

**EVERYDAY**

OCTOBER 1995

With **PRACTICAL**

# **ELECTRONICS**

INCORPORATING ELECTRONICS MONTHLY

FULLY S.O.R. £2.25

## **GINORMOUS VU METER**

Build this unusual  
audio/disco display

## **SECURITY TAGGING**

*Electronic tags protect  
high street merchandise*

**FREE**

## **MULTIPROJECT P.C.B.**

**WORTH**

**£3.00**

Build any of  
these  
projects  
on the  
FREE P.C.B.:

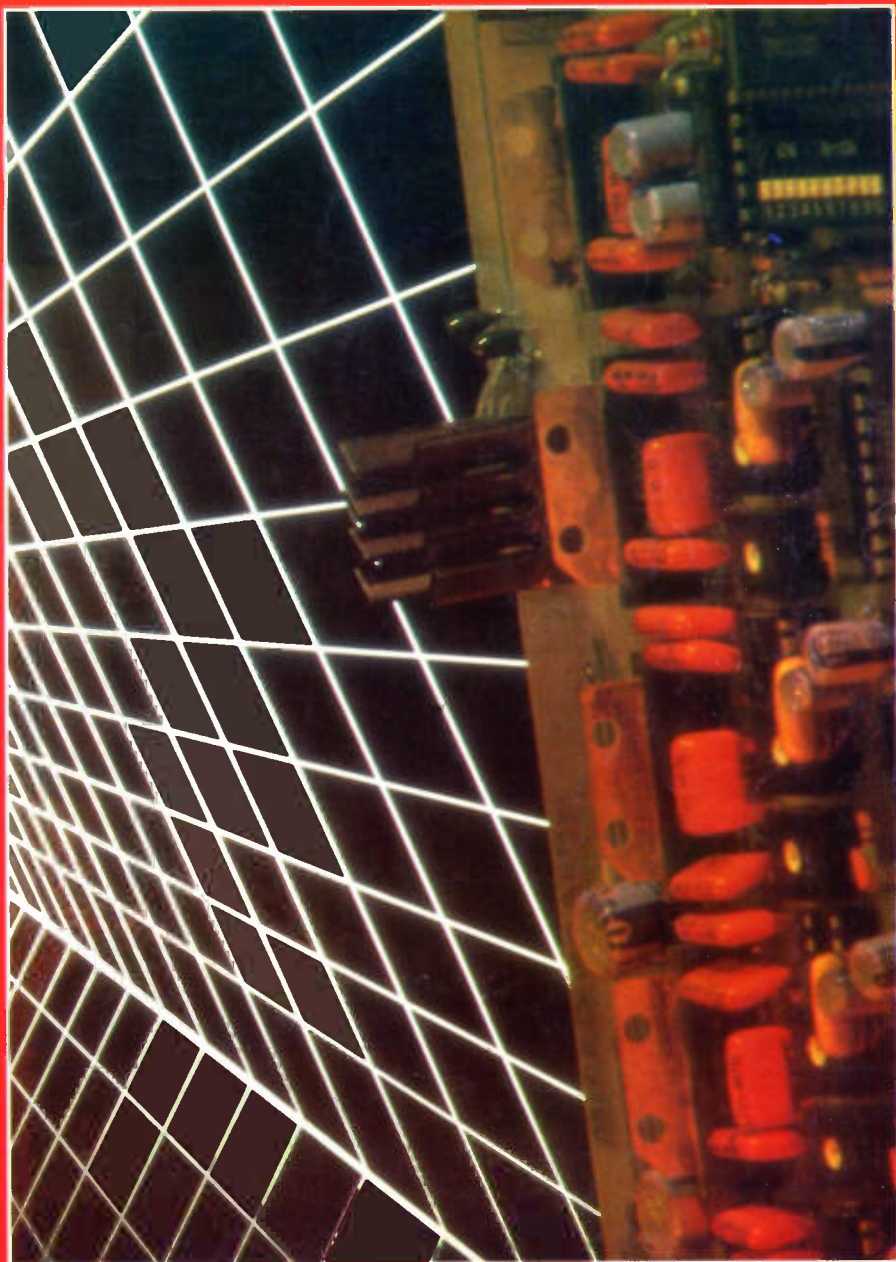
**IR ALARM/  
CONTROLLER**

**TREBLE BOOSTER**

**AUDIO SINEWAVE**

**GENERATOR**

Plus 3 more FREE p.c.b.  
projects next month!



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



# BULL CLEAROUT SALE

**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 operating time. E99 REF EP79. (probably not licensable!)

**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 fit it to anything from videos to caravans, provides a years protection from 1 PP3 battery, UK made. SALE PRICE £4.99 REF SA33.

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

**COMMODORE GAMES CONSOLES** Just a few of these left to clear at £5 ref SA31. Condition unknown.

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

**IBM PS2 MODEL 160Z CASE AND POWER SUPPLY** Complete with fan etc and 200 watt power supply. SALE PRICE £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 £4.99 ref EP69

**PP3 NICADS** New and unused but some storage marks. SALE PRICE £4.99 ref EP52

**SOLAR PANELS** 3v output with two flyleads, 100x60 mm pack of 10 SALE PRICE £6.99 ref EP56

**DELL PC POWER SUPPLIES** (Customer returns) Standard PC psu's complete with fly leads, case and fan, pack of two psus SALE PRICE £5 FOR TWO!! ref EP61

**GASHOBS 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

**BITS AND BOBS** We have a quantity of cased modems, multiplexers etc different specs but ideal strippers. SALE PRICE £4 each ref EP63

**RED EYE SECURITY PROTECTOR** 1,000 watt outdoor PIR switch SALE PRICE £9.99 ref EP57

**ENERGY BANK KIT** 100 6"x6" 6v 100mA panels, 100 diodes, connection details etc. £69.95 ref EP112

**CCTV CAMERA MODULES** 46X70X29mm, 30 grams, 12v 100mA auto electronic shutter, 3.6mm F2 lens, CCIR, 512x492 pixels, video output 1v p-p (75 ohm). Works directly into a scart or video input on a tv or video. IR sensitive. £79.95 ref EP137.

**IR LAMP KIT** Suitable for the above camera enables the camera to be used in total darkness! £5.99 ref EP138.

**PASTEL ACCOUNTS SOFTWARE**, does everything for all sizes of businesses, includes wordprocessor, 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!!

**MINI MICRO FANS** 12V 1.5" sq SALE PRICE £2. Ref SA13.

**REUSEABLE HEAT PACKS**, ideal for fishermen, outdoor enthusiasts elderly or infirm, warming food, drinks etc, defrosting pipes etc. reusable up to 10 times, lasts for up to 8 hours per go, 2,000wh energy, gets up to 90 degC. SALE PRICE £9.95 REF SA29

**12V ZAMP LAPTOP** psu's 110x55x40mm (includes standard IEC socket) and 2m lead with plug. 100-240v IP. SALE PRICE £6.99 REF SA15.

**PC CONTROLLED 4 CHANNEL TIMER** Control (on/off times etc) up to 4 items (BA 240v each) with this kit. Complete with Software, relays, PCB etc. £25.99 Ref 95/26

**COMPLETE PC 300 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. SALE PRICE just £89.00.

**SOLAR PATH LIGHTS** Low energy walklights powered by the sun built in PIR so they work when you walk past. Includes solar panel & rechargeable bat. SALE PRICE £19.99 REF EP62

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

**WANT TO MAKE SOME MONEY? STUCK FOR AN IDEA?** We have collected 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 a certificate enabling you to reproduce the manuals as much as you like! SALE PRICE £14 REF EP74

**RACAL MODEM BONANZA!** 1 Racal 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.

**NEW LASER POINTER**, Supplied in kit form, complete with power adjuster, 1.5mw, and beam divergence adjuster. Runs on 2 AAA batteries. Produces thin red beam ideal for levels, gun sights, experiments etc. Cheapest in the UK! just £39.95 ref DEC49 TRADE PRICE £28 MIN 10 PIECES

**RADIO PAGERS** Brand new, UK made pocket pagers clearance price is just £4.99 each 100x40x15mm packed with bits! Ref SEP5.

**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

**COMPUTER RS232 TERMINALS. (LIBERTY)** Excellent quality modern units, (like wyse 50, s) 2XRS232, 20 function keys, 50 thro to 38,400 baud, menu driven port, screen, cursor, and keyboard setup menus (18 menus). £29 REF NOV4.

**PC PAL VGA TO TV CONVERTER** Converts a colour TV into a basic VGA screen. Complete with built in psu, lead and sware. 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.

**SWINGFIRE GUIDED MISSILE WIRE**, 4,200 metre reel of ultra thin 4 core insulated cable, 28lbs breaking strain, less than 1mm thick! Ideal alarms, intercoms, fishing, dolls house's etc. SALE PRICE £13.99 ref EP51

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

**ASTEC SWITCHED MODE PSU** BM41012 Gives +5 @ 3.75A, +12 @ 1.5A, -12 @ 4A, 230/110, cased, BM41012. £5.99 ref AUG6P3.

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

**TOP QUALITY CENTRIFUGAL MAINS MOTORS SALE PRICE FOR JUST £2.50 REF SA38**

**ECLATRON FLASH TUBE** As used in police car flashing lights etc, full spec supplied, 60-100 flashes a min. SALE PRICE £6.99 REF SA15.

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

**MILITARY SPECGEIGER COUNTERS** Unused an straight from Her majesty's forces. SALE PRICE £44 REF SA16

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

**RGB/CGA/EGA/VGA/TTL COLOUR MONITORS** 12" in good condition. Back andised metal case. SALE PRICE £49 REF SA16

**SWITCHED MODE PSU** ex equip, 60w +5v @5A, -5v @ 5A, +12v @2A, -12v @.5A 120/220v cased 24.5x8x55mm IEC input socket £6.99 REF MAG7P1

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

**POWER SUPPLY** fully cased with mains and o/p leads 17v DC 900mA output. Bargain price £5.99 ref MAG6P9

**ACORN ARCHMEDES PSU +5v @ 4.4A** on/off sw uncased, selectable mains input, 145x100x45mm SALE PRICE £4.99 REF SA1

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

**PPC MODEM CARDS**. These are high spec plug in cards made for the Amstrad laptop computers. 2000 baud dial up unit complete with leads. Clearance price is £5 REF: MAG5P1

**200 WATT INVERTER** Converts 10-15v DC into either 110v or 240v AC. Fully cased 115x36x156mm, complete with heavy duty power lead, cigar plug, AC outlet socket. Auto overload shutdown, auto short circuit shut down, auto input over voltage shutdown, auto input under voltage shut down (with audible alarm), auto temp control, unit shuts down if overheated and sounds audible alarm. Fused reversed polarity protected. output frequency within 2%, voltage within 10%. A well built unit at a keen price. Just £64.99 ref AUG65.

**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

**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 PC's over a long distance. Complete kit £8.99.

**ELECTRIC MOTOR KIT** Comprehensive educational kit includes all you need to build an electric motor. £9.99 ref MAR10P4.

**VIEWDATA SYSTEMS** made by Philips, 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

\*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 POST PLUS VAT.

PLEASE ALLOW 7-10 DAYS FOR DELIVERY PHONE ORDERS  
WELCOME (ACCESS, VISA, SWITCH, AMERICAN EXPRESS)

TEL: 01273 203500  
FAX 01273 323077

**\*FM CORDLESS MICROPHONE** Small hand held unit with a 500' range! 2 transmit power levels. Reqs PP3 9v battery. Tuneable to any FM receiver. Price is £15 REF: MAG15P1

**\*MINIATURE RADIO TRANSCEIVERS** A pair of walkie talkies with a range up to 2 km in open country. Units measure 22x52x155mm. Including cases and earpieces 2XPP3 req'd. £30.00 pr. REF: MAG30

**FUTURE PC POWER SUPPLIES** These are 295x135x60mm, 4 drive connectors 1 mother board connector, 150watt 12v fan, IEC inlet and on/off switch. SALE PRICE £7.99 REF SA 22

**\*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 Transmits to any FM radio, (this is in kit form with full instructions.)

**\*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 looks missing and sometimes broken hinges. However they can be adapted for their original use or used for something else?? SALE PRICE JUST £2.50 REF SA23

**GAT AIR PISTOL PACK** Complete with pistol, darts and pellets £12.95 ref EF82 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 MAG5P13 deal for experimenters! 30 m for £12.99 ref MAG13P1

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

**SIDE LEVER .177 AIR RIFLE** Superb, low priced general purpose rifle, 18" tapered, rifled barrel, fully adjustable open sights, wooden stock, very accurate with low recoil. 41". £39.95 ref R/3

**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 goes back the other way! £1.99 ref GI/J01.

**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

**EDIBLE LONG LIFE CANDLES** Made from Oleo Beef Stearn so you can eat them in an emergency alternatively, you could just light them! Each candle burns for approx 10 hours. 2 for £2.99 ref O/N326

**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/L041

**LENSTATIC RANGER COMPASS** Oil filled capsule, strong metal case, large luminous points. Sight line with magnifying viewer. 50mm dia, 86gm. £10.99 ref O/K604.

**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 lights 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.

**SNOREBUSTER!** A small wristwatch style device that detects the noise of snoring and instantly produces a stimulation to the wrist of the snorer without waking them. The bio feedback effectively prevents future bouts of snoring, thus reducing Snorebuster to only occasional use. 10 of 1,000's sold. £24.99 ref LA15999.

**WORLDS SMALLEST TAPELESS MEMO PEN!** Not only is the smart pen but will record 20 seconds of memos etc. No more scabbing about for scraps of paper! £39.99 ref AA21381

**ELECTRIC TYRE INFLATOR** High power micro air compressor inflates tyres, airbeds footballs etc. Includes pressure gauge £14.99 ref JB231.

**MAMOD STEAM ENGINE SP2** Powerful compact model steam engine complete with fuel etc. £39.95 ref SP2.

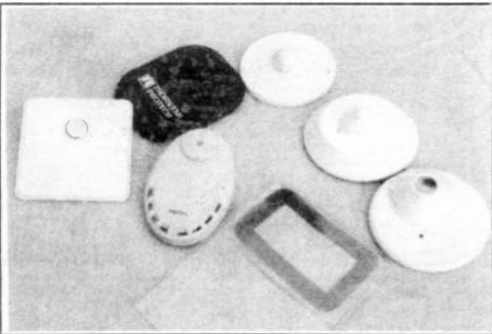
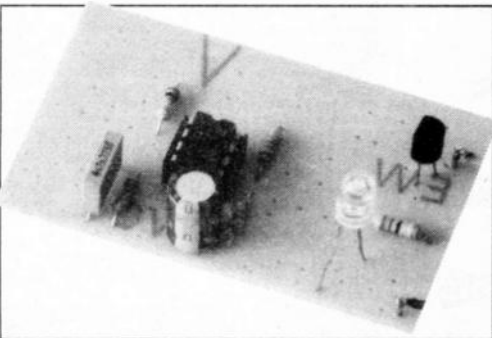
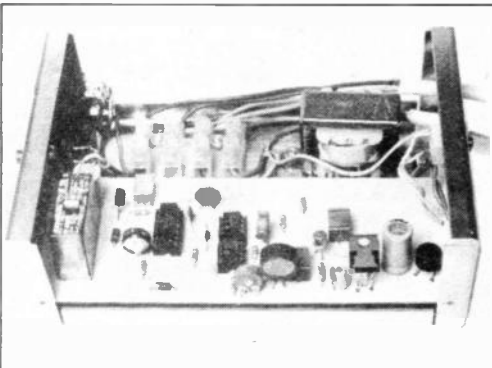
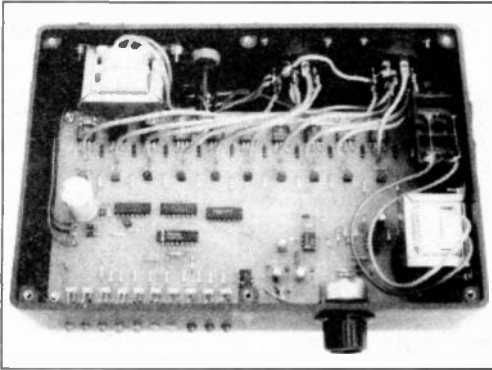
**SANYO NICAD PACKS** 120mmx14mm 4.8v 270 mA/h suitable for cordless phones etc. Pack of 2 just £5 ref EP78.

**WE BUY SURPLUS STOCK FOR CASH**  
**FREE CATALOGUE**

**1995 100 PAGE CATALOGUE NOW AVAILABLE, 45P STAMP OR FREE WITH ORDER.**

**PORTABLE RADIATION DETECTOR**  
**WITH NEW COMPUTER INTERFACE £59**

A Hand held personal Gamma and X Ray detector. This unit contains two Geiger Tubes, has a 4 digit LCD display with a Piezo speaker, giving an audio visual indication. The unit detects high energy electromagnetic quanta with an energy from 30K eV to over 1.2M eV and a measuring range of 5-9999 UR/h or 10-99990 Nr/h. ref NOV18



## Projects

- GINORMOUS VU METER** by Paul Stenning 754  
Add brilliant individuality to your disco display lighting
- SOUND SWITCH** by Terry de Vaux-Balbirnie 766  
Deter prowlers with a noise triggered security light controller
- AUDIO SINEWAVE GENERATOR** by Robert Penfold 778  
A switched-range signal generator to build on your FREE p.c.b.
- TREBLE BOOSTER** by Robert Penfold 782  
Lift your music to brighter levels with another project for your FREE p.c.b.
- INFRA-RED CONTROLLER/ALARM** by Robert Penfold 786  
Versatile I.R. transmitter/receiver system built using two FREE p.c.b.s
- CAPACITOR CHECK** by Terry de Vaux-Balbirnie 797  
Simply discover the standard value of disguised-identity capacitors

## Series

- CIRCUIT SURGERY** by Alan Winstanley 792  
Casing codes, flashy i.e.d. circuits, Netting chips, and etch dumping
- INTERFACE** by Robert Penfold 804  
Tone-decoding weak Morse signals improves their reception by Hamcomm
- TECHNIQUES - ACTUALLY DOING IT** by Robert Penfold 815  
The route to circuit understanding is via symbols and abbreviations
- AMATEUR RADIO** by Tony Smith G4FAI 824  
Novice RAE Licences and Exams; Young Ham Club; Free DX Booklet; SMA fee protest result; Ian Poole's new Superhet Handbook.

## Features

- EDITORIAL** 753
- NEW TECHNOLOGY UPDATE** by Ian Poole 763  
F.E.D.s are seen as the future face of computer display technology
- INNOVATIONS** 764  
Everyday news from the world of electronics
- OHM SWEET OHM** by Max Fidling 770  
Every smoke cloud has a silver lining for a famished technocrat cat
- SECURITY TAGGING** by Peter Nutt 772  
Those tags and detectors that deter shop thefts are ingenious and increasingly protect the High Street stores
- SHOPTALK** with David Barrington 790  
Component buying for EPE projects
- FOX REPORT** by Barry Fox 802  
The future appliance of science demands better training, and Telerate puts trust on display
- BACK ISSUES** Did you miss these? 806
- ELECTRONICS VIDEOS** Our range of educational videos 809
- USING BARGRAPH DISPLAYS** by Andy Flind 810  
How to make better use of the versatile LM3914/5 bargraph chips
- DIRECT BOOK SERVICE** 819  
A wide range of technical books available by mail order
- PRINTED CIRCUIT BOARD SERVICE** 822  
PCBs for EPE projects
- ADVERTISERS INDEX** 828
- FREE** Cover mounted multiproject p.c.b. - what it's for 777

© Wimborne Publishing Ltd 1995. Copyright in all drawings, photographs and articles published in **EVERYDAY with PRACTICAL ELECTRONICS** is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.

Our November '95 issue will be published on Friday, 6 October 1995. See page 743 for details.

Everyday with Practical Electronics, October 1995

**Readers Service • Editorial and Advertisement Departments 753**

Surplus always wanted for cash!

# THE ORIGINAL SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always wanted for cash!

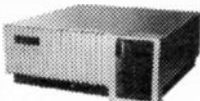
## LOW COST PC's - ALL EXPANDABLE - ALL PC COMPATIBLE

### 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 £149.00 (E)** CALL FOR QTY DISCOUNTS

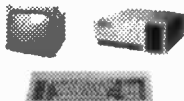
Optional Fitted extras: VGA graphics card £29.00  
1.44Mb 3 1/2" floppy disk drive (instead of 1.2 Mb) £24.95  
NE2000 Ethernet (thick, thin or twisted) network card £49.00



### PC SCOOP COMPLETE COLOUR SYSTEM ONLY £99.00

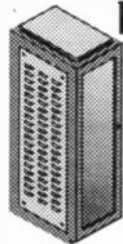
A massive bulk purchase enables us to bring you a COMPLETE ready to run colour PC system at an unheard of price! The Display Electronics PC99 system comprises of fully compatible and expandable XT PC with 256k of RAM, 5 1/4" 360k floppy disk drive, 12" CGA colour monitor, standard 84 key keyboard, MS DOS and all connecting cables - just plug in and go!! Ideal students, schools or anybody wishing to learn the world of PC's on an ultra low budget. Don't miss this opportunity. Fully guaranteed for 90 Days. **Order as PC99COL £99.00 (E)**

Optional Fitted extras: 640k RAM £29.00  
2nd floppy drive, specify 5 1/4" 360k or 3 1/2" 720k £29.95  
Above prices for PC99 offer ONLY.



## 19" RACK CABINETS

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

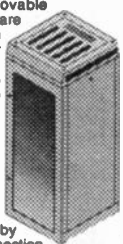


Top quality 19" rack cabinets made in UK by Optima Enclosures Ltd. Units feature designer, smoked acrylic lockable front door, full height lockable half covered back door and removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting plus 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 bays. Overall dimensions are: 7 7/8" H x 32 3/4" 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 cabinet

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 full 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 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 levers, prepunched utility panel at lower rear for cable / connector access etc. Supplied in excellent, slightly used condition with keys. Colour Royal blue. External dimensions 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 in all sizes 19" 22" & 24" 3 to 44 U. 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 a PCB with on board sophisticated electronics. From the board comes a standard serial RS232 or TTL output. The output 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 screen size!!! So, no position, however small falls detection. 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 in 'Windows' instead of a mouse!! (a driver is indeed available!!) The applications for this amazing product are only limited by your imagination!! Supplied as a complete system including Controller, Power Supply and Data at an incredible price of only: **£145.00 (G)** RFE. Full Software Support Available - Fully Guaranteed

## 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 disk supplied. In good used condition fully tested and guaranteed. Windows compatible. Order as: ABOVE CARD £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. £32.95 or 512k £38.95 (A1)

**SIMM OFFERS**

1 MB x 9 SIMM 9 chip 120ns only	£19.50 (A1)
1 MB x 9 SIMM 3 chip 80 ns	£26.00 (A1)
1 MB x 9 SIMM 9 chip 80 ns	£22.50 70ns
4 MB 70ns 72 pin SIMM module only	£125.00 (A1)
SPECIAL INTEL 486-DX33 CPU	£79.99 (A1)

## NO BREAK UNINTERRUPTIBLE PSU'S

EMERSON ACCUCARD UPS, brand new 8 Bit half length PC compatible card for all IBM XT/AT compatibles. Card provides DC power to all internal system components in the event of power supply failure. The Accusaver software provided uses only 6k of base RAM and automatically copies all system, expanded and video memory to the hard disk in the event of loss of power. When power is returned the machine is returned to the exact status when the power failed!! The unit features full self diagnostics on boot and is supplied brand new, with full, easy fitting instructions and manual. Normally £189.00 NOW! £69.00 or 2 for £120 (G)

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

5 1/4" from £22.95 - 3 1/2" from £24.95  
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	£24.95 (B)
3 1/2" Mitsubishi MF355C-L 1.4 Meg. Laptops only*	£36.95 (B)
3 1/2" Mitsubishi MF355C-D 1.4 Meg. Non laptop	£28.95 (B)
5 1/4" Teac FD-55GFR 1.2 Meg	£29.95 (B)
5 1/4" BRAND NEW Mitsubishi MF501B 360K	£22.95 (B)

\* Data cable included in price.  
Shugart 800/801 8" SS refurbished & tested £195.00 (E)  
Shugart 851 8" double sided refurbished & tested £250.00 (E)  
Mitsubishi M2894-83 8" double sided NEW £275.00 (E)  
Mitsubishi M2896-83-02U 8" DS slimline NEW £285.00 (E)

Dual 8" drives with 2 mbyte capacity housed in a smart case with built in power supply. Ideal as exterior drives! £499.00 (F)

## HARD DISK DRIVES

End of line purchase scoop! Brand new NEC D2246 8" 85 Mbyte of hard disk storage! Full industry standard SMD Interface. Ultra hi speed data transfer and access time, replaces Fujitsu equivalent model. Complete with manual. Only £299.00 (E)

3 1/2" FUJII FK-309-26 20mb MFM I/F RFE	£59.95 (C)
3 1/2" CONNER CP3024 20 mb IDE I/F (or equiv) RFE	£69.95 (C)
3 1/2" CONNER CP3044 40mb IDE I/F (or equiv) RFE	£89.00 (C)
3 1/2" RODRIGUE RG30575 45mb SCSI I/F (Mac & Acorn)	£99.00 (C)
3 1/2" MINISCRIBE 3425 20mb MFM I/F (or equiv) RFE	£49.95 (C)
5 1/4" SEAGATE ST-238R 30 mb RLL I/F Refurb	£69.95 (C)
5 1/4" CDC 9A205-01 40mb HI 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 £18.95

## THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER!

The TELEBOX consists of 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 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 £34.95  
TELEBOX STL as ST but with integral speaker £37.50  
TELEBOX MB Multiband VHF-UHF-Cable-Hyperband tuner £89.95  
For overseas PAL versions state 5.5 or 6MHz sound specification.  
\*For cable / hyperband reception TELEBOX MB should be connected to cable type service. Shipping code on all Teleboxes is (B)

## FANS & BLOWERS

MITSUBISHI MMF-D6D12DL 80 x 25 mm 12v DC	£4.95 10 / £42
MITSUBISHI MMF-09B12DH 92 x 25 mm 12v DC	£5.95 10 / £53
PANCAKE 12-3.5 92 x 18 2v DC	£7.95 10 / £89
EX-EQUIP 120 x 38mm AC fans - tested specify 110 or 240 v	£8.95
EX-EQUIP 80 x 38mm AC fans - tested specify 110 or 240 v	£5.95
VERO rack mount 1U x 19" fan tray specify 110 or 240v	£45.95 (M)
IMHOF B26 1900 rack mnt 3U x 19" Blower 110/240v NEW	£79.95

Shipping on all fans (A). Blowers (B). 50,000 Fans Ex Stock CALL

## IC's - TRANSISTORS - DIODES

OBSELETE - SHORT SUPPLY - BULK  
5,000,000 items EX STOCK  
For MAJOR SAVINGS - SAE or CALL FOR LATEST LIST

## 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 monitor with fine 0.28 dot pitch tube and guaranteed resolution of 1024 x 768. A variety of inputs allows connection to a host of computers including IBM PC's in CGA, EGA, VGA & SVGA modes, BBC, COMMODORE (including Amiga 1200), ARCHIMEDES and APPLE. Many features: Etched faceplate, text switching and LOW RADIATION NRP specification. Full 90 day warranty. Supplied in EXCELLENT little used condition. **Only £139 (E)**

Order as MITS-SVGA £139.00 (E)  
TRI & Swivel Base £30.00 Leads for IBM PC £8.95 (A)  
External Cables for other computers £ CALL

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with both RGB and standard composite 15.825 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 monitoring / security applications with direct connection to most colour cameras. High quality with many features such as front concealed fan controls, VCR correction button etc. Good used condition - fully tested with a 90 day guarantee. **Only £99 (E)** Dimensions: W14" x H12 3/4" x 15 1/2" D.

Special Offer save £16.95 - Order TELEBOX ST & HCS35 together - giving you a quality colour TV & AV system for Only £122.50 (E)

KME 10" high definition colour monitors. Nice tight 0.28" dot pitch for superb clarity and modern styling. Operates from any 15.825 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". Only £125 (E) Good used condition. 90 day guarantee.

KME 10" as above for PC EGA standard £145.00 (E)  
PHILIPS HCS31 Ultra compact 9" colour video monitor with standard composite 15.825 KHz video input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested with a 90 day guarantee (possible minor screen burns). In attractive square black plastic case measuring W10" x H10" x 13 1/2" D. Mains powered. Limited Quantity - Only £79.00 (D)

## 20" 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & optional sound inputs. Attractive teak 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)

## DC POWER SUPPLIES

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

## SPECIAL INTEREST

Zeta 3220-05 A0 4 pen HPGL RS232 fast drum plotter	£1950
3M VDA - Video Distribution Amps. 1" in 32 out	£375
Trío 0-18 vdc bench PSU. 30 amps. New	£470
Fujitsu M3041 600 LPM band printer	£1950
VG Electronics 1035 TELETXT Decoding Margin Meter	£3750
Andrews LARGE 3.1 m Satellite Dish + mount (For Voyageur)	£950
RED TOP IR Heat seeking missile (not armed!!)	POA
RNS EMC / Line interference tester NEW	£1200
Thurby LA 180B logic analyser	£375
INTEL SBC 486/133SE Multibus 486 system. 8Mb Ram	£1200
Brush 2Kw 400 Hz 3 phase frequency converter	£950
GEC 1.5kw 115v 60Hz power source	£850
Anton Pillar 75 kW 400 Hz 3 phase frequency converter	POA
Newton Derby 70 KW 400 Hz 3 phase frequency converter	POA
COMPONED EX T1000 Portable TELEX tester NEW	£250
Seikonix SD 150H 18 channel digital Hybrid chart recorder	£1995
HP 7580A A1 8 pen HPGL high speed drum plotter	£1850
Computer MCA1613APC 16mm auto iris lenses 'C' mount	£125
Seaward PAT 2000 dual voltage computerised PAT tester	£585
Densel MUD 0185AH 1KVA UPS system with batts NEW	£575

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

display  
-ELECTRONICS-  
ESTABLISHED 25 YEARS

LONDON SHOP  
Open Mon - Sat 9:00 - 5:30  
215 Whitehorse Lane  
South Norwood  
N. 24 Bus Route  
N. Thornton Heath &  
Selhurst Park SR Rail Stations

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

DISTEL © The Original  
FREE On line Database  
Info on 1000's of items  
V21, V22, V22 BIS  
0181 679 1888

ALL ENQUIRIES  
0181 679 4414  
FAX 0181 679 1927

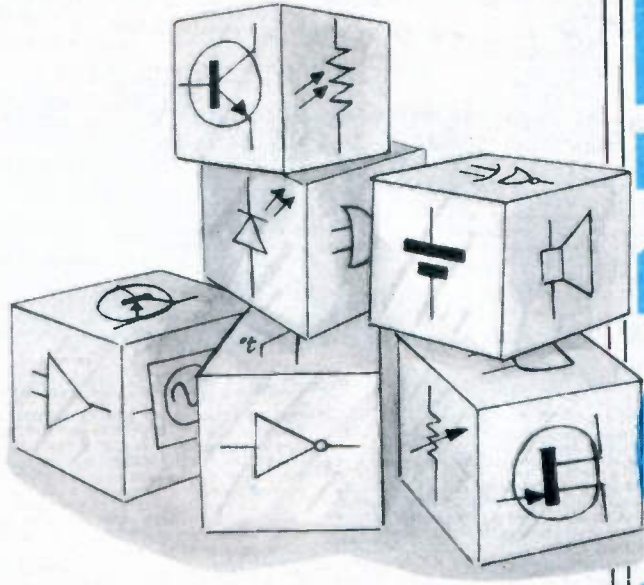
All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bonus Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Cheques over £100 are subject to 10 working days clearance. Card charges (A)=£3.00, (A1)=£4.00, (B)=£5.50, (C)=£8.50, (D)=£12.00, (E)=£15.00, (F)=£18.00, (G)=CALL. Allow approx 8 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 prices paid for surplus goods. All trademarks etc acknowledged. © Display Electronics 1986. E & O E 45

# Don't miss the start of

# TEACH-IN '96

Our regular Teach-In series is now highly respected for its straightforward, lively and informative approach to the study of electronics. Teach-In has been a regular feature of the magazine every other year since 1971. The new series, subtitled A Guide To Modular Circuit Design has been written by Max Horsey and is aimed at hobbyists and GCSE electronics and technology students, it will also appeal to AS and A Level students and those taking relevant City & Guilds and BTEC courses. Max is Head of Electronics at Radley College, he previously taught electronics and technology at GCSE and A level in state schools for many years.

The monthly ten part series will detail over fifty design modules and each month we will also publish a complete project made up from some of the modules. Part One is published next month. If you want to be able to design and build your own projects then this series is for you.



## PLUS

### THREE MORE FREE PCB PROJECTS

### VIDEO ENHANCER

### DISTORTION EFFECTS UNIT

### CURRENT TRACER

Each of these projects is designed to fit on the FREE Multiproject PCB cover mounted on this issue.

## DIGITAL DELAY LINE

Using the inexpensive HT8955 digital signal processor chip, together with a 64K or 256K DRAM, this design can produce maximum delay times of 200ms and 800ms respectively.

If you are after a simple, inexpensive and easy to build digital delay line to stick your guitar or keyboard through, and you don't need stunning noise performance, then this project is ideal.

## EVERYDAY

With **PRACTICAL**

# ELECTRONICS

NOVEMBER ISSUE ON SALE FRIDAY, OCTOBER 6

# TECHNOLOGY

**"moving from schematic to layout could not be easier"**

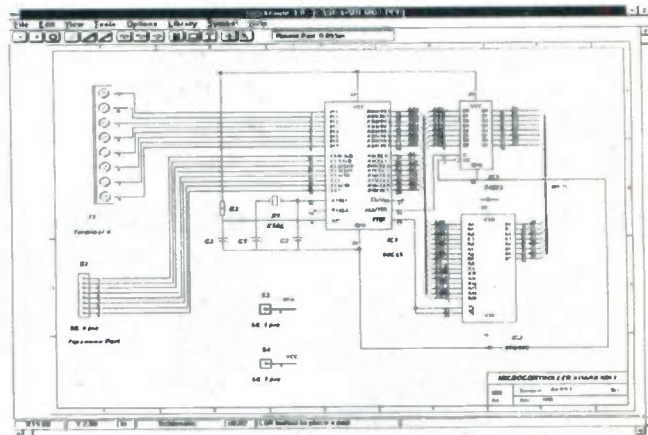
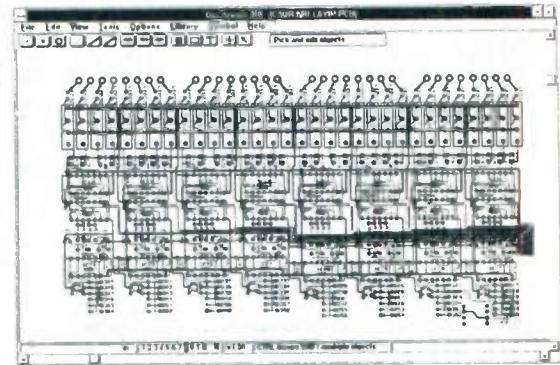
Electronics World & Wireless World Jan 1995

**PRO+ now  
with SPICE  
file export  
& SpiceAge  
DDE link!**

Quickroute 3.0 for Windows 3.1 has been designed from the start to be as easy to use as possible, without sacrificing the power professional engineers need to get the job done. Quickroute is available with schematic capture, support for busses & power rails, 1-8 layer auto-routing, SPICE file export, and our new extended library pack. Quickroute 3.0 PRO+ can also connect to the Windows simulation package SpiceAge using Windows DDE. Contact POWERware for more details!

## Quickroute 3.0

**Integrated Schematic and PCB  
Design for Windows 3.1**



**Busses and Power rails handled easily  
using Global Nets on PRO+**

### DESIGNER £99

\*Schematic & PCB Drawing \*1/2 layer auto-router  
\*Supports Windows printers/plotters \*Full set of  
libraries \*Clipboard support \*Designer Special (manual  
on disk) also available.

### PRO £199

\*Schematic & PCB Design \*Schematic Capture  
\*Integrated Rats-Nest Generation \*1-8 layer Auto-router  
(faster than Designer) \*Net-List Export \*Supports  
Windows printers/plotters \*CAD-CAM outputs.

### PRO+ £299

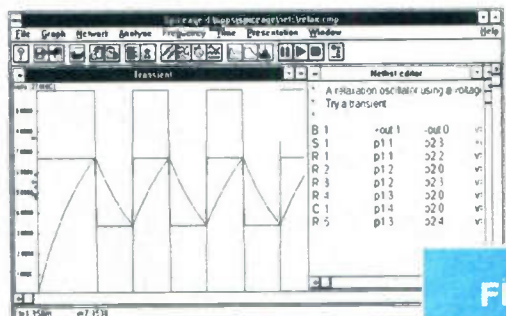
As the PRO but also includes \*Advanced Schematic Capture  
(Busses, Power rails, etc) \*Larger Schematic & PCB Designs  
\*Gerber file IMPORT for File Exchange \*Extended libraries  
(CMOS, SMT, etc) \*SPICE Export \*SpiceAge DDE link.

\*Prices exclude P+P and V.A.T. VISA/MasterCard  
Accepted \*Network versions available.

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

Tel/Fax 0161 449 7101

email [info@powrware.demon.co.uk](mailto:info@powrware.demon.co.uk)

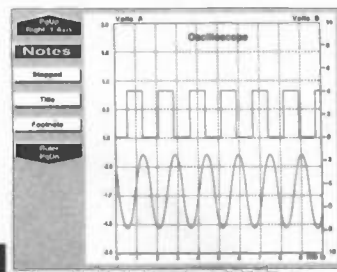


**DDE link to SpiceAge  
Simulator with PRO+**

**FREE  
Demo Pack  
Available.**

# Pico Releases PC Potential

Pico's Virtual Instrumentation enable you to use your computer as a variety of useful test and measurement instruments or as an advanced data logger.

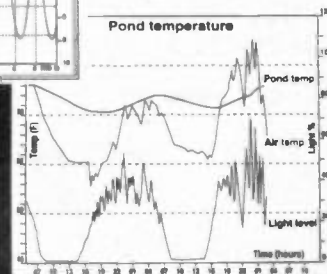


**PicoScope**  
'Virtual instrument' software.

Hardware and software are supplied together as a package - no more worries about incompatibility or complex set-up procedures. Unlike traditional 'plug in' data acquisition cards, they simply plug into the PC's parallel or serial port, making them ideal for use with portable PC's.

**Call for your Guide on 'Virtual Instrumentation'.**

**PicoLog**  
Advanced data logging software.



## NEW from Pico TC-08 Thermocouple to PC Converter

### 8 channel Thermocouple Interface

- Connects to your serial port - no power supply required.
- Supplied with PicoLog datalogging software for advanced temperature processing, min/max detection and alarm.
- 8 Thermocouple inputs (B,E,J,K,N,R,S and T types)
- Resolution and accuracy dependant on thermocouple type. For type K the resolution is better than 0.1°C.

**TC-08** £ 199

**TC-08** + Calibration Certificate £ 224

complete with PicoLog, software drivers and connecting cable. A range of thermocouple probes is available.



## SLA-16 & SLA-32 Logic Analysers

### Pocket sized 16/32 channel Logic Analysers

- Connects to PC serial port.
- Up to 50MHz sampling.
- Internal and external clock modes.
- 8K Trace Buffer.

**SLA-16** £ 219  
**SLA-32** £ 349  
with software, power supply and cables

## ADC-100 Virtual Instrument

### Dual Channel 12 bit resolution

- Digital Storage Scope
- Spectrum Analyser
- Frequency Meter
- Chart Recorder
- Data Logger
- Voltmeter

The ADC-100 offers both a high sampling rate (100kHz) and a high resolution. It is ideal as a general purpose test instrument either in the lab or in the field. Flexible input ranges ( $\pm 200\text{mV}$  to  $\pm 20\text{V}$ ) allows the unit to connect directly to a wide variety of signals.

**ADC-100** with PicoScope £199  
with PicoScope & PicoLog £219

## ADC-10 1 Channel 8 bit

- Lowest cost in the Pico range
- Up to 22kHz sampling
- 0 -5V input range



The ADC-10 gives your computer a single channel of analog input. Simply plug into the parallel port.

**ADC-10** with PicoScope £49  
PicoScope & PicoLog £59

Carriage UK free, Overseas £9 Oscilloscope Probes (x1, x10) £10

**PICO TECHNOLOGY**



Pico Technology Ltd. Broadway House, 149-151 St Neots Rd, Hardwick, Cambridge. CB3 7QJ  
Tel: (0)1954 - 211716 Fax: (0)1954 - 211880 E-mail: 100073.2365 @compuserve.com



Phone or FAX for sales, ordering information, data sheets, technical support. All prices exclusive of VAT

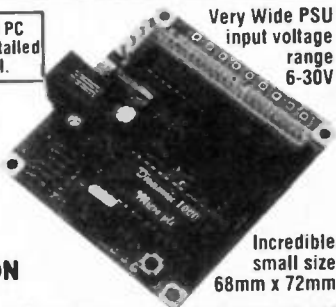
# Dianamic MPLC1000™

FROM £99 + VAT  
+£4.95 p&p in UK

The Dianamic MPLC1000 is an industrial specification Programmable Logic Controller with both ANALOGUE & DIGITAL I/O capability, at an affordable price.

STARTER KIT CONTAINS: MPLC, IBM PC programming interface & compiler, detailed programming & interfacing manual.

- PROGRAMMED IN BASIC
- ANALOGUE CAPABILITY
- 16 I/O PORTS(A&D)
- STANDALONE OPERATION
- APPLICATIONS LIMITED ONLY BY YOUR IMAGINATION



Very Wide PSU input voltage range 6-30V

Incredible small size 68mm x 72mm

Measuring just 68mm X 72mm. The MPLC is a stand alone micro computer, programmable in BASIC. An on board EEPROM stores your compiled programme and 16 channels of I/O interface to the real world. But that's not all -Despite the small footprint, the 16 channels of I/O can be configured as digital inputs, digital outputs, analogue inputs, or pulse counters or any combination thereof. If that is still not enough, the MPLC1000 has on board timers and can drive LCD displays directly. It can talk to external devices using the I<sup>2</sup>C protocol and also possesses an onboard 9600 baud RS232 interface. You might be forgiven for thinking that this type of performance comes at a price. Simply put, it doesn't. One of our main design aims was to produce the lowest cost analogue capable MPLC in the world...

Call NMB Marketing on Tel: 0171-731-8199  
London House, 100 New Kings Road, London SW6 4LX. Fax: 0171-731-8312

# 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



the new

## CRICKLEWOOD Electronics

Very Interesting CATALOGUE

### ASTRONOMICAL RANGE AT DOWN TO EARTH PRICES

- TRANSISTORS+ICs+SEMICONDUCTORS
- RESISTORS+CAPACITORS+INDUCTORS
- SURVEILLANCE+SECRECY+SECURITY
- PLUGS+SOCKETS+LEADS+CONNECTS
- TV & VIDEO SPARES (inc Video Heads)
- HI-FI+DISCO+HI-FI GADGETS+SPEAKERS
- AUDIOPHILE COMPONENTS (inc Capacitors)
- IN CAR AUDIO+SPEAKERS (inc Bass tubes)
- COMPUTER ACCESSORIES+BOARDS
- TOOLS+TEST EQUIPMENT+BENCHWARE

& much much much more (over 10,000 lines).

SEND TODAY FOR THE VERY INTERESTING CATALOGUE

Pay by PO, Cheque, Credit Card or tape Coins to Paper

Please send me .....copies of the 1995 Cricklewood Catalogue.

I enclose £2.50 per copy (UK & Europe). £5.00 overseas

Name.....

Address.....

.....

.....

.....

Please Charge my Credit Card.no.....

Expiry Date.....Tel no.....PEE

Cricklewood Electronics Ltd, 40-42 Cricklewood Broadway  
London NW2 3ET Tel 0181 450 0995 Fax 0181 208 1441

15 Amstrad Games .....£5.00\*

15 Spectrum Games .....£5.00\*

#### £1 PACKS

50 BC547A; 20 BS107; 20 BSS92;

10 2N2907A; 20 2N5086;

50 2N5551; 3 BD145; 10 BD237;

10 BD239A; 5 BFW43; 10 BFX30;

3 BSX59; 10 VN2010-L; 20 ZTX304;

20 ZTX311; 20 ZTX510; 20 ZTX551;

5 5V d.i.l. relays; 10 21-10MHz

crystals; 10 811MHz filters; 50 6-way

i.c. skts.; 50 14-way d.p. hors;

20 TO18 heatsinks; 20 TO5 heatsinks;

200 TO5 mounting pads; 200 TO18

mountings pads; 2 100Ω LOPT Tx;

5 12-way terminal blocks; 10 silver

control knobs; 10 95V V.D.R.; 3 12V

counters; 25 3-5mm jack plugs;

10 PCB MT microswitch; 10 6-way

d.i.l. switch; 10-1 pole 3-way rotary

switch; 25 slide switches; 5 3A 250V

power toggle switch; 50 4-7µF 25V

caps; 15 2200µF 25V caps;

10 0.047µF suppression caps;

25 neons; 10 1µF 250V polyesters.

5¼" to 3½" floppy converter

leads.....£1.50 ea\*

STC p.s.u. 240V Input; 5V 6A

Output, (converts to 12V 3A,

details supplied).....£5.95

Temperature probes, with

data.....£3.95\*

Universal Timer (10 min. delay and

20 min. cut-off functions).....£3.95\*

4-digit l.c.d. with 7211 driver.....£3.50\*

17-digit v.f. display.....£2.95\*

Giant 2-digit v.f. display.....£2.95\*

12V stepper motors, 48 steps

per rev., 7-3° step angle.....£3.95\*

250 off mixed electrolytic

caps.....£4.95\*

250 off polyester caps.....£4.95\*

1000 off mixed resistors ¼W.....£4.95\*

100 off phono plugs.....£2.95\*

50 off mixed terminal blocks.....£2.50\*

25 off buzzers & sounders.....£3.50\*

25 off mixed relays.....£4.95\*

50 off mixed switches.....£7.50\*

250 off i.c. sockets.....£3.95\*

1000 off Ceramic caps.....£7.50\*

5 off 3V Lithium memory

back-up batteries.....£2.00\*

100 off 2200µF 25V caps.....£6.00\*

3lb mixed component pack.....£4.95

Jumbo component pack.....£10

Crystal oscillators 10/12MHz.....£1 ea

5V DPCO D.I.L. relay.....60p ea\*

5V SPCO S.I.L. reed relay.....40p ea\*

12V Piezoelectric Sounders.....50p ea

DIL Switches 3/4/6 and

12-way.....35p ea\*

3-5mm jack plugs.....10 for £1\*

100 off Zener diodes, mixed.....£2\*

21-piece mini screwdriver set.....£3.95

Universal test lead kit.....£3.95\*

10 crocodile clip leads.....£3.50\*

20 off mixed R.F. Filters,

Crystals, etc.....£4.95\*

100m P.V.C. sleeving.....£4.50\*

#### VALVES

QQV0310, £10\*; QQV0320A, £10\*;

QQV0640A, £20\*; ECC 82, £3\*;

ECH 81, £2\*; PCL 805, £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



# SUPER SENSATIONAL SUMMER SALE

**LAST MONTH!** RING, WRITE, FAX or call in for your **FREE** copy of our 80 page catalogue **SALE ENDS SEPT 30th**

## Low Voltage Fans



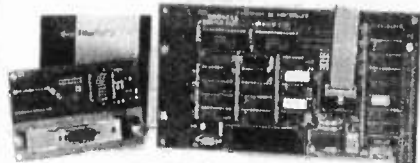
**SALE PRICE £2.00**

**Z3855**      **X6015**

**Z3855** Smallest fan we've seen! 42x42 by just 10mm thick. Made by Nitev. Model TA1500C. Rated 12V dc 0.11A. Normally £3.00

**X6015** Papst (mostly) 612L. 60x60x25mm 12V dc (6-15V) 0.7W fan. List is £27.47. Normally £3.00

## ETHERPORT FOR MACINTOSH



**SALE PRICE £11.70**

**X9012** Shiva EtherPort SE. This brand new boxed set of parts from Novell for networking Apple Macintosh computers is fantastic value. You get the Etherport SE Controller Board, the Etherport SE Access Board, the software on a 3.5" disk, an Installation Guide and a User's Guide. Wonder what the original cost was? Normally £14.95

## POWER SUPPLY



**SALE PRICE £9.95**

**X6071** Brand new unit by Ericsson, ideal shape and size for a PC. Steel and ally case. Mains on/off switch at front. 3 pin IEC mains input at back. Outputs on a 13 way socket are: +12V 5A, -12V 2A, +5V 10A, 200W max. Normally £14.95 10+ 8.00

## VERSATILE INSTRUMENT CASE



**SALE PRICE £2.95**

**X6147** Versatile soft padded instrument case measuring 250x250x80mm, with expanding side pocket 175x80x90mm. Both have Velcro fasteners. On one side are two apertures, one 15x15mm and the other 80x40mm covered by a leatherette flap. Strong carrying handle. Grey material with black edging. Stacks of uses - toolbag, electrical/electronic equipment, sandwiches/drinks, knitting, cassettes (holds 36), CDs (14), school books...

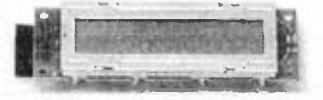
## CABLEVISION CALAMITY



**SALE PRICE £1.50**

**Z8939** Two tone brown case contains PCB 192x195mm with easily removed UHF modulator made by Labgear (Sound and Vision); video pre-amp; stabilized power supply and all the decoding circuitry - 9 transistors and TBA673 chip. Further details on request. Normally £6.95

## LCD DISPLAYS



LCD dot matrix modules all with HD44780 controller (and HD44100 on larger displays)

Code	Part No. (TLCM.)	Size	Char	Ht	SALE Price
Z5482	1620	16x2	5x7	4.3	£3.00
Z5483	1621	16x2	5x7	4.3	£3.00
Z5484	2011	20x1	5x7	5.2	£2.30

A data sheet is included in the price.

**Z2842** Application notes. A 16 page booklet with details on the above is available. Sale price £1.00

## SOUND EFFECTS CDs

**EFX001** Frights of the Night - Midnight Gongs, Ghostly Sounds, Creaking Door Opens, Demonic Laughter and many more.

**EFX002** 101 Sound Effects - Children Playing, Children Laughing, Men Cheering, Roller Coaster, Fire Crackers and many more.

**EFX003** Outer Space - Various Battles, Guns, Creature Noises, Spacecraft Taking Off and Landing, Explosion and many more.

**EFX004** Workshop of Sound - Animals Walking, Office Equipment, DIY Equipment, Laughter, Household, Boat and many more.

**EFX005** Musical - Opens and Ends, Strings, Textures, Solo Horns, Tempos, Moods, Bass and Drum Elec. Piano and many more.

**SALE PRICES:** Discs at £4.50 each. Set of all 5 for £17.95


## PIR SENSOR



**SALE PRICE £7.50**

**Z2700** PIR sensor. Extremely neat basic sensor (no electronics) in plastic moulding 33x28x30mm. Supplied with circuits and lots of information. Has 10m range, 164 degree angle of view, 1mW power consumption. Normally £9.96

## BATTERY TESTER



**SALE PRICE £2.95**

**Z5569** Battery tester. Will test any 1.5V cell including button cells and PP3s.

## 99P CLOCK



**Z3873** Super Offer! A complete clock in a 40x25mm module. 9V operation with sleep & snooze, 24hr alarm, PM, colon and alarm indicators. Simple fast/slow setting controls. 6 display modes. 12/24hr selectable, display brightness control. Full info supplied.

All this for 99p!

## MICROPHONE



**SALE PRICE £14.95**

**Z5964** Audix HM230S/Tact UDM 100 professional dynamic mic with on/off switch and cardioid characteristics. 5m lead with XLR socket fitted mic end. Impressive spec! 600R impedance. Supplied with clip and adaptor, individually boxed. List price £44.06

## 4 WAY TRAILING SOCKET WITH 2.7M LEAD & PLUG



**SALE PRICE £6.95**

**M3800** Was £10.70!

Order code P3525

## DIGITAL MULTIMETER



- Input impedance 10MR
- 3.5 digit 15mm LCD display
- 32 ranges including 20A ac/dc
- Transistor and diode test
- Continuity test with buzzer and LED
- Rugged yellow case
- Test leads with shrouded 4mm plugs
- Carrying case
- Fuse protection
- Automatic polarity and zero

Battery and instruction manual included

**SALE PRICE £29.95** Normally £36.95

## IBM PC COMPUTER



**SALE PRICE £35**

**X9018** IBM computer. An XT PC type 3270. This contains a motherboard with 640K RAM, 20 MB hard disk, MGA video card, 5.25" 360K floppy disk drive and a 130W PSU in a case 500x380x140mm. There's also a number of other cards fitted including a network PCB designed to link in to an IBM 3270 mainframe computer. Believed working.

## VOLTAGE TESTER



**SALE PRICE £3.50**

**Y023BA**

**Y023BA** Dual function screwdriver type circuit tester. Used as an inductance tester it will detect buried cables, breaks in cables etc. Touching a live part with the tip will indicate the voltage level on the LCD screen. AC or DC up to 250V max.

## SCART TO SCART LEAD



**SALE PRICE £2.00**

**P2940** Scart to scart lead. Length 1.5m. Normally £4.20

## SWITCH MODE PSU's



**SALE PRICE £6.95**

**X6016** Brand new, boxed SMPSU by ASTEC. Mains in, -12V 0.2A +12V 2A and +5V 5A out. 44W max PCB 160x100mm. Normally £9.95

## CAR VFD



**Z3100** Car VFD. This shows the plan view of a saloon and indicates whether doors are shut, lights are on etc. With data sheet. Normally £2.00

**SALE PRICE £1.00**

## HIGH VOLTAGE CAPACITORS



Code	Value	lxd	Pitch	Sale Price (1-24)
NK1001	1µF 450V	12x8	3mm	30p
NK1002	2.2µF 450V	13x10	5mm	31p
NK1003	4.7µF 450V	20x10	5mm	45p
NK1004	10µF 400V	25x13	5mm	51p
NK1005	22µF 450V	27x16	7.5mm	99p
NK1006	47µF 400V	36x16	7.5mm	£1.93

Prices for larger quantities available on request (listed in Summer Sale catalogue)

## GLUE GUN



**SALE PRICE £5.50**

**T216** A hot melt glue gun suitable for home and industrial use. Electronically controlled heating element melts the long stick of glue when inserted in the back of the gun. Smooth flow controlled by trigger feed. Sticks most metals, PVC, concrete. Supplied with two FREE glue sticks! Normally £9.95

**STOP PRESS ★ PRIZE ★ STOP PRESS**

**Prize Draw** Win an £850 Hitachi Oscilloscope for just £1 in our prize draw SEE SUMMER CATALOGUE FOR DETAILS

**DRAN** **FREE Maths Set** Get a FREE Helix Maths Set with orders over £20

SALES 01703 236363 Fax 236307 Accounts 231003

Single prices in this advert include VAT. Quantity prices don't. PGP £3 per order (950 next day) Min credit card £12. orders welcome from Education - min invoice charge £15. payment accepted by cheque, PO, cash, book tokens, Switch, Access, Visa, Connect. Our stores (over 10,000 sq ft) have enormous stocks. We are open 8 - 6.30 Mon - Sat. Come and see us!

**GREENWELD** ELECTRONIC COMPONENTS

**SWITCH** **VISA**

27D Park Road Southampton SO15 3UQ

# QUALITY KITS - QUAZY PRICES!!

## SURVEILLANCE

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

### MTX - Miniature 3V Transmitter

Easy to build & guaranteed to transmit 500 metres - over 1000m possible with higher voltage & better aerial. 3-9V operation. Only 45x18mm. 3007-KT. £8.95



### MRTX - Miniature 9V Room Transmitter

Our best selling 'bug'. Super sensitive, high power - 1000m range (2 miles possible with 18V supply & better aerial). 9-18V operation. Just 45x19mm. 3018-KT. £9.95

### HPTX - High Power Room Transmitter

High performance, 2 stage transmitter gives greater stability & high quality reception. 1000m range with 9V battery, 8-12V operation. On/Off switch. Size 70x15mm. 3032-KT. £8.95

### VTX - Voice Activated Transmitter

Activates only when sounds are detected. Low standby current conserves battery power. Adjustable sensitivity & turn-off delay. 6V operation. Size 63x30mm. Powerful 2 stage transmitter. 1000m range. 3028-KT. £8.95

### TRI - Telephone Recording Interface

Connects between phone line and cassette recorder. Automatically switches on tape when phone is used. Records all conversations. Powered from line. Size 48x32mm. 3033-KT. £8.25

### TRVS - Tape Recorder Vox Switch

Very sensitive, voice activated switch - automatically turns on cassette recorder when sounds are detected. Adjustable sensitivity and turn-off delay. Size 115x19mm including sensitive electret mic. 3013-KT. £7.95

### 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. 3018-KT. £8.95

## AUDIO ♦ LASER ♦ TEST GEAR ♦ FIBRE-OPTIC ♦ SECURITY ♦ TIMERS ♦ GAMES

Our range of HIGH QUALITY project kits are supplied with all components, top quality fibre glass PCB's & comprehensive instructions. Send 2 x 1st class stamps for our latest catalogue containing over 100 kits & publications. £2Mail order only. Please ADD £1.50 P. & P. per order & make cheques/P.O. payable to:

# QUASAR ELECTRONICS

(Dept EPE) Unit 14 Sunningdale BISHOP'S STORTFORD Hertfordshire CM23 2PA

## MISCELLANEOUS

### Ultrasonic Movement Detector

Xtal controlled oscillator, detector circuits & pair of edge mounted ultrasonic transducers on single board just 73x40mm. Detection range from 4-7m with adjustable sensitivity. Red LED indicator. Outputs to drive external relay or circuits. 9V DC operation. 3048-KT. £14.95



### 3 LED Sequence Flasher

3 LEDs flash in sequence. On/Off push switch controls flashing sequence. Ideal for model railways. Very small COB PCB 15x8mm with spare supplied. Intro to electronics in today's toys & games. 3V operation. 3052-KT. £3.95

### Roulette LED

10 LEDs simulate ball rotating around the 'wheel'. Press 'Roll' button & 'ball' runs at max. rate, release & 'ball' slows down & drops into slot. Adjustable ball speed illustrates principles of a Voltage Controlled Oscillator built using CMOS decade counter & Op-Amp. 9V powered. 3008-KT. £11.95

### Combination Lock

Versatile 9 key combination lock. Complete with separate keypad for remote installation from main circuit. Lock automatically resets. 120VAC/10A relay supplied. 9-12V operation. 3029-KT. £10.95

### Intro To Audio Power Amps

Build your own fully working Class AB amplifier. Get hands-on learning about Bootstrapping, Cross-over, Clipping, Complementary Pairs & Push-Pull outputs. Detailed explanation given. Delivers several watts of power to the 8 Ohm speaker supplied. 3048-KT. £10.95

### One Chip AM Radio

Complete AM radio on a PCB. Tuned radio frequency front-end AM Radio IC amplifier & detector and two stages of amplification of the audio signal into the speaker provided. All components supplied. Coil pre-wound. Excellent intro to modern mini-sized AM radio electronics. 3063-KT. £10.95

### Train Sounds Kits

4 selectable train sounds - Whistle, Blowing, Level Crossing Bell, Chugging & 'Click & Clack'. 2.5-5V operation. COB PCB 20x16mm. Speaker supplied. 2 boards can be joined to produce a sequence of sounds. SG1. £4.95

## WE HAVE THE WIDEST CHOICE OF USED OSCILLOSCOPES IN THE COUNTRY

### TEKTRONIX 7000 SERIES OSCILLOSCOPES AVAILABLE FROM £200 - PLUS VHS SOLD SEPARATELY

TEKTRONIX TA5475 4 Channel 100MHz Delay Cursors	£1300
TEKTRONIX TA6455 Dual Trace 50MHz Delay Cursors	£900
TEKTRONIX 2465 4 Channel 50MHz Delay Sweep Cursors	£1750
TEKTRONIX 2246A 4 Channel 100MHz Cursors/Voltmeter etc	£1250
TEKTRONIX 2335 Dual Trace 100MHz Delay	£750
TEKTRONIX 485 Dual Trace 350MHz Delay Sweep	£750
TEKTRONIX 475 Dual Trace 200MHz Delay Sweep	£600
TEKTRONIX 465 Dual Trace 100MHz Delay Sweep	£400
TEKTRONIX 2215 Dual Trace 50MHz Delay Sweep	£400
TEKTRONIX 2213 Dual Trace 60MHz	£350
H.P. 1740A Dual Trace 100MHz Delay Sweep	£330
PHILIPS PM5217 Dual Trace 50MHz Delay Sweep	£400
HITCHCOCK V423 Dual Trace 40MHz Delay Sweep	£350
GOLDO 05110051 Dual Trace 50MHz	£200
KIRKUSA 5530A Dual Trace 35MHz	£200
GOLDO 05300 Dual Trace 20MHz (no handle)	£180
GOLDO 4930 Dual Trace 20MHz Digital Storage Cursors	£250
GOLDO 054020 Dual Trace 10MHz Digital Storage	£250
GOLDO 4100 Dual Trace 10MHz Digital Storage 1" B X-Y Modes	£240
GOLDO 054000 Dual Trace 10MHz Digital Storage	£200
H.P. 1741A Dual Trace 100MHz Analogue Storage	£400

### THIS IS JUST A SAMPLE - MANY OTHERS AVAILABLE

EATON/ALTECH 380K11 Synthesized Sig Gen 1MHz-2000MHz	£1000
WITH PM5602 AM/FM Phase Mod	P.O.A.
MARCONI 2019 Synthesized AM/FM Sig Gen 80kHz-1040MHz	£1700
MARCONI 2018 Synthesized AM/FM Sig Gen 80kHz-520MHz	£1800
H.P. 8620C Sweep Osc. 5.50Hz-12.40Hz or 80Hz-12.40Hz	£350
H.P. 8620C Sweep Oscillator Main Frame only	£280
RACAL 9081 Syn. AM/FM Sig Gen. 5MHz-520MHz	£480
FARNELL S50520 Syn. AM/FM Sig Gen. 10MHz-520MHz	£400
MARCONI TF2337 Automatic Distortion Meter	£200
MARCONI TF2331A Dist. Pct. Meter 20Hz-20 kHz 0.05% u-used.	£250
MARCONI TF833B Audio Power Meter Stand	£100
MARCONI TF715 Attenuator DC-10MHz	£150
H.P. 8495B Attenuator DC-180kHz QdB-11dB in 1dB Steps	£375
HATFIELD 2105 Attenuator 50 Ohm	£70
TEKTRONIX TDR1502	£1250
R & S Video Noise Meter UPSF2 with UPSF2E2	£750
R & S Video Noise Meter UPSF2 with UPSF2E2 40kHz-10MHz	£1500
R & S Video Analyser Type UVP	P.O.A.

### BRUEL & KJØER EQUIPMENT AVAILABLE - PLEASE ENQUIRE

SIGNAL ANALYSERS	
FR A730 Synthesized 1GHz	£4000
H.P. 8555A 0.015GHz-220Hz	£4000
ANDO AC9281 with AC9211 1700MHz	£1500
POLAROID 641-1 10MHz-180Hz	£1500
H.P. 482 with 8555B 100kHz-1500MHz	from £1500
H.P. 141T with 8555A & 8552B 10MHz-180Hz	£1700
H.P. 141T with 8555B & 8552A 500kHz-1750MHz	£1200
H.P. 3580A 5Hz-500kHz	£800
MARCONI TF2370 30Hz-110MHz	£1000
TEKTRONIX 7L12 with Main Frame 10kHz-1800MHz	£1200
TEKTRONIX 7L5 with Main Frame 20MHz-5MHz	£1000

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 £18. VAT to be added to Total of Goods and Carriage.

**STEWART OF READING**  
110 WYKEHAM ROAD, READING, BERKS RG6 1PL  
Tel: 01734 268041 Fax: 01734 381696

HP 5341A Frequency Counter 50MHz-1.5GHz LED	£300
RACAL 1998 Freq. Counter 9.3GHz (approx) GHz & High Stabl.	£900
MARCONI DANA 1951 Universal Counter/Timer 160MHz 9 digit	£300
MARCONI 7437 Universal Counter/Timer DC-100MHz 8 digit	£175
RACAL 9916 Frequency Counter 10Hz-520MHz	£175
RACAL 9905A Universal Counter Timer 10Hz-200MHz	£250
BLACK STAR Meter 100 Frequency Counter 100MHz	£70
SOLARTRON 7065 6 1/2 digit Microprocessor Voltmeter	£400
AC/DC (Trms) Auto	£400
SOLARTRON 7045 4 1/2 digit Multimeter Volts/Amperes Ohms	£30
THANDER 1504 4 1/2 digit RMS Multimeter with Adapter	£100
GOLDO JS8 Sine Square Oscillator 10Hz-1000Hz	£150
FEEDBACK F6630 Sine/Sq/Tri 0.01Hz-100kHz	£80
THANDER T501 Func. Gen. 0-5005Hz-5MHz	
Sine/Sq/Tri/Ramp/Pulse etc.	£175
THANDER T102 Func. Gen. 0.02Hz-2MHz Sine/Sq/Tri/TTL	£70
UNIDOS LA1 M8 28 Audio Analyser	£300
UNIDOS E901 Audio Analyser	£300
PHILIPS PM555 Visual Form Monitor	£300
PHILIPS PAB517 Video Line Selector	£200
FERRISGRAPH RT52 Recorder Test Set	£250
AWA F242A Distortion Noise Meter	£400
AWA L5C21B Standard Signal Generator	£450
KEMO Dual Variable Filter VBF5 0.1Hz-10kHz	£200
RACAL Instrumentation Recorder Type Store 4DN	£350
RACAL Instrumentation Recorder Type Store 705	£300
NACRA N-5J Tape Recorder	£350
MARCONI TF2700 Universal Bridge Battery Operated	from £150
WAYNE KERR B424 Digital Component Meter LCR	£750
H.P. 16320 43 Channels	£700
SORENSEN DER600 4-5B 0-600V; 0-4.5A	£300
H.P. E268 0-40V; 0-30A	£300
FARNELL H50100 0-30V; 0-100A Metered	£300
THURLEY PL320Q 0-30V; 0-2A Twice Digital	£225
THURLEY PL320 0-30V; 0-2A Digital	£100
FARNELL L302 0-30V; 0-5A Metered	£100
FARNELL L302-2 0-30V; 0-2A Twice	£180
FARNELL L302-1 0-30V; 0-2A Metered	£80
FARNELL L302-1 0-30V; 0-1A Twice	£130
FARNELL E350 0-350V; 0-200mA Metered	£85
BRANDENBURG Model 472 4 1/2 2W Metered	£100
	£200

### MANY OTHER POWER SUPPLIES AVAILABLE

NEW EQUIPMENT	
HAMEG OSCILLOSCOPE HM1005 Triple Trace 100MHz	£847
Delay Timebase	
HAMEG OSCILLOSCOPE HM604 Dual Trace 60MHz Delay Sweep	£833
HAMEG OSCILLOSCOPE HM305 Dual Trace 30MHz Comp. Tester	£422
HAMEG OSCILLOSCOPE HM205-3 Dual Trace 20MHz Digital Storage	£833
All other models available - all oscilloscopes supplied with 2 probes	
<b>BLACK STAR EQUIPMENT (P&amp;P at units E5)</b>	
APOLLO 10 100MHz Counter Timer Ratio/Period/Time etc. etc.	£234
APOLLO 100 100MHz (as above) with more functions	£332
METRO 100 FREQUENCY COUNTER 100MHz	£119
METRO 600 FREQUENCY COUNTER 600MHz	£145
METRO 1000 FREQUENCY COUNTER 100Hz	£188
JUPITOR 500 FUNCTION GEN. 0.1Hz-500kHz Sine/Sq/Tri	£128
ORION COLOUR BAR GENERATOR PAL/TV/Video	£243
All other Black Star equipment available	
OSCILLOSCOPE PROBES Switched X1 X10 X100 X1000	£13

# SEETRAX CAE RANGER PCB DESIGN

## WITH COOPER & CHYAN AUTOROUTER

RANGER3 - DOS	£2500
- Windows\NT	£2900

RANGER2	£150
---------	------

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

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 (SP1)  
Gerber-in viewer, AutoCAD DXF in & out

### UPGRADE YOUR PCB PACKAGE TO RANGER2 £60

## TRADE IN YOUR EXISTING PACKAGE TODAY

Seetrax CAE, Hinton Daubney House, Broadway Lane, Loveland, Hants, PO8 0SG  
Call 01705 591037 or Fax 01705 599036 + VAT & P.P

All Trademarks Acknowledged

# 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/BVU 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"

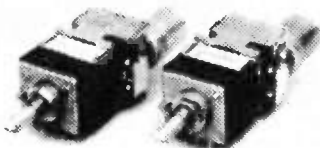
And now, hot off the press, yet another classic from the pen of John Linsley Hood. Following the ongoing enormous success of his "Art of Linear Electronics" the latest offering is the all-new edition of "Audio Electronics", now entirely re-written by the master himself.

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!

- .....**£111.58**
- K1450SA** Series Audiophile version with selected components.....**£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-Trk 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 months 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 ELECTRONIC KITS LTD  
6 PENYLAN MILL  
OSWESTRY, CHESHIRE  
SY10 6AF

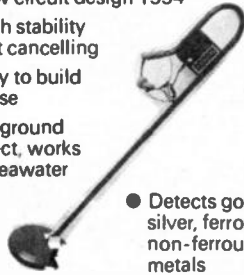


**SHOP OPEN 9-5 MON-FRI. CLOSED SAT --- OFFICIAL ORDERS WELCOME**

### 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 l.c.d. 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

### 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



### 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 TRANSUDER OUTPUT
- COMPLETELY INAUDIBLE TO HUMANS
- UP TO 4 METRES RANGE
- LOW CURRENT DRAIN

KIT Ref. 812 ..... £14.81



### 'COMSTEP' P.C. COMPUTER STEPPING MOTOR INTERFACE

An exciting project supplied with two 200 step motors, interface board, and easy to use P.C. software. Allows independent control of both motors - speed, direction, number of steps, and half/full step mode. Connects to computer parallel port. Requires 12V 1A D.C. supply and printer lead.

KIT 846 (with 2 motors) ..... £67.00 (Printer lead £5.00)

### 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

### HAMEG HM303 30 MHz DUAL TRACE OSCILLOSCOPE & COMPONENT CHECKER

Western Europe's best selling oscilloscope - now improved. It now features 30MHz bandwidth, triggering to 100MHz and 2mV/div sensitivity.

Sharp bright display on 8 x 10cm screen with internal graticule. Special component tester built in - allows capacitors, resistors, transistors, diode, and many other components to be checked at a glance.

As with its predecessor, the QUALITY OF THIS INSTRUMENT IS OUTSTANDING. It is supported with a two year warranty covering parts and labour. If you are buying an oscilloscope, this is the one. It costs a fraction more than some others, but it is far far superior. Supplied with test probes, mains lead, and manual.

£392.00 + £68.60 VAT Includes FREE Next-day delivery (Cheques must be cleared)

### EDUCATIONAL BOOKS & PACKS

#### ADVENTURES WITH ELECTRONICS

The classic book by Tom Duncan used throughout schools. Very well illustrated, ideal first book for age 10 on. No soldering. Uses an S.DEC breadboard.

Book & Components £28.95, Book only £7.25

#### FUN WITH ELECTRONICS

An Usborne book, wonderfully illustrated in colour. Component pack allows 6 projects to be built and kept. Soldering is necessary. Age 12 on, or younger with adult help. Book & Components £20.88, Book only £2.95

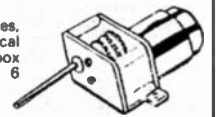
#### 30 SOLDERLESS BREADBOARD PROJECTS

A more advanced book to follow the others. No soldering. Circuits cover a wide range of interests.

Book & Components £30.69, Book only £2.95

### DC MOTOR/GEARBOXES

Ideal for robots, buggies, and many other mechanical projects. Min. plastic gearbox with 1.5-4.5V DC motor. 6 ratios can be set up.



Small type MGS...£4.77

### STEPPING MOTORS

For computer control via standard 4 pole unipolar drivers.

MD38 - miniature 48 steps per rev.....£9.15

MD35¼ - standard 48 steps per rev.....£12.99

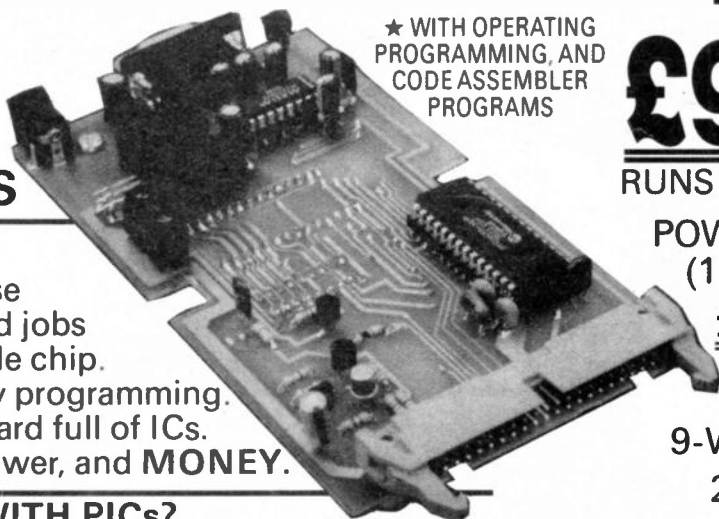
# PIC

# 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
- 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

A real-world application for a PIC microchip. This project can be made to do just what you choose 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**

## Motors and Controllers

A range of kits and components for motion control and computer interfacing. Ideal for Design and Technical projects, and a whole range of up to the minute 'Home Automation' applications.

### Comstep PC Computer Interface and Driver board

Drives two motors from PC parallel port. Supplied with comprehensive software. Needs 12Volt 1A supply.

With 2-200 Step Motors

**Kit 846.....£67.00**

### PC Joystick Interface for Comstep

Software for operating Comstep from a standard PC Joystick. Allows two Axis control, with acceleration, speed, and X-Y position control. Stores co-ordinates.

**Kit 852.....£28.95**

### 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**



### Power Booster for Comstep

Adds to Comstep and allows motors up to 4 Amps to be driven. Two boosters drive two motors from a single Comstep. Uses standard Comstep software.

With MD24 Motors

**Kit 850.....£39.95**

### Stand-Alone Stepping motor Driver/Interface

A Stand alone interface giving full control in all modes. Pushbutton operation with adjustable acceleration and speed. Ideal for demo and setting up. Then connect to computer port for full control.

**Kit 843.....£39.95**

### 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**



### PC Communications Protocol for Comstep

An interface board adding four switched inputs to the Comstep + All the code to develop your applications. Files in C, BASIC, FORTRAN & ASSEMBLER + demo.

**Kit 851.....£26.98**

### Versatile Stepping motor Interface

A Magenta design, gives Half and Full-Wave drive. Up to 1Amp and 24Volts. CMOS inputs – Drive from logic or computer port. Needs power supply.

**Kit 816.....£9.82**

### More Information:

All listed items come with data and instructions. For more information, including reprints of the appropriate magazine articles, send an SAE + £1.00 per kit – or phone and use Mastercard/Visa etc.

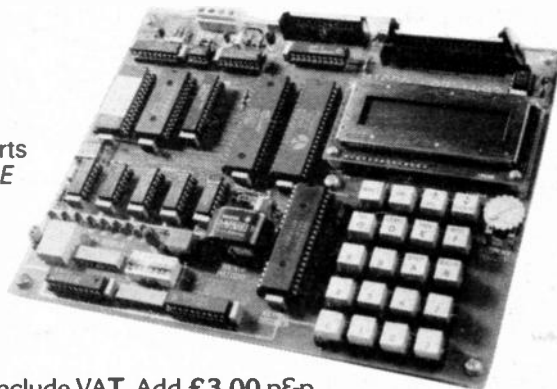
## Mini-Lab & Micro Lab Electronics Teach-In 7

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.





# EVERYDAY With PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

## VOL. 24 No. 10      OCTOBER '95

### HERE WE GO AGAIN

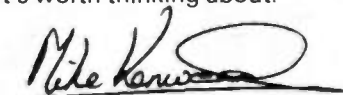
Every other year since 1971 *EPE* has published a *Teach-In* series. Right from the very first *Teach-In* the series has established itself as a high quality distance learning course, it is now highly respected around the world and has often been emulated in other publications. *Teach-In '96* is no exception, it deals – in a lively but straightforward way – with Modular Circuit Design, detailing over fifty versatile design modules and bringing them together to produce ten full constructional projects, thus demonstrating the simple techniques used to design and assemble various items of equipment. The projects range from a *Temperature Warning Device* to an *Automatic Camera Panning System* and a *Motor/Shaft Speed Display*. There are also plenty of other constructional projects; something to interest just about every potential constructor.

### HONED

This new series has been written for us by Max Horsey – the name will already be familiar to regular readers. Max is Head of Electronics at Radley College and has been contributing to the magazine since 1980. The information in *Teach-In '96* has been developed and honed over a number of years of teaching GCSE, AS and A Level students. It will, of course, be particularly interesting to teachers and students for both electronics and technology courses, but it also has a much wider appeal to all hobbyists who would like to be able to put together their own project designs without years of study and in-depth design calculations, etc. *Teach-In '96* will run for ten months and starts in next month's issue.

### GET IT

Whenever we start a new *Teach-In* the demand for copies is high so, to make sure you do not miss out on this exciting new series, either place an order with your newsagent, who will deliver or shop-save a copy for you, or why not take out a subscription, at just £24 (UK) for a year? With a subscription there is a saving of £3 on the cover price, your issue will be posted to you in time to arrive before the official publication date and you will be insulated from supply problems and cover price increases for a year. It's worth thinking about.



### 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 with 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 MasterCard (Access) or Visa.

### BINDERS

Binders to hold one volume (12 issues) are now 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.**



**Editorial Offices:**  
EVERYDAY with PRACTICAL ELECTRONICS EDITORIAL  
ALLEN HOUSE, EAST BOROUGH, WIMBORNE  
DORSET BH21 1PF  
Phone: Wimborne (01202) 881749  
Fax: (01202) 841692. DX: Wimborne 45314  
**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 with PRACTICAL ELECTRONICS  
ADVERTISEMENTS  
HOLLAND WOOD HOUSE, CHURCH LANE  
GREAT HOLLAND, ESSEX CO13 0JS  
Phone/Fax: (01255) 850596

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 with 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.

# GINORMOUS VU METER

PAUL STENNING

*Add brilliant individuality to your disco display - ten or more lights flashing, ascending, cascading, in harmony with the mood and strength of the music. It's a sight to be seen!*

**R**ECENTLY, while rummaging in the loft, the author found the circuit diagram of one of his favourite home-made lighting effects units, a large VU meter. It dated back to when he and a friend ran a small mobile disco. The friend was the DJ, while author dealt with the technical side, building most of their equipment to keep costs down. Feeling prompted to rebuild it, bringing it up-to-date in the process, resulted in this Ginormous VU Meter!

## ORIGINALITY

Seven lamps were controlled by the original unit, using individual comparators, whereas the Ginormous VU Meter design controls ten lamps and uses a bargraph driver chip. The effect is emphasized by reducing the difference between the bottom and top lamps, giving a more dramatic effect than a conventional VU meter. In addition, the scaling is linear, rather than the logarithmic scaling normally used.

The Effects potentiometer on the controller sets the level in a similar manner to a recording level control. Normally, this would be set so that the top light comes on at the loudest peaks in the music. However, it may be turned down to give a more romantic atmosphere when playing slower records. Once the desired effect is obtained, it is maintained by an automatic level control circuit, despite variations in volume and music style. This allows the DJ to concentrate on playing the music rather than fiddling with the lighting effects.

Low cost home disco lighting effects use a built-in microphone to pick up the sound. This arrangement is prone to picking up extraneous noises unless it is placed very close to the speakers. This effects unit, though, connects directly to the speaker terminals of an amplifier, eliminating the problem. A transformer is used to isolate the amplifier from mains circuitry.

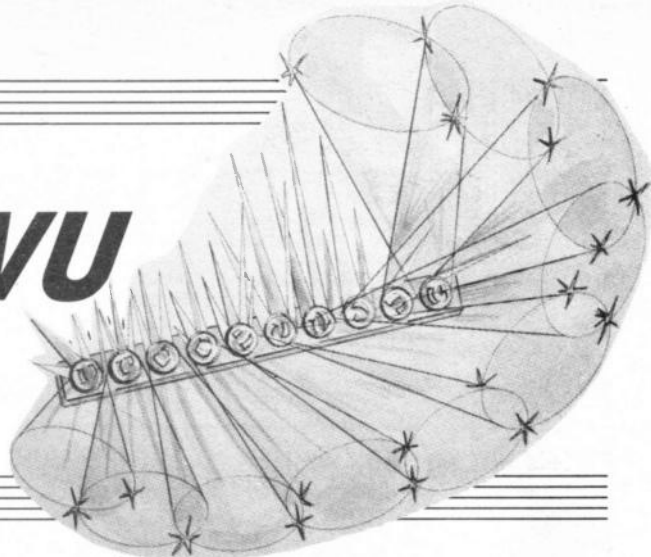
The input impedance is about one kilohm (1k), which will impose no significant additional load on the amplifier.

A high power amplifier is not necessary - by changing one component value the output from a domestic stereo system playing at a sociable volume can be accommodated. Each lamp output can drive up to 250W of lights, giving a total of 2.5kW! In practice, much smaller lamps would be used, 25W per channel being typical. Suggestions for constructing a suitable light box are given later.

Zero crossing control is used to minimize radio frequency interference (RFI). Note that the outputs are only suitable for resistive loads such as normal tungsten lamps. Inductive loads such as pin-spots and similar lights containing transformers are not suitable.

## WARNING

*This design operates at lethal mains voltages. If you are in any doubt about your ability to construct it safely, seek assistance from a suitably qualified or experienced person. It is not a suitable project for beginners.*

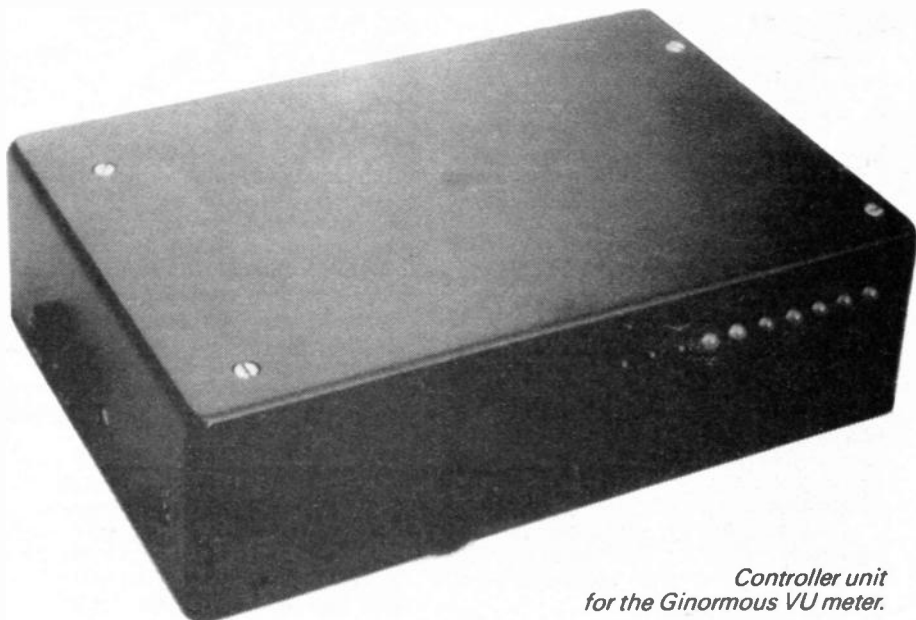


## HOW IT WORKS

The circuit diagram for the music level detection and control stages is shown in Fig. 1. Mains transformer T1 is used to isolate the circuit from an audio amplifier. Audio matching transformers are available, but these are not generally designed to isolate mains voltages, and are normally more expensive. Although a mains transformer does not have a particularly flat frequency response, it is good enough for this application. In addition, the transformer reduces the signal to a more manageable level.

The signal from an amplifier delivering hundreds of watts could be about 30V to 60V r.m.s., which is excessive for op.amp circuitry. The transformer used here has a turns ratio of about 10:1, which reduces these voltage levels to a more manageable 3V to 6V. On a domestic stereo amplifier producing maybe between 2V and 10V r.m.s. there will still be between 0.2V and 1V signal level available.

Resistors R1 and R2 form an attenuator to reduce the signal still further, to a level suitable for the input of op.amp IC1. The value of R1 can be adjusted to suit the audio power levels normally encountered. A value of 470k is ideal for domestic use if you wish to remain on speaking terms with the neighbours! If other members of the household do not appreciate your taste in music, it may be better to reduce it to about 220k. On the other hand, 2M2 is about right for use with a 100W power amplifier at high volume.



Controller unit  
for the Ginormous VU meter.



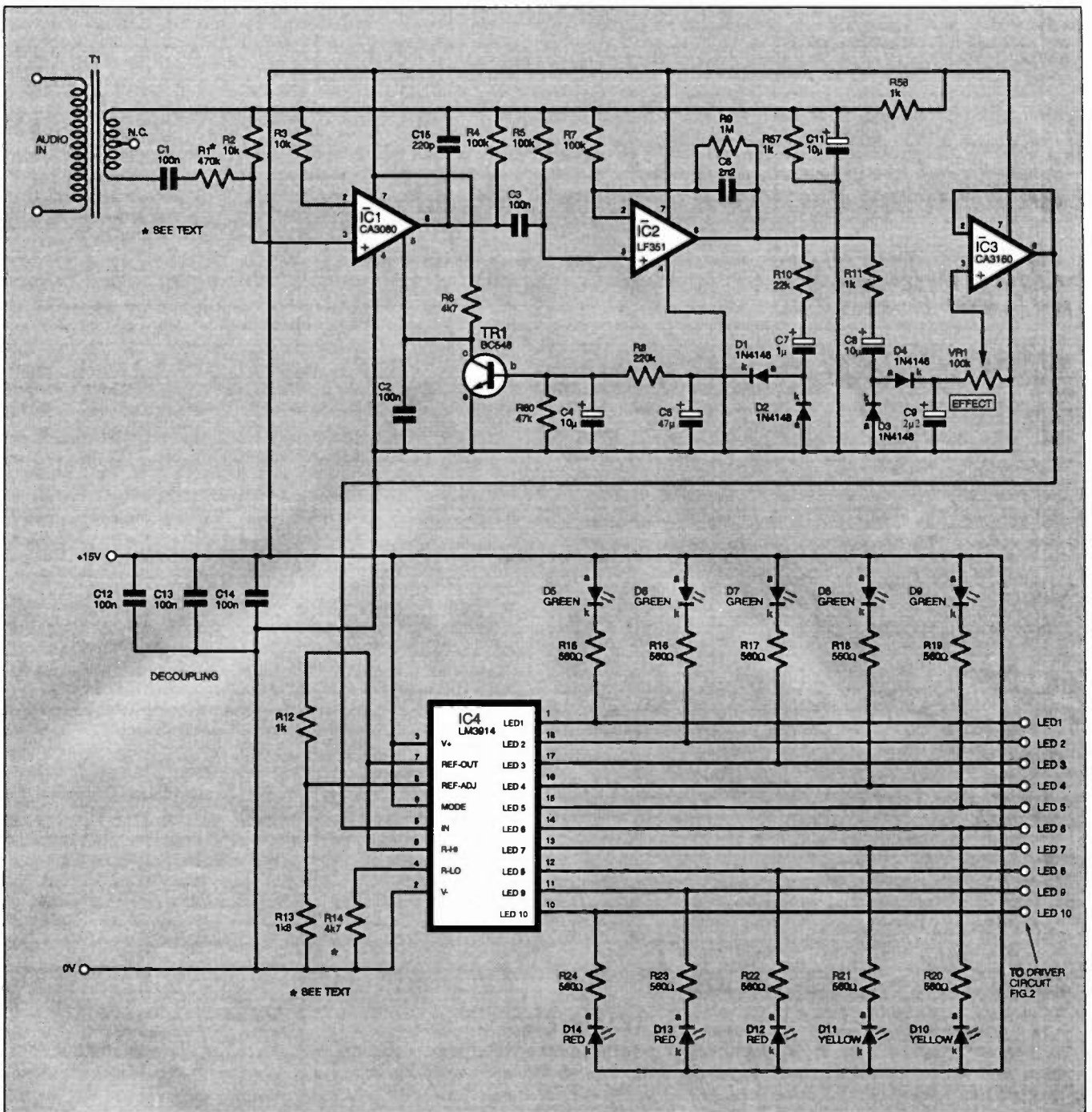


Fig. 1. Music level detection and control stages circuit diagram.

If the value of R1 is too high, there will be insufficient signal for the automatic level control to operate and the effect will vary as the volume is adjusted. If the value is too low, the automatic level control will be saturated and all the l.e.d.s will remain on with virtually no variation. The automatic level control has a wide acceptance range so the precise value is not at all critical.

### TRANS-CONDUCTANCE

A transconductance amplifier type CA3080 is used for IC1. The gain of this device is controlled by the current flowing into the control node, pin 5. Resistor R4 is the output load, which converts the output current into a voltage. Capacitor C15 reduces the impedance of the load at higher frequencies, reducing noise and giving some high frequency roll-off. Resistors R2 and R3 bias the two inputs, pins 2 and 3, to the mid-rail supply voltage. Inevitably,

there will be some small d.c. offset at the output of IC1, particularly at higher gains. This is blocked by capacitor C3.

If experimenting with the CA3080 device, note that it can easily be damaged by overdriving the control input. The input is connected directly to the base of an internal transistor. Connecting it directly to a low impedance voltage above about 0.6V, or allowing more than about 5mA to pass into it, will destroy the transistor.

A conventional op.amp is used for IC2 and is configured as a non-inverting amplifier with a gain of about ten at lower frequencies. Capacitor C6 progressively reduces the gain at higher frequencies. This is intentional since the effect works better at lower frequencies – in particular the bass beat. The value of C6 may be adjusted to suit individual preferences and music styles.

### RECTIFICATION

The output of IC2, pin 6, feeds a rectifier circuit comprising diodes D1 and D2.

Capacitor C7 is a d.c. blocking component and C5 is the smoothing capacitor. The latter charges at a rate set by resistor R10 and discharges at the rate set jointly by the paths through R6, R8 and the base of transistor TR1. The component values are arranged to give a gentle attack and slow decay characteristic.

Resistor R6 passes sufficient current to bias IC1 control pin 5 to give maximum gain when transistor TR1 is turned off. If the signal level on the output of IC2 is too great, the output from the rectifier network will rise, causing TR1 to conduct. This diverts current from the control pin of IC1, reducing the gain. This automatic level control circuit will maintain a virtually consistent output level from IC2 despite a large change in audio input level. From measurements taken, a variation of at least 30dB can be accommodated, as proved over many years.

The output of IC2 also drives another rectifier circuit comprising resistor R11, capacitors C8 and C9, and diodes D3

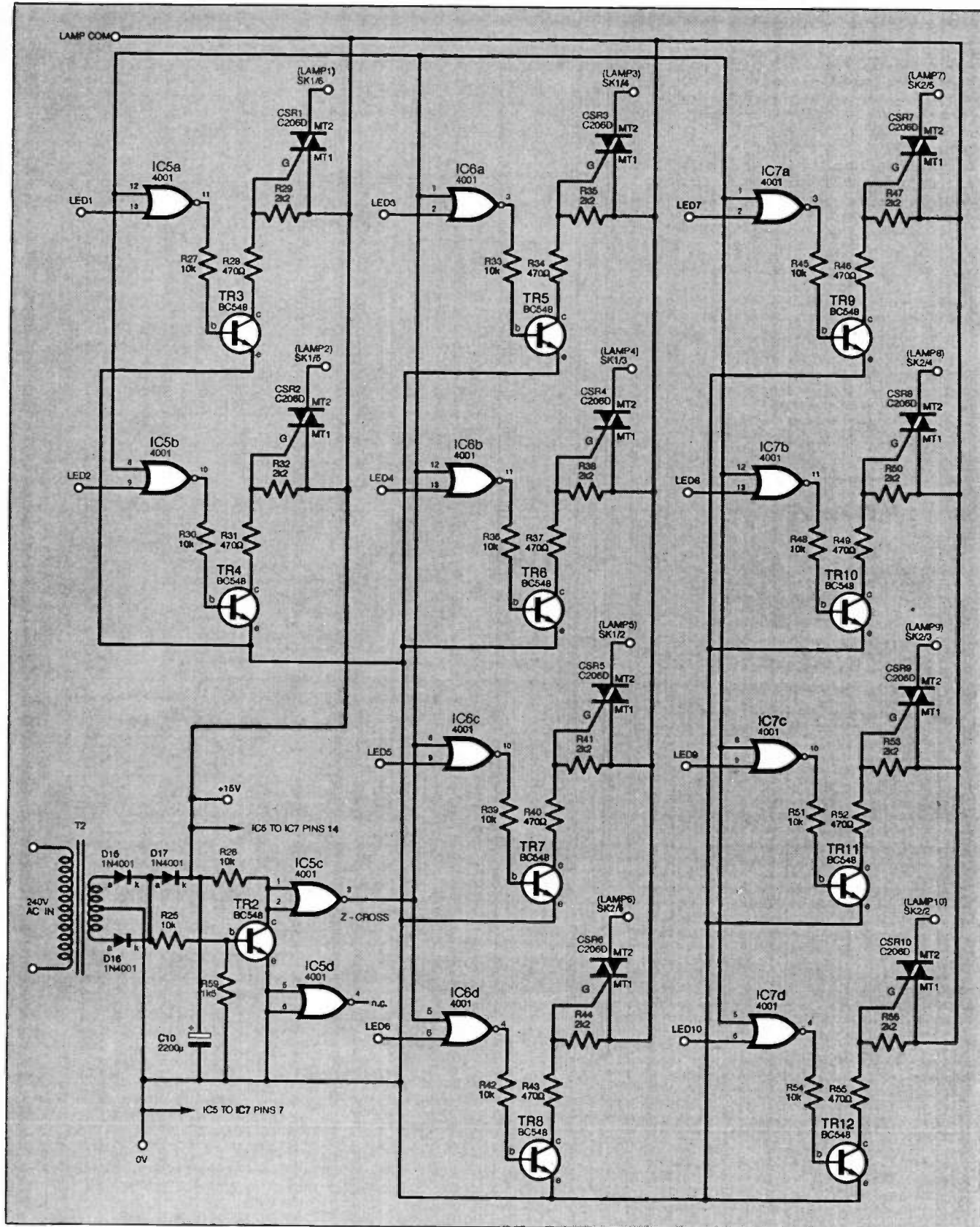


Fig. 2. Circuit diagram for the ten lamp drivers.

and D4. This circuit has a much faster response, due to the low values of R11 and C9. Potentiometer VR1 provides the discharge path for C9. A portion of the d.c. level from this rectifier is tapped off by the wiper of VR1 and buffered by op.amp IC3. A CA3160 op.amp was chosen because its output can be driven to within 0.1V of the positive and negative supply rails.

Mid-supply rail reference voltage for all three op.amps is provided by potential divider R57 and R58, decoupled by C11.

## BARGRAPH DRIVER

The output voltage from IC3 is taken to input pin 5 of IC4. This chip is an LM3914 linear 10-channel l.e.d. bargraph driver. A chain of resistors within IC4 provides separate reference voltage levels to 10 comparators. As the input voltage level rises, the comparators are tripped in ascending order, turning on the respective l.e.d.s D5 to D14.

Although current drive to the l.e.d.s is internally regulated, ballast resistors R15 to R24 have also been added in series with the l.e.d.s. If the resistors were omitted the outputs would still drive the l.e.d.s correctly, but the voltage on the output pins would vary from +14V to +11V, which is insufficient variation to drive the inputs of the digital chips in the next stage.

The resistors drop an additional 8V approximately, giving a level which is low enough to register as a logic 0, whilst

allowing the current regulation to operate. As a bi-product, the resistors also reduce the power dissipation within IC4. An output is low when the appropriate i.e.d. is lit.

The i.e.d. sink current is controlled by the voltage reference circuit and is about ten times the current flowing from the Ref-Out pin into resistor R13. In this case the reference voltage is set to 3.5V and the reference current is 1.3mA, giving an i.e.d. current of about 13mA.

The reference voltage is applied across the internal divider resistor chain. The bottom of the chain is lifted above 0V by the addition of R14. This reduces the dynamic range required, enhancing the effect. The value of R14 may be changed to suit personal preferences and the style of music played. Modern dance music has a low dynamic range for which the value of 4k7 is about right. For music from the 60s or 70s, 1k5 would be more suitable. If a selection of music styles is regularly played, 3k3 would be a good compromise. Alternatively, R14 could be replaced by a 10k potentiometer, adjusting it appropriately.

## LAMP DRIVERS

Details of the ten lamp driver circuits are shown in Fig. 2. As the circuits are identical, only one is described in detail, that around IC5a, transistor TR3 and triac CSR1:

When lines LED1 and Z-CROSS are both low, the output of NOR gate IC5a will be high. Via resistor R27, this turns on transistor TR3, which drives the gate of triac CSR1. Since the Z-CROSS line is low for only a brief period as the mains cycle passes through 0V, the triac can only be switched on at this point.

Once the triac is on, it will remain on until the current passing through it drops below a minimum holding value. With a resistive load, this occurs as the mains cycle approaches the next zero crossing point. Thus the load is driven for complete half cycles. No switching occurs at points in the cycle where the switched current would be high.

Because the triac is triggered only momentarily at the zero crossing point, the output is not suitable for driving inductive loads. With an inductive load the current and voltage are out of phase, so this simple triac driving arrangement will not operate correctly. Since the unit is only intended to drive normal lamps, this restriction should not cause any problems.

The Z-CROSS signal is derived from mains transformer T2. Diodes D15 and D16 provide full wave rectification, feeding into smoothing capacitor C10 via diode D17. The positively rectified ripple voltage at the junction of the three diodes is attenuated by the resistor chain R25 and R59 and fed to the base of transistor TR2. The transistor is turned off when the voltage at the junction of the diodes is below about 3V. Resistor R26 is the collector load for TR2 from which the triggered output voltage is inverted by NOR gate IC5c.

NOR gate IC5d is unused and so its input pins 5 and 6 are connected to 0V.

## CONSTRUCTION

All components except for the transformers are mounted on a single-sided printed circuit board (p.c.b.) which is available from the *EPE PCB Service*, code 956. Component positioning and track layout details for the board are shown in Fig. 3 and Fig. 4.

Components should be assembled in ascending order of size, or convenience. Use

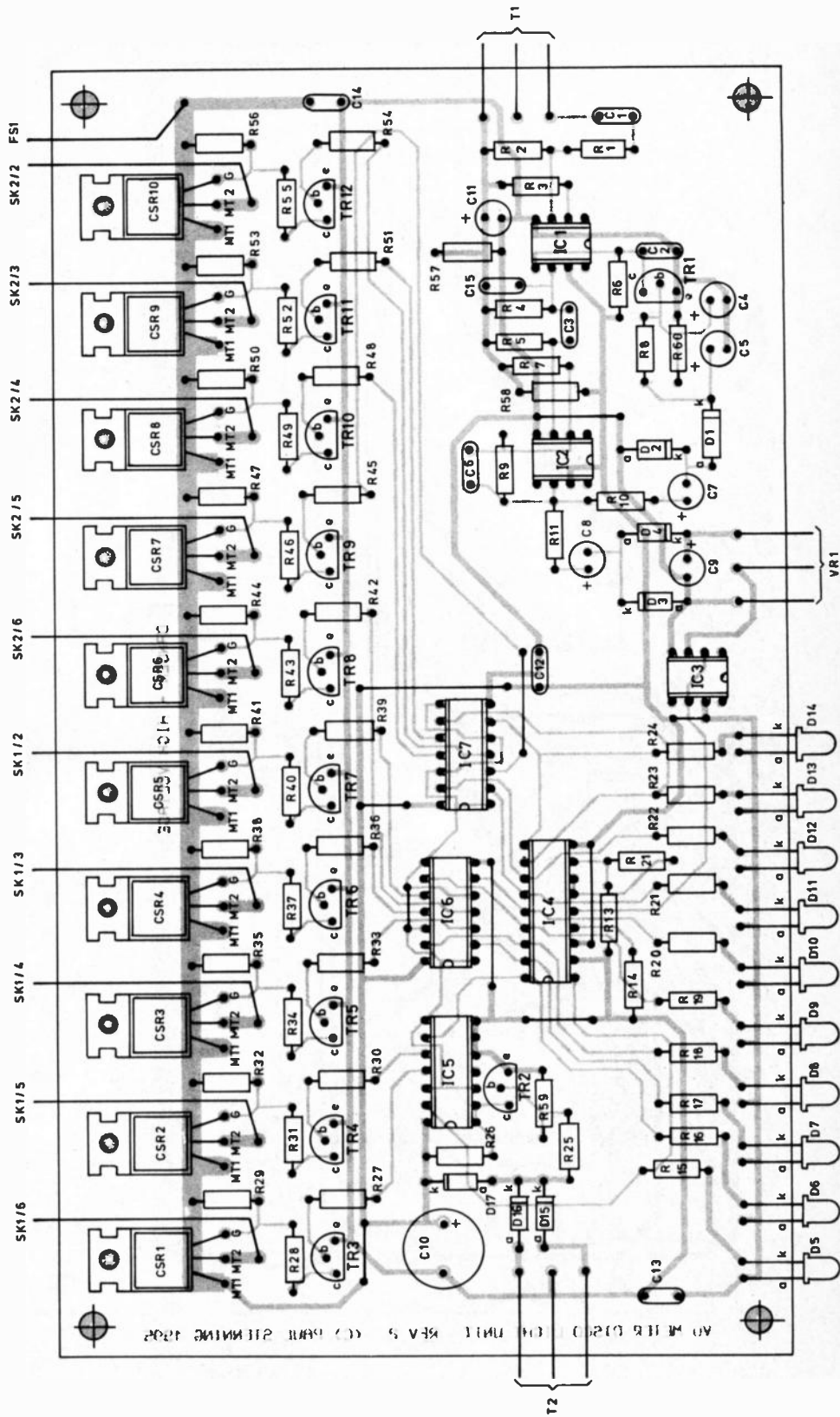


Fig. 3. Component layout for the Gigantic VU Meter p.c.b.

sockets for all the i.c.s., but do not insert the i.c.s. until after thoroughly checking the entire assembly. Don't forget to fit the ten wire links. Veropins or similar should be used for all off-board connections.

The leads of the i.e.d.s should be left at a suitable length to allow the faces of the components to protrude through holes in the panel of the chosen case. The "k" on the component overlay indicates the cathode of the i.e.d.; usually marked by a flat on the side of the i.e.d.

Potentiometer VR1 may be mounted directly onto the p.c.b. or connected to it by short lengths of insulated wire. On the overlay, the centre pin is the wiper, the left pin is the anti-clockwise end of the track and the right pin is the clockwise end.

Triacs CSR1 to CSR10 should be secured to the p.c.b. with M3 or 6BA nuts and bolts. No heatsinking is required. The heavy mains carrying p.c.b. tracks should be reinforced with solder or tinned copper wire of about 20 s.w.g.

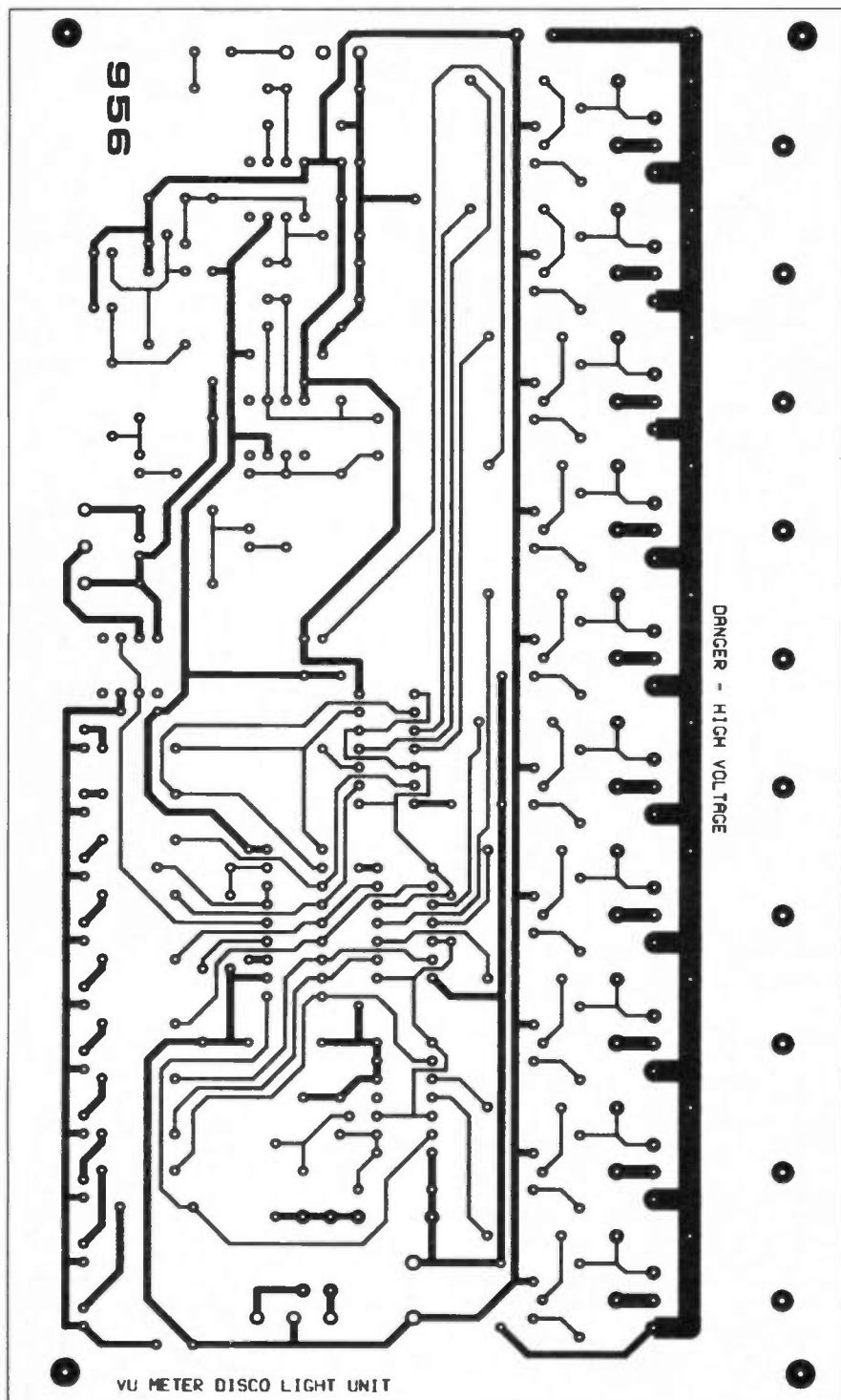


Fig. 4. Full size copper foil track master layout.

When construction is complete, carefully check the entire assembly, especially the area around the triacs, for short circuits and bad joints, etc. Short circuits could cause a nasty mess when the mains is applied!

### CASING IT

Once the p.c.b. is finished it should be mounted in a suitable case with the transformers etc. The author's model was housed in a case measuring 221mm x 150mm x 63mm. For professional use, a sturdy metal case should be used if the unit is to survive for any length of time – disco equipment leads a rough life! Even for home use, a metal case should be used for safety. Plastic cases are not recommended for this unit. Potentiometer VR1 should have a metal shaft, and a metal knob for strength.

However, a significant amount of money could be saved by building the controller into the light box – saving the cost of a case, some connectors and multicore mains cable.

### CONNECTIONS

Interwiring details are shown in Fig. 5. Mains wiring **MUST** be carried out with wire rated at a *minimum* of 6A. The insulated cores stripped out of mains cable will probably be suitable.

Bulgin 8-pin connectors are recommended for the lamps. These are commonly used for disco lighting. Their advantage is that either the plug or socket may be safely Live when de-mated. They are also fairly difficult to break, which is good to know when accidentally dropping a speaker cabinet! Nearly all professional disco controllers and light boxes are fitted with Bulgin P552 sockets.

## COMPONENTS

### Resistors

R1	470k (see text)
R2, R3, R25 to R27, R30, R33, R36, R39, R42, R45, R48, R51, R54	10k (14 off)
R4, R5, R7	100k (3 off)
R6, R14	4k7 (2 off)
R8	220k
R9	1M
R10	22k
R11, R12, R57, R58	1k (4 off)
R13	1k8
R15 to R24	560Ω (10 off)
R28, R31, R34, R37, R40, R43, R46, R49, R52, R55	470Ω (10 off)
R29, R32, R35, R38, R41, R44, R47, R50, R53, R56	2k2 (10 off)
R59	1k5
R60	47k

All 0.25W 5% carbon film or better

See  
SHOP  
TALK  
Page

### Potentiometer

VR1	100k lin. (see text)
-----	----------------------

### Capacitors

C1 to C3, C12 to C14	100n polyester, (6 off)
C4, C8, C11	10μ radial elect. 25V (3 off)
C5	47μ radial elect. 16V
C6	2n2 polyester
C7	1μ radial elect. 63V
C9	2μ2 radial elect. 63V
C10	2200μ radial elect. 16V
C15	220p ceramic plate

### Semiconductors

D1 to D4	1N4148 diode (4 off)
D5 to D9	green l.e.d. (5 off)
D10, D11	yellow l.e.d. (2 off)
D12 to D14	red l.e.d. (3 off)
D15 to D17	1N4001 1A rectifier diode (3 off)
TR1 to TR12	BC548 npn transistor (12 off)
CSR1 to CSR10	C206D triac (10 off)
IC1	CA3080 op.amp
IC2	LF351 op.amp
IC3	CA3160 op.amp
IC4	LM3914 bargraph driver
IC5 to IC7	4001 quad 2-input NOR gate (3 off)

### Miscellaneous

SK1, SK2	8-way Bulgin P552 sockets (2 off)
SK3, SK4	0.25in mono plastic jack sockets (2 off)
T1	12V/0V/12V mains transformer, 100mA
T2	12V/0V/12V mains transformer, 250mA

Printed circuit board, available from the EPE PCB Service, code 956; 8-pin d.i.l. socket (3 off); 14-pin d.i.l. socket (3 off); 18-pin d.i.l. socket; case (see text); knob; panel mounting 20mm fuse holder; 20mm anti-surge fuse (see text); 3-core mains cable; 3-way mains terminal block; cable clamp; solder tag; nuts, bolts; solder, etc.

Approx cost  
guidance only

£47

excl. case and light box

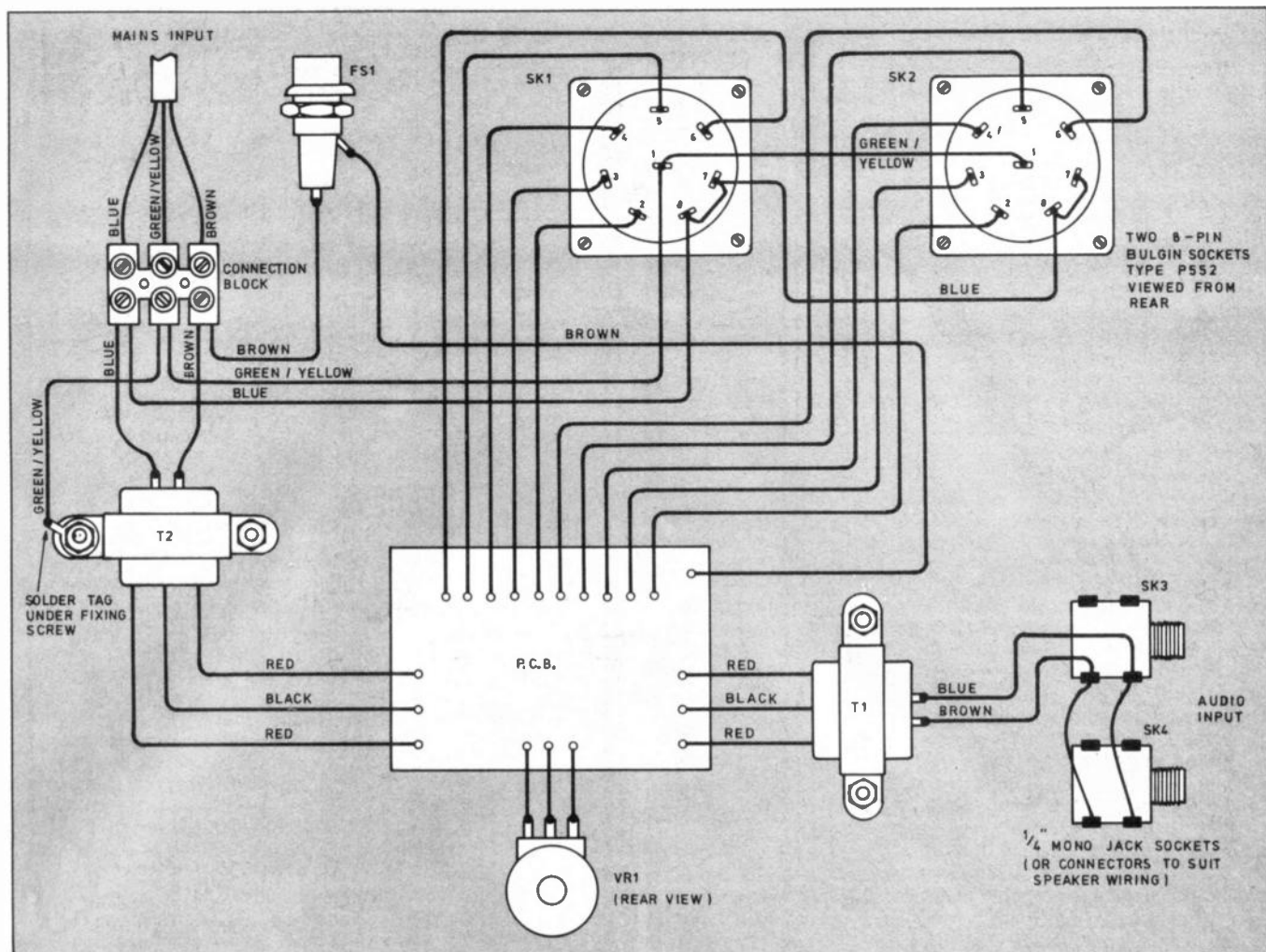


Fig. 5. Interwiring details between the p.c.b. and off-board components.

Connection leads have Bulgin P551 plugs on each end, and are wired for four channels using seven-core cable.

There are normally two sockets on the light boxes (wired in parallel), so a number of light boxes may be connected in a chain, with the controller at one end. This is an extremely flexible method of arranging things, since all the leads are the same, and any controller can be connected to any light box.

The standard wiring for these connectors is pins 7 and 8 for common (Neutral) and pin 1 for Earth. Pins 7 and 8 are linked in every connector, and a single wire is used in the connection leads. For three-channel lighting, pins 3, 4 and 5 are the three Live

connections. With four channels, pin 2 is also used. Pin 6 is normally unused or carries a permanent Live feed for motors etc. In this design, pin 6 is used for a further channel so that the ten channels may be carried on two connectors. Although this is slightly non-standard, no harm will be caused if the wrong light is connected to the wrong controller. Standard four-channel leads can be used if they are made up correctly (with pin 6 connected).

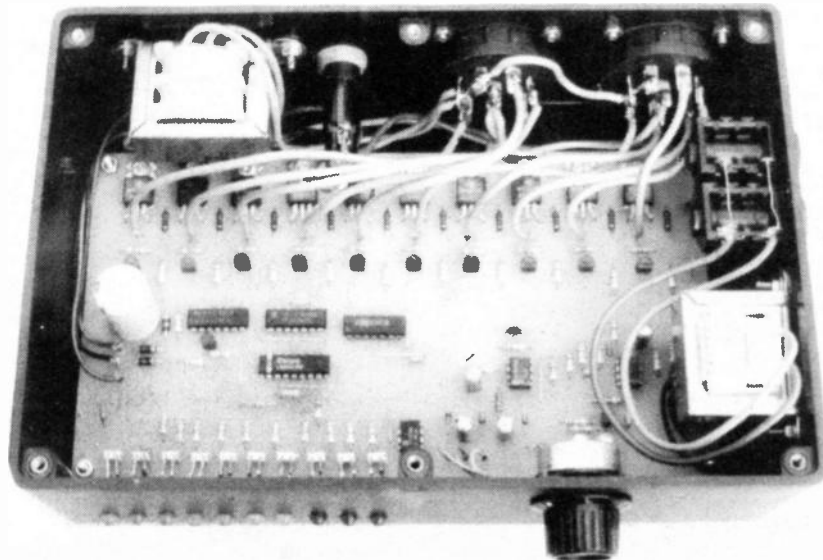
An insulating boot should be pushed onto the back of the fuseholder, which should be fitted with an anti-surge fuse. The fuse value should be chosen to suit the total current of all lamps connected, provided that wiring is adequate for the current.

Two standard mono jack sockets are used for the audio input. These **MUST** be the plastic bodied type so that no connection is made between the speaker wiring and the Earthed case (to prevent hum loops or damage to the amplifier). Two sockets are connected in parallel so that the unit may be connected between the amplifier and speakers using two leads. This arrangement is also fairly standard with disco equipment. Use 6A wire for the links between the two sockets as they have to carry the full speaker current. If existing equipment uses a different type of connector for the speaker wiring (such as 3-pin Cannon) these can be fitted instead.

Speaker leads have to handle significant current and should be made using round 2-core 6A mains cable (flat cable kinks too easily). The use of orange cable intended for garden power tools is recommended so that it can be readily distinguished from other audio cables fitted with jack plugs. Use metal jack plugs – the plastic ones break far too easily.

Since all the controllers will normally be stacked up in one place, a number of short speaker leads are useful for linking them together. The above information assumes that this controller is being used with professional disco equipment.

More detail has been given than is strictly necessary to build the controller in the hope that it will be of use to those readers who may be just starting to run a small mobile disco. If this unit is being built solely for home entertainment, any type of connector can be used as long as it is suitably rated for the voltages and currents involved.



## TESTING

Initially, the unit should be tested with the lamps disconnected. *Do not fit the fuse in the fuseholder yet.* Set potentiometer VR1 fully clockwise and connect the unit to the mains and amplifier. When playing some music, the l.e.d.s should flash in a manner similar to a VU meter. Reduce the setting of VR1 such that the top l.e.d. lights only occasionally. Now alter the volume on the amplifier. After a second or so (while the automatic level control sorts itself out) the l.e.d.s flashing should revert to the same level.

Switch off and fit the fuse. Connect lamps to the outputs and switch back on. **The whole p.c.b. is now Live, so do not touch it!** The lamps should flash in time with the l.e.d.s on the appropriate channel. If the light box has not yet been assembled, it may be easier to connect a table lamp to each output in turn (switching off while changing the connections).

## LIGHT BOX

Construction of the light box depends to a great extent on the resources available and your ability. The suggestions given here may be used as a guide. If a mobile disco is being run, the light box should be made fairly solid. It will get a battering – no matter how gentle its treatment is planned to be. There will be evenings when it is necessary to clear everything up and get out within ten minutes, because the landlord or whoever wants to lock up and go home!

First decide whether a vertical or horizontal light box is wanted. If a disco is being run and a vertical arrangement is chosen, two units will probably be needed to keep the setup symmetrical – which of course costs twice as much. Also bear in mind that vertical boxes could be somewhat unstable and prone to being knocked over, unless they are made fairly wide, deep and heavy. The controller will drive two light boxes without problems.

Alternatively, if the disco is stereo, two controllers could be made (possibly in one case with a dual potentiometer), to drive each light box separately. In this case it may be necessary to reduce the value of capacitor C6 to allow more mid-range through, otherwise the two units will appear to be doing the same thing!

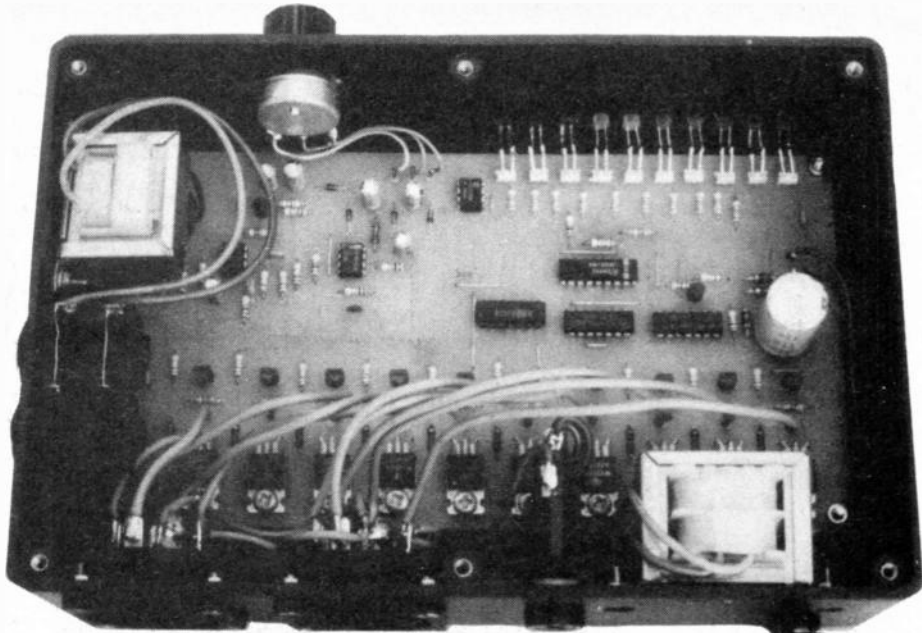
A horizontal light box could be positioned centrally, above or below the disco name sign. The disco name could even be put on the front of the light box, killing two birds with one stone! Make sure the chosen box fits the transporting vehicle!

## PERSPECTIVE

Whichever way it is intended to be mounted, basically the need is for a box divided into ten equal rectangular sections. Each division must be large enough to house the lamp without it touching the partitions, or overheating its surroundings. The front of the case is covered with translucent acrylic sheet (Perspex) to diffuse the light and protect the lamps. The Perspex should be at least 40mm away from the lamps for this to be effective. Buy the Perspex first, and hold it near a lamp to establish the best distance.

Translucent Perspex may not be the easiest product to find locally – try looking in *Yellow Pages* under "Plastics – Suppliers" or "Plastics – Film and Sheet". To save money, try to get an off-cut and trim it to size, or make the box to suit.

Perspex can be cut with a normal wood-working saw if GREAT care is taken. Beware that it is prone to cracking if



treatment is too heavy-handed. An electric jig-saw works well, if it is fitted with a fine blade. In any event, get a second person to help hold it steady, and progress slowly and gently. The Perspex should be about 2mm undersize on all sides so that it is not under any stress.

If professional lettering of the disco name on the front of the box is wanted, try the "Sign Makers" section of *Yellow Pages*. The service can probably be obtained for about twice the cost of a plain sheet.

## CHIPBOARD

The box should be made of solid chipboard, or even blockboard if it needs to be really substantial (and heavy). Corner joints should be made by gluing and screwing the chipboard onto battens. Dividers can be made with plywood, about 6mm thick. This is thick enough to fix into place with glue and small nails. The corner joint battens and the dividers should be recessed about 15mm from the front of the case to allow room for the Perspex to be inset.

Strips of 12mm quarter-round timber or similar can be fixed to the case in front of the Perspex to hold it in place. Use screws from the outside of the case for this, and no glue – the Perspex needs to be removed to change the lamps.

The back of the box should be wide enough to hold the bayonet-cap lamp batten holders, allowing about 15mm each side for ventilation. If the dividers stop about 20mm from the back, this will allow room for the wiring between the lampholders.

Air-flow sockets should be fitted through the back panel wherever there is room, and the rear connections covered with a generous quantity of insulation tape. This prevents an electric shock should someone poke their fingers through the ventilation gap.

Once complete, the box can be painted matt black on the outside, or covered with black vinyl sheet if preferred. A few corner protectors will prevent the chipboard from chipping, and a handle or two in the right place can be very useful. The inside should ideally be painted gloss white.

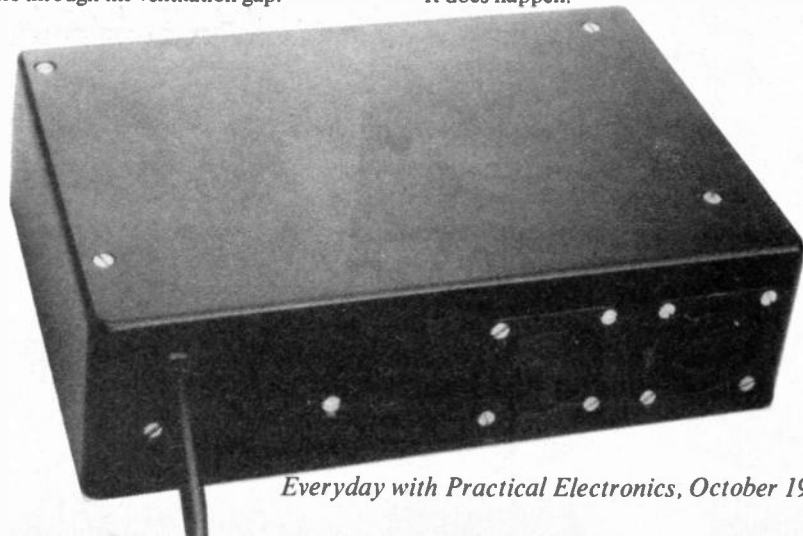
The lamps should be the normal coloured round type, like those used on the larger outdoor Christmas lights. A rating of 25W will generally be suitable, and will not get too hot. Larger lamps such as 40W or 60W could be used if more light is wanted – but there will be more heat too!

Colours could be used that give the impression of a VU meter: five green, two yellow and three red, for example. Or ten randomly coloured lamps could be used. Take spare lamps with you – discos with blown bulbs look most unprofessional!

## SUGGESTIONS

A few more suggestions: How about building a horizontal 20-lamp box, with the light effect coming in from the ends or out from the middle? This could look good with a name sign. How about a rectangular box with ten triangular sections each having a corner meeting at the bottom middle, in a fan effect? Or there could just be a row of R60 coloured spot lamps on an overhead gantry. Do something individual and get noticed!

One final suggestion – on a safety matter again. Buy residual current circuit breakers (RCCBs or RCDs) and plug them into the wall sockets where the inevitable multitudes of four-way trailing extension leads are connected. These could prevent an electric shock if some wally smashes a lamp or spills a pint of lager into the equipment. It does happen! □



# Get the Best Universal Diagnostics Toolkit on the market!

*Works on any PC!*

Featuring these two top-rated, award-winning diagnostic tools from MICRO 2000, Inc:



Winners of these awards:



"You name it, this tests it. If you maintain PC's, you'll love it."  
—Jerry Pournelle, BYTE Magazine, May 94



## Micro-Scope™ UNIVERSAL DIAGNOSTICS SOFTWARE Ver. 5.0

Fully O/S Independent diagnostic software...

MICRO-SCOPE Universal Computer Diagnostics was developed to satisfy the expanding need for accurate system diagnosis in the rapidly growing desktop computer market. Patterned after super-mini and mainframe diagnostic routines, MICRO-SCOPE runs independently of any standard operating system, and is therefore at home on any machine in the Intel world. Speed, ease-of-use, and razor sharp accuracy are a few of the advantages that arise from this system independence, together with an impressive list of functions including the ability to perform low level formatting on every drive currently manufactured, including all IDE drives.

- **LOW-LEVEL FORMAT** — Performs Low-level format on all drive types including IDE drives. This function cannot hurt IDE drives.
- **USE CONTROLLER BIOS** — Program will access BIOS format built into any hard disk controller—even Controllers yet to be invented.
- **O/S INDEPENDENT** — Does not rely on O/S for diagnostics. Talks to PC on hardware level. All tests are full function regardless of O/S (i.e. Novell, UNIX, OS/2).
- **TRUE HARDWARE DIAGNOSTICS** — Accurate testing of CPU, IRQ's, DMA's, memory, hard drives, floppy

drives, video cards, etc. ● **BATCH CONTROL** — All tests, even destructive, may be selected for testing. ● **ERROR LOGGING** — Automatically inputs errors during testing to an error log. ● **AUTOMAPPING** — Automatically bad sector maps errors found on hard disks. ● **IRQ DISPLAY** — Show bits enabled in IRQ chip for finding cards that are software driven. (Network, Tape Backup, etc.) ● **IRQ CHECK** — Talks directly to hardware and shows I/O address and IRQ of devices that respond. ● **MEMORY EXAMINE** — Displays any physical bit of memory under 1 Meg. Very useful for determining memory conflicts. Very useful for determining available memory space. ● **SECTOR EDITOR** — Allows the editing of any sector of floppy or hard disk media (even track 0). ● **AND MUCH MORE...** We don't have enough space here for everything this software can do!

## POST-PROBE™ BY EVER UNIVERSAL POST CARD FOR ALL PCs

The only Power-On Self-Test card you need to debug any "dead" PC...

"This is the only card that will function in every system on the market. The documentation is extensive, and not only covers the expected POST Codes for different BIOS versions, but also includes a detailed reference to the bus signals monitored

by the card." —Scott Mueller from his globally recognized book, 'Upgrading & Repairing PCs, Second Edition'

- Includes pads for voltmeter to attach for actual voltage testing under load.
- 4 LEDs monitor +5vdc -5vdc +12vdc -12vdc.
- Monitors HI & Lo clock and OSC cycles to distinguish between clock chip or crystal failure.
- Monitors I/O Write and I/O Read to distinguish between write and read errors.
- Monitors memory write/ read to distinguish between address line failures and memory chip failures.
- Monitors ALE for proper CPU/DMA operation.
- Monitors Reset to determine if reset is occurring during POST, indicating short.
- Monitors progress of POST without POST codes.
- Reads POST codes from any IBM or compatible that emits POST codes. ISA/EISA/MCA.
- Compatible with Micro Channel computers.
- Dip switch allows easy selection of I/O ports to read.
- Includes tri-state LOGIC PROBE to determine actual chip failures.
- Manual includes chip layouts and detailed POST procedures for all major BIOS's.
- AND MUCH MORE...

Also ask about our other Universal Products—**Micro-Scope CLIENT**: The practical answer to remote diagnostics (no modem required).

**The COMPUTER CONSULTANT**: 100% accurate realtime benchmarking tool.

**Micro-Scope CENSUS**: Inventory software to see and record what's inside all of your PCs.



Call Now for Special Pricing: Tel. +44 462 483483 or Fax +44 462 481484

MICRO 2000 EUROPE: P.O. Box 2000, Letchworth, Herts, SG6 1UT, England, United Kingdom

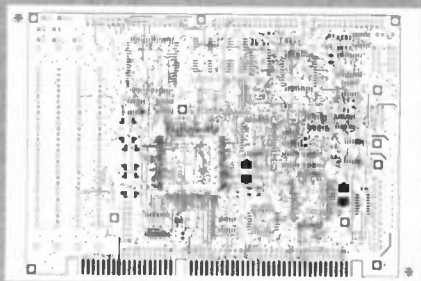
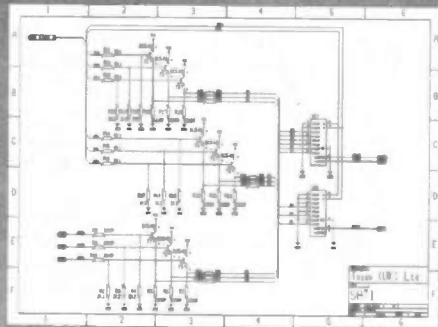
**Is your PCB design package not quite as "professional" as you thought? Substantial trade-in discounts still available.**

## 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**



## Board Maker

*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**

## Board Router

*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)

All trademarks acknowledged



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



**tsien**



# New Technology Update

*Ian Poole reveals that f.e.d.s are seen as the future face of computer display technology*

**D**ESPITE the major advances, the majority of computers still use cathode ray tubes (c.r.t.s). These were first thought of at the beginning of this century, and some of the work on them predates the diode valve.

Whilst the c.r.t. uses what is in a sense "old technology", its age means that it is a well developed technology, and it still has viewing, colour and price advantages over other forms of display which are more up to date.

Against this, the c.r.t. is very large. In some cases this is not too much of a disadvantage, but in others, particularly portable applications, it is crucial. Its power consumption is also high, requiring high voltages and appreciable amounts of current. This also makes it totally unsuitable for portable applications which are becoming increasingly common.

## Liquid Crystals

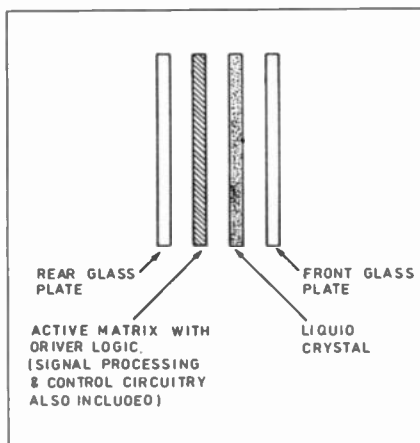
Currently, most portable computers use various forms of liquid crystal display (l.c.d.). These do not give the performance of the c.r.t. but have to be used because of their size and power consumption. Over the last few years major advances have been made with active matrix technologies where large amounts of control circuitry are integrated into the structure in the form of thin film transistor circuits, as shown in Fig.1. Now resolutions of 640 x 480 pixels are available in monochrome, and some displays also offer a limited colour capability.

The active matrix l.c.d. offers high definition combined with good contrast, and it eliminates flicker. Despite this, it is unlikely that this form of display can ever become the full answer to all computer display problems. Other technologies which are not as far advanced seem to offer better possibilities of becoming the longer term solution. One of these is called the Field Emitter Display (f.e.d.).

## The F.E.D.

The f.e.d. adopts a fundamentally different approach to all the new types of display which are emerging on the market. Arrays of thousands of minute cathodes acting as electron guns emit electrons which can be accelerated onto phosphor screen coatings causing them to emit light. These phosphors can be coloured to enable colour to be displayed in the same way as a cathode ray tube.

From Fig. 2 it can be seen that the f.e.d. possesses many similarities to the familiar c.r.t. Where the c.r.t. uses a single electron



*Fig. 1. Expanded view of an active matrix l.c.d.*

gun for each colour the f.e.d. uses its array of minute cathodes, each only about one micron in diameter. They emit electrons under the influence of a high electric field from the anode. A gate positioned just above the cathode is used to control the emission.

The anode is contained in the top layer and has a voltage of around 1kV applied to it. This pulls the electrons towards it in the same way that occurs in a c.r.t. The electrons hit the phosphor coatings on the anodes at sufficient velocity to cause them to release light energy.

To enable the images to be created, the cathodes are arranged in an array of rows and columns. These can be controlled by an array of drive circuits using thin film transistor circuits, in much the same way as many l.c.d.s. In this way the f.e.d. appears to borrow solutions from a number of different technologies and manages to improve on them all.

Within the display, the dimensions are microscopic. The distance between the cathode and anode is only about 200 microns. This means that with anode voltages of around a kilovolt problems can be experienced with arcing. Careful design and manufacture is needed to ensure this does not occur.

The overall displays are generally quite thin. Typically, they might be two or three millimetres thick. This makes them ideal for many portable applications.

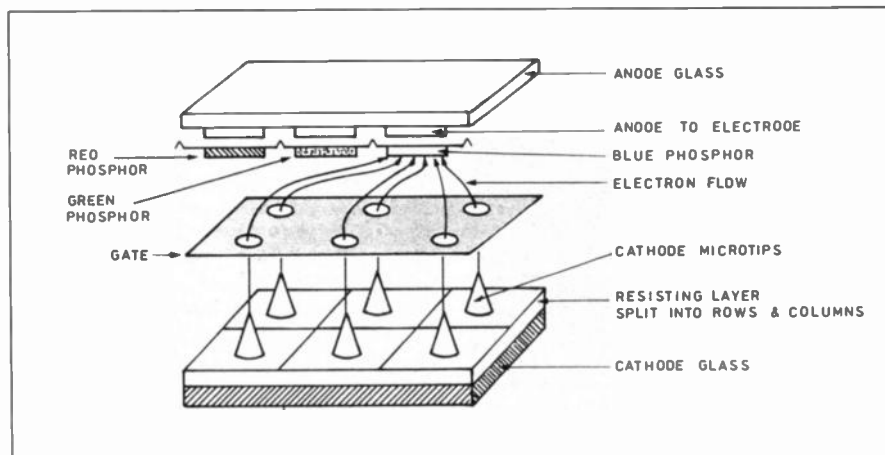
## Further Development

One of the main areas of f.e.d. research is in reducing the voltages required for operation.

Brightness is another important factor. Some experimental f.e.d.s have already produced greater output levels than average c.r.t.s., even though they needed a high anode voltage to achieve this.

The interest in the technology is such that a surprisingly large number of companies are developing them. Major American government organisations can also see their importance and are putting forward funding to help with their development.

Although there are no commercially viable displays available at the moment, a number of demonstration models have been made by various companies. The French company Pixel, which pioneered much of the early f.e.d. work, plans to produce its first six-inch colour displays shortly, and within a year it expects to have a twelve-inch version. Many other manufacturers, including Texas Instruments, Micron Technology and SI Diamond, are also working to produce displays in the near future.



*Fig. 2. Construction of a field emitter display (F.E.D.).*

## SEEING THROUGH THE PLOT

Lasers and new X-ray interface enhance airport security. Plants come under better scrutiny as well – by Hazel Cavendish

THE weakest link in airport security remains the luggage inspection process. Airport security officers typically have only a few seconds per bag to spot suspicious objects concealed in carry-on items, and checked luggage and other airline cargo are not routinely examined. Traditional X-ray inspection systems, developed in the 1960s to thwart airline hijackers, are excellent at finding metal handguns and grenades, which are relatively opaque to X-rays, but incapable of detecting hidden non-metallic, organic materials such as plastic explosives and a new generation of plastic firearms. Likewise drugs, cash, gemstones and foodstuffs are relatively transparent.

Now computers are to be linked to X-ray systems to ensure that the tools of a hijacker's trade are instantly detected. The UK's Fairey Group, increasingly involved in industrial electronics and specialist engineering in the USA, Britain and Europe, recently spent over 13 million dollars purchasing an American company called Imaging Technology. The purchased company uses electronic imaging techniques and "frame grabbers" – the name given to a transmission board which acquires images – to improve security measures in airports throughout the world where the threat of terrorism and the smuggling of contraband increases annually.

### FLYING SPOT X-RAY

The devices they manufacture for airport security were developed by American Science and Engineering of Cambridge, Massachusetts to detect narcotics and agricultural contraband invisible to traditional X-ray security systems. Aircraft carry-on bags placed on a conveyor belt are passed through a Micro-Dose X-ray security system to seek out plastic explosives and other

suspicious organic substances. A "flying spot" of X-rays is scanned rapidly over the bags, and as they are inspected scattered red beams are collected by the "Z R Backscatter" detection system, which uses a laser to bounce beams off different materials to create the image.

"The neat thing about this application is that it can detect many different types of plastic bombs concealed in luggage," says Patricia Mansfield, spokeswoman for Imaging Technology. "Most people think of a bomb as being round, but there is one particularly dangerous one made from materials which lay flat and can be spread out in the lining of a case. Our system using the spot-scanning technology of Backscatter can detect it immediately, as well as other forms of plastic explosives and drugs."

Airport staff use side-by-side monitors to watch for either metallic objects or organic materials. Any organic substance appears conspicuously in white on a video monitor, even when camouflaged by metallic or confusing mixed-density backgrounds caused by portable radios or tape recorders.

The system has been developed for a range of different environments, so that luggage can be inspected while being loaded on to an aircraft, furniture analysed as it is moved in and out of high-security buildings and trucks, trailers and sea cargo containers searched automatically for unauthorised goods. The new imaging system is already being used throughout America and the Middle East, as well as many other "hot spots" in the world, and is expected to be adopted internationally.

### HORTICULTURAL PLOT

Fairey's Imaging Technology processors are used in quite a different context to speed horticultural practices in Holland. Visser ITE B.V., a leading Dutch manufacturer of horticultural machines, required an automated vision system for their product and the new technology was able to provide the answer.

In the mass production world of Dutch flower-growing, seedlings are cultivated in sectioned trays for easy handling, and are planted from these trays using automatic machines at sites all over the world. Production levels are high, an average greenhouse measuring around eight hectares (20 acres) with an average of 320,000 trays containing 80 million seedlings and plants. Production of any one type of plant is usually over one billion a year.

For economy and efficiency all tray sections, or cells, must be fully filled



Modular Vision computer which relays the X-ray pictures.

before they leave the greenhouse. Until recently cells were cleared of soil and refilled manually – a time-consuming and labour-intensive business with up to 300 trays being handled per hour.

The automated vision system adopted by Visser was based on a 486 PC running at 66MHz and capable of inspecting up to 1,000 trays per hour and identifying the coordinates of seedlingless cells. This data was then used to control machinery that blew out the soil or rejected seedlings from the marked cells. Imaging Technology was asked to provide the processors.

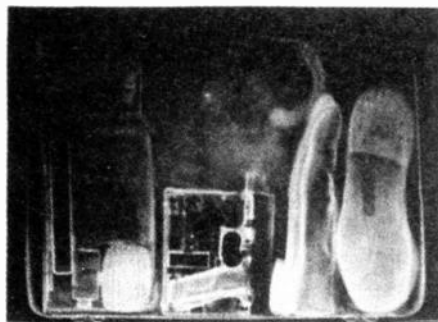
### GLEENING THE GREEN

The vision aspect of the project was challenging in the extreme. It was necessary for the system to distinguish between green seedlings and a background that consisted of white tray material, black soil, shiny vermiculite (a water absorber) and possible algae and moss, both of which were green.

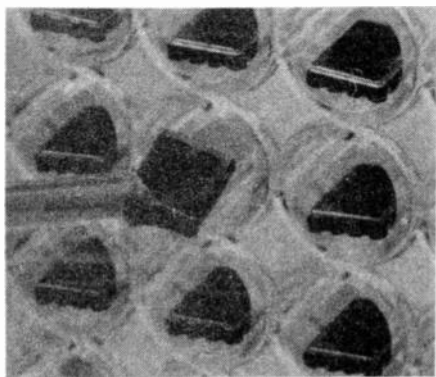
Imaging Technology's VISIONplus-AT Modular Frame Grabber was chosen to convert RGB (red, green, blue) colour to HSI (hue saturation intensity) almost instantaneously. By making a histogram analysis after conversion, the system measures the amount of plant material in each cell and rejects or accepts it. Software options change the colour conversion to inspect different sorts and sizes of plant. The use of this inspection system has halved the labour cost of the operation.

### APOLOGY

We apologise to Dr Euan Thomson, head of the Norfolk and Norwich Hospital's Radiotherapy Department, for so grossly misspelling his name in last month's *Innovations* column.



Silhouette of a plastic gun would not be seen on conventional X-ray machines.



IDT's new crystals extend to 80MHz.

## FASTER CRYSTAL OSCILLATORS

Extended frequency and temperature ranges are now available with the IXQO-70 series of oscillator chips from UK manufacturer IQD. The frequency range has been extended to cover from 1.8MHz to 80MHz to satisfy increasing demand for higher frequencies. (Readers may recall that the *EPE TV Camera* of March '94 required the use of an 80MHz oscillator based around several components as an 80MHz oscillator chip seemed unavailable at that time.)

The series is capable of driving both HCMOS and LSTTL loads in addition to providing a tri-state output, which provides for an almost instantaneous start up of the oscillator following logic 1 being applied to the enable pin.

Although the series is only available as surface mount devices, since the chips have only eight pins, experienced constructors should find no difficulty using them.

For more information contact Claire Northcott, IQD Ltd., Station Road, Crewkerne, Somerset TA18 7AR. Tel: 01460 77155.

## NEWLY BAFFLED

To complement their range of loudspeakers, Infinite Baffle Ltd. have introduced a foldback monitor stage loudspeaker. Its cabinet has been designed so that the user has a choice of angles, 30 degrees or 60 degrees, to suit most applications.

The frequency range has been especially tailored for foldback applications and will extend down to 45Hz and up to 20kHz. The cabinet comes fully flight cased and has a steel grille fitted on the front to protect the 12-inch driver. Compact in size, measuring 590mm x 400mm x 357mm (w x h x d), the unit weighs only 16kg and is competitively priced at £105, including VAT, plus £12.50 carriage.

For more information contact the sole UK suppliers B.K. Electronics, Dept. EPE, Unit 1, Comet Way, Southend-on-Sea, Essex SS3 9NR. Tel: 01702 527572.



## GOVERNORS SURF THE NET

British Telecom is to provide £25,000 of support to set up The National Governors Council communication and information system NGC-Online and get it onto the Internet. The soon-to-be-launched system will be open to all school governors whose governing bodies belong to NGC member associations.

Governors will be able to access the system either directly or via their schools' subscription to Campus World. Initially the service will provide e-mail, information about NGC's activities and newsgroups to discuss live issues and feed views to those who represent them. There will be a section devoted to the education market-place where local NGC groups and education authorities may publish information. There are also plans to provide a database of governor information and support resources.

For information from BT please contact Richard Hamer on 0171 356 5638.

For more information from NGC, contact Jeremy Dodd NGC EMail doddj@jezd.demon.co.uk

## DON'T GET LOST

Whether you are walking, climbing, fishing, cycling or simply lost, the new Global Position System (GPS) receiver from Magellan Systems Corporation will give you a precise position, direct you to a predetermined landmark or show you the way home, for less than £200.

With its compact size, ease of use and comparatively inexpensive price, the Magellan GPS 2000 can be used anywhere in the world. By keying-in the landmark or places you want to reach, you are shown the information needed for the route, including destination distance, travelling speed and how long it will take to get there. It even shows whether to head left or right.

Even when the weather closes in you can still find your way back. The receiver automatically stores your position every ten minutes, so you can simply select the back-track facility and it will guide you back the way you came.

About the size of a mobile telephone, the Magellan GPS 2000 locates its position from data transmitted by a constellation of 21 satellites orbiting at a height of 11,000 miles. Originally conceived as a military defence system, the GPS satellites provide navigation information to users of GPS receivers without subscription or charge.

For more information, contact UK distributor Next Destination Ltd., 7 Barnack Business Centre, Blakey Road, Salisbury, Wilts SP1 2LP. Tel: 01722 410800.



## TELECOP

Whether or not local communities like the idea, some police stations are not open for 24 hours a day. In some cases, telephone links are provided outside closed stations allowing callers to speak directly to Divisional Headquarters. Conscious that to many people a voice-only link is too impersonal, Surrey Police are trying out a new video link service in the Byfleet area.

Situated in a secure office, this unique telephone video link is open 24 hours and effectively extends the front counter service available at Woking Divisional Police



Open all hours - a new video link extends the long arm (and view) of the Law.

Station out into the Byfleet area. If successful, the service could become the way forward in improving and maintaining police standards throughout the country.

The system under review is an advanced access control system called TelGuard, manufactured by CommTel. TelGuard is BABT Approved and operates via the existing BT network, or PABX, offering many features and capabilities beyond those of more conventional systems. It can access up to a thousand call points and so has tremendous scope for expansion, with the

possibility of future linking with other emergency and local authority services.

Whilst providing Surrey Police a sophisticated yet user-friendly means of being in remote contact with the public, the cost of TelGuard came well below that of any hard-wired alternative system.

For more information, contact TelGuard, P.O. Box 192, Dorking, Surrey RH4 3YJ. Tel: 01306 877889.

Conjunctions astronomical, not astrological, help devine your destiny.

# SOUND SWITCH

TERRY de VAUX-BALBIRNIE



A noise-triggered security switch to deter burglars when a property is unoccupied.

ALTHOUGH we are told that we live in a violent society, most house crime is of the petty or opportunist kind. Most thieves prefer to go about their business in unoccupied premises and only a minority will risk apprehension or the possible need for violent tactics in an occupied house.

It follows that if premises appear occupied even when they are not, potential intruders are more likely to leave well alone. A light placed either inside or outside the house has been shown to be a good deterrent.

The Sound Switch is designed to operate a light when noises are "heard" by a sensor. This will give the house an "occupied" appearance. Any lighting up to 3A rating (720W on 240V mains) may be connected. The circuit operates for a preset time which is adjustable from 30 seconds to one hour approximately.

There is also a push-button cancel switch which enables the unit to be switched off at any time before the end of the natural timing period. The Sound Switch only works at night – a light sensor inhibits operation during daylight hours.

Since the circuit is mains-operated it may be left switched on continuously at very little cost. The prototype has been used successfully to switch on a garage light when activated by the sound of a car engine. However, in tests it has been shown better at detecting noises such as footsteps – particularly on gravel and similar surfaces.

## REMOTE SENSOR

The circuit has been designed to operate using a remote sound sensor. This means that it may be used over a long range and not necessarily in clear line of sight with the house. The sensor could, for example, be sited at the end of a pathway.

It must not be mounted inside the main unit or placed close to it. The chief reason for this is that the click from the relay is sufficient to trigger the circuit. Also, it tends to pick up hum from the mains transformer and this can result in repeated triggering.

## FALSE ALARM

It must be understood that some false triggering is inevitable. The unit will operate occasionally if electrical "noise" is picked up, possibly along the mains power line.

One possible cause is the operation of electric motors such as those found in washing machines. Another possibility is when a fluorescent light is switched on or off, although it does seem that some of these give much less trouble than others.

Due to the possibility of false triggering, it is not advisable to use the unit to operate a fluorescent light – only standard tungsten filament lamps should be connected. From the security point of view, some false triggering is not thought to be important and its random nature may be a positive advantage. Note that false triggering signals have no effect during daylight hours when the light sensor inhibits operation.

miniature audio-type jack plug and socket, PL1 and SK1. The speaker is used as a microphone and converts the sound impinging on its diaphragm into a weak a.c. electrical signal.

The use of a loudspeaker here provides good sensitivity by picking up sound over the large area of its cone. It may be used instead of a conventional microphone because, in this application, faithful sound reproduction is not required.

Signals derived from the sound sensor are applied to the base (b) of high-gain transistor TR1 via coupling capacitor C4. An amplified signal then appears at the collector (c). Resistor R1 provides base bias while R2 is the load resistor. Note that, for best results, a transistor with suffix "C" as specified (that is, the highest gain group) should be used.

The amplified signal is coupled to the non-inverting input (pin 3) of operational

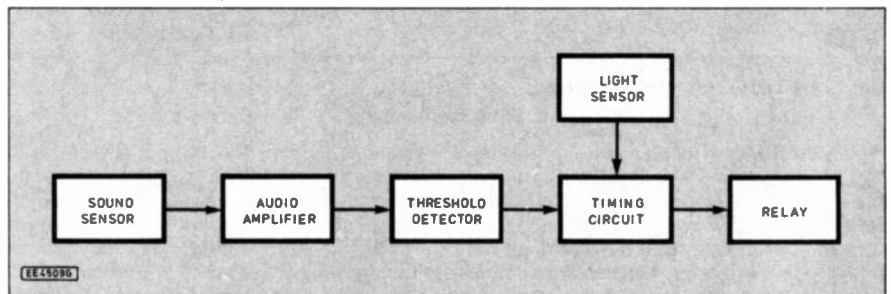


Fig. 1. Block diagram for the Sound Switch.

## CIRCUIT DESCRIPTION

The block diagram for the Sound Switch is illustrated in Fig. 1, from which it will be seen that the circuit comprises six main sections. These are: the Sound Sensor; Audio Amplifier; Threshold Detector; Timing Circuit; Relay and the Light Sensor which inhibits operation during the daytime.

The complete circuit diagram is shown in Fig. 2. The low-voltage supply needed to operate the system is derived from the conventional arrangement of mains transformer T1, bridge rectifier REC1 and smoothing capacitor C1. Fuse FS2 provides protection in the event of a fault developing in the secondary circuit.

Voltage regulator IC1 provides a precise 12V d.c. output and this helps to achieve stable operation of the rest of the circuit. Capacitors C2 and C3 additionally help the stabilisation process.

The sound sensor used is a miniature loudspeaker, LS1. This is connected using a

amplifier (op.amp) IC2, via capacitor C5. At the same time, this input receives a fixed bias voltage equal to one-half that of the supply by the potential divider action of equal-value resistors R3 and R4.

The inverting input of IC2, pin 2, is similarly biased but this time the voltage is adjustable by means of preset potentiometer VR1. This forms a potential divider in conjunction with resistors R5 and R6. These resistors limit the range of adjustment by VR1 and so facilitate setting-up later.

The threshold voltage level at IC2 pin 2 will be set a little below the normally steady one existing at the non-inverting input pin 3. Consequently, the output of IC2, pin 6, will therefore be high (close to the positive supply voltage). This is blocked by diode D1 and has no further effect.

When sound is detected by LS1, the voltage at the non-inverting input of IC2 will fluctuate and fall momentarily below that at the inverting input on each half-cycle. This will cause op.amp output pin 6 to briefly go low.

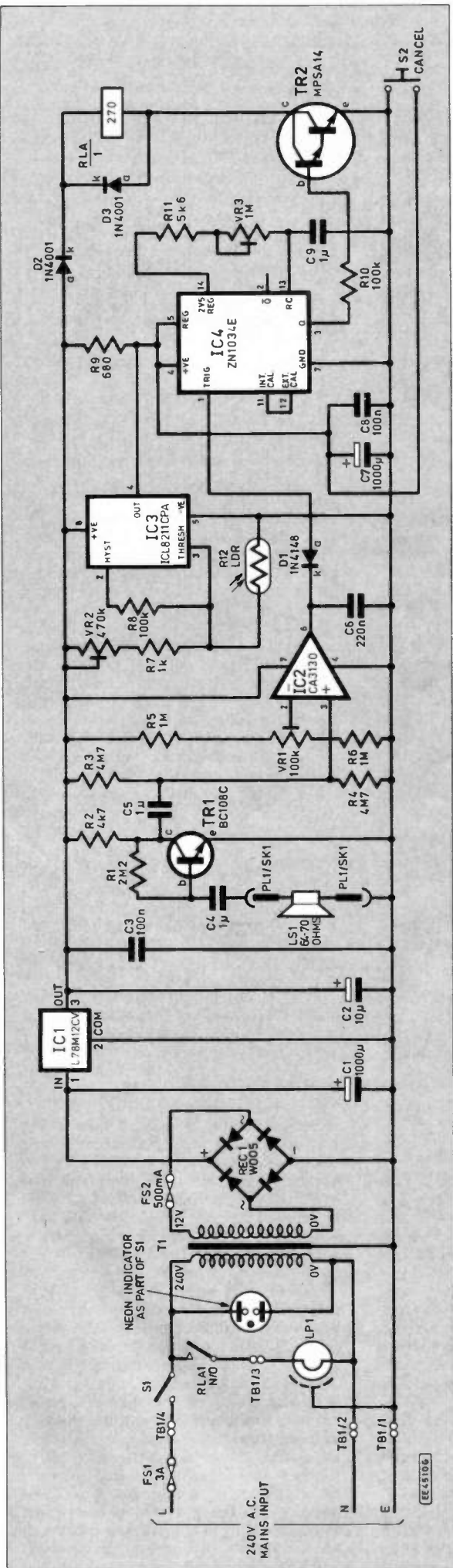
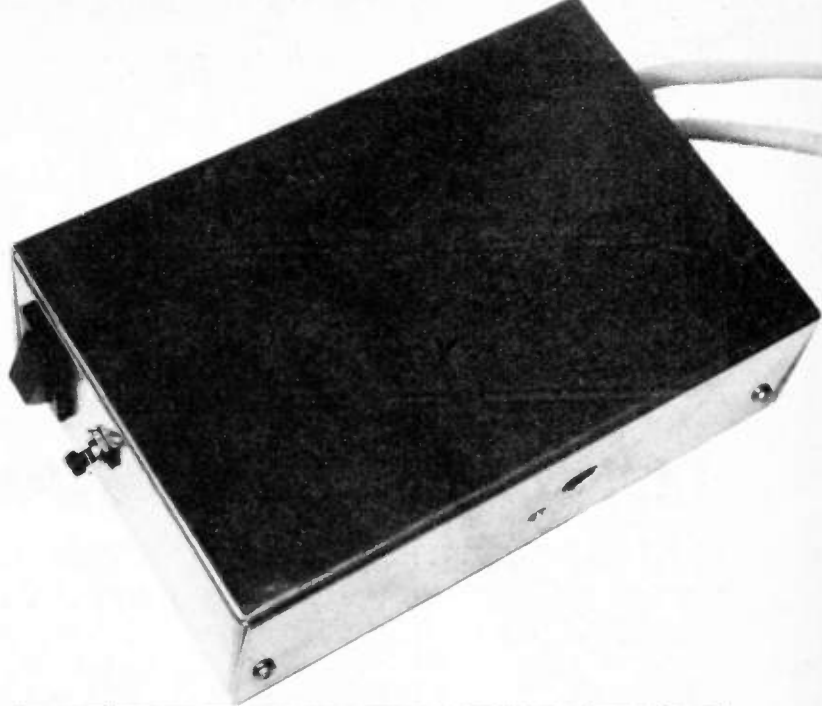


Fig. 2. Complete circuit diagram for the Sound Switch security unit.



## COMPONENTS

### Resistors

R1	2M2	R8, R10	100k (2 off)
R2	4k7	R9	680
R3, R4	4M7 (2 off)	R11	5k6
R5, R6	1M (2 off)	R12	ORP12 or similar light-dependent resistor (see text).
R7	1k		

All 0.6W 1% metal film, except R12.

### Potentiometers

VR1	100k sub-min. enclosed preset, vertical
VR2	470k sub-min enclosed preset, vertical
VR3	1M sub-min enclosed preset, vertical

### Capacitors

C1, C7	1000µ radial elect. 16V (2 off)
C2	10µ radial elect. 16V
C3, C8	100n ceramic (2 off)
C4, C5, C9	1µ polyester layer (3 off)
C6	220n ceramic

See  
**SHOP  
TALK**  
Page

### Semiconductors

REC1	W005 50V 1.5A bridge rectifier
D1	1N4148 signal diode
D2, D3	1N4001 1A 50V rectifier diode (2 off)
TR1	BC108C <i>n</i> pn transistor
TR2	MPSA14 <i>n</i> pn Darlington transistor
IC1	L78M12CV 12V 500mA voltage regulator
IC2	CA3130 CMOS op.amp
IC3	ICL8211 CPA voltage detector (see text)
IC4	ZN1034E precision timer

### Miscellaneous

T1	miniature mains transformer with 240V primary and 12V 500mA secondary (6VA rating)
LS1	miniature loudspeaker with 64 to 70Ω coil. Diameter 66mm approx.
PL1/SK1	3.5mm mono jack plug and socket
S1	mains rocker switch with inbuilt neon indicator and 3A minimum "make" contacts (see text)
S2	miniature push-to-make switch
RLA	miniature relay with 12V 270 ohm coil and "make" contacts rated at 240V 5A minimum
FS1	3A 20mm fuse and chassis fuse/holder
FS2	500mA 20mm fuse and chassis fuseholder

Printed circuit board available from the *EPEPCB Service*, code 915; aluminium box size 152mm x 114mm x 76mm approx.; plastic box for sound sensor - see text; 5A screw terminal block - 4 sections required; 8-pin d.i.l. sockets (2 off); 14-pin d.i.l. socket; stranded connecting wire; light-duty single screened wire; stand-off insulators; small fixings; solder, etc.

Approx cost  
guidance only

**£37**

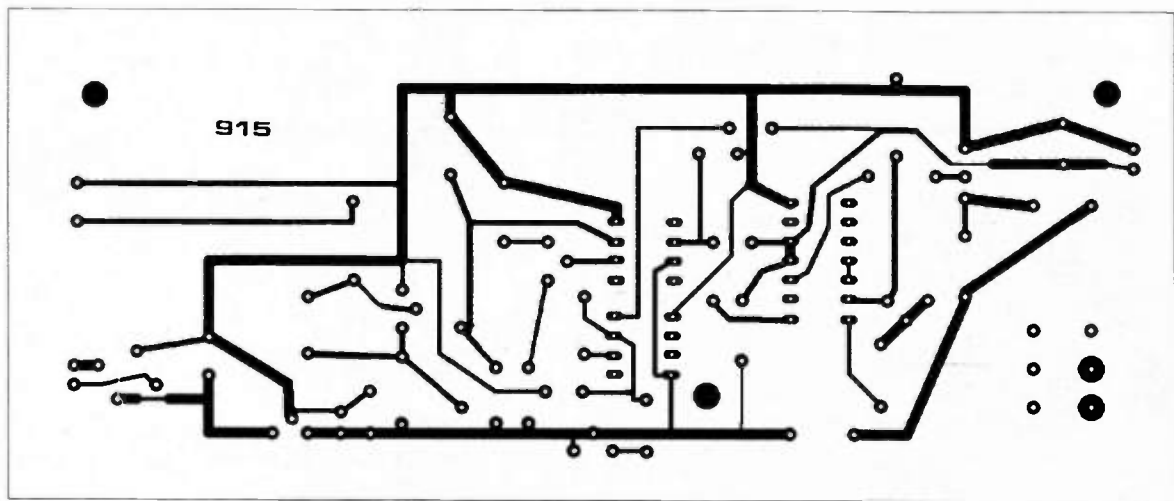
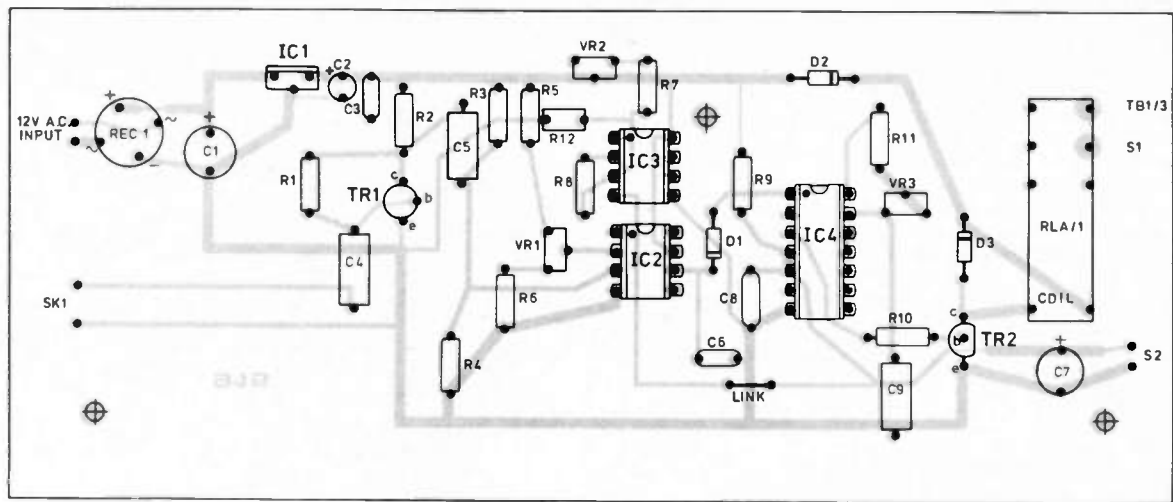


Fig. 3. Printed circuit board component layout and full-size copper foil track master.

This activates the precision timer IC4 by applying a low pulse to its trigger input pin 1 via diode D1. Further trigger signals have no effect during the course of timing. Since IC4 pin 1 is internally biased an external resistor is not needed on the anode of diode D1.

### TIMING CYCLE

When timer IC4 is triggered, its twin outputs, Q and  $\bar{Q}$  switch state – that is, output Q which is normally high goes low, and output  $\bar{Q}$  which is normally low goes high. However, in this application only output Q is used and when it is high, Darlington transistor TR2 is turned on by the base current entering through current-limiting resistor R10.

The relay coil, RLA, in the collector path of TR2 is now energized and the normally-open (n.o.) contacts close to complete the circuit from the mains Live connection to the lamp. At the end of the timing cycle, IC4 output Q reverts low, transistor TR2 is turned off and with it so too are the relay and lamp.

The operating period is dependent on the values of resistor R11, preset potentiometer VR3 and capacitor C9. With the values specified and with VR3 set to minimum, the timing is less than 30 seconds. When set to maximum it is approximately one hour.

To cut the timing short – that is, before the end of the natural cycle, push-to-make switch S2 (Cancel) is operated momen-

tarly. This takes IC4 pins 4 and 5 low so interrupting the supply and resetting the timer. Resistor R9 prevents a direct short-circuit – it is needed anyway for the correct operation of IC4's internal voltage regulator.

Capacitor C7 provides a soft starting action when S2 is released. This happens because the voltage across C7 and hence at IC3 pins 4 and 5 rises relatively slowly as it charges through R9. This prevents possible false triggering.

### DIGITAL TIMER

Precision timer IC4 uses digital techniques to provide a relatively long time interval without the need for a high value timing capacitor. This, in practice, means that an electrolytic capacitor is avoided so resulting in greater reliability.

The timer operates in the following way. When triggered, capacitor C9 charges from a precision 2.5V on-chip reference provided at pin 14 through resistor R11 and preset VR3. Thus, the voltage across it rises and when it reaches a certain value an internal counter registers a count of one. The capacitor is then discharged to begin a further cycle. When 4095 such charge/discharge cycles have been counted, IC4 pin 3 goes low and the i.c. reverts to its initial state.

### SEEING THE LIGHT

To inhibit operation under bright light conditions, light-dependent resistor (LDR)

R12, precision voltage detector IC3 and associated components are called into play. When the voltage applied to IC3 threshold pin 3 exceeds 1.15V (an internally-set reference) the output, pin 4, has no effect. When the voltage falls below this value, pin 4 provides a sink – that is, it becomes low with current able to flow into it.

When the amount of light falling on R12 rises, its resistance falls and the voltage across it will similarly fall. The LDR forms the lower arm of a potential divider with resistor R7 and preset potentiometer VR2 comprising the upper arm. Thus, with increasing light levels the voltage applied to IC3 pin 3 will, at some point, fall below the threshold and pin 4 will go low. The exact level at which this happens is adjustable using VR2.

This low output state is applied to IC4 pins 4 and 5. It has a similar effect to operating switch S2 and resets the chip. IC4 will not become active again until the voltage at IC3 pin 3 rises once more above the critical level – that is, when the LDR is sufficiently unilluminated.

Resistor R8, connected between IC3 pin 2 (hysteresis) and pin 3 (threshold), builds a little backlash into the operation. Thus, when the light level rises to the point required for the output to go low, it will need to go rather darker than this to switch off again. This prevents excessive on-off operation at the critical point. The resistor value stated gave good results in the prototype but could be the subject for reader's experiment.

## ELECTRICAL SAFETY

**Important Safety Notes:** *Constructing this circuit involves making mains connections. Any reader who is unsure of being able to make a safe job, must seek the help of a qualified electrician. If fixed wiring is needed – for example, for connecting exterior lighting, expert help is strongly recommended.*

The unit must be built in an **Earthed metal box** and situated in a **dry indoor location**. There must be a fuse and a switch fitted in the Live mains input and a neon indicator (which may be separate or part of the switch as in the prototype unit) to show the *on* state.

All external wiring should be of 5A rating minimum and the input protected using a 3A fuse. A fuse must also be included in the transformer secondary circuit. Input and output wires must be firmly gripped at the unit end using strain relief bushes.

with the soldered on-board components in the following order. Firstly the i.c. sockets then all resistors, flat with the board, and capacitors taking care over the polarity of C1, C2 and C7 since these are electrolytic capacitors and therefore polarity-sensitive.

Observing their polarity, follow with the voltage regulator, transistors, diodes and bridge rectifier – this latter component has lettering on top which indicates the correct orientation. The regulator does not need a separate heatsink – the metal tab is sufficient because the current drawn, 100mA maximum, is only a fraction of its rated 500mA.

The transistors and bridge rectifier should be soldered so that they stand approximately 3mm clear of the circuit board. Sleeve the leads of LDR and solder this component into position. Bend the leads at right angles as shown in the photograph. Complete construction of the circuit board by soldering the relay into position.

*the mains connections at the relay “make” contacts have several millimetres clearance from the base of the box. A piece of thick cardboard or insulating tape may be used as an additional precaution.*

## TRANSFORMER MOUNTING

Mount the transformer using a solder tag on one of its fixings. *This is used to earth the case and transformer core and is essential for safety reasons.* Referring to Fig. 4, mount all remaining components and complete the internal wiring. Note that the connections to switch S1 as shown are for a switch having an inbuilt neon indicator. If a standard switch is used, the neutral connection is not required.

The *sleeved* terminal of the Sound Sensor socket must be the one connected to the circuit panel *negative* track – that is, *not* the one leading to capacitor C4. The sleeved terminal must also be connected to the solder tag as shown.

Check that when the top section of the case is fitted temporarily, no wires are trapped and no short-circuits formed. Make a temporary mains input lead and connect a table lamp to the output for later testing purposes.

Decide whether a waterproof enclosure will be needed for the sound sensor – it is essential to protect the loudspeaker from rain. Drill the matrix of holes in the lid for the sound to pass through and mount the loudspeaker. If a waterproof box is used, secure a waterproof gland or tight-fitting grommet in the hole where the wire will pass through.

Connect the loudspeaker to a few metres of light-duty single *screened* wire. Solder the 3.5mm jack plug temporarily to the other end with the screening connected to the *sleeved* terminal of the plug. However, do not plug it in yet.

**Before plugging the unit into the mains, make insulating shields so that it is absolutely impossible to touch any of the mains connections.** Plug in and switch on. When powered-up it is usual for the unit to self-trigger – cancel this by pressing switch S2. The unit must now be left for several minutes to thermally-stabilise.

## ADJUSTMENT AND TESTING

While testing, place a piece of Blu-Tak on the LDR window to prevent light from reaching it.

Adjust preset VR1 slowly clockwise until triggering occurs. Rotate VR1 slightly anti-clockwise again and cancel using switch S2. Find the position where the circuit remains off. If there is instability (repeated operation) this indicates that the setting is too high. It is best to err on the low side.

Place the sensor several metres away from the main unit and plug it in. Doing this will probably cause the circuit to trigger again – cancel using switch S2. Test operation by making a sound close to the

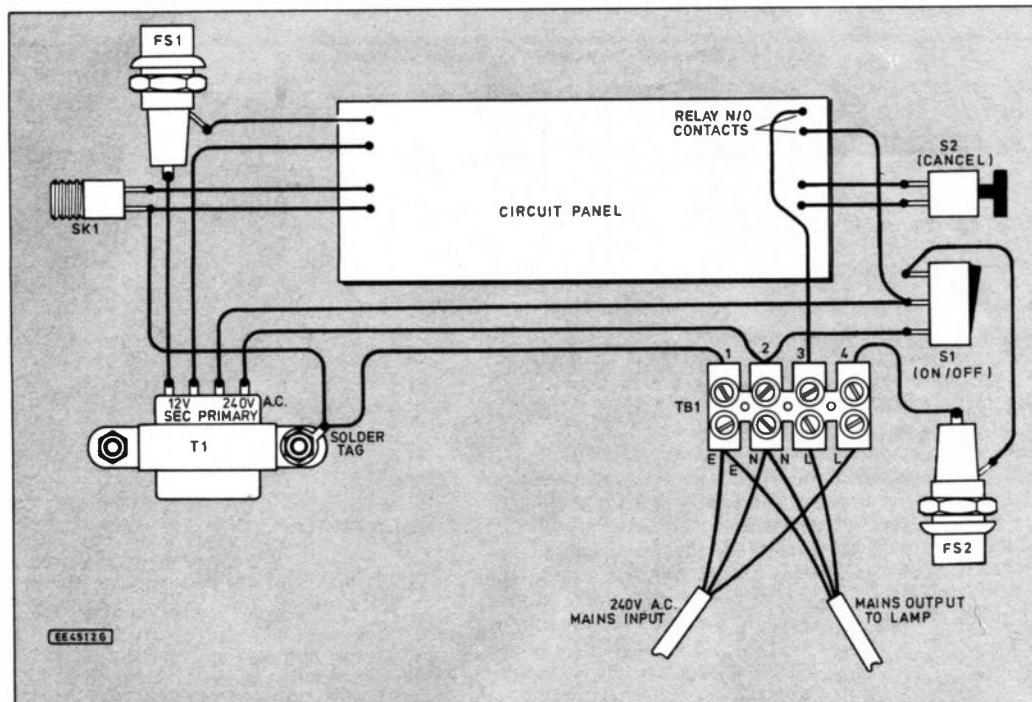


Fig. 4. Details of interwiring between components and the p.c.b.

For fixed wiring applications, the mains input and output cables must terminate in a double-pole switched and fused wall outlet. The unit should then be wall mounted adjacent to this.

To operate a portable appliance such as a reading lamp, the input lead should be plugged into a nearby wall socket. The output cable may have a standard trailing socket fitted so that the lamp may be plugged into this.

It is essential to use a generously-rated mains transformer (see components list). Not only will this remain cool during long periods of use but will promote stable operation of the circuit.

## CONSTRUCTION

Construction of the Sound Switch is based on a single-sided p.c.b. (printed circuit board) whose component layout and full size copper foil master track pattern is shown in Fig. 3. This board is available from the *EPE PCB Service*, code 915.

Begin by drilling the three mounting holes in the positions indicated. Follow

Solder 15cm pieces of light-duty stranded connecting wire to the p.c.b. pads marked “12V a.c. in”, “LS1” and “S2”. Solder pieces of *mains-type* wire of 5A rating minimum *direct* to the relay normally-open contacts as shown.

**Check carefully that these wires are secure so that they cannot dislodge in service. There must be no possibility of them making contact with the metal case.**

Prepare the case by drilling holes for the circuit board and transformer mounting. Drill holes also for fuseholders FS1, FS2, switches S1 and S2, socket SK1 and screw terminal block TB1. Drill the holes to be used later to accommodate the strain relief bushes on the mains input and output wires.

Drill a 10mm diameter hole directly above the LDR position and a further small one through which preset potentiometer VR2 may be adjusted using a miniature screwdriver or trimming tool. Make brackets to mount the unit on a wall if required and secure these to the case.

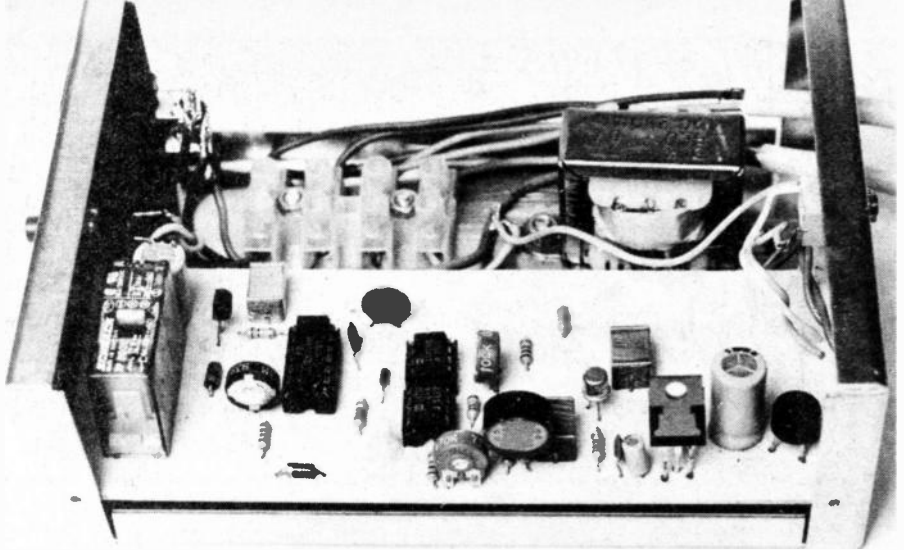
Mount the circuit panel on 5mm plastic stand-off insulators. **Check carefully that**

sensor. The circuit should operate and the lamp come on for about 30 seconds. The final adjustment can only be found over a trial period under real conditions.

Check the maximum timing by rotating preset VR3 fully anti-clockwise. The lamp should now operate for one hour or thereabouts. Return VR3 to its clockwise position.

Rotate preset VR2 to mid-track position and uncover the LDR. Under normal daylight conditions the circuit should now be inhibited. Accurate adjustment to the operating level cannot be made until the unit is in its final position and the case assembled.

Decide on the best positions for the unit and sensor. Note that light-duty screened wire must be used for the interconnection. If a waterproof box has been used for the speaker, the holes drilled for the sound to enter must face downwards. At the same time, remember that the sound of rain drops on the box is likely to trigger the unit so it is better to shelter it. Some shielding



may also be necessary to protect it from wind noise.

The unit should be sited so that no light from any lamps controlled by it reaches the

LDR or erratic operation may result. Over a period of trial, the best orientation for the sensor should be found, the timing set and final adjustments made. □

# Ohm Sweet Ohm

## Max Fiddling

### Smoke Signals

September! By now, the barbecue season is at its peak at the *Fiddling Ranch*, as we take every opportunity we can to scoff charred offerings before the autumnal weather rains us off! (Probably no bad thing since I'm a rotten Chef; I can solder the tiniest joint with split-second accuracy but I can't barbecue a burger to save my life.)

With my gardening chores gradually diminishing I can put my feet up a bit and indulge myself by pottering in the workshop, whilst contemplating my latest project. One balmy evening I lit our oversized barbecue ceremoniously for one final fling, slapped some sausages on it, opened a bottle of methylated *vin du table* to breathe, and then wandered into the workshop a few yards away, followed by Piddles the cat (who always perks up at the prospect of food, no matter how burnt).

At a recent summer sale, browsing around my local DIY store, I'd spotted a bin full of smoke alarms, being sold at a knock-down price! I couldn't resist buying one type in particular, which had a small torch beam built in. This illuminated when the smoke alarm activated, thus lighting a suitable escape route.

I'd gleefully bought a couple of these. They had lain on the bench ever since, waiting for a suitable opportunity for me to experiment further with the loot.

### Eyeball-to-Eyeball

So my eyes happened upon the smoke alarms. With Piddles, my trusty moggie, nosing around in the workshop in ritual search of meeces, I opened the packaging and swiftly fitted the batteries supplied (for once) with the alarms. Pressing the "test" button produced a beam of light which Thomas Edison would have been proud of, followed seconds later by a very feeble bleep from the internal piezo sounder!

This made Piddles look up briefly, not in the least worried because he was condi-

tioned to this sort of thing by now. Indeed I could swear the cat was rolling his eyes ceiling-wards!

Of course, the first thing I want to do when I buy any gadget, is to take it apart and see how it works! I don't always manage to put it back together in quite the same way (as my toaster will testify), but it did occur to me that there was maybe scope for improving the smoke alarms to enhance their effectiveness.

Steering clear of the worrisome radioactive-looking bits, I checked around the lamp section of one of the smoke alarms and wondered if I could take an output from this and use it to drive something else – perhaps a louder alarm unit to supplement its own ineffective internal offering?

### In the Spirit

I had a mini 6V siren in the workshop which I had been saving for a special occasion. Its time had come: I hooked it into one of the alarms across the lamp output, and stabbed the "test" button once again. It worked a treat!

I decided that an in-situ test was called for back at the house, so at this point the workshop was abandoned as we quickly scuttled house-wards in search of a suitable spot to test my idea further. The alarm was soon screwed into the hallway ceiling, just outside the kitchen, with its Cyclops-like lamp reflector peering down at myself and Piddles, by my side. The mini siren which I'd appended to the alarm was stuck on with a sticky-pad, rather incongruously.

Suitably pleased with myself at this latest notion, I ambled out of the workshop in the general direction of the barbecue to see what was cooking. A plume of dense woody smoke was spiralling upwards and generally engulfing the garden. Piddles nosed around near the *Hibachi*, ever hopeful of a tasty morsel.

The sausages were somewhat crispy black one side, and I nimbly turned them over and prodded the charcoal thought-



fully, for good measure. I knew that the Boss was in the kitchen preparing more yummy grub and overall, things were looking rosy! I could hear the clattering of cutlery and general activity through the open kitchen window.

Time for some wine! The barbecue appeared to be heading for thermo-nuclear meltdown as I slapped more grub onto the sizzling blackened grille. By now I was starting to warm to the task (literally!) in my happy haze as plumes of pungent smoke drifted housewards.

As more fiery fumes piroouetted into the air, a shrill scream was suddenly heard from the kitchen! Dashing inside, I heard the mini siren wailing angrily and I saw the smoke alarm lamp shining angrily, pointing like an accusing finger at myself standing below it!

In installing my latest brainchild alarm system, in my enthusiasm I had failed to warn the Boss! The smoke alarm had indeed done its job, encouraged by the carbonaceous fall-out from the barbecue outside, and putting the fear of God in the Boss at the same time!

I was thus evicted from the kitchen and consigned to tending the charcoal, in disgrace. Except that Piddles had tucked into the grub I'd managed to salvage from certain ruin on the glowing embers.



# 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. 3-12V operation. 500m range.....£16.45

#### MTX Micro-miniature Room Transmitter

Best-selling micro-miniature Room Transmitter  
Just 17mm x 17mm including mic. 3-12V operation. 1000m range.....£13.45

#### STX High-performance Room Transmitter

Hi performance transmitter with a buffered output stage for greater stability and range. Measures 22mm x 22mm including mic. 6-12V operation, 1500m range.....£15.45

#### VT500 High-power Room Transmitter

Powerful 250mW output providing excellent range and performance. Size 20mm x 40mm. 9-12V 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 AC 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 decoder 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. 9-12V 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

#### TLX700 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 180 MHz 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

#### QRX180 Crystal Controlled FM Receiver

For monitoring any of the 'Q' range transmitters. High sensitivity unit. All RF section supplied as a 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 0827 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 dip 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

#### MBX-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

DEPT. EE

THE WORKSHOPS, 95 MAIN ROAD,  
BAXTERLEY, NEAR AATHERSTONE,  
WARWICKSHIRE CV9 2LE

VISITORS STRICTLY BY APPOINTMENT ONLY

**SUMA  
DESIGNS**



Tel/Fax:  
**01827 714476**

# SECURITY TAGGING

PETER NUTT



*You may not spot them, but electronic tags are attached to ever increasing types of merchandise in most High Street stores. The detection techniques used are ingenious.*

**T**WENTY years ago the "Alligator" style plastic tags were first starting to dangle from the clothing in a few High Street stores. "Electronic Article Surveillance" (E.A.S.) had come to Britain.

The need for retailers to put a halt to losses from shoplifting had them looking to the electronics industry for answers. Cameras were the early solution, but with video recorders still rare and expensive, to be effective someone had to watch the monitor all day, and what if the camera was pointing the wrong way? Much better if the stock could look after itself!

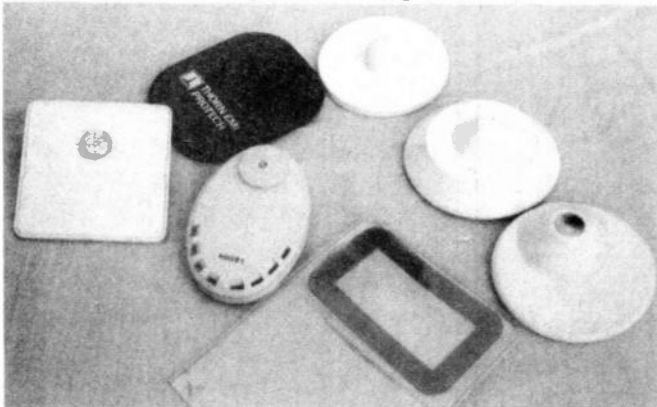
Engineers out in the field are frequently confronted by the inquisitive public. "How does that work: like those airport metal detectors, or does it use laser beams?", are questions frequently put forward. Thankfully not the latter, receiving an eyeful of laser light from some Star Trek beam sounds rather painful.

Precise constructional details of the "targets" (tags) that are fixed to the garments and the circuits that detect them are heavily patented and jealously guarded secrets by the companies concerned. However, the reality is that it is all based on some standard electronic principles. Two types of technology are used: radio frequency (r.f.) based systems (the ones commonly encountered in stores) and magnetic systems (found only in libraries in the early days but now spreading into the High Street).

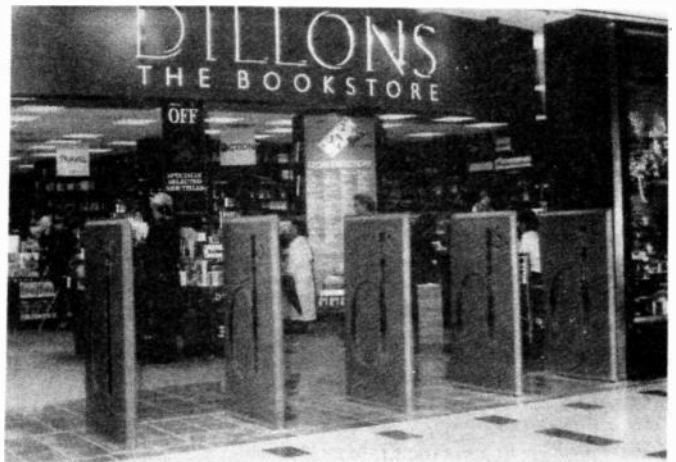
Radio based systems can be subdivided into two categories: low frequency (l.f.) and high frequency (h.f.) systems – sometimes inaccurately referred to in the industry as microwave systems. The different radio systems can be identified to some extent by the shape and size of the tags. In general, long thin tags belong to the h.f. family, and round or square tags to the l.f. The two types each offer a variety of advantages.

## LOW FREQUENCY SYSTEMS

Over the years, manufacturers have explored various avenues in search of the ultimate solution. One manufacturer's answer was the "active" or "live" tag, where the target itself was in essence a



*A selection of low frequency r.f. security tags.*



*Customised detectors at the exit of a major store.*

miniature battery operated transponder whose signal was picked up by a receiver at the doorway. This method had some problems, the biggest one being the power source. The life of the tag was determined by its battery life. Even if use could have been made of today's CMOS technology, the shelf-life of the battery (about two or three years then) was too limiting a factor.

There might be more success today with Lithium cells etc. but the biggest problem now, as then, is cost. These tags could not compete with the simpler passive ones that were developed, which cost much less to manufacture and never run flat!

Modern l.f. tags are all passive devices that use one of two methods for producing a detectable "signature". These devices use a variety of frequencies, depending upon the manufacturer and sometimes also on the application intended, ranging from several kilohertz with some methods, to several megahertz in the mid h.f. bands (short-wave) for others.

The l.f. systems are easily identified. They are normally slim stand-alone units, positioned one each side of the doorway or, if the doorway is wide, positioned in multiples, about two metres apart (approximately the limit in field strength for this type of system). One of the most popular, and a typical system of this type, is the familiar slim "stepped double loop" pattern of Knogo U.K.'s l.f. system evident in most High Streets.

## RINGING METHOD

As with most developing electronic products, the price of these devices has fallen and cost effective systems have been developed for even small corner shops. These tend to be single antenna systems with single circuit board "transceiver style" electronics. Although simpler than the traditional systems, they also can be linked to cover larger areas. Both the Transmitter/Receiver and Transceiver based systems use the same targets.

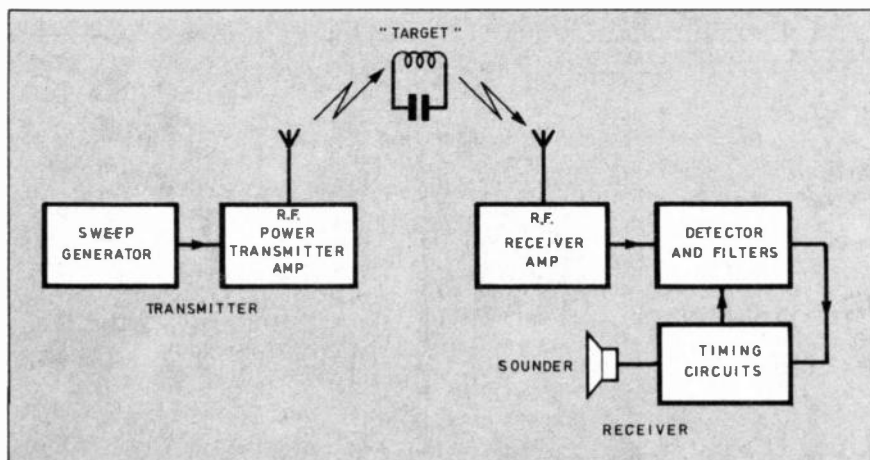


Fig. 1. A typical low frequency r.f. system.

By far the most popular method used is to make the target resonate, or ring. In this method, the target is a tuned circuit with special characteristics. As the target approaches the store exit, it is energised by a transmitter which is situated on one side of the doorway with a corresponding receiver on the other.

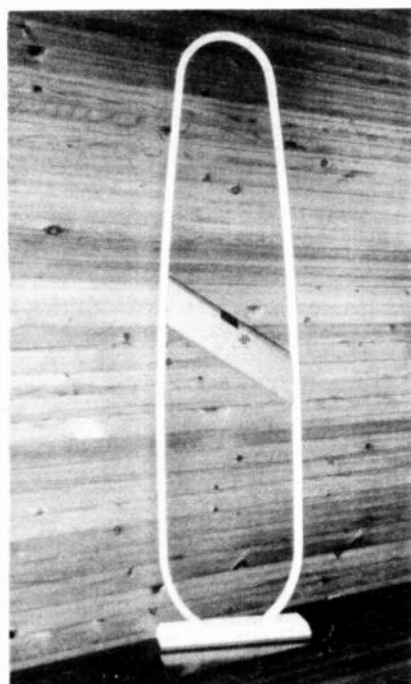
The electronics is either housed in a small briefcase sized base unit onto which the antenna is mounted or, with some manufacturers, remotely housed in a small cabinet. The actual configuration of the antennas is something else that manufacturers keep close to their chest. They need good directional properties, good spurious noise rejection and must still be able to detect the very small return signal from the target.

When the target is within the field it is "rung" by the swept r.f. signal from the transmitter (see Fig.1). The target resonates and "falls off" at the same period. The receiver amplifies the weak return signal, filters off the fundamental and then processes it.

Signal processing is the real hush-hush part of the system, manufacturers are very sensitive about their receiver technology, occasionally accusing others of transgressions over patents in this area. Filters and accurate timing circuits are the order of the day here, to ensure the vast array of innocent objects carried daily through stores are ignored. The output circuitry then drives the sounder and lamps that get your pulse jumping when you browse too close to the doorway.

## FREQUENCY CHANGING

With the frequency changing method the target is more complex. When the target enters the r.f. field the energy is received from the transmitter, as in the previous method, but is used to generate a different frequency to return for detection. The extra complexity of the target, and therefore construction cost, is



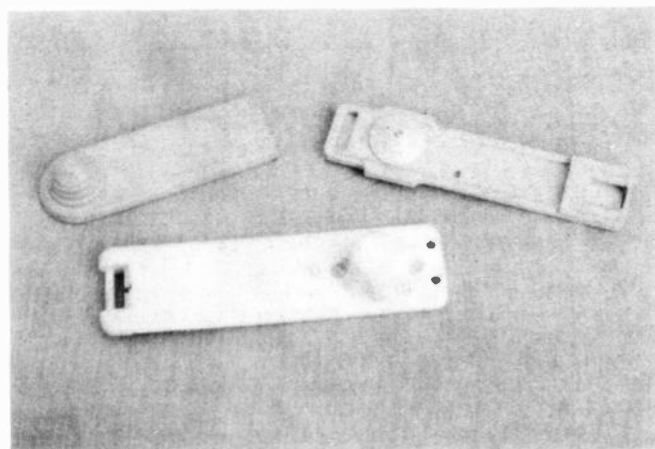
Slim-line r.f. transceiving detector.

balanced by the fact that a simpler antenna system can be employed. In practice, the transmitter is normally a loop around the doorway, with the receiver antennas placed in small pods around the door frame. Although the return signal is small, being of a different frequency to the transmitted signal has certain processing advantages. Yet again filtering and timing circuits are the key.

Recent advances in material technology are producing ferrite based targets that are proving to be as cost effective as the "ringing" targets.

## HIGH FREQUENCY SYSTEMS

Unlike l.f. systems, the principle of h.f. system operation remains broadly the same across the different manufacturers. The targets that belong to this family of systems are easy to identify, normally being long and slim,



Three typical high frequency r.f. tags.

benefiting from the fact that only a fairly simple arrangement is needed inside. All h.f. targets are passive devices. They are small "antennas" used in connection with a non-linear semiconductor.

Two frequencies are transmitted, mixed in the target and the radiated product is detected by the receiver. They tend to use primary frequencies up near 1GHz. This has advantages in the antenna department, making them small without directional problems, and a variety of system layouts is possible.

The white wooden box on both sides of the door virtually became a trademark for Sensormatic's h.f. system in the early days and many of these units are still operating. The slimmer more modern looking unit is essentially the same in principle. One of the advantages of the latter type of system is the fact that the equipment does not need to be shown at the doorway, and customising

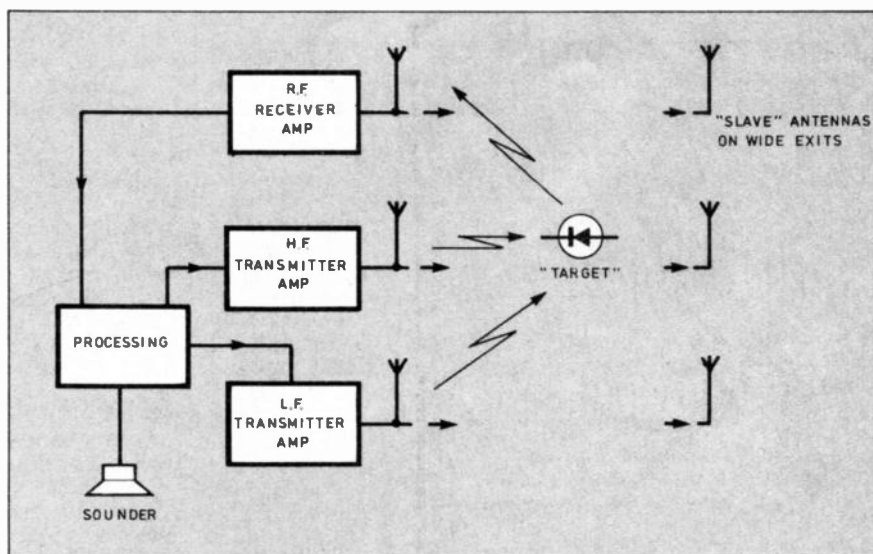


Fig. 2. A typical high frequency r.f. system.

becomes easy. It is possible to install them in the floor or in the ceiling, keeping the architecture of the doorway intact.

With a setup like this, the only way to tell if a store has an E.A.S. system is by the tags on the clothing. This is not to everyone's taste, though, as the deterrence factor is lost to some extent.

Regardless of installation or manufacturer's preference, all h.f. systems have two transmitters operating at two different frequencies (see Fig.2). However, the two major manufacturers choose to do it slightly differently, with one preferring to use one h.f. transmitter and one l.f., the other using two h.f. transmitters.

The signals are transmitted from either helical or "slab" antennas. At the target, the signals are mixed and then the re-radiated product is detected by the receiver. Signal processing is more simple than in the l.f. systems, helped by there being much less man-made spurious radiation at the h.f. frequencies used. Some systems also send a "pilot tone" as a means of double checking the validity of an alarm signal.

This all sounds so good you may wonder why anybody might bother with the l.f. units. The h.f. systems are very popular but there are a few disadvantages. The "bleed" area (how much the detection field intrudes into the store) tends to be larger than with l.f. units. Even though manufacturers have improved on this since the early systems, it can be a problem in small stores.

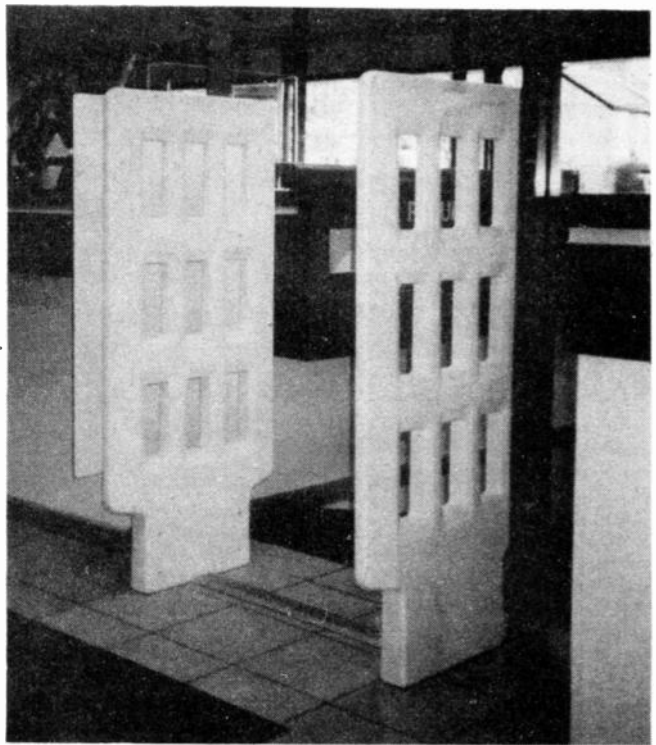
The other main disadvantage is lack of "aisle identification", as it is called: if the whole of a wide doorway is covered by one system it will be difficult to spot the culprit in a crowd.

## TAGS AND DETACHERS

How the various targets are attached is also interesting. They all use a fine pin with a large head, with the exception of some early h.f. tags that were of the hinged "alligator" type. Two methods are used:

The most popular is a small spring-loaded set of "teeth" fixed into the centre of the tag. These grab the pin when inserted, and then have an effect similar to the "Chinese finger grip", the teeth biting harder the more you pull on the pin. The device for detaching the pins uses magnets in a very clever way. The tag must be presented to the "decoupler" which has an annular polar magnet arrangement that pulls the teeth clear allowing the pin to be withdrawn.

Would-be shoplifters about to sprint off down the High Street with a magnet in their pocket can save themselves the trip, though. The strength, balance and relative position of the magnetic arrangement are critical and the materials to construct a magnet of the necessary power are difficult to obtain. In fact, this was difficult for the manufacturers to achieve in the early days and electromagnets were used.



Typical magnetic detectors either side of a store exit.

The other method, although less "hi-tech", is just as effective. It is used almost exclusively by one manufacturer. Imagine a piece of thin spring steel with a slit in it held under tension. This is the basis of the receiver mechanism in the tag. When the grooved pin is inserted into the slit, it is gripped hard. Pulling to try to remove it has the same "Chinese finger grip" effect again. To legitimately remove the pin a "gripper" style device that fits precisely relieves the tension in the metal, allowing the pin to be removed.

## MAGNETIC SYSTEMS

Magnetic systems, surprisingly, were the earliest E.A.S. systems to appear, they first appeared in libraries in the United States in the 1960s. Installed by Knogo Corporation, those early systems were enormous compared to today's and had to be literally "part of the furniture". As the concept became better understood and electronics marched ever onward, the systems became smaller and, more importantly, affordable. The principles employed are completely different to those in the radio systems.

The target is a small piece of metal alloy and a magnetic field is set up at the point of detection (i.e. check-out or doorway). As the target passes through the magnetic field, the alloy becomes saturated and the array of harmonics generated is picked up by receiving antennas and processed.

If only it was that simple in practice! The detected alloy is chosen for its specific properties, it has an almost unique harmonic "signature", making it an ideal target. There are very few materials, natural or manufactured, that exhibit the required properties and the chance of them unwittingly being carried on a shopping expedition makes accidental triggering of the system improbable.

Manufacturers have continued to refine the material, enabling the size of the target to be reduced. It is now possible to have the targets built into labels, tickets and price-guns, etc. One manufacturer even produced a system using a thread of the material about the same diameter as five-amp fuse-wire, virtually undetectable when inserted into the item to be detected. Target alloy can also be encapsulated in plastic and fitted with the pin clasp mechanism, making it suitable for clothing, just as with the r.f. systems.

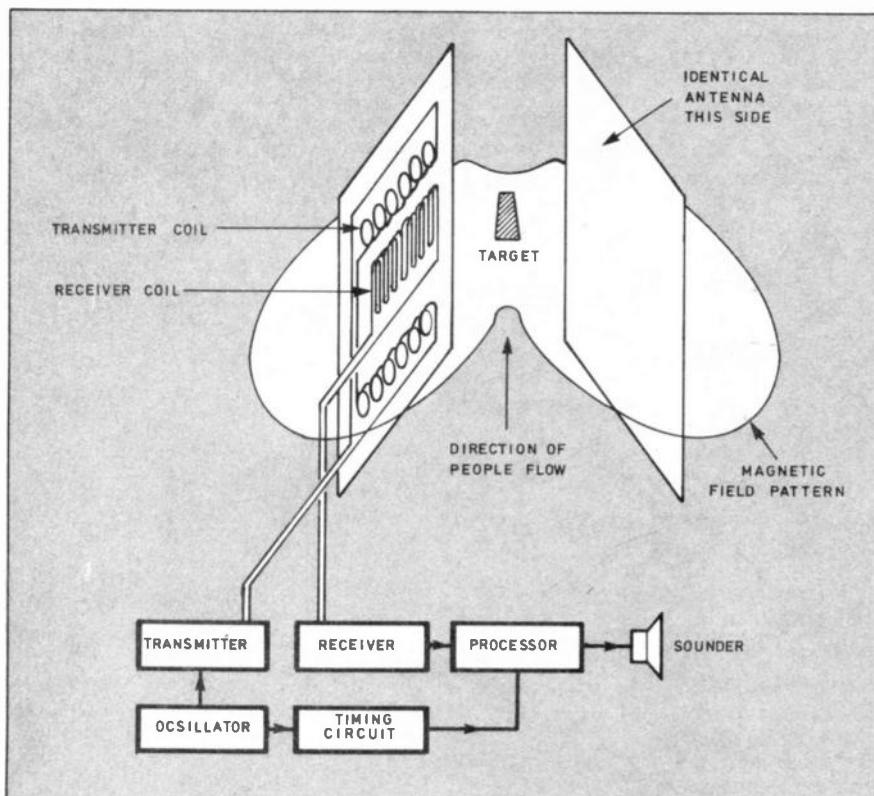


Fig. 3. A typical magnetic detection system.

The latest innovation from the industry is the move towards "source protection", this involves the target being inserted during manufacture, making life simpler for the retailer. It also makes the target tamper-proof. Applications for these systems are enormous, ranging from libraries, the original users, to supermarkets, bookshops and D.I.Y. stores. The technology has reached the point where sales of magnetic systems will probably outstrip radio systems over the coming years.

### HOW THEY WORK

A simple analogy that the author often uses to explain the magnetic systems is as follows: Think of the construction of a conventional transformer. The primary coil is the equivalent of the transmitter antenna, being energised by a low frequency source (see Fig.3). The secondary coil represents the receiver antenna, picking up the fundamental frequency from the primary through induction.

Now introduce a metal object, the target, into the field, acting as the "former" in the transformer analogy. The current induced into the secondary coil is still mainly at the fundamental frequency, but with the addition of low level harmonics generated by the target. What is interesting is that the harmonics are particular to the target metal concerned. After filtering out the fundamental frequency, there remains the "signature" of the introduced metal.

This is, of course, a much simplified version of events. As with their radio based products, manufacturers understandably protect their many years of research and investment with secrecy and patents. However, as with the radio products, the principle of operation lies in basic physics.

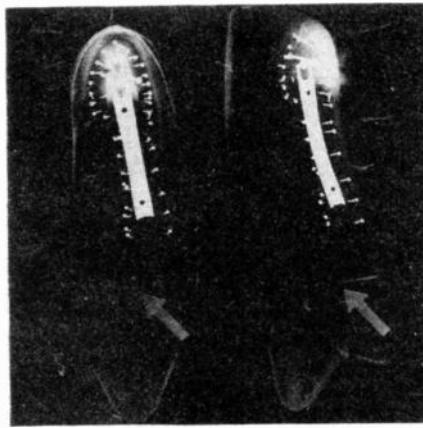
The antenna systems tend to be on the heavy side, as fairly large diameter turns of copper wire are required to produce the very high Q factor necessary for the transmitter coil. The receiving antenna tends to be much lighter. Layout of the antennas varies with design, and is also kept confidential.

The power emitted by these units is relatively modest and, contrary to popular myths about "frying" hearing aids, is in fact about the same as a "beefy" domestic hi-fi. The distance to which such a field can be sustained is limited by the power applied and the size of the antennas. Antennas have to be designed to suit their environment, and so this limits the size. Also, power requirements rise on a square law, thus to extend the range by a small amount would require an unreasonable increase in power.

These factors limit the practical range of magnetic systems to about a metre or aisle width, although this varies slightly with different designs. As with radio systems, they can be linked to cover wider gaps.

As the target material enters the system and moves through the magnetic field, signals appear in the receiver antenna. The first stage is to filter out the fundamental signal. Of the remaining harmonic signals, some may be the result of innocent objects carried into the store, or interference from electrical sources (drills, lighting, radio sources, etc.) and possibly line noise.

A lot of the local noise will be taken care of by the noise cancelling antenna configuration, but because of the low signal levels involved and the wide variety of metal objects carried by shoppers in normal daily life (i.e. watches, pens,



"Source protected" shoes with the targets manufactured into the soles (see arrows).

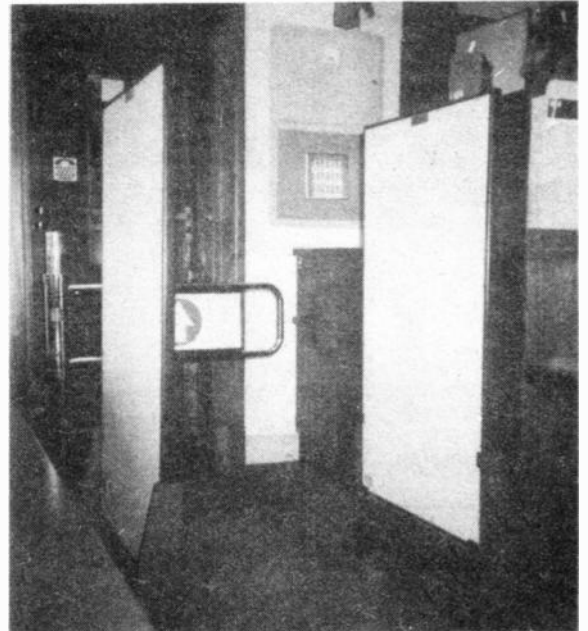
spectacles, keys, etc.) quite sophisticated signal processing is necessary.

Unsurprisingly, the most common metal encountered is steel, or other items with a ferrous content. These tend to produce even harmonics which are detected and filtered off at an early stage in the receiver, to be used for processing at a later stage.

The next step in sorting out a valid signal is handled in several ways. One major manufacturer uses the very effective method of signal averaging. It relies on accurate timing signals, as do most circuits in the E.A.S. business. The signal is applied to two averaging circuits of different periods, these are then sampled at specific times. The theory being that "instantaneous" noise will only be present for one or two samples, whereas the wanted signal will be synchronous. The output from these circuits then joins the "metal" signal for some final processing and then drives the

sounders, lamps or even locking gates.

This technology has benefited greatly from the introduction of microprocessors, and the very latest systems available are way ahead of those early library units. The sampling and processing power of the new designs make them more sensitive, versatile and adaptable. The latest system from Knogo even has the capability of having its parameters adjusted by engineers over the phone line.



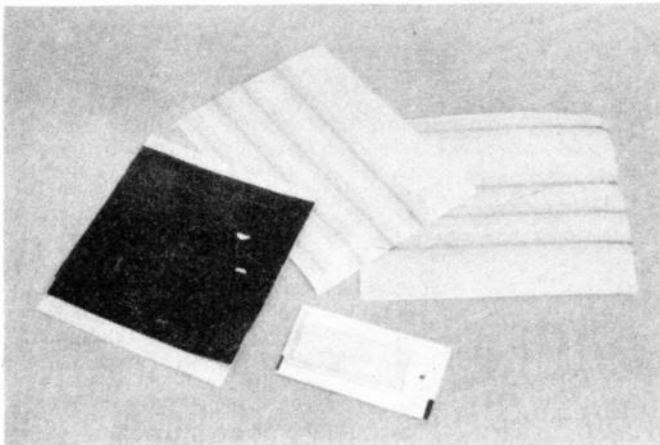
Magnetic system detectors installed in a library.

### TARGET OPERATION

Whether used in a library application or for retail protection there are two possible methods of target operation, full circulation or pass-around. Where the system antennas are mounted onto the check-outs, e.g. at the supermarket, after bar-code price scanning, the goods are normally fed past the back of the antennas by the conveyer belt to where you load them into a trolley. You then walk through the system, collect your purchases and the target goes into the waste bin at home with all the wrapping.

Where the pass-around method is not possible and the full circulation method is required, antennas have to be located at the doorway. It now becomes necessary to "turn off" the target at the point of sale, and in the case of libraries "turn on" the target when the book is returned. These systems have to use a recyclable target.

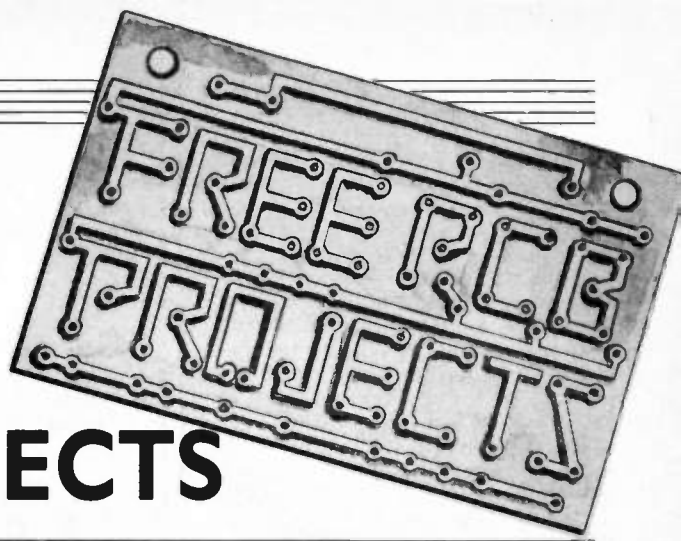
There are several different ways of making such a target but all use the same principle. The alloy is overlaid with a certain amount of soft iron. At the point of sale the goods are passed over a "desensitiser" plate. This puts a special magnetic pattern on the iron "coating" which causes the normal signature of the alloy to be disguised and not detected at the antennas. When the product is returned, the overlaid magnetic pattern is "cleaned off" with a magnetic eraser and the product returned to the shelf.



Magnetic system targets, the black ones are for videos, the small one is on the back of a barcode price tag.



# ABOUT YOUR FREE PCB MULTI-PCB PROJECTS



A SELECTION of "Pick and Mix" projects that can *all* be built on the FREE, cover mounted, printed circuit board attached to this issue.

This month we present three projects: **Audio Sinewave Generator** ★ **Treble Booster** ★ **Infra-Red Controller/Alarm** (two p.c.b.s). Next month's three projects will be: **Video Enhancer** ★ **Distortion Effects Unit** ★ **Current Tracer**.

Like the first six projects in the \*March and \*April issues, these simple projects cover a wide range of applications, but they are all based on the same printed circuit design. This is exactly the same design that was used for the original set of six projects. Any of this second batch of circuits can be built on the original FREE p.c.b., and any of the original batch of circuits can be built on the new FREE p.c.b.

If you wish to build all these "mini board" projects, then extra p.c.b.s will be needed and can be purchased from the *EPE PCB Service*, code 932, for the sum of £3 each (including VAT and postage). Alternatively, you can purchase extra copies of the October '95 issue from your *Newsagent*, whilst it is still on sale, and make a small saving on each additional p.c.b.

\*March '95 - (Back issues available)

★ Sound Activated Switch ★ Audio Amplifier  
★ Light Beam Communicator (two p.c.b.s)

\*April '95 - (Back issues available)

★ Light Activated Switch ★ Switch On/Off Timer  
★ Continuity Tester.

## Circuit Board

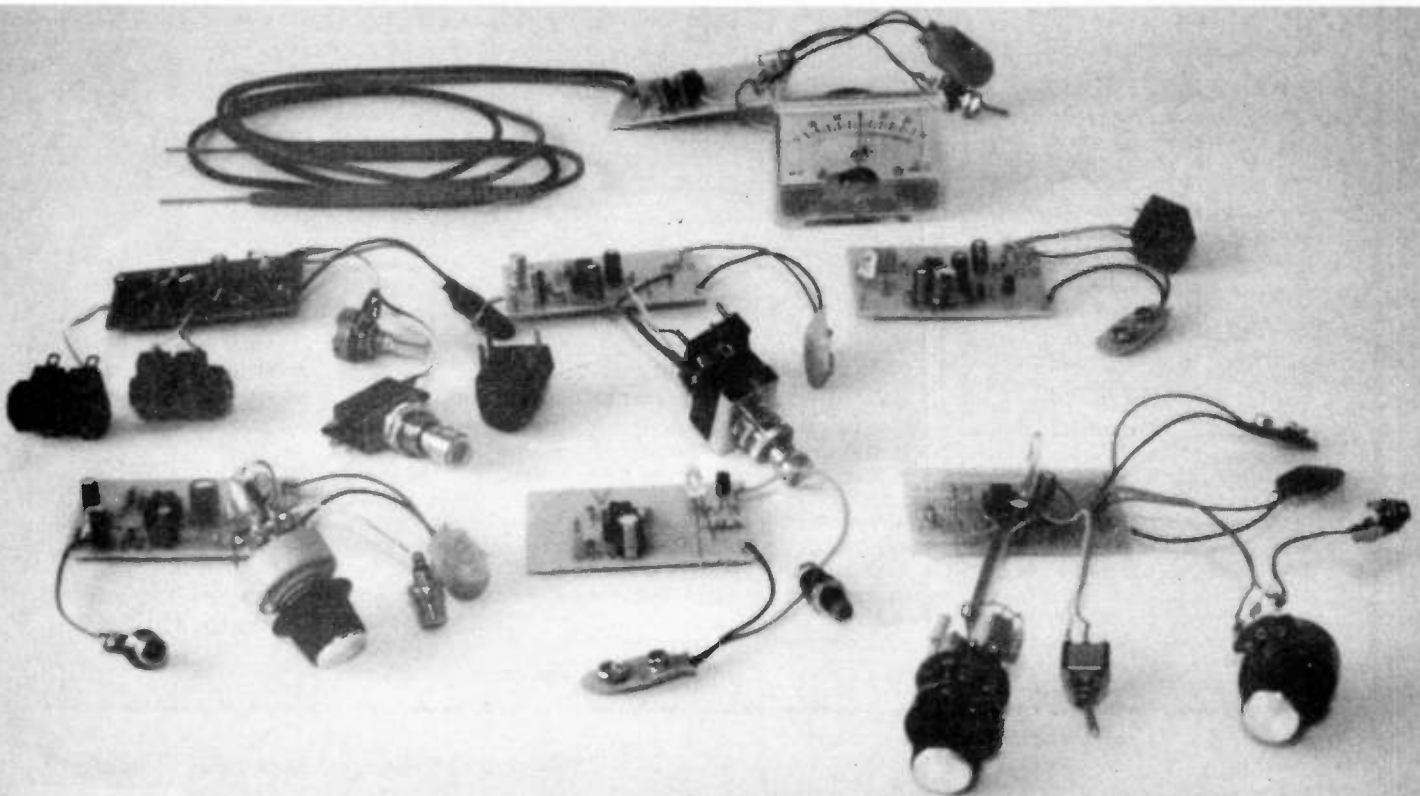
The board is designed to take a single operational amplifier having an 8-pin d.i.l. encapsulation and the standard 741 style pinout arrangement. The operational amplifier can be used in the inverting and non-inverting amplifier modes, as a voltage comparator, or as a trigger. At least two types of oscillator can also be accommodated. The board has provision for discrete relay driver and complementary class B output stages.

While the restriction of a single operational amplifier clearly limits the complexity of projects based on this board, using modern operational amplifiers it is still possible to accommodate a wide range of projects within its confines. This second set of six projects demonstrates the use of high quality audio, precision d.c., a wide bandwidth/high slew-rate operational amplifiers.

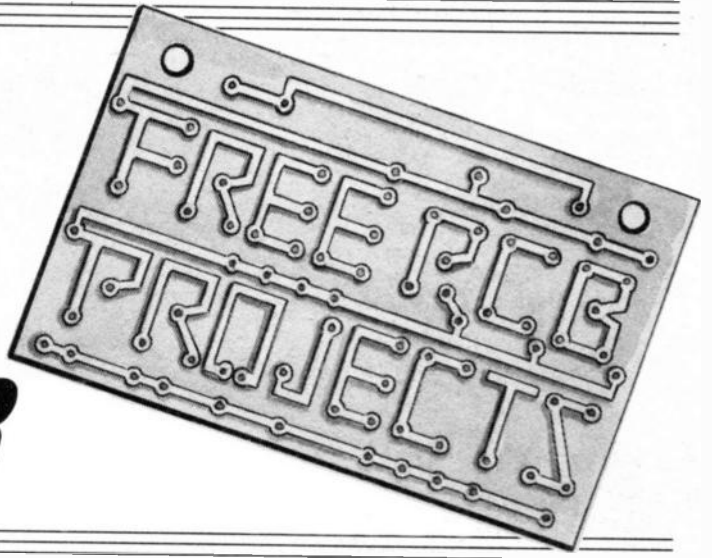
## Pad Carefully

Using the board is reasonably straightforward, but it does require slightly more care than when using a custom printed circuit board. None of the projects utilize all the pads, and in most cases more than 50 percent of the holes in the board are left vacant. This makes it essential to take a little more care when fitting the components, and to double-check the positioning of each one. Apart from this, using the Multi-PCB should be as easy as project building on a custom board.

*The Multi-PCB Projects (left to right, top to bottom): Current Meter - Treble Booster - Distortion Unit - IR Receiver - Video Enhancer - IR Transmitter - Audio Sinewave Generator.*



# AUDIO SINEWAVE GENERATOR



**ROBERT PENFOLD**

Use your FREE cover-mounted p.c.b. to build this simple, switched range audio sinewave generator. Output Frequencies:

100Hz • 1kHz • 10kHz •

**A**N AUDIO signal source of some kind is an essential piece of test gear for anyone involved in constructing and testing hi-fi amplifiers, or any other type of audio equipment. These signal sources range from simple signal injectors to up-market signal generators which cover a wide frequency range, and have two or three very high quality output waveforms to choose from.

This device falls somewhere between these two extremes. It only provides a single output waveform, but this is an extremely high quality sinewave type.

The output frequency is not variable, but three output frequencies of 100Hz, 1kHz, and 10kHz are available. This enables tests to be made at a *low*, *middle*, or *high* audio frequency.

The output level is continuously adjustable from zero to approximately 10 volts peak-to-peak. There is also a -20dB switch that can be used to attenuate the output by a factor of ten. The output voltage range is then zero to one volt peak-to-peak, which makes it easier to set low output levels.

## WIEN OSCILLATOR

There are many oscillator configurations that can provide a good quality sinewave signal, but the Wien oscillator is the most popular choice. This is reasonably simple, but can provide very good results provided oscillation is properly regulated. The basic circuit diagram for a Wien oscillator, using an integrated circuit, is shown in Fig. 1.

A non-inverting amplifier forms the basis of the circuit. The amplifier can be a discrete type, but modern designs are invariably based on an operational amplifier i.c.

The Wien network is formed by resistors R1, R2 and capacitors C1, C2, and its purpose is to provide frequency selective

positive feedback. At a certain frequency the phase-shift through the Wien network is zero, and at this frequency positive feedback is applied to the amplifier. The zero phase-shift frequency is equal to  $1/6.283 CR$  Hertz. It is assumed here that R1 equals R2, and that C1 equals C2, which is normally the case in practical designs.

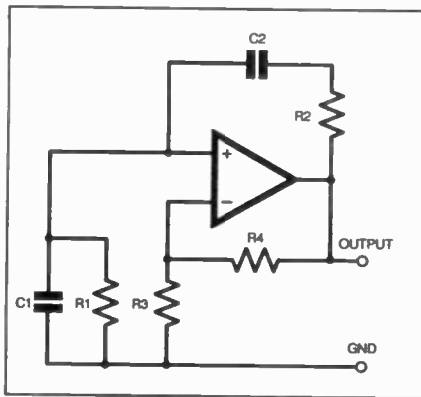


Fig. 1. The Wien oscillator configuration.

## GAIN

Provided the voltage gain of the amplifier is at least a little higher than the losses through the Wien circuit, the circuit will oscillate at the zero phase-shift frequency. In order to sustain oscillation the voltage gain of the amplifier needs to be at least three times.

The closed-loop voltage gain of the amplifier is set by resistors R3 and R4, which form a conventional negative feedback circuit. The voltage gain is equal to  $(R3 + R4)/R3$ .

In practice it is not good enough to merely set the voltage gain of the amplifier at a little over three times. This would

provide oscillation, but the circuit would oscillate so strongly that the output would become severely clipped. This would give an output waveform more like a low quality squarewave than a pure sinewave signal. Even if the gain was carefully adjusted to just the right level, it would only require a small change in the loading on the output of the amplifier to either quench oscillation, or to allow it to run out of control.

## STABILISATION

In order to obtain really good results it is necessary to incorporate an automatic gain control (a.g.c.) circuit. This automatically adjusts the gain of the amplifier so that the output level is maintained at a suitable level.

The exact output level is not too important, and anything that gives a reasonably strong but non-clipped output signal will suffice. The two normal types of automatic gain control have either a field effect transistor (f.e.t.) or a thermistor as one element of the negative feedback network.

## THERMISTOR

The thermistor method is probably the more popular, as it generally gives lower distortion, and is a much more simple arrangement. Its only real drawback is that the special thermistors for this application are relatively expensive.

The audio generator featured here uses a conventional thermistor stabilised design. The thermistor used is basically just a standard negative temperature coefficient type (increased temperature gives reduced resistance), but it is self-heating.

In other words, it is not designed to respond to the ambient temperature, and it is actually contained within an evacuated glass envelope which helps to minimise the influence of the outside world. The thermistor is designed to heat up when it passes a small current. The higher the current, the hotter it becomes, and the lower its resistance.

It is resistor R4, in Fig. 1, that is replaced by the thermistor. At switch-on the thermistor is cool. It therefore exhibits a high resistance, which in turn gives the amplifier a high voltage gain. This causes strong oscillation, and a large current flow through the thermistor.

This results in the thermistor heating up, giving greatly reduced resistance, much lower voltage gain, and weak oscillation.



With weaker oscillation there is reduced current flow through the thermistor, which therefore cools down and gives stronger oscillation.

The strength of the oscillations fluctuates momentarily, but the circuit soon settles down with a moderately strong output signal. If loading on the output produces a reduction in the output level, the current through the thermistor decreases, and it provides stronger oscillation.

Similarly, if a reduction in loading produces a stronger output signal, the current through the thermistor increases, thus decreasing the oscillator strength. The thermistor therefore sets the amplitude of the output signal at a suitable level initially, and then maintains it at that level with reasonable variations in loading, etc.

## CIRCUIT DESCRIPTION

The full circuit diagram for the Audio Sinewave Generator is shown in Fig. 2. Resistors R1 and R2 bias the non-inverting (pin 3) input of IC1, and their parallel resistance forms one element of the Wien network. They are the equivalent of R1 in Fig.1. The other resistor in the Wien network is R5.

Three switched pairs of capacitors (C2 to C7) provide the unit with its three different output frequencies. C4 and C7 provide the 100Hz signal, C3 and C6 provide the 1kHz signal, and C2 plus C5 produce the 10kHz output signal.

Resistors R3 and R4 bias the inverting (pin 2) input of IC1, and their parallel resistance also acts as one element of the negative feedback network. They are the equivalent of R3 in Fig.1.

Thermistor R7 is the other section of the negative feedback circuit. An RA53 thermistor is the normal choice for this application, but due to its lower cost an RA54 is used in this circuit.

The RA54 is very similar to the RA53, but it has a higher operating resistance. This means that it works at a slightly lower current than the RA53, but with a slightly higher operating voltage.

What this means in practice is that the output level from the oscillator is higher than would be obtained using an RA53. The peak-to-peak output voltage is about

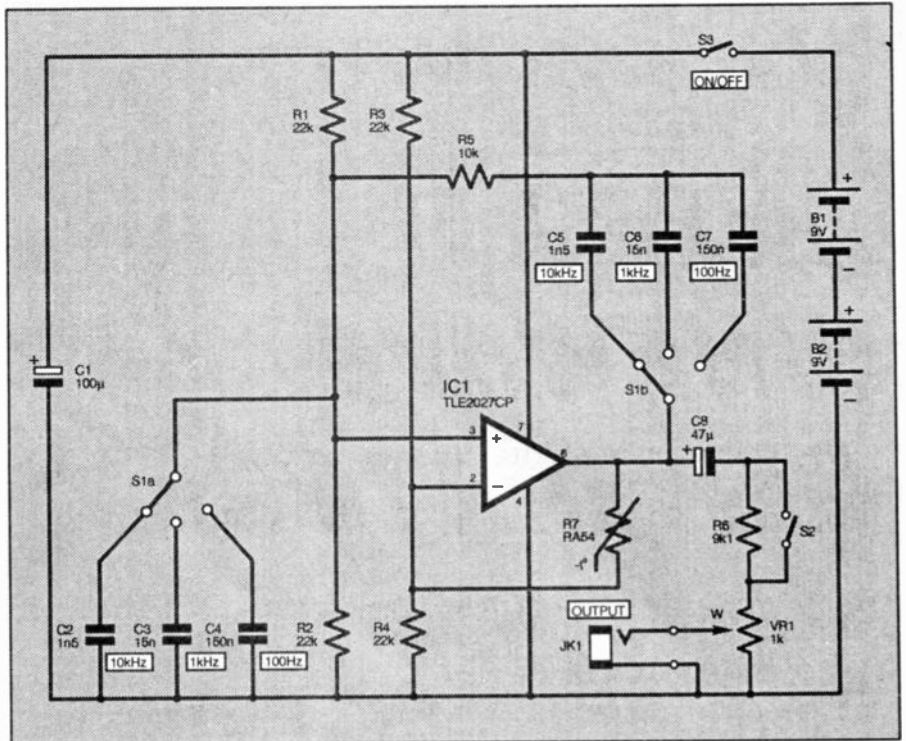


Fig. 2. The complete circuit diagram for the Audio Sinewave Generator.

10 volts, whereas a circuit based on an RA53 normally has an output level of about three volts peak-to-peak.

Potentiometer VR1 is the variable output attenuator. Opening switch S2 introduces losses through resistor R6 that reduce the output by about 20dB. Use a value of 100 kilohms for R6 if a reduction by about 40dB is preferred.

The 10 volt output level of the circuit precludes the use of a single 9V battery. The circuit is therefore powered from two small 9V batteries wired in series. This gives an 18V supply, and plenty of "headroom". The current consumption is approximately 5.5mA from each battery.

Although a very high quality operational amplifier is specified for IC1, the circuit will work using practically any type which has internal compensation. Using a very low noise and distortion component such as the TLE2027CP it is possible to obtain a very high quality output signal, which enables the

unit to be used in demanding applications such as distortion measurement. However, for simple signal tracing or gain testing a less expensive type such as an LF351N or  $\mu$ A741C is perfectly satisfactory.

## COMPONENTS

### Resistors

R1, R2,	
R3, R4	22k (4 off)
R5	10k
R6	9k1 (see text)
R7	RA54

See  
SHOP  
TALK  
Page

glass-encapsulated

NTC bead thermistor

All 0.25W 5% carbon film, except R7

### Potentiometer

VR1	1k rotary carbon, lin.
-----	------------------------

### Capacitor

C1	100µ radial elect. 25V
C2, C5	1n5 polyester (2 off)
C3, C6	15n polyester (2 off)
C4, C7	150n polyester (2 off)
C8	47µ radial elect. 25V

### Semiconductor

IC1	TLE 2027CP low-noise op.amp
-----	-----------------------------

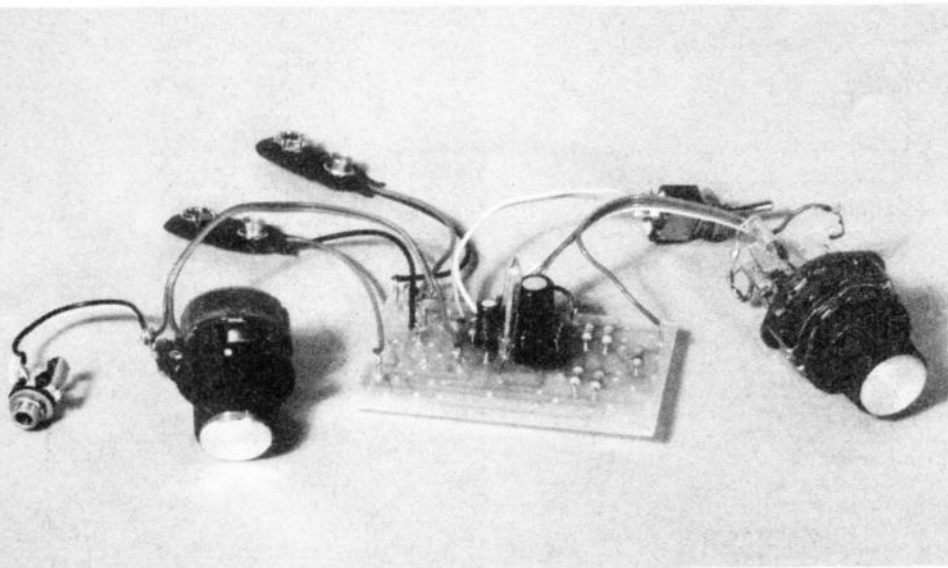
### Miscellaneous

JK1	3.5mm mono jack socket
S1	3-way 4-pole rotary (only two poles used)
S2	s.p.s.t. min. toggle switch
S3	s.p.s.t. min. toggle switch
B1, B2	9V battery, with clips (PP3 size, 2 off)

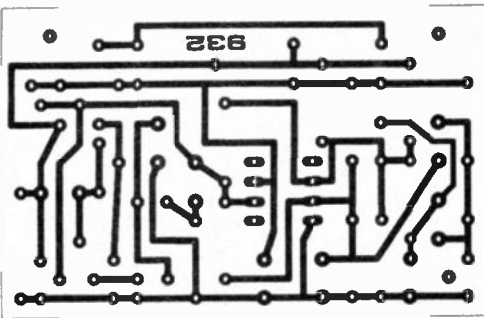
Printed circuit board, one FREE cover-mounted (or additional boards available from the *EPE PCB SERVICE*, code 932); small instrument case, size to choice; 8-pin d.i.l. socket; PP3 type battery clip (2 off); control knob (2 off); multistrand connecting wire, solder, etc.

Approx cost  
guidance only

**£19**  
excluding Batts.

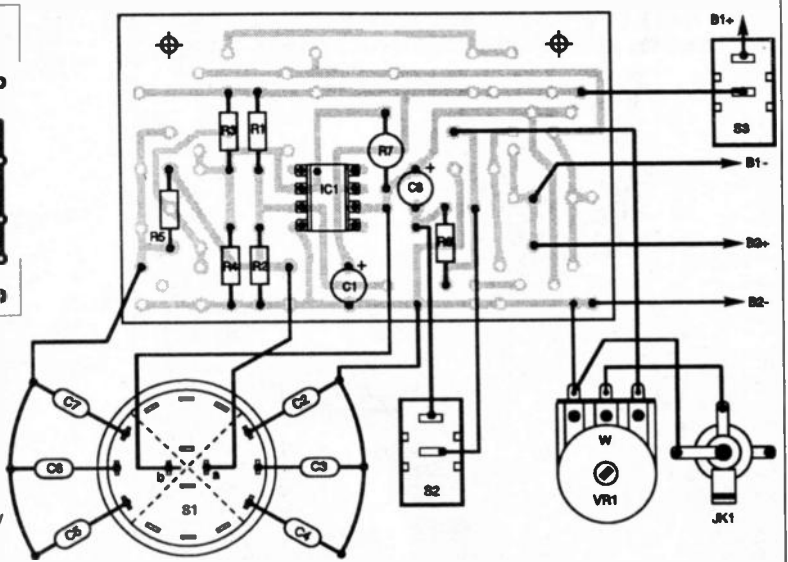


The completed Sinewave Generator awaiting a suitably sized case. Note the capacitors soldered directly on the rotary switch tags and the glass thermistor mounted on the p.c.b.



**Note:** None of the projects in the Multi-project PCB series use ALL the copper pads on the board, in most cases more than 50 per cent of the holes are left vacant. This makes it essential to double-check the positioning of each component, before soldering in place.

Fig. 3. Audio Sinewave Generator full size p.c.b. copper foil master pattern, component layout and interwiring to off-board components.



## CONSTRUCTION

This simple circuit can be built on the *FREE* printed circuit board (p.c.b.) attached to the front cover of this magazine. (If you intend to build all the designs using this p.c.b., you can obtain extra boards from the *EPE PCB Service*, code 932, for the sum of £3 each. Alternatively, you can, of course, purchase extra copies of this issue from your *Newsagent* and make a small saving on the cost of the p.c.b. (the extra copies could be passed to a friend).

The generator circuit will just about fit onto the *EPE Free* printed circuit board, but capacitor C2 to C7 must be mounted on the tags of rotary switch S1 rather than on the board itself. The topside component layout and full size underside copper foil master pattern is shown in Fig. 3.

Also included in the diagram is the interwiring to off-board components. There are a number of connections from the board to controls, etc., and single-sided solder pins should be fitted to the board at the appropriate places.

The TLE2027CP is not a static-sensitive device, but it is not particularly cheap

either. It is therefore a good idea to use a holder for this component. In fact it is advisable to use a holder even if a cheaper device is used for IC1.

The thermistor is fairly costly and has a glass encapsulation. It should obviously be treated with due respect. The thermistor can be fitted to the board either way round.

A three-way four-pole rotary switch is used for S1, but in this case only two poles are used, and eight tags are left unused. There should be little difficulty in fitting the six capacitors onto S1 provided the tags and the ends of the leadout wires are generously tinned with solder beforehand.

There is a fair amount of hard wiring for such a small project, so be especially careful to avoid crossed-over connections. Be particularly careful when wiring up switch S3 and the two battery clips. JK1 is a 3.5 millimetre jack socket on the prototype, but this can be a higher quality socket (such as a BNC type) if preferred.

## TESTING

If an oscilloscope is available, this can be used to check that the unit is producing

"clean" output signals at the appropriate frequencies, and at the correct maximum amplitude. The amplitude of the output signal will stabilise quite quickly when using the two higher output frequencies, but it might take a few seconds to fully settle down after switching S1 to the "100Hz" position.

In the absence of suitable test gear, a crystal earphone can be connected to socket JK1 and used to monitor the output signal. Other types of earphone are not suitable incidentally.

Check that adjustment of switch S1 provides *low*, *middle*, and *high* tones, and that the volume of the signal can be controlled properly using S2 and rotary control VR1. A sinewave signal contains just one frequency component, and has an unmistakable "pure" sound which should be readily apparent when listening to the 100Hz and 1kHz output signals.

## IN USE

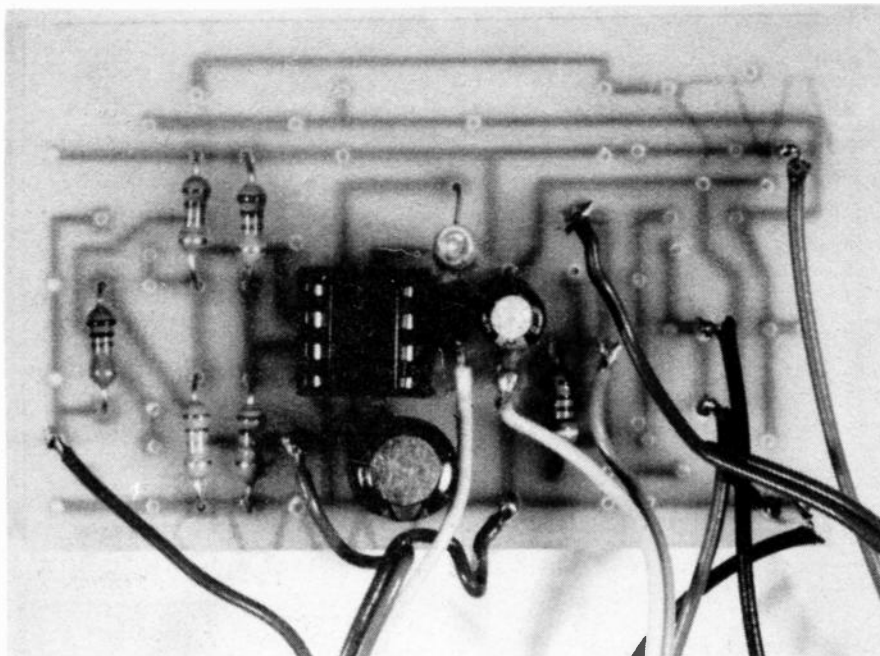
There are many ways of using a unit of this type, and a detailed description of its use goes beyond the scope of this article. The most simple way of using the unit is as a signal injector when trying to locate a fault in an audio amplifier.

The output of the Audio Sinewave Generator is connected to the input of the amplifier, and the generator is set for a suitable output level. For high level inputs (tape, tuner, etc.) results will usually be satisfactory with VR1 at a middle setting and S2 set to the "-20dB" position. For general testing the 1kHz output frequency should be selected.

A signal tracer, which can be something as basic as a crystal earphone and a set of test leads, is then used to check for the signal at various points along the signal path. At some point the signal will be too low in level, badly distorted, or whatever. The fault is then at that point in the amplifier, or immediately prior to it.

An advantage of using a high quality sinewave test signal is that practically any imperfection imposed on the signal is clearly audible, or easily seen on an oscilloscope display.

**The normal safety precautions MUST be taken when making tests on mains powered equipment. Those of limited experience should only use the Sinewave Generator to make tests on battery powered equipment.** □



The finished Generator board. Be especially careful when soldering in position the glass bead thermistor and use a d.i.l. socket to take the op.amp i.c.

# Baylin Publications

ALL ITEMS  
EX-STOCK.

**Ku Band  
Satellite TV.  
Theory,  
Installation &  
Repair**  
4th Edition,  
Footprints, dish  
theory, cables,  
site survey,  
polar mount  
adjustment.



£25.

**European  
Scrambling**

**Systems, Circuits, Tactics &  
Techniques.** By John McCormac,  
digital sound, smart cards, pirate  
decoders, for hackers. 4th Edn.

**World Satellite TV  
and  
Scrambling Methods**

The Technicians' Handbook



£32.

**World Satellite TV & Scrambling  
Methods.** 3rd Edition, by Baylin,  
Madox & McCormac for the  
service engineer.

£29.

**Home Satellite TV Installation Videotape.**

Forty minutes VHS Pal. See how 3 metre  
dishes are installed.

£27.

**Satellite Installation Guide.** 3rd Edition.

By John Breeds.

£15.

**The Satellite Book.** 4th Edition. A complete  
guide to satellite TV. Theory and practice by  
John Breeds.

£32.

**TVRO System Analysis and Aiming Software.** 5.25 or 3.5 disk, (DOS 3.2).

Calculates dish size and lists coordinates of all satellites in view.

£39.

**Satellite Toolbox Software,** for IBM Comp. Hard Disk - 5.25 or 3.5.

£59.

**Wireless, Cable & SMATV,** Microwave broadcasting & cable TV.

£35.

**World Satellite Yearly** by Dr. Baylin, Loading and 350 Footprints.

£59.

**PRICES INCLUDE P. & P. UK. Airmail Europe add 10%.  
Outside Europe + 30%.**

24 River Gardens,  
Purley, Reading.  
RG8 8BX, England.  
Tel/Fax  
01734-414468  
Mobile 0836-582785  
Pay by: UK cheque,  
Access, Mastercard,  
Visa,  
C.O.D.



# SUMMER 1995 CATALOGUE



The Summer '95 edition has 280 pages packed with over 4000 products and now with news and features including a full construction project.

The computer section is greatly increased with new ranges of equipment and accessories for PCs including:

- Mother boards, CPUs and SIMMs
- CD ROM drives and hard drives
- Sound cards, I/O cards, disc drive cards and video cards
- Mice, trackballs and joysticks
- Power supplies and cases

**£1.95**  
+ 30p p&p

- Feature project for an EPROM emulator
- New 20MHz 'scope from Leader, training systems from Flight and an extended range of mobile phone batteries and accessories from Uniross
- Latest addition from Velleman kits including a video digitiser card
- 280 pages, 26 sections, over 4000 products from some of the worlds finest manufacturers and suppliers
- Available at most large newsagents, from 13th April, or directly from Cirkit
- Send for your copy today!**

## Cirkit



### Cirkit Distribution Ltd

Park Lane · Broxbourne · Hertfordshire · EN10 7NQ  
Telephone: 01992 448899 · Fax: 01992 471314

## HEWLETT PACKARD HP71B

As easy to use as a calculator  
but as powerful as a  
computer



**BARCODE  
READER**  
Smart wand

— Automatically  
recognises and  
decodes all major  
bar-code standards.

**SPECIAL OFFER**  
Buy 2 kits for **£59.00**

● A powerful set of basic functions, statements, and operators - over 230 in all - many larger computers don't have a set of basic instructions this complete.

● Advanced statistics functions enabling computations on up to 15 independent variables.

● Recursive subprograms and user defined functions.

● An advanced internal file system for storing programs and data - The HP71 has continuous memory - when you turn the computer off it retains programs and data.

● A keyboard that can be easily customised for your specific application.

● HP-IL Interface pre-installed to create a system that can print, plot, store, retrieve and display information.

Control or read instruments or speak to other computers. 5000 bytes/sec.

Built in ROM includes 46 separate commands. Interface to HP-IL, HP-IB, RS232C, GPIO or series 80. Includes connection cables.

These are second users systems, ex NHS, are fully tested and working but have no programming (THAT IS UP TO YOU).

HP71B.....£29.95

Bar-code Reader.....£12.95

A.C. Power Supply.....£4.95

(Works from batteries normally)

Keyboard Overlay.....£1.00

(Limited quantities)

(Unknown Program) Memory

Module.....£3.00

Complete kit of HP71B, Bar-code Reader

and power supply.....£39.50

(Prices include VAT/Delivery within

7 days. £3.00 for UK)

(Currently selling in US for over US\$500!)

**INTERCONNECTIONS LTD**

Unit 51, InShops, Wellington Centre

Aldershot, Hants. GU11 5DB

Tel: (01252) 341900 Fax: (01293) 822786

Please rush me

HP71B Powerful Calc/Computer @ £29.95

Bar-code Reader @ £12.95

Power Supply @ £4.95

Keyboard overlay @ £1.00

Memory module @ £3.00

Complete kit of HP71B, Bar-code Reader

and Power Supply @ £39.50

Please debit credit card

No. .... Exp. ....

Name .....

Address .....

.....

.....

.....

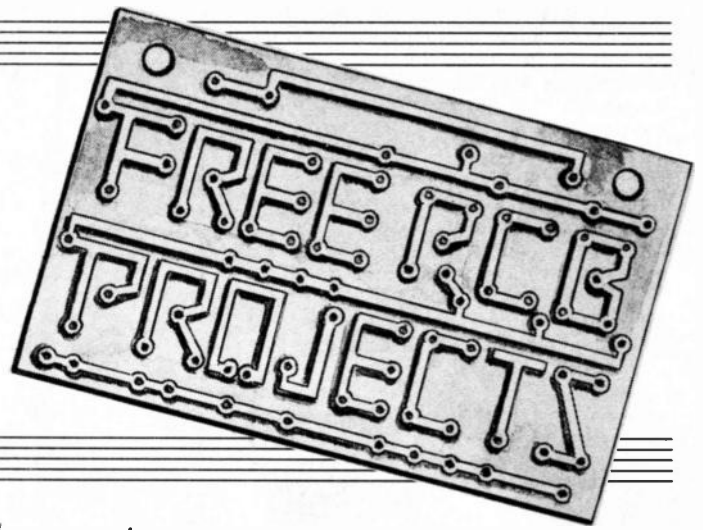
.....

Total payment £..... + £3 delivery = £..... Tel. ....

We accept Mastercard, Visa, Cheques or money orders - please post the above form to us, or Fax it, or Telephone with a verbal credit card order.

# TREBLE BOOSTER

ROBERT PENFOLD



Give your performance a boost with this popular sound effects unit. Can be built on the FREE p.c.b. attached to this issue.

THE MOST simple means of altering the sound of an electronic instrument is to use some frequency selective filtering. This is the method used in guitar treble boosters, which simply boost the higher audio frequencies.

In general, this means that the fundamental frequency of each note is left unaltered, but the harmonics are boosted. In particular, the higher harmonics are substantially boosted. This is said to give a much "brighter" and "livelier" sound.

The Treble Booster described here is really a form of treble tone control, and it can be used to provide a variable degree of boost or cut. It has a flat response with the tone control at a central setting. The frequency response graph of Fig.1 shows the responses of the unit when set for maximum boost and cut.

There is about 6dB of boost/cut at 1kHz, rising to around 15dB to 17dB of boost/cut at frequencies of about 4kHz to 10kHz. The response is tamed slightly at the highest audio frequencies and beyond, in order to reduce the risk of problems with instability.

When set for maximum boost the circuit provides a response which is comparable to a conventional tone booster. It is useful to be able to back-off the boost slightly if desired, so that a more subtle effect is obtained.

Using treble cut has the opposite effect to using boost, with the fundamental frequencies left largely untouched, and the harmonics severely attenuated. This gives a less shrill and more mellow sound, which could be useful for certain types of music.

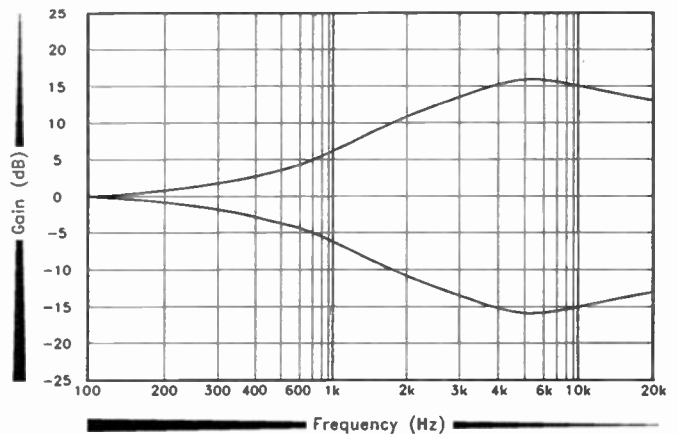


Fig. 1. Frequency responses with maximum boost and cut.

## CIRCUIT OPERATION

The complete circuit diagram for the Treble Booster is shown in Fig.2. The circuit is basically just a non-inverting mode amplifier. Resistors R2 and R3 bias IC1's non-inverting input (pin 3), and R1 plus R4 act as a negative feedback network that set the closed-loop voltage gain of IC1 at unity.

However, R1 and R4 are only used to set the operating conditions of IC1 at d.c. and low to middle audio frequencies. The high frequency voltage gain is governed by a more complex negative feedback network which is comprised of resistors R5, R6, potentiometer VR1 and capacitors C4, C6.

If we ignore capacitor C6 for the moment, R5, VR1, and R6 form a conventional negative feedback network which enables the voltage gain of the circuit to be varied. With the wiper (w) of VR1 towards the top end of its track the circuit provides losses of nearly 20dB. Taking VR1's wiper to the middle of its track gives unity voltage gain, and moving it down to the bottom of the track gives almost 20dB of gain.

If the wiper of VR1 was connected direct to the inverting input (pin 2) of IC1, this cut and boost would be provided at

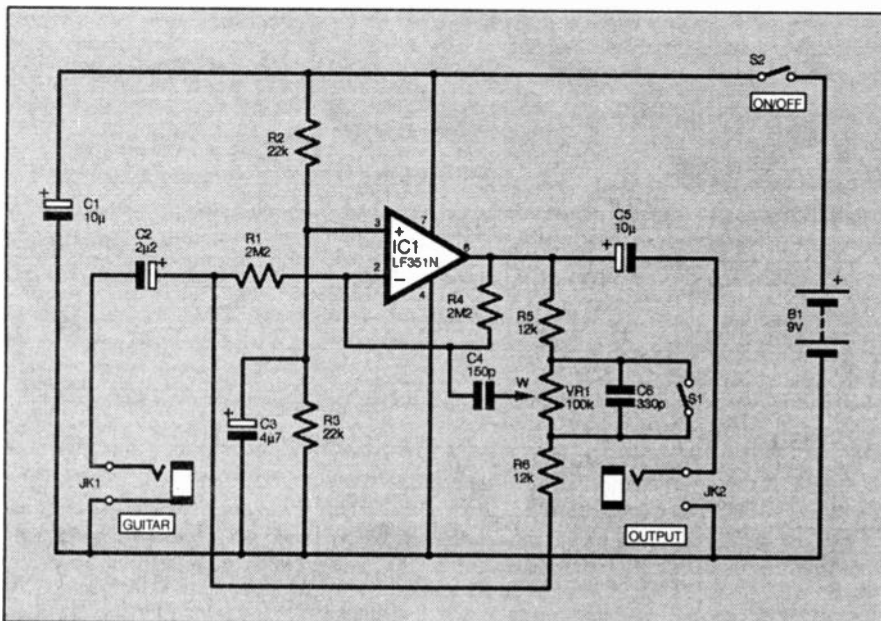


Fig. 2. Complete circuit diagram for the Treble Booster.

all frequencies. Instead, it is coupled to the inverting input via capacitor C4, which has quite a low value. Consequently, C4 only provides an efficient coupling at high frequencies.

At middle and bass frequencies capacitor C4 has a very high impedance, and provides only a loose coupling to IC1's inverting input. Therefore, control VR1 is ineffective at these lower frequencies, where the voltage gain of the circuit is largely governed by resistors R1 and R4. This permits the required boost and cut to be obtained at high frequencies, but keeps the gain at about unity at middle and low frequencies.

Capacitor C6 "tames" the boost at the highest audio frequencies. This is not essential to the effect, but it helps to avoid problems with instability and excessive high frequency "hiss". It effectively places a short circuit across the track of VR1 at very high frequencies, rendering it impotent.

The "bypass" switch S1 can be used to place a short circuit across VR1's track at all frequencies, and this provides a simple means of switching the effect in and out. The current consumption of the circuit is only about 2mA, which gives a very long battery life.

### CONSTRUCTION

Using the FREE printed circuit board from this issue makes construction of the Treble Booster fairly trouble-free. The full size copper foil pattern, component layout, and interwiring for the Treble Booster are shown in Fig.3. The LF351N used for IC1 is not a static sensitive device, but it is as well to use an i.c. holder for it anyway.

As IC1 operates at less than unity voltage gain at some frequencies when VR1 is set to provide treble cut, this can cause instability in some internally compensated operational amplifiers; which are only guaranteed to remain stable at voltage gains of more than unity. The LF351N was found to be stable in this circuit, but other operational amplifiers might have a tendency to oscillate at a high frequency.

Be careful to fit IC1 and the four electrolytic capacitors the right way round. Capacitors C4 and C6 do not need to be close tolerance (one per cent) polystyrene capacitors, and ordinary five per cent types will suffice.

Fit single-sided solder pins to the board at the points where leads from the off-

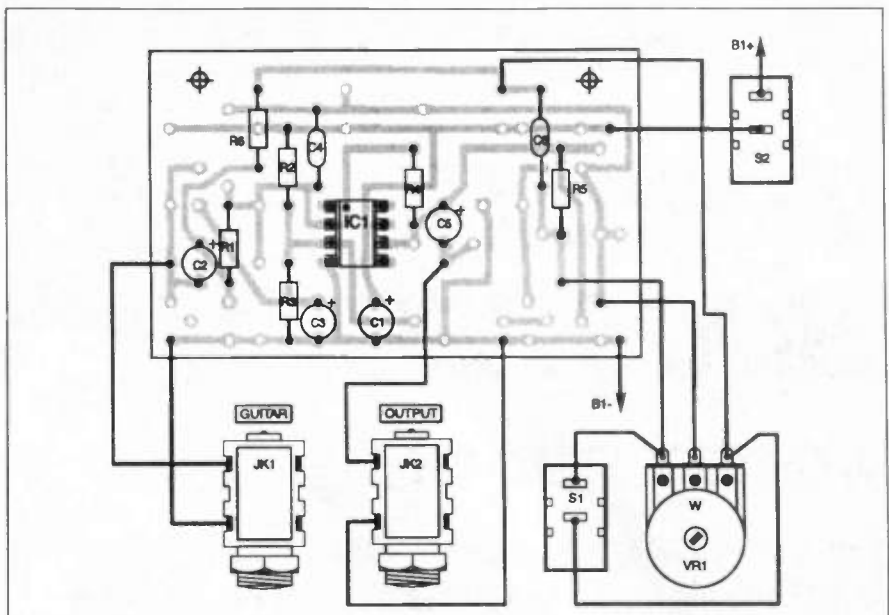
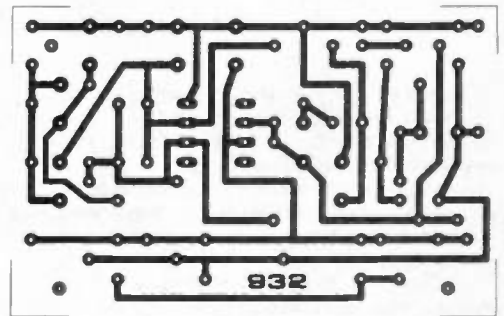


Fig. 3. Treble Booster printed circuit board (p.c.b.) component layout, full size copper foil master and wiring to off-board components.

**Note:** None of the projects in the Multi-Project PCB series use ALL the copper pads on the board, in most cases more than 50 per cent of the holes are left vacant. This makes it essential to double-check the positioning of each component, before soldering in place.



board components will need to be made. To ease soldering, "tin" the tops of the pins with plenty of solder.

There is no need to use "screened" leads for any of the wiring provided the leads are kept reasonably short. Insulated, plastic bodied, jack sockets are used for JK1 and JK2 on the prototype. These are equipped with single break contacts which are not needed in this case. Hence two tags of each socket are left unconnected. Of course, open style jacks can be used if preferred.

## COMPONENTS

### Resistors

R1, R4 2M2 (2 off)

R2, R3 22k (2 off)

R5, R6 12k (2 off)

All 0.25W 5% carbon film

See  
**SHOP  
TALK**  
Page

### Potentiometer

VR1 100k rotary carbon, lin

### Capacitors

C1, C5 10µ radial elect. 25V (2 off)

C2 2µ2 radial elect. 50V

C3 4µ7 radial elect. 50V

C4 150p polystyrene

C6 330p polystyrene

### Semiconductor

IC1 LF351N J-f.e.t. op.amp

### Miscellaneous

JK1, JK2 Standard, plastic-bodied, mono jack socket (2 off)

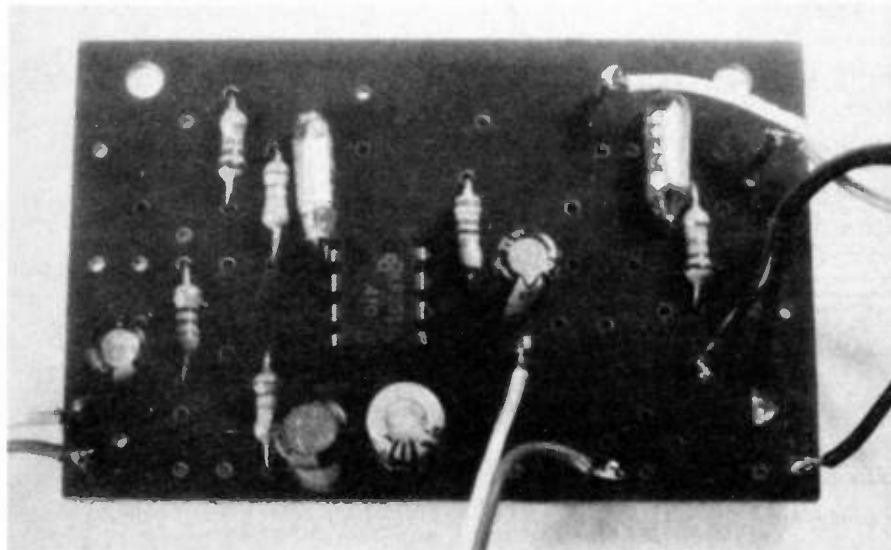
S1 s.p.s.t. heavy-duty pushbutton switch

(see text)

S2 s.p.s.t. min. toggle switch

B1 9V battery (PP3 size)

Printed circuit board, FREE (cover-mounted) with this issue or additional boards from EPE PCB Service, code 932; case, metal (size to choice); control knob; 8-pin d.i.l. socket, PP3 type battery clip, multistrand connecting wire, solder, etc.

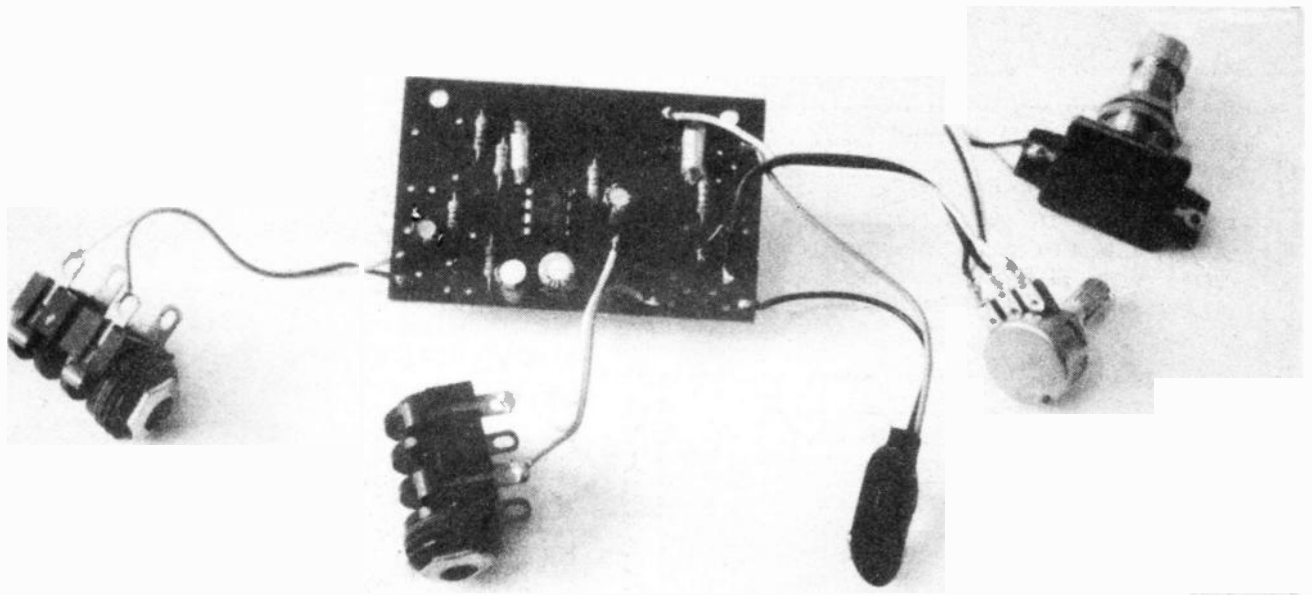


Component layout on the completed printed circuit board.

Approx cost  
guidance only

**£10**

excluding Batt.



The completed Treble Booster p.c.b. showing the two plastic-bodied jack sockets and, top right, the robust heavy-duty "foot-operated" pushbutton switch. These components should all be mounted in a strong metal case.

### FOOT CONTROL

A heavy-duty pushbutton switch (S1) is mounted on the top panel of the case so that it can be operated by foot. The normal choice is a successive operation switch. This type of switch is activated once to switch in the effect, a second time to switch it out again, and so on.

It might be difficult to obtain a s.p.s.t. switch of this type. If necessary, the appropriate pair of contacts on a d.p.s.t. or d.p.d.t. switch can be used.

Some users prefer to use a simple push-to-make, release-to-break pushbutton switch. Using an ordinary push-to-make switch, this results in the effect being activated when the switch is released, and switched out when it is pressed. A push-to-break switch has the opposite effect, with the treble boost being switched in when the switch is operated. This second method is probably the most convenient in use.

A small and inexpensive pushbutton switch is not really suitable for an

application such as this. It would be difficult to operate at all, and would almost certainly break before too long. The switch must be one of the larger and tougher pushbutton types.

Obviously the case for this project must also be quite tough. A metal case is definitely preferable to a plastic type. Apart from strength considerations, a metal case will provide some screening of the wiring, which will help to minimise stray pick-up of mains "hum" and other electrical noise.

Diecast aluminium boxes are extremely tough, and are a popular choice for guitar effects units. Unfortunately, they are also relatively expensive. A good quality folded aluminium box provides an inexpensive alternative to a diecast type.

### IN USE

The guitar is connected to the input socket JK1 on the Treble Booster using an ordinary screened jack lead. A lead of the same type is used to connect the out-

put from JK2 to the input of the guitar amplifier.

With the footswitch S1 closed, the circuit should act as a simple unity gain buffer stage, and the system should work much the same as normal. With S1 opened, the effect of adjusting VR1 should be readily apparent.

If the guitar has a built-in tone control, this should normally be set for maximum treble. Of course, when the Treble Booster is actually used to provide treble cut, it might be better to turn back the guitar's tone control. It is really just a matter of experimenting with various control combinations to find the effects you like best.

Bear in mind that this unit is adding gain into the signal path when it is used to provide boost. As there is no significant increase in gain at low frequencies this should not give increased problems with "hum" pick up. It could increase the risk of problems with feedback though, and it might be necessary to take a little more care in order to avoid such problems. □

**NEXT MONTH ★ VIDEO ENHANCER ★ DISTORTION EFFECTS ★ CURRENT TRACER ★  
PLUS TEACH-IN '96 DON'T MISS OUT - ORDER YOUR COPY NOW!**

**EVERYDAY**

With **PRACTICAL**

**ELECTRONICS**

INCORPORATING ELECTRONICS MONTHLY

### NEWSAGENTS ORDER FORM

Please reserve/deliver a copy of *Everyday with Practical Electronics* for me each month.

*Everyday with Practical Electronics* is published on the first Friday of each month and distributed 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.

Signed .....

Name and Address .....  
(BLOCK CAPITALS PLEASE)

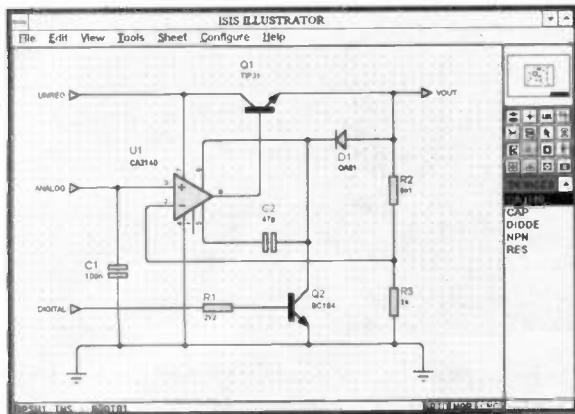
.....

.....

.....

## 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.



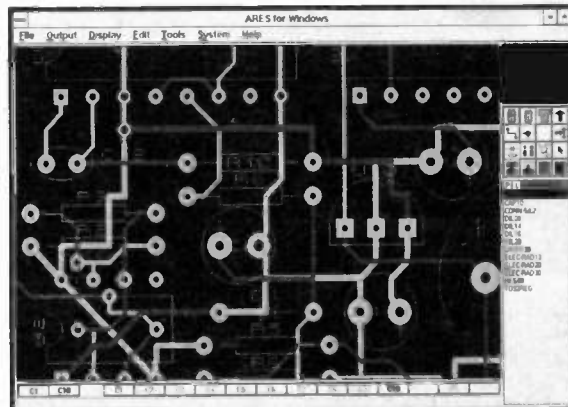
The schematic drawing module of CADPAK, ISIS ILLUSTRATOR, enables you to create circuit diagrams like the ones in the magazines.

- 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.

# labcenter

**E l e c t r o n i c s**  
 53-55 Main St. Grassington, N. Yorks. BD23 5AA  
 Tel: 01756 753440 Fax: 01756 752857

# INFRA-RED CONTROLLER/ ALARM



**ROBERT PENFOLD**

Use your FREE p.c.b., plus one extra board, to build a simple infra-red transmitter and receiver.

Designed to be useful in a number of applications, such as a remote control camera trigger or a "broken beam detector" type alarm

**T**HIS SYSTEM consists of a basic infra-red transmitter and receiver. It can be used as a simple remote control unit, to trigger a camera for example, or as a broken beam type detector for a burglar alarm system. The circuits are essentially the same for both applications.

The range of the system depends on the particular photocells used, but is generally about three to four metres. If the system is used as a broken beam alarm it is possible to obtain a much greater range using one or two lenses.

## MODULATED BEAM

The block diagram of Fig. 1 shows the basic arrangement used for this system. The Transmitter uses a special I.e.d. to generate the infra-red signal.

The "light" output from the infra-red I.e.d. is just off the end of the visible red part of the spectrum, at wavelengths of around 900nm. Consequently there is no visible light output, which is obviously important in security applications where the alarm must be heard but not seen.

The output level from the I.e.d. is not very high, which makes it difficult to obtain a useful operating range. At long ranges the output from the I.e.d. tends to be lost in the ambient infra-red level. Matters are made easier by using a pulsed beam, which

is easily distinguished from the background infra-red signal, which changes at a relatively slow rate.

The infra-red I.e.d. is driven from an oscillator via a buffer stage that can provide the relatively high drive current needed to give a good operating range. A pulse frequency of a little over 1kHz is used, but the exact operating frequency of the transmitter is unimportant.

A phototransistor at the Receiver turns the pulses of infra-red "light" into small electrical pulses. These are then fed to a high gain a.c. amplifier which boosts them by a factor of more than two hundred. This gives an output voltage swing of a few volts peak-to-peak at the output of the amplifier.

A rectifier and smoothing circuit converts this into a strong d.c. signal that is used to operate a relay driver. The latter in turn switches on the relay, which is basically just a conventional switch operated by an electro-magnet. The relay contacts are used to activate the camera, alarm system, or whatever.

When used in an application such as a remote camera trigger, the transmitter is normally switched off. The output from the amplifier is then just noise, which is inadequate to operate the relay driver and relay. The relay contacts are therefore open under standby conditions, but will close when the transmitter is operated.

If the system is used as a broken beam alarm sensor, the transmitter is switched on continuously, and the relay contacts are normally closed. Someone passing between the transmitter and the receiver will briefly cut off the infra-red signal to the receiver, causing the relay contacts to momentarily open. This momentary change is sufficient to trigger the main alarm circuit.

## TRANSMITTER CIRCUIT

The circuit diagram for the Infra-Red Transmitter appears in Fig. 2. The oscillator uses IC1 in what is really a form of relaxation oscillator. Resistors R1 and R2 bias the non-inverting input (pin 3) of IC1, and R3 provides positive feedback over IC1. This gives an inverting trigger action from IC1's inverting input (pin 2) to its output.

If the inverting input, pin 2, is taken slightly above half the supply voltage the output goes low. Taking the inverting input a little below half the supply voltage then results in the output of IC1 switching high again.

Capacitor C2 and resistor R4 are the timing components, and they are connected between the output of IC1 and its inverting input (pin 2). Initially there is no charge on C2, which results in the output of IC1 going high. C2 then charges via R4

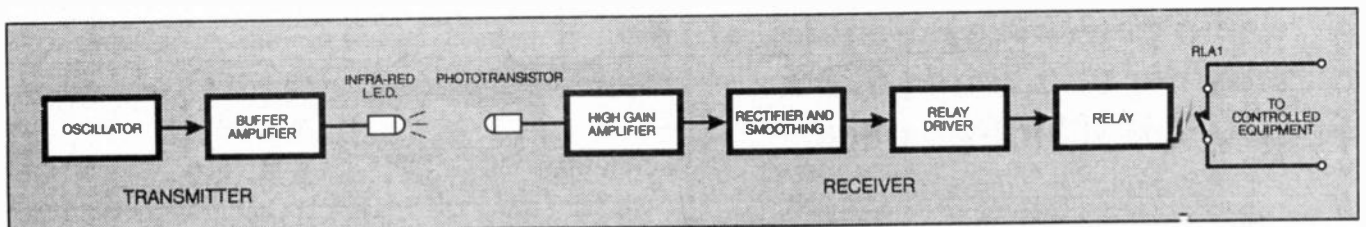


Fig. 1. The block diagram for the Infra-Red Controller/Alarm.



until the charge potential reaches slightly more than half the supply voltage. The output of IC1 then triggers to the low state, and C2 discharges via R4.

This continues until the charge voltage goes slightly below half the supply voltage. IC1's output then triggers to the high state again, and C2 starts to charge via R4 once more. This charge-discharge action continues indefinitely, with a roughly squarewave signal being generated at pin 6, the output of IC1.

This signal is used to drive the infra-red l.e.d. D1, via the emitter follower buffer stage transistor TR1, and current limiter resistor R5. The specified value for R5 sets the l.e.d. current at nearly 100 milliamps, but as the l.e.d. is switched off for about 50 per cent of the time, the average l.e.d. current is a little under 50 milliamps. This is the maximum acceptable drive current for most normal infra-red l.e.d.s.

If used in a Remote Control System, the Transmitter circuit is powered from a 9V battery. Even though the supply current will only be drawn briefly and very intermittently, an ordinary PP3 is not really adequate to power the unit. A "high power" PP3 size battery is suitable, or six HP7 size cells in a holder can be used.

Battery power is not practical if the unit is used in a Burglar Alarm System, and a mains power supply unit must then be used.

## RECEIVER CIRCUIT

The full circuit diagram for the Infra-Red Receiver is given in Fig. 3. TR1 is a phototransistor, and it is used in what is almost a standard common emitter amplifier. However, no bias current is fed to the base (b) terminal of TR1.

The collector (c) current is governed by the light level received by TR1. The higher the received light level, the higher the current flow. The pulses of infra-red from the Transmitter therefore produce pulses of leakage current through TR1, which give small negative pulses at TR1's collector.

The output signal from TR1 collector is coupled by capacitor C2 to a high gain inverting amplifier based on IC1. Resistors R2 and R5 are the negative feedback network, and these set the closed-loop voltage gain of IC1 at 220 times.

Capacitor C4 couples the amplified output signal from IC1 pin 6 to a conventional half-wave rectifier and smoothing circuit (D1, D2 and C5). Germanium rather than silicon diodes are used in the rectifier, because germanium types have a lower forward voltage drop. This gives slightly improved sensitivity.

The positive d.c. signal developed across capacitor C5 drives the base of TR2, which is a simple common emitter switch that controls the relay RLA coil. D3 is the usual relay protection diode, and this suppresses the high reverse voltage spike which would otherwise be produced across the highly inductive relay coil each time it was switched off.

A supply current of about 4.5mA to 5mA is drawn when the relay RLA is switched off. The current consumption is much higher while the relay is activated. The exact increase depends on the coil resistance of the relay, but it is generally around 35mA to 40mA.

Battery operation is possible in a remote control application, where the relay will be switched off for the majority of the time. It would still be advisable to use a fairly

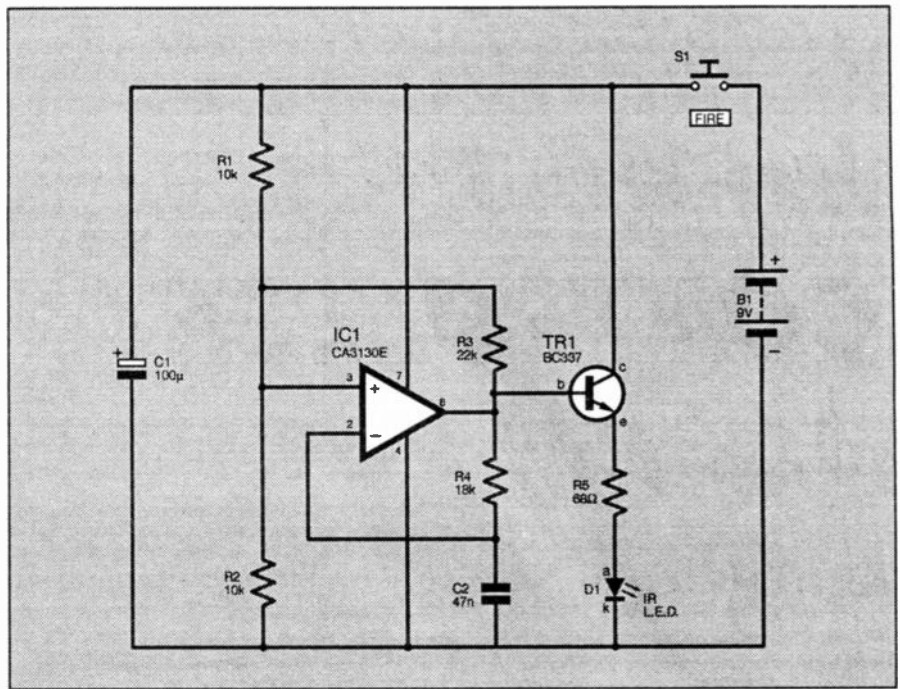
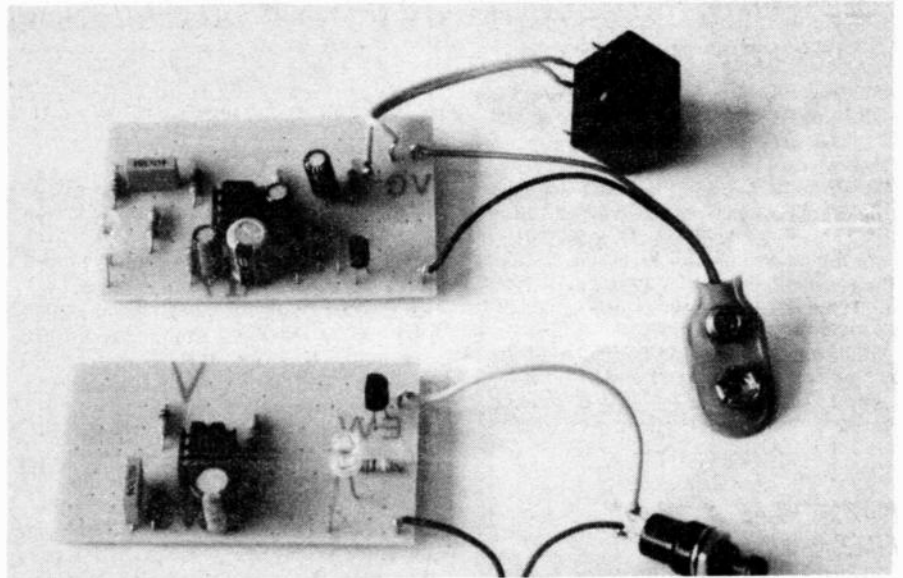


Fig. 2. Complete circuit diagram for the Infra-Red Transmitter.



The completed Transmitter and Receiver (top) p.c.b.s.

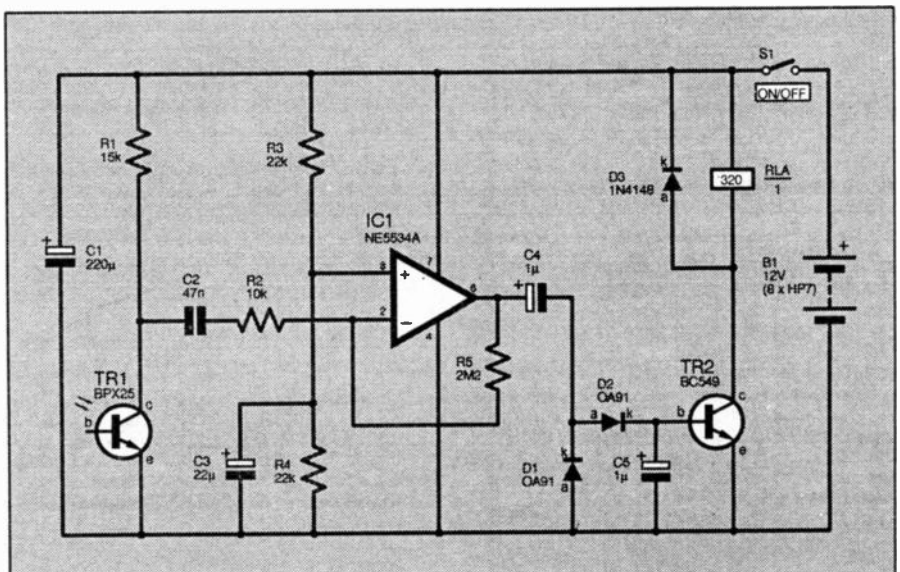


Fig. 3. Circuit diagram for the Infra-Red Receiver. The relay contacts are not shown.

high capacity battery, such as eight HP7 size cells in a holder.

Battery operation is not practical in an alarm application, where the relay will be switched on for long periods of time. A mains power supply must then be used.

## CONSTRUCTION

The Infra-Red Controller/Alarm system can be built on the *FREE* cover mounted printed circuit board, but two boards are needed in order to accommodate both ends of the system. Extra boards can be purchased from the *EPE PCB Service* for the sum of £3 each; code 923. (you could, of course, purchase an extra copy from your Newsagent and make a small saving).

The topside component layouts, actual size copper foil master and interwiring for the Transmitter and Receiver are shown in Fig. 4 and Fig. 5. Starting with the Transmitter, the CA3130E used for IC1 is a CMOS device, and it consequently requires the usual anti-static handling precautions.

Use an 8-pin d.i.l. socket for this component, but do not fit it into place until the unit is finished in all other respects. Until then it should be left in its anti-static packing. When fitting IC1 into place handle the device as little as possible.

Commence construction of the Transmitter p.c.b. by inserting and soldering in place the two single-sided pins for the pushbutton and battery negative leads. These should be followed by the resistors, capacitors and semiconductors. Note the polarities of the electrolytic capacitor C1, TR1, i.e.d. D1 and IC1.

Almost any five millimetre diameter infra-red i.e.d. of the type sold for use in remote control systems, etc., can be used for D1. L.E.D.s of this type generally seem to be sold simply as "infra-red i.e.d.s" rather than under a particular type number.

## COMPONENTS

### TRANSMITTER

#### Resistors

R1, R2	10k (2 off)
R3	22k
R4	18k
R5	68Ω

All 0.25W 5% carbon film

#### Capacitors

C1	100μ radial elect. 16V
C2	47n polyester

#### Semiconductors

D1	5mm infra-red light emitting diode
TR1	BC337 npn silicon transistor
IC1	CA3130E CMOS op.amp

#### Miscellaneous

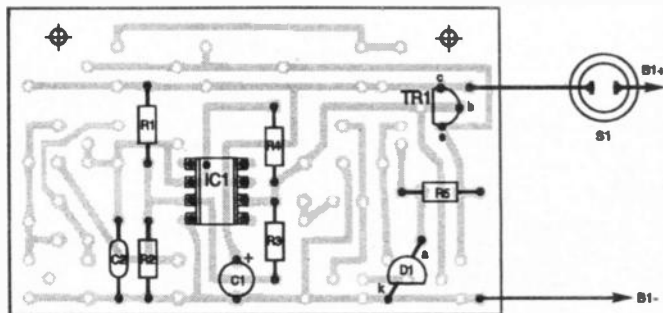
B1	9V (6 x HP7 cells in holder)
S1	Pushbutton switch, push-to-make, release-to-break

Printed circuit board, *FREE* with this issue (plus one extra board for Receiver - available from *EPE PCB Service*, code 932); plastic case, size to suit; 8-pin d.i.l. socket; PP3 type battery clip; multistrand connecting wire; single-ended solder pin (2 off); solder, etc.

Approx cost  
guidance only

£6

excluding Batts.



**Note:** None of the projects in the Multi-Project PCB series use ALL the copper pads on the board, in most cases more than 50 per cent of the holes are left vacant. This makes it essential to double-check the positioning of each component, before soldering in place.

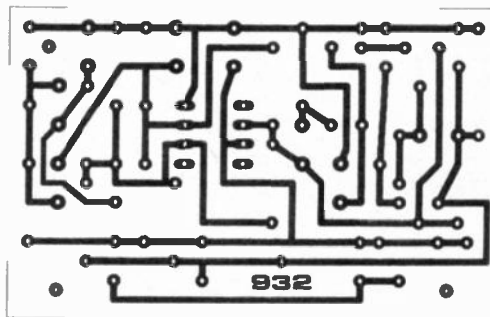


Fig. 4. Transmitter printed circuit board component layout and full size underside copper foil master pattern.

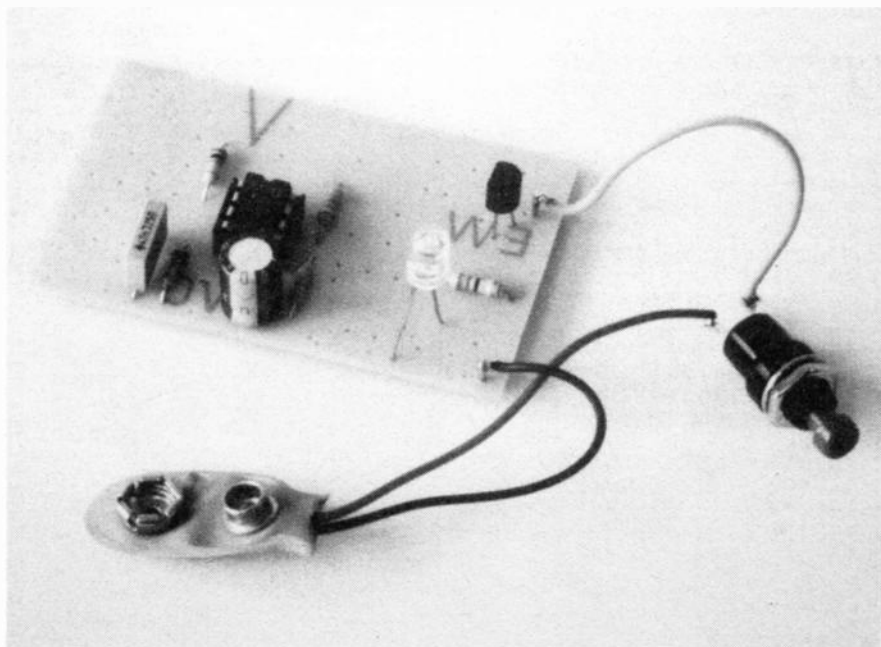
Some of these i.e.d.s have quite a narrow beam, which gives good range, but in a remote control application this can make it a little tricky to get the Transmitter aimed accurately enough. A normal infra-red i.e.d. is probably the better choice if the system will be used as a remote control.

Although D1 is shown as being mounted on the circuit board, in practice it may be better to mount it off-board in a panel-holder, and hard wire it to the board. Alternatively, it can be mounted on the circuit board, with its leadout wires bent through right angles so that it can be pushed into a small hole drilled in one end of the case.

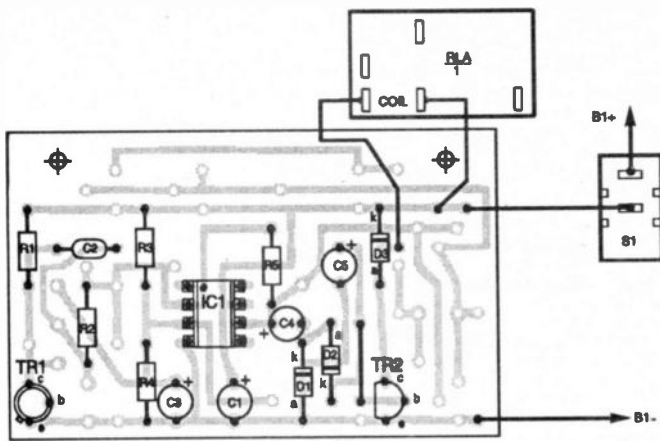
The pushbutton switch S1 is not needed if the system is used as an alarm sensor. The 9V supply is instead fed straight to the circuit board. In an alarm application it might be more convenient to use a 12V supply. This is acceptable, *but only if the value of resistor R5 is raised to 82 ohms.*

## RECEIVER

The NE5534A low-noise op.amp i.c. used in the Receiver is not static sensitive, but it is still worthwhile using a holder for this component. D1 and D2 are germanium diodes, and are more vulnerable to heat damage than silicon types.



Layout of components on the Transmitter board. It may be best to mount the infra-red emitting diode off-board in a suitable cutout in the case.



**Note:** None of the projects in the Multi-Project PCB series use ALL the copper pads on the board, in most cases more than 50 per cent of the holes are left vacant. This makes it essential to double-check the positioning of each component, before soldering in place.

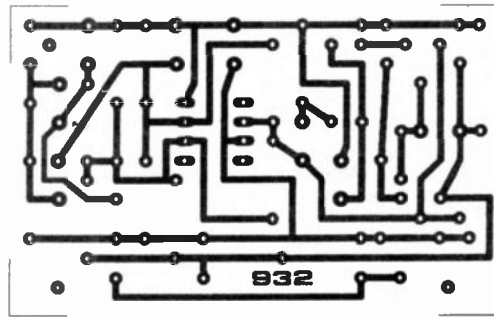


Fig. 5. Receiver p.c.b. component layout, interwiring to relay and switch, and full size underside copper foil master.

It should not be necessary to use a heat-shunt when fitting these two diodes, but the iron should be applied to each joint for no longer than is really necessary. Do not overlook the link-wire just to the right of D2.

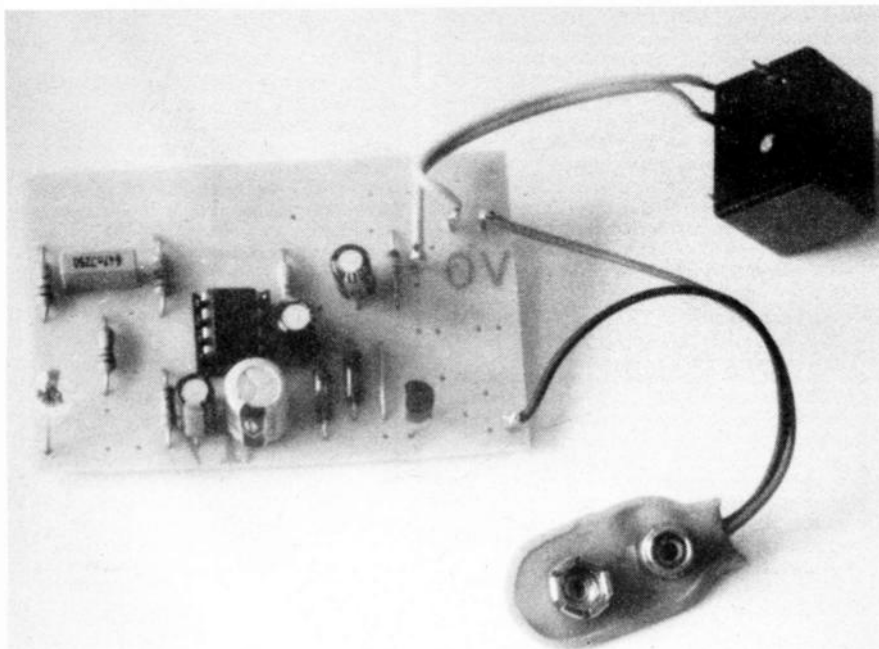
Although a BPX25 phototransistor is specified for TR1, virtually any silicon npn phototransistor will work well in this circuit. This includes lower cost types, such as the TIL81 and BPY62.

The circuit also seems to work well with i.e.d.-like devices such as the RS/Electromail BP103B. These do not

have a base leadout wire, but the base terminal is not used in this circuit anyway. The shorter lead is the collector (c) terminal. Photodiodes are not suitable for use in this circuit, because they give inadequate sensitivity.

### RELAY

The relay RLA has to be mounted off-board as there is insufficient space for the relay on the circuit board. Any relay having a 12V coil with a resistance of about 250 ohms or more, plus suitable contacts of adequate rating, is suitable for this project.



Component layout and wiring for the Receiver board. The relay will need to be glued in position in the case.

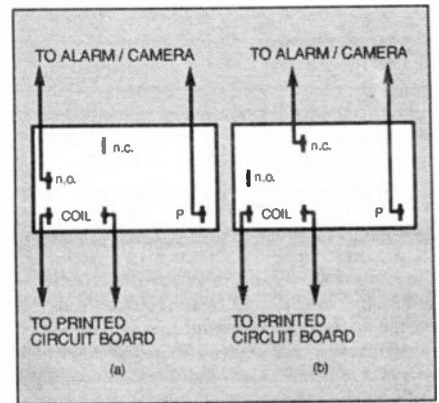


Fig. 6. Using the relay to provide normally open (a) and normally closed (b) contacts.

Modern relays do not usually have provision for any form of chassis mounting. However, there should be no difficulty in gluing the relay to the inside of a plastic or metal case. Use a good quality adhesive such as a "Super Glue" or an epoxy resin type.

The specified relay has changeover contacts, but in an alarm or remote control application the pole (p) and normally open (n.o.) contacts are used, with the normally closed (n.c.) tag being left unconnected, see Fig. 6a. In some applications it might be necessary to have a set of normally closed contacts. For example, if a camera must be triggered when the beam is broken, and the relay switches off. The connections to the relay if normally closed contacts are required is depicted in Fig. 6b.

## COMPONENTS

### RECEIVER

#### Resistors

- R1 15k
- R2 10k
- R3, R4 22k (2 off)
- R5 2M2
- All 0-25W 5% carbon film

See  
SHOP  
TALK  
Page

#### Capacitors

- C1 220µ radial elect. 16V
- C2 47n polyester
- C3 22µ radial elect. 16V
- C4, C5 1µ radial elect. 50V (2 off)

#### Semiconductors

- D1, D2 OA91 germanium signal diode (2 off)
- D3 1N4148 silicon diode
- TR1 BPX25 npn phototransistor (see text)
- TR2 BC549 npn silicon transistor
- IC1 NE5534A low-noise op.amp

#### Miscellaneous

- S1 s.p.s.t. min toggle switch
- B1 12V battery pack (8 x HP7 size cells in holder)
- RLA 12V 320 ohm coil, with s.p.d.t. contacts rated according to application (see text)

Printed circuit board, (extra) available from EPE PCB Service, code 932; case, size to suit; 8-pin d.i.l. socket; multi-strand connecting wire; PP3 type battery clip; solder pin (4 off); solder, etc.

Approx cost  
guidance only

**£11**  
excluding Batts.

## OPTICS

For most purposes the system will have sufficient range using just the built-in lenses of the photocells. In an alarm application where a large operating range is required it may be necessary to resort to one or two additional lenses.

Positive (convex) lenses having a diameter of about 25mm to 50mm and a focal length of around 50mm to 100mm are required. The lens at the Transmitter focuses the infra-red signal into a tight beam. The lens at the Receiver gathers up infra-red "light" over a relatively large area, and concentrates it onto the phototransistor.

It is not necessary to use high quality lenses, and the inexpensive plastic types available from electronic component retailers are perfectly suitable. These have an overall diameter of about 37mm, a lens diameter of 30mm, and a focal length of 80mm. The 3.5mm rim around each lens enables it to be glued in position using any good general purpose adhesive.

The basic arrangement used with a twin lens system is shown in Fig. 7. The distance between each photocell and its lens is equal to the focal length of the lens. The specified distance of 80mm will probably need to be altered if you use something other than the lenses mentioned above.

Adding the lenses greatly boosts the range of the system, and a maximum range as great as 40 to 50 metres might be

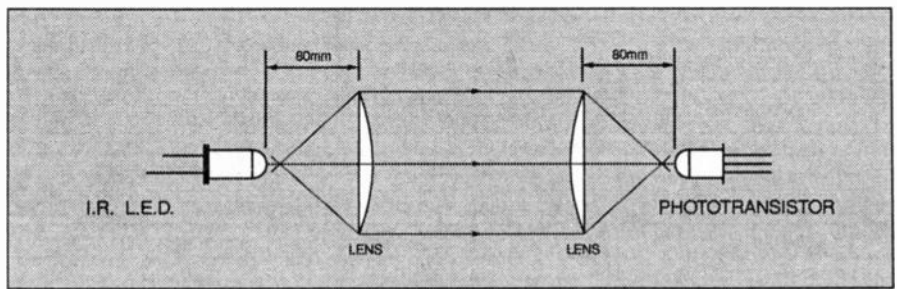


Fig. 7. Using a simple optical system to give increased range.

achievable. For a more modest increase in range (about 10 metres) it is only necessary to use a lens at one end of the system.

Adding a lens to either unit makes it extremely directional. The aim of the unit then needs to be extremely good if the system is to work, even over short distances.

With a lens used at each end of the system, both units must be aimed very accurately. Getting everything set up correctly is made more difficult by the invisible nature of the "light" from the transmitter.

Getting the system operating properly over a long range can take a lot of trial and error. Because of this increased directivity, it is not practical to use a lens or lenses to give increased range in a remote control application.

## TESTING

Initially it is best to try the system over a short range of about one metre, omitting any optical system. If all is well, gradually try the system over a greater range to establish its maximum usable range, and where appropriate, add in the lenses and try to get everything set up correctly.

In use, try to avoid having the equipment set up in a fashion that results in the receiver "looking" at strong light sources. In particular, avoid having the receiver "look" at modulated light sources, such as mains lighting. Strong light sources could reduce the sensitivity of the receiver, and modulated light sources could hold the receiver with the relay switched on. □

# SHOP TALK

with David Barrington

### Ginormous VU Meter

The transconductance op.amp i.c., type CA3080, used in the *Ginormous VU Meter* project is a fairly popular device and should be generally available. However, it is the 8-pin d.i.l. version that we are after here and the suffix E (denoting d.i.l. package) should be quoted after the type number.

As "disco" equipment usually leads a very robust lifestyle, the finished VU Meter should be housed in a strong metal box. Also, provided the unit is well "earthed," potentiometer VR1 should have a metal shaft and be fitted with a metal knob for strength.

The 8-way Bulgin P552 sockets and matching plugs should be available from most of our component supplier advertisers. They should also be able to offer suitable "mains" transformers. The ones used in the prototype model came from the Maplin wire-ended range.

The large printed circuit board is available from the *EPE PCB Service*, code 956. Don't forget to reinforce the mains carrying p.c.b. tracks with additional "runs" of solder and/or extra tinned copper wire. All mains carrying wiring **MUST** be 6A minimum rating.

### Sound Switch

The main points to watch out for when constructing the *Sound Switch* project are: the presence of "mains" voltages; to use properly rated, about 5A to 6A minimum, wiring were indicated and, most importantly, to use a well Earthed metal case.

The relay used in the prototype appears to be the Maplin "Miniature Double-pole Mains Relay" (code YX98G), with contacts rated at 5A 240V a.c. and a coil rating of 200 ohms. This is a fairly standard rating for a mains relay and other similar rated types can be used, but check first that it will sit on the circuit board or be prepared to "hard-wire" it to the p.c.b. Make sure the relay connecting tags are covered with insulating sleeving.

The 8211 voltage reference chip is currently listed by Cricklewood Electronics and

Maplin. The small 66m dia. loudspeaker used as the sensor transducer should be available from most of our component advertisers. The ZN1034E precision timer should also be generally available.

The Sound Switch p. c.b. is available from the *EPE PCB Service*, code 915.

### Capacitor Check

Selecting the resistors for the range selector switch in the *Capacitor Check* project may prove quite a problem as we progress around the switch to the higher megohm values. The table in the article helps by showing the "ideal" value together with the actual make up or grouping of resistors to find the best compromise.

Once you reach the lowest capacitor range you require a resistor above the 100 megohm value. Resistors greater than even 10 megohms do not appear to be that readily available and multiple resistors connected in series will be needed.

The 47M $\Omega$  and 33M $\Omega$  resistors used in the prototype are listed by Maplin as "high voltage", metal film resistors. An alternative would be to use resistors from the "high ohmic" range supplied by Electromail (☎ 01536 204555). Two would be required one of 100M $\Omega$  and one of 33M $\Omega$ .

The single-pole 12-way, make-before-break, rotary switch will be found to have only 11 positions instead of the 12 required. The answer is to remove the brass nut and discard the tab washer which acts as the limit stop. The Rotary switch in the model is a Lorlin type and came from Maplin (code FH42V). Note it must be a "make-before-break" type.

The printed circuit board is available from the *EPE PCB Service*, code 955.

### Audio Sinewave Generator

Some readers may find difficulty in locating the precision low-noise op.amp type TLE2027CP for the *Audio Sinewave Generator*,

Free p.c.b. project. This was purchased from Maplin, code CP86T.

The RA53 is usually the normal choice of thermistor in this type of circuit, but due to its lower cost an RA54 has been selected for this circuit. Although, to be honest, it was found that prices did not vary too much from one device to another, according to where the purchase was made. In fact, Cricklewood (☎ 0181 450 0995) list both devices at £9 whereas Maplin only list the RA53 at £12.99.

### Infra-Red Controller/Alarm

The 5mm infra-red light emitting diode used in the Transmitter circuit of the *Infra-red Controller/Alarm*, Free p.c.b. project should be readily available from advertisers.

Turning now to the Receiver all components seem straightforward and should not present any sourcing difficulties. Most of our component advertisers should stock the BPX25 phototransistor or its equivalent. This includes the TIL81 and the BPY62 types.

Any relay having a 12V coil with a resistance of about 250 ohms or more, plus suitable contacts of adequate rating, is suitable for this project. The one used here is from the Maplin "Ultra Miniature High Power Mains Relay, code YX97F. This can control currents up to 10A and can be used to control 240V a.c. equipment.

The lenses used in this system do not have to be high quality types. The ones used in the models are the red plastic type sold by Maplin, code FA95D, and have a focal length of 80mm, an overall diameter of 37mm, and a lens diameter of 30mm.

### Treble Booster

The only item that needs to be chosen with care when building the *Treble Booster*, a Free p.c.b. project, is the robust, heavy-duty footswitch. It is difficult to find a s.p.s.t. type and the one used in our model came from Maplin, code FH92A, and is a s.p.d.t. type; the centre tag being the common one. These switches are fairly expensive and advertisers such as Bull Electrical, Greenwold and J&N Factors often have them on "special offer".

Extra printed circuit boards for all this month's and next month's "Multi-PCB" projects are available from the *EPE PCB Service*, code 932 (see page 822).

**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. £45/set Ref F/KE1.

**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/BTC1A/G5.

**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/CV1.

**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. £65/set Ref F/V59.

**PULSED TV JOKER PLANS** Little hand held device utilises pulse techniques that will completely disrupt TV picture and sound works on FM too! DISCRETION ADVISED. £85/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. £85/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 £125/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. £65/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. £65/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. £65/set Ref F/HGA7.

**ANTI DOG FORCE FIELD PLANS** Highly effective circuit produces time variable pulses of acoustical energy that dogs cannot tolerate. £65/set Ref F/DOG2.

**LASER BOUNCE LISTENER SYSTEM PLANS** Allows you to hear sounds from a premises without gaining access. £125/set Ref F/LL1ST1.

**CRAWLING INSECT ROASTER PLANS** Harmless high frequency energy pulses destroy pests as they crawl into the energy field! £45/set Ref F/RCR1.

**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. £65/set Ref F/PS4.

**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. £55/set Ref F/BD1.

**ELECTROMAGNETIC COIL GUN PLANS** Projects a metal object a considerable distance - requires adult.

**ELECTRIC MAN PLANS, SHOCK PEOPLE WITH THE TOUCH OF YOUR HAND!** £55/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. £85/set Ref F/FM5.

**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/TCL4.

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

**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 63-130 Mhz. Works with a common 9v (PP3) battery. 0.2W RF. £7 Ref 1001.

**ELECTRONIC SIREN KIT** Impressive 5 watt power output. Ideal for car/bike alarm etc. 6-12v dc max current 1A, 1.2kHz £6 Ref 1003.

**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 microphone 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 yourself 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.

**MOSQUITO REPELLER KIT** Modern way to keep mosquitoes at bay! Runs for about a month on one 1.5v battery. £7 Ref 1015.

**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.

**MOTORBIKE/CYCLE TREMBLER ALARM KIT** Adjustable sensitivity, preset alarm time, auto reset. Could be connected to horn etc. £12 Ref 1011.

**0-5 MINUTE TIMER KIT** adjustable, will switch up to 2A mains. Perfect for alarms, photography, etc. £7 Ref 1020.

**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.

**ULTRASONIC RADAR KIT** ideal as a movement detector with a range of about 10 metres, automate your car flap! 12v dc. £15 Ref 1049.

**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.

**FUNCTION GENERATOR KIT** Produces sinusoidal, saw tooth and square waves from 20-20khz, separate level controls for each shape. Will produce all 3 together. 24vac. £16 ref 1008.

**3 CHANNEL LIGHT CHASER KIT** 800 watts per channel, speed and direction controls supplied with 12 LEDs (you can fit tracs 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 records etc. adjustable sensitivity. £8 ref 1073.

**INCAR SOUND TO LIGHT KIT** Put some atmosphere in your car with this mini 3 channel sound to light. Each channel has 6 LEDs. £10 ref 1086.

**7W HI FI AMPLIFIER KIT** Useful, powerful, ideal for audio systems, intercoms etc. 12-18vdc £7 ref 1025.

**PHONE CALL RELAY KIT** Useful device that operates a relay whenever the 'phone rings. Switches mains at 2A. £10 ref 1122.

**LEAD ACID CHARGER KIT** Two automatic charging rates, visual indication of battery state, ideal for alarm systems etc, 100mA 12vdc £12 ref 1095.

**CAR ALARM KIT** Works on voltage drop and vibration, entry/exit delays, adjustable alarm duration. Ideal caravans etc £12 ref 1019.

**PORTABLE ALARM KIT** Based on mercury switch, alarm continues to sound until reset by owner. Buzzer inc. £11 ref 1150.

**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.

**SINGLE CHANNEL SOUND TO LIGHT KIT** Mains operated, add rhythm to your party for only £8 ref 1006.

**SOUND EFFECTS GENERATOR KIT** Produces sounds ranging from bird chips to sirens. Complete with speaker, add sound effects to your projects for just £9 ref 1045.

**GUITAR PREAMP KIT** Complete with tone controls, small enough to fit in any guitar, based on TL082 IC. 9-12vdc £8 Ref 1091.

**16 WATT FM TRANSMITTER (BUILT)** 4 stage high power, preamp required 12-18vdc, can use ground plane, yagi or open dipole. £69 ref 1021.

**TELEPHONE AMPLIFIER KIT** Very sensitive amplifier which uses a pickup coil (supplied) will let you follow a conversation with out holding the 'phone. £11 ref 1059.

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

## BULL ELECTRICAL

250 PORTLAND ROAD, HOVE, SUSSEX.  
BN1 5QT. (ESTABLISHED 50 YEARS).

MAIL ORDER TERMS: CASH, PO OR CHEQUE  
WITH ORDER PLUS £3 POST PLUS VAT.  
PLEASE ALLOW 7-10 DAYS FOR DELIVERY PHONE ORDERS  
WELCOME (ACCESS VISA, SWITCH, AMERICAN EXPRESS)

TEL: 01273 203500  
FAX 01273 323077

**HUMIDITY METER KIT** Builds into a precision LCD humidity meter. 9 ic design, pcb, lcd display and all components included. £49  
**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 port, hard drive with min 100K free. £24.99

**DIVING RODS** Expensive technology cannot challenge the fool proof 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 E3.

**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 is possible to make bubbles up to 40 feet long. £11.99 ref E9.

**FM CORDLESS MICROPHONE** This unit is an FM broadcasting station in miniature, 3 transistor transmitter with electret condenser mic+fetamp design results in maximum sensitivity and broad frequency response. 90-105mhz, 50-1500hz, 500 foot range in open country! PP3 battery required. £15.00 ref 15P42A.

**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 G1R/20.

**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 to plate 1,000 sq inches. You will also need a 12v supply, a container and 2 12v light bulbs. £39.99 ref NIK39.

**SHOP WOBBLERS!** Small assemblies designed to take D size batteries and 'wobble' signs about in shops! £3.99 Ref SEP54P2.

**OMRON ELECTRONIC INTERVAL TIMERS.**

\*\*\*\*\*NEW LOW PRICES TO CLEAR!!!!\*\*\*\*\*

**Miniature adjustable timers, 4 pole c/o output 3A 240v,**

HY1230S, 12vDC adjustable from 0-30 secs. £4.99

HY1210M, 12vDC adjustable from 0-10 mins. £4.99

HY1260M, 12vDC adjustable from 0-60 mins. £4.99

HY2460M, 24vAC adjustable from 0-60 mins. £2.99

HY243H, 24vAC adjustable from 0-3 hours. £2.99

HY2401S, 240v adjustable from 0-1 secs. £4.99

HY2405S, 240v adjustable from 0-5 secs. £4.99

HY24060m, 240v adjustable from 0-60 mins. £6.99

**DRINKING BIRD** Remember these? hook onto wine glass (supplied) and they drink, standup, drink, standup ETC! £4 each Ref E1

**SOLAR POWER LAB SPECIAL** You get TWO 6"x6" 6v 130mA solar cells, 4 LEDs, wire, buzzer, switch plus 1 relay or motor. Superb value kit just £5.99 REF: MAG6PB

**BUGGING TAPE RECORDER** Small voice activated recorder, uses micro cassette complete with headphones. £28.99 ref MAR29P1.

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

**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.

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

**INFRA RED REMOTE CONTROLLERS** Originally made for hi spec satellite equipment but perfect for all sorts of remote control projects. Our clearance price is just £2 REF: MAG2

**MAINS CABLE** Precut black 2 core 2 metre lengths ideal for repairs, projects etc. 50 metres for £1.99 ref AUG2P7.

**COMPOSITE VIDEO KIT.** Converts composite video into separate H sync, V sync, and video. 12v DC. £8.00 REF: MAG8P2.

**UNIVERSAL PC POWER SUPPLY** complete with flyleads, switch, fan etc. 200w at £20 REF: MAG20P3 (265x155x125mm).

**GYROSCOPE** About 3" high and an excellent educational toy for all ages! Price with instruction booklet £6 Ref EF15.

**FUTURE PC POWER SUPPLIES** These are 295x135x60mm, 4 drive connectors 1 mother board connector. 150watt, 12v fan, tec inlet and on/off switch. £12 Ref EF6.

**VENUS FLYTRAP KIT** Grow your own carnivorous plant with this simple kit £3 ref EF34.

**TWEETERS** 2" diameter good quality tweeter 140R (ok with the above speaker) 2 for £2 REF: MAG2P5 or 4 for £3 REF: MAG3P4

**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 MAG5P13 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 needles! 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 CATAPULTS** Hinged arm brace for stability, tempered steel yoke, super strength latex power bands. Departure speed of ammunition is in excess of 200 miles 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 G1/E99R

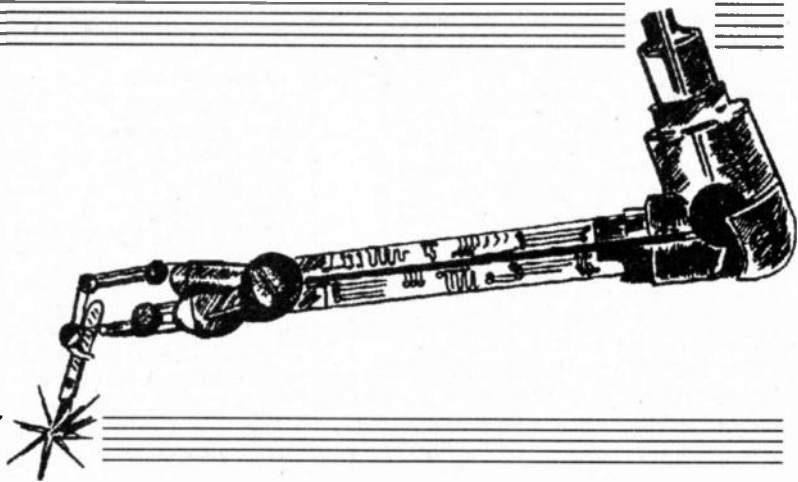
WE BUY SURPLUS STOCK FOR CASH

FREE CATALOGUE

1995 100 PAGE CATALOGUE NOW AVAILABLE, 45P STAMP OR FREE ON REQUEST WITH ORDER.

# CIRCUIT SURGERY

ALAN WINSTANLEY



Welcome aboard to our regular roundup of readers' queries. We look at those mysterious IP numbers describing enclosures, several simple circuits are offered for l.e.d. flashers for cyclists and modelmakers, and we've a brief roundup of major semiconductor sites available on the World Wide Web. We also ask – how do you dispose of used p.c.b. etchant?

LET'S kick off straight away with a question on using heavy duty boxes for projects which are likely to have to withstand some rough treatment.

## Boxing Clever

*My young son and I enjoy metal detecting. However we have succeeded twice in ruining one of my cherished metal detectors – both by severe impact and also by drowning in seawater!*

*This raises the questions of how one may best protect electronic equipment against impact and moisture. Could you help? Kind regards from Rev. Thomas Scarborough, Cape Town 8001, South Africa.*

If you're referring to home-made equipment, then there are several things that can be done when buying parts which will help your project to survive a tough environment. For instance, certain switches (notably larger toggle types) can sometimes be fitted with a specially-made waterproof "boot" over the toggle of the switch, this will completely seal the switch and prevent water entering.

Potentiometers are a bit trickier, but I've seen silicone rubber waterproof seals which fasten down over a standard 1/4in. shaft ("Hexseals" Order Code 146-839, from Farnell Electronic Components Ltd., ☎ 0113 263 6311) and they prevent the ingress of salt water, etc. into the electronics within the casing – but only if the shaft is circular and doesn't have a "flat" all the way down. Miniature hermetically sealed potentiometers with integral control knob can be bought, too. One manufacturer is Vishay (again, distributed by Farnell, Order Code 350-618 et al.).

If your metal detector has a loudspeaker output, then a mylar (polyester) cone type could be used as these, unlike ordinary paper cones, are waterproof. Presenting much more of a problem are components such as jack

sockets, slide switches, meters etc. I don't know of any realistic and reliable way of "weatherproofing" them, and so they represent a potential trouble spot if you decide to dunk your treasure hunter into the briny!

Also consider the use of aerosol spray varnishes to cover printed circuit boards fully, provided that no moving parts are interfered with. Ultimately, plastic embedding compounds can be used to "pot" the entire board and make it completely weatherproof, but impossible to repair into the bargain!

## IP Ratings

By manufacturing them to a tighter tolerance and by using suitable gaskets etc., plastic and metal boxes are available which are specially designed to be

waterproof and dustproof. You'll often see an "IP" Rating for such enclosures given in the more up-market catalogues.

The table below summarises the IP system, as defined in BS EN 60529:1992 *Specification for degrees of protection provided by enclosures*. You'll see that the higher the IP number, the more dust- and waterproof they become (and consequently they become increasingly expensive).

## Shock Proof

A limited degree of entry by water may be allowed under this system, providing the amount is deemed insignificant. An enclosure rated IP65 would probably be adequate for most weather-sensitive applications, or IP67 for extreme conditions – if you can afford it!

Table 1: IP Ratings

Digit	First Digit (Protection against entry by solid objects)	Second Digit (Protection against entry by liquids)
0	Nil protection	Nil protection
1	Protected against solid objects > 50mm diameter	Protected against dripping water
2	Protected against solid objects > 12mm diameter	Protected against spray entry up to 15 degrees from vertical
3	Protected against solid objects > 2.5mm diameter	Protected against spray entry up to 60 degrees from vertical
4	Protected against solid objects > 1.0mm diameter	Protected against water splashing from any direction
5	Limited protection against entry by dust particles	Protected from low pressure water jets
6	Fully protected against dust entry.	Protected against heavy sea spray
7		Protected when immersed between 15cm to 1m depth
8		Protected when fully submerged for long periods.

As far as mechanical shock protection goes, any printed circuit boards which are made of fibreglass can be considered virtually indestructible (not withstanding hole-density weaknesses). Paxolin boards are susceptible to damage and shouldn't really be used in such applications. The same goes for stripboard, which by its very nature, breaks extremely easily. Any large, bulky components which are p.c.b. mounted are best secured down on the board using hot melt glue for instance, to guard against impact and vibration damage.

Obviously, select an enclosure which is strong enough to withstand some abuse. Polystyrene will shatter and isn't suitable, high-impact styrene, polypropylene or ABS (Acrylonitrile Butadiene Styrene) housings are better, otherwise go for an aluminium-alloy diecast type, choosing a suitable IP rating. Also, very many plastics become brittle at low temperatures and are more likely to crack through impact when it's cold.

## Cycle L.E.D. Flasher

John. O. Allen in Navan County, Meath, Ireland, pedalled along with the following question:

"I was wondering if you have a circuit for blinking l.e.d.s, for the rear of push bikes, it's the "in-thing" today. Hope you can help!"

The fact that light emitting diodes (l.e.d.s) are compact and use minimal current means that they've really caught on as flashing beacons for bicycles. Horsersiders use them as well. Red flashers are used for the rear whilst green or yellow l.e.d.s may often be seen facing on-coming traffic.

In the UK, though, it is not yet legal to use these as the main cycle light, but the law is currently under review. The British Standard BS6102 Part 3 – against which current legislation cross refers – does not in its present form allow l.e.d. lamps to be fitted, so they're technically illegal when used as the sole light source.

However, when riding at night, although cyclists must have lamps and reflectors which comply with the Standards, they can fit additional lighting within certain constraints – notably that lights at the front should be white, and red to the rear and technically they should not flash. Nonetheless, flashing lamps are now widely available and UK law is expected to change soon to permit them to be used, says the Bicycle Association. It's up to you whether you decide to use one or not. Personally, I think their merits far outweigh any arguments against.

A suitable bipolar integrated circuit which was specially designed for flashing l.e.d.s efficiently, is the National LM3909. In theory this can drive a 2V l.e.d. just from one 1.5V cell, however I find it more effective to use two batteries.

A suitable "flasher" circuit, using the LM3909, which could be used to supplement existing traditional filament lighting is shown in Fig. 1. Note the low component count, it powers one l.e.d.

I suggest that a high intensity l.e.d. is used, which although superbright has a

## Etchant Disposal – How?

One question which crops up time and again, and which causes concern amongst readers, relates to the safe and proper disposal of ferric chloride etchant. Is there an environmentally-friendly way?

One thing I'd never do is tip it down a kitchen sink or a lavatory. The product stains everything it touches and can ruin domestic kitchen surrounds if splashed or spilt.

Some will say that it should be taken to a rubbish dump – but in my locality at least, local authorities will not accept ferric chloride solution or any other such substances at a household refuse site. A minor dilemma is that it's unrealistic to expect people to travel vast distances to find a properly licensed

chemical waste site, but it's also clearly irresponsible to tip any used etchant onto soil or bury it.

At least one product, the Seno "Etch-In-A-Bag" system includes a neutraliser powder which when added to the etchant, will solidify it and render it harmless. The resulting solid mass can then be thrown away in a dustbin when it will eventually finish up at a landfill site.

One suggestion I've seen somewhere on the Internet is to neutralise the product with caustic or sodium carbonate and mix it with a concrete or mortar mix. The etchant is converted to an immobile form which can safely go to landfill.

Any more views? Write in!

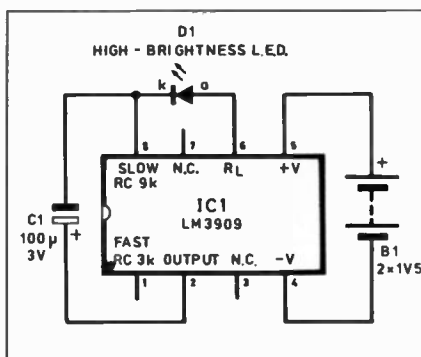


Fig. 1. Circuit diagram for a single L.E.D. Flasher, with low component count.

relatively narrow viewing angle which could perhaps be enhanced with the use of l.e.d. reflectors. I can point readers in the direction of ElectroValue Ltd. (☎ 01784 442253) who uniquely list in their catalogue, 12mm diameter plastic reflectors which push-fit onto 3mm and 5mm devices.

How multiple light emitting diodes could be driven from one chip, still using the LM3909, is given in the circuit diagram of Fig. 2. Try the circuit with one or two 1.5V cells, and experiment with the component values.

One point to observe is the use of individual series resistors with each l.e.d. This may seem over-elaborate, but there is a reason: light-emitting diodes each have a forward voltage ( $V_f$ , typically 1.8V) which may differ from that of its neighbours.

If one l.e.d. has an unusually low forward voltage, it would shunt all the other l.e.d.s. which would then all be dimmed undesirably. Using a series

resistor enables each l.e.d. to "settle" to its own inherent forward voltage, any error voltage appearing across the resistor – so none of the l.e.d.s. forward voltages will affect the performance of any of the others.

The intensity of l.e.d.s is measured in mcd's – milliCandelas. Ordinary l.e.d.s may have an intensity of just a few mcds, but superbright high intensity lamps are made, notably by Hewlett Packard, which output several Candelas (2000 – 3000 mcds).

The down-side is that the viewing angle of high brightness types may be restricted to just a few degrees. Check through the current crop of catalogues and compare specifications (and price!).

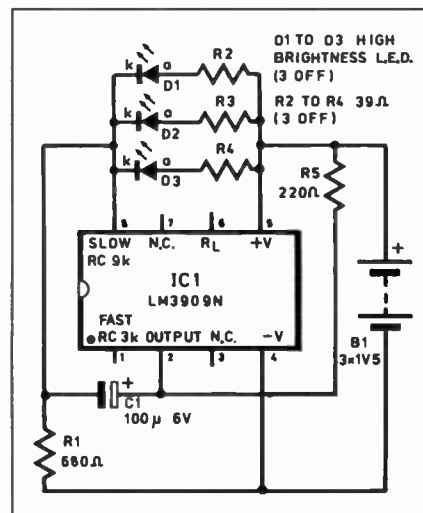


Fig. 2. Circuit diagram for driving multiple l.e.d.s from a single LM3909 "flasher" chip.

**HAVE YOU BOOKED YOUR PLACE  
FOR OUR NEW TEACH-IN'96 COURSE?  
– See page 743**

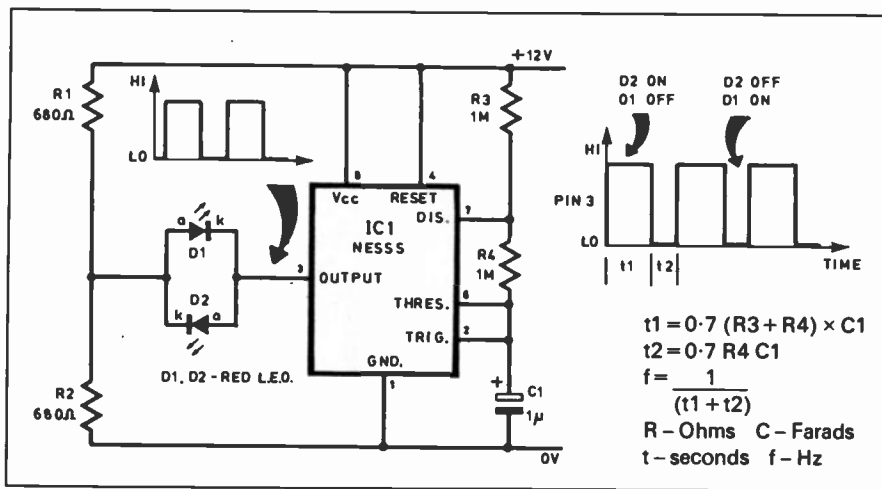


Fig. 3. Circuit diagram of an L.E.D. Flasher, suitable for 12V operation. The timing formulae are also shown.

## Aerial Combat

A couple of questions more on l.e.d. flasher circuits. One from **Mr. T. J. Angell** of Cwmaman, Mid Glamorgan:

*"I hope you can help me with what must be a very simple device! How can I make two l.e.d.s. flash alternately at about one cycle per second (not critical) using a 12V supply?"*

Also from **Philip Wheeler** of Sandstead, Surrey (via CompuServe):

*"At a model show I recently attended, I saw an interesting electronics circuit to simulate 'guns' on an aircraft. It used two ultrabright red l.e.d.s. for each wing. They flashed at a rate of about 3Hz to 4Hz to simulate automatic fire, and were activated by a servomotor. Could you help with a circuit?"*

Probably the easiest way is to use an ordinary 555 timer chip, connected as an astable multivibrator. In the case of Mr. Angell's requirement for an alternating flasher, in Fig. 3 the output section is slightly unusual in that the square wave output toggles between high and low which causes the appropriate l.e.d.s. to illuminate alternately although it's impossible to obtain a perfect 1:1 mark:space ratio. This will function from 12V d.c. without any problem. I've also shown the formulae for calculating the timing.

To fit the modelmaker's application, Fig. 4 is suggested. I'm not sure how tight space will be, the circuit will run from 4.5V upwards, so I suggest a supply of 9V d.c. derived from a PP3 battery. A small lever-operated microswitch could be used for S1 which could be closed by a servo cam. I'll leave the aerospace mechanics up to you!

The maximum output of the bipolar NE555V is 200mA – twice that of the CMOS version whose output tends to fall when the output current rises. The downside is that the NE555V draws a higher quiescent current – but I think an alkaline battery (e.g. MN1604) would be fine, otherwise you may be able to use the aircraft's existing supply.

## Semiconductor WWW Sites

Finishing with what's happening on the Internet, many semiconductor manufacturers now have their own presence on the World Wide Web, and some of them let you gain access to product information and data sheets on-line. For example, you could try:

Harris Semiconductor:  
<http://www.harris.com> (under construction; or try [www.semi.harris.com/datasheets](http://www.semi.harris.com/datasheets))  
 Intel: <http://www.intel.com>  
 Motorola: <http://www.motorola.com>

National Semiconductor:  
<http://www.nsc.com:8080/ds/ds.html>

Philips Semiconductors:  
<http://www.semiconductors.philips.com/ps/>

Texas Instruments: <http://www.ti.com>  
 The URL's (Universal Resource Locator) shown above were accurate at the time of writing. Be warned that some Data Sheets, when available, may only be available in Adobe or Postscript format – the Harris WWW site looks like it will give you Adobe Acrobat (1.5Mb), free of charge, but I haven't tried it. If anyone knows of any other interesting sites, either WWW or vanilla ftp, please Email me and I'll share them with everyone!

One topical site which did catch my eye – anyone who has built our *Simple Theremin* project will be interested in the Theremin Home Page maintained by Vanderbilt University School of Engineering, Nashville, Tennessee: <http://www.vuse.vanderbilt.edu/~jbbareil/wwwfiles/theremin.html>

This American World Wide Web page is dedicated to the inventor of the Theremin, its use and construction. It gives a history of the invention plus a list of bands using the Theremin, and more!

Finally – for all budding scientists, try the URL

<http://www.eskimo.com/~billb/ama-sci.html> which is a link to the American "Information for the Science Hobbyist" Home Page. Must see, lots of really cool and exciting things to do and see! (It says here.)

## Education Service

It's that time again! *Our Circuit Surgery Education Service* is designed to support the teaching of GCSE and Advanced Level electronics, helping teachers as well as students. If you have any particular questions, feel free to drop us a line and we'll do our best to help!

Please *don't* ask us for circuit diagrams for your chosen project – we won't do it! But we'll be happy to offer pointers, advice and subtle tips wherever possible, especially if you're stuck with your current project work or would like another opinion. *If you do not wish your query to be published, please state this clearly.*

## Two-way Clinic

*Circuit Surgery* is our "two-way" page devoted to helping readers with questions and queries, and generally passing on hot hints and tips. If you have any topical comments or puzzling problems in the field of hobby or educational electronics which you'd like us to investigate, please write to: Alan Winstanley, Circuit Surgery, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. Email [alan@epemag.demon.co.uk](mailto:alan@epemag.demon.co.uk).

We can't guarantee an individual reply unless we intend to use it in the column, but you'll find we'll generally come up with something! Next month is the turn of *Ingenuity Unlimited* once again – see you soon.

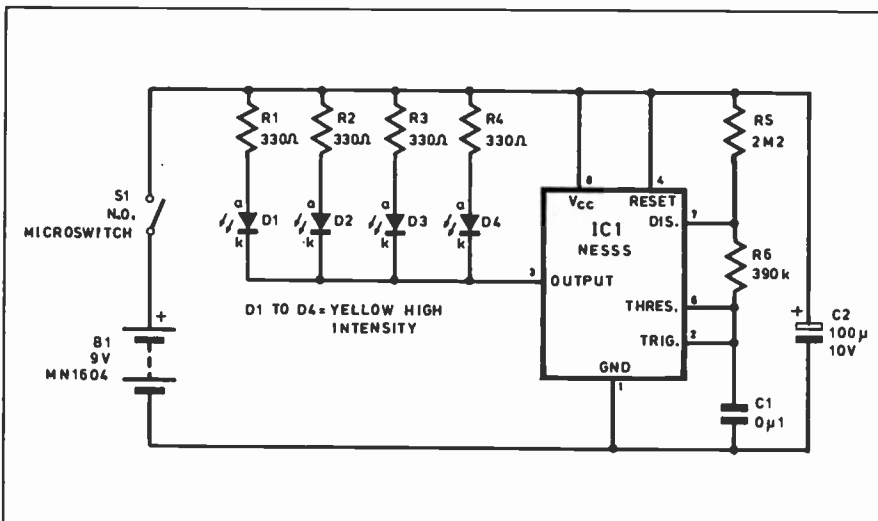


Fig. 4. Experimental circuit diagram for producing an imitation machine-gun effect for model aircraft.



# PCB Designer

For Windows 3.1

Runs on any PC running Windows 3.1 in standard or enhanced mode with 2MB RAM  
Will work with any Windows supported printer and monitor

PCB Designer - [c:\pcb\sample1.pcb]

File Edit Board Text Snap Window Help

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.

- ✓ 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.

Internet  
A working demo is available via anonymous FTP from  
ftp.demon.co.uk as /pub/ibmpc/windows/pcbdemo/pcbdemo.zip  
e-mail enquiries can be addressed to orders@niche.demon.co.uk

Niche Software (UK)  
22 Tavistock Drive, Belmont, Hereford, HR2 7XN  
Phone (01432) 355 414

X: 1.000 Y: 0.000

VISA

## VARIABLE VOLTAGE TRANSFORMERS

INPUT 220V/240V AC 50/60 OUTPUT 0V-260V	Price	P&P
0.5KVA 2.5 amp max	£31.90	£6.00
	(£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	£78.85	£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 transfer 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 £4.90 + 75p p&p	(£6.52 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 £8.05 + £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 (£62.28 inc VAT)

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

VISA  
Ample Parking Space

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 3TH8022-0B 2 x NO and 2 x NC 230V AC 10A. Contacts Screw or Din Rail fixing. Size H 120 x W 45 x D 75mm. Brand New. Price £7.83 incl. P&P and VAT.

240V AC WESTOOL SOLENOIDS  
TT2 Mod. 1 Rat. 1 Max. stroke 1/2 in. Base mounting 1/2 in. stroke 5lbs pull approx. TT6 Mod. 1 Rat. 1 Max. stroke 1 in. Base mounting 1/2 in. stroke 15lbs pull approx. SERIES 400 Mod. 1 Rat. 2 Max. stroke 1/2 in. Front mounting 1/2 in. 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 £7.25 incl. P&P and VAT.  
Other voltages and sizes available from stock. Please telephone your enquiries.

240V AC CENTRIFUGAL BLOWER  
New Manuf. Surplus Skeleton Blower suitable for mounting inside an enclosure to cool equipment. Overall size 130 x 110 x 85mm. Outlet 80 x 35mm. Impeller 60mm dia. x 60mm long. Price £14.10 inc p&p & VAT.

SEWING MACHINE MOTOR  
Brand new 220V/240V AC/DC SEW-TRIC 2 lead Brush Motor. Size L 100mm x H 70mm x W. 65mm. Spindle 1/2 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 Argon Tube Ballast unit, pair of bi-pin 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 1/2 in. outlet 1 in. dia. Price includes p&p & VAT. £11.20 each or 2 for £20.50 inclusive.

## 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.

## TEST EQUIPMENT SPECIAL OFFER

10MHz Function Generator (offer valid while stocks lasts)

- Δ Sine, square, triangle, pulse & sawtooth
- Δ 20mV to 20Vpp output
- Δ 50Ω and TTL outputs
- Δ Frequency modulation & sweep
- Δ Pulse width modulation
- Δ Supplied with carrying case

H6000 0.1Hz - 10MHz £192.64 £129.00

All equipment is supplied new, complete with mains lead, operating manual and 1 year guarantee. Prices include VAT and free delivery, phone for complete list.

H1001	Continuity tester inc probes & carry case	£23.00	£ 9.99
MX210T	3 1/2 multimeter V,I,R, inc probes & case	£29.00	£ 12.00
MX501	3 1/2 multimeter V,I,R, diode, probes & holster	£6.54	£ 29.00
MX250	3 1/2 multimeter V,I,R, Cap, °C, Hfe, inc probes	£6.68	£ 55.00
H2001	2MHz bench pulse generator inc carry case	£133.89	£ 69.00
H3001	Digital storage adapter, use on any scope	£251.40	£119.00
MX2020	2MHz sweep function gen, 4 dig counter	£233.83	£139.00

VANN DRAPER ELECTRONICS LTD. Tel (0116) 2813091 Fax (0116) 2570893  
Alexander House, Bampton Close, Wigston, Leicester. LE18 2RZ

## £1 BARGAIN PACKS

### - List 1

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

- 1 x 12V Stepper Motor, 7.5 degree. Order Ref: 910.
- 1 x 10 pack Screwdrivers. Order Ref: 909.
- 2 x 5 amp Pull Cord Ceiling Switches. Brown. Order Ref: 921.
- 5 x reels Insulation Tape. Order Ref: 911.
- 4 x 14mm Bulb-races. Order Ref: 912.
- 2 x Cord Grip Switch Lamp Holders. Order Ref: 913.
- 1 x DC Voltage Reducer, 12V-6V. Order Ref: 916.
- 1 x 10 amp 40V Bridge Rectifier. Order Ref: 889.
- Lightweight Stereo Headphones. Moving coil so superior sound. Order Ref: 896.
- 2 x 25W Crossovers. For 4ohm loudspeakers. Order Ref: 22.
- 2 x NiCad Constant Current Chargers. Easily adaptable to charge almost any NiCad battery. Order Ref: 30.
- 16V-0-16V 10VA mains transformer. Order Ref: 813.
- 2 x White Plastic Boxes. With lids, approx. 3" cube. Lid has square hole through the centre so these are ideal for light operated switch. Order Ref: 132.
- 2 x Reed Relay Kits. You get 8 reed switches and 2 coil sets. Order Ref: 148.
- 12V-0-12V 6VA mains transformer, p.c.b. mounting. Order Ref: 938.
- 1 x Big Pull Solenoid. Mains operated. Has 1/2" pull. Order Ref: 871.
- 1 x Big Push Solenoid. Mains operated. Has 1/2" push. Order Ref: 872.
- 1 x Mini Mono Amp. 3W into 4 ohm speaker or 1W into 8 ohm. Order Ref: 495.
- 1 x Mini Stereo 1W Amp. Order Ref: 870.
- 15V DC 150mA p.s.u., nicely cased. Order Ref: 942.
- 1 x In-Flight Stereo Unit is a stereo amp. Has two most useful mini moving coil speakers. Made for BOAC passengers. Order Ref: 29.
- 1 x 0-1mA Panel Meter. Full vision fact 70mm square. Scaled 0-100. Order Ref: 756.
- 2 x Lithium Batteries. 2.5V penlight size. Order Ref: 874.
- 2 x 3m Telephone Leads. With BT flat plug. Ideal for 'phone extensions, fax, etc. Order Ref: 552.
- 1 x 12V Solenoid. Has good 1/2" pull or could push if modified. Order Ref: 232.
- 4 x In-Flex Switches. With neon on/off lights, saves leaving things switched on. Order Ref: 7.
- 2 x 6V 1A Mains Transformers. Upright mounting with fixing clamps. Order Ref: 9.
- 2 x Humidity Switches. As the air becomes damper, the membrane stretches and operates a micro switch. Order Ref: 32.
- 5 x 13A Rocker Switch. Three tags so on/off, or changeover with centre off. Order Ref: 42.
- Mini Cassette Motor, 9V. Order Ref: 944.
- 1 x Suck or Blow-Operated Pressure Switch. Or it can be operated by any low pressure variation such as water level in tanks. Order Ref: 67.
- 1 x 6V 750mA Power Supply. Nicely cased with mains input and 6V output lead. Order Ref: 103A.
- 2 x Stripper Boards. Each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc. Order Ref: 120.
- 12 Very Fine Drills. For PCB boards etc. Normal cost about 80p each. Order Ref: 128.
- 5 x Motors for Model Aeroplanes. Spin to start so needs no switch. Order Ref: 134.
- 6 x Microphone Inserts. Magnetic 400 ohm, also act as speakers. Order Ref: 139.
- 6 x Neon Indicators. In panel mounting holders with lens. Order Ref: 180.
- 1 x In-Flex Solderstat. Keeps your soldering iron etc always at the ready. Order Ref: 196.
- 1 x Mains Solenoid. Very Powerful as 1/2" pull, or could push if modified. Order Ref: 199.
- 1 x Electric Clock. Mains operated. Put this in a box and you need never be late. Order Ref: 211.
- 4 x 12V Alarms. Makes a noise about as loud as a car horn. All brand new. Order Ref: 221.
- 2 x (6" x 4") Speakers. 16 ohm 5 watts, so can be joined in parallel to make a high wattage column. Order Ref: 243.
- 1 x Panostat. Controls output of boiling ring from simmer up to boil. Order Ref: 252.
- 2 x Oblong Push Switches. For bell or chimes, these can switch mains up to 5A so could be foot switch if fitted in patters. Order Ref: 263.
- 50 x Mixed Silicon Diodes. Order Ref: 293.
- 1 x 6 Digit Mains Operated Counter. Standard size but counts in even numbers. Order Ref: 28.
- 2 x 6V Operated Reed Relays. One normally on, other normally closed. Order Ref: 48.
- 1 x Cabinet Lock. With two keys. Order Ref: 55.
- 6 1/2 x 8 1/2 Watt Speaker. Order Ref: 824.
- 1 x Shaded Pole Mains Motor. 3/4" stack, so quite powerful. Order Ref: 85.
- 2 x 5 Aluminium Fan Blades. Could be fitted to the above motor. Order Ref: 86.
- 1 x Case, 3 1/2 x 2 1/4 x 1 1/4 with 13A socket pins. Order Ref: 845.
- 2 x Cases. 2 1/2 x 2 1/4 x 1 1/4 with 13A pins. Order Ref: 565.
- 4 x Luminous Rocker Switches. 10A mains. Order Ref: 793.
- 4 x Different Standard V3 Micro Switches. Order Ref: 340.
- 4 x Different Sub Min Micro Switches. Order Ref: 313.

## £1.50 BARGAIN PACKS

- NICAD BATTERY 3.8V with PCB mounting prongs, Order Ref: 1.5P2.
- 8 DIGIT COUNTER 12V. Order Ref: 1.5P3.
- PAIR OF ULTRASONIC MODULES, one sender, one receiver, Order Ref: 1.5P4.
- 100 CORE CABLE, any length, Order Ref: 1.5P6 per metre.
- KEY SWITCH, 2 position, complete with 2 Yale type keys, Order Ref: 1.5P12.
- CASSETTE MOTOR, 9V brushless, Order Ref: 1.5P14.
- 80 OHM COAX TV CABLE, extra thin, 10m, Order Ref: 1.5P17.
- WATERPROOF SPEAKER, 3 1/2in. round, 8 Ohm 11W, Order Ref: 1.5P27.
- 6V 1A ENCASED POWER SUPPLY with input and output leads, Order Ref: 1.5P22.
- FLUORESCENT CHOKE for 60W or 80W tube, Order Ref: 1.5P23.
- MAINS TRANSFORMER, totally enclosed, 12V 1/2A, Order Ref: 1.5P25.
- 3" TWEETER 15W 8 Ohms, Order Ref: 1.5P28.
- 13A SWITCH SOCKET, white, Order Ref: 1.5P29.
- RELAY, flash proof, 12V coil, SPCC, Order Ref: 1.5P31.
- ENCASED PSU, twin outputs, 15V 850mA and 9V 550mA, both A.C. output, Order Ref: 1.5P32.
- 12V MOTOR, mini but quite powerful, 32mm diameter, 25mm long, Order Ref: 1.5P33.

## £2 BARGAIN PACKS

- 20W TWEETER 4" x 4" 8 Ohm by Goodmans, Order Ref: 2P403.
- MOVING COIL CHARGE METER, 0-3A, Order Ref: 2P366.
- LIGHT-OPERATED SWITCH, kit of parts, Order Ref: 2P369.
- W-SHAPED 30W FLUORESCENT TUBE by Philips. Ideal name plate illuminator, Order Ref: 2P372.
- DIMMER SWITCH, standard size plate, colours - red, yellow, green, blue, Order Ref: 2P380.
- TOROIDAL TRANSFORMER 7V 5A, Order Ref: 2P390.
- TELEPHONE EXTENSION LEAD, flat plug one end, socket the other, 12m, Order Ref: 2P338.
- INTERNAL TELEPHONE EXTENSION, 4-core cable, 25m, Order Ref: 2P339.
- FIGURE-8 FLEX, insulated to mains voltage, 50m, Order Ref: 2P345.
- INFRARED RECEIVER, has fitted TV receiver, Order Ref: 2P304.
- LCD CLOCK MODULE with details on other uses, Order Ref: 2P307.
- AM/FM RADIO RECEIVER with speaker and dial but not cased, Order Ref: 2P308.
- 12V 200mA PSU on 13A base, Order Ref: 2P313.
- 2A MAINS FILTER AND PEAK SUPPRESSOR, Order Ref: 2P315.
- 45A DP 250V SWITCH on 8" x 3" gold plate, Order Ref: 2P318.
- ILLUMINOUS PANEL, 18 x 6V bulbs to light cool effect electric heater, etc, Order Ref: 2P317.
- D.C. VOLT REDUCER, 12V-6V, fits into car lighter socket, Order Ref: 2P318.
- SOLAR CELL 3V, five of these in series would make you a 12V battery charger, £2 each, Order Ref: 2P374.
- PERMANENT MAGNET SOLENOID, opposite action, core is released when voltage is applied, Order Ref: 2P327.
- HEATER PAD, not waterproof, Order Ref: 2P329.
- DISK DRIVE, complete less stepper motor, has all the electronics to control stepper motor, Order Ref: 2P280.
- 15V 320mA A.C. POWER SUPPLY, in case with 13A base, ideal for bell or chime controller, Order Ref: 2P281.
- VERY POWERFUL MAGNETIC BASE on circular metal plate, Order Ref: 2P286.
- 20M 80 OHM TV COAX, Order Ref: 2P270.
- LOCTITE METAL ADHESIVE, tube and some accessories, Order Ref: 2P215.
- 6-DIGIT COUNTER, mains operated, Order Ref: 2P235.
- TWIN 150pF TUNER, air spaced with 1/4in. spindle, Order Ref: 2P237.
- 2-GANG 0-0005 TUNING CAPACITOR, standard size, made by Jacksons, Order Ref: 2P240.
- 13A ADAPTORS, takes two 13A plugs, pack of 5 - £2, Order Ref: 2P187.
- 3-CORE 5A PVC FLEX, 15m, Order Ref: 2P189.
- MAINS TRANSFORMER, 15V 1A, Order Ref: 2P198.
- FLIP-OVER CLOCK, mains operated, only requires a simple case, Order Ref: 2P205.
- THERMOSTAT with calibrated knob, oven temperatures, Order Ref: 2P158.
- 7-SEGMENT NEON DISPLAYS, pack of 8, Order Ref: 2P126.
- MODERN TELEPHONE HANDSET, ideal office extension, Order Ref: 2P94.
- 13A SWITCH SOCKET on satin chrome plate, Order Ref: 2P95.
- 500 STAPLES, hardened pin, suit burglar alarm or telephone wire, Order Ref: 2P99.
- TIME AND SET SWITCH 15A mains, Order Ref: 2P104.
- PAD SWITCH for under carpets, Order Ref: 2P119.
- 6 1/2" FAN AND MAINS MOTOR, Order Ref: 2P64.
- MUFFIN FAN 115V, ex-computer, Order Ref: 2P72.
- 24V STEREO POWER SUPPLY, Mullard, Order Ref: 2P80.
- UP TO 90 MIN 25A SWITCH, clockwork, Order Ref: 2P90.
- UNI-SELECTOR, 25-way, 3-pole, Order Ref: 2P53.
- POWERFUL MAINS MOTOR, 1 1/2" stack, double spindle, Order Ref: 2P55.
- POWER SUPPLY FOR MODELS, 6-12V variable and reversible, Order Ref: 2P3.
- MAINS TO 115V AUTO TRANSFORMER 100W, ex-GPO, Order Ref: 2P6.
- MAINS TIME AND SET SWITCH 25A, up to 9 hours delay, Order Ref: 2P9.
- MOTORISED 6 MICRO SWITCHES but motor 50V AC, Order Ref: 2P19.
- TWIN EXTENSION LEAD, ideal lead lamp, Black & Decker tools, etc, 20m, Order Ref: 2P20.
- UP TO 12 HOUR CLOCKWORK 25A SWITCH, Order Ref: 2P24.
- MAINS COUNTER, resettable, 3 digit, Order Ref: 2P26.

## £3.50 BARGAIN PACKS

- SOLAR CELL 1A, Order Ref: 3.5P2.
- CIRCUIT BREAKER 5A, Order Ref: 3.5P3.
- AM/FM CHASSIS with LCD time, date and alarm display, Order Ref: 3.5P5.
- 12V-0V-12V 40W MAINS TRANSFORMER, Order Ref: 3.5P7.

## £3 BARGAIN PACKS

- MAINS SUPPRESSOR/FILTER, 25A, Order Ref: 3P13.
- MAINS TRANSFORMER, 36V 3A, Order Ref: 3P14.
- SIGNAL BOX, 3 pilot lamps in white metal case, Order Ref: 3P16.
- 120W CHOKE, 8ft tube, Order Ref: 3P17.
- 0-5A PANEL METER, ex-W.D. equipment, Order Ref: 3P20.
- KEYBOARD intended for OPD computer, Order Ref: 3P27.
- SOLAR CELL, 750mA, Order Ref: 3P42.
- PROJECT BOX with lid, 165 x 119 x 75mm, Order Ref: 3P49.
- INSTRUMENT TYPE MAINS INPUT SOCKET with built-in filter, Order Ref: 3P50.
- 6-CORE 5A FLEX, 12m, Order Ref: 3P54.
- 20V 3A MAINS TRANSFORMER, Order Ref: 3P58.
- 1/2 RPM 2W MOTOR, Order Ref: 3P64.
- METAL PROJECT BOX, size 8 x 4 1/2 x 4", made for GPO, Order Ref: 3P74.
- THIN CONNECTING WIRE, 2-cores twisted together, full length 500m, Order Ref: 3P78.
- 12V 1A PSU, filtered and regulated on PCB with relays and Piezo sounder, Order Ref: 3P80.
- HORN SPEAKER, 8 Ohm, size 4 1/2", Order Ref: 3P82.
- 20A TIME SWITCH, ex-electricity board, Order Ref: 3P84.
- ABS PROJECT BOX, 145 x 95 x 58mm, Order Ref: 3P85.
- HEAT AND LIGHT LAMP BC 250W, Order Ref: 3P86.
- 16-IN-ONE TOOL KIT, Order Ref: 3P100.
- RAINBOW PIANO with tune chart, Order Ref: 3P101.
- BT INSULATION TESTER, faulty but should be repairable. Supplied with circuit diagram, Order Ref: 3P103.
- MODERN TELEPHONE HANDSET without dial, cream, Order Ref: 3P104.
- 20V 4A MAINS TRANSFORMER, Order Ref: 3P106.
- 40V 2A MAINS TRANSFORMER, Order Ref: 3P107.
- 3-CORE 20A FLEX, 10m, Order Ref: 3P109.
- 2-CORE 20A FLEX, 15m, Order Ref: 3P110.
- QUARTZ CLOCK MOVEMENT with 2 sets of hands, modern and period, Order Ref: 3P111.
- 20W LOUDSPEAKER, 5" 4 Ohm by Goodmans, Order Ref: 3P145.
- 0V-80V PANEL METER, Order Ref: 3P147.
- CUPBOARD DOOR ALARM, Order Ref: 3P155.
- WATER LEVEL ALARM, fully adjustable, Order Ref: 3P156.
- HEAVY DUTY MAINS MOTOR with 2 1/2" spindle each side, Order Ref: 3P157.
- RESETTABLE 6-DIGIT 12V COUNTER, Order Ref: 3P158.
- 0V-10V PANEL METER, Order Ref: 3P159.
- 8FT MINERAL FILLED METAL CLAD 1000W ELEMENT, Order Ref: 3P161.
- TIME AND SET SWITCH for mains at 30A, Order Ref: 3P164.
- 25A 3-CORE FLEX, 10m, Order Ref: 3P166.
- AMSTRAD 8" 15W WOODER, Order Ref: 3P167.
- 12V BRUSHLESS FAN mounted in frame with its own drive circuit, Order Ref: 3P168.
- SOLENOID AIR VALVE 110V, Order Ref: 3P178.
- TRANSFORMER AND RECTIFIER for 12V charger, Order Ref: 3P188.
- 12V 3A MAINS TRANSFORMER, Order Ref: 3P181.
- WALL MOUNTING MAINS THERMOSTAT, Order Ref: 3P182.
- 5" 8 OHM SPEAKER IN WOODEN CABINET, Order Ref: 3P183.
- MULTI CORE VIDEO LEAD with end plugs, Order Ref: 3P187.
- D.C. PANEL METER, 0V-20V, Order Ref: 3P189.
- 15uF 440V A.C. CAPACITOR, Order Ref: 3P190.
- 20uF 440V A.C. CAPACITOR, Order Ref: 3P191.
- 25uF 370V A.C. CAPACITOR, Order Ref: 3P192.
- MINI STEPPER MOTOR, 1.5 degree steps, Order Ref: 3P193.
- MAINS OPERATED WATER VALVE, suit high or low pressure, Order Ref: 3P192.
- PANEL METER, 0V-100V D.C., Order Ref: 3P194.
- AMSTRAD AMPLIFIER, ref no. not known, is stereo and has 10 LED's on front panel, Order Ref: 3P195.
- 14uF 400V A.C. CAPACITOR, Order Ref: 3P199.
- HALOGEN LAMP 12V 20W, Order Ref: 3P200.

## £4 BARGAIN PACKS

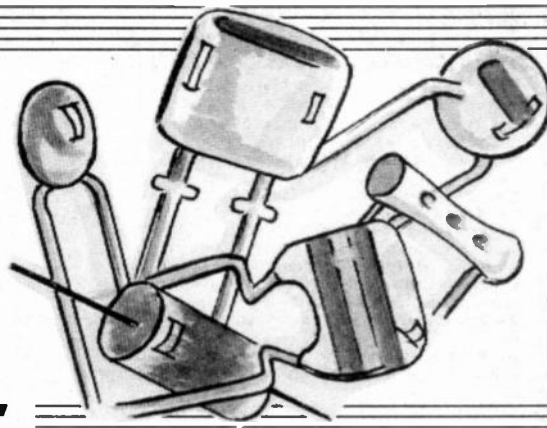
- MOTORISTS LEAD LAMP, hand grip plastic body, glass lamp cover and heavy duty wire shield with hanging bracket, Order Ref: 4P31.
- ABS BOX with lid, size 220 x 150 x 64mm, Order Ref: 4P8.
- 120W TRANSFORMER 40V at 3A output, Order Ref: 4P15.
- 100W TRANSFORMER, main winding 30V at 3 1/2A, secondary winding 20V-0V-20V at 1A, Order Ref: 4P24.
- PANEL METER 0-100uA, 100 x 100mm, complete with glass front but less case, Order Ref: 4P32.
- DITTO but 100-0-100uA, Order Ref: 4P32A.
- 80W TRANSFORMER 20V-0V-20V with one winding tapped at 16V, Order Ref: 4P36.
- AMSTRAD 8" 15W SPEAKER with matching tweeter, 8 Ohm, Order Ref: 4P57.
- FAN 12V by Jap Nipon, body size 93 x 93mm, Order Ref: 4P65.
- STRIPPER BOARD with lots of IC's, all plug-in, ex-Sentinel phone control unit, Order Ref: 4P67.
- AM/FM RADIO, nicely cased with clip for attaching to cycle, Order Ref: 4P72.
- VENNER TIME SWITCH, 24hr, day length controller, ex-electricity board, Order Ref: 4P74.
- EMI 2-SPEED MOTOR 100 and 500rpm, reversible, Order Ref: 4P80.
- LARGE PANEL METER, scaled 20-0-40A but needs a shunt, Order Ref: 4P91.
- 2-PART METAL CASE, ideal car battery charger, etc, Order Ref: 4P89.
- JAPANESE PRECISION MADE MOTOR, reversible, 1500rpm, Order Ref: 4P94.

The above prices include VAT but please add £3 towards our packing and carriage if your order is under £25. Send P.O. or cheque or phone and quote credit card number.

## J & N FACTORS

Pilgrim Works (Dept. E.E.)  
Stairbridge Lane, Bolney,  
Sussex RH17 5PA

Telephone: 01444 881965  
(Also fax but phone first)



# CAPACITOR CHECK

**TERRY de VAUX-BALBIRNIE**

*A cheap and cheerful capacitance "meter" that will measure values from less than 10nF to 5000µF with an accuracy good enough to confirm the nearest standard value of an "unknown" capacitor.*

**T**HERE is often a need to measure or confirm the value of an "unknown" capacitor or one on which the lettering has become obscured. Also, certain components of dubious origin appear to have non-standard markings and this makes them difficult to match up if ever they need to be replaced.

The more up-market digital multimeters are able to measure capacitance in addition to having the familiar voltage, current and resistance ranges. Owning such an instrument is fine where capacitor values need to be measured frequently. However, the "hobby" type of multimeter which many amateurs use is not capable of measuring capacitance and there is no point in buying an expensive instrument when this facility would only be used occasionally.

## CAPACITOR CHECK

The Capacitor Check to be described is probably the simplest which can be constructed that will find the value of a capacitor with reasonable accuracy. It will measure values from less than 10nF up to 5,000µF with an accuracy good enough to determine the nearest standard value of an "unknown" component.

There are twelve ranges: 10nF; 50nF; 100nF; 500nF etc. up to 5000µF. There is also a test facility which may be used to check that the unit is working correctly and that the battery is in good condition.

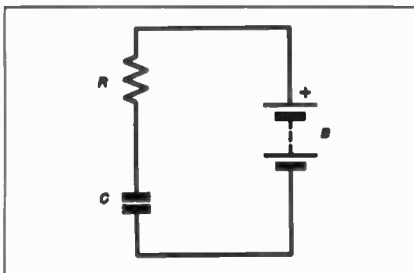


Fig. 1. Charging a capacitor (C) from a battery (B) through a resistor (R).

The cost of construction could be minimised by using any plastic box of suitable size instead of the more expensive sloping-front instrument case used in the prototype (see photograph).

## TIME CONSTANT

The principle upon which the Capacitor Check circuit works is that of *time constant* and since some readers will not be too familiar with this concept, a short description follows.

When an initially uncharged capacitor (C) charges from a battery (B) through a resistor (R), it takes a certain time to do so - see Fig. 1. The charging pattern obtained when a 1µF capacitor charges through a 1MΩ (megohm) resistor from a 9V battery is shown in Fig. 2.

Here, the voltage across the capacitor is measured as time passes. The time taken depends on the values of C and R - the higher they are, the longer it takes. Thus, the time taken to charge will be greater if either C or R is increased or, of course, if both are raised in value.

If the voltage of the supply is different, the time scale will be the same, the line simply approaches whatever the supply voltage happens to be. It will be seen that the voltage rises quickly at first but reduces its rate of increase as time passes.

Note that the voltage across the capacitor is proportional to the charge stored and may therefore be used to represent it. In Fig. 2, when the voltage reaches 4.5V the charge will be 50 per cent of maximum (shown by the dotted lines).

## MOVE CLOSER

The voltage across a charging capacitor will never reach that of the supply but

simply approach it more closely as time goes by. It therefore makes little sense to talk about the time taken to fully charge a capacitor.

A more useful concept is to relate the time to some fraction of the maximum charge. In practice, this fraction is taken to be about 0.63 or 63 per cent - a figure following from some rather deep maths.

The time taken for the voltage across the capacitor to reach this figure (5.7V on a 9V supply) is called the *time constant* and, in the example, is one second. This is marked "1 TC" in Fig. 2.

The rather strange figure in the definition of time constant comes about because it provides a convenient link with the values of

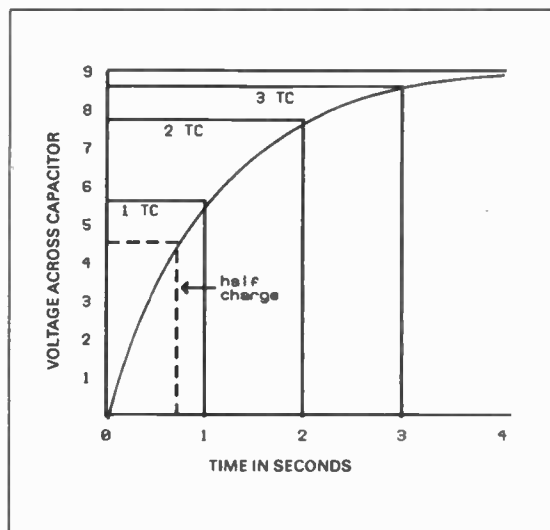


Fig. 2. Charging graph using a 1µF capacitor through a one megohm resistor from a 9V battery.

C and R. The time constant may be calculated by multiplying these together - i.e.

$$T = CR$$

where T is the time constant in seconds, C is the value of the capacitor (in Farads) and R is the value of the resistor through which it charges (in ohms).

The 1µF capacitor charging through a 1MΩ resistor will therefore provide a time constant of one second, which is shown in Fig. 2. There is therefore no need to go to the trouble of taking measurements and drawing a graph to determine the time constant.

When one time constant is reached, there will be 37 per cent of charge still to be delivered. During the next time constant, this will be topped up by 63 per cent of itself. Since 37% of 63% gives a further 23

per cent, and since there is already 63% of the total charge held by the capacitor, the percentage of supply voltage appearing across the capacitor after two time constants will be 86 per cent. For a 9V supply this corresponds to about 7.7V (marked "2 TC" in Fig. 2).

After three time constants, the 14% of charge still to be given is itself topped up by 63% giving a total of almost 95 per cent or about 8.5V (marked "3 TC"). Many electronic engineers use the three time constants criterion to regard a capacitor as "fully charged".

This circuit works by measuring the time taken for a capacitor to charge by two time constants i.e. to the 86 per cent level through a resistor of known value. The time taken to do this is  $2CR$  and, by measuring this time, the capacitance may be found.

## CIRCUIT DESCRIPTION

The complete circuit for the Capacitor Check is shown in Fig. 3. Switch S4 performs the on-off function. Light emitting diode D4 is an On/Off indicator with resistor R10 limiting the operating current. Switch S2 is used to select "Measure" (M) or "Test" (T) mode as required. Assume for the moment that it is in the M position as shown.

Operational amplifier IC1 is configured as a voltage comparator. If the voltage at

its non-inverting (+) input, pin 3, exceeds that at the inverting (-) one, pin 2, the output at pin 6 will be high. In other cases it will be low.

Resistors R3 and R4 form a potential divider connected across the nominal 9V supply. The values of these resistors have been chosen to provide 86 per cent (actually it is nearer 87%) of the supply voltage to the non-inverting input, pin 3.

Meanwhile, the capacitor being measured,  $C_t$ , charges through resistor, R1, so the voltage across it rises and follows the form shown in Fig. 2. R1 is selected from a chain of resistors using the rotary Range switch, S1 (inset in Fig. 3).

The value of "R1" in the chain will be such that, with a capacitor at the top of the range selected (i.e. a 100nF capacitor on the 100nF range), the time constant will be 1.66 seconds. The values of "R1" required to provide this time constant on the various ranges are shown in Table 1. In practice, the resistors are connected cumulatively and the third column shows the actual resistors used in the prototype.

Assuming the "test" capacitor  $C_t$  is discharged to begin with, the voltage across it will initially be zero and so the inverting input voltage will lie below the non-inverting one. The op.amp will therefore be on with output pin 6 high. After two time constants have elapsed, the voltage across the capacitor will rise above 86 per cent of the

supply. The op.amp input conditions will now be reversed and it switches off with pin 6 becoming low.

## RAPID PULSE

Being configured as an *astable* means that IC2's output, pin 3, switches repeatedly between high and low states providing there is a supply connected and pin 4 (Reset input) is high. This allows the red light-emitting diode D3 to flash with the operating current limited by resistor R7.

While IC1 pin 6 is high (during the initial stages of  $C_t$  charging), IC2 pin 4 is maintained in a high state and this enables the i.c. When the capacitor charges through two time constants, IC1 pin 6 becomes low, IC2 is disabled and the flashing stops.

The nominally "low" state of IC1 output would still be high enough to enable IC2 if connected direct and the two diodes, D1 and D2, correct this. Since approximately 0.7V appears across a forward-biased silicon diode, the introduction of two diodes in series will reduce the output voltage by about 1.4V. The voltage at IC2 pin 4 will therefore not be sufficient to enable the chip. Resistor R6 maintains IC2 pin 4 low in the absence of a high state from IC1 output.

The rate at which pulses are produced depends on the values of fixed resistors R8, R9 and preset potentiometer VR2 in con-

Table 1

Range	Total resistance needed	Resistors used cumulatively
5000 $\mu$ F	333 $\Omega$	330 $\Omega$
1000 $\mu$ F	1k67	1k3
500 $\mu$ F	3k33	1k8
100 $\mu$ F	16k7	13k
50 $\mu$ F	33k3	18k
10 $\mu$ F	167k	130k
5 $\mu$ F	333k	180k
1 $\mu$ F	1M67	820k + 470k
500nF	3M33	1M + 820k
100nF	16M7	6M8 + 6M8
50nF	33M33	10M + 6M8
10nF	167M	47M + 47M + 33M (or 100M + 33M see Shop Talk)

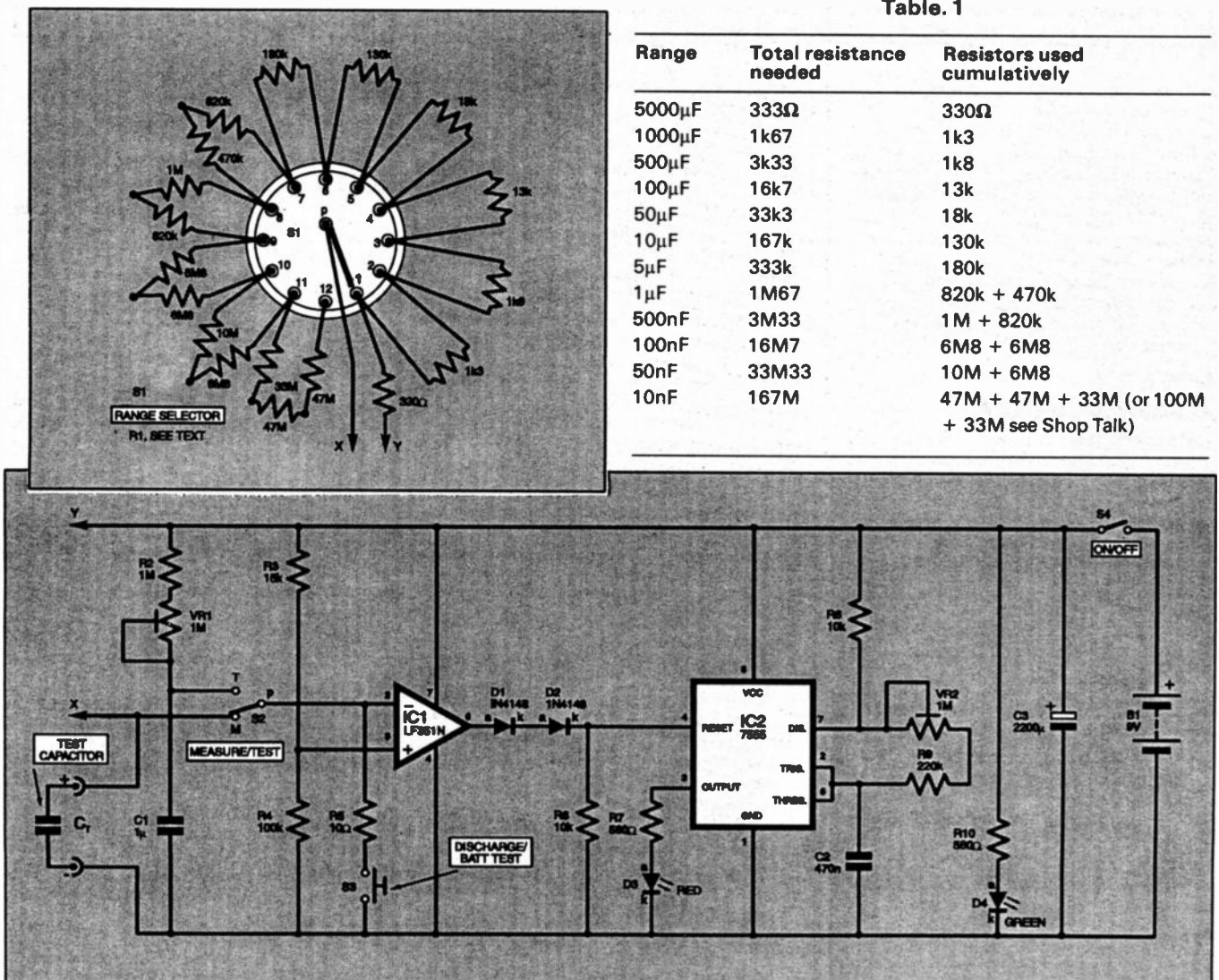


Fig. 3. Full circuit diagram for the Capacitor Check. The Range Selector chain of resistors (R1) is shown inset and is connected to points X and Y in the main circuit.

## Resistors

R1 resistors chain (see also Table 1)  
330Ω, 1k3, 1k8, 13k, 18k, 130k, 180k, 470k, 820k (2 off),  
1M, 6M8 (3 off), 10M, 33M, 47M (2 off)  
R2 1M  
R3 15k  
R4 100k  
R5 10Ω  
R6, R8 10k (2 off)  
R7, R10 560Ω (2 off)  
R9 220k  
All 0.6W 1% metal film, except 33M and 47M which are 5% metal film.

## Potentiometers

VR1, VR2 1M sub-min carbon preset, vert. (2 off)

## Capacitors

C1 1μ polyester layer  
C2 470n polyester layer  
C3 2200μ p.c.b. radial elect. 16V

## Semiconductors

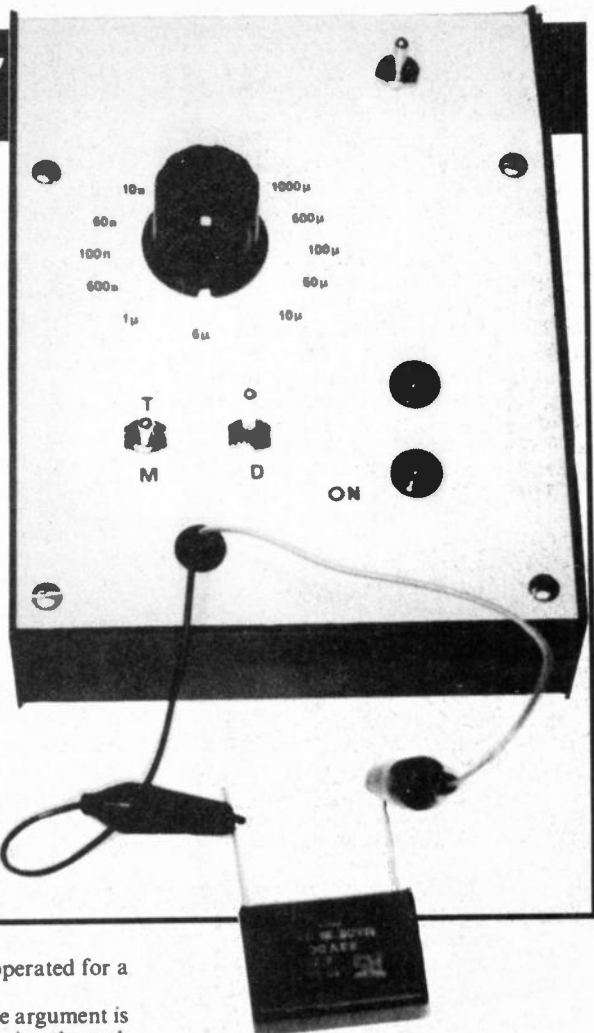
D1, D2 1N4148 signal diode (2 off)  
D3 5mm red l.e.d.  
D4 5mm green l.e.d.  
IC1 LF351N j.f.e.t. op.amp  
IC2 ICM75551PA CMOS timer

## Miscellaneous

S1 Single-pole 12-way rotary switch, make-before-break action  
S2, S4 Min. s.p.d.t. toggle switch (2 off)  
S3 Min. s.p.d.t. biased toggle switch or press-to-make pushbutton switch (see text)  
B1 9V battery (PP3)

Printed circuit board available from the *EPE PCB Service*, code 955; ABS plastic or metal box with sloping front panel, size to choice; 8-pin d.i.l. socket (2 off); miniature crocodile clip (2 off); PP3 battery holder and snap connector; control knob; p.c.b. stand-off insulator and mounting bolt; rubber grommet; red and black stranded connecting wire; multi-coloured stranded interconnecting wire; cable ties; solder etc.

See  
**SHOP  
TALK**  
Page



junction with capacitor C2. With the values chosen, they will be delivered at between one and 10 per second approximately depending on the adjustment of VR2.

During initial setting-up, the preset VR2 will be adjusted so that exactly *three* flashes per second are provided – this being the maximum rate at which they may be counted without too much difficulty. Ten flashes therefore correspond to 3.33 seconds which is equal to *two time constants* for a capacitor at the limit of the range selected.

## VALID ARGUMENT

When switch S2 is in the alternative (T) position, IC1 pin 2 is connected to the arrangement of fixed resistor R2, preset potentiometer VR1 and capacitor C1. Preset VR1 will be adjusted so that exactly ten flashes are given by l.e.d. D3. This may be used to check that the circuit is working correctly.

It also acts as a “battery test” since a battery in poor condition will fail to maintain the charge rate to capacitor C1. This will be indicated by an apparent increase in value of the test capacitor – i.e. more than ten flashes given.

When pressed, switch S3 applies a virtual short-circuit to any capacitor before a measurement is made – this ensures that it is initially discharged. Resistor R5 limits the current through the switch contacts to 1A approximately. If a large-value capacitor were to be discharged with no series resistor, there would be an instantaneous high current and the consequent sparking could possibly damage the switch contacts.

Resistor R5 still has a sufficiently low value to allow the highest-value capacitor on test to be virtually fully discharged in a fraction of a second. This is important be-

cause the switch will only be operated for a short time.

It will be clear that the above argument is valid only if all the current flowing through resistor chain R1 actually charges C1. In practice, this means that none must be diverted into IC1 inverting input. This, in turn, implies that the input resistance of IC1 must be much higher than the maximum value of R1 which is about 167MΩ.

The specified op.amp for IC1 has an input resistance in the region of one 1TΩ (one million megohms) which is many thousands of times greater than this. The effect of the op.amp on any capacitor charging is therefore negligible.

Capacitor C3 is charged from the battery while the circuit is switched on. This provides a reserve of energy which may be needed when testing high-value capacitors since here the value selected from the resistor chain for R1 will be low (see Table 1). In these cases, a high initial current will be drawn from the supply. When the battery is old and its internal resistance high, the initial current would be reduced and this would slow down the charging process. This would increase the timing and apparently increase the value of a capacitor being measured.

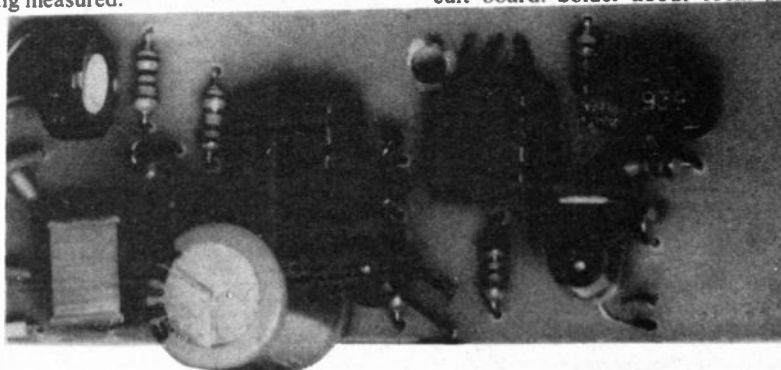
Since the time constant is independent of supply voltage, there will be no adverse effect as the battery ages to a reasonable level and the available voltage falls. The potential divider, R3/R4 will always supply IC1 pin 3 with 86 per cent of the supply voltage whatever this might be.

## CONSTRUCTION

Details of the component layout and full-size copper foil master track pattern for the Capacitor Check printed circuit board (p.c.b.) are shown in Fig. 4. This board is available from the *EPE PCB Service*, code 955.

Begin construction by drilling the single mounting hole and soldering the two i.c. sockets into position. Follow with the resistors, preset potentiometers, capacitors and diodes. Pay special attention to the polarities of the diodes, i.c.s and electrolytic capacitor C3.

Solder the two l.e.d.s in position using most of the length of their connecting leads so that they stand 15mm above the circuit board. Solder about 15cm pieces of



Layout of components on the finished printed circuit board.

stranded connecting wire to the points labelled: S4; S2 (T) (2 off); S2(p); S3 and Batt. -V. Adjust presets VR1 and VR2 to approximately mid-track position.

Note that, in the prototype, switches S2 and S4 were of the miniature s.p.d.t. toggle variety and S3 was a s.p.d.t. *biased* toggle type all chosen from the same range to harmonize with one another. Of course, an ordinary push-to-make pushswitch could be used instead for S3.

### RANGE SWITCH

Prepare rotary Range switch S1, by cutting the spindle to a suitable length to accommodate the control knob. As supplied, the switch will be found to have only 11 positions instead of the 12 required. To correct this, remove the brass nut and the tab washer beneath. Discard the tab washer and replace the brass nut. The switch will now have its full complement of positions.

Solder the resistors (R1 chain) shown in Table 1 around the tags of the rotary switch S1 as shown in Fig. 5. Unfortunately, some of the larger value resistors are not readily available (see *ShopTalk*) and for the low ranges, multiple resistors connected in series will be needed to make up the value. For the lowest range (10nF), *three* resistors were used in the prototype – two 47MΩ and one 33MΩ. The 47MΩ resistors have a rather large body profile but this does not really matter.

The first resistor in the “R1” chain, 330 ohms, used for the highest range (5000μF) is not soldered between rotary switch tags but only to the first one and the other end is left free for the moment. Both its ends should be sleeved using a little insulation stripped from a connecting wire.

### CASE PREPARATION

Drill holes in the lid of the box for the l.e.d. clips, the four switches and for the battery holder. Drill a hole to align with that already made in the p.c.b.. Make a hole for the test leads which will pass through from the inside and fit it with a rubber grommet.

Attach the switches, l.e.d. clips and battery holder. Referring to Fig. 6, complete the internal wiring. Insert the i.c.s into their sockets observing the orientation. Note that IC1 is a j.f.e.t. device and needs no special han-

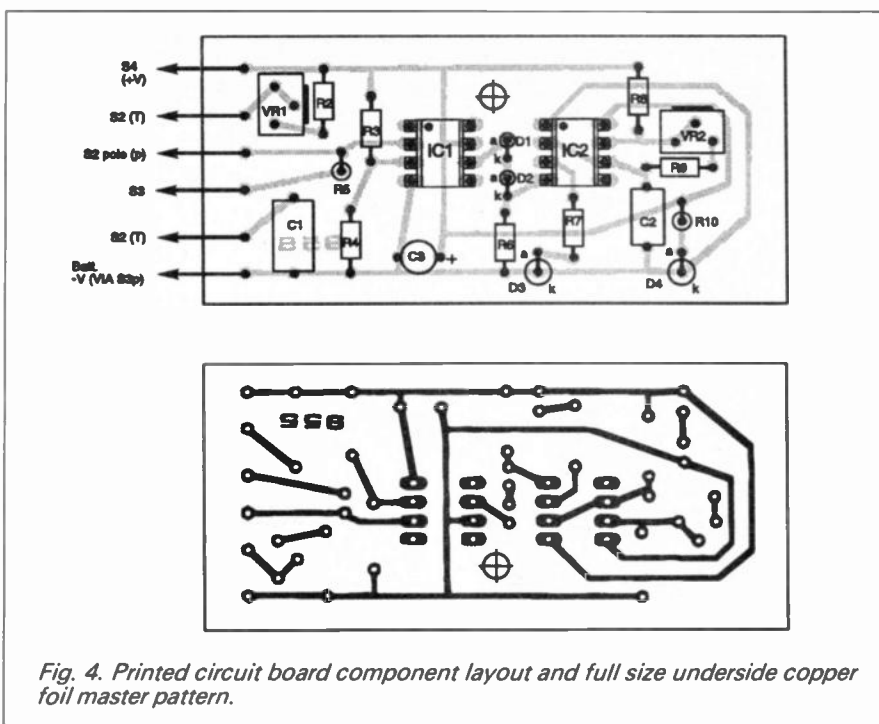


Fig. 4. Printed circuit board component layout and full size underside copper foil master pattern.

dling precautions. IC2 is a CMOS i.c. and vulnerable to damage by static charge which might exist on the body. To avoid this, touch something which is “earthed” – such as a water tap – first.

Attach the p.c.b. so that the l.e.d.s snap into their clips. Secure it using a single

fixing and a 20mm long plastic stand-off insulator on the bolt shank. In this way, everything will be attached to the lid so providing least strain on the connecting wires. Fit self-adhesive plastic feet to the bottom of the box to prevent scratching the work surface.

Make up the test leads using short pieces of light-duty flexible wire with small

The p.c.b. flipped over to reveal the position of the l.e.d. clips on the front panel.

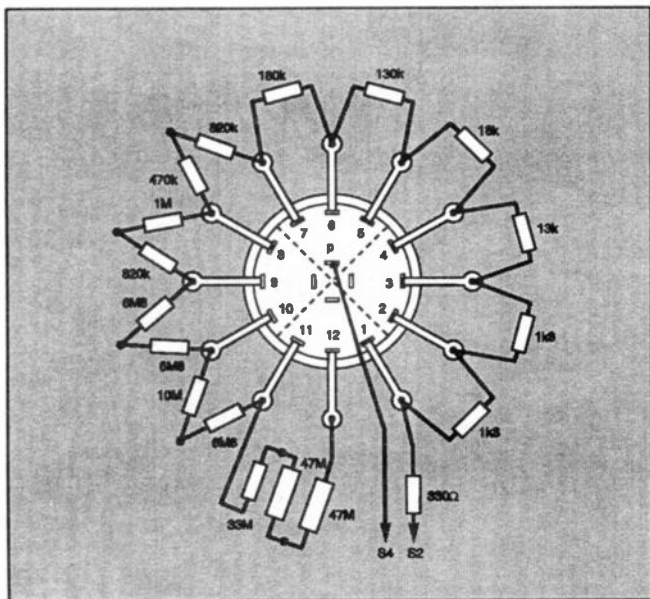
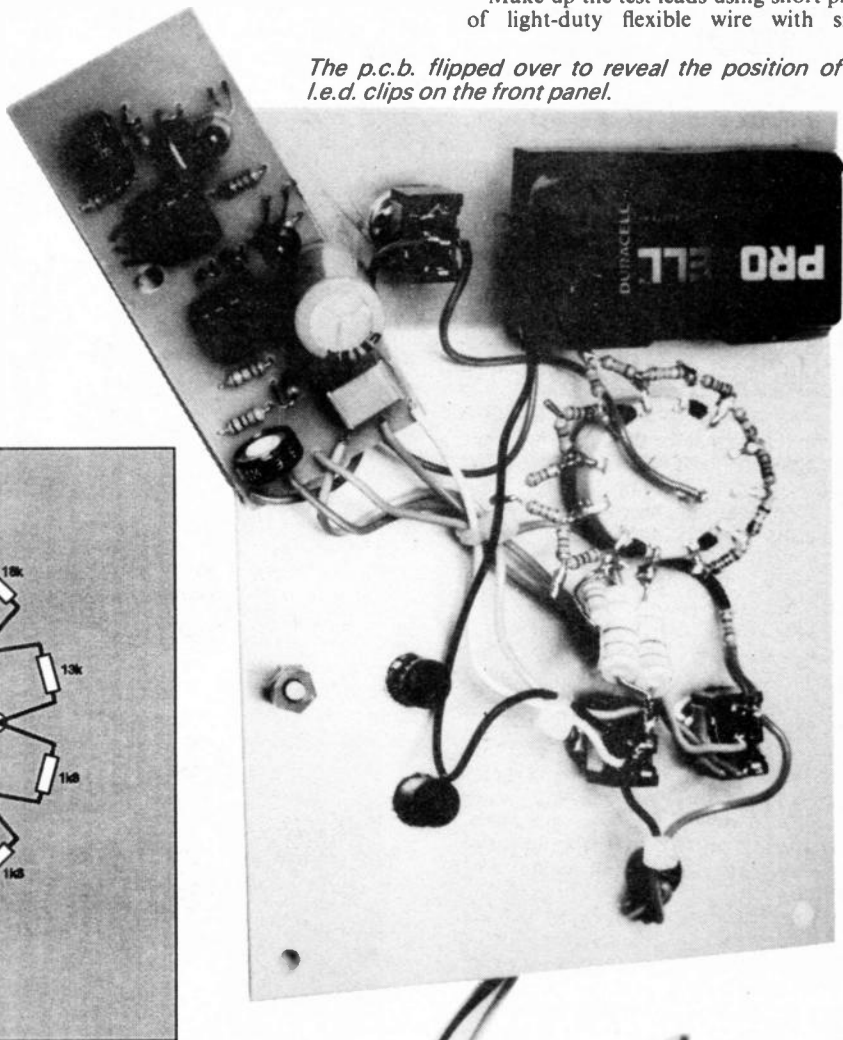


Fig. 5. Resistor chain wired to the Range switch S1.

crocodile clips on the ends. A red wire should be used for the positive wire – that is, the one leading to switch S2 (M). The other one should be black. Pass the ends of the "test" leads through the grommet and, leaving a little slack, attach a cable clamp on the inside to provide strain relief. Switch S4 off and connect the battery. Do not attach the lid yet.

## SETTING-UP

Set switch S2 to *measure* (M) and switch S4 on. Note that the green l.e.d. glows. The range is unimportant at this stage.

Short-circuit the two crocodile clips together. This should make the red l.e.d. flash continuously. Using a trimming tool or small screwdriver, adjust preset VR2 so that exactly *three* flashes per second are given. Listening to the one-second clicks from an analogue clock and counting in threes is the easiest method.

With S2 set to *test* (T), the red l.e.d. may continue to flash for a short while then stop. If capacitor C1 is already charged, it will remain off. Press S3 for an instant and note that it flashes again. On releasing S3, count the number of flashes until they stop. Adjust preset VR1 until *ten* flashes are given and check this a few times.

## CHECKING IT OUT

To use the Capacitor Check, rotary switch S1 is first set to the range required. If this is not known, a guess can be made from the physical size of the capacitor and the procedure followed by trial and error.

When the "checker" is first switched on the green l.e.d. glows. The red l.e.d. will also flash at the rate of three per second. The "unknown" capacitor is now connected in-circuit, using the pair of crocodile clips, and the momentary-action switch S3 operated.

The number of flashes – nominally up to ten – is now counted until the red l.e.d. goes off. If there is only one flash, none at all, or many more than ten the Range switch S1 will need to be adjusted up or down accordingly.

Taking account of the range setting, the number of flashes indicates the approximate value of the capacitor. For example, suppose the 100 $\mu$ F range is selected and "six" flashes are given. The value of the capacitor will lie between 60 $\mu$ F and 70 $\mu$ F (remember, there could have been a further flash just about to happen).

As a further example, suppose the 50nF range was selected, then "four" flashes would indicate a capacitor value between 20nF and 25nF (one flash here being equivalent to 5nF). It is permissible to allow a few more flashes than the nominal ten. If, in the last example, 13 flashes were given the value would lie between 65nF and 70nF.

## MAKING THE TEST

Select the appropriate range and connect the "test capacitor" to be measured between the crocodile clips. If it is an electrolytic capacitor, it is important to observe the polarity marked on the body – i.e. connect the negative end to the black test lead.

Switch S2 to the M position and note that if the capacitor is uncharged the red l.e.d. will begin to flash. Do not wait for it to stop but press S3 and, on releasing it, count the flashes as before. Repeat this once or twice.

Convert this number into a value as explained previously. There should be no

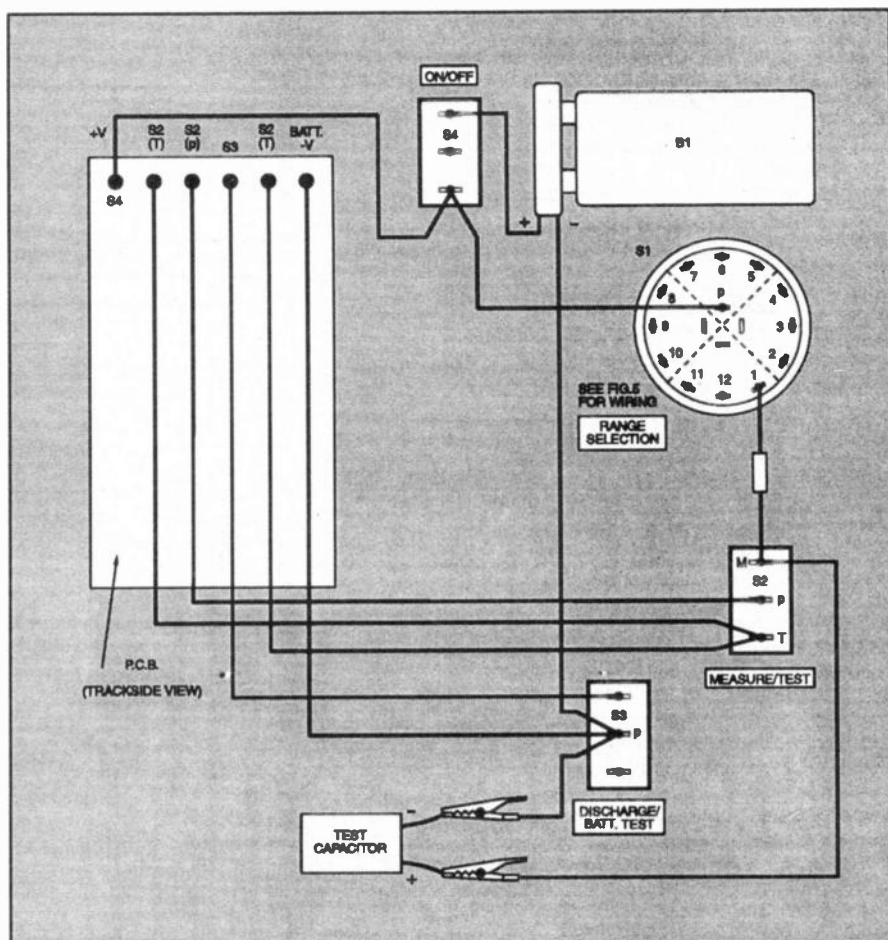


Fig. 6. Interwiring from the p.c.b. to the switches and also wiring between off-board components.

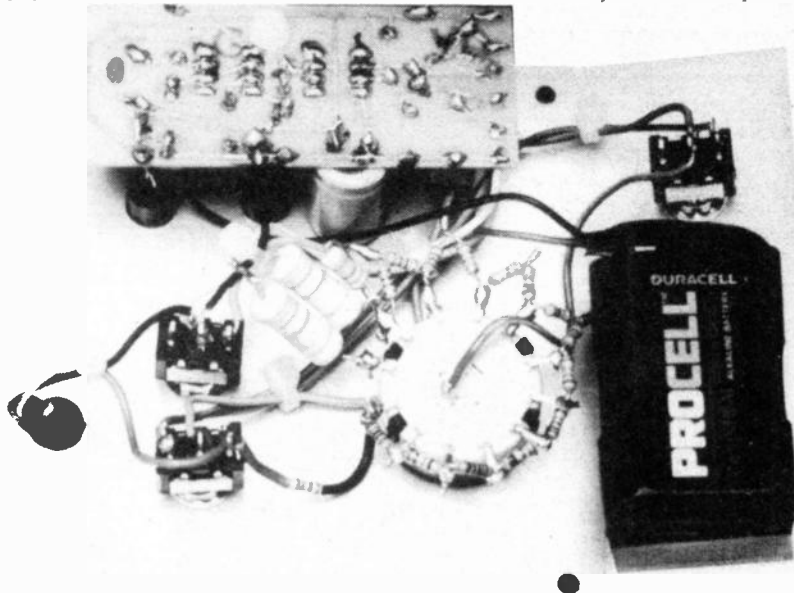
be more than one flash difference between readings using the same capacitor. Note that each time a measurement is made, the discharge switch S3 *MUST* be used – never assume that any capacitor is fully discharged to begin with.

Do not hold both capacitor leads between the fingers while testing it. If you do, your body resistance will interfere with the charging action and lead to an apparent increase in its value. There would be little effect when testing high value capacitors but it would make a large difference with small ones.

Electrolytic capacitors tend to deform somewhat in storage. In practice, this means that the value may not settle down until they have been charged and discharged a few times. Also, this type of capacitor is subject to a wider tolerance than other types – typically 20 per cent.

## CHECK MATE

Every so often, the circuit should be checked. Set S2 to *Test*, press S3 momentarily and count the number of flashes. This should be *ten* as previously set. If it is more than this, the battery needs to be replaced. □



Chain resistors wired directly to the Range switch and the p.c.b. mounted "face-down" on the rear of the front panel.

# FOX REPORT by Barry Fox



## Trusting Telerate

I do hope the financial community looks at Telerate Live in action, before signing up for the service. Judging by the way the city suits applauded Telerate's launch party pitch, they are quite likely to sign on the strength of a promise.

This is truly ironical, because the whole thrust of the pitch was that financial professionals need to see politicians and government officials in action, so that they can judge who is telling the truth. That way they avoid ending up like Barings Bank.

Dow Jones, publisher of the *Wall Street Journal*, already runs a service called Telerate. It delivers financial information to office computers. Now DJ is offering Telerate Live, which delivers TV news pictures of important announcements into a Windows workstation.

## Non-Appliance of Science

Recently, one of the main employers in Wales, Panasonic, issued an uncharacteristically blunt warning. This had clearly been timed to coincide with DTI Minister Ian Taylor's launch of Britain's *Science, Engineering and Technology Week*.

While Taylor was telling industrialists, teachers and students that it was "never too early to master the appliance of science", Panasonic's parent Matsushita was warning that serious shortcomings in the British education system will soon stop foreign countries investing in the UK. Matsushita, the largest manufacturer of consumer electronics equipment in the world, also publicly criticised Britain's attitude to engineering.

Panasonic has built factories in Wales which employ 2000 people to make television sets and microwave ovens. Panasonic offers technical apprenticeships and tries to train employees for engineering jobs which must otherwise be done by Japanese employees on secondment from the company's factories in Osaka. But last year when Panasonic advertised for engineering apprentices, the company could only recruit three of the two hundred applicants. Less than ten of the applicants were women.

Other Japanese companies are facing the same difficulties, says Panasonic, and the flow of inward investment by overseas companies "could slow to a trickle unless significant steps are taken to improve technical and engineering skills training".

## Trust Me

To ram the message home Telerate showed video clips of George Bush promising no tax rises, Margaret Thatcher promising to "fight on and win" her leadership battle and a corrupt Italian politician pleading innocence. "All broken promises" said the man from Telerate "You need to see their expression to know who to trust".

The news pictures looked clear and crisp, because they were shown from a tape recording on six large screen TV sets. I was waiting for a demonstration of how they look, live, on a computer screen. But as the tape ended the lights went up and the show was over.

I asked Peter Kingsley, Telerate's Director of Marketing, whether we could see a Windows terminal in action. There wasn't one. But Kingsley assured me that

## Training Perception

David Fowler, Panasonic's board member for personnel, told a seminar of 60 technology teachers from all parts of Wales that "Far too many university graduates are opting for degrees in the arts and humanities, where the prospects of finding well paid work are receding by the hour".

Panasonic also wants to change the general perception of the role of an engineer in industry. In most countries, an engineer is respected as a skilled technician. But in the UK engineers are regarded as second-class necessities. I frequently see management and marketing "suits" making fools of themselves at meetings and conferences by talking about technical issues they do not understand. They are too proud to let their engineers do the talking.

"Students really need to be warned of the high price they will have to pay in terms of employment prospects for choosing subjects not related to future opportunities", Fowler told the teachers. "Companies like ours have to dig very deeply indeed to find people with relevant skills for further training. That applies as much to graduates as anyone else, even if they have degrees in technical subjects".

"There appears to be a lack of commitment actively to support and finance the development of courses that satisfy our business needs. At graduate level, for example, we need more people trained in digital electronics".

the pictures would be as good as those we had seen on the TV screens. "Haven't you heard of the cards that you can add to a PC to display TV pictures?", he asked.

Yes, I have. But these cards take full bandwidth analogue TV signal from an aerial and display them on the PC screen. Depending on the screen resolution and circuit bandwidth, the pictures should be as good as on an ordinary TV set.

## Rating the Cards

But the rules of the game change completely when the picture signals are digital, either streaming down a line or off a CD-ROM. Although it is possible to get VHS or better quality pictures from a Video CD with MPEG-1 coding at under 1.5 Mbit/s, considerable care is needed for the coding process. It needs several passes and usually the coding is done off-line, in slow time.

Higher data rates (3 or 4 Mbits/s) are needed to deliver similar quality pictures if they are coded in real time, completely automatically.

It turns out that Telerate has been banking on the launch of Eutelsat's *Hot Bird* satellite, originally scheduled for Christmas and finally launched three months late because of Ariane rocket problems. One of Hot Bird's transponders will carry the European Business News TV station (from which Telerate's news clips are sourced) as an analogue signal, with 27MHz bandwidth. On top of this, the same transponder will carry a 9-Megabit data stream to deliver Telerate's picture, sound and text information.

But this service will not be ready until "later this year" and as a stop gap Telerate will deliver its signals by 2-Megabit optic fibre link into offices. This drastically limits the data rate available for video, and with real time coding the picture quality inevitably suffers.

## Game Show

The information pack which Telerate gave guests as they left their party gives the game away. Inside there is a photograph of a computer screen with four-fifths of the screen area displaying financial text and one-fifth working as a window to display a TV picture. Although the text display is clear and crisp, I'd say that the TV display is sufficiently blurred and fuzzy to let a lying politician go on lying.




## ADVANCED COMPUTER SERVICES

COMPUTER COMPONENTS BY MAIL ORDER  
P.O. BOX 21 SEAFORTH LIVERPOOL L21 5LE  
TEL: 0151 286 0370 FAX: 0151 286 0361  
ACCESS|VISA|DELTA|SWITCH

<b>CPU'S</b>		270MB HARD DRIVE	£100-00
UMC 486 SX33	£54-00	368MB HARD DRIVE	£109-00
UMC 486 SX40	£60-00	420MB HARD DRIVE	£120-00
SGS 486 DX2 50	£55-00	540MB HARD DRIVE	£137-00
SGS 486 DX2 66	£73-00	730MB HARD DRIVE	£171-00
SGS 486 DX2 80	£75-00	850MB HARD DRIVE	£181-00
CYRIX DX2 66	£67-00	1GB HARD DRIVE	£207-00
CYRIX DX2 80	£73-00	CD ROM X2 DRIVE	£76-00
IBM DX2 50	£62-00	CD ROM X4 DRIVE	£132-00
IBM DX2 66	£72-00		
AMD DX2 66	—	<b>MOTHERBOARDS</b>	
AMD DX2 80	—	486 DX4 READY	FROM £68-00
AMD DX4 100	£97-00	PENTIUM P60/66	£100-00
INTEL DX 33	—	PENTIUM P75-120	£142-00
INTEL DX2 66	£102-00		
INTEL DX4 100	£145-00	<b>I/O CARDS</b>	
PENTIUM P75	£192-00	VESA ENH. MULTI I/O	£16-00
PENTIUM P90	£244-00	VESA ENH. I/O 16550	£18-00
PENTIUM P100	£293-00	ISA HIGH SPEED I/O	£15-00
PENTIUM P120	£400-00	ISA MULTI I/O	£18-00
		PCI IDE	£15-00
		PCI SCSI II	£51-00
<b>VIDEO CARDS</b>		<b>KEYBOARDS</b>	
VESA 1MB SVGA	£71-00	KEYBOARD NONCLICK	£16-00
VESA CIRRUS LOG	£71-00	CHERRY KEYBOARD	£28-00
VESA 1MB DIAMOND	£112-00	MOUSE (KWIK)	£10-00
VESA 2MB DIAMOND	£148-00	MOUSE (MICROSOFT)	£26-00
<b>DISK DRIVES</b>		<b>CASES</b>	
3.5" FLOPPY DRIVE	£25-00	MINI TOWER	£54-00
5.25" FLOPPY DRIVE	£45-00	DESKTOP	£54-00
		MIDI TOWER	£73-00
		BIG TOWER	£83-00
<b>MONITORS</b>			
14" SVGA	FROM £165-00		

PLEASE NOTE THERE IS NO V.A.T. TO PAY ON OUR PRICES

## The MICRO MODULE A NEW LOW COST controller that gives you customisation for as little as £95 one off



**For users of  
PCs, 8051 &  
68000**

**and that's just the half of it!!**

### FEATURES

- 16/32 bit 68307 CPU for fast operation
- Up to 1 Mbyte of EPROM space onboard
- Up to 512Kbyte SRAM space onboard
- 32 Kbyte SRAM fitted as standard
- RS232 serial with RS485 option
- MODBUS & other protocols supported
- Up to 22 digital I/O channels
- 2 timer/counter/match registers
- I<sup>2</sup>C port or Mbus & Watch dog facilities
- Large Proto-typing area for user circuits
- Up to 5 chip selects available
- Program in C, C++, Modula-2 & Assembler
- Real time multitasking Operating System
- OS9 or MINOS with free run time license option
- Manufacturing available even in low volumes
- A full range of other Controllers available

### P.C. 'C' STARTER PACK AT ONLY £295

The Micro Module will reduce development time for quick turnaround products/projects and with the P.C. 'C' Starter pack allow you to start coding your application immediately, all drivers and libraries are supplied as standard along with MINOS the real time operating system all ready to run from power on.

The 'C' Starter pack includes: A Micro Module with 128 Kbyte SRAM, PSU, Cables, Manuals, C compiler, Debug monitor ROM, Terminal program, Downloader, a single copy of MINOS, Extensive example software, and free unlimited technical support all for £295.

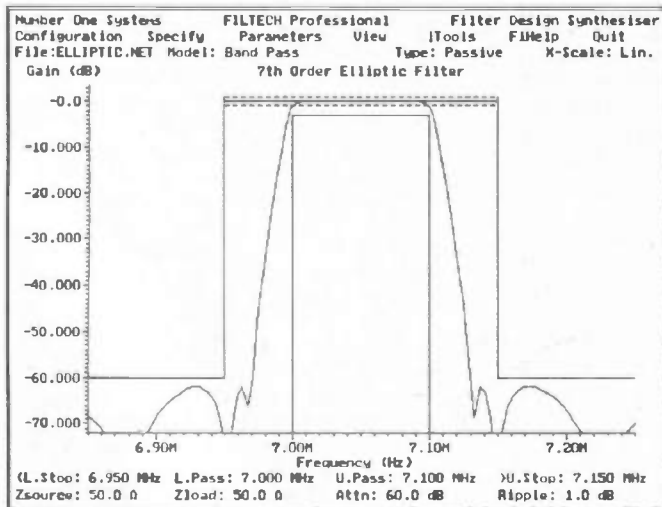
## BMS

Cambridge Microprocessor  
Systems Limited

Unit 17-18 Zone 'D', Chelmsford Rd. Ind. Est.,  
Great Dunmow, Essex. U.K. CM6 1XG  
Phone 0371 875644 Fax 0371 876077

# Electronic Designs Right First Time?

## Active and Passive Filter Design - FILTECH -



From only £145!



## Affordable Electronics CAD

LAYAN: NEW Electromagnetic Layout Simulator. Links to EASY-PC Pro' XM and ANALYSER III Pro'.	£495.00
EASY-PC Professional: Schematic Capture and PCB CAD. Links to ANALYSER III and PULSAR.	From £195.00
PULSAR: Digital Circuit Simulator	From £98.00
ANALYSER III: Linear Analogue Circuit Simulator	From £98.00
Z-MATCH for Windows: Smith Chart based problem solving program for R.F. Engineers	£245.00
FILTECH: Active and Passive Filter design	From £145.00
STOCKIT: NEW, Comprehensive stock control program for small / medium sized businesses	£145.00
EASY-PC: Entry level PCB and Schematic CAD	£98.00

Technical Support FREE for life! Prices exclude P&P and VAT.

Special discount schemes for education

## Number One Systems

Ref: EVD, Harding Way, St. Ives,  
Huntingdon, Cambs. PE17 4WR, UK.

For Full Information Please Write, Phone or Fax.

Tel: +44 (0) 1480 461778  
Fax: +44 (0) 1480 494042

# INTERFACE

**Robert Penfold**



**T**HIS month we conclude our probe into the "Hamcomm" shareware program, and consider the use of an external tone decoder for RTTY reception. Using a tone decoder gives the potential for improved results on weak signals, or when there is a lot of QRM.

It does not require the use of a particularly complex circuit. In fact the circuit featured here is based on just a couple of dual operational amplifiers.

There is a slight problem when using an RTTY tone decoder, which is simply one of tuning in signals with adequate accuracy. Amateur RTTY uses a frequency shift of only 170Hz, which requires the tuning to be accurate within a few hertz in order to obtain efficient decoding. Simple tuning indicators tend to be awkward to use due to the lopsided nature of most amateur RTTY, with one tone present for a far greater percentage of the time than the other tone.

## On the Mark

Using the "Hamcomm" program it is quite easy to switch between the internal and external decoding modes, and this enables the program's built-in tuning aids to be used with an external decoder. It is just a matter of aligning the program's tuning markers with the operating frequencies of the tone decoder, and then tuning received signals so that they match up with the markers.

Once a signal has been tuned correctly, switch to the external decoder mode to copy the station. This method is quite effective, and avoids the need for a complex and expensive hardware tuning indicator.

It is perhaps worth pointing out that the frequency stability of the communications receiver is an important consideration for RTTY reception. Once a signal is tuned in, the tuning accuracy must be maintained if efficient decoding is to be obtained.

This can be very difficult using a receiver that drifts continuously. A modern receiver with synthesised tuning is generally much better in this respect than an older set. On the other hand, a set with synthesised tuning is only usable if it has quite fine resolution (about 25Hz or less), or has a "fine tuning" control that permits the tuning to be varied between synthesised tuning steps.

Each bandpass filter drives a rectifier and smoothing circuit. The positive d.c. output voltage from each smoothing circuit is roughly proportional to the strength of the output signal from the relevant bandpass filter.

As the input signal switches from one tone to the other, the output voltages from the smoothing circuits seesaw in sympathy with the input signal. The two

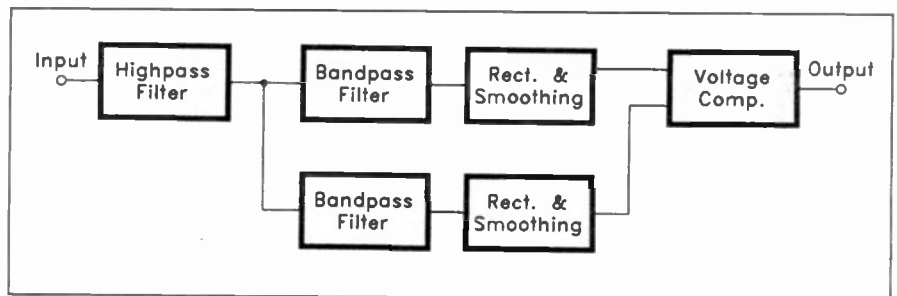


Fig. 1. Block diagram for the RTTY Tone Decoder.

## Highs and Lows

When used with an external decoder "Hamcomm" provides the serial to parallel conversion. All the decoder has to do is take the CTS line of the serial port high when one tone is present, and low when the other tone is detected. Fig. 1 shows the block diagram for the RTTY Tone Decoder.

A highpass filter at the input helps to reduce problems with low frequency QRM. This stage drives two bandpass filters which operate at approximately 1.2kHz and just over 1kHz.

In other words, they operate on frequencies that are 170Hz apart, which is the same as the frequency shift of the input signal. In use the receiver is tuned to bring the two tones of the RTTY signal to the centre frequencies of the bandpass filters.

voltages are fed to the inputs of a voltage comparator.

The output of the comparator switches fully high or low, depending on which input voltage is at the higher potential. It does not matter which tone gives which output level, but in this case the higher tone sends the output low.

If this gives an output signal of the wrong polarity the software can be switched to the "reverse" mode, and correct decoding should then be obtained. Alternatively, switching from lower sideband to upper sideband (or vice versa) will invert the output signal to one of the right polarity.

## Circuit Operation

The full circuit diagram for the RTTY Tone Decoder as shown in Fig. 2. The input filter is based on IC1a, and it is a

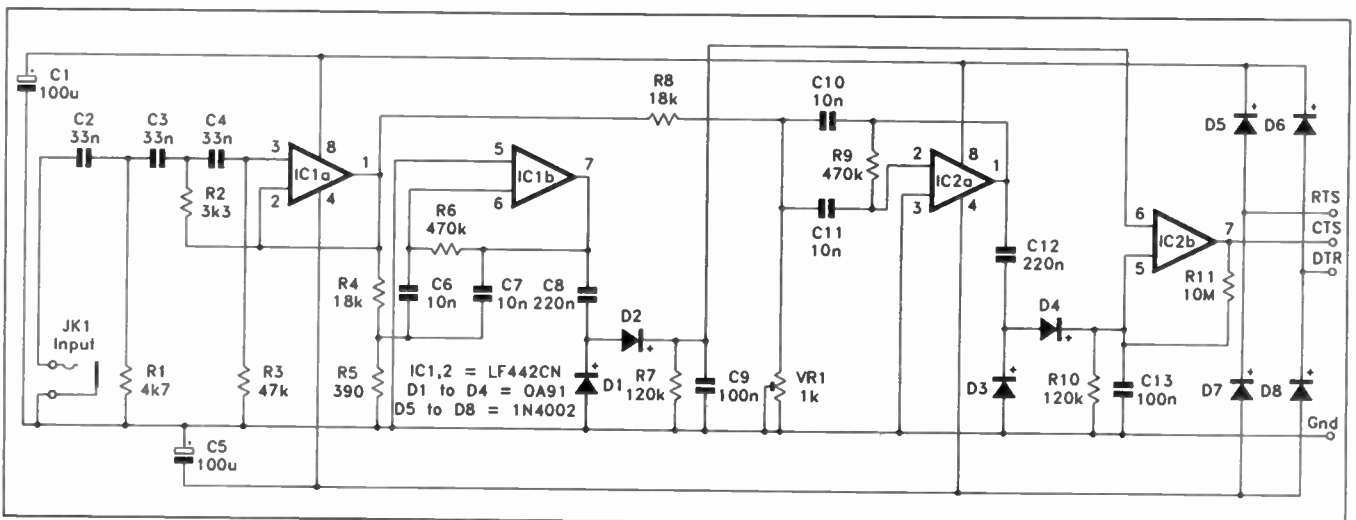


Fig. 2. The RTTY tone decoder circuit diagram.

conventional third order (18dB per octave) highpass type having a cut-off frequency at approximately 750Hz. IC1b is used in the higher frequency bandpass filter, and this uses a conventional configuration.

The parallel resistance of R4 and R5 forms one element of the C-R filter network, and these also provide attenuation which counteracts the otherwise excessive gain of the filter. Capacitors C6, C7, and resistor R6 provide the other three elements of the filter network.

Capacitor C8 couples the output of this filter to a conventional half-wave rectifier and smoothing network based on diodes D1 and D2. The time constant of R7 and C9 is long enough to give a well smoothed output signal, but is short enough to permit the unit to respond rapidly as the input signal alternates between one tone to the other.

The second bandpass filter is based on IC2a and is essentially the same as the first, but it has a preset resistor (VR1) as one section of the input attenuator. This enables the centre frequency of the filter to be adjusted over quite a wide frequency range, but in practice it is set 170Hz lower than the centre frequency of the other filter.

If preferred, preset potentiometer VR1 can be set to give a centre frequency 170Hz higher than the other filter. Results seem to be much the same either way. It can also be set for shifts of other than 170Hz.

In fact, it could be replaced by two or three switched presets, giving the option of several shift frequencies. It is advisable to use a multiturn "trimpot" for VR1, since it could be difficult to set an ordinary preset with adequate accuracy.

The output of IC2a (pin 1) feeds into a rectifier and smoothing circuit that is identical to the one used at the output of the other filter. The outputs of both the smoothing circuits drive the inputs of IC2b, which acts as the voltage comparator. A small amount of d.c. positive feedback is provided by resistor R11, and this helps to avoid problems with "jitter" at the output when only background noise is present at the input.

## Powerful Handshake

In common with the interfaces described previously, power is obtained from two of the otherwise unused handshake outputs of the PC's serial port. Diodes D5 to D8 form a bridge rectifier that ensures the circuit is always provided with a supply of the correct polarity.

Only a milliamp or two can be drawn from the handshake outputs. Accordingly, IC1 and IC2 must be low supply current operational amplifiers.

Using the LF442CN a total current consumption of only about one milliamp is obtained. Most other dual operational amplifiers (LF353N, LM1458C, etc.) will give a very much higher current drain, and might not give usable results unless a proper dual-balanced 12V supply is used.

## In Use

This interface requires the same serial port connections as the CW decoder described in last month's article. Also in common with the CW decoder, the simple interface is needed if the built-in tuning aids of

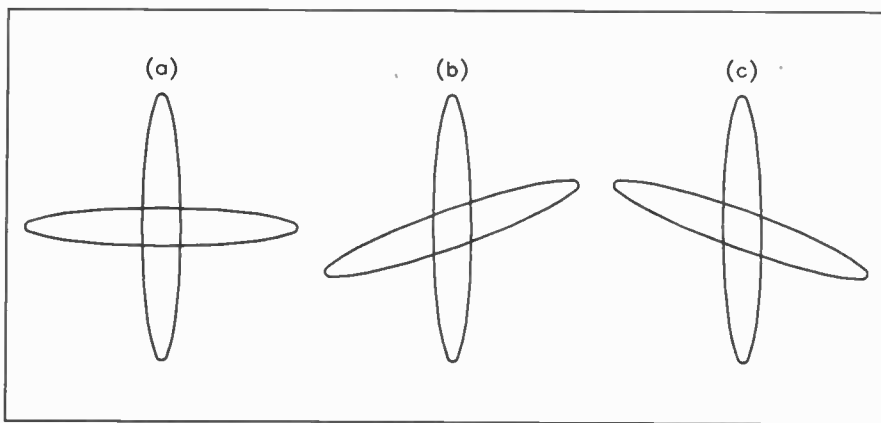


Fig. 3. (a) The correct oscilloscope display; (b and c) the display with incorrect shift.

"Hamcomm" are to be utilized. Refer to last month's article if you require details of either the serial port connections or the circuit for the simple interface.

Obviously, the RTTY Tone Decoder will not work properly until VR1 has been set for the correct frequency shift. If an accurately calibrated sinewave generator and an oscilloscope or audio millivolt meter are available, first determine the centre frequency of the higher frequency filter.

To do this, couple the output of the generator to the input of the Tone Decoder, and use the oscilloscope or millivolt meter to monitor the output level at pin 7 of IC1b. Adjust the signal generator for maximum output, being careful to keep the signal below the clipping level of IC1b.

Next set the audio signal generator 170Hz lower in frequency, and monitor the output level from IC2a pin 1. Adjust VR1 for maximum output from IC2a, again making sure that the signal is kept below the clipping level so that a definite peak is obtained.

The unit should then work quite well, but the oscilloscope can be used to check the setting of preset VR1, provided it has an X-input. Monitor the output from IC1a pin 7 using the X-input, and the output from IC2a pin 1 using the Y-input.

One tone will produce a horizontal ellipse on the oscilloscope's screen, and the other tone will produce a vertical ellipse. As the signal switches rapidly from one tone to the other this will generate a sort of cross shape on the screen. Fig. 3a shows a slightly idealised version of the correct display with an accurately tuned RTTY transmission.

## Trail and Error

If the shift of the decoder is not quite right, the two sections of the display will not be at right angles to each other at any

setting of the receiver's tuning control. This gives a display of the type shown in Fig. 3b or Fig. 3c, depending on whether the shift is too great or too small.

Try tuning to several stations to check that it is the decoder which is at fault, and not the initial test station. If the decoder is at fault, a little trial and error with the setting of VR1 will soon correct things.

Without the aid of suitable test equipment it can be difficult to get the decoder set up correctly. It can be done using trial and error, but this could be very time consuming, since the shift has to be set very accurately if good results are to be obtained.

Probably the best simple method is to monitor the output from IC1b pin 7 using a crystal earphone. Connect the earphone between IC1 pin 7 and "ground".

If you slowly tune across an RTTY station you should hear the output from the earphone grow quite loud as each of the tones falls within the passband of the filter. Adjust the tuning so that the higher frequency tone produces maximum output from IC1b.

Next, monitor the output from IC2a pin 1, and adjust VR1 for maximum output from the lower frequency tone. Be careful not to peak VR1 on the higher frequency tone. The signal will peak at two settings of VR1, and it is the peak at the higher resistance setting that is the correct one.

Results using the prototype decoder were very good, and seemed to be somewhat better than those obtained using a simple interface and software to provide all the decoding. The system is still not immune to fading though, and something less than 100 per cent copy has to be accepted when band conditions are unfavourable.

"Hamcomm 3.0" is available from the PDSL, Dept EPE, Winscombe House, Beacon Road, Crowborough, Sussex, TN6 1UL (Tel. 01892 663298, Fax 01892 667473).

COMING SOON ..

**WEATHER STATION**

**DON'T MISS IT!**

**TAKE OUT A SUBSCRIPTION NOW!**

# EVERYDAY With PRACTICAL ELECTRONICS

# BACK ISSUES

We can supply back issues of *EPE* by post, most 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?

### APRIL '94 Photostats Only (see below)

**PROJECTS** • MOSFET Variable Bench Power Supply • *EPE* Soundac PC sound output board • CCD TV Camera, Part 2/Frame Grab • Impulse Clock Master Unit • Telephone Ring Detector.  
**FEATURES** • Best of British, Part 1 • Calculation Corner, Part 4 • Electronics Workbench Review • FREE Wall Chart – Electronics Formulae 2.

### MAY '94

**PROJECTS** • Simple TENS Unit (transcutaneous pain relief) • Capacitance/Inductance Meter • L.E.D. Matrix Message Display, Part 1 • Stereo Noise Gate • Dual Stepping Motor Driver for PCs.  
**FEATURES** • Calculation Corner, Part 5 • Best of British, Part 2.

### JUNE '94

**PROJECTS** • Microcontroller P.I. Treasure Hunter • Digital Water Meter • Microprocessor Smart Switch • Advanced TENS Unit (transcutaneous pain relief) • L.E.D. Matrix Message Display, Part 2.  
**FEATURES** • Best of British, Part 3 • Calculation Corner, Part 6.

### JULY '94

**PROJECTS** • Voxbox Voice Recording Board • Simple NiCad Charger • Watering Wizard (automatic garden watering) • Pocket Print Timer • Stereo HiFi Controller, Part 1.  
**FEATURES** • Best of British, Part 4 • Calculation Corner, Part 7.

### AUG. '94

**PROJECTS** • Experimental Noise Cancelling Unit • Dancing Fountains, Part 1 • Charged-Up (PC battery tip) • 6802 Development Board • TV Camera Update • Stereo HiFi Controller, Part 2.  
**FEATURES** • Calculation Corner, Part 8 • Best of British, Part 5 • I'll Be Seeing You (multimedia communications)

### SEPT. '94

**PROJECTS** • Protector Plus Car Alarm • Greenhouse Watering System • Experimental Seismograph, Part 1 • Three-Channel Lamp Controller • Dancing Fountains, Part 2.  
**FEATURES** • Calculation Corner, Part 9 • The Invisible Force (magnetic force).



### OCT. '94

**PROJECTS** • Digilogue Clock • Visual/Audio Guitar Tuner • Hobby Power Supply • Audio Auxilexer • Experimental Seismograph, Part 2.  
**FEATURES** • Electronics from the Ground Up, Part 1 with FREE PC Software • Calculation Corner, Part 10.

### NOV. '94 Photostats Only (see below)

**PROJECTS** • 1000V/500V Insulation Tester • Video Modules, Part 1 (Simple Fader, Improved Fader, Video Enhancer) • Active Guitar Tone Control • Power Controller • TV Off-er.  
**FEATURES** • Electronics from the Ground Up, Part 2 • Consumer Electronics Show.

### 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

**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

**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

**PROJECTS** • Simple Therman • Low Range Ohmmeter Adaptor • Comprehensive Security System • Vandata • Hum-Free Battery Eliminator.  
**FEATURES** • Cave Radio • Ingenuity Unlimited.

## 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 the following issues from earlier years: 1989 (except March, June and Nov), 1990 (except March), 1991 (except Aug., Sept. and Nov.), 1992 (except April and Dec.), 1993 (except Jan., Feb. and March), 1994 (except April and Nov.), 1995 (except Jan.). 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/P.O./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 with Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF.

Tel: 01202 881749. Fax: 01202 841692.

Send a copy of this form, or order by letter if you do not wish to cut your issue.

M10/95

# MIXED-MODE SIMULATION. THE POWER OF VERSION 4.

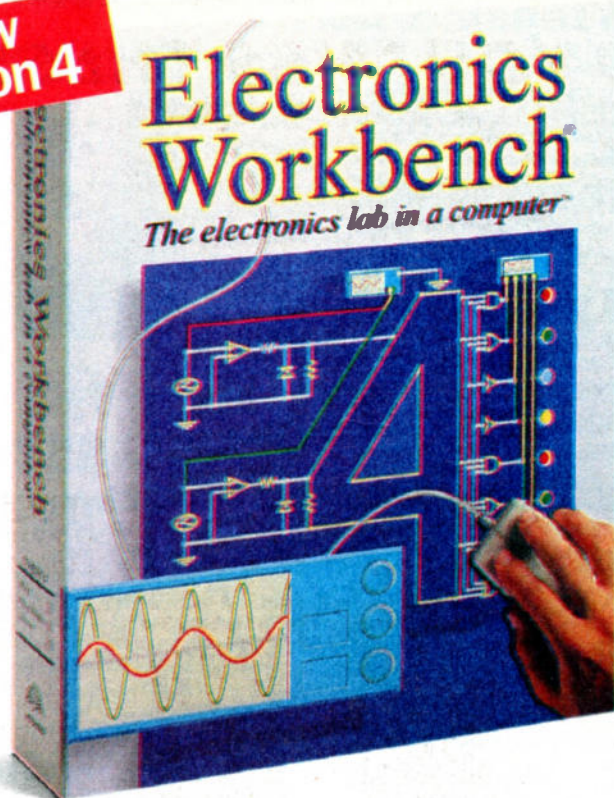
New  
Version 4

## Analog, Digital & Mixed Circuits

Electronics Workbench® Version 4 is a fully integrated schematic capture, simulator and graphical waveform generator. It is simple to mix analog and digital parts in any combination.

## Design and Verify Circuits... Fast!

Electronics Workbench's simple, direct interface helps you build circuits in a fraction of the time. Try 'what if' scenarios and fine tune your designs painlessly.



## More Power

Simulate bigger and more complex circuits. Faster. On average, Electronics Workbench Version 4 is more than 5 times faster than Version 3.

## More Parts

Multiple parts bins contain over twice the components of Version 3.

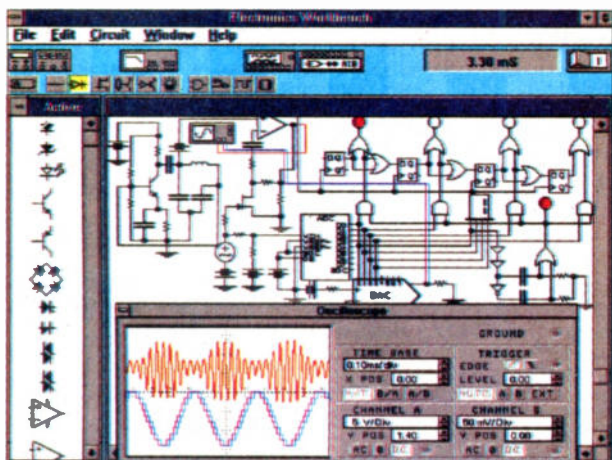
## More Models

Over 350 real world analog and digital models are included free with Electronics Workbench. And, if you need more, an additional 2,000 models are available.

## Incredibly Powerful. Incredibly Affordable.

If you need mixed-mode power at a price you can afford, take a look at this simulator and graphical waveform generator that mixes analog and digital with ease.

With over 20,000 users world-wide, Electronics Workbench has already been tried, tested and accepted as an invaluable tool to design and verify analog and digital circuits. With Version 4 true mixed-mode simulation is now a reality with incredible simplicity.



True mixed-mode simulation: Simultaneous AM transmission, digitization and pulse-code modulation of a signal.

Electronics Workbench™  
*The electronics lab in a computer™*

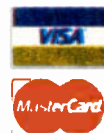
Order Now! Just £199\*

44-(0)1203-233-216

 Robinson Marshall (Europe) Plc

Nadella Building, Progress Close,  
Leofric Business Park,  
Coventry, Warwickshire CV3 2TF  
Fax: 44 (0)1203 233-210  
E-mail: [rme@cityscape.co.uk](mailto:rme@cityscape.co.uk)

Shipping charges UK £5.99. All prices are plus VAT.  
All trade marks are the property of their respective owners.  
Electronics Workbench is a trademark of Interactive Image Technologies Ltd., Toronto, Canada.  
\* 30 Day money-back guarantee.



Australia: 2-519-3933 • Brazil: 11-453-5588 • Cyprus: 2-62-1068 • Denmark: 33-25-0109 • Finland: 0-297-5033 • France: 14-908 9000 • Germany: 711-62-7740 • Greece: 1-524-9981  
Hungary: 1-215-0082 • India: 11-544-1343 • Israel: 3-647-5613 • Italy: 11-437-5549 • Japan: 3-3382-3136 • Malaysia: 603-7778945 • Mexico: 5-396-3075 • Netherlands: 18-031-7666  
New Zealand: 9-267-1756 • Norway: 22-16-70-45 • Portugal: 1-814-6609 • Singapore: 462-0006 • Slovenia: 61-317-830 • South Africa: 331-6-8309 • South Korea: 2-2-222-3431  
Spain: 1-553 3234 • Sri Lanka: 1-86-5970 • Sweden: 8-740-5500 • Thailand: 66-2-398-6952 • United Kingdom: 203-23-3216



# Don't despair . . . Repair!

The all new Electronics Service Manual shows you how to troubleshoot and repair electronic equipment successfully. It is suitable for the beginner and more experienced enthusiast, trainee or repairman.

## You can become a repair expert

- Understand electricity and electronics.
- Confidently use test equipment to pinpoint problems.
- Become skilled at understanding flow charts, circuit diagrams and manufacturers data.
- Successfully identify components and understand their function.
- Learn how to skillfully remove and replace components.

## One source for all your repair needs

The Electronics Service Manual will get you started, or help develop your skills, in repairing and servicing electronic equipment. Over 850 pages, loose leaf A4 format in a durable, sturdy ring binder all for just £39.95 plus £5.50 post and packing.

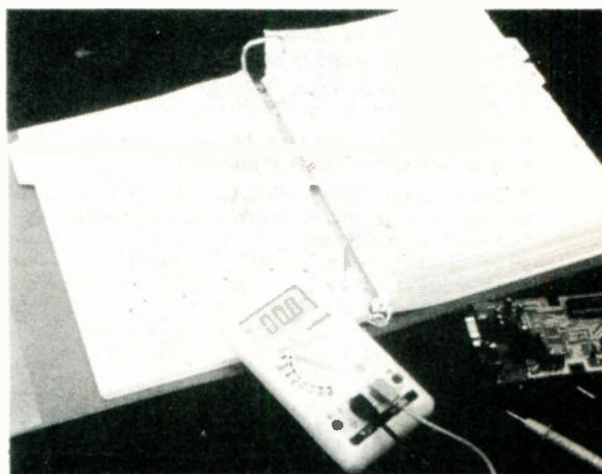
## Continue to broaden your repair expertise

You'll receive regular Supplements (about five a year) with new technical notes and information to enable you to service and repair an increasingly wide range of equipment. Each Supplement contains around 160 pages all for only £23.50 plus £2.50 p&p. You can of course return any Supplement (within ten 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)



## THE ELECTRONICS SERVICE MANUAL

### Covers:

- Safety
- Underpinning Knowledge
- Practical Skills
- Test Equipment
- Technical Notes
- Reference Data
- Full Index

**Easy to use format, professionally edited by Mike Tooley BA to be easily understandable by the beginner yet valuable to the more experienced enthusiast, trainee or repairman.**

Wimborne Publishing Ltd., Dept. E10  
Allen House, East Borough, Wimborne,  
Dorset BH21 1PF.  
Tel: 01 202 881749. Fax: 01 202 841692.

## PLEASE send me the ELECTRONICS SERVICE MANUAL

I enclose payment of **£45.45**. I shall also receive the appropriate Supplements several times a year. These are billed separately and can be returned (within 10 days) or 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 Exp. Date .....

## ORDER FORM

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

Wimborne Publishing Ltd, Dept. E10  
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	AIR MAIL ONLY £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 around 4kg when packed.

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

# 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.

**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**

By the time you have completed VT206 you have completed the basic electronics course and should have a good understanding of the operation of basic circuit elements.

## 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**

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)

**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**

By now you should have a good understanding of computer technology and what makes computers work. This series is also invaluable to the computer technician to understand the basics and thus aid troubleshooting.

**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**

**VT501** 58 minutes. Fibre Optics. From the fundamentals of fibre optic technology through cable manufacture to connectors, transmitters and receivers.  
**Order Code VT501**

**ORDERING:** Add £1.50 p&p per order for UK orders. **OVERSEAS ORDERS:** Add £3 postage 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

**£29.95**  
each inc. VAT

VCR EDUCATIONAL PRODUCTS COMPANY PRESENTS



UCA  
VCR EDUCATIONAL

**ORDER EIGHT OR MORE TOGETHER - GET ONE FREE (or order 16 together and get TWO FREE)**

PHOTOTRANSISTOR



PHOTOTRANSISTOR



# USING BARGRAPH DISPLAYS

ANDY FLIND

*An experimental approach to understanding the workings of bargraph displays, and to highlight just how versatile they really are!*

**T**HERE are many occasions when an experimenter or circuit designer will wish to convert an analogue signal into a visual display. The traditional way of doing this has always been the moving-coil meter, but since these are relatively large and fragile an alternative method is sometimes welcome.

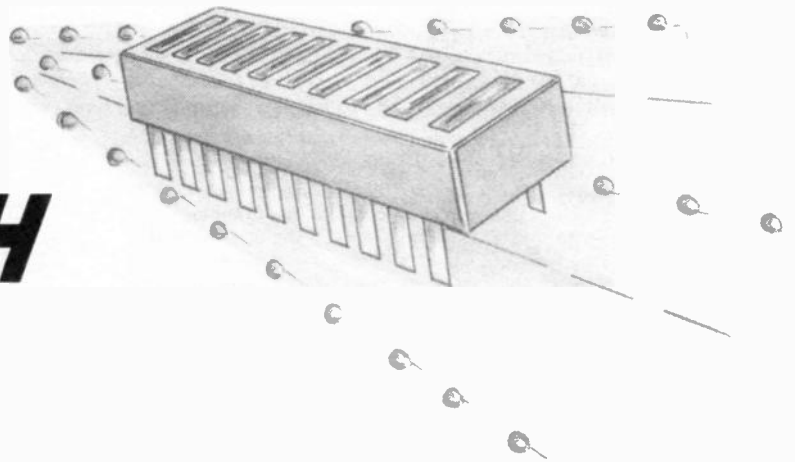
One modern solution is the i.e.d. bargraph display, often used to indicate amplitude levels on audio equipment. These are small, rugged, low in cost and easy to read, with a very fast response to input changes. They also look impressive!

It might be thought that the driving of a whole string of i.e.d.s in accurate sequence would require a complex circuit. It does, but thanks to some inexpensive "bargraph driver" i.c.s the designer doesn't have to worry about this.

Using these drivers, "dot" or "bar" style displays can easily be made to track input voltages accurately. For increased resolution displays may be cascaded, and there

is even a choice of linear, log or "VU" response. The log version is particularly useful where a wide signal input range is to be covered.

Power supplies range from just three up to eighteen volts so they are well suited to battery operation. All this flexibility, however, requires less effort from the designer than simply controlling the brilliance of a single i.e.d. with a discrete circuit, and this article will explain exactly how it is done together with some practical experiments.



## CHAIN GANG

The drivers to be described are the LM3914/LM3916 series, intended for use with 10-segment i.e.d. displays. Apart from the log, linear, or VU response characteristics they are internally similar so a suitable place to start is with a brief description of their internal structure.

A simplified diagram of the internal structure of the display drivers appears in Fig. 1, together with the pin positions and functions in Fig. 2. The heart of the device

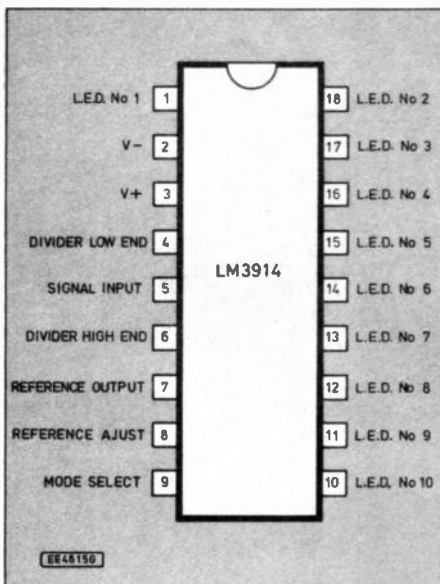
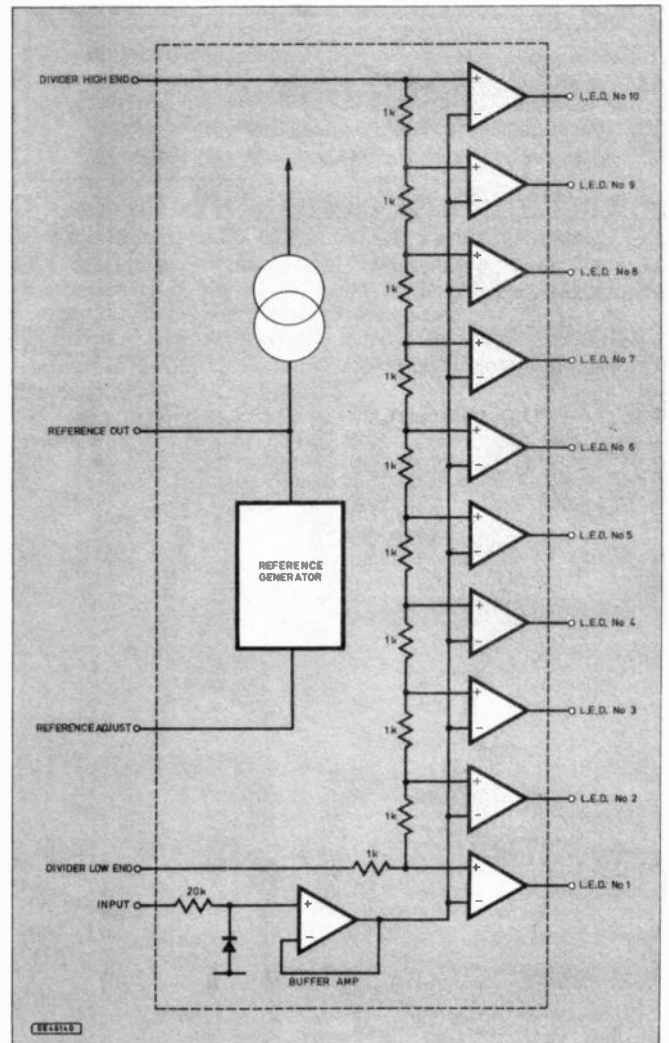


Fig. 1. (right). Internal structure of the LM3914 bargraph display driver i.c.

Fig. 2. (left). The pinout line-up and functions for the bargraph driver i.c.





is a ten-stage "divider chain" of resistors, to which a reference voltage can be connected. This reference may be derived either from an external source or from one supplied within the chip.

Each divider stage is connected to one input of an associated comparator, and the other inputs of all ten comparators are driven by a buffer amplifier to which the signal input is connected. As the input voltage rises, the comparators switch in sequence to drive the display i.e.d.s.

### ON THE BUFFER

The buffer and comparators have some useful properties which make them exceptionally easy to design with. They can operate with input voltages down to the negative supply, so single supply circuit design is simple.

The buffer input impedance is very high, so it may be connected directly to high-impedance sources. It can withstand up to thirty-five volts both above and below negative supply, so additional protection will usually be unnecessary.

The comparator outputs are open-circuit in the "off" state. When "on", they become constant-current sinks so the i.e.d.s can be connected directly to them without current limiting resistors, and the display brightness does not change with supply voltage variations. The i.e.d. drive current is set by the user with the value of a single external resistor.

Two operating modes, "Bar" and "Dot", are available, selected by a single pin connection. "Dot" is better for battery operation as only one i.e.d. is normally alight, whilst "Bar" may be preferred for some mains-operated applications. In both modes, with a few extra connections two or more driver chips and their displays may be cascaded for greater resolution.

### EXPERIMENTER'S TEST BOARD

The simple "Test Bed" stripboard component layout of Fig. 4 will enable constructors to experiment with these displays. The circuit diagram for the Experimenter's Test Board is shown in Fig. 3, consisting of the driver IC1, the ten-segment display IC2, and a decoupling capacitor C1. This is a tantalum bead type, recommended by the

## EXPERIMENTER'S BARGRAPH TEST BOARD

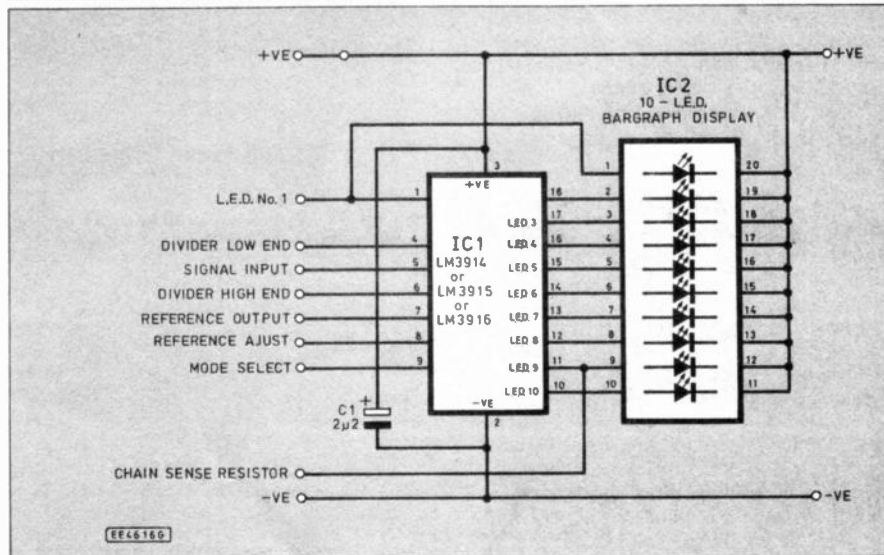


Fig. 3. Circuit diagram for the Experimenter's Bargraph Test Board.

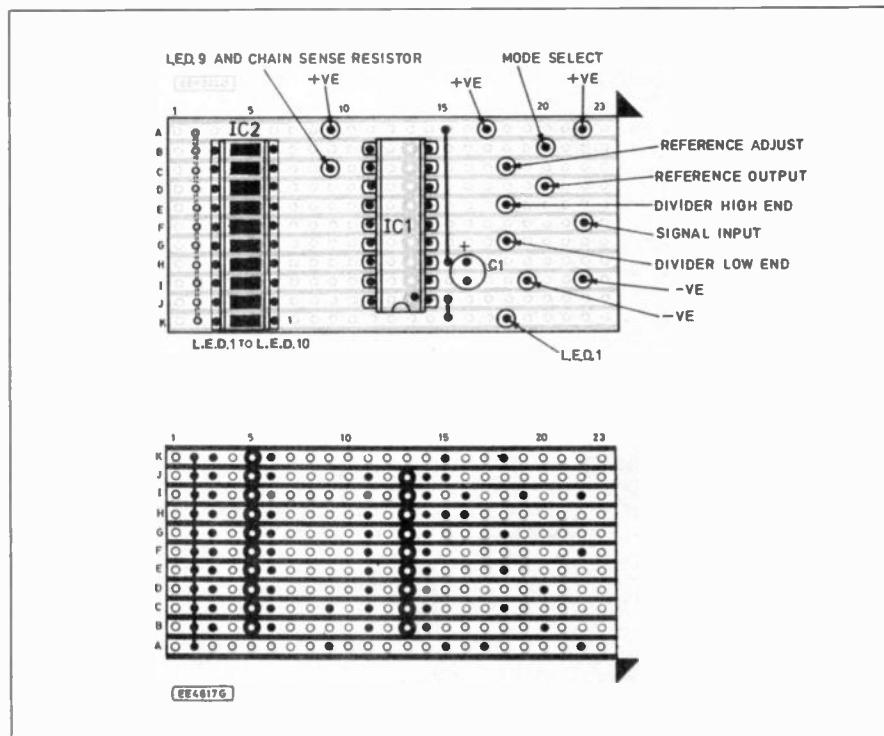


Fig. 4. Stripboard topside component layout, solder pin function details and underside view showing copper track breaks and links across tracks at points A2 to K2.

## COMPONENTS

### EXPERIMENTER'S TEST BOARD

#### Capacitors

C1 2µ2 tantalum bead, 35V

See  
**SHOP  
TALK**  
Page

#### Semiconductors

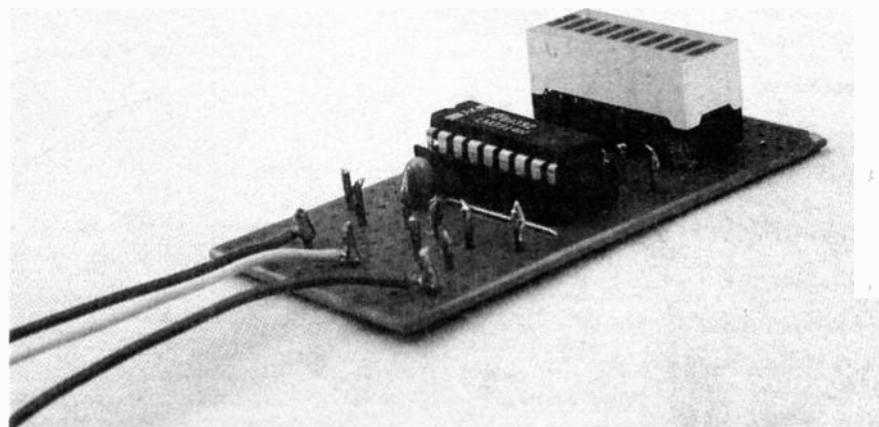
IC1 LM3914 (linear),  
LM3915 (log) or  
LM3916 (VU)  
bargraph display driver  
IC2 10-segment i.e.d. bargraph  
array, red

#### Miscellaneous

Stripboard, 0.1in. matrix, 13 strips x 23 holes; 18-pin d.i.l. socket; 20-pin d.i.l. socket; single-core link wire; multi-strand connecting wire; solder pins (13 off); solder etc.

Approx cost  
guidance only

**£9**



manufacturers to eliminate any possibility of spurious oscillation.

Connection points for configuring various circuits are readily accessible on the stripboard. The use of solder pins, available from board suppliers, for these is recommended here. The Experimenter's board has 13 strips of 23 holes.

Construction involves making nineteen breaks in the underside copper tracks as shown (Fig. 4), then fitting two topside wire links, three components, a third wire link on the underside and the thirteen solder pin connection points. The link on the copper track side is soldered to every strip across the left end, at points A2 down to K2, to make the common connection of the l.e.d. anodes (a); its position can be seen in Fig. 3.

Sockets are advised for the driver i.c. and the l.e.d. display so that if the circuit is later transferred to a p.c.b., these components can be re-used. Also, comparisons between log, linear and VU displays can be made by simply plugging in the appropriate chips and, if by some mischance an i.c. becomes damaged, it may be easily replaced.

Capacitor C1 is a tantalum bead type, care should be taken with the polarity of this as the markings are often difficult to read. The position of IC1, with pin one at bottom right, should be observed.

### TEST CIRCUIT

Following construction, experiments with the bargraph can be carried out. The pin functions of the various solder pin connections are also shown in Fig. 4. The simplest circuit arrangement is that of Fig. 5, where the bottom of the divider chain and the "reference adjust" are connected to negative supply whilst "reference output" is connected to the top of the divider chain, with a one kilohm resistor R2 to negative.

A variable input of about 0V to 1.6V, is supplied by VR1. The other connections are simply left unused. The voltage supplied by the "reference output" is about 1.25V, so when this simple circuit is powered VR1 should cover the full range of the display, which will be "Dot" mode.

Resistor R2 sets the l.e.d. drive current. The current supplied to each illuminated l.e.d. is about ten times the current drawn

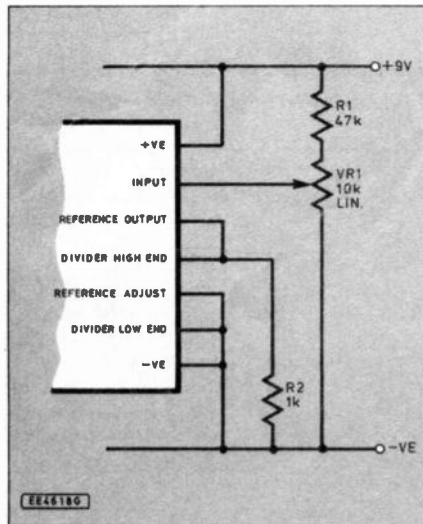
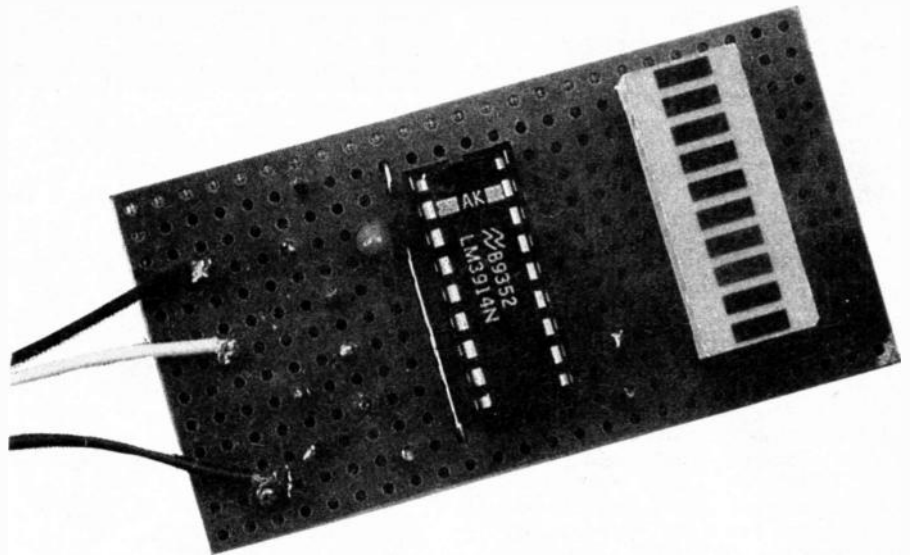


Fig. 5. Simplest form of test circuit arrangement.

from the reference output pin, so in this case, with 1.25V across one kilohm, it will be about 12.5mA.

For many battery-powered applications, this simple circuit will be all that is re-

quired. One chip, one l.e.d. array, two passive components and the circuit is complete! It will operate down to three volts, so three 1.5V cells are adequate to operate it, though anything up to 18V can be used.

However, it's worth exploring the capabilities of these i.c.s in more depth. If "mode select" (pin 9) is connected to the positive supply the display will change to "Bar" mode. This uses more current, but may be preferred for some applications. Heat generation within the chip can cause problems in this mode but a simple remedy for this will be explained later.

### FURTHER REFERENCE

Meanwhile, some alternative methods of providing the reference for the divider chain can be described. Fig. 6a and Fig. 6b show two ways of using the internal reference to obtain full scales of 1V and 0.5V respectively, whilst maintaining the l.e.d. drive current at about 12mA. Both can be trimmed by about  $\pm 25$  per cent.

The "reference adjust" pin (8) can be used in the same way as the "adjust" terminal on some 3-pin regulators, with a resistor to negative supply raising the

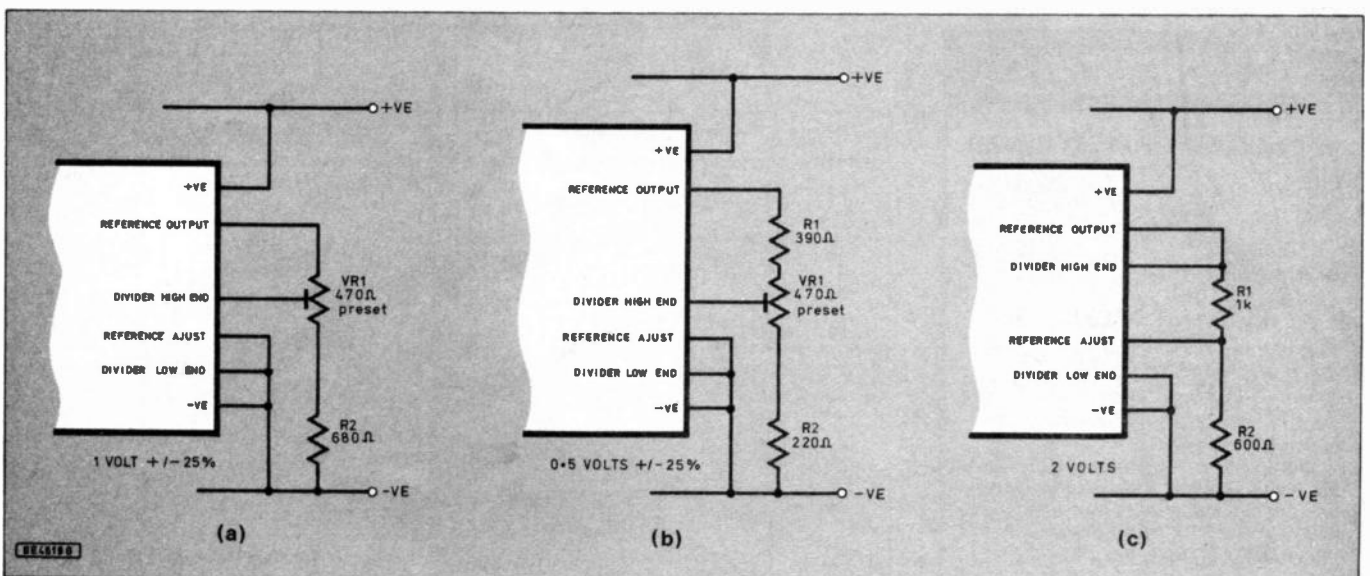


Fig. 6. Varying the reference with the internal generator of the bargraph driver chip. (a) and (b) show two ways of using the "internal reference" to obtain full-scales of 1V and 0.5V respectively. (c) using the "reference adjust" and internal reference to produce 2V.

voltage as shown in Fig. 6c. The internal reference of 1.25V appears between the "reference out" and "reference adjust" pins so the current flowing through resistor R1 flows to ground through the additional resistor R2, in this case adding another 0.75V to give a total of 2V.

The value of R2 for any voltage can be calculated from  $R2 = (V_{out} - 1.25) \times R1 / 1.25$ , remembering that the value of R1 will be determined by the i.e.d. drive current required. A small current, about 125µA, flows out of "reference adjust" and will add a little to this voltage, but in most cases this will be too small to be of significance.

## EXTERNAL INFLUENCE

Use of the internal reference is not essential, of course. So long as the i.e.d. drive has been set by connecting "reference adjust" and "reference out" to negative, the latter with a suitable resistor, the divider reference can be supplied from anywhere.

An adjustable 2V reference taken from a 5V regulated supply rail is shown in Fig. 7a. The bottom of the divider doesn't have to be connected to negative, either. Fig. 7b shows an arrangement which will give about 3V full-scale, starting from +2V.

In these arrangements the resistance of the divider chain must taken into account. In the case of the LM3914 linear driver this is about 10kilohms which, in parallel with the middle resistor, makes the scale 1V instead of about 1.6V.

## CASCADE

For greater resolution, drivers and their displays may be cascaded. In "Bar" mode this is simple. All that is necessary is to connect the "mode select" pin of each chip to positive to select "bar" display, set the "reference out" current of each for the required display brilliance, then connect the divider chains in series and apply the reference across them all. These connections, for two i.c.s., are shown in Fig. 8a.

Things get a little more complicated where the mode is to be "dot". The i.e.d. current and divider chain connections are the same, but as the first i.e.d. of each successive chip turns on, it is necessary to extinguish the last i.e.d. of the previous one.

Special circuitry is provided in the chips to achieve this. To use it, the "mode select" pin (9) of each i.c. in the circuit should be connected to pin 1 ("i.e.d.") of the following i.c. The "mode select" of the last chip can be left unconnected.

All chips except the last should also have a 22 kilohm resistor in parallel with i.e.d. 9 (between pin 11 and +Ve). Three i.c.s. connected in this manner are shown in Fig. 8b.

## TAKING PRECAUTIONS

A couple of basic precautions are necessary when using these i.c.s. The first, already mentioned, is the use of a 2.2µF tantalum bead decoupling capacitor close to the supply pins to prevent possible oscillation.

A second and more serious consideration concerns power dissipation when used in "Bar" mode. Let's say a chip is programmed to supply 18mA to each i.e.d., with a 680 ohm load resistor connected to the reference. With all ten i.e.d.'s lit, the drain will be about 180mA.

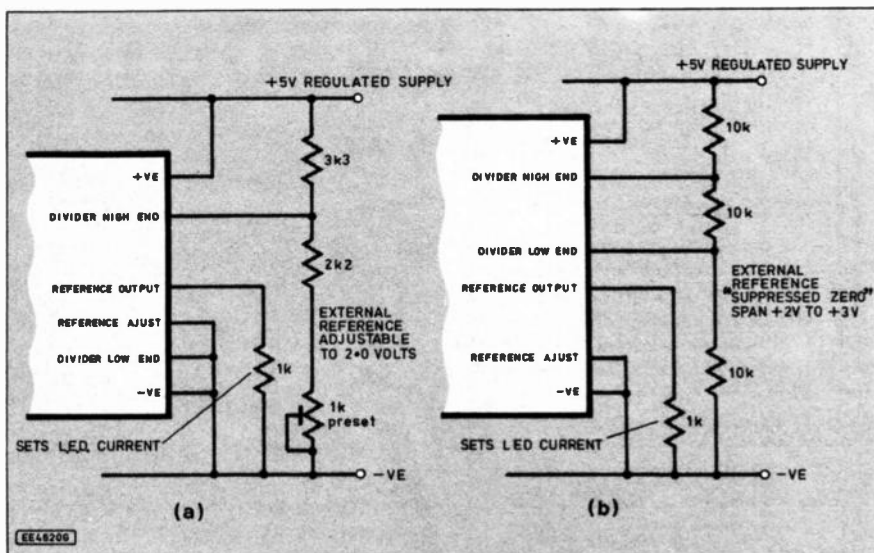


Fig. 7. Using external reference sources, (a) to produce an adjustable 2V and (b) up to +3V starting from +2V.

If the supply voltage is 9V, the i.e.d.s will drop about 1.75V of this and the remainder, some 7.25V, will appear across the current sinking outputs of the chip, giving rise to an internal dissipation of about 1.3W. The snag is that the i.c. is only rated for a total dissipation of 600mW so this would fry the chip faster than your local chippie!

The simple solution is to incorporate a resistor in series with the positive supply to the i.e.d. anodes, chosen to reduce the voltage to about 3V when the maximum current is drawn. In the example above a value of 33 ohms would be about right.

This would reduce the supply to 3V, of which about 1.3V would appear across the drivers in the chip, producing a dissipation

of about 230mW which is well within the safe area. The resistor would dissipate about a watt of course, so a suitably-rated type would be required.

For mains-driven circuits incorporating a number of bargraph displays a good starting point would be a separate regulated 5V supply of suitable current rating. Series resistors would still be required, but their value would be reduced to 10 ohms with a 0.4W rating, and the overall amount of heat to be dissipated would be much reduced.

To try this with the "Experimenter's Test Board" stripboard an extra break will be required in the positive supply strip, with an extra connection point to make a separate supply connection to the i.e.d. array. □

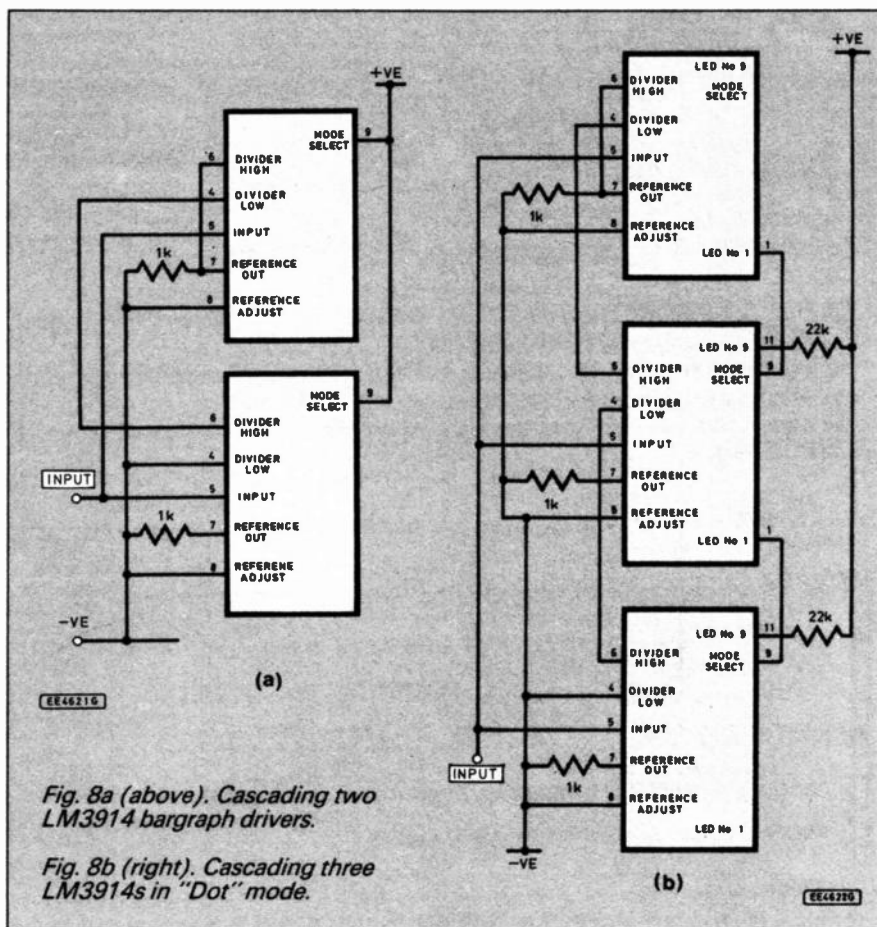


Fig. 8a (above). Cascading two LM3914 bargraph drivers.

Fig. 8b (right). Cascading three LM3914s in "Dot" mode.

# 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 **£6.00** 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. E10**  
**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 **£45.95**. 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.

### ORDER FORM

Simply complete and return the order form with your payment to the following address:  
**Wimborne Publishing Ltd, Dept. E10**  
**Allen House, East Borough, Wimborne,**  
**Dorset BH21 1PF**

**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** .....

**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	AIR MAIL ONLY £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.

# Techniques

## ACTUALLY DOING IT!

by Robert Penfold

**E**LECTRONICS is a hobby that can be pursued more or less as a craft, with projects being constructed by people who have little or no idea of how everything works. At the other extreme it is possible to read and learn about the theory of electronics without ever bothering to build a single project. Virtually all electronic hobbyists steer a course somewhere between these two limits, learning a fair amount about both the practical and theoretical sides of the hobby.

Even if you wish to pursue electronics largely for the pleasure of constructing projects, there are still some technicalities which you will need to tackle. An understanding of circuit diagrams is something you will probably want to master at a fairly early stage.

### INGENUITY

An ability to read circuit diagrams is not needed in order to tackle a constructional project featured in *EPE* since a printed circuit or stripboard design is provided for every project. You basically just have to follow the drawings, which use physical representations of the components rather than symbols which often have little in common with the physical appearance of the components.

There are numerous circuits published in books, and in magazine features such as *Ingenuity Unlimited* and *Circuit Surgery*. Many of these are quite simple but useful, and before too

long you will probably wish to try your hand at building one.

With this type of thing you normally have no help other than the circuit diagram, and you must design your own circuit layouts. You must obviously learn to read circuit diagrams before you can progress to the component layout. Fortunately, reading most circuit diagrams is very straightforward.

### SYMBOLISM

A selection of common circuit symbols is given in Fig. 1. When dealing with circuit diagrams it is important to realise that there are variations in a given symbol from one circuit diagram to another.

In a few cases this is due to the fact that there are old and new versions of the symbol. The obvious example is the resistor, which has the old zigzag style symbol, and the box style symbol which is the current British standard.

Although it is officially obsolete, the zigzag resistor symbol remains popular, and is still used a great deal. It is, of course, the resistor symbol used in circuit diagrams that appear in this magazine.

In a similar vein, circuit symbols do not seem to be internationally standardised. Publications that have their origins outside the UK often have circuit symbols that are significantly different to the British standard set.

Perhaps the most common examples are the American capacitor symbols. In an American capacitor symbol one line is curved, whereas both lines are straight in the British version.

The other reason for differences between supposedly identical circuit symbols is simply differences in drawing style from one symbol designer to another. These usually produce relatively minor variations, and should not give any major difficulties.

There is actually a style of circuit diagram which has virtually all two terminal components represented by a rectangle, like the box style resistor symbol. This type of circuit diagram has not been used much in publications aimed at amateurs, but is used a great deal in service manuals, etc.

**Table 1: Component Identification**

Letter(s)	Component
B	Battery
BY	Battery
C	Capacitor (any fixed value type)
CH	Chassis
CRT	Cathode ray tube
CSR	Thyristor or triac (controlled silicon rectifier)
D	Diode (any type, including photodiodes, i.e.d.s, and rectifiers)
E	Earth
FL	Filter (usually a ceramic, mechanical, or crystal type)
FS	Fuse
JK	Jack socket
IC	Integrated circuit
IFT	Intermediate frequency transformer
L	Inductor
LP	Lamp (neon or filament, but not an i.e.d.)
LS	Loudspeaker
M	Motor
ME	Meter
Mic	Microphone
PCC	Photo conductive cell (photoresistor, usually a cadmium sulphide type)
PL	Plug (any type)
Q	Transistor
R	Resistor (fixed value)
RL	Relay (coil or contacts)
RV	Variable resistor or potentiometer
S	Switch
SK	Socket (any type, but jack sockets are often given "JK" identification letters)
SW	Switch
T	Transformer (any type including r.f.)
TC	Trimmer capacitor (preset variable capacitor)
Th	Thermistor
TL	Earphone or headphones
Tr	Transistor
TR	Transistor
V	Valve (any type except c.r.t.)
VC	Variable capacitor
VR	Variable resistor or potentiometer
WD	Warning device (horn, bell, buzzer, etc.)
X	Crystal (also used where other letters inapplicable)

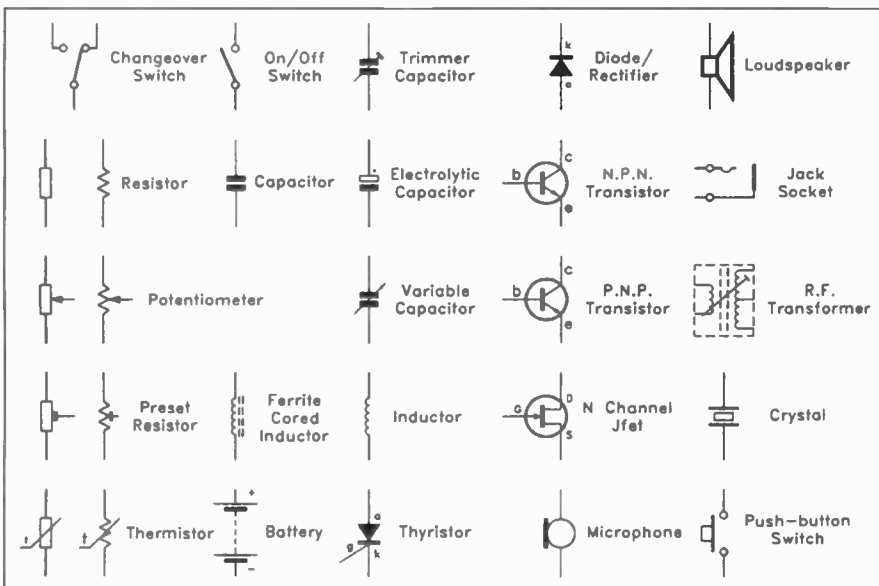


Fig. 1. A selection of common circuit symbols. The styles in which they can be drawn vary greatly.

If in doubt about a circuit symbol, the letter in the component number should enable you to identify the type of component the symbol is meant to represent. With the circuit diagrams that use rectangles for most types of component, this is the only means of telling whether a component is a resistor, a capacitor, or an inductor.

There are a few minor variations in the letters used in component numbers. For example, transistors are normally TR1, TR2, etc, but can be Tr1, Tr2, etc., or Q1, Q2, etc. The list of component identification letters compiled in Table 1 should help to clarify matters.

## BETWEEN THE LINES

On circuit diagrams, symbols are used to represent the components, and lines are used to represent the wires connecting one component to the next. Fig. 2 shows a simple "dummy" circuit diagram. Sometimes things are very straightforward, and in this example resistor R4 simply connects between pin 6 of IC1 (integrated circuit) and the base (b) terminal of TR1 (transistor).

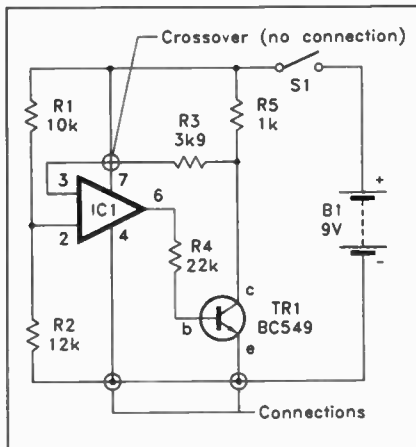


Fig. 2. Circuit diagram example showing connections and a crossover.

Often though, a lead or pin of a component will connect to more than one other component. For example, pin 2 of IC1 connects to both R1 and R2. This inevitably leads to some "T" junctions where three leads meet, and the "dot" circuit symbol is then used to indicate that there is a connection between all three leads. If one lead crosses over another but there is no connection between them, no dot symbol is used at the intersection of the two lines. Thus, in this example circuit there is no connection between pins 3 and 7 of IC1.

## POLARITY

Most of the two-terminal components can be connected either way round. This includes resistors, non-polarised capacitors, inductors, and crystals. Electrolytic capacitors, and other polarised types such as tantalum capacitors, however, must be connected with the right polarity. There is no difficulty here since the positive terminal is marked with a "+" sign on circuit diagrams, and the actual components are marked with "+" and (or) "-" signs. Also, "axial" electrolytic capacitors usually have an indentation

around the body next to the positive leadout wire.

Diodes of any type (rectifiers, photodiodes, l.e.d.s, etc.) must also be connected the right way round. On the circuit diagram the bar part of the symbol denotes the cathode ("k" or "+" terminal of a diode or rectifier.

On most diodes and small rectifiers the cathode terminal is indicated by a band around the appropriate end of the body, see Fig. 3. With some of the larger rectifiers the cathode is indicated by a thinning of the body at the cathode end.

The 1N4148 is a popular general purpose silicon diode, and this sometimes has four bands around the body. These indicate the "4148" part of the type number using a method of coding based on resistor colour codes. The first yellow band is the one next to the cathode leadout, and this band should be slightly wider than the other three.

With the more exotic devices, such as photodiodes and l.e.d.s, the retailer's catalogue will usually provide connection details. One of the reasons I frequently advise buying at least a couple of the larger component catalogues is that they provide a massive amount of useful data. This often includes leadout data for all the semiconductors included in the catalogue.

Obviously great care needs to be taken in order to get three lead semiconductors (transistors, triacs, etc.) connected the right way round. Again, the larger component catalogues provide leadout information for all the three terminal semiconductors you are likely to use.

Note that it is the convention for the leadout diagrams for transistor, triacs, and the like to be *base views*. In other words, they show the components viewed with the leadout wires pointing towards you.

## INTEGRATED CIRCUITS

There are specific circuit symbols for logic gates, and for operational amplifiers (op.amps), but for other integrated circuits (i.c.s) a rectangle is used. In the present context the symbol used is not important. All you need to worry about are the component *identification numbers* which enable you to distinguish between one integrated circuit and another, and the *pin numbers* for each device.

These days, most integrated circuits are housed in d.i.l. (dual in-line) plastic encapsulations. These either

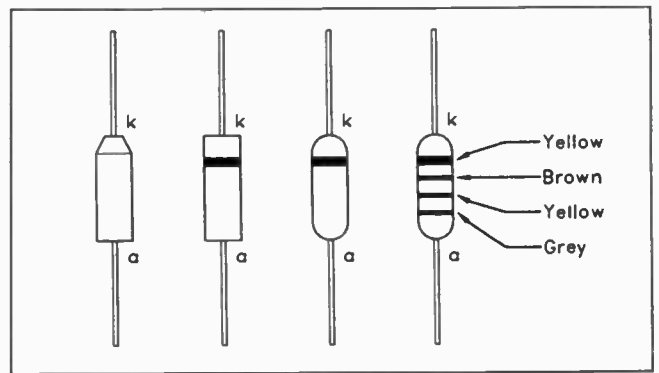


Fig. 3. Common methods of indicating the polarity of diodes and rectifiers.

have pin one indicated by a "small dimple in the case, or the pin 1/14 end of the component is indicated by a notch or line at that end of the case, see Fig. 4.

Many actual components seem to use two of these methods, as in the fourth example of Fig. 4. Always look carefully at d.i.l. integrated circuits as there are often moulding marks that can look rather like the notch, but are actually at the other end of the case.

Only 14-pin devices are shown in Fig. 4, but the method of numbering is the same regardless of the number of pins. The pins are numbered in a counter-clockwise direction with the device *viewed from the top* (with the pins pointing away from you). Note that the convention is for i.c. pinout diagrams to be top views, which is the opposite to the convention for transistors and physically similar semiconductor devices. With the more exotic integrated circuits, such as some of the power types, the all-important component catalogues should be able to provide pinout details.

## PRACTICE MAKES PERFECT

Ultimately there is only one way to get to grips with reading circuit diagrams, and that is to try your hand at it, starting with a few simple circuits and progressing to more complex ones as you advance your skills. Start by looking at some of the simpler projects in *EPE*, and compare the theoretical circuit with the circuit board and wiring diagrams. This will teach you a great deal about laying out circuit boards as well as improving your proficiency at reading circuit diagrams.

Alternatively, you could "sign-on" for the new *Teach-In '96* series starting next month. This exciting series will be combining both the theoretical and practical sides of electronics - *Most of the emphasis being on the "PRACTICAL"* - Ed.

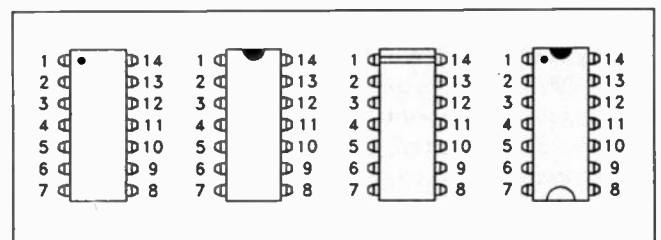
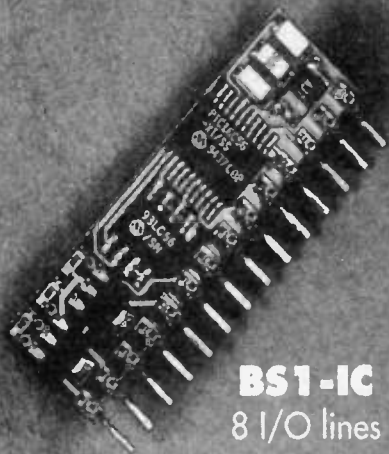
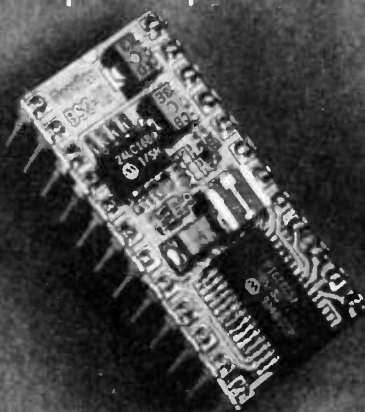


Fig. 4. Polarity indications and pin numbering for typical d.i.l. integrated circuits.

**When Performance is more important than size:-**  
two new re-programmable BASIC Stamp Computers.



**BS1-IC**  
8 I/O lines  
up to 100 program lines  
2,000 lines/sec  
Comms to 2400 baud  
**£29** single price



**BS2-IC**  
16 I/O lines  
up to 600 program lines  
10,000 lines/sec  
Comms to 9600 baud  
**£49** single price

Programming package £66

Milford Instruments Tel 01977 683665 Fax 01977 681465

## 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 (see photo).

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 with Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Fax: 01202 841692 (We cannot reply to overseas queries or confirm orders by fax due to the high costs).

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).



# ELECTRONICS SOFTWARE

If you are looking for a means of improving your knowledge of the basics of electronics then this software is for you.

## ELECTRONICS PRINCIPLES 2.1

- ★ Insulators, Conductors, Resistance ★ D.C. Circuits
- ★ Capacitance and Inductance ★ A.C. Series Circuits
- ★ A.C. Parallel Circuits ★ Reactance and Impedance
- ★ A.C. and D.C. Power ★ Frequency and Tuned Circuits
- ★ Using Numbers ★ Complex Numbers, Phase Angles
- ★ P.N. Junction Diode ★ Bi-polar and MOSFET Transistors
- ★ Operational Amplifiers ★ Logic Gates ★ Digital Number Systems
- ★ Combinational Logic ★ Flip Flops ★ Counters and Shift Registers
- ★ Memory ★ Microcomputer operation

Now an extended range of electronics topics with an improved graphics presentation, available to electronics hobbyists, students, schools, colleges, and used for training within industry throughout the UK and overseas. A fully interactive electronics program where the user selects from over 250 analogue and digital topics. Circuit diagrams, wave forms, phase angles, voltages and currents or logic states are shown, drawn to scale, in full colour. Formulae are given demonstrating all the calculation steps, exactly as in a textbook, using your input values.

An 'on screen' electronics package including circuit theory to enable a learning through doing approach to encourage experimentation. For the young student, mature hobbyist or the engineer that just needs to keep up-to-date in an easy and enjoyable way.

*Having reviewed a dozen, or more, educational software packages designed to "teach" electronics, I was more than a little sceptical when I first heard about Electronics Principles: there seemed to be little that could be done that has not been done elsewhere. When I started to use the package my views changed. Indeed, I was so impressed with it that I quickly came to the conclusion that readers should have an opportunity to try the package out for themselves! - MIKE TOOLEY B.A. Dean of Faculty of Technology, Brooklands Technical College.*

Complete package **Still only £49.95**

## ELECTRONICS PC TOOLBOX VERSION 2.0

An extended and improved version of the popular Toolbox software. Presents commonly used formulae in a way that makes calculations easier thus encouraging experimentation in circuit design.

Covers D.C. Calculations from Ohm's Law to Loading a Potential Divider; Further D.C. Calculations from Power Ratio Decibels to Kirchhoff's Laws; A.C. Calculations from Average Peak Current to Filters and Admittance; Capacitance Calculations from Values to RC Time Constants; Inductance Calculations from Values to Selectivity; Binary Calculations from Addition to 2's Complement; Numbers and Phase Angles from Addition to Polar to Rectangular; Operational Amplifiers from Inverting Op.Amp to Op.Amp Differentiator.

**Only £19.95**

These programs require a PC (or fully compatible system) running DOS or Windows with an 80286 or better processor and VGA (ideally colour) graphics. In addition you must have 4Mb of hard disk space, a high density (1.44Mb) floppy drive and at least 640K of RAM. We also recommend the use of a mouse. Site licences are available - please enquire.

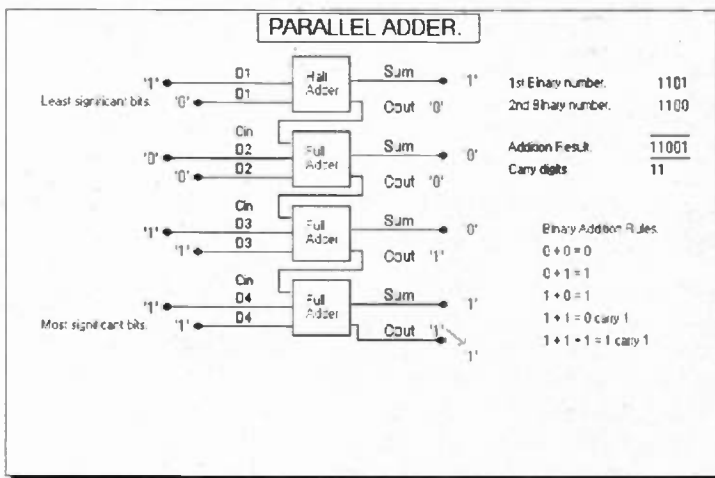
Available from

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

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

Visa and Mastercard orders accepted - please give card number, expiry date and cardholders address if different from the delivery address.

OVERSEAS ORDERS: Add £2.50 postage for countries in the E.E.C. Overseas readers, outside the E.E.C. countries add £3.50 for airmail postage.



## GCSE ELECTRONICS VERSION 2.0

Designed to complement the *EPE Teach-In No. 7* publication, which contains a complete electronics course aimed at GCSE and A Level students, this software can also be used as a stand alone learning package for everyone interested in electronics. From simple d.c. current flow and Ohm's Law it covers the whole GCSE syllabus including a.c., semiconductors, op.amps, digital electronics, radio and fibre optic communications, digital numbering systems and goes on to look at microprocessor c.p.u.s, 6502 addressing modes and instruction sets. It even produces a program listing, which can be saved or retrieved from hard disk, when any of the instructions from the listed instruction set are input, thus allowing the user to monitor the registers for each of the addressing modes.

The original version is now widely used in schools and colleges throughout the UK.

An interactive, user friendly medium which assists learning in an enjoyable and interesting way.

**Only £39.95**

For more information or software upgrades call us on 01376 514008

## GCSE MATHS now version 2.0

A series of programs covering all the major topics required by the school syllabus. Designed to be user friendly enabling you to study or revise in what we believe is an interesting and enjoyable way. There are nearly one hundred and fifty menu driven screens with interactive graphics, enabling a "learning through doing" approach to encourage experimentation. Now being used in many schools throughout the UK.

**Only £49.95**

## JUST FOR FUN!

EPT Lottery Selector. Windows version. £5.00 + £1 p&P



# Direct Book Service

The books listed have been selected by *Everyday with 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.

## Everyday with Practical Electronics Books

### ELECTRONIC PROJECTS - BOOK 1

Published by *Everyday 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 Ioniser, 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 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 88 89** £2.45

### ELECTRONICS TEACH-IN No. 6

#### DESIGN YOUR OWN CIRCUITS

(Published by *Everyday with 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 Amplifier; 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 with 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 complement the course and a FREE DISC covering the first two parts of the course is included with the book.

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 BP326** £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 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 meaning 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.

64 pages **Order code BP322** £3.95

### UNDERSTANDING PC SPECIFICATIONS

R. A. Penfold

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 EGA!

104 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

# 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

# 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 PC101

£8.95

## AN INTRODUCTION TO LOUDSPEAKERS 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 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 inexpensive 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

# Theory and Reference

## ELECTRONIC HOBBYISTS HANDBOOK

R. A. Penfold

Provides an inexpensive single source of easily located information that the amateur electronics enthusiast is likely to need for the day-to-day pursuance of this fascinating hobby. Covers common component colour codes. Details the characteristics and pinouts of many popular semiconductor devices, including various types of logic i.c.s, operational amplifiers, transistors, FETs, unijunctions, diodes, rectifiers, SCRs, diacs, triacs, regulators and SMDs, etc. Illustrates many useful types of circuits, such as timers and oscillators, audio amplifiers and filters, as well as including a separate section on power supplies. Also contains a multitude of other useful data.

88 pages

Order code BP233

£4.95

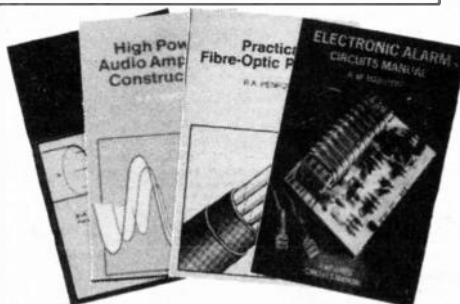
## A REFERENCE GUIDE TO PRACTICAL ELECTRONICS TERMS

F. A. Wilson

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 Electronics 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 BP266

£3.95

# 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, F.M. 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 BP374

£4.95

## HOW TO GET YOUR ELECTRONIC PROJECTS WORKING

R. A. Penfold

We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

96 pages

Temporarily out of print

## 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 BP285

£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

## DESIGN YOUR OWN CIRCUITS

See the first page of books - ELECTRONICS TEACH-IN No. 6 - for full details.

## ELECTRONICS PROJECT BOOK

Published by *Everyday Electronics* in association with *Magenta Electronics*.

See the first page of books for full details.

## 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 strip-board layout and assembly, as well as notes on setting up and using the units. Contents include: Guitar tuner; Guitar preamplifier; Guitar headphone amplifier; Soft distortion unit; Compressor; Envelope was was; Phaser; Dual tracking effects unit; Noise gate/expander; Treble booster; Dynamic treble booster; Envelope modifier; Tremolo unit; DI box.

110 pages

Order code PC110

£8.95

## 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

# 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

## Electronic Power Supply Handbook

Ian R. Sinclair

This book covers the often neglected topic of electronic power supplies. All types of supplies that are used for electronics purposes are covered in detail, starting with cells and batteries and extending by way of rectified supplies and linear stabilisers to modern switch-mode systems, i.e. switch-mode regulators, DC-DC converters and inverters.

The devices, their operating principles and typical circuits are all dealt with in detail. The action of rectifiers and the reservoir capacitor is emphasised, and the subject of stabilisation is covered. The book includes some useful formulae for assessing the likely hum level of a conventional rectifier reservoir supply.  
136 pages **Order code PC108** £7.95

## 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 l.e.d. circuits.

50 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 amplifiers and 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

## 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; sine-wave 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 Op.Amps

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

## 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 BP352** £4.95

# 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 wavetrap 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 serials 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 broadcast 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 t.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.

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

## 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 with Practical Electronics*) before ordering from old lists.

For a further selection of books see next month's issue.

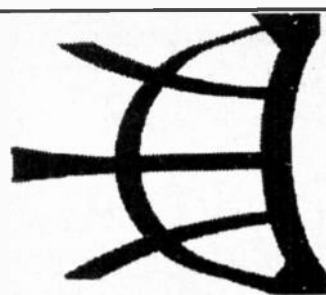
**DIRECT BOOK SERVICE IS A DIVISION OF WIMBORNE PUBLISHING LTD.**



# REPORTING

# AMATEUR RADIO

Tony Smith G4FAI



## NOVICE ENTRY

Last month I explained how to become a radio amateur, by taking the "full" Radio Amateurs' Examination (RAE). This time I'm looking at the Novice Radio Licence which is designed to encourage people of all ages, but particularly the young, to take up amateur radio.

Courses for the Novice Radio Amateurs' Examination (NRAE) are run by the Radio Society of Great Britain at locations throughout the UK. Local instructors who are also radio amateurs run the courses. These last for about 30 hours over 12 weeks, and the exams are held four times a year.

Candidates must successfully complete the course before taking the examination. Encouragingly, the courses achieve very good results as can be seen from the following statistics. In the three years up to September 1994, 3,603 candidates took the exam and 2898 passed, a success rate of 80 per cent.

## EXAMINATION

The 75-minute examination is set by the City & Guilds of London Institute and has 45 multiple choice questions.

The subjects covered are: Receivers and receiving techniques; components, applications and units; measurements; propagation and antennas; transmitters and transmitting techniques; operating techniques; station layout; construction; safety; and licensing conditions.

A candidate passing only one paper can carry forward that pass indefinitely, needing only to pass the remaining paper in a future examination. As in the case of the RAE, special arrangements can be made for disabled or housebound candidates. Subject to receipt of satisfactory evidence, extra time may be allowed, or the examination may be taken at home or in hospital.

## TWO TYPES OF LICENCE

Once you have passed the examination there are two types of Novice licence available. Class A requires a Morse test to be passed at five words per minute, and Class B can be obtained without the need to take a Morse test.

Unlike the holders of the "full" Class A and Class B licences, Novice licensees have restricted frequencies available to them, and must use low power when transmitting. Class A Novices have some access to the HF bands (using mainly Morse with some telephony) and to the VHF/UHF bands (with several modes, including voice, Morse, and use of computers). Class B Novices have limited access as above only to the VHF/UHF bands.

Despite these limitations, Novice operators are able to experience many aspects of amateur radio at first hand, and many go on to take the RAE to become "full" A or B licensees.

## HOW TO START

Information about Novice training courses, including details of where they are held in your locality, can be obtained from the *Radio Society of Great Britain, Dept EPE, Lambda House, Cranborne Road, Potters Bar, Herts EN6 3JE*. The Society has several publications specially written for Novice students.

Additionally, as mentioned last month, the Radiocommunications Agency has a free booklet, *How to Become a Radio Amateur*, obtainable by phoning 0171 215 2352. Copies of the NRAE examination syllabus (price £2 post free), plus free sample questions, can be obtained from *The City & Guilds of London Institute, Dept EPE, 46 Britannia Street, London WC1X 9RG*. The subject number to be quoted is 773.

Next month I will finish this review of the ways to become a radio amateur by looking at the two different types of Morse test, and various methods of learning the code.

## RSGB MEMBERSHIP CHANGES

The RSGB has just announced a new membership category for young people under 18 called the "HamClub". For £10 a year members receive a special Junior Membership pack and a free annual subscription to *D-i-Y Radio* magazine.

At the other end of the scale, veteran Home Corporate members with 50 years continuous membership will receive a 50 per cent discount on their fees, and those with 60 years membership will be given free life membership.

As from September, the Home Corporate membership fee increased from £32 to £34 p.a. The rate for senior citizens is unchanged at £27. Full-time students and family members' fees are reduced.

Details of the new categories and changed rates are in the August issue of *Radio Communication*. Copies of this issue are available to non-members by sending an A4 s.a.e. with 43p in stamps to: "John Davies, August RadCom", at the RSGB address above.

## FREE DX BOOKLET

A useful free booklet for SWLs, *Radio Propagation For Beginners* is available from radio station KNLS in Alaska. This is written by Carl Mann, a radio news reporter in Omaha, Nebraska, himself an enthusiastic shortwave listener.

Intended to help listeners improve their reception during the low end of the 11-year propagation cycle, its chapters cover: An Introduction to Propagation; Groundwave, Skywave and the Ionosphere; The Radio Spectrum; The Solar Cycle; and Understanding and Using Propagation Knowledge.

There are four appendices, providing definitions of the geophysical alerts

broadcast at 18 minutes past the hour by WWV (the standard frequency and time signal station); information about the current state of solar cycle 22, which is forecast to end in mid-1996; a frequency/wavelength conversion chart covering the shortwave broadcast bands; and details of a simple long wire antenna suitable for shortwave reception.

The booklet is free of charge, but two international reply coupons should be sent to cover postage. Write to *DX Propagation for Beginners, c/o Station KNLS, Anchor Point, Alaska 99556, USA*. Please mention that you read about the booklet in this magazine.

## AUSTRALIAN FEE REDUCED

In May, I reported that Australia's Spectrum Management Agency (SMA) had imposed a 92 per cent increase on its amateur licence fees, including a new "Spectrum Access Tax".

After receiving a barrage of protest from amateurs around Australia, the SMA has compromised by reducing the new licence fee from the proposed A\$71 to A\$51, a final increase over the old fee of just under 38 per cent.

The Wireless Institute of Australia (WIA) is continuing its fight against any increase at all, and is currently seeking to make the government more aware of the true value of amateur radio in the hope that it will set a more appropriate (lower) licence fee.

## SUPERHET RADIO HANDBOOK

A new book by Ian Poole, G3YWX, a regular contributor to *EPE*, looks at the operation of the superhet radio. He says: "It has formed the basis for most radios since the 1920's. Now over seventy years later there are no other ideas even on the horizon which might replace it."

During this period, valves have been replaced by transistors, which in turn have been replaced by integrated circuits. Although the superhet principle has remained the same, today's circuits are more complicated than those of the past, and provide more facilities with greatly improved performance.

This book takes the reader through every stage of the superhet circuit, from basic principles to modern refinements. If you want to understand what radio is all about, you can make a good start with this small handy volume. Whether you are interested in communications equipment, worldband radios, scanners or domestic broadcast receivers, it will help you understand how they work, and what to look for when in the market for a new receiver.

*The Superhet Radio Handbook*, by I.D. Poole, is published by Bernard Babani (publishing) Ltd, price £4.95. It is available from the *EPE Direct Book Service*.

## KITS

**TIMER KIT.** Controls 4 outputs at preset times over a 7 day cycle. LED display. Easily programmed via keyboard. **£65.95**  
**ELECTRONIC LOCK KIT.** Over 38,000 possible combinations. Alarm sounds after 3-9 failed guesses and locks out keyboard for preset time. **£25.50**  
**SUPER SENSITIVE FM MICROBUG.** Runs off a 9V battery, fits in a match box, listen in on any FM radio. **£10.25**  
**STROBE KIT.** Can be triggered by external voltage e.g. loudspeaker or as a slave flash for photographic purposes. **£21.85**  
 Plus many many more. Including all TK Kits.  
 For full details send your SAE now.

## COMPONENTS

We have a full range of electronic components at competitive prices. Send an SAE for price lists.  
**NEW BOOK! Beginner's Guide to the Internet.** 88pp £5 Inc.

**GATS**  
ELECTRONICS

149 The Vale, Acton W3 7HR  
 Tel: 0181 932 0144  
 Fax: 0181 932 0145

**Semiconductors, connectors, capacitors, fans, resistors, relays, manuals, data books and much more...**

— All available at very low VAT inclusive prices —  
 Large SAE for current list

**BHA Trading**

15 OAKWELL CLOSE, STEVENAGE,  
 HERTS SG2 8UG  
 TEL: 01438 816474  
 FAX: 01438 812569



**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.

## 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. Includes FET mic, 2 x 3 cm PCB **£6.95**

**MICRO FM (b).** Variable mic, sensitivity. Tuneable 80-110MHz 1km range. 2 x 3.5 cm PCB **£7.95**

**ULTRA MINI FM.** 200mtrs range, 80-100MHz, runs off watch battery (inc), only 1 x 2cm PCB **£8.95**

**FM TRACKER.** Transmits a constant tone for direction finding, tracking etc. 80-110MHz **£8.50**

**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 amp and tuning LED **£13.50**

**CRYSTAL RADIO.** Great Introduction to radio electronics. Includes tuner, ferrite aerial and earphone **£7.50**

**AM RADIO.** Single chip radio for use with headphones. (not inc.) or an external amplifier **£8.90**

**I.R. REMOTE CONTROL.** Single channel for lights, garage doors etc. Transmitter - **£6.95**  
 Receiver (with mains relay) - **£9.50**

**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**

**AU13 SMALL SIGNAL.** Single FET preamp for boosting low output piezo pickups or acoustic transducers **£3.90**

**AU14 SMALL SIG + EQ.** An AU13 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. **£8.95**

**AU17 7-BAND EQ** board for graphic/tone control applications. Pots included **£12.95**

**AU18 NOISE REDUCTION SYSTEM.** High quality dynamic noise gate with variable effect and level **£15.95**  
**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**  
**AU20 CONTROL OSC.** Low frequency oscillator to modulate the analogue delay line for Flanging, Chorus and other effects **£8.50**  
**AU21/21 DIGITAL DELAYS.** 200ms and 800ms digital delay lines with 10-bit a/d d/a conversion. Variable sample rate from 25kHz-50kHz variable delay time. 200ms - **£20.40**, 800ms - **£24.95**

**POWER AMPS**  
**P2 15 WATT.** General purpose upgrade. Uses TDA2030. 24V single rail with heatsink **£9.95**  
**P3 40 WATT.** High quality power amp for compact disc and other demanding applications. Switch on mute, thermal/short protection. Distortion less than 0.003% 27V ± with heatsink **£15.50**  
**PA 150 WATT.** Rugged and powerful MOSFET design, excellent response and reliability, 50V ± with heatsink. Ideal for guitar amps. PA or sound system **£22.95**

## 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)

SEND FOR A LIST OF OUR FULL RANGE OF RADIO AND AUDIO KITS. ALL KITS COME COMPLETE WITH PRE-DRILLED P.C.B.'s, HIGH SPEC COMPONENTS AND FULL INSTRUCTIONS - MAIL ORDER ONLY - MAKE CHEQUEST/PO'S PAYABLE TO J.C.G. PRICES INCLUDE POSTAGE AND PACKING

Mixed metal/carbon film resistors 1/4W E12 series 10 ohms to 1 Megohm	2p
Carbon Film resistors 1/4W 5% E24 series 0.51 R to 10MO	1p
100 off per value - 75p, even hundreds per value totalling 1000	£6.00p
Metal Film resistors 1/4W 10R to 1 MO 5% E12 series - 1/p. 1% E24 series	2p
Mixed metal/carbon film resistors 1/2W E24 series 1R0 to 10MO	1 1/2p
1 watt mixed metal/Carbon Film 5% E12 series 4R7 to 10 Megohms	5p
Linear Carbon pre-sets 100mW and 1/4W 100R to 2M2 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, 0.68 - 1p, 1.0 - 12p	
Mylar (polyester) capacitors 100V working E12 series vertical mounting	
1000p to 8200p - 3p, .01 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	2p
Disc/plate ceramics 50V E12 series 1P0 to 1000P, E6 Series 1500P to 47000P	4p
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 (Mfds/Volts)	
1/50, 2/50, 4/50, 10/25, 10/50	5p
22/16, 22/25, 22/50, 33/16, 47/16, 47/25, 47/50	6p
100/16, 100/25, 100/50	12p
220/16, 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 (Mfds/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, 220/6, 20p.	
VOLTAGE REGULATORS	
1A + or - 5V, 8V, 12V, 15V, 18V & 24V - 55p, 100mA, 5.8, 12, 15, V +	30p
DIODES (piv/amps)	
75/25mA 1N4148 2p, 800/1A 1N4006 4 1/2p, 400/3A 1N5404 14p, 115/15mA OA91	8p
100/1A 1N4002 3p, 1000/1A 1N4007 5p, 60/1.5A S1M1 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, Greenets 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, A/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 2 1/2" x 1" 9 rows 25 holes - 25p, 3 1/2" x 2 1/2" 24 rows 37 holes	70p
Jack plugs 2.5 & 3.5mm - 14p, Sockets Panel Mtg, 2.5 & 3.5mm	10p
Ear pieces 2.5 & 3.5mm, 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, BFX88 - 15p, 2N3055 - 55p, TIP31, 32 - 30p, 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.	
<b>THE CR SUPPLY CO</b>	
127 Chesterfield Rd., Sheffield S8 0RN Tel: 0114 2557771 Return posting	

# EVERYDAY CLASSIFIED

With **PRACTICAL**

# ELECTRONICS

Everyday with 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 ten 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 with Practical Electronics. VAT must be added. Advertisements, together with remittance, should be sent to Everyday with 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**  
1 to 24 volts up to 1/2 amp. 1 to 20 volts up to 1 amp. 1 to 16 volts up to 1 1/2 amps d.c. Fully stabilised. Twin panel meters for instant voltage and current readings. Overload protection.  
Fully variable.  
Operates from 240V a.c.  
Compact unit.  
Size 9 x 5 1/2 x 3 in.  
NEW MODEL. Up to 38volts d.c. at 6 amps. 10 amps peak. Fully variable. Twin panel meters. Size 14 1/2 x 11 x 4 1/2 in. £98 inc. VAT. Carr. C6



**£45 inc. VAT**  
+ Post and insurance £4

**RADIO COMPONENT SPECIALISTS**  
337 WHITEHORSE ROAD, CROYDON SURREY, CR0 2HS. Tel: 0181-6841665

Lots of transformers, high volt caps, valves, speakers, in stock. Phone or send your wants list for quote.

**PIC PROGRAMMER**  
PIC EEZE Development system the easiest way to start using this powerful microcontroller family. Basic PIC EEZE Programmer supports 16C61/64/71/74/84-only £44.95. Upgradeable to support all above plus 16C54/55/56/57 and give I.C.E. on 18/28 pin devices (A/D on 16C71)-only £29.95. Supplied with assembler, simulator and programming software. We also supply PIC chips and EEPROMs at affordable prices with additional discounts for users of PIC EEZE. For more info/price lists send S.A.E. (First 20 replies get £5 discount voucher).

Lennard Research, 29 Lavender Gardens, Jesmond, Newcastle upon Tyne NE2 3DD.

**TINY VIDEO CAMERAS**  
From £69.95 incl. p&p.

Over 30 types. A complete CCD Camera on a PCB with Lens. From 32x32x15mm with PINHOLE lens. Low Light & Infra-Red Sensitive. Wide Angle, Pinhole & C. Mount Lenses, Cases, Tech. Notes, 50mW IR LEDs. Standard Video O/P connect to video I/P on TV, Monitor, VCR. Link into antenna system, view/record on all TVs & VCRs.

Info A.S.&S. PO Box 25, Westminster, 6061, WESTERN AUSTRALIA.  
Fax: 00 61 9344 5905 all hours  
Phone: 00 61 9349 9413 1am-3pm

1/2W 5% resistors any value, 10 off 10p; 10 off 100 values £8. Mylar caps 0.1, 0.022, 0.047 5 for 20p; 0.1, 0.15, 4 for 20p; Electrolytic 2µ/100, 4µ/7/100, 6µ/8/100, 15µ/63 5 for 30p; 33µ/40, 220µ/40 4 for 30p; 470µ/63 25p; 1000µ/25 25p; BC109 12off £1; 2N3819 12 off £1; 2N3055 3 for £1; NE555 4 for £1; LM308, LM304, CA741 5 for £1; LEDs 3mm with clips red/green, 15 for £1; 3 or 4mm plugs, red or black, 15p; 3mm or 4mm sockets, red or black 10p; 4mm socket with wire terminal, red/black, HD, 35p; Meins IEC 3 pin plug 50p, socket 50p; Bulgin 3 pin plug/socket, 60p; mono std jack plug, 15p; BNC chassis socket on plate, 90p.

**RED CASTLE SERVICES**  
43 Enfield Street, Pemberton, Wigan WN5 8DY  
Tel: 01942 227688 Fax: 01942 709957

Access/Visa Send AES for list £1 post. Prices incl. VAT

**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 18th September 1995

FULL PROSPECTUS FROM

**LONDON ELECTRONICS COLLEGE**  
(Dept EPE) 20 PENYWERN ROAD EARLS COURT, LONDON SW5 9SU  
TEL: 0171-373 8721

## 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.

**PLDs AND EPROMS** copied or programmed. We supply logic devices/convert discrete logic to PLDs. Also PCBs designed. Send for details to PO Box 1561 Bath (01225 444467).

**VALVE ENTHUSIASTS:** Capacitors and other parts in stock. For free advice/lists please ring, Geoff Davies (Radio), Tel: 01788 574774.

**MIDI LIGHTING MODULE**, eight 500W channels, 64 levels, 127 presets, assembled and tested. Requires 20V AC supply and case. Cheques for £59, made payable to Technology Direct, 27 Hartland Grove, Priestfield, Middlesbrough, Cleveland TS3 0HL.

**PLASTIC INJECTION MOULDING** at prices you can afford. Very low cost (sometimes free) Tooling. Small quantities speciality. 01685 (Aberdare) 874763.

**PIC CHIP PROGRAMMER.** Low cost solution, uses PC printer port, full constructional details, plus all software and examples, £20. I. Bailey, 15 Mount Road, Fleetwood FY7 6EZ. Tel: 01253 875148.

**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).

**FOR SALE - VINTAGE TELEQUIPMENT SERVICSCOPE**, type S32A, single trace, includes service manual and I/P socket adapter, £160. Also Intel 386SX-16/32MHz motherboard, includes 4 x 256K simms, £100. Phone: 01634 719585.

**VALVES.** About 300 inc. 5 pin, int. octal, B7, B9, valve tester, data books, £50. Ultrasonic Cleaner, 200W, no sink, heavy, £50. 01303 267122.

**ELECTROVERT WAVE SOLDER MACHINE**, £650. "Microline" Bench top machine, single phase. Little used with full bath of solder, bargain. Tel: 01745 591944.

**OSCILLOSCOPE, GOULD OS300**, £200, heated bubble etch tank plus light boxes, various bench equipment components. Brighton (01273) 418222.

**FREE STRIPBOARD** with our book of 25 Easy-Build Projects, includes combination lock, digital die, train controller, LED displays, plus audio, car and household projects, £2.95 post paid. Trax Controls, P.O. Box 419, Norwich, NR1 3BZ.

**OSCILLOSCOPE, KENWOOD CS8010** real time and DSO. T and V cursors. 2 years old, immaculate. Only £180 for a very quick sale. Frequency Counter, Marconi 2430A, 80MHz, £35. Tel: (01933) 50119.

**FREE ... 30 assorted capacitors + LISTS!!** S.A.E. K.I.A., 1 Regent Road, Ilkley, W. Yorkshire. 60 watt amplifiers, £5.00 (ex-equipment).

**MAKE MONEY IN SOFTWARE DISTRIBUTION!** Huge profits to be made from duplicating and selling business plan software! Starter pack includes printed instructions, master disks (IBM or compatible), 200 pre-printed disk labels, plus full reproduction rights. Only £25 from Paul Clark, PO Box 228, Portsmouth, Hampshire, PO2 7UD.

**NO ROOM FOR A CD-ROM DRIVE?** External drive cases for CD-ROM, tape and floppy disk drives available in colour matched ABS, £9.95 each inc. VAT and postage. Telefax 01232 452011.

**PCB ARTWORK**, Layout, product design, surface-mount components and much more, details. Tel: 01708 379054, Fax: 01708 379404.

## 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 with Practical Electronics

## EVERYDAY

# With PRACTICAL ELECTRONICS

## SUBSCRIPTION ORDER FORM

Annual subscription rates (1995/6):  
UK £24.00.

Overseas £30.00 surface mail,  
£47.50 airmail.

To:

Everyday with 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 with 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 Editorial page.

M10/95

## MAKE YOUR INTERESTS PAY!

Over the past 100 years more than 10 million students throughout the world have found it worth their while! An ICS home-study course can help you get a better job, make more money and have more fun out of life! ICS has over 100 years experience in home-study courses, and is the largest correspondence school in the world. You learn at your own pace, when and where you want under the guidance of expert 'personal' tutors. Find out how we can help YOU. Post or phone today for **FREE INFORMATION** on the course of your choice. (Tick one box only!)

GCSE/A\* LEVEL over 20 examination subjects to choose from. Ask for details.

Electronics	<input type="checkbox"/>	TV, Video & Hi-Fi Servicing	<input type="checkbox"/>
C & G Basic Electronic Engineering	<input type="checkbox"/>	Refrigeration & Air Conditioning	<input type="checkbox"/>
Electrical Engineering	<input type="checkbox"/>	PC Repair	<input type="checkbox"/>
Electrical Contracting/Installation	<input type="checkbox"/>	Computer Programming	<input type="checkbox"/>

Mr/Mrs/Miss/Ms

Address

P.Code

**ICS** International Correspondence Schools, Dept. ECS A5, 312/314 High Street, Sutton, Surrey SM1 1PR. Tel: 0141-221 7373 (24 hours). Fax: 0141-221 8151.

## 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'.

## ELECTRONIC ASSEMBLERS

Immediate vacancies for persons used to fine soldering of electronic components, interesting work in modern rapidly expanding company, a conscientious and careful attitude and a basic knowledge of electronics would be helpful.

## ELECTRONIC TECHNICIANS

Previous experience of Audio and Video with the ability to work with the minimum of supervision from either basic drawings or verbal instruction is essential.

Please apply in writing to:-

Sonic Communications (Int) Ltd  
Communication Centre  
The Green  
Castle Bromwich  
Birmingham B36 9AJ



NO telephone calls please.

COMMUNICATIONS (Int) LTD



## 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

## 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 £3.50 for the complete Service Manuals Index on PC Disc plus catalogue.

NAME

ADDRESS

POSTCODE

Photocopy this coupon if you do not wish to cut the magazine

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 lecturettes, 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



## SHERWOOD ELECTRONICS

\*\*\*\*\*

Special packs £1 each -  
choose 1 x £1 pack FREE with 10 purchased

SP1	15 x 5mm Red Leds	SP41	20 x Mixed transistors
SP2	15 x 5mm Green Leds	SP42	200 x Mixed 0.25W C.F. resistors
SP3	12 x 5mm Yellow Leds	SP43	2 x LM1458
SP4	10 x 5mm Amber Leds	SP47	5 x Min. push button switches
SP6	15 x 3mm Red Leds	SP49	5 x 5 metres stranded wire
SP7	12 x 3mm Green Leds	SP102	20 x 8 pin DIL sockets
SP10	100 x 1N4148 diodes	SP103	15 x 14 pin DIL sockets
SP11	30 x 1N4001 diodes	SP104	15 x 16 pin DIL sockets
SP12	30 x 1N4002 diodes	SP105	5 x 74LS00
SP18	20 x BC182 transistors	SP109	15 x BC557 transistors
SP19	20 x BC183 transistors	SP112	5 x Cmos 4093
SP20	20 x BC184 transistors	SP115	3 x 10mm Red Leds
SP21	20 x BC212 transistors	SP116	3 x 10mm Green Leds
SP22	20 x BC214 transistors	SP118	2 x Cmos 4047
SP23	20 x BC549 transistors	SP125	10 x 1000/16V radial elect caps
SP28	5 x Cmos 4011	SP128	100 x Cable ties (small)
SP36	25 x 10/25V radial elect caps	SP130	100 x Mixed 0.5W C.F. resistors
SP37	15 x 100/35V radial elect caps	SP133	20 x 1N4004 diodes
SP39	10 x 470/16V radial elect caps	SP147	5 x Stripboard 8 strips/25 holes
SP40	15 x BC237 transistors	SP156	3 x Stripboard 14 strips/27 holes

RESISTOR PACKS - 0.25W C.Film	
RP3	5 each value - total 365 £2.60
RP7	10 each value - total 730 £3.95
RP10	1000 popular values £5.30

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.

## N. R. BARDWELL LTD (EPE)

200	Signal diodes 1N4148.....	£1.00	25	3mm red l.e.d.s.....	£1.00
75	Rectifier Diodes 1N4001.....	£1.00	25	Asstd. high brightness l.e.d.s.....	£1.00
50	Rectifier Diodes 1N4007.....	£1.00	50	Axial l.e.d.s (Diode package).....	£1.00
25	Rectifier Diodes 1N5401.....	£1.00	12	Asstd. 7-segment displays.....	£1.00
8	NE555 Timer I.C.s.....	£1.00	2	ORP12 light dependant resistors.....	£1.00
50	Asstd. Zener Diodes.....	£1.00	30	Asstd. IF transformers.....	£1.00
30	BC212L Transistors.....	£1.00	48	Asstd. coil formers.....	£1.00
30	BC213L Transistors.....	£1.00	100	Asstd. RF chokes (Inductors).....	£1.00
20	BC327 Transistors.....	£1.00	30	Asstd. connectors edge,d.i.l., sil etc.....	£1.00
30	BC328 Transistors.....	£1.00	30	Asstd. d.i.l. sockets up to 40-pin.....	£1.00
30	BC337 Transistors.....	£1.00	200	Asstd. disc ceramic capacitors.....	£1.00
30	BC478 Transistors.....	£1.00	80	Asstd. capacitors 1nF to 1µF.....	£1.00
30	BC546 Transistors.....	£1.00	80	Asstd. electrolytic capacitors.....	£1.00
30	BC547 Transistors.....	£1.00	10	4P3W MBB min. rotary switches.....	£1.00
30	BC548 Transistors.....	£1.00	20	Min. SP/CO slide switches.....	£1.00
30	BC549 Transistors.....	£1.00	20	1" glass reed switches.....	£1.00
30	BC550 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	c/f ¼W 5% resistors any one value, E24, range 1R to 10M.....	£0.45
30	MPSA42 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			
25	5mm red l.e.d.s.....	£1.00			

Prices include VAT, postage £1.25. Stamp for Lists  
288 Abbedale Road, Sheffield S7 1FL  
Phone (0114) 2552886 Fax (0114) 2500689

High quality stepping motor kits (all including stepping motors) 'Comstep' independent control of 2 stepping motors by PC. (Via the Parallel Port) with 2 motors and software. Kit £67.00, ready built £99.00

Software support and 4-digital inputs kit. £27.00  
Power interface 4A kit £36.00, power interface 8A kit £46.00

Stepper kit 4 (manual control) includes 200 step stepping motor and control circuit. £23.00

We are now stocking a range of stepping motors and kits to drive them - please ask for the stepping motor data sheet for full information.

Inverter toroidal transformers 225VA 10 5 0 - 10.5V primary 0-260-285V secondary..... £29.95  
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.

High quality photo resist copper clad epoxy glass boards

Dimensions	single-sided	double-sided
3x4 inches	£1.09	£1.23
4x8 inches	£2.75	£2.99
6x12 inches	£6.20	-
12x12 inches	£12.25	-

### RECHARGEABLE BATTERIES

AA (HP7) 500mAh.....	£0.99
AA 700mAh.....	£1.75
C 2AH with solder tags.....	£3.60
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) 1.8AH.....	£2.20
D (HP2) 1.2AH.....	£2.50
PP3 8-1V 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 4Cs 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 twos or fours..... £10.95

Nickel Metal Hydride AA cells, high capacity with no memory, if charged at 100mA and discharged at 250mA or less 1200mAh capacity (lower capacity for high discharge rates)..... £3.75

SPECIAL OFFERS - PLEASE CHECK FOR AVAILABILITY

Stick of 4, 42mm x 16mm NiCad batteries 1.71mm x 16mm dia, with red and black leads, 4-BV..... £5.95

115V AC, 80V DC Motor, 4mm x 22mm shaft, 50mm dia, x 60mm long body (excluding shaft), it has a replaceable thermal fuse and brushes..... £4.95 each, £3.95 100+

7-segment common anode LED display, 12mm, 45p LM337K TO3 case variable regulator..... £1.95 100+ £1.44 each

GeAs F.E.T. low leakage current S8873 £12.95 each, £9.95 10+, £7.95 100+

BS250 p channel MOSFET..... £2.50 45p  
BC659 transistor..... £3.95 per 100  
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

AM250Z..... £1.25 each, 30p 100+  
CD4007UB..... 10p 100+, 6p 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 input 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 switches, new..... £6.00

Airpax A82903-C large stepping motor 14V 7.5' step, 27 ohm, 68mm dia. body, 6.3mm shaft..... £8.95 or £200.00 for a box of 30

Polyester capacitors, box type, 22.5mm lead pitch 0.9µF 250V d.c., 18p each, 14p 100+, 9p 1000+ µF 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, 32 x 29 x 17mm case, 75p each, 60p 100+

Philips 123 series solid aluminium axial leads, 33µF 10V and 2.2µF 40V 40p each, 25p 100+

Philips 108 series long life 22µF 63V axial

Multilayer AVX ceramic capacitors, all 5mm pitch, 100V 100pF, 150pF, 220pF, 10,000pF (10n) 10p each, 5p 100+, 3.5p 1000+

500pF compression trimmer..... 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, 270hm 2W, 680hm 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 (intel part 20115-001) with standard motherboard and 5 disk drive connectors, fan and mains inlet/outlet connectors on back and switch on the side (top for tower case) dims. 212 x 149 x 149mm excluding switch, £28.00 each, £138.00 for 8

MX180 Digital Multimeter 7 ranges, 1000V d.c., 750V a.c., 2Mohm 200mA transistor Hfe 9V and 1.5V battery test..... £12.95

AMD 27256-3 EPROMS £2.00 each, £1.25 100+ DIP swtch, 3PCO 12-pin (ERG SDC-3-023) 80p 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

CV2486 gas relay 30mm x 10mm dia with 3 wire terminals, will also work as a neon light..... 20p each, £7.50 per 100

All products advertised are new and unused unless otherwise stated.

Wide range of CMOS TTL 74HC 74F 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

## 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**

## ADVERTISERS INDEX

ADVANCED COMPUTER SERVICES.....	803
N. R. BARDWELL.....	828
BAYLIN PUBLICATIONS.....	781
BHA TRADING.....	825
B.K. ELECTRONICS.....	Cover (iii)
BRIAN J. REED.....	828
BULL ELECTRICAL.....	Cover (ii)/791
CAMBRIDGE MICROPROCESSOR SYSTEMS.....	803
CHATWIN GUITARS (JCG).....	825
CIRKIT DISTRIBUTION.....	781
COMPELEC.....	746
COOKE INTERNATIONAL.....	827
CRICKLEWOOD ELECTRONICS.....	746
CR SUPPLY COMPANY.....	825
DIRECT CCTV.....	795
DISPLAY ELECTRONICS.....	742
EPT EDUCATIONAL SOFTWARE.....	819
ESR ELECTRONIC COMPONENTS.....	752
GATS ELECTRONICS.....	825
GREENWELD ELECTRONICS.....	747
HART ELECTRONIC KITS.....	749
ICS.....	827
INFOTECH & STREE.....	827
INTERCONNECTIONS.....	781
J&N FACTORS.....	796
JPG ELECTRONICS.....	828
LABCENTER.....	785
MAGENTA ELECTRONICS.....	750/751
MAPLIN ELECTRONICS.....	Cover (iv)
MAURITRON.....	827
MICRO 2000 EUROPE.....	761
MILFORD INSTRUMENTS.....	817
NATIONAL COLLEGE TECH.....	827
NICHE SOFTWARE.....	795
NMB MARKETING.....	746
NUMBER ONE SYSTEMS.....	803
OMNI ELECTRONICS.....	746
PICO TECHNOLOGY.....	745
QUASAR ELECTRONICS.....	748
QUICKROUTE SYSTEMS.....	744
ROBINSON MARSHALL.....	807
SEETRAX CAE.....	748
SERVICE TRADING CO.....	795
SHERWOOD ELECTRONICS.....	828
SONIC COMMUNICATIONS.....	827
STEWART OF READING.....	748
SUMA DESIGNS.....	771
TSINE.....	762
VANN DRAPER ELECTRONICS.....	795

ADVERTISEMENT MANAGER:

PETER J. MEW

ADVERTISEMENT OFFICES:

EVERYDAY with PRACTICAL ELECTRONICS,

ADVERTISEMENTS,

HOLLAND WOOD HOUSE, CHURCH LANE,

GREAT HOLLAND, ESSEX CO13 0JS.

Phone/Fax: (01255) 850596

For Editorial address and phone numbers see page 753.

**POWER AMPLIFIER MODULES-TURNABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS**

PRICES INCLUDE V.A.T. & PROHIBIT OF EXCISES & FRIENDLY SERVICE • LARGE (A4) S.A.E. 60p STAMPED FOR CATALOGUE

**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 1/2" 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.

TYPE 'O'

**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, complemented 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

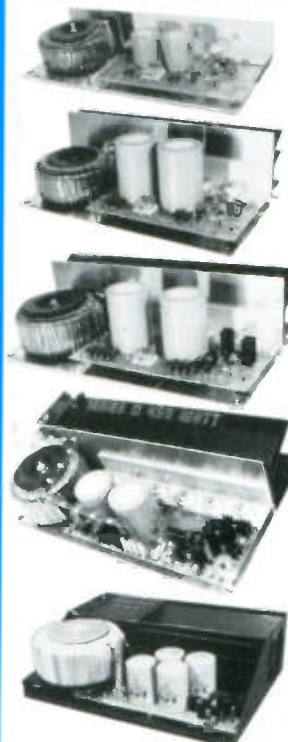
Features: ★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

**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 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, BAND WIDTH 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  
B" 100 WATT R.M.S. ME8-100 GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO. RES. FREQ. 72Hz, FREQ. RESP. TO 4KHz, SENS 97dB. PRICE £32.71 + £2.00 P&P  
10" 100 WATT R.M.S. ME10-100 GUITAR, VOCAL, KEYBOARD, DISCO, EXCELLENT MID. RES. FREQ. 71Hz, FREQ. RESP. TO 7KHz, SENS97dB. PRICE £33.74 + £2.50 P&P  
10" 200 WATT R.M.S. ME10-200 GUITAR, KEYB'D, DISCO, VOCAL, EXCELLENT HIGH POWER MID. RES. FREQ. 65Hz, FREQ. RESP. TO 3.5KHz, SENS 99dB. PRICE £43.47 + £2.50 P&P  
12" 100 WATT R.M.S. ME12-100LE GEN. PURPOSE, LEAD GUITAR, DISCO, STAGE MONITOR. RES. FREQ. 49Hz, FREQ. RESP. TO 6KHz, SENS 100dB. PRICE £43.47 + £2.50 P&P  
12" 100 WATT R.M.S. ME12-100LT (TWIN CONE) WIDE RESPONSE, P.A., VOCAL, STAGE MONITOR. RES. FREQ. 42Hz, FREQ. RESP. TO 10KHz, SENS 98dB. PRICE £36.67 + £3.50 P&P  
12" 200 WATT R.M.S. ME12-200 GEN. PURPOSE, GUITAR, DISCO, VOCAL, EXCELLENT MID. RES. FREQ. 58Hz, FREQ. RESP. TO 6KHz, SENS 98dB. PRICE £46.71 + £3.50 P&P  
12" 300 WATT R.M.S. ME12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARD, DISCO ETC. RES. FREQ. 47Hz, FREQ. RESP. TO 5KHz, SENS 103dB. PRICE £70.19 + £3.50 P&P  
15" 200 WATT R.M.S. ME15-200 GEN. PURPOSE BASS, INCLUDING BASS GUITAR. RES. FREQ. 46Hz, FREQ. RESP. TO 5KHz, SENS 99dB. PRICE £50.72 + £4.00 P&P  
15" 300 WATT R.M.S. ME15-300 HIGH POWER BASS, INCLUDING BASS GUITAR. RES. FREQ. 39Hz, FREQ. RESP. TO 3KHz, SENS 103dB. PRICE £73.34 + £4.00 P&P

**EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC**

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohm)  
BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND  
B" 50watt EB8-50 DUAL IMPEDANCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. PRICE £8.90 + £2.00 P&P  
10" 50WATT EB10-50 DUAL IMPEDANCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. PRICE £13.65 + £2.50 P&P  
10" 100WATT EB10-100 BASS, HI-FI, STUDIO. RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. PRICE £30.39 + £3.50 P&P  
12" 100WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO. RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. PRICE £42.12 + £3.50 P&P  
FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND  
5" 60WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. PRICE £9.99 + £1.50 P&P  
6 1/2" 60WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. PRICE £10.99 + 1.50 P&P  
8" 60WATT EB8-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 99dB. PRICE £12.99 + £1.50 P&P  
10" 60WATT EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC. RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. PRICE £16.49 + £2.00 P&P

**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, GOVT. BODIES, PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER, VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX.



# With over 14,000 products the new Maplin Catalogue is now bigger than ever



## THE EIFFEL TOWER

Built in 1889 by Alexandre Gustave Eiffel, the Eiffel Tower is 984 feet high and gives an unrivalled view of the whole of Paris.



## THE NEW MAPLIN CATALOGUE

Built in 1995 by Maplin, the new catalogue is almost 1,200 pages long and gives an unrivalled view of the whole world of electronics.  
**Now Only £2.95**



Catalogue available at branches of **WHSMITH**, **John Menzies** and **Maplin** stores nationwide, or  
**order direct NOW on 01702 554161**

Catalogue Mail order Price £3.45 (inc p&p). Prices depicted are from the 1996 Maplin Catalogue and are inclusive of VAT.  
All items are subject to availability. E & OE. Maplin Electronics, P. O. Box 3, Rayleigh, Essex, England SS6 8LR.