Y - higher spec., for filtering noise and spikes from Live or Neutral, directly to Earth.

Being connected to Earth, Class Y capacitors have a much tighter specification for maximum permitted leakage currents, and strict rules exist for their use, especially in medical equipment filtering.

According to the handy book *Newnes Electronics Toolkit* (Geoff Phillips, ISBN 0-7506-0929-X), Class X types further divide into X1 which are rated for noise pulses exceeding 1.2kV, and X2 class for spikes equal to or less than this level. Be sure to use ONLY Class X or Y mains rated capacitors for DIRECT connection as suppressors across the mains.

Resistors, too, need careful consideration if used in mains-voltage circuits. Whilst you'll often bear in mind the power dissipation value ( $I^2R$ ) for a resistor as a matter of course, it's rare that you have to consider its voltage rating. A rating of 200V a.c. is typical.

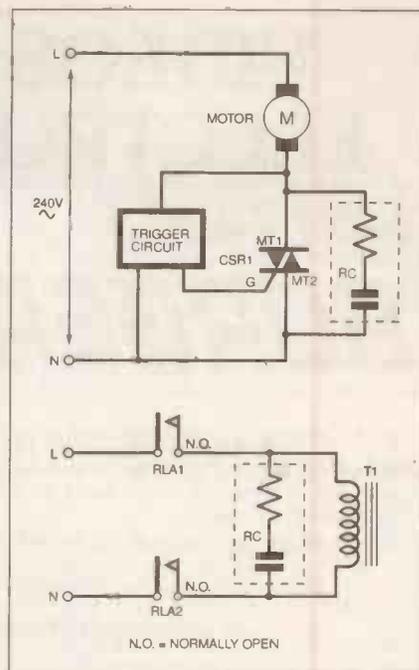


Fig. 3. Typical RC snubber applications

The trick is to use two resistors in series if required, so that the applied a.c. voltage is dropped across both of them, keeping them well within their voltage rating.

An unusual place where filter capacitors may crop up unexpectedly is in the secondary side of power supplies. Very occasionally, a ceramic capacitor may be seen placed across the secondary winding, and even across the rectifiers of a bridge rectifier network. They shunt any spikes, which helps to protect the rectifiers from transients borne on the a.c. supply.

Another source of noise is apparently the rectifier itself. An effect which I believe is "hole storage" noise (I'm open to correction - any offers?) can occasionally arise which may become apparent with audio equipment, for example. I once heard a low frequency crackling/buzzing noise on an amplifier which was only eventually eliminated by adding capacitors around the bridge rectifier.

## Back Next Month!

I'm delighted to say that due to demand, *Circuit Surgery* returns to its regular monthly slot starting next month. This is your column and your chance to have your say! If you have any hints and tips which you'd like to pass on, any questions you'd like to quiz us with - or any topical comments to make, then write in!

Drop a line to Alan Winstanley, *Circuit Surgery*, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. E-mail alan@epemag.demon.co.uk. Send a stamped addressed envelope for a written reply.

For Internet users, you'll also see a new regular column appearing which is geared specially towards the electronics enthusiast, which is penned by yours truly and deals with Internet, World Wide Web and general connectivity issues. A lot is going on at the moment in this area, here at EPE... watch this space!

Next Month: I hope to follow up with a few more 555 circuit hints, plus a look at current sources and capacitor charging curves.

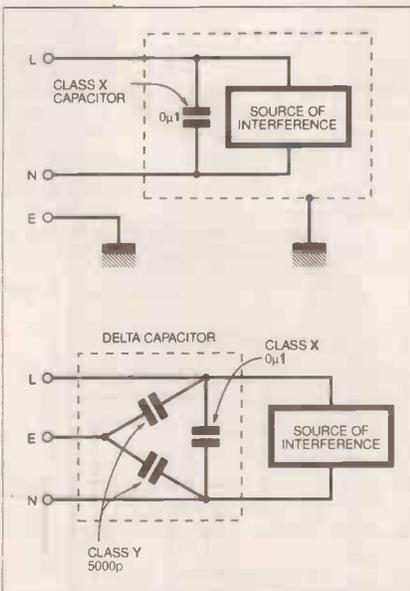


Fig. 4. Suppressor capacitors help prevent interference generated by equipment, feeding into the mains supply, and reduce electromagnetic interference.

# VIDEOS ON ELECTRONICS

A range of videos designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They have proved particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc.



## BASICS

VT201 to VT206 is a basic electronics course and is designed to be used as a complete series, if required.

VT201 54 minutes. Part One; D.C. Circuits. This video is an absolute must for the beginner. Series circuits, parallel circuits, Ohms law, how to use the digital multimeter and much more.

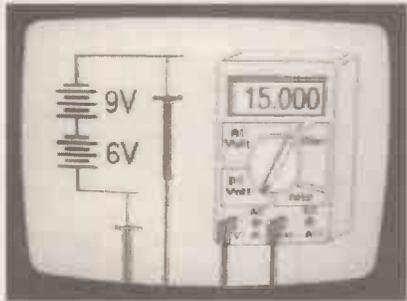
Order Code VT201

VT202 62 minutes. Part Two; A.C. Circuits. This is your next step in understanding the basics of electronics. You will learn about how coils, transformers, capacitors, etc are used in common circuits.

Order Code VT202

VT203 57 minutes. Part Three; Semiconductors. Gives you an exciting look into the world of semiconductors. With basic semiconductor theory. Plus 15 different semiconductor devices explained.

Order Code VT203



VT204 56 minutes. Part Four; Power Supplies. Guides you step-by-step through different sections of a power supply.

Order Code VT204

VT205 57 minutes. Part Five; Amplifiers. Shows you how amplifiers work as you have never seen them before. Class A, class B, class C, op.amps. etc.

Order Code VT205

VT206 54 minutes. Part Six; Oscillators. Oscillators are found in both linear and digital circuits. Gives a good basic background in oscillator circuits.

Order Code VT206

**£29.95**

each inc. VAT

Order 8 or more get one FREE

Order 16 get two FREE

## VCR MAINTENANCE

VT102 84 minutes: Introduction to VCR Repair. Warning, not for the beginner. Through the use of block diagrams this video will take you through the various circuits found in the NTSC VHS system. You will follow the signal from the input to the audio/video heads then from the heads back to the output.

Order Code VT102

VT103 35 minutes: A step-by-step easy to follow procedure for professionally cleaning the tape path and replacing many of the belts in most VHS VCR's. The viewer will also become familiar with the various parts found in the tape path.

Order Code VT103

## DIGITAL

Now for the digital series of six videos. This series is designed to provide a good grounding in digital and computer technology.

VT301 54 minutes. Digital One; Gates begins with the basics as you learn about seven of the most common gates which are used in almost every digital circuit, plus Binary notation.

Order Code VT301

VT302 55 minutes. Digital Two; Flip Flops will further enhance your knowledge of digital basics. You will learn about Octal and Hexadecimal notation groups, flip-flops, counters, etc.

Order Code VT302

VT303 54 minutes. Digital Three; Registers and Displays is your next step in obtaining a solid understanding of the basic circuits found in today's digital designs. Gets into multiplexers, registers, display devices, etc.

Order Code VT303

VT304 59 minutes. Digital Four; DAC and ADC shows you how the computer is able to communicate with the real world. You will learn about digital-to-analogue and analogue-to-digital converter circuits.

Order Code VT304

VT305 56 minutes. Digital Five; Memory Devices introduces you to the technology used in many of today's memory devices. You will learn all about ROM devices and then proceed into PROM, EPROM, EEPROM, SRAM, DRAM, and MBM devices.

Order Code VT305

VT306 56 minutes. Digital Six; The CPU gives you a thorough understanding in the basics of the central processing unit and the input/output circuits used to make the system work.

Order Code VT306

## RADIO

VT401 61 minutes. A.M. Radio Theory. The most complete video ever produced on a.m. radio. Begins with the basics of a.m. transmission and proceeds to the five major stages of a.m. reception. Learn how the signal is detected, converted and reproduced. Also covers the Motorola C-QUAM a.m. stereo system.

Order Code VT401

VT402 58 minutes. F.M. Radio Part 1. F.M. basics including the functional blocks of a receiver. Plus r.f. amplifier, mixer oscillator, i.f. amplifier, limiter and f.m. decoder stages of a typical f.m. receiver.

Order Code VT402



VT403 58 minutes. F.M. Radio Part 2. A continuation of f.m. technology from Part 1. Begins with the detector stage output, proceeds to the 19kHz amplifier, frequency doubler, stereo demultiplexer and audio amplifier stages. Also covers RDS digital data encoding and decoding.

Order Code VT403

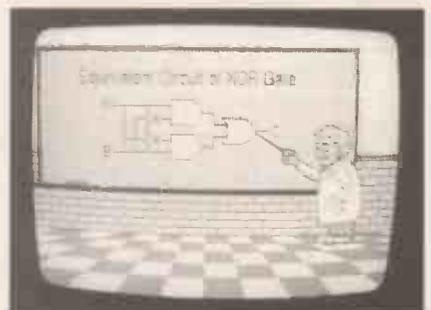
## MISCELLANEOUS

VT501 58 minutes. Fibre Optics. From the fundamentals of fibre optic technology through cable manufacture to connectors, transmitters and receivers.

Order Code VT501

VT502 57 minutes. Laser Technology A basic introduction covering some of the common uses of laser devices, plus the operation of the Ruby Rod laser, HeNe laser, CO<sub>2</sub> gas laser and semiconductor laser devices. Also covers the basics of CD and bar code scanning.

Order Code VT502



Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier. (All videos are to the UK PAL standard on VHS tapes)

**ORDERING:** Add £1.50 p&p per order for UK orders.

**OVERSEAS ORDERS:** Add £3 postage (per order) for countries in the EEC. Overseas orders outside the EEC countries add £3 per tape airmail postage (or £6 per order surface mail postage). All payments in £ sterling only (send cheque or money order drawn on a UK bank). Visa and Mastercard orders accepted - please give card number, card expiry date and cardholder's address if different from the delivery address.

Orders are normally sent within seven days but please allow a maximum of 28 days - longer for overseas orders.

Send your order to: Direct Book Service, 33 Gravel Hill, Merley, Wimborne, Dorset BH21 1RW (Mail Order Only)

Direct Book Service is a division of Wimborne Publishing Ltd.,

Tel: 01202 881749. Fax: 01202 841692

## Everyday Practical Electronics Books



**ELECTRONIC PROJECTS - BOOK 1**  
Published by *Everyday Practical Electronics* in association with *Magenta Electronics*. Contains twenty of the best projects from previous issues of *EE* each backed with a kit of components. The projects are: Seashell Sea Synthesiser, *EE* Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor Interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, *EE* Equaliser Isoliser, Bat Detector, Acoustic Probe, Mains Tester and Fuse Finder, Light Rider - (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, *EE* Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.  
128 pages (A4 size) **Order code EP1** £2.45

**ELECTRONICS TEACH-IN 88/89 - INTRODUCING MICROPROCESSORS**  
Mike Tooley BA (published by *Everyday Practical Electronics*)  
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc. Starting with basic terminology, integrated circuits, logic families and numbering systems the text builds in stages, with revision and assessments built in, up to programming, languages, flow charts, etc. The course is ideal for the newcomer to the subject.  
80 pages (A4 size) **Order code TI- 8/89** £2.45

**ELECTRONICS TEACH-IN No. 6 DESIGN YOUR OWN CIRCUITS**  
(Published by *Everyday Practical Electronics*)  
Mike Tooley BA  
This book is designed for the beginner and

experienced reader alike, and aims to dispel some of the mystique associated with the design of electronic circuits. It shows how even the relative newcomer to electronics can, with the right approach, design and realise quite complex circuits.

Fourteen individual p.c.b. modules are described which, with various detailed modifications, should allow anyone to design and construct a very wide range of different projects. Nine "hands-on" complete DIY projects have also been included so readers can follow the thinking behind design, assembly, construction, testing and evaluation, together with suggested "mods" to meet individual needs. The practical projects have each been designed to stand on their own as complete items of equipment. P.C.B.s for all the modules and projects are available by mail order.

The subjects covered in each chapter of the book are: Introduction and Power Supplies; Small Signal Amplifiers; Power Amplifiers; Oscillators; Logic Circuits; Timers; Radio; Power Control; Optoelectronics.

The nine complete constructional projects are: Versatile Bench Power Supply; Simple Intercom; Bench Amplifier/Signal Tracer; Waveform Generator; Electronic Die; Pulse Generator; Radio Receiver; Disco Lights Controller; Optical Communications Link.  
136 pages (A4 size) **Order code T16** £3.45

**TEACH-IN No. 7 plus FREE Software ANALOGUE AND DIGITAL ELECTRONIC COURSE**  
(Published by *Everyday Practical Electronics*)  
Alan Winstanley and Keith Dye  
B.Eng(Tech)AMIEE

The highly acclaimed *Teach-In* series, which included the construction and use of the *Mini Lab* and *Micro Lab* test and development units, has been put together in book form. Additionally EPT Educational Software have developed a GCSE Electronics software program to compliment the course and a FREE DISC covering the first two parts of the course is included with the book.

files from accidental erasure, a simplified backup process, a screen saver, and a disc cataloguing system.

The Debug program and how it can be used to create, see and change the contents of any file, including those of programs written in assembler code. This includes how to find your way around the names and tasks of the CPU registers and the meeting of some simple assembler mnemonics.  
182 pages **Order code BP319** £4.95

**MULTIMEDIA ON THE PC**  
Ian R. Sinclair

In this book, you'll find out what a CD ROM is, how it works, and why it is such a perfect add-on for a PC, allowing you to buy programmes, text, graphics and sound on a CD. It also describes the installation of a CD ROM drive and a sound card, pointing out the common problems that arise, and then shows how to use them to create a complete multimedia presentation that contains text, photos, a soundtrack with your own voice recorded as a commentary, even animation and edited video footage.  
184 pages **Order code PC112** £11.95

**A CONCISE INTRODUCTION TO MS-DOS**  
N. Kantaris

(Revised Edition Covers Version 6.2)  
This guide is written with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nevertheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.  
176 pages **Order code BP232** £3.95

## DIRECT BOOK SERVICE

*The books listed have been selected by Everyday Practical Electronics editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page. For another selection of books see next month's issue.*

An interesting and thorough tutorial series aimed specifically at the novice or complete beginner in electronics. The series is designed to support those undertaking either GCSE Electronics or GCE Advanced Levels, and starts with fundamental principles.

If you are taking electronics or technology at school or college, this book is for you. If you just want to learn the basics of electronics then this is for you. If you are teaching electronics or technology you must make sure you see it. *Teach-In No. 7* will be invaluable if you are considering a career in electronics or even if you are already training in one. The *Mini Lab* and software enable the construction and testing of both demonstration and development circuits. These learning aids bring electronics to life in an enjoyable and interesting way: you will both see and hear the electron in action! The *Micro Lab* microprocessor add-on system will appeal to higher level students and those developing microprocessor projects.  
152 pages (A4 size) **Order code T17** £3.95

## Computers and Computing

**HOW TO CHOOSE A SMALL BUSINESS COMPUTER SYSTEM**  
D. Weale

This book is for anyone intending to buy an IBM compatible computer system, whether it is their first system or a replacement. There are sections on hardware, application and systems programs and how to actually make your choice as well as sections on the law, ergonomics and a glossary of common terms.

The text contains many useful tips and some warnings (which could save much effort and expense).  
114 pages **Order code BP323** £4.95

**MAKING MS-DOS WORK FOR YOU** (covers version 6.2)  
N. Kantaris & P. R. M. Oliver

This book was written with the busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the book has also been designed to be circular, which means that you don't have to start at the beginning and go to the end.

The book explains: How to write customised batch files which allow you to display what you want on your screen, and in the form and order you want it, instead of being forced to use the DOS prompt on a blank screen. How to design and set up a fast interactive and professional looking menu system, so that you or anyone else can run utility applications or commercial software packages easily. How the ANSI.SYS display and keyboard commands can be used to position the cursor on any part of the screen, change the intensity of the displayed characters or change their colour. How the Edit screen editor or the Edlin line editor can be used to enter ESCape (ANSI.SYS) commands into simple ASCII files to allow control of both your screen display and your printer. How to control the operation of the two main types of printers in use today, Epson compatible dot matrix and HP compatible laser printers. How to use several routines, such as moving and finding files, protecting

**UNDERSTANDING PC SPECIFICATIONS**  
R. A. Penfold (Revised Edition)

If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGAL.  
128 pages **Order code BP282** £4.95

**AN INTRODUCTION TO 6800 ASSEMBLY LANGUAGE**

R. A. & J. W. Penfold  
Obtain a vast increase in running speed by writing programs for 6800 based micros such as the Commodore, Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals.  
112 pages **Order code BP184** £2.95

# Circuits and Design

## PRACTICAL ELECTRONIC FILTERS

Owen Bishop

This book deals with the subject in a non-mathematical way. It reviews the main types of filter, explaining in simple terms how each type works and how it is used.

The book also presents a dozen filter-based projects with applications in and around the home or in the constructor's workshop. These include a number of audio projects such as a rhythm sequencer and a multi-voiced electronic organ.

Concluding the book is a practical step-by-step guide to designing simple filters for a wide range of purposes, with circuit diagrams and worked examples.  
88 pages Order code BP299 £4.95

## ELECTRONIC ALARM CIRCUITS MANUAL

R. M. Marston

One hundred and forty useful alarm circuits, of a variety of types, are shown in this volume. The operating principle of each one is explained in concise but comprehensive terms, and brief construction notes are given where necessary.

Aimed at the practical design engineer, technician and experimenter, as well as the electronics student and amateur.  
124 pages Order code NE11 £13.95

## DIGITAL GATES AND FLIP-FLOPS

Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.  
200 pages Order code PC106 £8.95

## ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS

Robert Penfold

Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kit and a wide range of mechanical components available. The microcontroller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.

The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.  
92 pages Order code BP179 £2.95



## 50 SIMPLE LED CIRCUITS

R. N. Soar

Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components - the light-emitting diode (LED). Also includes circuits for the 707 common anode display.  
64 pages Order code BP42 £1.95

## BOOK 2 50 more I.e.d. circuits.

90 pages

Order code BP87 £1.95

## CIRCUIT SOURCE BOOK 1

A. Penfold

Written to help you create and experiment with your own electronic designs by combining and using the various standard "building block" circuits provided. Where applicable, advice on how to alter the circuit parameters is given.

The circuits covered in this book are mainly concerned with analogue signal processing and include: Audio amplifiers (op amp and bipolar transistors); audio power amplifiers; d.c. amplifiers; highpass, lowpass, bandpass and notch filters; tone controls; voltage controlled amplifiers and filters; triggers and voltage comparators; gates and electronic switching; bargraphs; mixers; phase shifters, current mirrors, hold circuits, etc.

Over 150 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.  
182 pages Order code BP321 £4.95

## A BEGINNER'S GUIDE TO TTL DIGITAL ICs

R. A. Penfold

This book first covers the basics of simple logic circuits

in general, and then progresses to specific TTL logic integrated circuits. The devices covered include gates, oscillators, timers, flip/flops, dividers, and decoder circuits. Some practical circuits are used to illustrate the use of TTL devices in the "real world"

142 pages Order code BP332 £4.95

## CIRCUIT SOURCE BOOK 2

R. A. Penfold

This book will help you to create and experiment with your own electronic designs by combining and using the various standard "building blocks" circuits provided. Where applicable, advice on how to alter the circuit parameters is provided.

The circuits covered are mainly concerned with signal generation, power supplies, and digital electronics.

The topics covered in this book include: 555 oscillators; sinewave oscillators; function generators; CMOS oscillators; voltage controlled oscillators; radio frequency

oscillators; 555 monostables; CMOS monostables; TTL monostables; precision long timers; power supply and regulator circuits; negative supply generators and voltage boosters; digital dividers; decoders, etc; counters and display drivers; D/A and A/D converters; opto-isolators, flip/flops, noise generators, tone decoders, etc.

Over 170 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.  
192 pages Order code BP322 £4.95

## HOW TO USE ORAMPS

E. A. Parr

This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

160 pages Order code BP88 £2.95

# Project Building

## ELECTRONIC PROJECTS FOR EXPERIMENTERS

R. A. Penfold

Many electronic hobbyists who have been pursuing their hobby for a number of years seem to suffer from the dreaded "seen it all before" syndrome. This book is fairly and squarely aimed at sufferers of this complaint, plus any other electronics enthusiasts who yearn to try something a bit different. No doubt many of the projects featured here have practical applications, but they are all worth a try for their interest value alone.

The subjects covered include:- Magnetic field detector, Basic Hall effect compass, Hall effect audio isolator, Voice scrambler/descrambler, Bat detector, Bat style echo location, Noise cancelling, LED stroboscope, Infra-red "torch", Electronic breeze detector, Class D power amplifier, Strain gauge amplifier, Super hearing aid.

138 pages Order code BP371 £4.95

## PRACTICAL FIBRE-OPTIC PROJECTS

R. A. Penfold

While fibre-optic cables may have potential advantages over ordinary electric cables, for the electronics enthusiast it is probably their novelty value that makes them worthy of exploration. Fibre-optic cables provide an innovative interesting alternative to electric cables, but in most cases they also represent a practical approach to the problem. This book provides a number of tried and tested circuits for projects that utilize fibre-optic cables.

The projects include:- Simple audio links, FM, audio link, P.W.M. audio links, Simple d.c. links, P.W.M. d.c. link, P.W.M. motor speed control, RS232C data links, MIDI link, Loop alarms, R.P.M. meter.

All the components used in these designs are readily available, none of them require the constructor to take out a second mortgage.

132 pages Order code B 374 £4.95

## ELECTRONIC PROJECT BUILDING FOR BEGINNERS

R. A. Penfold

This book is for complete beginners to electronic project building. It provides a complete introduction to the practical side of this fascinating hobby, including the following topics:

Component identification, and buying the right parts; resistor colour codes, capacitor value markings, etc; advice on buying the right tools for the job; soldering; making easy work of the hard wiring; construction methods, including stripboard, custom printed circuit boards, plain matrix boards, surface mount boards and wire-wrapping; finishing off, and adding panel labels; getting "problem" projects to work, including simple methods of fault-finding.

In fact everything you need to know in order to get started in this absorbing and creative hobby.

135 pages Order code BP392 £4.95

## 45 SIMPLE ELECTRONIC TERMINAL BLOCK PROJECTS

R. Bebbington

Contains 45 easy-to-build electronic projects that can be constructed, by an absolute beginner, on terminal blocks using only a screwdriver and other simple hand tools. No soldering is needed.

Most of the projects can be simply screwed together, by following the layout diagrams, in a matter of minutes and readily unscrewed if desired to make new circuits. A theoretical circuit diagram is also included with each project to help broaden the constructor's experience and knowledge.

The projects included in this book cover a wide range of interests under the chapter headings: Connections and Components, Sound and Music, Entertainment, Security Devices, Communication, Test and Measuring.  
163 pages Order code BP378 £4.95

## HOW TO DESIGN AND MAKE YOUR OWN P.C.B.S

R. A. Penfold

Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.

80 pages Order code BP121 £2.50

## A BEGINNER'S GUIDE TO MODERN ELECTRONIC COMPONENTS

R. A. Penfold

The purpose of this book is to provide practical information to help the reader sort out the bewildering array of components currently on offer. An advanced knowledge of the theory of electronics is not needed, and this book is not intended to be a course in electronic theory. The main aim is to explain the differences between components of the same basic type (e.g. carbon, carbon film, metal film, and wire-wound resistors) so that the right component for a given application can be selected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor.

166 pages Order code BP28F £3.95

## ELECTRONICS SIMPLIFIED - CRYSTAL SET CONSTRUCTION

F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

Especially written for those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day one can read intelligently and handle simple tools.

80 pages Order code BP92 £1.75

# Theory and Reference

## UNDERSTANDING DIGITAL TECHNOLOGY

F. A. Wilson C.G.I.A., C.Eng., F.I.E.E., F.I. Mgt.

This book examines what digital technology has to offer and then considers its arithmetic and how it can be arranged for making decisions in so many processes. It then looks at the part digital has to play in the ever expanding Information Technology, especially in modern transmission systems and television. It avoids getting deeply involved in mathematics.

Various chapters cover: Digital Arithmetic, Electronic Logic, Conversions between Analogue and Digital Structures, Transmission Systems. Several Appendices explain some of the concepts more fully and a glossary of terms is included. Altogether a useful foray into the digital world both for newcomers and also for those who need some revision or updating.

183 pages Order code B 376 £4.95

## A REFERENCE GUIDE TO PRACTICAL ELECTRONICS TERMS

F. A. Wilson C.G.I.A., C.Eng., F.I.E.E., F.I. Mgt.

Electronic devices surround us on all sides and their numbers are increasing without mercy. Ours is the problem therefore in keeping up with this relentless expansion. Unfortunately we cannot know it all and most of us do not wish to afford the cost of large reference books which explain many concepts in fair detail. Here is an answer, an inexpensive reference guide which explains briefly (but we hope, well) many of the underlying electronics features of practical devices, most of which, to a certain extent, control our lives.

This book is in effect more than just a dictionary of practical electronics terms, it goes a stage further in also getting down to fundamentals. Accordingly the number of terms may be limited but the explanations of the many which are included are designed to leave the reader more competent and satisfied - and this is without the use of complicated mathematics which often on first reading can be confusing.

For those who also wish to get right down to the root of the matter, there is a second volume entitled *A Reference Guide to Basic Electronic Terms* (BP286), each of the books referring to its companion as necessary.

A reference guide for practically everybody concerned with electronics.  
432 pages Order code BP287 £5.95

## ELECTRONIC MODULES AND SYSTEMS FOR BEGINNERS

Owen Bishop

This book describes over 60 modular electronic circuits, how they work, how to build them, and how to use them. The modules may be wired together to make hundreds of different electronic systems, both analogue and digital. To show the reader how to begin building systems from modules, a selection of over 25 electronic systems are described in detail, covering such widely differing applications as timing, home security, measurement, audio (including a simple radio receiver), games and remote control.

200 pages Order code B 266 £3.95

# Radio, TV, Satellite

## PROJECTS FOR RADIO AMATEURS AND S.W.L.S.

R. A. Penfold

This book describes a number of electronic circuits, most of which are quite simple, which can be used to enhance the performance of most short wave radio systems.

The circuits covered include:- An aerial tuning unit; A simple active aerial; An add-on b.f.o. for portable sets; A wavetramp to combat signals on spurious responses; An audio notch filter; A parametric equaliser; C.W. and S.S.B. audio filters; Simple noise limiters; A speech processor; A volume expander.

Other useful circuits include a crystal oscillator, and RTTY/C.W. tone decoder, and a RTTY serial to parallel converter. A full range of interesting and useful circuits for short wave enthusiasts.

92 pages Order code BP304 £3.95

## AN INTRODUCTION TO AMATEUR RADIO

I. D. Poole

Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century.

This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.

150 pages Order code BP257 £3.50

## AERIAL PROJECTS

R. A. Penfold

The subject of aerials is vast but in this book the author has considered practical aerial designs, including active, loop and ferrite aerials which give good performances and are relatively simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.

Also included are constructional details of a number of aerial accessories including a pre-selector, attenuator, filters and a tuning unit.

96 pages Order code BP105 £2.50

## SIMPLE SHORT WAVE RECEIVER CONSTRUCTION

R. A. Penfold

Short wave radio is a fascinating hobby, but one that seems to be regarded by many as an expensive pastime these days. In fact it is possible to pursue this hobby for a minimal monetary outlay if you are prepared to undertake a bit of d.i.y., and the receivers described in this book can all be built at low cost. All the sets are easy to construct, full wiring diagrams etc. are provided, and they are suitable for complete beginners. The receivers only require simple aerials, and do not need any complex alignment or other difficult setting up procedures.

The topics covered in this book include: The broad-

cast bands and their characteristics; The amateur bands and their characteristics; The propagation of radio signals; Simple aerials; Making an earth connection; Short wave crystal set; Simple i.r.f. receivers; Single sideband reception; Direct conversion receiver.

Contains everything you need to know in order to get started in this absorbing hobby.

88 pages Order code BP275 £3.95

## AN INTRODUCTION TO AMATEUR COMMUNICATIONS SATELLITES

A. Pickford

Communications and broadcast satellites are normally inaccessible to individuals unless they are actively involved in their technicalities by working for organisations such as British Telecom, the various space agencies or military bodies. Even those who possess a satellite television receiver system do not participate in the technical aspects of these highly technological systems.

There are a large number of amateur communications satellites in orbit around the world, traversing the globe continuously and they can be tracked and their signals received with relatively inexpensive equipment. This equipment can be connected to a home computer such as the BBC Micro or IBM compatible PCs, for the decoding of received signals.

# Audio and Music

## PRACTICAL MIDI HANDBOOK

R. A. Penfold

The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.

The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those manuals.

128 pages Order code BP101 £6.95

## AN INTRODUCTION TO LOUSPEAKERS AND ENCLOSURE DESIGN

V. Capel

This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the Kapellmeister loudspeaker enclosure.

148 pages Order code BP256 £2.95

## ACOUSTIC FEEDBACK - HOW TO AVOID IT

V. Capel

Feedback is the bane of all public address systems. While feedback cannot be completely eliminated, many things can be done to reduce it to a level at which it is no longer a problem.

Much of the trouble is often the hall itself, not the equipment, but there is a simple and practical way of greatly improving acoustics. Some microphones are prone to feedback while others are not. Certain loudspeaker systems are much better than others, and the way the units are positioned can produce or reduce feedback. All these matters are fully explored as well as electronic aids such as equalizers, frequency-shifters and notch filters.

The special requirements of live group concerts are considered, and also the related problem of instability

This book describes several currently available systems, their connection to an appropriate computer and how they can be operated with suitable software.

102 pages Order code BP290 £3.95

## A GUIDE TO THE WORLD'S RADIO STATIONS (1995/96)

P. Shore

Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed to guide him or her around the ever more complex radio bands. This new edition has been completely revised and rewritten and incorporates much more information which is divided into the following sections:

Listening to Short Wave Radio; Choosing a Short Wave Radio Receiver; How to Use the IRSG; Abbreviations; County Codes; Worldwide Short Wave Radio Stations; European, Middle Eastern and African Long Wave Radio Stations; European, Near and Middle Eastern and African Medium Wave Radio Stations; Canadian Medium Wave Radio Stations; USA Medium Wave Radio Stations; Broadcasts in English; Programmes for DXers and Short Wave Listeners; UK FM Radio Stations; Time Differences From GMT; Wavelength/Frequency Conversion.

256 pages Order code BP355 £5.95

that is sometimes encountered with large set-ups. We even take a look at some unsuccessful attempts to cure feedback so as to save readers wasted time and effort duplicating them.

Also included is the circuit and layout of an In-expensive but highly successful twin-notch filter, and how to operate it.

92 pages Order code BP310 £3.95

## PREAMPLIFIER AND FILTER CIRCUITS

R. A. Penfold

This book provides circuits and background information for a range of preamplifiers, plus tone controls, filters, mixers, etc. The use of modern low noise operational amplifiers and a specialist high performance audio preamplifier i.c. results in circuits that have excellent performance, but which are still quite simple. All the circuits featured can be built at quite low cost (just a few pounds in most cases).

The preamplifier circuits featured include: Microphone preamplifiers (low impedance, high impedance, and crystal). Magnetic cartridge pick-up preamplifiers with R.I.A.A. equalisation. Crystal/ceramic pick-up preamplifier. Guitar pick-up preamplifier. Tape head preamplifier (for use with compact cassette systems).

Other circuits include: Audio limiter to prevent overloading of power amplifiers. Passive tone controls. Active tone controls. PA filters (highpass and lowpass). Scratch and rumble filters. Loudness filter. Audio mixers. Volume and balance controls.

92 pages Order code BP309 £3.95

## COMPUTERS AND MUSIC - AN INTRODUCTION

R. A. Penfold

Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone.

If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.

This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully.

174 pages Order code PC107 £8.95

## ELECTRONIC PROJECTS FOR GUITAR

R. A. Penfold

This book contains a collection of guitar effects and some general purpose effects units, many of which are suitable for beginners to project building. An introductory chapter gives guidance on construction.

Each project has an introduction, an explanation of how it works, a circuit diagram, complete instructions on stripboard layout and assembly, as well as notes on setting up and using the units. Contents include: Guitar tuner; Guitar preamplifier; Guitar head-phone amplifier; Soft distortion unit; Compressor; Envelope wasa was; Phaser; Dual tracking effects unit; Noise gate/expander; Treble booster; Dynamic treble booster; Envelope modifier; Tremolo unit; DI box.

110 pages Temporarily out of print

## HIGH POWER AUDIO AMPLIFIER CONSTRUCTION

R. A. Penfold

Practical constructional details of how to build a number of audio power amplifiers ranging from about 50 to 300/400 watts r.m.s. Includes MOSFET and bipolar transistor designs.

96 pages Order code BP277 £3.95

# Testing and Test Gear

## HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT

R. A. Penfold

This book explains the basic function of an oscilloscope, gives a detailed explanation of all the standard controls, and provides advice on buying. A separate chapter deals with using an oscilloscope for fault finding on linear and logic circuits, plenty of example waveforms help to illustrate the control functions and the effects of various fault conditions. The function and use of various other pieces of test equipment are also covered, including signal generators, logic probes, logic pulsers, and crystal calibrators.

104 pages Order code BP267 £3.50

# DIRECT BOOK SERVICE ORDERING DETAILS

Please state the title and order code clearly, print your name and address and add the required postage to the total order.

Add £1.50 to your total order for postage and packing (overseas readers add £3 for countries in the EEC, or add £6 for all countries outside the EEC, surface mail postage) and send a PO, cheque, international money order (£ sterling only) made payable to **Direct Book Service** or credit card details (including card expiry date), Visa or Mastercard (Access) - minimum credit card order is £5 - quoting your name and address, the order code and quantities required to **DIRECT BOOK SERVICE, 33 GRAVEL HILL, MERLEY, WIMBORNE, DORSET BH21 1RW (mail order only).**

Although books are normally sent within seven days of receipt of your order, please allow a maximum of 28 days for delivery. Overseas readers allow extra time for surface mail post.

Please check price and availability (see latest issue of Everyday Practical Electronics) before ordering from old lists.

For a further selection of books see next month's Issue.

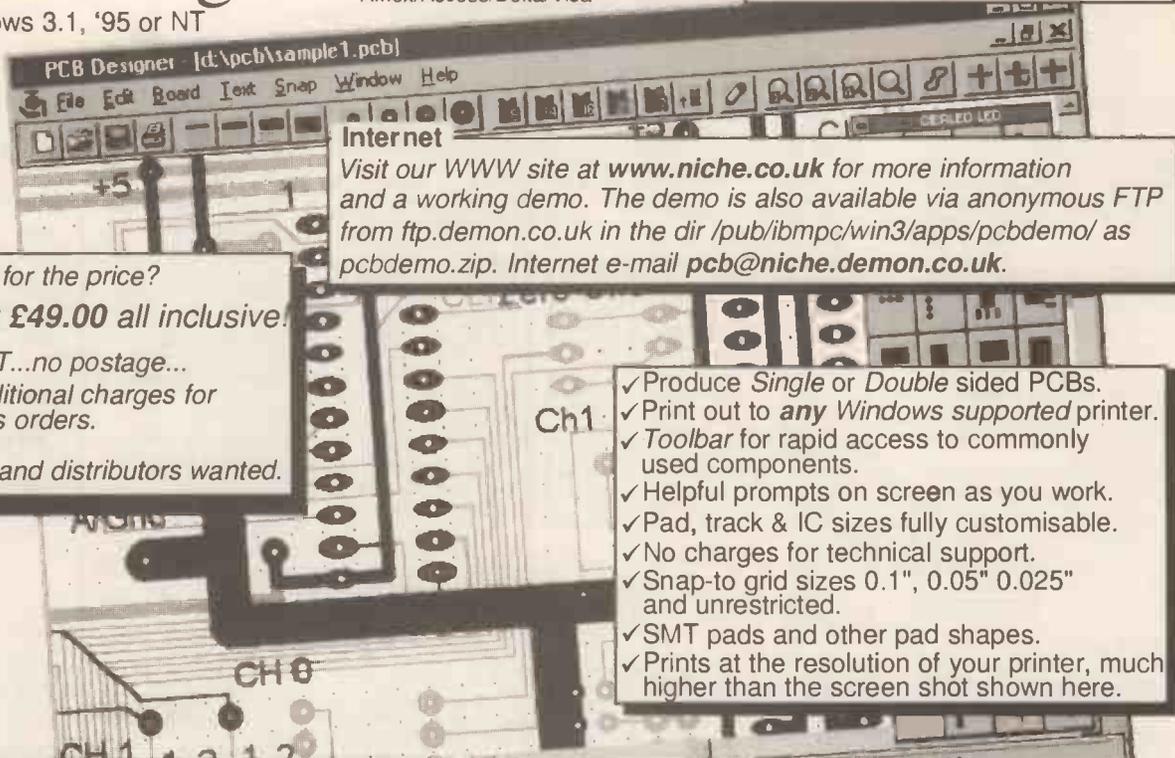
**DIRECT BOOK SERVICE IS A DIVISION OF WIMBORNE PUBLISHING LTD.**

# PCB Designer



Runs on any PC running Windows 3.1, Windows 95 or Windows NT with a minimum 2MB RAM  
Will work with any Windows supported printer and monitor

For Windows 3.1, '95 or NT



Looking for the price?  
**It's just £49.00 all inclusive!**  
...no VAT...no postage...  
...no additional charges for overseas orders.  
**Dealers and distributors wanted.**

Internet  
Visit our WWW site at [www.niche.co.uk](http://www.niche.co.uk) for more information and a working demo. The demo is also available via anonymous FTP from <ftp:demon.co.uk> in the dir /pub/ibmpc/win3/apps/pcbdemo/ as pcbdemo.zip. Internet e-mail [pcb@niche.demon.co.uk](mailto:pcb@niche.demon.co.uk).

- ✓ Produce Single or Double sided PCBs.
- ✓ Print out to **any** Windows supported printer.
- ✓ **Toolbar** for rapid access to commonly used components.
- ✓ Helpful prompts on screen as you work.
- ✓ Pad, track & IC sizes fully customisable.
- ✓ No charges for technical support.
- ✓ Snap-to grid sizes 0.1", 0.05" 0.025" and unrestricted.
- ✓ SMT pads and other pad shapes.
- ✓ Prints at the resolution of your printer, much higher than the screen shot shown here.

## Niche Software (UK)

22 Tavistock Drive, Belmont, Hereford, HR2 7XN.

Phone (01432) 355 414

Available in South Africa from JANCA Enterprises, PO Box 32131, 9317 FichardtPark at R299,00

# PCB SERVICE

Printed circuit boards for certain EPE constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to The PCB Service, *Everyday Practical Electronics*, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Cheques should be crossed and made payable to *Everyday Practical Electronics* (Payment in £ sterling only).

NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.

Back numbers or photostats of articles are available if required – see the *Back Issues* page for details.

**Please check price and availability in the latest issue.**

Boards can only be supplied on a payment with order basis.

## Special KNOCK DOWN SALE of PCBs.

We have a few p.c.b.s left from past projects these are being offered at the knock down price of **£1.00** each – *no matter what size they are (some of these boards are worth over £9.00 each)* while stocks last. This price includes VAT and UK post – overseas orders please add 50p postage (or £1 per board for airmail postage).

**£1.00**  
EACH  
inc. VAT  
and p&p

Doorbell Delay 616; Midi Pedal 639, Midi Merge 640; Audio Lead Tester 641; Hand Tally, main board 699 and display board 700; Automatic Light Control – PSU board 747; Modular Disco Lights – Masterlink 752 – Dimmer Interface 765; Knockerbox 775; Auto Nightlight 779; Tie Pulsar, 794; Car Electric Window Enhancer, 821; Electronic Fire, 820; Linear Clock – Timing Board 830, Display Board, 831; Electronic Snooker Scoreboard, 832; Mind Machine MkII – Computer Interface, 833; Electronic Gong, 835; Bike Odometer (pair of boards), 836/7; Amstrad PCW A to D Converter (double-sided), 838; Sound-Activated Camera Trigger, 840; L.E.D. Sandglass – Main and Display boards, 841/2; Kettle Alert, 843; Linear Power Supply (double-sided), 844.

**Any of the above for just £1 each inc. VAT and p&p.**

Back numbers or photostats of articles are available see the *Back Issues* page for details.

PROJECT TITLE	Order Code	Cost
Experimental Electronic Pipe Descaler	AUG '93 839	£5.50
Multi-Purpose Audio System Six-Channel Stereo Mixer	OCT '93 845	£11.98
Multi-Purpose Audio System Microphone Pre-Amp module	NOV '93 846	£4.88
RIAA Pre-Amp module	847	£5.11
20 Metre Receiver	848	£6.63
Multi-Purpose Audio System 1W Stereo Amplifier	DEC '93 851	£4.88
Three-Way Christmas Tree Lights Flasher	853	£5.65
Auto Alarm	854	£5.49
250W/600W Battery to Mains Inverter	855	£13.92
Multi-Purpose Audio System 10W + 10W Stereo Power Amplifier	JAN '94 852a	£5.65
Amplifier	852b	£5.49
Power Supply	856	£5.77
Pond Heater Thermostat	857	£6.30
Timer/NiCad Capacity Checker		
Multi-Purpose Audio System Balanced Microphone Preamplifier	FEB '94 858	£5.30
Balanced Microphone Power Supply	859	£5.14
Whistle Controlled Light Switch	860	£5.19
Battery to Mains Inverter – U.P.S. charger board	862	£7.38
Three Phase Generator	MAR '94 861	£5.95
Visual Doorbell	863	£5.80
CCD TV Camera – Control Board (double-sided, plated-through-hole)	865	£15.00
Telephone Ring Detector	APR '94 864	£4.72
CCD TV Camera Combined Video, Test & Ext Plug Boards	866a/e	£11.00
Frame Grab Control (double-sided p.t.h.)	867	£15.00
EPE SoundDAC PC Sound Board	868	£4.77
L.E.D. Matrix Message Display Unit Display Board	MAY '94 870	£18.00
CPU Board	871	£7.20
Stereo Noise Gate	873	£6.14
Simple TENS Unit	875	£5.84
Capacitance/Inductance Meter	876	£6.44
Advanced TENS Unit	JUN '94 877	£6.56
Digital Water Meter – Scaler	878	£11.19
Counter/Display pair	879	
L.E.D. Matrix Message Display Unit Keypad	872	£5.19
PC Interface	880	£5.82
Microprocessor Smartswitch	881	£5.61
Microcontroller P.I. Treasure Hunter	882	£6.60

PROJECT TITLE	Order Code	Cost
Print Timer <b>JULY '94</b>	874	£5.82
Watering Wizard	883	£6.60
Simple NiCad Charger	884	£4.98
Stereo HiFi Controller - 1 Power Supply	886	£5.66
Stereo HiFi Controller - 2 <b>AUG '94</b>		
Main Board	887	£7.39
Expansion/Display Boards (pair)	888	£9.80
Dancing Fountains - 1 Pre.amp	889	£5.28
Pump Controller	890	£5.41
Filter	891	£5.23
6802 Microprocessor Development Board	894	£9.15
Dancing Fountains - 2 <b>SEPT '94</b>		
PC-Compatible Interface (double-sided)	892	£10.90
Automatic Greenhouse Watering System	895	£5.33
Seismograph - 1 Sensor/Filter	896	£6.23
Clock/Mixer	897	£5.87
3-Channel Lamp Controller	899	£8.17
Seismograph - 2 <b>OCT '94</b>		
PC-Compatible Interface (double-sided)	898	£10.72
Visual/Audio Guitar Tuner	900	£7.55
Digilogue Clock	901	£12.50
Hobby Power Supply	902	£5.00
Audio Auxplexer - Control Board	903	£7.72
Receiver	904	£6.24
Power Controller <b>NOV '94</b>		
1000V/500V Insulation Tester	905	£4.99
Active Guitar Tone Control	906	£5.78
TV Off-er (pair)	907	£4.50
Video Modules - 1 Simple Fader	908/909	£7.25
Improved Fader	910	£5.12
Video Enhancer	911	£6.37
Video Enhancer	912	£5.15
Rodent Repeller <b>DEC '94</b>		
EPE Fruit Machine	913	£6.26
Video Modules -2 Horizontal Wiper	914	£8.14
Vertical Wiper	916	£6.23
4-Channel Audio Mixer	917	£6.35
Spacewriter Wand	918	£6.20
Universal Digital Code Lock	921	£4.00
Universal Digital Code Lock	922	£6.25
Video Modules - 3 <b>JAN '95</b>		
Dynamic Noise Limiter	919	£5.92
System Mains Power Supply	920	£4.98
Magnetic Field Detector	923	£5.77
Model Railway Track Cleaner	924	£5.11
Moving Display Metronome	925	£6.24
The Ultimate Screen Saver <b>FEB '95</b>		
Foot-Operated Drill Controller	927	£5.66
Model Railway Signals	928	£5.73
12V 35W PA Amplifier	929	£5.96
12V 35W PA Amplifier	930	£12.25
Multi-Purpose Thermostat <b>MAR '95</b>		
Multi-Project PCB	931	£6.30
Sound-Activated Switch	932	£3.00
Audio Amplifier		
Light Beam Communicator (2 boards required)		
Multi-Project PCB <b>APR '95</b>		
Light-Activated Switch	932	£3.00
Switch On/Off Timer		
Continuity Tester		
Auto Battery Charger	934	£5.36
National Lottery Predictor	935	£5.34
R.F. Signal Generator - R.F./Mod. <b>MAY '95</b>		
Coil & Power Supply (pair)	936	£6.48
MIDI Pedal	937a/b	£6.10
Club Vote Totaliser	938	£7.78
PIC-DATS Development System (double-sided p.t.h.)	939	£6.05
PIC-DATS Development System (double-sided p.t.h.)	940	£9.90
EPE HiFi Valve Amplifier - <b>JUNE '95</b>		
Phase splitter	941	£6.71
PIC-DATS 4 -channel Light Chaser	942	£7.90
HV Capacitor Reformer <b>JULY '95</b>		
Ramp Generator	943	£5.60
Logic Board (double-sided p.t.h.) & Analogue board (pair)	944/5	£32.00
Automatic Curtain Winder	946	£6.75
Windicator	947	£4.10
Microcontrolled 3-Digit Timer <b>AUG '95</b>		
IR Remote Control - Transmitter	933	£6.61
IR Remote Control - Receiver	948	£5.76
Personal Practice Amplifier	949	£6.14
Personal Practice Amplifier	950	£6.09
Low-Range Ohmmeter Adaptor <b>SEPT '95</b>		
Simple Theremin	926	£5.55
Vandata	952	£6.68
Boot Control Unit	953	£10.52
Display Unit	954	£6.61

PROJECT TITLE	Order Code	Cost
Sound Switch <b>OCT '95</b>	915	£6.55
Multiple Project PCB	932	£3.00
Audio Sinewave Generator		
Treble Booster		
Infra-Red Controller/Alarm (2 boards required)		
Capacitor Check	955	£5.76
Ginormous VU Meter	956	£9.31
Multiple Project PCB <b>NOV '95</b>		
Video Enhancer	932	£3.00
Current Tracer		
Distortion Effects Unit		
Digital Delay Line	958	£8.04
50Hz Field Meter	959	£8.32
Temperature Warning Alarm (Teach-In '96)	960	£6.15
Stereo "Cordless" Headphones <b>DEC '95</b>		
Transmitter	961	£8.04
Receiver	962	£7.66
EPE Met Office - Sensor/Rainfall/Vane	963/965	£11.33
Spiral transparency free with above p.c.b.		
Light-Operated Switch	966	£6.37
Modular Alarm System (Teach-In '96)	967a/b	£7.12
Audio Meter and Amplifier	968	£5.99
EPE Met Office - <b>JAN '96</b>		
Computer Interface (double-sided)	964	£7.69
Audio Signal Generator	969	£6.58
Mains Signalling Unit, Transmitter and Receiver	970/971 (pr)	£9.09
Automatic Camera Panning (Teach-In '96)	972	£6.63
Printer Sharer	973	£9.93
Analogue Frequency Meter <b>FEB '96</b>		
Vari-Speed Dice (Teach-In '96)	957	£6.70
Mains Signalling Unit - 2	974	£5.69
12V Capacitive PSU	975	£6.07
PIC-Electric Meter - Sensor/PSU - Control/Display	977/978 (pr)	£9.90
Multi-Purpose Mini Amplifier <b>MAR '96</b>		
PIC-Electric - Sensor/PSU - Control/Display	976	£6.12
High Current Stabilised Power Supply	977/978 (pr)	£9.90
Mind Machine Mk III - Sound and Lights	979	£6.62
Infra-Zapper Transmitter/Receiver (Teach-In '96)	980	£7.39
Mind Machine Mk III - Programmer	981/982 (pr)	£8.01
Bat Band Converter/B.F.O. <b>APRIL '96</b>		
Hearing Tester	983	£7.36
Event Counter (Teach-In '96)	984a/b	£5.80
B.F.O. and Bat Band Converter	985	£6.87
Versatile PIR Detector Alarm	986	£8.39
Mind machine Mk III - Tape Controller <b>MAY '96</b>		
Midi Analyser	984a/b	£5.80
Countdown Timer (Teach-In '96)	988	£6.76
Ultra-Fast Frequency Generator and Counter - Oscillator/L.C.D. Driver	989	£6.70
Sarah's Light	992	£6.74
Home Telephone Link	993	£9.44
PulStar		
VU Display and Alarm	994/995 (pr)	£12.72
PulStar	996	£7.17
VU Display and Alarm	997 (pr)	£10.72
PulStar	998	£6.60
VU Display and Alarm	999	£7.02

## EPE PRINTED CIRCUIT BOARD SERVICE

Order Code    Project    Quantity    Price

Name.....

Address.....

I enclose payment of £.....(cheque/PO in £ sterling only) to:



Everyday  
Practical Electronics



Access (MasterCard) or Visa No.  
Minimum order for credit cards £5

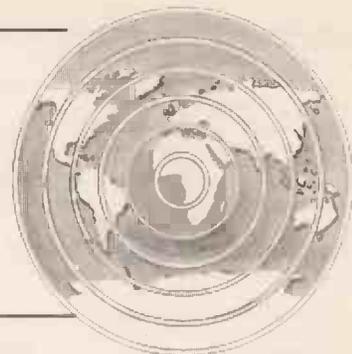
--	--	--	--	--	--	--	--	--	--

Signature.....Card Exp. Date.....

Please supply name and address of cardholder if different from the address shown

# REPORTING AMATEUR RADIO

Tony Smith G4FAI



## EMC AND KITS

The European Community's Directive on electromagnetic compatibility (EMC) came into force in January 1996. This requires that electrical and electronic equipment sold commercially must now comply with defined EMC protection requirements. In general, this means that such products must have the ability to operate without mutual interference.

Concern has been expressed by the Radio Society of Great Britain about the impact of the Directive on the small manufacturers of kits aimed at the amateur radio market. Such kits are an intrinsic part of the Novice Licence training scheme, they provide a relatively inexpensive way to enjoy amateur radio, and provide a degree of self-training which is fundamental to the hobby.

The RSGB's EMC Committee recently posed a number of questions about the effect of the Directive on home-made equipment to the DTI Standards and Technical Regulations Directorate and the following information was received relating to the status of kits:

"Amateur radio apparatus is outside the scope of the EMC Directive 89/336/EEC, so long as it is not offered commercially for sale. If the kit i.e. set of parts is assembled by an amateur radio operator, it does not have to comply.

"Also, if a kit is deemed a sub-assembly it does not have to comply. When a kit is offered as a finished product when assembled (not amateur radio) it does have to comply."

The RSGB has issued a press release detailing its correspondence and representations to the DTI on this matter over the last six years. The outcome, it says, "will come as a great relief to many kit manufacturers who faced going out of business because of the expense of the compliance procedure."

In case it is thought that users of amateur radio kits are receiving special privileges not accorded to other kit users, it should be mentioned that all amateur radio equipment, home-made or not, is still subject to the terms of the Wireless Telegraphy Acts. The conditions of the amateur licence continue to impose stringent requirements to ensure that no interference is caused to other radio services, including a requirement to close down when in breach of the regulations.

## THE AMATEUR'S CODE

In 1928, an American amateur, Paul A. Segal W9EEA, wrote an *Amateur's Guide* which to this day describes what a radio amateur should aspire to. The code is re-published annually in the American Radio Relay League's *Handbook for Radio Amateurs* and the wording is specific to the USA.

A few years ago, New Zealand's national society, NZART, suggested an

amended non-specific version of the code and the International Amateur Radio Union invited all member societies to adopt this version as their own. The amended code reads as follows:

"The Radio Amateur is:

**CONSIDERATE** . . . never knowingly operates in such a way as to lessen the pleasure of others.

**LOYAL** . . . offers loyalty, encouragement and support to other amateurs, local clubs, and the national membership of the International Amateur Radio Union, through which Amateur Radio is represented to government and internationally.

**PROGRESSIVE** . . . with knowledge abreast of science, a well built and efficient station and operation above approach.

**FRIENDLY** . . . slow and patient sending when requested, friendly advice and counsel to the beginner; kindly assistance, cooperation and consideration for the interests of others. These are the hallmarks of the amateur spirit.

**BALANCED** . . . radio is an avocation, never interfering with duties owed to family, job, school, or community.

**PATRIOTIC** . . . station and skill always ready for service to country and community."

With its roots in the '20s the wording of the code is slightly archaic, and calls for standards that nowadays seem to be somewhat out of fashion. It does show, though, that within at least one area of secular activity such values are still regarded as something to try to live up to!

## MEGS MORSE TUITION

While there is a possibility that the amateur Morse test may be abolished in 1999, there is also a possibility that it will be replaced by some other test, such as a computer examination. In the meantime, anyone wishing to obtain a licence to operate on the amateur bands below 30MHz must still pass a 12w.p.m. Morse test.

There are plenty of ways to learn Morse, but one particular scheme shows very clearly how dedicated some people are in putting back into their hobby something of what they have taken out. Their activities are a good example of what the Amateur's Code is all about!

In this instance, I'm referring to MEGS (Morse Enthusiasts Group Scotland), which provides assistance to beginners or existing operators wishing to improve their Morse skills.

All are welcome to join the Group, without geographical restriction, and to take part in its comprehensive training programme. This ranges from a beginners' course to advanced techniques, using both tape and "on-air" training methods as appropriate.

Life membership costs just £1, and further information can be obtained from George M. Allan GM4HYF, 22 Tynwald Avenue, High Burnside, Rutherglen, Glasgow G73 4RN. Please mention that you read about MEGS in this column.

To encourage members to achieve greater ability, and to enjoy using Morse on the air, the Group has introduced a progressive Proficiency Award. The 12w.p.m. award requires one contact at that speed with MEGS club stations GMORSE or GMORSE/P plus contacts with two other MEGS members.

Awards for higher speeds at 15, 18, and 20w.p.m., each require a further contact with GMORSE or GMORSE/P and a further two members, so that for the final 20w.p.m. award four contacts with the club station are required (at 12, 15, 18 and 20w.p.m.) plus eight other contacts with MEGS members.

Qualifying contacts are arranged by calling in to the MEGS nets on 3-530MHz on Monday and Thursday evenings from 7.30p.m. to 8.30p.m. local time. Any amateur station may call in and work MEGS stations on these 12w.p.m. nets but only members may take part in the awards programme.

## ISWL NEW PUBLICATION

The International Short Wave League has published an updated version of its booklet containing all amateur radio callsign prefixes worldwide, listed alphabetically by country and alpha-numerically by prefix. This new publication includes all new prefixes allocated since the last edition.

It has two separate listings. The first is the official DXCC list, showing all countries with which contacts qualify for the prestigious DX Century Club Awards administered by the American Radio Relay League. This list is also used for many awards issued by other organisations.

The second listing is intended for those working for ISWL awards or taking part in ISWL contests. This expands on the DXCC list and includes the call areas of countries such as Australia, Canada, and the USA, plus many islands and other locations.

While particularly useful for DXers and contesters, this book is also helpful for other licensed amateurs or shortwave listeners, enabling them to identify the country of origin (and sometimes the particular part of that country) where an amateur station worked or heard is located.

The price is unchanged at £2.50, and IRCs or postage stamps to the same value are also acceptable. The book can be obtained from the *International Short Wave League (Ref. EPE)*, 3 Bromyard Drive, Chellaston, Derby DE73 1PF.

**200 WATT INVERTERS** Nicely cased units 12v input 240v output 150watt continuous, 200 max. £49 ref LOT62.

**6.8MW HELIUM NEON LASERS** New units, £65 ref LOT33  
**COIN SLOT TOKENS** You may have a use for these? mixed bag of 100 tokens £10 ref LOT20.

**PORTABLE X RAY MACHINE PLANS** Easy to construct plans on a simple and cheap way to build a home X-ray machine! Effective device, X-ray sealed assemblies, can be used for experimental purposes. Not a toy or for minors! £65/set Ref F/XP1.

**TELEKINETIC ENHANCER PLANS** Mystify and amaze your friends by creating motion with no known apparent means or cause. Uses no electrical or mechanical connections, no special gimmicks yet produces positive motion and effect. Excellent for science projects, magic shows, party demonstrations or serious research & development of this strange and amazing psychic phenomenon. £4/set Ref F/TK1.

**ELECTRONIC HYPNOSIS PLANS & DATA** This data shows several ways to put subjects under your control. Included is a full volume reference text and several construction plans that when assembled can produce highly effective stimuli. This material must be used cautiously. It is for use as entertainment at parties etc only, by those experienced in its use. £15/set Ref F/EH2.

**GRAVITY GENERATOR PLANS** This unique plan demonstrates a simple electrical phenomena that produces an anti-gravity effect. You can actually build a small mock spaceship out of simple materials and without any visible means - cause it to levitate. £10/set Ref F/GRA1.

**WORLDS SMALLEST TESLA COIL/LIGHTENING DISPLAY GLOBE PLANS** Produces up to 750,000 volts of discharge, experiment with extraordinary HV effects. 'Plasma in a jar', St Elmo's fire, Corona, excellent science project or conversation piece. £5/set Ref F/BTC1/LG5.

**COPPER VAPOUR LASER PLANS** Produces 100mw of visible green light. High coherency and spectral quality similar to Argon laser but easier and less costly to build yet far more efficient. This particular design was developed at the Atomic Energy Commission of NEGEV in Israel. £10/set Ref F/CVL1.

**VOICE SCRAMBLER PLANS** Miniature solid state system turns speech sound into indecipherable noise that cannot be understood without a second matching unit. Use on telephone to prevent third party listening and bugging. £6/set Ref F/VS9.

**PULSED TV JOKER PLANS** Little hand held device utilises pulse techniques that will completely disrupt TV picture and sound works on FM tool DISCRETION ADVISED. £8/set Ref F/TJ5.

**BODYHEAT TELESCOPE PLANS** Highly directional long range device uses recent technology to detect the presence of living bodies, warm and hot spots, heat leaks etc. Intended for security, law enforcement, research and development, etc. Excellent security device or very interesting science project. £8/set Ref F/BHT1.

**BURNING, CUTTING CO2 LASER PLANS** Projects an invisible beam of heat capable of burning and melting materials over a considerable distance. This laser is one of the most efficient, converting 10% input power into useful output. Not only is this device a workhorse in welding, cutting and heat processing materials but it is also a likely candidate as an effective directed energy beam weapon against missiles, aircraft, ground-to-ground, etc. Particle beams may very well utilize a laser of this type to blast a channel in the atmosphere for a high energy stream of neutrons or other particles. The device is easily applicable to burning and etching wood, cutting, plastics, textiles etc. £12/set Ref F/LC7.

**MYSTERY ANTI GRAVITY DEVICE PLANS** Uses simple concept. Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or science project. £6/set Ref F/ANT1K.

**ULTRASONIC BLASTER PLANS** Laboratory source of sonic shock waves. Blow holes in metal, produce 'cold' steam, atomize liquids. Many cleaning uses for PC boards, jewellery, coins, small parts etc. £6/set Ref F/ULB1.

**ULTRA HIGH GAIN AMP/STETHOSCOPIC MIKE/SOUND AND VIBRATION DETECTOR PLANS** Ultrasensitive device enables one to hear a whole new world of sounds. Listen through walls, windows, floors etc. Many applications shown, from law enforcement, nature listening, medical heartbeat, to mechanical devices. £6/set Ref F/HGA7.

**ANTI DOG FORCE FIELD PLANS** Highly effective circuit produces time variable pulses of acoustical energy that dogs cannot tolerate. £6/set Ref F/DOG2.

**LASER BOUNCE LISTENER SYSTEM PLANS** Allows you to hear sounds from a premises without gaining access. £12/set Ref F/LIST1.

**LASER LIGHT SHOW PLANS** Do it yourself plans show three methods. £6 Ref F/LLS1.

**PHASOR BLAST WAVE PISTOL SERIES PLANS** Handheld, has large transducer and battery capacity with external controls. £6/set Ref F/PSP4.

**INFINITY TRANSMITTER PLANS** Telephone line grabber/room monitor. The ultimate in home/office security and safety! simple to use! Call your home or office phone, push a secret tone on your telephone to access either: A) On premises sound and voices or B) Existing conversation with break-in capability for emergency messages. £7 Ref F/TELEGRAB.

**BUG DETECTOR PLANS** Is that someone getting the goods on you? Easy to construct device locates any hidden source of radio energy! Sniffs out and finds bugs and other sources of bothersome interference. Detects low, high and UHF frequencies. £5/set Ref F/BD1.

**ELECTROMAGNETIC GUN PLANS** Projects a metal object a considerable distance - requires adult supervision £5 Ref F/EML2.

**ELECTRIC MAN PLANS, SHOCK PEOPLE WITH THE TOUCH OF YOUR HAND!** £5/set Ref F/EMA1.

**PARABOLIC DISH MICROPHONE PLANS** Listen to distant sounds and voices, open windows, sound sources in 'hard to get or hostile' premises. Uses satellite technology to gather distant sounds and focus them to our ultra sensitive electronics. Plans also show an optional wireless link system. £8/set Ref F/PM5.

**2 FOR 1 MULTIFUNCTIONAL HIGH FREQUENCY AND HIGH DC VOLTAGE, SOLID STATE TESLA COIL AND VARIABLE 100,000 VDC OUTPUT GENERATOR PLANS** Operates on 9-12Vdc, many possible experiments. £10 Ref F/HVM7/

## WOLVERHAMPTON BRANCH NOW OPEN AT WORCESTER ST W'HAMPTON TEL 01902 22039

**INFINITY TRANSMITTERS** The ultimate 'bug' fits to any phone or line, undetectable, listen to the conversations in the room from anywhere in the world 24 hours a day 7 days a week! Just call the number and press a button on the mini controller (supplied) and you can hear everything! Monitor conversations for as long as you choose £249 each, complete with leads and mini controller Ref LOT9. Undetectable with normal RF detectors, fitted in seconds, no batteries required, lasts forever!

**SWITCHED MODE PSU'S** 244 watt, +5 32A, +12 6A, -5 0.2A, -12 0.2A. There is also an optional 3.3v 25A rail available. 120/240V I/P. Cased, 175x90x145mm. IEC Inlet Suitable for PC use (6 d/drive connectors 1 m/board). £10 Ref PSU1.

**VIDEO PROCESSOR UNITS/75V 10AH BATT/12V 8A TX** Not too sure what the function of these units is but they certainly make good strippers! Measures 390X320X120mm, on the front are controls for scan speed, scan delay, scan mode, loads of connections on the rear. Inside 2x 6V 10AH sealed lead acid batts, pcb's and a 8A? 17V toroidal transformer (mains in). Condition not known, may have one or two broken knobs due to poor storage. £17.50 ref VP2

**RETRO NIGHT SIGHT** Recognition of a standing man at 300m in 1/4 moonlight, hermetically sealed, runs on 2 AA batteries, 80mm F1.5 lens, 20mw Infrared laser included. £325 ref RETRON.

**MINI FM TRANSMITTER KIT** Very high gain preamp, supplied complete with FET electret microphone. Designed to cover 88-108 MHz but easily changed to cover 63-130MHz. Works with a common 9v (PP3) battery. 0.2W RF. £7 Ref 1001.

**3-30V POWER SUPPLY KIT** Variable, stabilized power supply for lab use. Short circuit protected, suitable for professional or amateur use 24v 3A transformer is needed to complete the kit. £14 Ref 1007.

**1 WATT FM TRANSMITTER KIT** Supplied with piezo electric mic. 8-30Vdc. At 25-30v you will get nearly 2 watts! £12 ref 1009.

**FM/AM SCANNER KIT** Well not quite, you have to turn the knob your self but you will hear things on this radio that you would not hear on an ordinary radio (even TV). Covers 50-160MHz on both AM and FM. Built in 5 watt amplifier, inc speaker. £15 ref 1013.

**3 CHANNEL SOUND TO LIGHT KIT** Wireless system, mains operated, separate sensitivity adjustment for each channel, 1,200 w power handling, microphone included. £14 Ref 1014.

**4 WATT FM TRANSMITTER KIT** Small but powerful FM transmitter, 3 RF stages, microphone and audio preamp included. £20 Ref 1028.

**STROBE LIGHT KIT** Adjustable from 1-60 hz (a lot faster than conventional strobes). Mains operated. £16 Ref 1037.

**LIQUID LEVEL DETECTOR KIT** Useful for tanks, ponds, baths, rain alarm, leak detector etc. Will switch 2A mains. £5 Ref 1081.

**COMBINATION LOCK KIT** 9 key, programmable, complete with keypad, will switch 2A mains. 9v dc operation. £10 ref 1114.

**PHONE BUG DETECTOR KIT** This device will warn you if somebody is eavesdropping on your line. £6 ref 1130.

**ROBOT VOICE KIT** Interesting circuit that distorts your voice adjustable, answer the phone with a different voice! 12vdc £9 ref 1131

**TELEPHONE BUG KIT** Small bug powered by the 'phone line, starts transmitting as soon as the phone is picked up! £8 Ref 1135.

**3 CHANNEL LIGHT CHASER KIT** 800 watts per channel, speed and direction controls supplied with 12 LEDs you can fit traces instead to make kit mains, not supplied! 9-12vdc £17 ref 1026.

**12V FLOURESCENT LAMP DRIVER KIT** Light up 4 foot tubes from your car battery! 9v 2a transformer also required. £8 ref 1069.

**VOX SWITCH KIT** Sound activated switch ideal for making bugging tape recorders etc, adjustable sensitivity. £8 ref 1073.



Check out our  
**WEB SITE**

<http://www.pavilion.co.uk/bull-electrolab>

**PREAMP MIXER KIT** 3 input mono mixer, sep bass and treble controls plus individual level controls. 18vdc, Input sens 100mA. £15 ref 1052.

**METAL DETECTOR KIT** Range 15-20cm, complete with case, 9vdc. £8 ref 1022.

**SOUND EFFECTS GENERATOR KIT** Produces sounds ranging from bird chirps to sirens. Complete with speaker, add sound effects to your projects for just £9 ref 1045.

**16 WATT FM TRANSMITTER (BUILT)** 4 stage high power, preamp required 12-18vdc, can use ground plane, yagi or open dipole. £69 ref 1021.

**HUMIDITY METER KIT** Builds into a precision LCD humidity meter, 9 ic design, pcb, lcd display and all components included. £29

**PC TIMER KIT** Four channel output controlled by your PC, will switch high current mains with relays (supplied). Software supplied so you can program the channels to do what you want whenever you want. Minimum system configuration is 286, VGA, 4.1, 640k, serial

\*SOME OF OUR PRODUCTS MAY BE UNLICENSEABLE IN THE UK

## BULL ELECTRICAL

250 PORTLAND ROAD, HOVE, SUBSEX.

BNS SQ. (ESTABLISHED 50 YEARS)

MAIL ORDER TERMS: CASH, PO OR CHEQUE

WITH ORDER PLUS 43 P&P PLUS VAT.

PLEASE ALLOW 7-10 DAYS FOR DELIVERY PHONE ORDERS

WELCOME (ACCESS VISA, SWITCH, AMERICAN EXPRESS)

TEL: 01273 203500

FAX 01273 323077

E-mail [bull@pavilion.co.uk](mailto:bull@pavilion.co.uk)

port, hard drive with min 100k free. £24.99

**DVING RODS** Expensive technology cannot challenge the fool proof art of water diving, passed down from generation to generation. Seeing is believing. Use in the home, garden, countryside or desert, it's divinely simple! £4.99 a pair ref E/3.

**HUGE BUBBLE MAKING KIT** You'll be amazed at the size of the bubbles you can achieve with this bubble making kit. Once you have got the knack it's possible to make bubbles of up to 40 feet long. £11.99 ref E/9.

**FM CORDLESS MICROPHONE** This unit is an FM broadcasting station in miniature, 3 transistor transmitter with electret condenser mic + fet amp design result in maximum sensitivity and broad frequency response. 90-105MHz, 50-1500Hz, 500 foot range in open country! PP3 battery required. £15.00 ref 1542A.

**MAGNETIC MARBLES** They have been around for a number of years but still give rise to curiosity and amazement. A pack of 12 is just £3.99 ref G/IR20

**STETHOSCOPES** A fully functioning stethoscope for all those intricate projects. Enables you to listen to motors, pipes, heartbeats, walls, insects etc. £6 ref MAR6P6.

**NICKEL PLATING KIT** Professional electroplating kit that will transform rusting parts into showpieces in 3 hours! Will plate onto steel, iron, bronze, gunmetal, copper, welded, silver soldered or brazed joints. Kit includes enough top plate 1,000 sq.inches. You will also need a 12v supply, a container and 2 12v light bulbs. £39.99 ref NIK39.

**Minute adjustable timers, 4 pole o/o output 3A 240v, HY1230S, 12VDC adjustable from 0-30 secs. £4.99**

**HY1260M, 12VDC adjustable from 0-60 mins. £4.99**

**HY2405S, 240v adjustable from 0-5 secs. £4.99**

**HY24060m, 240v adjustable from 0-60 mins. £6.99**

**BUGGING TAPE RECORDER** Small voice activated recorder, uses micro cassette complete with headphones. £28.99 ref MAR29P1.

**POWER SUPPLY** fully cased with mains and o/p leads 17v DC 900mA output. Bargain price £5.99 ref MAG6P9

**9v DC POWER SUPPLY** Standard plug in type 150ma 9v DC with lead and DC power plug, price for two is £2.99 ref AUG3P4.

**COMPOSITE VIDEO KIT** Converts composite video into separate H sync, V sync, and video. 12v DC. £8.00 REF: MAG8P2.

**FUTURE PC POWER SUPPLIES** These are 295x135x60mm, 4 drive connectors 1 mother board connector. 150watt, 12v fan, IEC Inlet and on/off switch. £12 Ref EF6.

**VENUS FLYTRAP KIT** Grow your own carnivorous plant with this simple kit £3 ref EF34.

**6"X12" AMORPHOUS SOLAR PANEL** 12v 155x310mm 130mA. Bargain price just £5.99 ea REF MAG6P12.

**FIBRE OPTIC CABLE BUMPER PACK** 10 metres for £4.99 ref MAG6P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

**ROCK LIGHTS** Unusual things these, two pieces of rock that glow when rubbed together believed to cause rain! £3 a pair Ref EF29.

**3' by 1' AMORPHOUS SOLAR PANELS** 14.5v, 700mA 10 watts, aluminium frame, screw terminals, £44.95 ref MAG45.

**ELECTRONIC ACCUPUNCTURE KIT** Builds into an electronic version instead of needless good to experiment with. £7 ref 7P30

**SHOCKING COIL KIT** Build this little battery operated device into all sorts of things, also gets worms out of the ground! £7 ref 7P36.

**FLYING PARROTS** Easily assembled kit that builds a parrot that actually flaps its wings and flies! 50 m range £6 ref EF2.

**HIGH POWER CATALUPS** Hinged arm brace for stability, tempered steel yoke, super strength latex power bands. Departure speed of ammunition is in excess of 200 metres per hour! Range of over 200 metres! £7.99 ref R/9.

**BALLON MANUFACTURING KIT** British made, small blob blows into a large, longlasting balloon, hours of fun! £3.99 ref G/IE99R

**9-0-9V 4A TRANSFORMERS**, chassis mount. £7 ref LOT19A.

**2.6 KILOWATT INVERTERS**, Packed with batteries etc but as they weigh about 100kg CALLERS ONLY! £120.

**MEGA LED DISPLAYS** Build your self a clock or something with these mega 7 seg displays 55mm high, 38mm wide 5 on a pcb for just £4.99 ref LOT16 or a bumper pack of 50 displays for just £29 ref LOT17.

## CLEARANCE SECTION, MINIMUM ORDER £15, NO TECHNICAL DETAILS AVAILABLE, NO RETURNS, TRADE WELCOME.

2000 RESISTORS ON A REEL (SAME VALUE) 99P REF BAR340

AT LEAST 200 CAPACITORS (SAME VALUE) 99P REF BAR342

INFRA RED REMOTE CONTROLS JUST 99P REF BAR333

CIRCUIT BREAKERS, OUR CHOICE TO CLEAR 99P REF BAR335

MICROWAVE CONTROL PANELS TO CLEAR £2 REF BAR 328

2 TUBES OF CHIPS (2 TYPES OUR CHOICE) 90P REF BAR305

LOTTERY PREDICTOR MACHINE! JUST £1.50 REF BAR313

HELLA/ROVER ELECTRIC/LAMP LEVELLER £2 REF BAR311

SINCLAIR IC 18" TYRES TO CLEAR AT JUST 75P REF BAR318

LARGE MAINS MOTORS (NEW) TO CLEAR AT 75P REF BAR310

MODEMS ETC FOR STRIPPING £2.50 EACH REF BAR324

110V LARGE MOTORS (NEW) TO CLEAR AT 50P REF BAR332

MODULATOR UNITS UNKNOWN SPEC JUST 50P REF BAR323

GX4000 GAMES COSOLLES JUST £4 REF BAR320

SMART CASED MEMORY STORAGE DEVICE, LOADS OF BITS INSIDE, PCB, MOTOR, CASE ETC. BUMPER PACK OF 5 COMPLETE UNITS TO CLEAR AT £2.50 (FOR 5) REF BAR 330

2 CORE MAINS CABLE 2M LENGTHS PACK OF 4 £1 REF BAR337

PC USER/BASIC MANUALS, LOADS OF INFO. £1 REF BAR304

PCB STRIPPERS TO CLEAR AT 2 FOR 99P REF BAR341

3 M 3CORE MAINS CABLE AND 13A PLUG. 80P REF BAR325

## WE BUY SURPLUS STOCK

FOR CASH  
BUYERS DIRECT LINE 0860 425692

FREE CATALOGUE

100 PAGE CATALOGUE NOW  
AVAILABLE, 45P STAMP OR FREE  
ON REQUEST WITH ORDER.

# ELECTRONICS

Everyday Practical Electronics reaches nearly twice as many UK readers as any other independent monthly hobby electronics magazine, our audited sales figures prove it. We have been the leading independent monthly magazine in this market for the last eleven years.

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £8 (+VAT) per single column centimetre (minimum 2.5cm). The prepaid rate for classified adverts is 30p (+VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Practical Electronics. VAT must be added. Advertisements, together with remittance, should be sent to Everyday Practical Electronics Advertisements, Holland Wood House, Church Lane, Great Holland, Essex CO13 0JS. Phone/Fax (01255) 850596.

For rates and information on display and classified advertising please contact our Advertisement Manager, Peter Mew as above.

**RCS VARIABLE VOLTAGE D.C. BENCH POWER SUPPLY**  
Up to 38 volts d.c. at 6 amps continuous, 10 amps peak, fully variable from 1 to 38 volts. Twin Voltage and Current meters for easy read-out. 240 volt a.c. input. Fully smoothed, size 14½ x 11 x 4½ inches.

**£96 inc. VAT**  
carriage £6

**RADIO COMPONENT SPECIALISTS**  
337 WHITEHORSE ROAD, CROYDON SURREY, CR0 2HS. Tel: 0181-684 1665

Lots of transformers, high volt caps, valves, speakers, in stock. Phone or send your wants list for quote.

**THE BRITISH AMATEUR ELECTRONICS CLUB**  
exists to help electronics enthusiasts by personal contact and through a quarterly Newsletter.  
For membership details, write to the Secretary:  
**Mr. J. F. Davies, 70 Ash Road, Cuddington, Northwich, Cheshire CW8 2PB.**  
*Space donated by Everyday Practical Electronics*

**PC ELECTRONIC AND TECHNICAL PROGRAMS**  
LOW COST SPECIALIST LIBRARY  
GOOD QUALITY PROGRAMS THAT WORK.  
Descriptive catalogue available priced at £2.50. Comes with £2.00 off money voucher to place against your first order.  
Phone/Fax for your catalogue from **PDSL, Winscombe House, Beacon Road, Crowborough, East Sussex TN6 1UL**  
Tel: 01892 663298 Fax: 01892 667473

**MAIL ORDER**

**FROM DUBAI TO ALL MIDDLE EAST AND AFRICA**

**WIDE RANGE OF ELECTRONIC COMPONENTS FOR ALL YOUR NEEDS**

\* \* \* \* \*

**AL TALEEA ELECTRONICS EQP. S.P.**  
TEL: +971 (4) 280247 FAX: +971 (4) 274556  
P.O. BOX: 1396, DUBAI, U.A.E.

**BTEC ELECTRONICS TECHNICIAN FULL-TIME TRAINING**

THOSE ELIGIBLE CAN APPLY FOR E.T. GRANT SUPPORT AN EQUAL OPPORTUNITIES PROGRAMME

O.N.C., O.N.D. and H.N.C.  
*Next course commences*  
**Monday 16th September 1996**  
FULL PROSPECTUS FROM

**LONDON ELECTRONICS COLLEGE (Dept EPE) 20 PENYWERN ROAD EARLS COURT, LONDON SW5 9SU**  
TEL: 0171-373 8721

**THE PARALLEL INTERFACE POWER CARD** by **HANDDI Ltd** for complete **COMPUTER CONTROL**. This could be your most useful and cheapest computer/PC "add-on" at only **£19.95** . . . Post FREE!  
Drives robotics, motor speeds, stepper motors, lamps, relays etc. using its 8 x 20V/2A outputs.  
Many sold already for successful Model Railway Layout control . . . FULL INSTRUCTIONS supplied!  
Send cheque for **£19.95 OR S.A.E.** for details to:- **HANDDI Ltd. P.O. 503, Milton Keynes, MK5 6JD.**

**FIRST ON THE WEB**  
with over 300 kits. We are on the Internet with DIY Electronics. See our web page at:  
<http://www.hk.super.net/~diykit>

Current specials: 5mW He-Ne (red) laser tube & 12V inverter kit: £60, 5mW/660nm laser diode kit with case: £21, Used air cooled Argon-ion laser head only: £150, Automatic 3 motor Laser Light Show: £35, Dual (stereo) 20k motor driven potentiometer: £7, 8 channel IR remote control kit, Rx + Tx have logic outputs: £18, IR remote control extender kit: £3, Breath analyser kit: £15, Movement triggered (PIR) recording control kit for domestic VCR's via a learning IR remote control (included): £33, 42 LED IR illuminator kit for CCD cameras (see in the dark): £20, Passtev night viewer tube (USSR) & EHT supply kit: £40, Masthead amplifier kit based on MAR-6 (2GHz) IC: £9.  
We accept Mastercard, Visa, Amex.

**OATLEY ELECTRONICS**  
PO Box 89, OATLEY, NSW, 2223, AUSTRALIA  
Fax: 61-2-5707910

**SAVE OVER £5 - SUBSCRIBE NOW!**

EVERYDAY PRACTICAL ELECTRONICS

SUBSCRIPTION ORDER FORM

Annual subscription rates (1996):  
UK £24.00.  
Overseas £30.00 surface mail, £47.50 airmail.  
To:  
Everyday Practical Electronics,  
Allen House, East Borough,  
Wimborne,  
Dorset BH21 1PF  
Tel: 01202 881749  
Fax: 01202 841692

Name .....

Address .....

I enclose payment of £.....

(cheque/PO in £ sterling only, payable to Everyday Practical Electronics). Alternatively send Access or Visa number and card expiry date.

Signature .....

Please supply name and address of cardholder if different from the subscription address shown above. Subscriptions can only start with the next available issue. For back numbers see the Back Issues page.

M6/96

**Miscellaneous**

**PROTOTYPE PRINTED CIRCUIT BOARDS** one offs and quantities, for details send s.a.e. to **B. M. Ansbro, 38 Poynings Drive, Hove, Sussex BN3 8GR**, or phone Brighton 883871.

**G.C.S.E. ELECTRONICS KITS**, at pocket money prices. S.A.E. for FREE catalogue. **SIR-KIT Electronics, 70 Oxford Road, Clacton, CO15 3TE.**

**VALVE ENTHUSIASTS:** Capacitors and other parts in stock. For free advice/lists please ring, **Geoff Davies (Radio)**, Tel: 01788 574774.

**PRINTED CIRCUIT BOARDS - QUICK SERVICE.** Prototype and Production. Artwork raised from magazines or draft designs at low cost. PCB's also designed from schematics. Production assembly also undertaken. For details send to **P. Agar, 36 Woodcot Avenue, Belfast, BT5 5JA** or phone 01232 473533 (7 days).

**NOVICE REQUIRES HELP.** Has anyone interpreted and manufactured DOG2 circuit, if so contact **Alf 01977 706713.**

**MOTOR INVERTER DRIVE (0-55kW).** Suitable for direction/speed control of 220/240V 3 phase induction motor using single phase 220/240V input. Six available £50 each, £250 the lot. Tel: (01604) 784978 or (0850) 267576.

**THYRISTORS.** Stripped from unused equipment and tested. 40A, 1200V (¼in.-28UNF 2A) 200 available £1. each, £150 the lot. 110A, 1200V (½in.-20UNF 2A) 200 available £2 each, £300 the lot. Tel: (01604) 784978 or (0850) 267576.

## TRAIN TODAY FOR A BETTER FUTURE

Now you can get the skills and qualifications you need for career success with an ICS Home Study Course. Learn in the comfort of your own home at the pace and times that suit you. ICS is the world's largest, most experienced home study school. Over the past 100 years ICS have helped nearly 10 million people to improve their job prospects. Find out how we can help YOU. Post or phone today for FREE INFORMATION on the course of your choice.

Electrical Contracting  
Electrical Engineering  
C & G Basic Electronics  
C & G Basic Mechanics  
TV, Video & Hi-Fi Servicing  
Refrigeration & Air Conditioning  
PC Repair  
Electronic Engineering

Call 0141 306 1195

Please send me my Free Information on your Electronics Courses.

Mr/Mrs/Ms/Miss  
(BLOCK CAPITALS PLEASE)

Date of Birth / /

Address

Postcode

Occupation

Tel. No.

ICS International Correspondence Schools, Dept. ZEEEF, FREEPOST 882, 8 Elliot Place, Clydeway Centre, Glasgow, G3 8BR. Tel. 0141 306 1195 (9am-7pm) or Tel/Fax: Ireland 01 285 2533. Further offers, which may be of interest, may be sent to you by ICS or other carefully selected companies.

## SERVICE MANUALS & Technical Books

Available for most equipment, any make, age or model.  
Return the coupon for your FREE catalogue

MAURITRON TECHNICAL SERVICES (EPE)  
8 Cherry Tree Road, Chinnor, Oxon, OX9 4QY.  
Tel: 01844-351694. Fax: 01844 352554.

Please forward your latest catalogue for which I enclose 2 x 1st Class Stamps or £4.11 inc VAT for the Service Manuals Index on PC Disc plus catalogue.

NAME

ADDRESS

POSTCODE

Photocopy this coupon if you do not wish to cut the magazine

## N. R. BARDWELL LTD (EPE)

200	Signal diodes 1N4148.....	£1.00	25	5mm red l.e.d.s.....	£1.00
75	Rectifier Diodes 1N4001.....	£1.00	25	3mm red l.e.d.s.....	£1.00
50	Rectifier Diodes 1N4007.....	£1.00	25	Asstd. high brightness l.e.d.s.....	£1.00
10	W02 Bridge Rectifiers.....	£1.00	50	Axial l.e.d.s (Diode package).....	£1.00
5	NE555 Timer I.C.s.....	£1.00	12	Asstd. 7-segment displays.....	£1.00
50	Asstd. Zener Diodes.....	£1.00	2	FRP12 light dependant resistors.....	£1.00
30	BC212L Transistors.....	£1.00	30	Asstd. IF transformers.....	£1.00
30	BC213L Transistors.....	£1.00	48	Asstd. coil formers.....	£1.00
30	BC214C Transistors.....	£1.00	50	Asstd. RF chokes (inductors).....	£1.00
30	BC237 Transistors.....	£1.00	30	Asstd. connectors edge,d.I.L, sil etc.....	£1.00
20	BC327 Transistors.....	£1.00	30	Asstd. d.i.l. sockets up to 40-pin.....	£1.00
30	BC328 Transistors.....	£1.00	200	Asstd. disc ceramic capacitors.....	£1.00
30	BC337 Transistors.....	£1.00	80	Asstd. capacitors 1nF to 1µF.....	£1.00
30	BC478 Transistors.....	£1.00	80	Asstd. electrolytic capacitors.....	£1.00
30	BC546 Transistors.....	£1.00	10	4P3W MBB min. rotary switches.....	£1.00
30	BC547 Transistors.....	£1.00	20	Min. SP/CO slide switches.....	£1.00
30	BC548 Transistors.....	£1.00	20	1" glass reed switches.....	£1.00
30	BC549 Transistors.....	£1.00	200	4N7 mini axial capacitors.....	£1.00
25	BC557 Transistors.....	£1.00	24	24-pin d.i.l. wire wrap i.c. skts.....	£1.00
30	BC558 Transistors.....	£1.00	1	12V motorised volume control 50k.....	£1.00
30	BC559 Transistors.....	£1.00	50	Grommets 6.3mm id, 9.5mm od.....	£1.00
25	BC640 Transistors.....	£1.00	100	cfl ¼W 5% resistors any one value, E24, range 1R to 10M.....	£0.45
30	MPS442 Transistors.....	£1.00			
30	MPSA92 Transistors.....	£1.00			
20	2N3702 Transistors.....	£1.00			
20	2N3904 Transistors.....	£1.00			
5	78L12 12V 100mA Pos Regulators.....	£1.00			
10	79M08 8V 500mA Neg Regulators.....	£1.00			

Prices include VAT, postage £1.25. Stamp for Lists  
288 Abbeydale Road, Sheffield S7 1FL  
Phone (0114) 2552886 Fax (0114) 2500689

## INFOTECH & STREE

76 Church St, Larkhall, Lanarks, ML9 1HE  
Phone (01698) 883334/888343 or Fax (01698) 884825

Remember: Not only do we have every sheet ever produced, but we also have

### The World's Largest Collection of SERVICE MANUALS & CIRCUITS

We are now successfully running a Library Service which allows you to borrow any manual you want for as long as you want, and when you need another manual, just return the one you have, plus a £4.95 exchange fee and tell us what you want next.

*Borrow any Service Manual for £4.95 regardless of its size or normal cost*

The cost of this service is a yearly subscription fee of only £59.95.  
Join now & get a free 'Data Ref Guide'.

VISA



## Cooke International

SUPPLIER OF QUALITY USED TEST INSTRUMENTS

ANALYSERS, BRIDGES, CALIBRATORS, VOLTMETERS, GENERATORS, OSCILLOSCOPES, POWER METERS, ETC. ALWAYS AVAILABLE

ORIGINAL SERVICE MANUALS FOR SALE  
COPY SERVICE ALSO AVAILABLE

EXPORT, TRADE AND U.K. ENQUIRIES WELCOME  
SEND FOR LISTS OF EQUIPMENT & MANUALS  
ALL PRICES EXCLUDE VAT AND CARRIAGE

DISCOUNT FOR BULK ORDERS SHIPPING ARRANGED

OPEN MONDAY TO FRIDAY 9AM-5PM

Unit Four, Fordingbridge Site, Main Road, Barnham, Bognor Regis, West Sussex, PO22 0EB

Tel (+ 44) 01243 545111/2 Fax (+ 44) 01243 542457

EQUIPMENT & ACCESSORIES PURCHASED

31b mixed component pack.....	£4.95
Jumbo component pack.....	£10
250 off mixed capacitors.....	£4.95
250 off i.c. sockets.....	£3.95
1000 off mixed ceramic caps.....	£7.50*
20 off mixed crystals/filters.....	£4.95
25 off mixed relays.....	£3.50
100 off phono plugs.....	£2.95*
10 off mixed displays.....	£3.75*
50 off d.i.l. switches.....	£3.75*
30 off mixed heatsinks.....	£3.75*
30 off mixed switches.....	£3.75*
Brand new 360k 5¼" floppy drive.....	£4.50
5¼" to 3½" floppy drive converter leads.....	£1.50*
50Ω BNC to BNC lead.....	£1.75
2 phono plug to 2 phono plug lead.....	£1.50*
21-Pin SCART plug to SCART plug lead (all connected).....	£3.50
As above but plug to socket.....	£3.50*
SCART plug to 4 phone plug lead.....	£2.95
10 off crocodile clip leads.....	£3.50*

Universal Test Lead Kit.....£3.75\*

### VALVES

QQV0310, £10\*; QQV0320A, £10\*;  
QQV0640A, £20\*; ECC82, £3\*;  
ECH81, £2\*; PCL805, £3\*;  
ORP 11, £3; ORP 40, £3; CV 4004,  
4005, 4006, 4007, 4014, 4020,  
4024, 4043, 4055, 4064, 5042,  
5080, ALL £5 each\*.

QUANTITY DISCOUNTS AVAILABLE  
PLEASE RING.

We also buy all forms of electronic components, p.s.u.'s, disk drives etc. Lists to below address.

ALL PRICES INCLUDE V.A.T.  
PLEASE ADD £2.00 p&p EXCEPT  
ITEMS MARKED \* WHICH ARE 50P.  
SAE FOR BULK BUYING LIST  
PAYMENT WITH ORDER TO:

Dept EE, COMPELEC,  
14 Constable Road,  
St. Ives, Huntingdon,  
Cambs PE17 6EQ  
Tel/Fax: 01480 300819

Mixed metal/carbon film resistors ¼W E12 series 10 ohms to 1 Megohm.....	2p
Carbon Film resistors ¼W 5% E24 series 0.51 R to 10MΩ.....	1p
100 off per value - 75p. even hundreds per value totalling 1000.....	£6.00p
Metal Film resistors ¼W 10R to 1 MO 5% E12 series - 1½p. 1% E24 series.....	2p
Mixed metal/carbon film resistors ½W E24 series 1R to 10MΩ.....	1½p
1 watt mixed metal/Carbon Film 5% E12 series 4R7 to 10 Megohms.....	5p
Linear Carbon pre-sets 100mW and ¼W 100R to 2M E6 series.....	7p
Miniature polyester capacitors 250V working for vertical mounting .015, .022, .033, .047, .068 - 4p. 0.1 - 5p. 0.12, 0.15, 0.22 - 6p. 0.47 - 8p. 1.0 - 12p	
Mylar (polyester) capacitors 100V working E12 series vertical mounting 1000p to 8200p - 3p. 0.1 to .068 - 4p. 0.1 - 5p. 0.12, 0.15, 0.22 - 6p. 0.47/50V - 8p	
Submin ceramic plate capacitors 100V wkg vertical mountings. E12 series 2% 1.8p to 47p - 3p. 2% 56p to 330p - 4p. 10% 390p-4700p.....	4p
Polystyrene capacitors 50V E12 series 1P0 to 1000P. E6 Series 1500P to 47000P.....	2p
Polystyrene capacitors 63V working E12 series long axial wires 10p to 820p - 5p. 1000p to 10,000p - 6p. 12,000p.....	7p
741 Op Amp - 20p. 555 Timer - 20p. LM3900.....	80p
CMOS 4001 - 20p. 4011 - 22p. 4017 - 40p. 4069UB unbuffered.....	20p
DIL holders. 8-pin 9p; 14-, 16-, 18-pin 12p; 24-pin 18p; 28-pin 20p; 40-pin 25p.	
ALUMINIUM ELECTROLYTICS (Mids/Volts)	
1/50, 2/250, 4/750, 10/25, 10/50.....	5p
22/16, 22/25, 22/50, 33/16, 47/16, 47/25, 47/50.....	6p
100/16, 100/25 7p; 100/50.....	12p
220/16 8p; 220/25, 220/50 10p; 470/16, 470/25.....	11p
1000/25 25p; 1000/35, 2200/25 35p; 4700/25.....	70p
Subminiature, tantalum bead electrolytics (Mids/Volts) 0.1, 0.22, 0.47, 1.0, 2.2, 3.3 @35V - 4.7/16, 6.8/10, 10/6, 10p; 6.8/35, 12p. 4.7/25, 6.8/16, 10/6, 11p; 15/16, 22/6, 33/10, 15p; 10/25, 16p; 10/35, 22/16, 20p. 47/10, 20p; 47/16, 25p; 47/20, 30p; 47/35, 32p; 100/3, 18p; 100/6, 22/6, 20p.	
VOLTAGE REGULATORS 1A + or - 5V, 8V, 12V, 15V, 18V & 24V - 55p. 100mA. 5.8, 12, 15, V +.....	30p
DIODES (piv/amperes)	
75/25mA 1N4148 2p. 800/1A 1N4006 4½p. 400/3A 1N5404 14p. 115/15mA OA91.....	8p
100/1A 1N4002 3½p. 1000/1A 1N4007 5p. 60/1.5A 1M41 5p. 100/1A bridge.....	25p
400/1A 1N4004 4p. 1250/1A BY 127 10p. 30/150mA OA47 gold bonded.....	18p
Zener diodes E24 series 3V3 to 33V 400mW - 6p. 1 watt.....	10p
Battery snaps for PP3 - 7p for PP9.....	12p
L.E.D.'s 3mm, & 5mm. Red, Green, Yellow - 10p. Grommets 3mm - 2p. 5mm.....	2p
Red flashing L.E.D.'s require 9-12V supply only, 5mm.....	50p
Mains indicator neons with 220k resistor.....	10p
20mm fuses 100mA to 5A. O. blow 6p./surge 10p. Holders, chassis, mounting.....	6p
High speed pc drill 0.8, 1.0, 1.3, 1.5, 2.0mm - 40p. Machines 12V dc.....	£15.00
HELPING HANDS 6 ball joints and 2 croc clips to hold awkward jobs.....	£4.50
AA/HP7 Nicad rechargeable cells 90p each. Universal charger unit.....	£6.50
AA/HP7 zinc/carbon batteries in packs of 4.....	£1.10 per pack
Glass reed switches with single pole make contacts - 8p. Magnets.....	20p
0.1" Stripboard 2½" x 1" 9 rows 25 holes - 25p. 3" x 2½" 24 rows 37 holes.....	70p
Jack plugs 2.5 & 3.5m - 14p; Sockets Panel Mtg. 2.5 & 3.5m.....	10p
Ear pieces 2.5 & 3.5m, dynamic - 20p; 3.5mm crystal.....	£1.50
Multi cored solder, 22G - 8p yard, 18G - 14p yard.	
TRANSISTORS	
BC107/8/9 - 12p. BC547/8/9 - 8p. BC557/8/9 - 8p. BC182, 182L, BC183, 183L, BC184, 184L, BC212, 212L - 10p.	
BC327, 337, 337L - 12p. BC727, 737 - 12p. BD135/6/7/8/9 - 25p. BCY70 - 18p.	
BFY50/51/52 - 20p.	
BFX88 - 15p, 2N3055 - 55p, TIP31, 32 - 20p, TIP41, 42 - 40p, BU208A - £1.50, BF195, 197 - 12p	
Ionisers with seven year guarantee, 240V AC, list price £16.95 or more.....	£12.50

Do not add VAT. Postage 30p (free over £5). Stamp for list.

### THE CR SUPPLY CO

127 Chesterfield Rd., Sheffield S8 0RN Tel: 0114 2557771 Return posting

# OMNI ELECTRONICS

174 Dalkeith Road, Edinburgh EH16 5DX ★ 0131 667 2611

The supplier to use if you're looking for:-

★ A WIDE RANGE OF COMPONENTS AIMED

AT THE HOBBYIST

★ COMPETITIVE VAT INCLUSIVE PRICES ★

★ MAIL ORDER - generally by RETURN OF POST ★

★ FRIENDLY SERVICE ★

1995/6 CATALOGUE NOW IN STOCK!

**COST: £2.00.** Includes vouchers to offset against future purchases.

OPEN: Monday-Thursday 9.15 - 6.00.

Friday 9.15-5.00

Saturday 9.30-5.00



## Millions of quality components at lowest ever prices!

Plus Tools, Watches, Fancy Goods, Toys. Mail order UK only.

All inclusive prices - **NO** VAT to add on.

Send 43p stamped self addressed label or envelope for catalogue/clearance list.

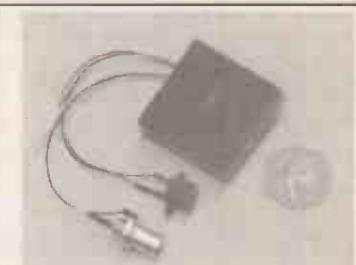
At least 2,100 offers to amaze you.

**Brian J Reed**

**6 Queensmead Avenue, East Ewell Epsom, Surrey KT17 3EQ**  
**Tel: 0181-393 9055**

### HIGH QUALITY LOW COST C.C.T.V. CAMERA

VERY LOW LIGHT LEVEL. AUTO ELECTRONIC SHUTTER. COMPOSITE VIDEO OUT VIA BNC PLUG. SMALL DISCRETE SIZE. CAN BE USED WITH PC DIGITISER.



This super quality CCD camera can be connected into your existing TV or video using the AV channel and can be used for discrete surveillance or observing your property externally using a suitable weatherproof housing. Can accommodate lighting levels ranging from daylight to street lighting using its built in electronic shutter. Excellent when using with an infra red source. Built in wide angle fixed focus lens the camera has a resolution of 380 TVL. Can be housed inside an empty floodlight case, (extra).

Special offer price of only: **£79.95 Plus VAT, (P&P £3.50)**

For full range of CCTV products send SAE to: **Direct CCTV Ltd., Dept. PE27., Unit 6, Carrick Court, Forrest Grove Business Park, Middlesbrough, TS2 1QE.**

### NEW MINI CAMERA and SPECIAL OFFERS

**NEW - Mini Waterproof TV Camera, 40 x 40 x 15mm, requires 10V to 16V at 120mA with composite video output (to feed into a Video or a TV with a SCART plug) it has a high resolution of 450 TV lines vertical and 380 TV lines horizontal, electronic auto iris for nearly dark (1 LUX) to bright sunlight operation and a pinhole lens with a 92 degree field of view, it focuses down to a few CM. It is fitted with a 3-wire lead (12V in and video out). £93.57 + VAT = £109.95 or 10+ £89.32 + VAT = £104.55.**

High quality Stepping Motor Kits (all including stepping motors) 'Comstep' independent control of two stepping motors by PC (via the Parallel Port) with two motors and software..... Kit £67.00, Built £99.00

Software support and 4-digital inputs kit..... £27.00

Power Interface: 4A kit £36.00, 8A kit, £46.00

Stepper kit 4 (manual control) includes 200 step stepping motor and control circuit..... £23.00

Hand Held Transistor Analyser. It tells you which lead is the base, the collector and emitter and if it is NPN or PNP or faulty. £33.45. Spare 6V battery £1.20.

LEDs 3mm or 5mm Red or Green 7p each, Yellow 11p each. Cable Ties 1p each, £5.95 per 1000, £49.50 per 10,000.

#### RECHARGEABLE BATTERIES

AA (HP7) 500mAh..... £0.99  
AA 700mAh..... £1.75  
C 2Ah with solder tags..... £3.50  
D 4Ah with solder tags..... £4.95  
1/2AA with solder tags..... £1.55  
AAA (HP16) 180mAh..... £1.75  
AA 500mAh with solder tags..... £1.55  
C (HP11) 1.2Ah..... £2.20  
D (HP2) 1.2Ah..... £2.60  
PP3 B-4V 110mAh..... £4.95  
Sub C with solder tags..... £2.50  
1/3 AA with tags (Philips CTV)..... £1.95

Standard Charger, charges 4 AA cells in 5 hours or 4 Cs or Ds in 12 to 14 hours, plus 1xPP3 (1, 2, 3 or 4 cells may be charged at a time)..... £5.95

High Power Charger, as above but charges the Cs and Ds in 5 hours; AAs, Cs and Ds must be charged in two or four hours..... £10.95

Nickel Metal Hydride AA cells, high capacity with no memory if charged at 100mA and discharged at 250mA or less 1100mAh capacity (lower capacity for high discharge rates)..... £3.75

#### SPECIAL OFFERS -

##### PLEASE CHECK FOR AVAILABILITY

Stick of 4, 42mm x 16mm NiCad batteries, 171mm x 16mm dia., with red and black leads, 4xV..... £5.95

Five button cell, 6V 280mAh battery with wires (Varia 5x 2500K)..... £2.45

Shaded-pole motor, 240V a.c. 5mm x 20mm shaft, 80mm x 60mm x 55mm, excluding the shaft..... £4.95

115V a.c. 80V d.c. motor, 4mm x 22mm shaft, 50mm dia. x 60mm long body (excluding the shaft) it has a replaceable thermal fuse and brushes..... £4.94 each, £3.95 100+

7-segment, common anode, i.e. d. display, 12mm..... 45p

LM337K. TO3 case. Variable regulator..... £1.95, 100+ £1.44

GAAs F.E.T. low leakage current 58573..... £12.95 each, £9.95 10+, £7.95 100+

BS250 p-channel MOSFET..... 45p

BC559 transistor..... £3.95 per 100

BC547A transistor..... 20 for £1.00

74LS05 Hex inverter..... £10.00 per 100

Used 8748 Microcontroller..... £3.50

SL952 UHF Limiting amplifier, LC 16 surface mounting package with data sheet..... £1.95

AM27S02..... £1.25 each; 90p 100+

CD4007UB..... 10p 100+, 5p 1000+

Sinclair Light Gun, terminated with a jack plug and PP3 clip, gives a signal when pointed at 50Hz flickering light, with output waveform chart..... £3.95

DC-DC Converter. Reliability model V12P5, 12V in, 5V 200mA out, 300V input-to-output isolation, with data..... £4.95 each or pack of 10 £39.50

Hour Counter used 7 digit 240V a.c. 50Hz..... £1.45

QWERTY keyboard, 58-key, good quality..... £6.00

Airpax AB2903-C large stepping motor 14V 7.5" step, 27 ohm, 68mm dia. body, 6.3mm shaft..... £8.95 or £200 for a box of 30

Polyester capacitors, box type, 22.5mm lead pitch  
0.22µF 250V d.c. 15p each, 100 + 7.5p 1000 +  
1µF 250V d.c. 20p each, 15p 100 +, 10p 1000 +  
1µF 50V bipolar electrolytic axial leads, 15p each, 7.5p 1000 +  
0.22µF 250V polyester axial leads, 15p each, 100 + 7.5p each  
Polypropylene 1µF 400V d.c. (Wima MKP10) 27.5mm pitch, 32mm x 29mm x 17mm case, 75p each, 60p 100 +  
Philips 125 series solid aluminum axial leads, 33µF 10V and 2.2µF 40V 40p each, 25p 100 +  
Philips 108 series, long life, 22µF 63V axial..... 30p each, 15p 1000 +  
Multilayer AVX ceramic capacitors, all 5mm pitch, 100V 100pF, 150V 220pF, 10,000pF (10n) 10p each, 5p 100 +, 3.5p 1000 +  
500pF compression trimmer capacitor..... 60p  
40µF 370V a.c. motor start capacitor (dielectric type containing no p.c.b.s.)..... £5.95 or £49.50 for 10  
Solid carbon resistors, very low inductance, ideal for r.f. circuits, 27 ohm 2W, 68 ohm 2W 25p each, 15p each 100 +  
We have a range of 0.25W, 0.5W, 1W and 2W solid carbon resistors - please send SAE for list  
P.C.-400W PSU (initial part 201035-001) with standard motherboard and five disk drive connectors, fan and mains input/output connectors on back and switch on the side (top for lower case) dims. 212mm x 149mm x 149mm excluding switch. £26.00 each, £138.00 for 6  
M1180 Digital Multimeter 17 ranges, 1000V d.c. 750V a.c. 2Megohm 200mA transistor Hie 9v and 1.5V battery test..... £9.95

AMD 2756-3 EPROMs £2.00 each. £1.25 100 +  
Immac deluxe anti-glare static control panel, window size 228mm x 161mm, overall size 264mm x 200mm, held to the monitor with hook and loop tape pads..... £7.95 each  
DIP switch 3PDC 12-pin (ERG SDC-3-023) 60p each, 40p 100 +  
Disk Drive Boxes for a 5.25 disk drive, with room for a power supply, light-grey plastic 67mm x 268mm x 247mm £7.95 or £49.50 for 10  
Handheld Ultrasonic Remote Control..... £3.95  
C12386 Gas Relay 30mm x 10mm dia. with 3-wire terminals, will also work as a neon light..... 20p each, or £7.50 per 100

All products advertised are new and unused unless otherwise stated.  
Wide range of CMOS TTL 74HC74F Linear, Transistors kits, rechargeable batteries, capacitors, tools etc. always in stock. Please add £1.95 towards P&P. VAT included in all prices.

### JPG ELECTRONICS

276-278 Chatsworth Road  
Chesterfield S40 2BH

Access/Visa Orders:  
Tel: (01246) 211202 Fax: (01246) 550959

Callers welcome 9.30am to 5.30pm  
Monday to Saturday

## ADVERTISERS INDEX

N. R. BARDWELL.....	487
B.K. ELECTRONICS.....	Cover (iii)
BRIAN J. REED.....	488
BULL ELECTRICAL.....	Cover (ii)/485
CHATWIN GUITARS (JCG).....	429
CIRKIT DISTRIBUTION.....	429
COMPELEC.....	487
COOKE INTERNATIONAL.....	487
CRICKLEWOOD ELECTRONICS.....	466
CR SUPPLY CO.....	487
DIRECT CCTV.....	488
DISPLAY ELECTRONICS.....	410
ELECTRONICS SERVICE MANUAL.....	474
EPT EDUCATIONAL SOFTWARE.....	414
ESR ELECTRONIC COMPONENTS.....	420
GREENWELL ELECTRONICS.....	415
HART ELECTRONIC KITS.....	427
ICS.....	487
INFOTECH & STREE.....	487
J&N FACTORS.....	416
JPG ELECTRONICS.....	488
LABCENTER ELECTRONICS.....	430
LENNARD RESEARCH.....	455
MAGENTA ELECTRONICS.....	418/419
MAPLIN ELECTRONICS.....	Cover (iv)
MAURITRON.....	487
MODERN ELECTRONICS MANUAL.....	413
NATIONAL COLLEGE OF TECHNOLOGY.....	429
NICHE SOFTWARE.....	482
OMNI ELECTRONICS.....	488
QUASAR ELECTRONICS.....	417
QUICKROUTE SYSTEMS.....	412
RADIO-TECH.....	417
SEETRAX CAE.....	455
SERVICE TRADING CO.....	455
SHERWOOD ELECTRONICS.....	473
STEWART OF READING.....	466
SUMA DESIGNS.....	467
TSIEN (UK).....	443

ADVERTISEMENT MANAGER: PETER J. MEW

ADVERTISEMENT OFFICES:  
EVERYDAY PRACTICAL ELECTRONICS,  
ADVERTISEMENT,  
HOLLAND WOOD HOUSE, CHURCH LANE,  
GREAT HOLLAND, ESSEX CO13 0JS.  
Phone/Fax: (01255) 850596

For Editorial address and phone numbers see page 421.

**OMP MOS-FET POWER AMPLIFIERS  
HIGH POWER, TWO CHANNEL 19 INCH RACK**

**THOUSANDS PURCHASED  
BY PROFESSIONAL USERS**



**THE RENOWNED MXF SERIES OF POWER AMPLIFIERS  
FOUR MODELS:- MXF200 (100W + 100W) MXF400 (200W + 200W)**

**MXF600 (300W + 300W) MXF900 (450W + 450W)  
ALL POWER RATINGS R.M.S. INTO 4 OHMS, BOTH CHANNELS DRIVEN**

**FEATURES:** ★Independent power supplies with two toroidal transformers ★ Twin L.E.D. Vu meters ★ Level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 & MXF900 fan cooled with D.C. loudspeaker and thermal protection.

**USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.**

**SIZES:-** MXF200 W19" x H3 1/2" (2U) x D11"  
MXF400 W19" x H5 1/4" (3U) x D12"  
MXF600 W19" x H5 1/4" (3U) x D13"  
MXF900 W19" x H5 1/4" (3U) x D14 1/2"

**PRICES:-** MXF200 £175.00 MXF400 £233.85  
MXF600 £329.00 MXF900 £449.15  
SPECIALIST CARRIER DEL. £12.50 EACH



**OMP XO3 STEREO 3-WAY ACTIVE CROSS-OVER**



Advanced 3-Way Stereo Active Cross-Over, housed in a 19" x 1U case. Each channel has three level controls: bass, mid & top. The removable front fascia allows access to the programmable DIL switches to adjust the cross-over frequency: Bass-Mid 250/500/800Hz, Mid-Top 1.8/3/5KHz, all at 24dB per octave. Bass invert switches on each bass channel. Nominal 775mV input/output. Fully compatible with OMP rack amplifier and modules.

**Price £117.44 + £5.00 P&P**

**STEREO DISCO MIXER SDJ3400SE ★ ECHO & SOUND EFFECTS★**

**STEREO DISCO MIXER** with 2 x 7 band L & R graphic equalisers with bar graph LED Vu meters. **MANY OUTSTANDING FEATURES:-** including Echo with repeat & speed control, DJ Mic with talk-over switch, 6 Channels with individual faders plus cross fade, Cue Headphone Monitor, 8 Sound Effects. Useful combination of the following inputs:- 3 turntables (mag), 3 mics, 5 Line for CD, Tape, Video etc.



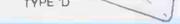
**Price £144.99 + £5.00 P&P**

**SIZE: 482 x 240 x 120mm**

**PIEZO ELECTRIC TWEETERS - MOTOROLA**

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

**TYPE 'A'** (KSN1036A) 3" round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi speakers. Price £4.90 + 50p P&P.  
**TYPE 'B'** (KSN1005A) 3 1/2" super horn for general purpose speakers, disco and P.A. systems etc. Price £5.99 + 50p P&P.  
**TYPE 'C'** (KSN1016A) 2" x 5" wide dispersion horn for quality Hi-Fi systems and quality discos etc. Price £6.99 + 50p P&P.  
**TYPE 'D'** (KSN1025A) 2" x 6" wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. Price £9.99 + 50p P&P.  
**TYPE 'E'** (KSN1038A) 3 3/4" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £5.99 + 50p P&P.  
**LEVEL CONTROL** Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. Price £4.10 + 50p P&P.



**IBI FLIGHT CASED LOUDSPEAKERS**

A new range of quality loudspeakers, designed to take advantage of the latest speaker technology and enclosure designs. Both models utilize studio quality 12" cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands.

**POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET  
FREQUENCY RESPONSE FULL RANGE 45Hz - 20KHz**

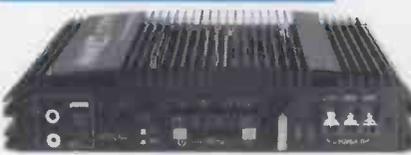
**IBI FC 12-100WATTS (100dB) PRICE £159.00 PER PAIR**  
**IBI FC 12-200WATTS (100dB) PRICE £175.00 PER PAIR**

SPECIALIST CARRIER DEL. £12.50 PER PAIR

**OPTIONAL STANDS PRICE PER PAIR £49.00**  
Delivery £6.00 per pair



**IN-CAR STEREO BOOSTER AMPS**



**PRICES: 150W £49.99 250W £99.99  
400W £109.95 P&P £2.00 EACH**

**THREE SUPERB HIGH POWER  
CAR STEREO BOOSTER AMPLIFIERS**  
150 WATTS (75 + 75) Stereo, 150W Bridged Mono  
250 WATTS (125 + 125) Stereo, 250W Bridged Mono  
400 WATTS (200 + 200) Stereo, 400W Bridged Mono  
**ALL POWERS INTO 4 OHMS**  
**Features:**  
★ Stereo, bridged mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

**OMP MOS-FET POWER AMPLIFIER MODULES SUPPLIED READY BUILT AND TESTED.**

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

**THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS**



**OMP/MF 100 Mos-Fet Output power 110 watts**  
R.M.S. into 4 ohms, frequency response 1Hz - 100KHz  
-3dB, Damping Factor > 300, Slew Rate 45V/uS,  
T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R.  
-110 dB. Size 300 x 123 x 60mm.  
**PRICE £40.85 + £3.50 P&P**



**OMP/MF 200 Mos-Fet Output power 200 watts**  
R.M.S. into 4 ohms, frequency response 1Hz - 100KHz  
-3dB, Damping Factor > 300, Slew Rate 50V/uS,  
T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R.  
-110 dB. Size 300 x 155 x 100mm.  
**PRICE £64.35 + £4.00 P&P**



**OMP/MF 300 Mos-Fet Output power 300 watts**  
R.M.S. into 4 ohms, frequency response 1Hz - 100KHz  
-3dB, Damping Factor > 300, Slew Rate 60V/uS,  
T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R.  
-110 dB. Size 330 x 175 x 100mm.  
**PRICE £81.75 + £5.00 P&P**



**OMP/MF 450 Mos-Fet Output power 450 watts**  
R.M.S. into 4 ohms, frequency response 1Hz - 100KHz  
-3dB, Damping Factor > 300, Slew Rate 75V/uS,  
T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R.  
-110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2  
Second Anti-Thump Delay. Size 385 x 210 x 105mm.  
**PRICE £132.85 + £5.00 P&P**



**OMP/MF 1000 Mos-Fet Output power 1000 watts**  
R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms,  
frequency response 1Hz - 100KHz -3dB, Damping  
Factor > 300, Slew Rate 75V/uS, T.H.D. typical  
0.002%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan  
Cooled, D.C. Loudspeaker Protection, 2 Second  
Anti-Thump Delay. Size 422 x 300 x 125mm.  
**PRICE £259.00 + £12.00 P&P**

**NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS:  
STANDARD - INPUT SENS 500mV, BANDWIDTH 100KHz,  
PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS  
775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.**

**LOUDSPEAKERS**



**LARGE SELECTION OF SPECIALIST LOUDSPEAKERS  
AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER  
GRILLES, CROSS-OVERS AND HIGH POWER, HIGH  
FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E.  
(60p STAMPED) FOR COMPLETE LIST.**

McKenzie and Fane Loudspeakers are also available.

**EMINENCE- INSTRUMENTS, P.A., DISCO, ETC**

**ALL EMINENCE UNITS 8 OHMS IMPEDANCE**  
8" 100 WATT R.M.S. ME8-100 GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO. PRICE £32.71 + £2.00 P&P  
RES. FREQ. 72Hz, FREQ. RESP. TO 4KHz, SENS 97dB.  
10" 100 WATT R.M.S. ME10-100 GUITAR, VOCAL, KEYBOARD, DISCO, EXCELLENT MID. PRICE £33.74 + £2.50 P&P  
RES. FREQ. 71Hz, FREQ. RESP. TO 7KHz, SENS 97dB.  
10" 200 WATT R.M.S. ME10-200 GUITAR, KEYB'D, DISCO, VOCAL, EXCELLENT HIGH POWER MID. PRICE £43.47 + £2.50 P&P  
RES. FREQ. 65Hz, FREQ. RESP. TO 3.5KHz, SENS 99dB.  
12" 100 WATT R.M.S. ME12-100LE GEN. PURPOSE, LEAD GUITAR, DISCO, STAGE MONITOR. PRICE £35.64 + £3.50 P&P  
RES. FREQ. 49Hz, FREQ. RESP. TO 6KHz, SENS 100dB.  
12" 100 WATT R.M.S. ME12-100LT (TWIN CONE) WIDE RESPONSE, P.A., VOCAL, STAGE MONITOR. PRICE £36.67 + £3.50 P&P  
RES. FREQ. 42Hz, FREQ. RESP. TO 10KHz, SENS 98dB.  
12" 200 WATT R.M.S. ME12-200 GEN. PURPOSE, GUITAR, DISCO, VOCAL, EXCELLENT MID. PRICE £46.71 + £3.50 P&P  
RES. FREQ. 58Hz, FREQ. RESP. TO 6KHz, SENS 98dB.  
12" 300 WATT R.M.S. ME12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARD, DISCO ETC. PRICE £70.19 + £3.50 P&P  
RES. FREQ. 47Hz, FREQ. RESP. TO 5KHz, SENS 103dB.  
15" 200 WATT R.M.S. ME15-200 GEN. PURPOSE BASS, INCLUDING BASS GUITAR. PRICE £50.72 + £4.00 P&P  
RES. FREQ. 46Hz, FREQ. RESP. TO 5KHz, SENS 99dB.  
15" 300 WATT R.M.S. ME15-300 HIGH POWER BASS, INCLUDING BASS GUITAR. PRICE £73.34 + £4.00 P&P  
RES. FREQ. 39Hz, FREQ. RESP. TO 3KHz, SENS 103dB.

**EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC**

**ALL EARBENDER UNITS 8 OHMS** (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohms)  
**BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND**  
8" 50Watt EB8-50 DUAL IMPEDANCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. PRICE £8.90 + £2.00 P&P  
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB.  
10" 50Watt EB10-50 DUAL IMPEDANCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. PRICE £13.65 + £2.50 P&P  
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB.  
10" 100Watt EB10-100 BASS, HI-FI, STUDIO. PRICE £30.39 + £3.50 P&P  
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB.  
12" 100Watt EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO. PRICE £42.12 + £3.50 P&P  
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB.  
**FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND**  
5 1/2" 60Watt EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. PRICE £9.99 + £1.50 P&P  
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB.  
6 1/2" 60Watt EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. PRICE £10.99 + 1.50 P&P  
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB.  
8" 60Watt EB8-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. PRICE £12.99 + £1.50 P&P  
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB.  
10" 60Watt EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC. PRICE £16.49 + £2.00 P&P  
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB.

**TRANSMITTER HOBBY KITS**

**PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE  
PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS  
COMPLETE WITH CIRCUIT AND INSTRUCTIONS**  
3W TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE. RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP. PRICE £14.85 + £1.00 P&P  
FM MICRO TRANSMITTER 100-108MHz, VARICAP TUNED. COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATTERY. PRICE £8.80 + £1.00 P&P



PHOTO: 3W FM TRANSMITTER

**B.K. ELECTRONICS**

**UNITS 1 & 5 COMET WAY, SOUTHEND-ON-SEA,  
ESSEX. SS2 6TR.  
Tel.: 01702-527572 Fax.: 01702-420243**

POSTAL CHARGES PER ORDER £100 MINIMUM. OFFICIAL ORDERS FROM SCHOOLS, COLLEGES, GOV'T, BODIES, PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER, VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX.



# ELECTRONICS is FUN with

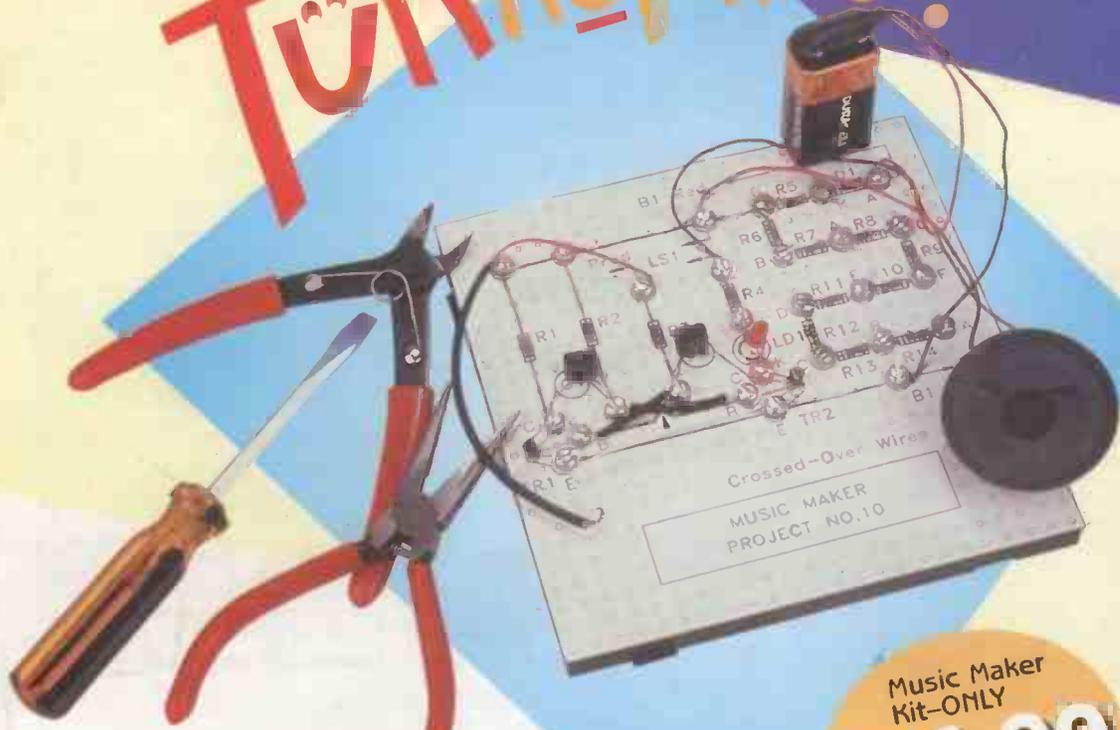
# funtronics!

No soldering is required and only a small screwdriver, pliers and wire cutters are normally needed. The components and connecting wire are held in place by self-tapping screws which fit into holes in the plastic 'peg-board' supplied. The kits include all the parts needed except battery and tools.

A range of 10 educational projects, ideal for the beginner to electronics.

## Music Maker

An electronic organ with 10 notes, which are sufficient to play a range of simple tunes. The kit introduces the concept of an astable multivibrator oscillating at different speeds to produce notes of differing frequencies.



Music Maker  
Kit-ONLY  
**£4.99**  
51285

### The Flasher

Two LEDs (light-emitting diodes) flash on and off alternately, under the control of an astable circuit. Ideal for warning lights on a model level crossing, etc.  
Order code 51280, **£3.99**

### Electronic Siren

An adjustable oscillator circuit that is ideal for model cars, etc., as it produces a controllable range of siren sounds.  
Order code 51281, **£4.99**

### Light/Dark Indicator

A circuit that can detect the light level in a room and switch on an LED indicator accordingly. Ideal as a photographic darkroom indicator.  
Order code 51279, **£4.99**

### Water Indicator

This circuit can detect the amount of water, for example in a plant-pot, and light an LED to show when the soil is dry

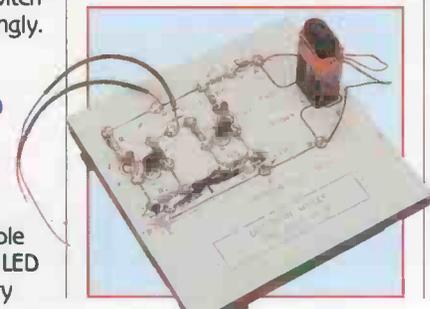
and the plant needs watering.  
Order code 51278, **£3.99**

### Bulb and Fuse Tester

A simple, yet useful circuit, which tests fuses, switches, bulbs, etc. If the device under test is good, the LED will light.  
Order code 51276, **£3.99**

### Decision Maker

A 'heads-or-tails' circuit that lights one of either of two LEDs at 'random' for easy solutions to those "shall I?, shan't I?" decisions.  
Order code 51283, **£3.99**



### Morse Code Communicator

A circuit that produces an audio tone like that associated with Morse Code, allowing you to produce audible messages and learn this famous code.  
Order code 51284, **£5.99**

### Pet Communicator

At low light levels the audio frequency output of this circuit is very low, but in daylight the frequency is very high and can probably only be heard by your cat or dog.  
Order code 51282, **£5.99**

### Transistor Tester

This useful circuit teaches you how transistors work and allows you to test diodes and transistors for use in your other projects.  
Order code 51277, **£3.99**



Watch as you build...  
**AM RADIO Kit**  
A simple AM radio receiver kit which includes a step-by-step construction guide on a VHS video tape.  
Order code 51286, **£19.99**

**ORDER NOW ON  
0800 136156**



or phone **01702 552911** for details of your local Maplin or Mondo store

All items subject to availability. Handling charge £1.55 per mail order. All prices include VAT. E&OE.

