

PRACTICAL

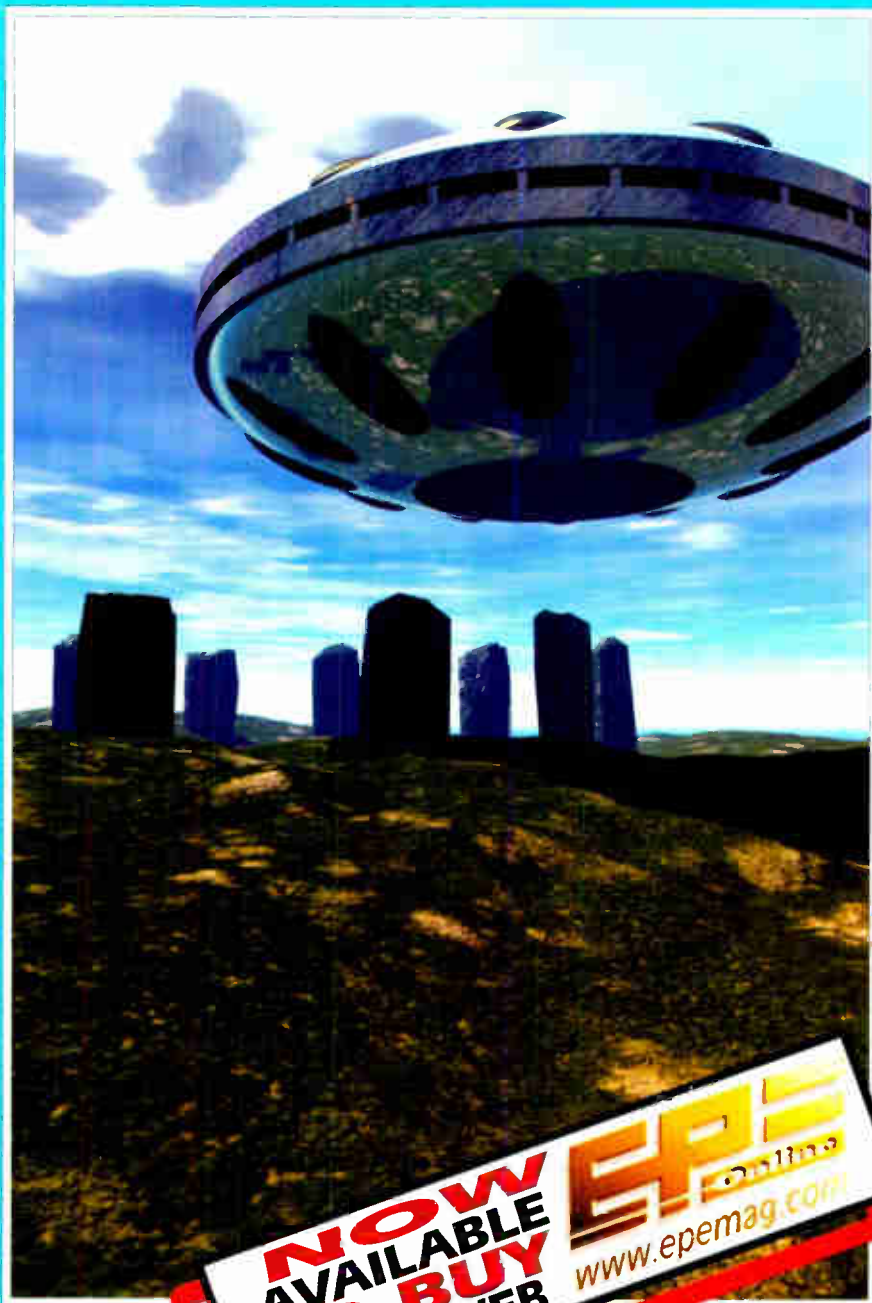
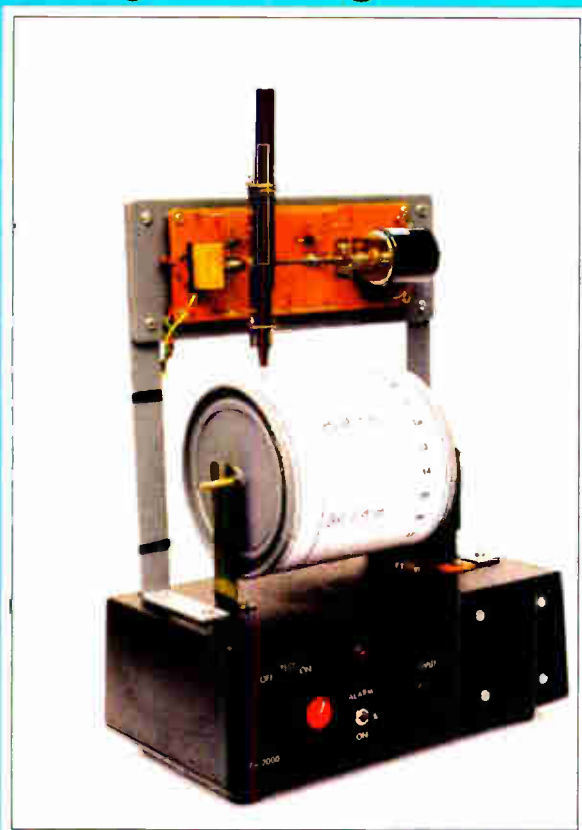
ELECTRONICS

INCORPORATING **ELECTRONICS TODAY INTERNATIONAL**

£2.75

UFO DETECTOR/ RECORDER

Are you being visited?



INTERCOM

Useful & educational

PICS & KEYPADS

Interfacing & software

OPTICAL TRIGGER

Top Tenner project

■■■■ PLUS

Circuit Surgery • Ingenuity Unlimited

<http://www.epemag.wimborne.co.uk>

NOW AVAILABLE TO BUY ON THE WEB **EPe** online www.epemag.com



12v 18Ah SEALED LEAD ACID BATTERIES, new and boxed, unused pack of 4 £39.95 ref CYC7 or £15 each ref CYC6

AUTOMATIC CHARGER For the above batteries charges 2 at once, charge level indicator circuitry, 6 hour charge £10 ref CYC8

A new range of 12v to 240v INVERTERS
IV400S (400 watt) £89
IV800S (800 watt) £159
IV1200S (1200 watt) £219

ECG MACHINES? 6v 10AH BATT/24V 8A TX Ex government ECG machines! Measures 390x320x120mm, on the front are controls for scan speed, scan delay, scan mode, loads of connections on the rear including video out etc. On the front panel are two DIN sockets for connecting the body sensors to. Sensors not included. Inside 2 x 6v 10AH lead acid batts (not in good condition), PCB's and a 8A 7.24V transformer (mains in) sold as seen, may have one or two broken knobs etc due to poor storage. £15.99 ref VP2

SODIUM LAMP SYSTEMS £75.70 Complete system with 250w or 400watt SON-T Agro bulb, reflector with bulb holder and remote ballast and starter (uncased) all you need is wire. 250W system ref SLS1, 400W system SLS2.

PC SUPPORT HANDBOOK The ultimate technical guide to building and maintaining PC's. Over 460 A4 pages packed with technical data and diagrams just £10 ref PCBK. If you want 4 copies for £33 ref PCBK2. Also available is a CD packed with diagnostic programmes to use with the book £5 ref PCBK1

D SIZE NICADS Tagged, 1200mA, 1.2v pack of 4 for £6 ref CYC9 or as a pack of 24 for £22 ref CYC10

D SIZE SEALED LEAD ACID BATTERIES

2v 2.5ah rechargeable sealed lead acid battery made by Cyclon 60x45mm (standard D size) supplied as a pack of 12 or 20 giving you options for battery configurations eg 12v at 5ah, 24v at 2.5ah, 6v at 10ah. These batteries are particularly useful in that you can arrange them in your project to optimise space etc (eg boat ballast etc) Pack of 12 £10 ref CYC4, pack of 20 £16 ref CYC5

HYDROPONICS DO YOU GROW YOUR OWN?

We have a full colour hydroponics catalogue available containing nutrients, pumps, fittings, environmental control light fittings, plants, test equipment etc Ring for your free copy.

PC COMBINED UPS AND PSU The unit has a total power of 292 watts, standard mother board connectors and 12 peripheral power leads for drives etc. Inside is 3 12v 7.2Ah sealed lead acid batteries. Backup time is 8 mins at full load or 30 mins at half load. Made in the UK by Magnum, 110 or 240vac input, +5v at 35A, -5v at 5A, +12v at 9A, -12v at 5A outputs. 170x260x220mm, new and boxed £29.95 Ref PCUPS2

ALTERNATIVE ENERGY CD, PACKED WITH HUNDREDS OF ALTERNATIVE ENERGY RELATED ARTICLES, PLANS AND INFORMATION ETC £14.50 REF CD56

AERIAL PHOTOGRAPHY KIT This rocket comes with a built in camera! It flies up to 500 feet (150 m) turns over, and takes an aerial photograph of the ground below. The rocket then returns with its film via its parachute. Takes 110 film. Supplied complete with everything including a launch pad and 3 motors (no film) £29.98 ref astro

PROJECT BOXES Another bargain for you are these smart ABS project boxes, smart two piece screw together case measuring approx 6"x5"x2" complete with panel mounted LED. Inside you will find loads of free bits, tape heads, motors, chips resistors, transistors etc. Pack of 20 £19.95 ref MD2

TELEPHONES Just in this week is a huge delivery of telephones, all brand new and boxed. Two piece construction - illuminated keypad, tone or pulse (switchable) recall, redial and pause, high/low and off ringer switch and quality construction. Off white colour and is supplied with a standard international lead (same as US or modems) if you wish to have a BT lead supplied to convert the phones these are £1.55 each ref BT LX. Phones £4.99 each ref PH2 10 off £30 ref SS2

3HP MAINS MOTORS Single phase 240v, brand new, 2 pole, 340x180mm, 2850 rpm, builtin automatic reset overload protector, keyed shaft (40x16mm) Made by Leeson £99 each ref LEE1

BUILD YOUR OWN WINDFARM FROM SCRAP New publication gives step by step guide to building wind generators and propellers. Armed with this publication and a good local scrap yard could make you self sufficient in electricity! £12 ref LOTB1

CHIEFTAN TANK DOUBLE LASERS 9 WATT + 3 WATT + LASER OPTICS Could be adapted for laser listener, long range comms etc. Double beam units designed to fit in the barrel of a tank, each unit has 2 semi conductor lasers and motor drive units for alignment. 7 mile range, no circuit diagrams due to MOD, new price £50.000? us? £199. Each unit has two gallium Arsenide injection lasers, 1 x 9 watt, 1 x 3 watt, 900nm wavelength, 28vdc, 600Hz pulse freq. The units also contain a receiver to detect reflected signals from targets. £99 Ref LOT4

MAGNETIC CREDIT CARD READERS AND ENCODING MANUAL £9.95 Cased with flyleads, designed to read standard credit cards! complete with control electronics PCB and manual covering everything you could want to know about what's hidden in that magnetic strip on your card! just £9.95 ref BAR31

SOLAR POWER LAB SPECIAL 2x 6"x6" 6v 130mA cells, 4LED's, wire, buzzer switch + relay or motor £7.99 REF SA27

SOLAR NICAD CHARGERS 4x AA size £9.99 ref 6P47, 2x C size £9.99 ref 6P477

BRAND NEW MILITARY ISSUE DOSE METERS

Current NATO issue Standard emergency services unit. Used by most of the worlds Military personnel. New and boxed. Normal retail price £400. BULLS bargain price just £99! The PDRM 82 M is a portable, lightweight, water resistant gamma radiation survey meter to measure radiological dose rate in the range 0.1 to 300 centigrays per hour in air. The Geiger Muller (G M) tube detecting unit is energy and polar response corrected. The radiation level is displayed on a Liquid Crystal Display. The microcomputer corrects for the non-linearity of the G M tube response. The instrument is powered by three international C size batteries giving typically 400 hours operation in normal conditions. The dose rate meter PDRM 82M designed and selected for the United Kingdom Government, has been fully evaluated to satisfy a wide range of environmental conditions and is nuclear hard. The construction enables the instrument to be easily decontaminated. The instrument is designed for radiation surveys for post incident monitoring. Used in a mobile role, either carried by troops or in military vehicles for rapid deployment enabling radiation hot spots to be quickly located. Range 0 - 300 cGy/h in 0.1 cGy/h increments. Over range to 1500 cGy/h - indicates flashing 300. Accuracy 20% of true dose rate +0.1 cGy/h, 0 - 100 cGy/h. 130% of true dose rate, 100 - 300 cGy/h. Energy Response 0.3 MeV to 3 MeV - within 20% (Ra 226). 80 KeV to 300 KeV - within 140% (Ra 226). Detector Energy compensated Halogen quenched Geiger Muller Tube. Controls. Combined battery access and ON/OFF switch. Batteries 3 International standard Cells. Weight 560 grms. Operating Temperature Range -30deg C to +60 deg C. Indications High contrast 4 digit LCD. Battery low indication. Dose Rate Rising/Falling £99 ref PDRM

Hydrogen fuel cells Our new Hydrogen fuel cells are 1v at up to 1A output, Hydrogen input, easily driven from a small electrolosis assembly or from a hydrogen source, our demo model uses a solar panel with the output leads in a glass of salt water to produce the hydrogen! Each cell is designed to be completely taken apart, put back together and expanded to what ever capacity you like, (up to 10 watts and 12v per assembly. Cells cost £49 ref HFC11

PHILIPS VP406 LASER DISC PLAYERS, SCART OUTPUT, JUST PUT YOUR VIDEO DISK IN AND PRESS PLAY, STANDARD AUDIO AND VIDEO OUTPUTS, £14.95 REF VP406

SMOKE ALARMS Mains powered, made by the famous Gent company, easy fit next to light fittings, power point. Pack of 5 £15 ref SS23, pack of 12 £24 ref SS24

4AH D SIZE NICADS pack of 4 £10 ref 4AHPK SENDER KIT Contains all components to build a AV transmitter complete with case £35 ref VSXX2

10 WATT SOLAR PANEL Amorphous silicon panel fitted in a anodized aluminum frame. Panel measures 3' by 1' with screw terminals for easy connection. 3' x 1' solar panel £56 ref MAG46

12V SOLAR POWERED WATER PUMP Perfect for many 12v DC uses, from solar fountains to hydroponics! Small and compact yet powerful works direct from our 10 watt solar panel in bright sun. Max hd 17 ft. Max flow = 8 Lpm. 1 5A Ref AC8 £18.99

SOLAR ENERGY BANK KIT 50x6"x12" 6v solar panels (amorphous) + 50 diodes £98 ref EF112
PINHOLE CAMERA MODULE WITH AUDIO! Superb board camera with on board sound! extra small just 28mm square (including microphone) ideal for covert surveillance. Can be hidden inside anything - even a matchbox. Complete with 15 metre cable, psu and tv/cv connectors. £49.95 ref CC6J

SOLAR MOTORS Tiny motors which run quite happily on voltages from 3-12vdc. Works on our 6v amorphous 6" panels and you can run them from the sun! 32mm dia 20mm thick. £1.50 each
WALKIE TALKIES 1 MILE RANGE £37/PAIR REF MAG30
LIQUID CRYSTAL DISPLAY Bargain prices, 40 character 1 line 154x16mm £6.00 ref SMC4011A
YOUR HOME COULD BE SELF SUFFICIENT IN ELECTRICITY Comprehensive plans with loads of info on designing systems, panels, control electronics etc £7 ref PV1

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead and cigar plug 12v 2w £12.99 REF AUG10P3
SOLAR POWER LAB SPECIAL 2x 6"x6" 6v 130mA cells, 4LED's, wire, buzzer switch + relay or motor £7.99 REF SA27
SOLAR NICAD CHARGERS 4 x AA size £9.99 ref 6P476, 2 x C size £9.99 ref 6P477

MINATURE TOGGLE SWITCHES These top quality Japanese panel mount toggle switches measure 35x13x12mm, are 2 pole changeover and will switch 1A at 250vac, or 3 A at 125vac. Complete with mounting washers and nuts. Supplied as a box of 100 switches for £29.95 ref. SWT35 or a bag of 15 for £4.99 ref SWT34

VOICE CHANGERS Hold one of these units over your phone mouth piece and you can adjust your voice using the controls on the unit! Battery operated £15 ref CC3

BULL ELECTRICAL

250 PORTLAND ROAD, HOVE, SUSSEX.
BN3 5QT. (ESTABLISHED 50 YEARS).

MAIL ORDER TERMS: CASH, PO OR CHEQUE
WITH ORDER PLUS £4.00 P&P PLUS VAT.

24 HOUR SERVICE £6.50 PLUS VAT.

OVERSEAS ORDERS AT COST PLUS £3.50
(ACCESS, VISA, SWITCH, AMERICAN EXPRESS)

phone orders : 01273 203500

FAX 01273 323077

Sales@bull-electrical.com

30 WATTS OF SOLAR POWER for just £69, 4 panels each one 3'x1' and producing 8w, 13v. PACK OF FOUR £69 ref SOLX

200 WATT INVERTERS plugs straight into your car cigarette lighter socket and is fitted with a 13A socket so you can run your mains operated devices from your car battery. £49.95 ref SS66

THE TRUTH MACHINE Tells if someone is lying by micro tremors in their voice, battery operated, works in general conversation and on the phone and TV as well! £42.49 ref TD3

INFRA RED FILM 6" square piece of flexible infra red film that will only allow IR light through. Perfect for converting ordinary torches, lights, headlights etc to infra red output only using standard light bulbs. Easily cut to shape. 6" square £15 ref IRF2

33 KILO LIFT MAGNET Neodymium 32mm diameter with a fixing bolt on the back for easy mounting. Each magnet will lift 33 kilos. 4 magnets bolted to a plate will lift an incredible 132 kilos! £15 ref MAG33. Pack of 4 just £39.95 ref MAG33AA

HYDROGEN FUEL CELL PLANS Loads of information on hydrogen storage and production. Practical plans to build a Hydrogen fuel cell (good workshop facilities required) £8 set ref FCP1

STIRLING ENGINE PLANS Interesting information pack covering all aspects of Stirling engines, pictures of home made engines made from an aerosol can running on a candle! £12 ref STIR2

ENERGY SAVER PLUGS Saves up to 15% electricity when used with fridges, motors up to 2A, light bulbs, soldering irons etc. £9 ea ref LOT71, 10 pack £69 ref LOT72

12V OPERATED SMOKE BOMBS Type 3 is a 12v trigger and 3 smoke canisters. Each canister will fill a room in a very short space of time! £14.99 ref SB3. Type 2 is 20 smaller canisters (suitable for mock equipment fires etc) and 1 trigger module for £29 ref SB2. Type 1 is a 12v trigger and 20 large canisters £49 ref SB1

HI POWER ZENON VARIABLE STROBES Useful 12v PCB fitted with hi power strobe tube and control electronics and speed control potentiometer. Perfect for interesting projects. etc 70x55mm 12vdc operation £6 ea ref FLS1, pack of 10 £49 ref FLS2

NEW LASER POINTERS 4 5mm, 75 metre range. hand held unit runs on two AA batteries (supplied) 670nm. £29 ref DEC49J

HOW TO PRODUCE 35 BOTTLES OF WHISKY FROM A SACK OF POTATOES Comprehensive 270 page book covers all aspects of spirit production from everyday materials. Includes construction details of simple stills. £12 ref MS3

NEWHIGH POWER MINI BUG With a range of up to 800 metres and a 3 days use from a PP3. This is our top selling bug! Less than 1" square and a 10m voice pickup range. £28 Ref LOT102

IR LAMP KIT Suitable for CCTV cameras, enables the camera to be used in total darkness! £6 ref EF138

INFRA RED POWER BEAM Handheld battery powered lamp, 4 inch reflector, gives out powerful pure infrared light! perfect for CCTV use, night sights etc. £29 ref PB1

SUPER WIDEBAND RADAR DETECTOR Detects both radar and laser. X K and KA bands, speed cameras and all known speed detection systems. 360 degree coverage, front & rear waveguides, 1 1/2" x 4" 6" fits on visor or dash. £149

LOPTX Made by Samsung for colour TV. £3 each ref SS52

LAPTOP LCD SCREENS 240x175mm, £12 ref SS51

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

ELECTRONIC SPEED CONTROLLER KIT For the above motor. £19 ref MAG17. Save £5 if you buy them both together, 1 motor plus speed controller rrp is £41, offer price £36 ref MOT5A

INFRA RED REMOTE CONTROLS made for TVs but may have other uses. pack of 100 £39 ref IREM

RCB UNITS In line IEC lead with fitted RC breaker. Installed in seconds. Pack of 3 £9.98 ref LOT5A

On our web sites you can

1. Order online.
2. Check your premium bonds.
3. Enter our auction or build your own.
4. Add E-commerce to your own site.
5. Discover our software site, optical site, hydroponics site, holiday home exchange site, inkjet site, hotels site.
6. View our web camera.
7. Invest in our future.

<http://www.bullnet.co.uk>

YOUR HOME COULD BE SELF SUFFICIENT IN ELECTRICITY Comprehensive plans with loads of info on designing systems, panels, control electronics etc £7 ref PV1

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead and cigar plug 12v 2w £12.99 REF AUG10P3
STEPPER MOTORS Brand new stepper motors, 4mm fixing holes with 47 14mm fixing centres, 20mm shaft, 6.35mm diameter, 5v/phase, 0.7A/phase, 1.8 deg step (200 step) Body 56x36mm £14.99 ea ref STEP6, pack of 4 for £49.95. PIC based variable speed controller kit £15 ref STEP7

ISSN 0262 3617

PROJECTS ... THEORY ... NEWS ...
COMMENTS ... POPULAR FEATURES ...

VOL. 30. No. 1 JANUARY 2001

Cover illustration by Jonathan Robertson

EVERYDAY

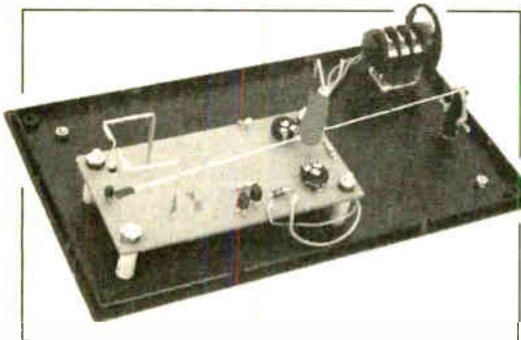
PRACTICAL

ELECTRONICS

INCORPORATING ELECTRONICS TODAY INTERNATIONAL

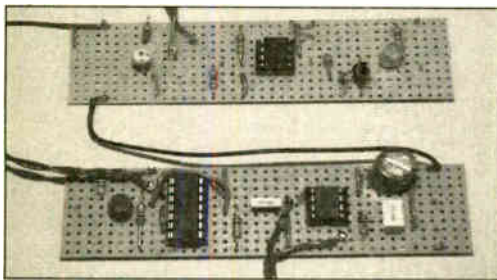
www.epemag.wimborne.co.uk

EPE Online: www.epemag.com



Projects and Circuits

- VERSATILE OPTICAL TRIGGER** by Owen Bishop 12
A Top-Tenner project for light-controlling electrical equipment
- INGENUITY UNLIMITED** hosted by Alan Winstanley 18
Wide Range Squarewave Generator; Etch Tank/UV Light Box Control System; Pico Prizewinners
- UFO DETECTOR AND EVENT RECORDER** by Raymond Haigh 20
Charting the X-Files revolution!
- TWO-WAY INTERCOM** by Andy Flind 38
How to create your own local two-way chat zone
- PIC-MONITORED DUAL PSU - 2** by John Becker 64
Workshop power supply with multiple options and monitoring of voltage and current using a PIC microcontroller plus I.c.d. readout



Series and Features

- USING PICS AND KEYPADS** by John Becker 28
How to interface PICs to matrixed keypad switches, plus I.c.d. readout
- NEW TECHNOLOGY UPDATE** by Ian Poole 32
Organic lasers
- CIRCUIT SURGERY** by Alan Winstanley and Ian Bell 35
Voltage Multiplier Circuits; UK/USA Clock Rates
- THE SCHMITT TRIGGER - 3.**
Precision Triggers and Multivibrators by Anthony H. Smith 50
A designer's guide to investigating and using Schmitt triggers
- PRACTICALLY SPEAKING** by Robert Penfold 58
A novice's guide to component polarity
- NET WORK - THE INTERNET PAGE** surfed by Alan Winstanley 62
Backing-Up Security; Unwilling BT Partners
- CIRSIM SHAREWARE REVIEW** by Colin Sloan 70
Examining a Circuit Simulation program for PC computers



Regulars and Services

- EDITORIAL** 11
- NEWS** - Barry Fox highlights technology's leading edge 15
Plus everyday news from the world of electronics
- READOUT** John Becker addresses general points arising 46
- SHOPTALK** with David Barrington 55
The *essential* guide to component buying for EPE projects
- BACK ISSUES** Did you miss these? Some now on CD-ROM! 56
- CD-ROMS FOR ELECTRONICS** 60
Electronic Projects; Filters; Digital Works 3.0; Parts Gallery + Electronic Circuits and Components; Digital Electronics; Analogue Electronics; PICtutor; Modular Circuit Design; Electronic Components Photos
- ELECTRONICS MANUALS** 68
Essential reference works for hobbyists, students and service engineers
- DIRECT BOOK SERVICE** 72
A wide range of technical books available by mail order
- ELECTRONICS VIDEOS** Our range of educational videos 76
- PRINTED CIRCUIT BOARD AND SOFTWARE SERVICE** 77
PCBs for EPE projects. Plus EPE software
- ADVERTISERS INDEX** 80

THE SEASON'S GREETINGS
TO ALL OUR READERS

May we wish you a peaceful
and prosperous 2001

© Wimborne Publishing Ltd 2000. Copyright in all drawings, photographs and articles published in EVERYDAY PRACTICAL ELECTRONICS is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.

Our February 2001 issue will be published on Thursday, 11 January 2001. See page 3 for details

Readers Services • Editorial and Advertisement Departments 11

Visit our website
www.distel.co.uk

THE ORIGINAL SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always
wanted for cash!

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!



TV SOUND & VIDEO TUNER
CABLE COMPATIBLE*

The TELEBOX is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors or AV equipment which are fitted with a composite video or SCART input. 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. Ideal for desktop computer video systems & PIP (picture in picture) setups. 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. Brand new - fully guaranteed.

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

NEW State of the art PAL (UK spec) UHF TV tuner module with composite 1V pp video & NICAM hi fi stereo sound outputs. Micro electronics all on one small PCB only 73 x 160 x 52 mm enable full tuning control via a simple 3 wire link to an IBM pc type computer. Supplied complete with simple working program and documentation. Requires +12V & +5V DC to operate.
BRAND NEW - Order as MY00. Only £49.95 code (B)
See www.distel.co.uk/data_my00.htm for picture + full details

FLOPPY DISK DRIVES 2 1/2" - 8"

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 full 90 day guarantee. Call or see our web site www.distel.co.uk for over 2000 unlisted drives for spares or repair.

- 3 1/2" Mitsubishi MF355C-L 1.4 Meg. Laptops only £25.95(B)
- 3 1/2" Mitsubishi MF355C-D 1.4 Meg. Non laptop £18.95(B)
- 5 1/4" Teac FD-55GR-U 1.2 Meg (for IBM PCs) RFE £18.95(B)
- 5 1/4" Teac FD-55F-03-U 720K 40/80 (for BBC's etc) RFE £29.95(B)
- 5 1/4" BRAND NEW Mitsubishi MF501B 360K £22.95(B)
- Table top case with integral PSU for HI 5 1/4" Floppy / HD £29.95(B)
- 8" Shugart 800/801 8" SS refurbished & tested £210.00(E)
- 8" Shugart 810 8" SS HI Brand New £195.00(E)
- 8" Shugart 851 8" double sided refurbished & tested £260.00(E)
- 8" Mitsubishi M2894-63 double sided NEW £295.00(E)
- 8" Mitsubishi M2896-63-02U DS slimline NEW £295.00(E)
- Dual 8" cased drives with integral power supply 2 Mb £499.00(E)

HARD DISK DRIVES 2 1/2" - 14"

- 2 1/2" TOSHIBA MK1002MAV 1.1Gb laptop (12.5 mm H) New £79.95
 - 2 1/2" TOSHIBA MK2101MAN 2.16 Gb laptop (19 mm H) New £89.50
 - 2 1/2" TOSHIBA MK4309MAT 4.3Gb laptop (8.2 mm H) New £105.00
 - 2 1/2" TOSHIBA MK6409MAV 6.1Gb laptop (12.7 mm H) New £190.00
 - 2 1/2" to 3 1/2" conversion kit for PCs, complete with connectors £14.95
 - 3 1/2" FUJII FK-309-26 20mb MFM I/F RFE £59.95
 - 3 1/2" CONNER CP3024 20 mb IDE I/F (or equiv.) RFE £59.95
 - 3 1/2" CONNER CP3044 40 mb IDE I/F (or equiv.) RFE £69.00
 - 3 1/2" QUANTUM 40S Prodr II vs 42mb SCSI I/F, New RFE £49.00
 - 5 1/4" MINISCRIBE 3425 20mb MFM I/F (or equiv.) RFE £49.95
 - 5 1/4" SEAGATE ST-238R 30 mb RLL I/F Rebuilt £69.95
 - 5 1/4" CDC 94205-51 40mb HH MFM I/F RFE tested £69.95
 - 5 1/4" HP 97548 850 Mb SCSI RFE tested £99.00
 - 5 1/4" HP C3010 2 Gbyte SCSI differential RFE tested £195.00
 - 8" NEC D2246 85 Mb SMD interface. New £199.00
 - 8" FUJITSU M2322K 160Mb SMD I/F RFE tested £195.00
 - 8" FUJITSU M2392K 2 Gb SMD I/F RFE tested £345.00
- Many other drives in stock - Shipping on all drives is code (C1)

TEST EQUIPMENT & SPECIAL INTERESTS

- MITTS. FA3445ETKL 14" Industrial spec SVGA monitors £245
- FARNELL 0-60V DC @ 50 Amps, bench Power Supplies £995
- FARNELL AP3080 0-30V DC @ 80 Amps, bench Supply £1850
- 1kW to 400 kW - 400 Hz 3 phase power sources - ex stock £POA
- IBM 8230 Type 1, Token ring base unit driver £760
- Wayne Kerr RA200 Audio frequency response analyser £2500
- IBM 53F5501 Token Ring ICS 20 port lobe modules £750
- IBM MAU Token ring distribution panel 8228-23-5050N £95
- AIM 501 Low distortion Oscillator 9Hz to 330KHz, IEIE £550
- ALLGON 8360.11805-1880 MHz hybrid power combiners £250
- Trend DSA 274 Data Analyser with G703(2M) 64 v/o £POA
- Marconi 6310 Programmable 2 to 22 GHz sweep generator £6500
- Marconi 2022C 10KHz-1GHz RF signal generator £1550
- Marconi 2030 opt 03 10KHz-1.3 GHz signal generator, New £4995
- HP1650B Logic Analyser £3750
- HP3781A Pattern generator & HP3782A Error Detector £2950
- HP6621A Dual Programmable GPIB PSU 0.7 V 160 watts £1800
- HP6264 Rack mountable 0-20V @ 20A metered PSU £1800
- HP54121A DC to 22 GHz four channel test set £POA
- HP8130A opt 020 300 MHz pulse generator, GPIB etc £7900
- HP A1, AO 8 pen HPGL high speed drum plotters from HP DRAFTMASTER 1.8 pen high speed plotter £550
- EG-G Brookdeal 95035C Precision lock in amp £1800
- View Eng. Mod 1200 computerised inspection system £POA
- Sony DXC-3000A High quality CCD colour TV camera £995
- Keithley 590 CV capacitor / voltage analyser £POA
- Racal ICR40 dual 40 channel voice recorder system £3750
- Fiskers 45KVA 3 ph On Line UPS - Now batteries £9500
- Emerson AP130 2.5KVA industrial spec UPS £2100
- Mann Tally MT645 High speed line printer £2200
- Intel SBC 486/133SE Multibus 486 system 8Mb Ram £945
- Siemens K4400 64Kb to 140Mb demux analyser £2950

IC's - TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK
10,000,000 items EX STOCK

For MAJOR SAVINGS
CALL OR SEE OUR WEB SITE www.distel.co.uk

VIDEO MONITOR SPECIALS

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

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

used condition.
Tilt & Swivel Base £4.75
VGA cable for IBM PC Included.
External cables for other types of computers available - CALL

Order as
Only £119 (E) MITS-SVGA

Ex demo 17" 0.28 SVGA Mitsubishi Diamond Pro monitors, Full multisync etc.
Full 90 day guarantee. Only £199.00 (E)

Just In - Microvitec 20" VGA (800 x 600 res.) colour monitors. Good SH condition - from £299 - CALL for Info
PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with both RGB and standard composite 15.625 KHz video inputs via SCART socket and separate phono jacks. Integral audio power amp and speaker for all audio visual uses. Will connect direct to Amiga and Atari BBC computers. Ideal for all video monitoring / security applications with direct connection to most colour cameras. High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12 1/4" x 1 1/2" D. (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with standard composite 15.625 KHz video input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen blem). In attractive square black plastic case measuring W10" x H10" x 1 1/2" D. 240 V AC mains powered.
Only £79.00 (D)

KME 10" 15M10009 high definition colour monitors with 0.28" dot pitch. Superb clarity and modern styling. Operates from any 15.625 kHz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13 1/2" x 12" x 1 1/2". Good used condition.
Only £125 (E)

20" 22" and 26" AV SPECIALS

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

We probably have the largest range of video monitors in Europe. All sizes and types from 4" to 42" call for info.

DC POWER SUPPLIES

Virtually every type of power supply you can imagine. Over 10,000 Power Supplies Ex Stock
Call or see our web site.

- HP6030A 0-200V DC @ 17 Amps bench power supply £1950
- Intel SBC 486/125C08 Enhanced Multibus (MSA) New £1150
- Nikon HFX-11 (Ephiphot) exposure control unit £1450
- PHILIPS PM5518 pro. TV signal generator £1250
- Motorola VME Bus Boards & Components List. SAE / CALL £POA
- Trilo 0-18 vdc linear, metered 30 amp bench PSU. New £550
- Fujitsu M3041R 600 LPM high speed band printer £1950
- Fujitsu M3041D 600 LPM printer with network interface £1250
- Perkin Elmer 299B Infrared spectrophotometer £500
- Perkin Elmer 597 Infrared spectrophotometer £3500
- VG Electronics 1035 TELETEXT Decoding Margin Meter £3250
- LightBand 60 output high spec 2u rack mount Video VDA's £495
- Sekonic SD 150H 18 channel digital Hybrid card recorder £1995
- B&K 2633 Microphone pre amp £300
- Taylor Hobson Tallysurf amplifier / recorder £1450
- AIC S5200 Carbon dioxide gas detector / monitor £750
- BBC AM203 PPM Meter (Ernest Turner) + drive electronics £75
- ANRITSU 9654A Optical DC-2.5Gb/wavelorn monitor £5650
- ANRITSU MS9001B1 0.6-1.7 uM optical spectrum analyser £POA
- ANRITSU ML93A optical power meter £990
- ANRITSU Fibre optic characteristic test set £POA
- R&S FTDZ Dual sound unit £650
- R&S SBUF-E1 Video modulator £775
- WILTRON 6630B 12.4 / 20GHz RF sweep generator £5750
- TEK 2445 150 MHz 4 trace oscilloscope £1250
- TEK 2465 300 MHz 3 trace oscilloscope rack mount £1955
- TEK TDS380 400MHz digital realtime + disk drive, FFT etc £2900
- TEK TDS524A 500MHz digital realtime + colour display etc £5100
- HP3585A Opt 907 20Hz to 40 Mhz spectrum analyser £3950
- PHILIPS PW1730/10 60KW XRAY generator & accessories £POA
- CLAUDE LYONS 12A 240V single phase auto. volt. regs £325
- CLAUDE LYONS 100A 240/415V 3 phase auto. volt. regs £2900

19" RACK CABINETS



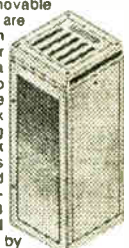
Superb quality 6 foot 40U
Virtually New, Ultra Smart
Less than Half Price!

Top quality 19" rack cabinets made in UK by Optima Enclosures Ltd. Units feature designer, smoked acrylic lockable front door, full height lockable half louvered back door and louvered removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting, plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the most versatile we have ever sold. Racks may be stacked side by side and therefore require only two side panels to stand singly or in multiple bays. Overall dimensions are: 77 1/2" H x 32 1/2" D x 22" W. Order as:
OPT Rack 1 Complete with removable side panels. £345.00 (G)
OPT Rack 2 (Back & base side panels). £245.00 (B)

Over 1000 racks, shelves, accessories
19" 22" & 24" wide 3 to 46 U high.
Available from stock !!

32U - High Quality - All steel RakCab

Made by Eurocraft Enclosures Ltd to the highest possible spec, rack features all steel construction with removable side, front and back doors. Front and back doors are hinged for easy access and all are lockable with five secure 5 lever barrel locks. The front door is constructed of double walled steel with a 'designer style' smoked acrylic front panel to enable status indicators to be seen through the panel, yet remain unobtrusive. Internally the rack features fully slotted reinforced vertical fixing members to take the heaviest of 19" rack equipment. The two movable vertical fixing struts (extras available) are pre punched for standard 'cage nuts'. A mains distribution panel internally mounted to the bottom rear, provides 8 x IEC 3 pin Euro sockets and 1 x 13 amp 3 pin switched utility socket. Overall ventilation is provided by fully louvered back door and double skinned top section with top and side louvers. The top panel may be removed for fitting of integral fans to the sub plate etc. Other features include: fitted castors and floor levelers, pre-punched utility panel at lower rear for cable / connector access etc. Supplied in excellent, slightly used condition with keys. Colour Royal Blue. External dimensions mm=1625H x 635D x 603 W (64" H x 25" D x 23 1/2" W)



Sold at LESS than a third of makers price !!

A superb buy at only £245.00 (G)

42U version of the above only £345 - CALL

12V BATTERY SCOOP - 60% off !!

A special bulk purchase from a cancelled export order brings you the most amazing savings on these ultra high spec 12v DC 14 Ah rechargeable batteries. Made by Hawker Energy Ltd, type SBS15 featuring pure lead plates which offer a far superior shelf & guaranteed 15 year service life. Full BT & BS6290 approved. Supplied BRAND NEW and boxed. Dimensions 200 wide, 137 high, 77 deep. M6 bolt terminals. Fully guaranteed. Current makers price over £70 each
Our Price £35 each (C) or 4 for £99 (E)

RELAYS - 200,000 FROM STOCK

Save ££££'s by choosing your next relay from our Massive Stocks covering types such as Military, Octal, Crede, Hermetically Sealed, Continental, Contactors, Time Delay, Relay, Mercury Wetted, Solid State, Printed Circuit Mounting etc. CALL or see our web site www.distel.co.uk for more information. Many obsolete types from stock. Save ££££'s

COLOUR CCD CAMERAS

Undoubtedly a miracle of modern technology our OBSCURE CCD CAMERAS offer you special buying power! A quality product featuring a fully cased COLOUR CCD camera at a give away price! Unit features full autolight sensing for use in low light & high light applications. A 10 mm fixed focus wide angle lens gives excellent focus and resolution from close up to long range. The composite video output will connect to any composite monitor or TV (via SCART socket) and most video recorders. Unit runs from 12V DC so ideal for security & portable applications where mains power not available. Overall dimensions 66 mm wide x 117 dwp x 43 high. Supplied BRAND NEW & fully guaranteed with user data, 100's of applications including Security, Home Video, Web TV, Web Cam's etc.

Web ref = LK33 ONLY £99.00 or 2 for £180.00 (B)

SOFTWARE SPECIALS

NT4 WorkStation, complete with service pack 3 and licence - OEM packaged. ONLY £89.00 (B)
ENCARTA 95 - CDROM, Not the latest - but at this price! £7.95
DOS 5.0 on 3 1/2" disks with concise books c/w Basic £14.95
Windows for Workgroups 3.11 + Dos 6.22 on 3.5" disks £55.00
Wordperfect 6 for DOS supplied on 3 1/2" disks with manual £24.95
shipping charges for software is code B

DISTEL on the web !! - Over 16,000,000 items from stock - www.distel.co.uk

Display Electronics
-ELECTRONICS-

ALL MAIL TO
Dept PE, 29/35 Osborne Rd
Thornton Heath
Surrey CR7 8PD
Open Mon - Fri 9.00 - 5:30

LONDON SHOP
Open Mon - Sat 9.00 - 5:30
215 Whitehorse Lane
South Norwood
On 68A Bus Route
N. Thornton Heath &
Selhurst Park SR Rail Stations

NEW DISTEL
Visit our web site
www.distel.co.uk
email = admin@distel.co.uk

ALL ENQUIRIES
0208 653 3333
FAX 0208 653 8888

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bona Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Cheques over £100 are subject to 10 working days clearance. Carriage charges (A)-£3.00, (A1)-£4.00, (B)-£5.50, (C)-£8.50, (D)-£12.50, (D)-£15.00, (E)-£18.00, (F)-£20.00, (G)-CALL. Allow approx 6 days for shipping - faster 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, tradenames etc acknowledged © Display Electronics 1999 E & O E. 0759.

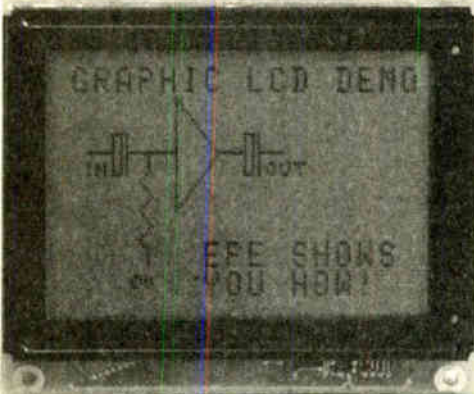
NEXT MONTH

SPECIAL SUPPLEMENT

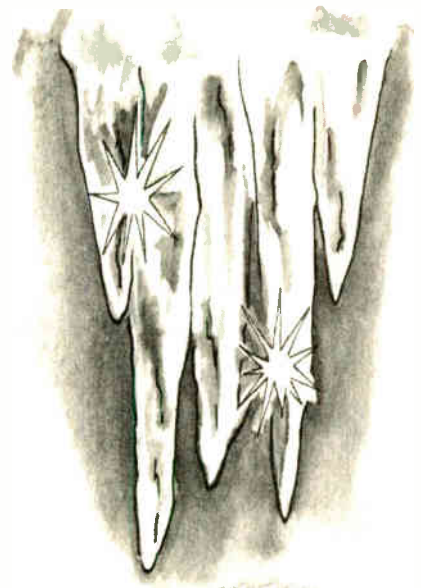
HOW TO USE GRAPHICS LIQUID CRYSTAL DISPLAYS

Graphics liquid crystal displays have been available for several years. It would appear, though, that EPE readers have not successfully explored them. Possibly the principal reason we have not been offered working designs is that readers have not been able to obtain, let alone interpret, the data sheets associated with them.

The latter stumbling block very much faced the author when he decided that he would like to know how to use such displays. Intermittently over several days, he scoured the Internet in search of their manufacturers and suppliers. As it turned out, there are quite a few around the globe, but when it came to obtaining data sheets – well, that was a totally different matter.



Eventually he succeeded (after a fair bit of hassle!), and set about getting to know how to use the family of displays based on the Toshiba T6963C l.c.d. controller. He describes in extensive detail how PIC microcontrollers can be programmed to use these versatile displays, with many interactive demo examples of the program codes required. They are easy to use once their mysteries are revealed!



ICE ALERT

This project gives an indication of the outside temperature by the changing appearance of a three-colour light-emitting diode (l.e.d.). Above a certain threshold (nominally 6°C), it will be off. As the temperature falls, it will progressively appear Green (below 6°C), Yellow (below 4°C) and Red (below 2°C). These operating points could be changed over a small range to suit the application.

The Ice Alert will be found particularly useful by car drivers. However, readers will find many other applications for it. For example, gardeners could use it to monitor the temperature inside a greenhouse or at the ground surface from a point inside the house.

PC AUDIO POWER METER

This project is the latest in the occasional series of PC-based test equipment. This device is based on an analogue-to-digital converter, it enables a PC to measure power, and it is primarily intended for use with audio power amplifiers. However, the interface uses d.c. coupling and it could probably be modified for use in some d.c. power measuring applications.

When used for audio power measurement, it provides an eight-ohm dummy load, and shows the peak power and voltage delivered to the load. It also has a virtual panel meter that shows the r.m.s. power level when using sinewave test signals. The eight-ohm dummy load can handle a little over 100 watts r.m.s.

The circuit connects to the printer port of the host PC, and the port does not need to be a bi-directional type. The power meter program is written in VisualBASIC 6, and it requires Windows 95, 98 or ME to run.

PLUS ALL THE REGULAR FEATURES

NO ONE DOES IT BETTER

EVERYDAY
PRACTICAL
ELECTRONICS
INCORPORATING **ELECTRONICS TODAY INTERNATIONAL**

**DON'T MISS AN
ISSUE – PLACE YOUR
ORDER NOW!**
Demand is bound to be high

FEBRUARY 2001 ISSUE ON SALE THURSDAY, JANUARY 11

ADD £2.00 P&P to all orders (for 1st Class Recorded £4. Next day (Inscribed £25) £7 Europe £40 Rest of World £50.00). We accept all major credit cards. Make cheques/PO's payable to Quasar Electronics. Prices include 17.5% VAT. MAIL ORDER ONLY. FREE CATALOGUE with order or send 2 x 1st class stamps (refundable) for details of over 150 kits & publications.

PROJECT KITS

Our electronic kits are supplied complete with all components, high quality PCBs (NOT cheap Tripad strip board!) and detailed assembly/operating instructions

- **2 x 25W CAR BOOSTER AMPLIFIER** Connects to the output of an existing car stereo cassette player, CD player or radio. Heatsinks provided. PCB 76x75mm 1046KT £27.95
- **3-CHANNEL WIRELESS LIGHT MODULATOR** No electrical connection with amplifier. Light modulation achieved via a sensitive electret microphone. Separate sensitivity control per channel. Power handling 400W/channel PCB 54x112mm Mains powered. Box provided. 6014KT £27.95
- **12 RUNNING LIGHT EFFECT** Exciting 12 LED light effect ideal for parties, discos, shop-windows & eye-catching signs. PCB design allows replacement of LEDs with 220V bulbs by inserting 3 TRIACs. Adjustable rotation speed & direction. PCB 54x112mm 1026KT £17.95; BOX (for mains operation) 2026BX £10.00
- **DISCO STROBE LIGHT** Probably the most exciting of all light effects. Very bright strobe tube. Adjustable strobe frequency. 1-60Hz. Mains powered. PCB: 60x68mm. Box provided. 6037KT £31.95

- **ANIMAL SOUNDS** Cat, dog, chicken & cow. Ideal for kids farmyard toys & schools. SG10M £6.95
- **1/2 DIGIT LED PANEL METER** Use for basic voltage/current displays or customise to measure temperature, light, weight, movement, sound levels, etc. with appropriate sensors (not supplied). Various input circuit designs provided. 3061KT £13.95
- **IR REMOTE TOGGLE SWITCH** Use any TV/VCR remote control unit to switch onboard 12V/1A relay on/off. 3058KT £10.95
- **SPEED CONTROLLER** for any common DC motor up to 100V/5A. Pulse width modulation gives maximum torque at all speeds. 5-15VDC. Box provided. 3067KT £12.95
- **3 x 8 CHANNEL IR RELAY BOARD** Control eight 12V/1A relays by Infra Red (IR) remote control over a 20m range in sunlight. 6 relays turn on only, the other 2 toggle on/off. 3 operation ranges determined by jumpers. Transmitter case & all components provided. Receiver PCB 76x89mm 3072KT £52.95

PRODUCT FEATURE

4 WATT FM TRANSMITTER

Small but powerful 4 Watt 88-108MHz FM transmitter with an audio preamplifier stage and 3 RF stages. Accepts a wide variety of input sources - the electret microphone supplied, a tape player or for more professional results, a separate audio mixer (like our 3-Input Mono Mixer kit 1052). Can be used with an open dipole or ground plane antenna. Supply: 12-15V DC/0.5A. PCB: 45 x 145mm.



ORDERING INFO: Kit 1028KT £24.95. OPTIONAL EXTRAS: 3-Input Mono Mixer Kit 1052KT £17.95. AS1028 £39.95.

- **SOUND EFFECTS GENERATOR** Easy to build. Create an almost infinite variety of interesting/unusual sound effects from birds chirping to sirens. 9VDC. PCB 54x85mm 1045KT £9.95
- **ROBOT VOICE EFFECT** Make your voice sound similar to a robot or Darlek. Great fun for discos, school plays, theatre productions, radio stations & playing jokes on your friends when answering the phone! PCB 42x71mm. 1131KT £9.95
- **AUDIO TO LIGHT MODULATOR** Controls intensity of one or more lights in response to an audio input. Safe, modern optical-coupler design. Mains voltage experience required. 3012KT £8.95
- **MUSIC BOX** Activated by light. Plays 8 Christmas songs and 5 other tunes. 3104KT £7.95
- **20 SECOND VOICE RECORDER** Uses non-volatile memory - no battery backup needed. Record/replay messages over & over. Playback as required to greet customers etc. Volume control & built-in mic. 6VDC PCB 50x73mm. 1313KT £8.95
- **TRAIL SOUNDS** 4 selectable sounds: whistle blowing, level crossing bell, 'clackety-clack' & 4 in sequence. SG01M £6.95

- **PC CONTROLLED RELAY BOARD** Convert any 286 upward PC into a dedicated automatic controller to independently turn on/off up to eight lights, motors & other devices around the home, office, laboratory or factory using 8 240VAC/12A onboard relays. DOS utilities, sample test program, full-featured Windows utility & all components (except cable) provided. 12VDC. PCB 70x200mm. 3074KT £31.95
- **2 CHANNEL UHF RELAY SWITCH** Contains the same transmitter/receiver pair as 30A15 below plus the components and PCB to control two 240VAC/10A relays (also supplied). Ultra bright LEDs used to indicate relay status. 3082KT £27.95
- **TRANSMITTER RECEIVER PAIR** 2-button keyfob style 300-375MHz Tx with 30m range. Receiver encoder module with matched decoder IC. Components must be built into a circuit like kit 3082 above. 30A15 £14.95
- **PC DATA ACQUISITION/CONTROL UNIT** Use your PC to monitor physical variables (e.g. pressure, temperature, light, weight, switch state, movement, relays, etc.), process the information & use results to control physical devices like motors, sirens, relays, servo & stepper motors. Inputs: 16 digital & 11 analogue. Outputs: 8 digital & 1 analogue. Plastic case with printed front/rear panels, software utilities, programming examples & all components (except sensors & cable) provided. 12VDC 3093KT £99.95
- **PIC 16C71 FOUR SERVO MOTOR DRIVER** Simultaneously control up to 4 servo motors. Software & all components (except servo-control pots) supplied. 5VDC PCB 50x70mm 3102KT £15.95
- **PC SERIAL PORT ISOLATED I/O BOARD** Provides eight 240VAC/10A relay outputs & 4 optically isolated inputs. Designed for use in various control & sensing applications e.g. load switching, external switch input sensing, contact closure & external voltage sensing. Controlled via serial port & a terminal emulator program (built into Windows). Can be used with ANY computer/operating system. Plastic case with printed front/rear panels & all components (except cable) provided. 3108KT £54.95
- **UNIPOLAR STEPPER MOTOR DRIVER** for any 5/6/8 lead motor. Fast/slow & single step rates. Direction control & on/off switch. Wave, 2-phase & half-wave step modes. 4 LED indicators. PCB 50x65mm. 3109KT £14.95
- **PC CONTROLLED STEPPER MOTOR DRIVER** Control two unipolar stepper motors (3A max each) via PC printer port. Wave, 2-phase & half-wave step modes. Software accepts 4 digital inputs from external switches & will single step motors. PCB fits in O-shell case provided. 3113KT £17.95
- **12-BIT PC DATA ACQUISITION/CONTROL UNIT** Similar to kit 3093 above but uses a 12 bit Analogue-to-Digital Converter (ADC) with Internal analogue multiplexer. Reads 8 single ended channels or 4 differential inputs or a mixture of both. Analogue inputs read 0-4V. Four TTL/CMOS compatible digital input/outputs. AOC conversion time <10us. Software (C QB & Win), extended D shell case & all components (except sensors & cable) provided. 3118KT £52.95

X-FACTOR PUBLICATIONS

THE EXPERTS IN RARE & UNUSUAL INFORMATION!

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

- **SUPER-EAR LISTENING DEVICE** Complete plans to build your own parabolic dish microphone. Listen to distant voices and sounds through open windows and even walls! Made from readily available parts. R002 £3.50
- **TELEPHONE BUG PLANS** Build your own micro-bee telephone bug. Suitable for any phone. Transmits over 250 metres - more with good receiver. Made from easy to obtain cheap components. R006 £2.50
- **LOCKS** - How they work and how to pick them. This fact filled report will teach you more about locks and the art of lock picking than many books we have seen at 4 times the price. Packed with information and illustrations. R008 £3.50
- **RADIO & TV JOKER PLANS** We show you how to build three different circuits for disrupting TV picture and sound plus FM radio! May upset your neighbours & the authorities! DISCRETION REQUIRED. R017 £3.50
- **INFINITY TRANSMITTER PLANS** Complete plans for building the famous Infinity Transmitter. Once installed on the target phone, device acts like a room bug. Just call the target phone & activate the unit to hear all room sounds. Great for home office security. R019 £3.50
- **THE ETHER BOX CALL INTERCEPTOR PLANS** Grabs telephone calls out of thin air! No phone lines to be heard bug. Simply place this device near the phone lines to hear the conversations taking place! R025 £3.00
- **CASH CREATOR BUSINESS REPRINTS** Need ideas for making some cash? Well this could be just what you need! You get 40 reports (approx. 300 pages) on floppy disk that give you information on setting up different businesses. You also get valuable reproduction and duplication rights so that you can sell the manuals as you like. R030 £7.50

SURVEILLANCE

High performance surveillance bugs. Room transmitters supplied with sensitive electret microphone & battery holder/cap. All transmitters can be received on an ordinary VHF/FM radio between 88-108MHz. Available in Kit Form (KIT) or Assembled & Tested (AST)

ROOM SURVEILLANCE

- **MTX - MINIATURE 3V TRANSMITTER** Easy to build & guaranteed to transmit 300m @ 3V. Long battery life. 5-5V operation. Only 45x18mm. ● 3007KT £6.95 AS3007 £11.95
- **MTTX - MINIATURE 9V TRANSMITTER** Our best selling bug. Super sensitive, high power - 500m range @ 9V (over 1km with 18V supply and better aerial) 45x19mm 3018KT £7.95 AS3018 £12.95
- **HPTX - HIGH POWER TRANSMITTER** High performance, 2 stage transmitter gives greater stability & higher quality reception. 1000m range. 6-12V DC operation. Size 70x15mm. 3032KT £9.95 AS3032 £18.95
- **MMTX - MICRO-MINIATURE 9V TRANSMITTER** The ultimate bug for its size performance and price. Just 15x25mm. 500m range @ 9V. Good stability 6-18V operation. 3051KT £8.95 AS3051 £14.95
- **VTX - VOICE ACTIVATED TRANSMITTER** Operates only when sounds detected. Low standby current. Variable trigger sensitivity. 500m range. Peaking circuit supplied for maximum RF output. On/off switch. 6V operation. Only 63x38mm. 3028KT £12.95 AS3028 £21.95
- **HARD-WIRED BUG/TWO STATION INTERCOM** Each station has its own amplifier, speaker and mic. Can be set up as either a hard-wired bug or two-station intercom. 10m x 2-core cable supplied. 9V operation. 3021KT £15.95 (kit form only)
- **TRTX - TAPE RECORDER VOX SWITCH** Used to automatically operate a tape recorder (not supplied) via its REMOTE socket when sounds are detected. All conversations recorded. Adjustable sensitivity & turn-off delay. 115x19mm. 3013KT £9.95 AS3013 £21.95

TELEPHONE SURVEILLANCE

- **MTTX - MINIATURE TELEPHONE TRANSMITTER** Attaches anywhere to phone line. Transmits only when phone is used! Tune-in your radio and hear both parties. 300m range. Uses line as aerial & power source. 20x45mm. 3016KT £8.95 AS3016 £14.95
- **TRI - TELEPHONE RECORDING INTERFACE** Automatically records all conversations. Connects between phone line & tape recorder (not supplied). Operates recorders with 1.5-12V battery systems. Powered from line. 50x33mm. 3033KT £9.95 AS3033 £18.95
- **TPA - TELEPHONE PICK-UP AMPLIFIER/WIRELESS PHONE BUG** Place pick-up coil on the phone line or near phone earpiece and hear both sides of the conversation. 3055KT £11.95 AS3055 £20.95
- **IWATT FM TRANSMITTER** Easy to construct. Delivers a crisp, clear signal. Two-stage circuit. Kit includes microphone and requires a simple open dipole aerial. 8-30VDC. PCB 42x45mm 1009KT £14.95
- **4 WATT FM TRANSMITTER** Comprises three RF stages and an audio preamplifier stage. Piezoelectric microphone supplied or you can use a separate preamplifier circuit. Antenna can be an open dipole or Ground Plane. Ideal project for those who wish to get started in the fascinating world of FM broadcasting and want a good basic circuit to experiment with. 12-18VDC. PCB 44x146mm 1028KT £24.95 AS1028 £39.95
- **15 WATT FM TRANSMITTER (PRE-ASSEMBLED & TESTED)** Four transistor based stages with Philips BLY 6B in final stage. 15 Watt alarm power switch. 88-108MHz. Accepts open dipole, Ground Plane, 5/8 J, or YAGI configuration antennas. 12-18VDC. PCB 70x220mm. SW5 meter needed for alignment. 1021KT £74.95
- **SIMILAR TO ABOVE BUT 25W Output.** 1031KT £84.95

- **LIQUID LEVEL SENSOR/RAIN ALARM** Will indicate fluid levels or simply the presence of fluid. Relay output to control a pump to add/remove water when it reaches a certain level. 1080KT £6.95
- **STEREO VU METER** shows peak music power using 2 rows of 10 LEDs (mixed green & red) moving bar display. 0-30db. 3089KT £11.95
- **AM RADIO KIT 1 Tuned Radio Frequency** front-end, single chip AM radio IC & 2 stages of audio amplification. All components inc. speaker provided. PCB 32x45mm 3063KT £10.95
- **DRILL SPEED CONTROLLER** Adjust the speed of your electric drill according to the job at hand. Suitable for 240V AC mains powered drills up to 700W power. PCB: 48mm x 65mm. Box provided. 6074KT £18.95
- **3 INPUT MONO MIXER** Independent level control for each input and separate bass/treble controls. Input sensitivity. 240mV. 18V DC. PCB: 60mm x 185mm 1052KT £17.95
- **NEGATIVE/POSITIVE ION GENERATOR** Standard Cockcroft-Walton multiplier circuit. Mains voltage experience required. 3057KT £10.95
- **LED DICE** Classic intro to electronics & circuit analysis. 7 LEDs simulate dice roll, slow down & land on a number at random. 555 IC circuit. 3003KT £9.95
- **STAIRWAY TO HEAVEN** Tests hand-eye co-ordination. Press switch when green segment of LED lights to climb the stairway - miss & start again! Good intro to several basic circuits. 3005KT £9.95
- **ROULETTE LED** Ball spins round the wheel, slows down & drops into a slot. 10 LEDs. Good intro to CMOS decade counters & Op-Amps. 3006KT £10.95
- **9V XENON TUBE FLASHER** Transformer circuit. Just use 9V battery to flash a 25mm Xenon tube. Adjustable flash rate (0.25-2 Secs). 3022KT £11.95
- **LED FLASHER 1** 5 ultra bright red LEDs flash in 7 selectable patterns. 3037MKT £5.95
- **LED FLASHER 2** Similar to above but flash in sequence or randomly. Ideal for model railways. 3052KT £5.95

- **STABILISED POWER SUPPLY 3-30V/2.5A** Ideal for hobbyist & professional laboratory. Very reliable & versatile design at an extremely reasonable price. Short circuit protection. Variable DC voltages (3-30V). Rated output 2.5 Amps. Large heatsink supplied. You just supply a 24VAC/3A transformer. PCB 55x112mm. Mains operation. 1007KT £18.95
- **STABILISED POWER SUPPLY 2-30V/5A** As kit 1007 above but rated at 5Amp. Requires a 24VAC/5A transformer. 1096KT £32.95
- **MOTORBIKE ALARM** Uses a reliable vibration sensor (adjustable sensitivity) to detect movement of the bike to trigger the alarm & switch the output relay to which a siren, bell, horn, indicators or other warning device can be attached. Auto-reset. 6-12VDC. PCB 57x64mm. 1011KT £19.95. Box 2011BX £7.00
- **CAR ALARM SYSTEM** Protect your car from theft. Features vibration sensor, courtesy/boot light voltage drop sensor and bonnet/boot earth switch sensor. Entry/exit delays, auto-reset and adjustable alarm duration. 6-12V DC. PCB: 47mm x 55mm 1019KT £12.95. Box 2019BX £8.00
- **PIEZO CREAMER** 110dB of ear piercing noise. Fits in box with x 2 35mm piezo elements built into their own resonant cavity. Use as an alarm siren or just for fun! 6-9VDC. 3015KT £10.95
- **COMBINATION LOCK** Versatile electronic lock comprising main circuit & separate keypad for remote opening of lock. Relay supplied. 3029KT £10.95
- **ULTRASONIC MOVEMENT DETECTOR** Crystal locked detector frequency for stability & reliability. PCB 75x40mm houses all components. 4-7m range. Adjustable sensitivity. Output will drive external relay/circuits. 9VDC. 3049KT £13.95
- **PIR DETECTOR MODULE 3** Lead assembled unit just 25x35mm as used in commercial burglar alarm systems. 3076KT £8.95
- **INFRARED SECURITY BEAM** When the invisible IR beam is broken a relay is tripped that can be used to sound a bell or alarm. 25 metre range. Mains rated relays provided. 12VDC operation. 3130KT £12.95
- **SQUARE WAVE OSCILLATOR** Generates square waves at 6 preset frequencies in factors of 10 from 1Hz-100KHz. Visual output indicator. 5-18VDC. Box provided. 3111KT £8.95
- **PC DRIVEN POCKET SAMPLER/DATA LOGGER** Analogue voltage sampler records voltages up to 2V or 20V over periods from milli-seconds to months. Can also be used as a simple digital scope to examine audio & other signals up to about 5KHz. Software & D-shell case provided. 3112KT £18.95
- **20 MHz FUNCTION GENERATOR** Square, triangular and sine waveform up to 20MHz over 3 ranges using 'coarse' and 'fine' frequency adjustment controls. Adjustable output from 0.2V p-p. A TTL output is also provided for connection to a frequency meter. Uses MAX038 IC. Plastic case with printed front/rear panels & all components provided. 7-12VAC. 3101KT £69.95

- **INTRODUCTION TO PIC PROGRAMMING.** Learn programming from scratch. Programming hardware, a P16F84 chip and a two-part, practical, hands-on tutorial series are provided. 3081KT £22.95
- **SERIAL PIC PROGRAMMER** for all 8/18/28/40 pin DIP serial programmed PICs. Shareware software supplied limited to programming 256 bytes (registration costs £14.95). 3096KT £13.95
- **PICALL SERIAL & PARALLEL PIC PROGRAMMER** for all 8/18/28/40 pin DIP parallel AND serial PICs. Includes fully functional & registered software (DOS, W3.1, W95/8). 3117KT £59.95
- **ATMEL 89C051 PROGRAMMER** Simple-to-use yet powerful programmer for the Atmel 89C1051, 89C2051 & 89C4051 uC's. Programmer does NOT require special software other than a terminal emulator program (built into Windows). Can be used with ANY computer/operating system. 3121KT £24.95
- **3V/1.5V TO 9V BATTERY CONVERTER** Replace expensive 9V batteries with economic 1.5V batteries. IC based circuit steps up 1 or 2 AA batteries to give 9V/18mA. 3035KT £5.95

BARGAIN BUY!!

Great introduction to electronics. Ideal for the budding electronics expert! Build a radio, burglar alarm, water detector, Morse code practice circuit, simple computer circuits, and much more! NO soldering tools or previous electronics knowledge required. Circuits can be built and unassembled repeatedly. Comprehensive 68-page manual with explanations, schematics and assembly diagrams. Suitable for age 10+. Excellent for schools. Requires 2 x AA batteries. ONLY £14.95 (phone for bulk discounts).

30-IN-ONE Electronic Projects Lab



WEB: <http://www.QuasarElectronics.com>
email: epesales@QuasarElectronics.com

Secure Online Ordering Facilities
Full Kit Listing, Descriptions & Photos
Kit Documentation & Software Downloads

Credit Card Sales: 01279 306504

www.QuasarElectronics.com

ABC Mini 'Hotchip' Board

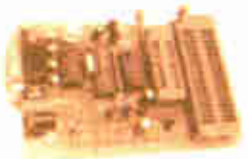


Currently learning about microcontrollers? Need to do something more than flash a LED or sound a buzzer? The ABC Mini 'Hotchip' Board is based on Atmel's AVR 8535 RISC technology and will interest both the beginner and expert alike. Beginners

will find that they can write and test a simple program, using the BASIC programming language, within an hour or two of connecting it up. Experts will like the power and flexibility of the Atmel microcontroller, as well as the ease with which the little Hot Chip board can be "designed-in" to a project. The ABC Mini Board 'Starter Pack' includes just about everything you need to get up and experimenting right away. On the hardware side, there's a pre-assembled micro controller PC board with both parallel and serial cables for connection to your PC. Windows software included on CD-ROM features an Assembler, BASIC compiler and in-system programmer. The pre-assembled boards only are also available separately.

Order Ref	Description	Inc. VAT ea
ABCMINISP	ABC MINI Starter Pack	£64.95
ABCMINIB	ABC MINI Board Only	£39.95

ATMEL 89xxxx Programmer



Powerful programmer for Atmel 8051 micro controller family. All fuse and lock bits are programmable. Connects to serial port. Can be used with ANY computer & operating system. 4 LEDs to

indicate programming status. Supports 89C1051, 89C2051, 89C4051, 89C51, 89LV51, 89C52, 89LV52, 89C55, 89LV55, 89S8252, 89LS8252, 89S53, 89LS53 devices. NO special software required - uses any terminal emulator program (built into Windows). **NB ZIF sockets not included.**

Order Ref	Description	Inc. VAT ea
3023KT	ATMEL 89xxx Programmer	£24.95
AS3023	Assembled 3023	£39.95

Atmel 89Cx051 and AVR programmers also available.

Educational Robot Kits



This range of nine computerised battery robot kits teaches the basic principles of robotic sensing and locomotion. Each of the kits features pre-assembled PCBs, hardware and mechanical drive systems that can be handled by almost

anyone from ages 10 and up. Only basic hand tools are required for assembly. These fascinating robots allow you to experience and learn any one of the following features: sound sensor, remote control, infrared sensor, wired control and/or programmable memory.

See the full range of these high quality Japanese robot kits on our website or call for details.

'PICALL' PIC Programmer

Kit will program ALL 8, 18, 28 and 40 pin serial AND parallel programmed PIC micro controllers. Connects to the parallel port of a PC. Supplied with fully functional pre-registered PICALL DOS and WINDOWS AVR software packages, all components and high quality DSPTH PCB. Also programs certain ATMEL AVR, serial EPROM and SCENIX SX devices. New PIC's can be added to the software as they are released. Software shows you where to place your PIC chip on the board for programming. Now has new-chip auto sensing feature for super-fast bulk programming.

Order Ref	Description	Inc. VAT ea
3117KT	PICALL' PIC Programmer Kit	£59.95
AS3117	Assembled PICALL' PIC Programmer	£69.95
AS3117ZIF	Assembled 'PICALL' PIC Programmer c/w ZIF socket	£84.95

Advanced Schematic Capture, Simulation, PCB Layout Software

Advanced Schematic Capture, Simulation, PCB Layout

- Advanced Hierarchical Schematic Capture Includes Graphical Library Browser and Device Spooler. Device Library Editor. Schematic PCB Netlist Generation. Over 7000 device models. Model import Wizard allows you to download and import models from various manufacturers web pages.
- Advanced 32-bit Analog, Digital and Mixed Mode Simulation
- Virtual Instruments: Ohm's Law, Current/Voltage Multi-meter, shows complex Voltage, Current, Phase, Magnitude etc.
- Built in 64-Channel Real-Time Virtual Oscilloscope
- Built in Digital Logic Analyzer allows you to set breakpoints
- Supports Advanced BSIM3v3, BSIM4, and SOI Models
- 21 Different analysis types including advanced blocks, Curve Fitter

- PCB design up to 255 layers, 32"x32" boards, 601" resolution
- AutoRouter/AutoPlacement/Viewer, Thousands of Parts!!!

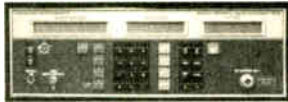
VisualSpice Software Purchasing Options
 Personal Edition £64.95 Standard Edition £129.95
 Professional Edition £194.95 (see web or call for full details)

Serial Port Isolated I/O Controller

Kit provides eight 12A 240VAC (15A 110VAC) rated relay outputs and four optically isolated inputs. Can be used in a variety of control and sensing applications including load switching, external switch input sensing, contact closure and external voltage sensing. Programmed via a computer serial port, it is compatible with ANY computer & operating system. After programming, PC can be disconnected. Serial cable can be up to 35m long, allowing 'remote' control. User can easily write batch file programs to control the kit using simple text commands. NO special software required - uses any terminal emulator program (built into Windows). All components provided including a plastic case with pre-punched and silk screened front/rear panels to give a professional and attractive finish (see photo).

Order Ref	Description	Inc. VAT ea
3108KT	Serial Port Isolated I/O Controller Kit	£54.95
AS3108	Assembled Serial Port Isolated I/O Controller	£69.95

MARCONI 2019A



AM/FM SYNTHESISED SIGNAL GENERATOR
80 kHz - 1040MHz
£400
NOW ONLY

H.P. 3312A Function Gen., 0-1Hz-13MHz, AM/FM Sweep/Tr/Gate/Burst etc. £300
H.P. 331DA Function Gen., 0-005Hz-5MHz, Sine/Sq/Tr/Ramp/Pulse £125
FARNELL LF4M Sine/Sq Oscillator, 10Hz-1MHz, low distortion, TTL output, Amplitude Meter £125
H.P. 545A Logic Probe with 546A Logic Pulser and 547A Current Tracer £90
FLUKE 77 Multimeter, 3 1/2-digit, handheld £60
FLUKE 77 Series 11 £70
HEME 1000 L.C.D. Clamp Meter, 00-1000A, in carrying case £60

RACAL 9008

Automatic Modulation Meter, AM/FM 1-5MHz-2GHz
£95
ONLY



H.P. 8494A Attenuator, DC-4GHz, 0-11dB, N/SMA £250
H.P. 8492A Attenuator, DC-18GHz, 0-6dB, APC7 £95
MANY OTHER ATTENUATORS, LOADS, COUPLERS ETC. AVAILABLE

DATRON 1061

HIGH QUALITY 5 1/2-DIGIT BENCH MULTIMETER
True RMS/4 wire Res/Current Converter/IEEE
£150

TIME 1051 LOW OHM RES. BOX

0-01 ohm to 1Mohm in
0-01 ohm steps.
£100
UNUSED

STILL AVAILABLE AS PREVIOUSLY ADVERTISED WITH PHOTOS

MARCONI 893C AF Power Meter, Sinad Measurement Unused £100, Used £60
MARCONI 893B, No Sinad £30
MARCONI 2610 True RMS Voltmeter, Autoranging, 5Hz-25MHz £125
GOULD J3B Sine/Sq Osc., 10Hz-100kHz, £75-£125
low distortion
AVO 8 Mk. 6 in Every Ready case, with leads etc. £80
Other AVOs from £50
GOODWILL GFC8010G Freq. Counter, 1Hz-120MHz, unused £75
GOODWILL GVT427 Dual Ch AC Millivoltmeter, 10mV-300V in 12 ranges, Freq. 10Hz-1MHz £100-£125
SOLARTRON 7150 DMM 6 1/2-digit Tru RMS-IEEE £395-£150
£200

SOLARTRON 7150 Plus
RACAL TRUE RMS VOLTMETERS
9300 5Hz-20MHz usable to 60MHz, 10V-316V £95
9300B Version £150
9301/9302 RF Version to 1.5MHz from £200-£300
HIGH QUALITY RACAL COUNTERS
9904 Universal Timer Counter, 50MHz £50
9916 Counter, 10Hz-520MHz £75
9918 Counter, 10Hz-560MHz, 9-digit £50
FARNELL AMM255 Automatic Mod Meter, 1-5MHz-2GHz, unused £400

CLASSIC AVOMETER DA116

Digital 3-5 Digit
Complete with batteries and leads
£30
ONLY



SOLARTRON 7045 BENCH MULTIMETER

4 1/2-Digit bright i.e.d. with leads
It's so cheap you should have it as a spare
£30
ONLY

MARCONI TF2015 AM/FM sig gen, 10-520MHz £175
RACAL 9008 Auto Mod Meter, 1-5MHz-2GHz £200
LEVELL TG2000AMP RC Oscillator, 1Hz-1MHz £50
Sine/Sq. Meter, battery operated (batts. not supplied)
FARNELL LF1 Sine/Sq. Oscillator, 10Hz-1MHz £75
RACAL/AIM 9343M LCR Databridge, Digital Auto measurement of R, C, L, Q, D £200
HUNTRON TRACKER Model 1000 £125
H.P. 5315A Universal Counter, 1GHz, 2-ch £80
FLUKE 8050A DMM 4 1/2-digit 2A True RMS £75
FLUKE 8010A DMM 3 1/2-digit 10A £50

RADIO COMMUNICATIONS TEST SETS

MARCONI 2955/2955S £200
MARCONI 2955A/2960 £250
MARCONI 2022E Synth AM/FM sig gen 10Hz-1.01GHz i.c. display etc. £525-£750
H.P. 8672A Synth 2-18GHz sig gen £4000
H.P. 8657A Synth sig gen, 100kHz-1040MHz £2000
H.P. 8656B Synth sig gen, 100kHz-990MHz £1350
H.P. 8656A Synth sig gen, 100kHz-990MHz £995
H.P. 8640A AM/FM sig gen, 500kHz-1024MHz £400
H.P. 8640A AM/FM sig gen, 500kHz-512MHz £250
PHILIPS PM5328 sig gen, 100kHz-180MHz with 200MHz, freq. counter, IEEE £550
RACAL 9081 Synth AM/FM sig gen, 5-520MHz £250
H.P. 3325A Synth function gen, 21MHz £600
MARCONI 6500 Amplitude Analyser £1500
H.P. 4275A LCR Meter, 10Hz-10MHz £2750
H.P. 8903A Distortion Analyser £1000
WAYNE KEER 3245 Inductance Analyser £2000
H.P. 8112A Pulse Generator, 50MHz £1250
DATRON AutoCal Multimeter, 5 1/2-7 1/2-digit, 1065/1061A/1071 from £300-£600
MARCONI 2800 Frequency Counter, 20GHz £1800
H.P. 5350B Frequency Counter, 20GHz £2000
H.P. 5342A 10Hz-18GHz Frequency Counter £800
FARNELL AP10030 Power Supply £1000
FARNELL AP7030 Power Supply £800
PHILIPS PM5418TN Colour TV Pattern Generator £1750
PHILIPS PM5418TX1 Colour TV Pattern Generator £2000
B&K Accelerometer, type 4366 £300
H.P. 11892D Dual Directional Coupler, 2MHz-18GHz £1600
H.P. 11891D Dual Directional Coupler, 2MHz-18GHz £1250
TEKTRONIX P6109B Probe, 100MHz readout, unused £50
TEKTRONIX P6106A Probe, 250MHz readout, unused £85
FARNELL AMM2000 Auto Mod Meter, 10Hz-2-4GHz Unused £950
MARCONI 2035 Mod Meter, 500kHz-2GHz from £750
TEKTRONIX 577 Transistor Curve Tracer £500

ROHDE & SCHWARZ APN 62

Synthesised 1Hz-260kHz Signal Generator
Balanced/unbalanced output
LCD display
£425

H.P. 6012B DC PSU, 0-60V, 0-50A, 1000W £1000
FARNELL AP6050 1kW Autoranging £1000
FARNELL H6050 0-60V, 0-50A £750
FARNELL H6025 0-30V, 0-25A £400
Power Supply HPS3010 0-30V, 0-10A £140
FARNELL L30-2 0-30V, 0-2A £80
FARNELL L30-1 0-30V, 0-1A £50
Many other Power Supplies available
Isolating Transformer 250V In/Out 500VA £40

WELLER EC3100A

Temperature controlled Soldering Station 200°C-450°C, Unused
£125

SCOPE FOR IMPROVEMENT



GOULD OS 300

Dual Trace, 20MHz Tested with Manual
£95

FOR THE FIRST TIME EVER ONLY
It's so cheap you should replace that old scope

SPECTRUM ANALYSERS

TEKTRONIX 492 50kHz-18GHz £3500
EATON/ALTECH 757 0-001-22GHz £2500
ADVANTEK R3261A 9kHz-2.6GHz, synthesised £4000
H.P. 853A (Dig. Frame) with 8559A 100kHz-21GHz £2750
H.P. 8558B with main frame, 100kHz-1500MHz £1250
H.P. 3580A Audio Analyser 5Hz-50kHz, as new £1000
MARCONI 2382 100Hz-400MHz, high resolution £2000
B&K 2033R Signal Analyser £1500
H.P. 182 with 8557 10kHz-350MHz £500
MARCONI 2370 30Hz-110MHz from £500
H.P. 141 SYSTEMS
8553 1kHz-110MHz from £500
8554 500kHz-1250MHz from £750
8555 10MHz-18GHz from £1000

UNUSED OSCILLOSCOPES

TEKTRONIX TDS640A 4-ch, 500MHz, 2G/S £4000
TEKTRONIX TDS380 dual trace, 400MHz, 2G/S £2000
TEKTRONIX TDS350 dual trace, 200MHz, 1G/S £1250
TEKTRONIX TA5485, 4-ch, 200MHz, etc. £900

OSCILLOSCOPES

PHILIPS PM3092 2-2-ch, 200MHz, delay, etc. £800 as new £950
PHILIPS PM3082 2-2-ch, 100MHz, delay, etc. £700 as new £800
TEKTRONIX TA5485 dual trace, 100MHz, delay, etc. £800
TEKTRONIX 2465B 4-ch, 400MHz, delay cursors etc. £1250
TEKTRONIX 2465 4-ch, 300MHz, delay cursors etc. £900
TEKTRONIX 2445A/B 4-ch 150MHz, delay cursors etc. £500-£900
TEKTRONIX 468 dig. storage, dual trace, 100MHz, delay £450
TEKTRONIX 465 Analogue storage, dual trace, 100MHz £250
TEKTRONIX 465 dual trace, 30MHz, delay sweep £600
TEKTRONIX 475 dual trace, 200MHz, delay sweep £400
TEKTRONIX 465B dual trace, 100MHz, delay sweep £325
PHILIPS PM3217 dual trace, 50MHz delay £250-£300
GOULD OS1100 dual trace, 30MHz delay £200
HAMEG HM303.4 dual trace, 30MHz component testerr £325
HAMEG HM303 dual trace, 30MHz component tester £300
HAMEG HM203.7 dual trace, 20MHz component tester £250
FARNELL DTV20 dual trace, 20MHz component tester £180

PORTABLE APPLIANCE TESTER
Megger Pat 2 ONLY **£180**

STEWART of READING

110 WYKEHAM ROAD, READING, BERKS. RG6 1PL
Telephone: (0118) 9268041. Fax: (0118) 9351696
Callers welcome 9am-5.30pm Monday to Friday (other times by arrangement)

Used Equipment - GUARANTEED. Manuals supplied
This is a VERY SMALL SAMPLE OF STOCK. SAE or Telephone for lists.
Please check availability before ordering.
CARRIAGE all units £16. VAT to be added to Total of Goods and Carriage

FRUSTRATED!

Looking for ICs TRANSISTORS?
A phone call to us could get a result. We offer an extensive range and with a world-wide database at our fingertips, we are able to source even more. We specialise in devices with the following prefix (to name but a few).



2N 2SA 2SB 2SC 2SD 2P 2SJ 2SK 3N 3SK 4N 6N 17 40 AD
ADC AN AM AY BA BC BD BDT BDV BDW BDX BF
BFR BFS BFT BFX BFY BLY BLX BS BR BRX BRY BS
BSS BSV BSW BSX BT BTA BTB BRW BU BUK BUT BUV
BUW BUX BUY BUZ CA CD CX CXA DAC DG DM DS
DTA DTC GL GM HA HCF HD HEF HCL ICM IRF J KA
KIA L LA LB LC LD LF LM M MSM MA MAB MAX MB
MC MDAJ MJE MJF MM MN MPS MPSA MP SH MPSU
MRF NJM NE OM OP PA PAL PIC PN RC S SAA SAB
SAD SAJ SAS SDA SG SI SL SN SO STA STK STR STRD
STRM STRS SVI T TA TAA TAG TBA TC TCA TDA TDB
TEA TIC TIP TIPL TEA TL TLC TMP TMS TPU U UA
UAA UC UDN ULN UM UP A UPC UPD VN X XR Z ZN
ZTS + many others

We can also offer equivalents (at customers' risk)
We also stock a full range of other electronic components
Mail, phone, Fax Credit Card orders and callers welcome



Connect

Cricklewood Electronics Ltd
40-42 Cricklewood Broadway London NW2 3ET
Tel: 0181 452 0161 Fax: 0181 208 1441



DISTANCE LEARNING COURSES in:

Analogue and Digital Electronics, Fibre Optics, Fault Diagnosis, Mechanics, Mathematics and Programmable Logic Controllers leading to a

BTEC PROFESSIONAL DEVELOPMENT CERTIFICATE

- Suitable for beginners and those wishing to update their knowledge and practical skills
- Courses are very practical and delivered as self contained kits
- No travelling or college attendance
- Learning is at your own pace
- Each course can stand alone or be part of a modular study programme
- Tutor supported and BTEC certified

For information contact:
NCT Ltd., P.O. Box 11
Wendover, Bucks HP22 6XA
Telephone 01296 624270; Fax 01296 625299
Web: <http://www.nct.ltd.uk>

£1 BARGAIN PACKS Selected Items

CROCODILE CLIPS. Small size 10 each red and black. Order Ref: 116.

PLASTIC HEADED CABLE CLIPS. Nail in type, several sizes. Pack of 50. Order Ref: 123.

30A PANEL MOUNTING TOGGLE SWITCH. Double pole. Order Ref: 166.

SUB MIN TOGGLE SWITCHES. Pack of 3. Order Ref: 214.

HIGH POWER 3in. SPEAKER (1W 8ohm). Order Ref: 246.

MEDIUM WAVE PERMEABILITY TUNER. It's almost a complete radio with circuit. Order Ref: 247.

HEATING ELEMENT. Mains voltage 100W, brass encased. Order Ref: 8.

MAINS MOTOR with gearbox giving 1 rev per 24 hours. Order Ref: 89.

ROUND POINTER KNOBS for flatted 1/4in. spindles. Pack of 10. Order Ref: 295.

CERAMIC WAVE CHANGE SWITCH. 12-pole, 3-way with 1/4in. spindle. Order Ref: 303.

REVERSING SWITCH. 20A double pole or 4CA single pole. Order Ref: 343.

LUMINOUS PUSH-ON PUSH-OFF SWITCHES. Pack of 3. Order Ref: 373.

SLIDE SWITCHES. Single pole changeover. Pack of 10. Order Ref: 1053.

PAXOLIN PANEL. Approximately 12in. x 12in. Order Ref: 1033.

CLOCKWORK MOTOR. Suitable for up to 6 hours. Order Ref: 1036.

TRANSISTOR DRIVER TRANSFORMER. Maker's ref. no. LT44, impedance ratio 20k ohm to 1k ohm, centre tapped, 50p. Order Ref: 1/23R4.

HIGH CURRENT RELAY. 12V D.C. or 24V A.C., operates changeover contacts. Order Ref: 1026.

2-CORE CURLY LEAD. 5A, 2m. Order Ref: 846.

3 CHANGEOVER RELAY. 6V A.C., 3V D.C. Order Ref: 859.

3 CONTACT MICRO SWITCHES, operated with slightest touch. Pack of 2. Order Ref: 861.

HIVAC NUMICATOR TUBE. Hivac ref XN3. Order Ref: 865.

2IN. ROUND LOUDSPEAKERS. 50Ω coil. Pack of 2. Order Ref: 908.

5K POT, standard size with DP switch, good length 1/4in. spindle, pack of 2. Order Ref: 11R24.

13A PLUG, fully legal with insulated legs, pack of 3. Order Ref: GR19.

OPTO SWITCH on p.c.b., size 2in. x 1in., pack of 2. Order Ref: GR21.

COMPONENT MOUNTING PANEL, heavy Paxolin 10in. x 2in., 32 pairs of brass pillars for soldering binding components. Order Ref: 7RC26.

PEA LAMPS, only 4mm but 14V at 0.04A, wire ended, pack of 4. Order Ref: 7RC28.

HIGH AMP THYRISTOR, normal 2 contacts from top, heavy threaded fixing underneath, think amperage to be at least 25A, pack of 2. Order Ref: 7FC43.

BRIDGE RECTIFIER, ideal for 12V to 24V charger at 5A, pack of 2. Order Ref: 1070.

TEST PRODS FOR MULTIMETER with 4mm sockets. Good length very flexible lead. Order Ref: D86.

LUMINOUS ROCKER SWITCH, approximately 30mm square, pack of 2. Order Ref: D64.

MES LAMP HOLDERS, slide onto 1/4in. tag, pack of 10. Order Ref: 1054.

HALL EFFECT DEVICES, mounted on small heatsink, pack of 2. Order Ref: 1022.

12V POLARISED RELAY, 2 changeover contacts. Order Ref: 1032.

PROJECT CASE, 95mm x 66mm x 23mm with removable lid held by 4 screws, pack of 2. Order Ref: 876.

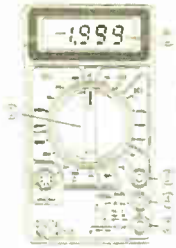
LARGE MICRO SWITCHES, 20mm x 6mm x 10mm, changeover contacts, pack of 2. Order Ref: 826.

PIEZO ELECTRIC SOUNDER, also operates efficiently as a microphone. Approximately 30mm diameter, easily mountable, 2 for £1. Order Ref: 1084.

LIQUID CRYSTAL DISPLAY on p.c.b. with ICs etc. to drive it to give 2 rows of 8 characters, price £1. Order Ref: 1085.

THIS MONTH'S SPECIAL

IT IS A DIGITAL MULTI-TESTER, complete with backrest to stand it and hands-free test prod holder. This tester measures d.c. volts up to 1,000 and a.c. volts up to 750; d.c. current up to 10A and resistance up to 2 megs. Also tests transistors and diodes and has an internal buzzer for continuity tests. Comes complete with test prods, battery and instructions. Price £6.99. Order Ref: 7P29.



1mA PANEL METER. Approximately 80mm x 55mm, front engraved 0-100. Price £1.50 each. Order Ref: 1/16R2.

VERY THIN DRILLS. 12 assorted sizes vary between 0.6mm and 1.6mm. Price £1. Order Ref: 128.

EVEN THINNER DRILLS. 12 that vary between 0.1mm and 0.5mm. Price £1. Order Ref: 129.

BT PLUG WITH TWIN SOCKET. Enables you to plug 2 telephones into the one socket for all normal BT plugs. Price £1.50. Order Ref: 1.5P50.

D.C. MOTOR WITH GEARBOX. Size 60mm long, 30mm diameter. Very powerful, operates off any voltage between 6V and 24V D.C. Speed at 6V is 200 rpm, speed controller available. Special price £3 each. Order Ref: 3P108.

FLASHING BEACON. Ideal for putting on a van, a tractor or any vehicle that should always be seen. Uses a Xenon tube and has an amber coloured dome. Separate fixing base is included so unit can be put away if desirable. Price £5. Order Ref: 5P267.

MOST USEFUL POWER SUPPLY. Rated at 9V 1A, this plugs into a 13A socket, is really nicely boxed. £2. Order Ref: 2P733.

MOTOR SPEED CONTROLLER. These are suitable for D.C. motors for voltages up to 12V and any power up to 1/6h.p. They reduce the speed by intermittent full voltage pulses so there should be no loss of power. In kit form these are £12. Order Ref: 12P34. Or made up and tested, £20. Order Ref: 20P39.

VARTA BATTERIES. A big purchase enables us to offer you 8 Varta AA batteries for only £1. These are really good batteries, give you long life. Order Ref: D511.

BT TELEPHONE EXTENSION WIRE. This is proper heavy duty cable for running around the skirting board when you want to make a permanent extension. 4 cores properly colour coded, 25m length. Only £1. Order Ref: 1067.

A MUCH LARGER PROJECT BOX. Size 216mm x 130mm x 85mm with lid and 4 screws. This is an ABS box which normally retails at around £6. All brand new, price £2.50. Order Ref: 2.5P28.

LARGE TYPE MICROSWITCH with 2in. lever, changeover contacts rated at 15A at 250V, 2 for £1. Order Ref: 1/2R7.

BALANCE ASSEMBLY KITS. Japanese made, when assembled ideal for chemical experiments, complete with tweezers and 6 weights 0.5 to 5 grams. Price £2. Order Ref: 2P44.

CYCLE LAMP BARGAIN. You can have 100 6V 0.5A MES bulbs for just £2.50 or 1,000 for £20. They are beautifully made, slightly larger than the standard 6.3V pilot bulb so they would be ideal for making displays for night lights and similar applications.

DOORBELL PSU. This has AC voltage output so is ideal for operating most doorbells. The unit is totally enclosed so perfectly safe and it plugs into a 13A socket. Price only £1. Order Ref: 1/30R1.

TWO MORE POST OFFICE INSTRUMENTS

Both instruments contain lots of useful parts, including sub-min toggle switch sold by many at £1 each. They are both in extremely nice cases, with battery compartment and flexible carrying handles, so if you don't need the instruments themselves, the case may be just right for a project you have in mind.

The first is **Oscillator 87F.** This has an output, continuous or interrupted, of 1kHz. It is in a plastic box size 115mm wide, 145mm high and 50mm deep. Price only £1. Order Ref: 7R1.

The other is **Amplifier Ref. No. 109G.** This is in a case size 80mm wide, 130mm high and 35mm deep. Price £1. Order Ref: 7R2.

HEAVY DUTY POT

Rated at 25W, this is 20 ohm resistance so it could be just right for speed controlling a d.c. motor or device or to control the output of a high current amplifier. Price £1. Order Ref: 1/33L1.

STEPPER MOTOR

Made by Philips as specified for the wind-up torch in the Oct '00 Practical Electronics is still available, price £2. Order Ref: 2P457.

SOLDERING IRON, super mains powered with long-life ceramic element, heavy duty 40W for the extra special job, complete with plated wire stand and 245mm lead, £3. Order Ref: 3P221.

RELAYS

We have thousands of relays of various sorts in stock, so if you need anything special give us a ring. A few new ones that have just arrived are special in that they are plug-in and come complete with a special base which enables you to check voltages of connections of it without having to go underneath. We have 6 different types with varying coil voltages and contact arrangements. All contacts are rated at 10A 250V AC.



Coil Voltage	Contacts	Price	Order Ref.
12V DC	4-pole changeover	£2.00	FR10
12V DC	2-pole changeover	£1.50	FR11
24V DC	2-pole changeover	£1.50	FR12
24V DC	4-pole changeover	£2.00	FR13
240V AC	1-pole changeover	£1.50	FR14
240V AC	4-pole changeover	£2.00	FR15

Prices include base

NOT MUCH BIGGER THAN AN OXO CUBE. Another relay just arrived is extra small with a 12V coil and 6A changeover contacts. It is sealed so it can be mounted in any position or on a p.c.b. Price 75p each, 10 for £6 or 100 for £50. Order Ref: FR16.

RECHARGEABLE NICAD BATTERIES. AA size, 25p each, which is a real bargain considering many firms charge as much as £2 each. These are in packs of 10, coupled together with an output lead so are a 12V unit but easily dividable into 2 x 6V or 10 x 1.2V. £2.50 per pack, 10 packs for £25 including carriage. Order Ref: 2.5P34.

FOR QUICK HOOK-UPS

You can't beat leads with a croc clip each end. You can have a set of 10 leads, 2 each of 5 assorted colours with insulated crocodile clips on each end. Lead length 36cm, £2 per set. Order Ref: 2P459.



12V 8A DC POWER SUPPLY. Totally enclosed with its own cooling fan. Normal mains operation. Price £11. Order Ref: 11P6.

TWIN 13A SWITCHED SOCKET. Standard in all respects and complete with fixing screws. White, standard size and suitable for flush mounting or in a surface box. Price £1.50. Order Ref: 1.5P61.

BIG 12V TRANSFORMER. It is 55VA so that is over 4A which is normal working, intermittently it would be a much higher amperage. Beautiful transformer, well made and very well insulated, terminals are in a plastic frame so can't be accidentally touched. Price £3.50. Order Ref: 3.5P20.

BUY ONE GET ONE FREE

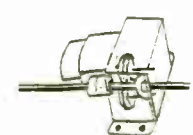
ULTRASONIC MOVEMENT DETECTOR. Nicely cased, free standing, has internal alarm which can be silenced. Also has connections for external speaker or light. Price £10. Order Ref: 10P154.

CASED POWER SUPPLIES which, with a few small extra components and a bit of modifying, would give 12V at 10A. Originally £9.50 each, now 2 for £9.50. Order Ref: 9.5P4.

3-OCTAVE KEYBOARDS with piano size keys, brand new, previous price £9.50, now 2 for the price of one. Order Ref: 9.5P5.

1.5-6V MOTOR WITH GEARBOX

The motor is mounted on the gearbox which has interchangeable gears giving a range of speeds and motor torques. Comes with full instructions for changing gears and calculating speeds, £7. Order Ref: 7P26.



MINI BLOWER HEATER. 1kW, ideal for under desk or airing cupboard, etc., needs only a simple mounting frame, price £5. Order Ref: 5P23.

TERMS

Send cash, PO, cheque or quote credit card number - orders under £25 add £3.50 service charge.

J & N FACTORS
Pilgrim Works (Dept. E.E.)
Stalbridge Lane, Bolney
Sussex RH17 5PA
Telephone: 01444 881965

MAIL ORDER ONLY • CALLERS BY APPOINTMENT

**EPE MICROCONTROLLER
P.I. TREASURE HUNTER**

The latest MAGENTA DESIGN – highly stable & sensitive – with I.C. control of all timing functions and advanced pulse separation techniques.

- 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

**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

**68000 DEVELOPMENT
TRAINING KIT**

- NEW PCB DESIGN
- 8MHz 68000 16-BIT BUS
- MANUAL AND SOFTWARE
- 2 SERIAL PORTS
- PIT AND I/O PORT OPTIONS
- 12C PORT OPTIONS



KIT 621

£99.95

- ON BOARD 5V REGULATOR
- PSU £6.99
- SERIAL LEAD £3.99

Stepping Motors

MD38...Mini 48 step...£8.65

MD35...Std 48 step...£9.99

MD200...200 step...£12.99

MD24...Large 200 step...£22.95



PIC PIPE DESCALER

- SIMPLE TO BUILD
- HIGH POWER OUTPUT
- AUDIO & VISUAL MONITORING
- SWEPT FREQUENCY

An affordable circuit which sweeps the incoming water supply with variable frequency electromagnetic signals. May reduce scale formation, dissolve existing scale and improve lathering ability by altering the way salts in the water behave.

Kit includes case, P.C.B., coupling coil and all components. High coil current ensures maximum effect. L.E.D. monitor.

KIT 868 £22.95 POWER UNIT.....£3.99



MICRO PESt SCARER

Our latest design – The ultimate scarer for the garden. Uses special microchip to give random delay and pulse time. Easy to build reliable circuit. Keeps pets/pests away from newly sown areas, play areas, etc. uses power source from 9 to 24 volts.

- RANDOM PULSES
- HIGH POWER
- DUAL OPTION



Plug-in power supply £4.99

KIT 867.....£19.99

KIT + SLAVE UNIT.....£32.50

WINDICATOR

A novel wind speed indicator with LED readout. Kit comes complete with sensor cups, and weatherproof sensing head. Mains power unit £5.99 extra.

KIT 856.....£28.00

★ TENS UNIT ★

DUAL OUTPUT TENS UNIT

As featured in March '97 issue.

Magenta have prepared a FULL KIT for this excellent new project. All components, PCB, hardware and electrodes are included. Designed for simple assembly and testing and providing high level dual output drive.

KIT 866.. Full kit including four electrodes £32.90

Set of 4 spare electrodes £6.50

**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

**EPE
TEACH-IN
2000**

Full set of top quality NEW components for this educational series. All parts as specified by EPE. Kit includes breadboard, wire, croc clips, pins and all components for experiments, as listed in introduction to Part 1.

*Batteries and tools not included.

TEACH-IN 2000 -

KIT 879 £44.95

MULTIMETER £14.45

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 plus 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£29.90

**SUPER BAT
DETECTOR**

1 WATT O/P, BUILT IN
SPEAKER, COMPACT CASE
20KHZ-140KHZ

NEW DESIGN WITH 40kHz MIC.

A new circuit using a 'full-bridge' audio amplifier i.c., internal speaker, and headphone/tape socket. The latest sensitive transducer, and 'double balanced mixer' give a stable, high performance superheterodyne design.



KIT 861£24.99

ALSO AVAILABLE Built & Tested... £39.99

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

Based on our Mk1 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 No. 845£64.95

**EPE
PROJECT
PICS**

Programmed PICs for all* EPE Projects
16C84/18F84/16C71
All **£5.90 each**

PIC16F877 now in stock

£10 inc. VAT & postage

(*some projects are copyright)

ULTRASONIC PESt SCARER

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

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

- UP TO 4 METRES RANGE
- LOW CURRENT DRAIN



KIT 812.....£15.00

SIMPLE PIC PROGRAMMER

INCREDIBLE LOW PRICE! Kit 857 **£12.99**

INCLUDES 1-PIC16F84 CHIP
SOFTWARE DISK, LEAD
CONNECTOR, PROFESSIONAL
PC BOARD & INSTRUCTIONS

Power Supply £3.99

EXTRA CHIPS:
PIC 16F84 £4.84

Based on February '96 EPE. Magenta designed PCB and kit. PCB with 'Reset' switch, Program switch, 5V regulator and test L.E.D.s, and connection points for access to all A and B port pins.

PIC 16C84 DISPLAY DRIVER

INCLUDES 1-PIC16F84 WITH
DEMO PROGRAM SOFTWARE
DISK, PCB, INSTRUCTIONS
AND 16-CHARACTER 2-LINE
LCD DISPLAY

Kit 860 **£19.99**

Power Supply £3.99

FULL PROGRAM SOURCE
CODE SUPPLIED – DEVELOP
YOUR OWN APPLICATION!

Another super PIC project from Magenta. Supplied with PCB, industry standard 2-LINE x 16-character display, data, all components, and software to include in your own programs. Ideal development base for meters, terminals, calculators, counters, timers – Just waiting for your application!

PIC 16F84 MAINS POWER 4-CHANNEL CONTROLLER & LIGHT CHASER

- WITH PROGRAMMED 16F84 AND DISK WITH SOURCE CODE IN MPASM
- ZERO VOLT SWITCHING MULTIPLE CHASE PATTERNS
- OPTO ISOLATED 5 AMP OUTPUTS
- 12 KEYPAD CONTROL
- SPEED/DIMMING POT.
- HARD-FIRED TRIACS

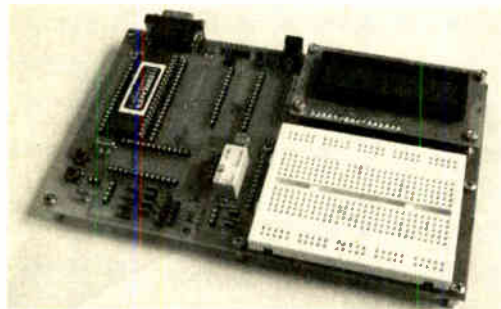
Kit 855 **£39.95**

Now features full 4-channel chaser software on DISK and pre-programmed PIC16F84 chip. Easily re-programmed for your own applications. Software source code is fully 'commented' so that it can be followed easily.

LOTS OF OTHER APPLICATIONS

ICEBREAKER

□□□□□□□□□□



PIC Real Time In-Circuit Emulator

- Icebreaker uses PIC16F877 in circuit debugger
- Links to Standard PC Serial Port (lead supplied)
- Windows™ (95+) Software included
- Works with MPASM and MPLAB Microchip software
- 16 x 2 L.C.D., Breadboard, Relay, I/O devices and patch leads supplied

As featured in March '00 EPE. Ideal for beginners AND advanced users. Programs can be written, assembled, downloaded into the microcontroller and run at full speed (up to 20MHz), or one step at a time.

Full emulation means that all I/O ports respond exactly and immediately, reading and driving external hardware.

Features include: Reset; Halt on external pulse; Set Breakpoint; Examine and Change registers, EEPROM and program memory; Load program, Single Step with display of Status, W register, Program counter, and user selected 'Watch Window' registers.

KIT 900 . . . **£34.99**

POWER SUPPLY **£3.99** STEPPING MOTOR **£5.99**

EPE PIC Tutorial

At last! A Real, Practical, Hands-On Series

- Learn Programming from scratch using PIC16F84
- Start by lighting I.e.d.s and do 30 tutorials to Sound Generation, Data Display, and a Security System.
- PIC TUTOR Board with Switches, I.e.d.s, and on board programmer

PIC TUTOR BOARD KIT

Includes: PIC16F84 Chip, TOP Quality PCB printed with Component Layout and all components* (*not ZIF Socket or Displays). Included with the Magenta Kit is a disk with Test and Demonstration routines.

KIT 870 **£27.95**, Built & Tested **£42.95**

Optional: Power Supply – **£3.99**, ZIF Socket – **£9.99**

LCD Display **£7.99** LED Display **£6.99**

Reprints Mar/Apr/May 98 – **£3.00** set 3

PIC TOOLKIT V2

- SUPER UPGRADE FROM V1 • 18, 28 AND 40-PIN CHIPS
- READ, WRITE, ASSEMBLE & DISASSEMBLE PICS
- SIMPLE POWER SUPPLY OPTIONS 5V-20V
- ALL SWITCHING UNDER SOFTWARE CONTROL
- MAGENTA DESIGNED PCB HAS TERMINAL PINS AND OSCILLATOR CONNECTIONS FOR ALL CHIPS
- INCLUDES SOFTWARE AND PIC CHIP

KIT 878 . . . **£22.99** with 16F84 . . . **£29.99** with 16F877

SUPER PIC PROGRAMMER

- READS, PROGRAMS, AND VERIFIES
- WINDOWS® SOFTWARE
- PIC16C6X, 7X, AND 8X
- USES ANY PC PARALLEL PORT
- USES STANDARD MICROCHIP • HEX FILES
- OPTIONAL DISASSEMBLER SOFTWARE (EXTRA)
- PCB, LEAD, ALL COMPONENTS, TURNED-PIN SOCKETS FOR 18, 28, AND 40 PIN ICs

- SEND FOR DETAILED INFORMATION – A SUPERB PRODUCT AT AN UNBEATABLE LOW PRICE.

Kit 862 **£29.99**

Power Supply **£3.99**

DISASSEMBLER SOFTWARE **£11.75**

PIC STEPPING MOTOR DRIVER

INCLUDES PCB, PIC16F84 WITH DEMO PROGRAM, SOFTWARE DISC, INSTRUCTIONS AND MOTOR.

Kit 863 **£18.99**

FULL SOURCE CODE SUPPLIED ALSO USE FOR DRIVING OTHER POWER DEVICES e.g. SOLENOIDS

Another NEW Magenta PIC project. Drives any 4-phase unipolar motor – up to 24V and 1A. Kit includes all components and 48 step motor. Chip is pre-programmed with demo software, then write your own, and re-program the same chip! Circuit accepts inputs from switches etc and drives motor in response. Also runs standard demo sequence from memory.

8-CHANNEL DATA LOGGER

As featured in Aug./Sept. '99 EPE. Full kit with Magenta redesigned PCB – LCD fits directly on board. Use as Data Logger or as a test bed for many other 16F877 projects. Kit includes programmed chip, 8 EEPROMs, PCB, case and all components.

KIT 877 **£49.95** inc. 8 x 256K EEPROMS

MAGENTA

All prices include VAT. Add **£3.00** p&p. Next day **£6.99**

Tel: 01283 565435 Fax: 01283 546932 E-mail: sales@magenta2000.co.uk

012001



Station Road, Cullercoats, Tyne & Wear, NE30 4PQ



All Major Credit cards Accepted

Prices Exclude Vat @17.5%. Add £1.25 (UK) carriage & Vat to all orders. Cheques / Postal orders payable to ESR Electronic Components

See Next / Last Months Ad. for ELECTRONIC COMPONENTS

DIL Sockets

6 Pin DIL 0.3"	£0.06
8 Pin DIL 0.3"	£0.06
14 Pin DIL 0.3"	£0.11
16 Pin DIL 0.3"	£0.11
18 Pin DIL 0.3"	£0.12
20 Pin DIL 0.3"	£0.12
24 Pin DIL 0.6"	£0.12
28 Pin DIL 0.6"	£0.13
40 Pin DIL 0.6"	£0.19

Stamped Pin

6 Pin DIL 0.3"	£0.06
8 Pin DIL 0.3"	£0.06
14 Pin DIL 0.3"	£0.11
16 Pin DIL 0.3"	£0.11
18 Pin DIL 0.3"	£0.12
20 Pin DIL 0.3"	£0.12
24 Pin DIL 0.6"	£0.12
28 Pin DIL 0.6"	£0.13
40 Pin DIL 0.6"	£0.19

Turned Pin

8 Pin DIL 0.3"	£0.11
14 Pin DIL 0.3"	£0.20
16 Pin DIL 0.3"	£0.23
18 Pin DIL 0.3"	£0.25
20 Pin DIL 0.3"	£0.28
24 Pin DIL 0.6"	£0.35
28 Pin DIL 0.6"	£0.39
40 Pin DIL 0.6"	£0.64

ZIF Sockets

Universal ZIF DIL Sockets	
24 Way 0.3-0.6"	£5.78
28 Way 0.3-0.6"	£6.60
32 Way 0.3-0.6"	£7.50
40 Way 0.3-0.6"	£8.93

Transistor Sockets

T018-4 Base Socket	£0.24
T05 Base Socket	£0.24

IDC Cable Sockets

10 Way Socket	£0.25
14 Way Socket	£0.35
16 Way Socket	£0.37
26 Way Socket	£0.38
34 Way Socket	£0.39
40 Way Socket	£0.55
50 Way Socket	£0.80

IDC Cable Plugs

10 Way Plug	£0.52
14 Way Plug	£0.58
16 Way Plug	£0.62
20 Way Plug	£0.66
26 Way Plug	£0.70
34 Way Plug	£0.80
40 Way Plug	£0.92
50 Way Plug	£1.12

PCB Box Headers

10 Way Straight	£0.23
14 Way Straight	£0.33
16 Way Straight	£0.32
20 Way Straight	£0.41
26 Way Straight	£0.55
34 Way Straight	£0.68
40 Way Straight	£0.75
50 Way Straight	£1.03
10 Way 90°	£0.32
14 Way 90°	£0.39
16 Way 90°	£0.42
20 Way 90°	£0.63
26 Way 90°	£0.82
34 Way 90°	£0.81
40 Way 90°	£1.17
50 Way 90°	£1.14

PCB Latch Headers

10 Way Straight	£0.41
14 Way Straight	£0.45
16 Way Straight	£0.51
20 Way Straight	£0.55
26 Way Straight	£0.73
34 Way Straight	£0.88
40 Way Straight	£0.92
50 Way Straight	£1.27
10 Way 90°	£0.46
14 Way 90°	£0.48
16 Way 90°	£0.54
20 Way 90°	£0.59
26 Way 90°	£0.81
34 Way 90°	£1.03
40 Way 90°	£1.23
50 Way 90°	£1.41

DIL Headers

14 Way DIL	£0.51
16 Way DIL	£0.53
24 Way DIL	£0.90
40 Way DIL	£1.37

Transistion Headers

10 Way Transistion	£0.42
14 Way Transistion	£0.42
16 Way Transistion	£0.48
20 Way Transistion	£0.48
26 Way Transistion	£0.52
34 Way Transistion	£0.56
40 Way Transistion	£0.63
50 Way Transistion	£0.84

D Type Connectors

9 Way Male Plug	£0.20
9 Way Female Socket	£0.20
15 Way Male Plug	£0.28
15 Way Female Socket	£0.28
15 Way H.D. Plug	£0.48
15 Way -I.D. Socket	£0.64
23 Way Male Plug	£0.44
23 Way Female Socket	£0.50
25 Way Male Plug	£0.32
25 Way Female Skt	£0.35

Solder Bucket

9 Way Male Plug	£0.20
9 Way Female Socket	£0.20
15 Way Male Plug	£0.28
15 Way Female Socket	£0.28
15 Way H.D. Plug	£0.48
15 Way -I.D. Socket	£0.64
23 Way Male Plug	£0.44
23 Way Female Socket	£0.50
25 Way Male Plug	£0.32
25 Way Female Skt	£0.35

IDC Ribbon Mounting

9 Way Male Socket	£0.08
9 Way Female Socket	£0.93
15 Way Male Plug	£1.32
15 Way Female Socket	£1.32
25 Way Male Plug	£1.10
25 Way Female Socket	£1.13
IDC Crimp Tool	£1.80

RF Connectors

BNC Plug 50Ω Solder	£0.99
BNC Plug 50Ω Crimp	£0.68
BNC Plug 75Ω Solder	£0.95
BNC Plug 75Ω Crimp	£0.68
BNC Chassis Socket	£0.81
F Plug - Twist	£0.24
F Plug - Crimp	£0.26
TNC Plug 50Ω Solder	£1.24
TNC Plug 50Ω Crimp	£0.85
TNC Plug 75Ω Solder	£1.40
TNC Plug 75Ω Crimp	£1.16
UHF Plug 5mm Cable	£0.63
UHF Plug 11mm Cable	£0.75
UHF Chassis Skt. - Sar	£0.50
UHF Chassis Skt. - Rnd	£0.73

Terminals

Colours: Red, Black, Green, Blue, White or Yellow	
2mm Solder Plugs	£0.18
2mm Chassis Sockets	£0.26
4mm Plugs - Solder	£0.33
4mm Plugs - Screw	£0.38
4mm Stackable Plugs	£0.40
4mm Shrouded Plugs	£0.74
4mm Chassis Sockets	£0.24
4mm Binding Posts	£0.46
33mm Crocodile Clips	£0.10

Power Connectors

DC Plug 0.71D 2.35OD	£0.47
DC Plug 1.31D 3.40D	£0.32
DC Plug 1.71D 4.00D	£0.47
DC Plug 1.71D 4.75OD	£0.47
DC Plug 2.11D 5.00D	£0.25
DC Plug 2.51D 5.00D	£0.24
DC Plug 3.11D 6.30D	£0.46
DC Line Socket 2.1mm	£0.57
DC Line Socket 2.5mm	£0.68
DC Chassis Skt 2.1mm	£0.40
DC Chassis Skt 2.5mm	£0.41

DC Low Voltage

3 Pin IEC Line Socket	£1.08
3 Pin IEC Line Plug	£1.78
3 Pin Chassis Socket	£0.55
3 Pin Chassis Plug	£0.72

8 Way Buzlin

8 Pin IEC Line Socket	£3.58
8 Pin Chassis Skt P551	£1.28

Toggle Switches

Sub-Miniature	
3A 125V 3A 250V	
5mm Ø Mounting Hole	
SPST 5 x 10mm	£0.58
SPDT 5 x 10mm	£0.60
SPDT C/Off 5 x 10mm	£0.81
DPDT 9.2 x 10mm	£0.66

Miniature

6A 125V 3A 250V	
6.2mm Ø Mounting Hole	
SPST 8 x 13mm	£0.65
SPDT 8 x 13mm	£0.54
SPDT c/o/8 x 13mm	£0.60
SPDT c/o Biased 2 way	£0.97
SPDT c/o Biased 1 way	£1.04
DPDT 12 x 13mm	£0.72
DPDT c/o/12 x 13mm	£0.80
DPDT c/o Biased 2 way	£1.28
DPDT c/o Biased 1 way	£1.28

Standard

10A 250V Push on terminals	
12mm Ø Mounting Hole	
SPST 18 x 30mm	£1.28
DPDT 7 x 23mm	£0.18

Slide Switches

Miniature	
300mA 125V	
7 x 15mm Mounting Hole	
DPDT 7 x 23mm	£0.18

Rotary Switches

150mA 250V	
Make before Break 22mm Ø	
9.8mm Ø Mounting Hole	
1 Pole 1 Way	£0.84
2 Pole 6 Way	£0.84
3 Pole 4 Way	£0.84
4 Pole 3 Way	£0.84

Push Switches

Miniature Round	
250mA 125V 28 x 10mm	
7mm Ø Mounting Hole	
Non Latching Push to Make	
Black, Red, Yellow, Green, Blue or White	£0.23
Non Latching Push to Break	
Black PTF	£0.24

Standard Square

1A 250V	
39 x 15MM	
12mm Ø Mounting Hole	
Non Latching Push to Make	
Black, Red, Blue or White	£0.60
Latching - push On push Off	
Black, Red, Blue or White	£0.65

Rocker Switches

Miniature	
13 x 19mm Mounting Hole	
SPST 4A 250V	£0.57
SPST 6A Red Neon	£1.65
SPST 3A Red LED	£1.92
SPDT 6A 250V	£0.75
DPST 4A 250V	£0.81
DPST 4A Red Neon	£1.10
DPST 3A Amber Neon	£1.40
DPST 3A Green Neon	£1.32

Standard

10(SP)/22(DP) x 30mm	
Mounting Hole	
SPST 10A 250V	£0.60
SPST 16A 250V	£0.75
SPST 15A Red Neon	£0.90
SPDT 16A 250V	£0.75
DPST 10A 250V	£0.90
DPST 15A Red Neon	£1.18
DPST Amber Neon	£1.25
DPST Green Neon	£1.25
DPDT 10A 250V	£0.90

Relays

PCB Mounting	
1A 24Vdc DPDT 5V	£1.38
1A 24Vdc DPDT 12V	£2.00
3A 110V SPDT 6V	£0.58
3A 110V SPDT 12V	£0.58
5A 110V SPDT 6V	£0.72
5A 110V SPDT 12V	£0.72
5A 110V DPDT 6V	£0.93
5A 110V DPDT 12V	£0.93
5A 240V DPDT 6V	£1.76
5A 240V DPDT 12V	£1.76
10A 240V SPDT 6V	£1.25
10A 240V SPDT 12V	£1.44
10A 240V SPDT 24V	£1.44

Computer Accessories Adaptors

9M Gender Changer	£2.18
9F Gender Changer	£2.29
25M Gender Changer	£2.60
25F Gender Changer	£2.80
9 Male - 25 Female	£1.90
9 Female - 25 Male	£1.90
9M - 6 Mini Dim Male	£2.40
9F - 6 Mini Dim Female	£2.40
5M Din - 6M Mini Din	£2.08
5F Din - 6M Mini Din	£2.08

Testers / Patch Boxes

Mini Tester 7 LEDs	£4.72
Enhanced + Switches	£15.25
25D Jumper Box M-F	£2.90
25D Patch Box M-F	£7.32
Anti-Static Wrist Strap	£4.76
RS232 Surge Protector	£5.43
Mains Surge Protector	£11.99
4 Gang Surge Block	£15.50

Leads & Cables

1.5m Printer Lead	£2.63
2m BD Printer Lead	£2.98
5m BD Printer Lead	£4.98
10m BD Printer Lead	£9.88
2m IEEE1284 Printer L	£4.38
5m IEEE1284 Printer L	£8.13
10m IEEE1284 Printer L	£16.13
Serial Printer 25M-9F	£4.88
Serial Printer 25M-25F	£4.38

Null Modem Leads

9 Female - 9 Female	£4.38
25 Female- 25 Female	£6.48
9 Female - 25 Female	£4.38
9&25F to 9&25F	£4.88

Modem Leads

25Male to 9Female	£4.08
25Male to 25Female	£3.78

PC Link Leads

Interlink 25M to 25M	£3.88
25Male to 25Male	£3.60
36Male to 36Male	£2.60

Internal Leads

Floppy Cable A/B	£2.70
Hard Disk 2xIDE	£1.65
Hard Disk 2xATA66	£3.38
Power 3/2-2 x 3/2	£1.88
Power 5/2-2 x 3/2	£1.50
Power 5/2-3/2 x 3/2	£1.88
Power 5/2-3/2 x 5/4	£1.88

Networking

BNC T Piece FMB	£1.71
BNC Coupler F	£0.81
BNC Ratchet Crimper	£15.68
50Ω BNC Terminator	£0.98
Thinned Cable per m	£0.38

Boxes & Cases

Many more sizes available	
General Purpose Plastic	
75 x 56 x 25mm	£0.99
75 x 51 x 22mm	£0.99
111 x 57 x 22mm	£1.12
79 x 61 x 40mm	£1.70
100 x 76 x 41mm	£1.79
118 x 98 x 45mm	£2.08
150 x 100 x 60mm	£2.77
150 x 80 x 50mm	£2.72

Diecast Aluminium

50 x 50 x 31mm	£2.67
100 x 50 x 25mm	£3.50
112 x 62 x 31mm	£4.18
120 x 65 x 40mm	£4.61
150 x 80 x 50mm	£6.30
121 x 95 x 61mm	£7.06

Steel/Aluminium

Plastic coated steel top, Aluminium base	
152 x 114 x 44mm	£4.19
203 x 127 x 51mm	£5.04
229 x 127 x 63mm	£5.80
114 x 63 x 57mm	£3.04

Wire & Cable

Ribbon Cable	
--------------	--

EVERYDAY PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS TODAY INTERNATIONAL

THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

VOL. 30 No. 1 JANUARY 2001

E-VERYTHING

The web and E-mail etc are wonderful developments that encourage correspondence and allow access to a whole new world full of information. For instance, the web allows you to "instantly" download issues of *EPE* from anywhere in the world via our Online website – just think of the advantages of that if you need a project design quickly, particularly if you are in a remote part of the UK or Africa/Asia/Australia etc.

We can also supply back issues on CD-ROM in PDF format and now our *Teach-In 2000* series (the whole 12 parts, plus the software) is available in this format - see page 44.

E-ASY

It's easy to E-mail anyone anywhere in the world; as they say in the USA it's a "no brainer". But we would like you to think before you jump on the keyboard with your request.

- Q1. "Where do I get a WWW component?"
- Q2. "When did you publish a XXX?"
- Q3. "My HNC project is a YYY how can I use a PIC to do this?"
- Q4. "I'm trying to solder an aluminium bracket to my bike what solder should I use?"
- Q5. "How do I order a back issue?"
- Q6. "Can you E-mail me the circuit for a ZZZ?"

Because it is E-asy it does not mean you should not look for the answer yourself.

A1. We give details on buying unusual components for *EPE* projects in *Shoptalk* each month, if you want components for your own designs or to repair commercial equipment try the various component supplier or manufacturer's websites. There are a number of links on our UK website.

A2. Please look through the back issues and indexes on the website before asking.

A3. Sorry but we cannot undertake to assist with advice or designs to meet the needs of individual readers.

A4. Alan Winstanley's *Soldering Guide* on the website gives details on soldering for electronics projects, unfortunately we are not able to offer advice on specialist soldering requirements – try the solder or soldering iron manufacturer's websites.

A5. Full details are on the website and are given in each issue.

A6. Sorry but we cannot do this, we do have to make a profit to stay in business so we can't E-mail designs for free and we don't hold everything we have ever published on one computer, so this is not readily achievable anyway. If you want the circuit for a project you must buy the back issue it was in (or a photocopy of the article if we are sold out), or the relevant back issue CD-ROM, or download it from our Online magazine site if it is available there.

Of course, we try to answer all E-mails but please be aware that with floods of them coming in from all over the world everyday it would help if you check to see if the information is available in the magazine or on the website before you bang off that E-asy E-mail.

Please help us to help you.



AVAILABILITY

Copies of *EPE* are available on subscription anywhere in the world (see below), from all UK newsagents (distributed by COMAG) and from the following electronic component retailers: Omni Electronics and Yebo Electronics (S. Africa). *EPE* can also be purchased from retail magazine outlets around the world. An Internet on-line version can be purchased for just \$9.99(US) per year available from www.epemag.com

SUBSCRIPTIONS

Subscriptions for delivery direct to any address in the

UK: 6 months £14.50, 12 months £27.50, two years £50; Overseas: 6 months £17.50 standard air service or £27 express airmail, 12 months £33.50 standard air service or £51 express airmail, 24 months £62 standard air service or £97 express airmail

Online subscriptions, for downloading the magazine via the Internet, \$9.99(US) for one year available from www.epemag.com.

Cheques or bank drafts (in £ sterling only) payable to *Everyday Practical Electronics* and sent to EPE Sub. Dept., Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Fax: 01202 841692. E-mail: subs@epemag.wimborne.co.uk. Also via the Web at: <http://www.epemag.wimborne.co.uk>. Subscriptions start with the next available issue. We accept MasterCard, Switch or Visa. (For past issues see the *Back Issues* page.)

BINDERS

Binders to hold one volume (12 issues) are available from the above address. These are finished in blue p.v.c., printed with the magazine logo in gold on the spine. Price £5.95 plus £3.50 p&p (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.

Payment in £ sterling only please. Visa, Switch and MasterCard accepted, minimum credit card order £5. Send, fax or phone your card number and card expiry date with your name, address etc. Or order on our secure server via our UK web site. Overseas customers – your credit card will be charged by the card provider in your local currency at the existing exchange rate.

Editorial Offices:

EVERYDAY PRACTICAL ELECTRONICS EDITORIAL
ALLEN HOUSE, EAST BOROUGH, WIMBORNE
DORSET BH21 1PF

Phone: Wimborne (01202) 881749

Fax: (01202) 841692.

E-mail: editorial@epemag.wimborne.co.uk

Web Site: <http://www.epemag.wimborne.co.uk>

EPE Online www.epemag.com

See notes on Readers' Enquiries below – we regret lengthy technical enquiries cannot be answered over the telephone.

Advertisement Offices:

EVERYDAY PRACTICAL ELECTRONICS ADVERTISEMENTS

MILL LODGE, MILL LANE

THORPE-LE-SOKEN, ESSEX CO16 0ED

Phone/Fax: (01255) 861161

Editor: MIKE KENWARD

Deputy Editor: DAVID BARRINGTON

Technical Editor: JOHN BECKER

Business Manager: DAVID J. LEAVER

Subscriptions: MARILYN GOLDBERG

Administration: FAY KENWARD

Editorial/Admin: Wimborne (01202) 881749

Advertisement Manager:

PETER J. MEW, Frinton (01255) 861161

Advertisement Copy Controller:

PETER SHERIDAN, Wimborne (01202) 882299

On-Line Editor: ALAN WINSTANLEY

EPE Online (Internet version) Editors:

CLIVE (MAX) MAXFIELD and ALVIN BROWN

READERS' ENQUIRIES

E-mail: techdept@epemag.wimborne.co.uk

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

ADVERTISEMENTS

E-mail: adverts@epemag.wimborne.co.uk

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

The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture.

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; readers should check local laws.



VERSATILE OPTICAL TRIGGER

OWEN BISHOP Project 5



This short collection of projects, some useful, some instructive and some amusing, can be made for around the ten pounds mark. The estimated cost does not include an enclosure. All of the projects are built on stripboard, and most have been designed to fit on to boards of standard dimensions. All of the projects are battery-powered, so are safe to build. In a few cases in which, by its nature, the project is to be run for long periods, power may be provided by an inexpensive mains adaptor. Again, the cost of such a unit is not included.

THIS is a circuit that is flexible enough to cater for many different applications. In its basic form, the Versatile Optical Trigger switches a load on or off, depending on the amount of light falling on its sensor. It can be set to respond in reasonably bright conditions or in dim light. It can be adapted to work either way round, switching on when the light gets brighter, or when it becomes dimmer.

Applications for the basic circuit include switching on a porch lamp at dusk, briefly sounding a buzzer when someone's shadow falls on the sensor (or when the cat leaves the house by the cat door), or to switch on a lamp in a cupboard when the door is opened. We leave it to the imagination of the reader to find other interesting things to do with this circuit. There is more later about how to adapt it to different uses.

If the load is a relay with contacts suitably rated, the circuit can be used to switch devices powered by a.c., including a.c. mains. *However, you should NOT attempt to switch mains currents without considerable previous experience.*

FAST RESPONSE

With the addition of a second circuit board, there is an optional extra stage to this project, called the Differentiator. This changes the response of the trigger. Instead of being sensitive to light level, it becomes sensitive to the rate of change of light level.

With the Differentiator incorporated into the circuit, it is unaffected if light levels change slowly but shows a sharp change in output when the level changes rapidly. For example, in a security system a slowly changing light level, such as might be caused by the arrival of dusk or dawn, or the passing of clouds over the Sun, has no effect. By contrast, the circuit responds to someone walking past and causing the light level at the sensor to change very quickly.

It is able to make a transient response or a permanent one. A permanent response is useful in a security system. Once the intruder has triggered the circuit to sound a

siren, the warning carries on until the circuit is reset.

HOW IT WORKS

The basic Trigger circuit diagram is shown in Fig.1 and uses an MEL12 phototransistor, TR1. This is a very sensitive device incorporating an amplifying circuit in the form of a Darlington pair. In the circuit diagram, it is drawn as an npn transistor, including a base (b) terminal.

However, we do not make a connection to the base in this trigger circuit because the light energy falling on the phototransistor generates the equivalent of a small base current. This is amplified within the device to produce a collector-emitter current in the region of 3mA in bright light. In darkness, the current is only a few nanoamps.

When the light is shining on the phototransistor the resulting current flows through resistor R1 and Level control VR1 in series. If the current is 2mA, for example, and VR1 is set so that the total resistance of R1 and VR1 is 2.25kΩ, the voltage drop across the two resistors is 4.5V. Then, if the supply voltage is 9V, the voltage at pin 2 of the op.amp is 9 - 4.5 = 4.5V. The voltage at pin 3 is also equal to 4.5V, since resistor R2 equals R3 and the voltage is half way between the power lines. In this state, the op.amp is just at its trigger point and its output is 4.5V (also half way between the power lines).

Now let us see what happens if the light level changes. If the light level increases, the current through phototransistor TR1 increases, the voltage across R1 and VR1 increases and the voltage at pin 2 falls. A

fall in voltage at the inverting input (-) of an op.amp produces a rise in voltage at the output. The op.amp is connected as a comparator, with no negative feedback, so its full open loop gain of around 200,000 comes into play.

With even the slightest increase in light, the output voltage swings rapidly as high as it can go, to within a volt or so of the

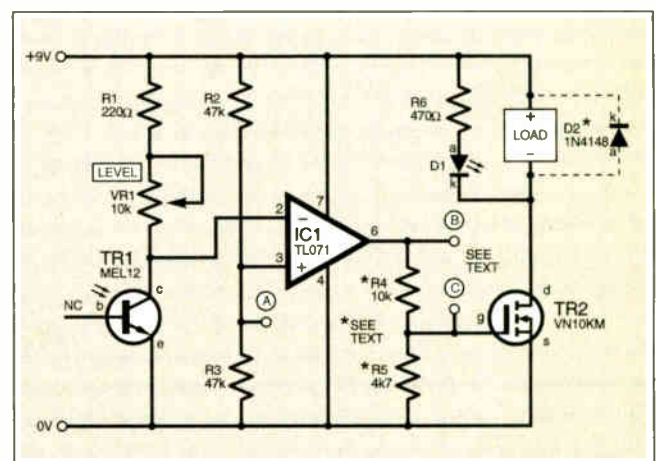


Fig.1. Trigger circuit diagram of the Versatile Optical Trigger.

COMPONENTS

BASIC TRIGGER

Resistors
 R1 220Ω (see text)
 R2, R3 47k (2 off)
 R4 10k (see text)
 R5 4k7 (see text)
 R6 470Ω

All 0.25W 5% or better

Potentiometer

VR1 10k rotary carbon (or preset or fixed, see text), linear

Semiconductors

TR1 MEL12 phototransistor
 TR2 VN10KM n-channel MOSFET
 IC1 TL071 bifet op.amp

See
SHOP
TALK
 page

positive rail. If the light level falls even slightly, the reverse occurs and the output falls rapidly to about 1V with respect to the 0V rail.

OUTPUT DRIVE

The next stage is a MOSFET, TR2. Typically, this is turned on when the gate-source voltage exceeds 2.5V. Thus, it would be turned on by a 4.5V output from the op.amp.

However, we drop the output voltage by using a potential divider, made up of resistors R4/R5. The ratio of these resistors is 10:4.7 so, if the op.amp output is 4.5V, the voltage at the gate (g) of TR2 is only $4.5 \times 4.7/14.7 = 1.4V$.

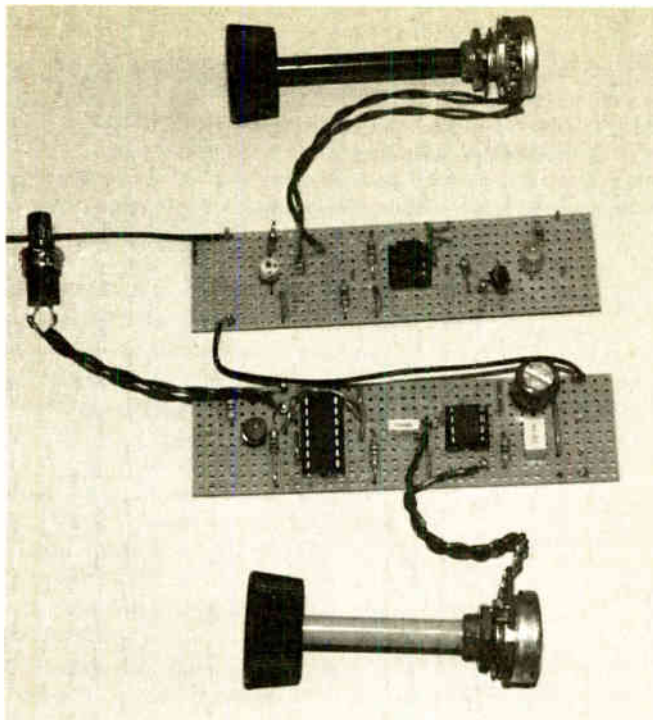
This is not high enough to turn TR2 on. As a result, TR2 is off if the incident light is less than the triggering level. As light increases and the op.amp output swings to around 8V, the gate voltage rises sharply to 2.56V and TR2 is switched on.

Current flows through the load, such as a relay coil, when TR2 comes on. The load could be a lamp, a buzzer, a siren, a solenoid, a d.c. motor or any other d.c. operated device, provided that it takes no more than 500mA. This is the largest current that a VN10KM can safely handle. To switch a larger current, substitute a MOSFET of higher current rating, such as a VN66AF, which can carry up to 2A.

A light emitting diode (l.e.d.), D1, is shown in parallel with the load in Fig.1. This is an indicator, which lights when the load is switched on. If the load is inductive, such as a relay, motor, or solenoid, then a large reverse current is generated when the load is suddenly switched off. To conduct this current away safely, add a signal diode such as a 1N4148 type in parallel with the load. This diode must be connected with *opposite* polarity to that of D1.

DIFFERENTIATOR

The Differentiator circuit diagram is shown in Fig.2 and is based on a second op.amp, IC2. It takes its inputs from the Trigger circuit. Input A is from the junction of the voltage divider resistors R2/R3, which sits at half the supply voltage. Input B comes from the output junction of the trigger op.amp, IC1, and is coupled to the inverting input (pin 2) of IC2 through capacitor C2. The output of this op.amp is then used to drive TR2 and switch the load and l.e.d. on or off.



Prototype circuit boards for the Opto-Trigger (top) and Differentiator.

The output voltage of an op.amp Differentiator is given by:

$$V_{OUT} = -RC \times dv_{IN}/dt$$

In this equation, R is the series resistance of R7 and VR2, and C is the capacitance of C2. The differential expression dv_{IN}/dt means the *rate of change* of input voltage, in volts per second. It can be seen that the output is proportional to this too.

This expression shows several things:

- An increase in input voltage produces a fall in output voltage.
- Output is proportional to R and C . We can adjust the sensitivity by adjusting VR2.
- Output is proportional to the rate of change of input voltage. This means that even a very short and small input pulse can produce a high output pulse provided that the rate of change is high.

The third point above makes the circuit a little too sensitive to small "spikes" on the signal from IC1. Therefore, capacitor C1 is connected across the input to eliminate the effect of such spikes.

When the light level on the sensor rises quickly, the output of IC2 falls. A low pulse passes across capacitor C3 to the input of the flip-flop IC3b/IC3c. This type of flip-flop, built from two NAND gates, is stable if both its inputs are high. Resistors R8 and R9 provide for this.

However, a negative pulse arriving by way of C3 will briefly make pin 6 low and so set the flip-flop; its output at pin 4 goes high. The rising output is used to switch the transistor TR2 in the Trigger circuit (Fig.1). The load is energised and D1 comes on. The flip-flop is reset by briefly pressing pushswitch S1.

MODIFICATIONS

To make the basic circuit operate in the opposite sense, simply exchange TR1 with R1 and VR1. If you are using the circuit with the Differentiator, the sense of operation may not be relevant. When a person (say, an intruder), briefly shades the sensor, the pulse from IC2 rises as the sensor is shaded and falls as the sensor is exposed. The flip-flop is triggered as the person moves away.

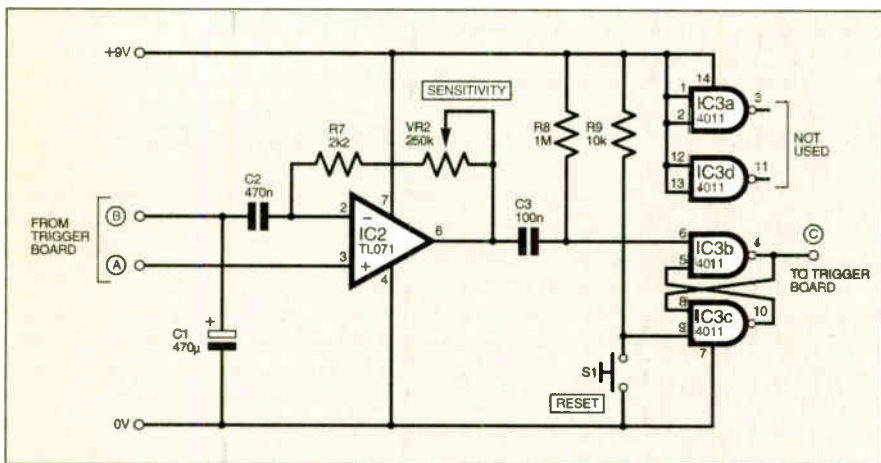


Fig.2. Circuit diagram for the Differentiator section. Switch S1 is a "normal-open" type.

- D1 5mm l.e.d., red
D2 1N4148 signal diode, if load is inductive (see text)

Miscellaneous

Stripboard, 10 strips x 39 holes; 1mm terminal pins (9 off); 8-pin i.c. socket; PP3 battery clip; s.p.s.t. toggle switch (optional); load according to application; multistrand connecting wire; solder, etc.

DIFFERENTIATOR

Resistors

- R7 2k2
R8 1M
R9 10k

All 0.25W 5% or better

Potentiometer

- VR2 250k rotary carbon or preset, linear

Approx. Cost
Guidance Only

£10

Capacitors

- C1 470µ radial elect. 16V
C2 470n plastic film
C3 100n plastic film

Semiconductors

- IC2 TL071 bifet op.amp
IC3 4011 CMOS quad 2-input NAND gate

Miscellaneous

- S1 pushswitch, push-to-make
Stripboard, 10 strips x 39 holes; 1mm terminal pins (9 off); 8-pin i.c. socket; 14-pin i.c. socket; multistrand connecting wire; solder, etc.

The values of R1 and VR1 given in Fig. 1 are more suited to operation in full daylight. If you want to operate the circuit in dim light, a larger resistance is needed to produce the required voltage drop of about 4.5V. Try increasing the value of R1 to, say, ten kilohms (10kΩ) or more. You could also try increasing VR1 to 47kΩ.

The circuit will also work on a 6V supply, but in this case the value of R5 should be increased to 22kΩ. It works on 12V without modification.

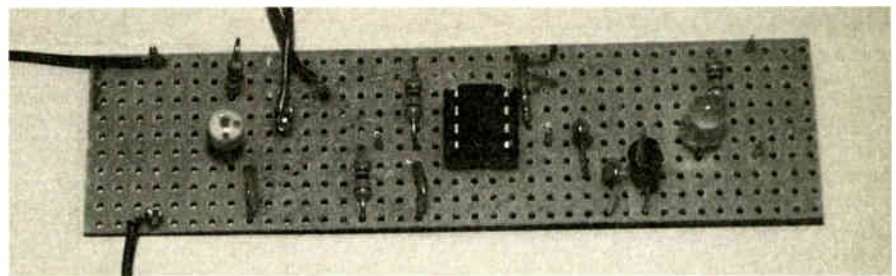
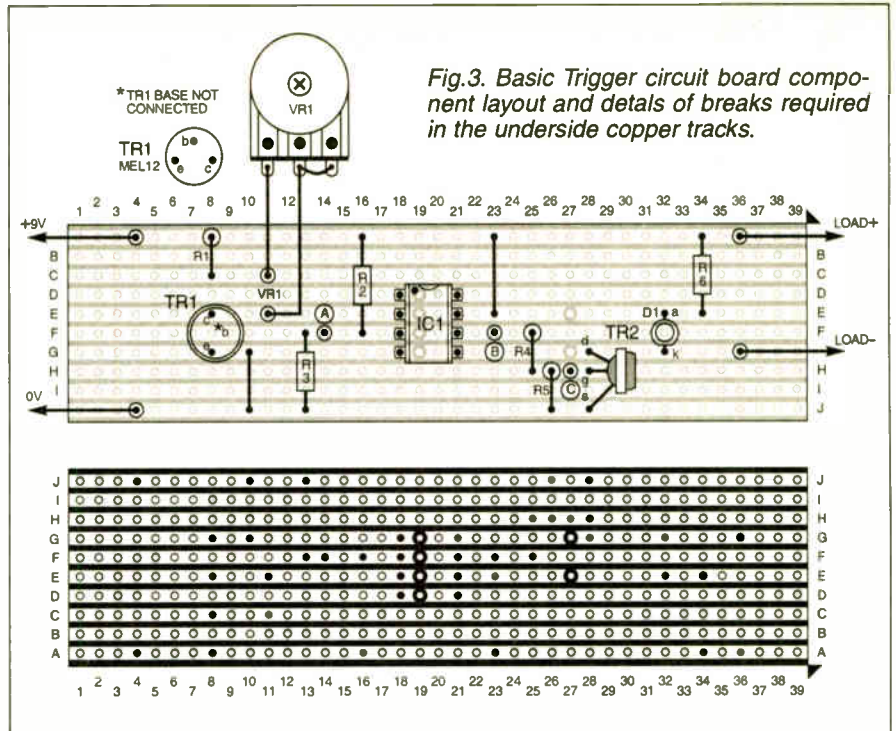
CONSTRUCTION - TRIGGER BOARD

The phototransistor type MEL12 is supplied with three terminal wires, but the base is not used and the wire can be cut short before mounting. Mount R1 and TR1 on the stripboard as shown in the component layout diagram of Fig. 3. In some applications it may be necessary to mount phototransistor TR1 off-board, with leads running to terminal pins at E8 and G8. Level control VR2 is off-board with leads running to terminal pins at C11 and E11. However, if the unit is to be used for a specific application, there may be no need to vary the sensitivity. In that case, experiment to find what total resistance is required and then replace R1 and VR1 by a fixed resistor between A10 and E10.

Check this section of the circuit by monitoring the voltage at the collector of phototransistor TR1 as the sensor is exposed to all the differing light levels that it will receive in use. The voltage should be more than the mid-rail voltage (4.5V for a 9V supply) when the incident light exceeds the required triggering level.

Complete the board assembly, noting that the terminal pins at (A) and at (B) are not needed if you are *not* intending to add the Differentiator. Resistors R4 and R5 are not needed if you *are* adding the Differentiator circuit.

Apply power and check that the output of IC1 rises above 4.5V only when the light level exceeds the triggering level. If you are



Completed prototype board for Trigger stage of the Versatile Optical Trigger.

not adding the Differentiator, check that the diode D1 comes on when the circuit is triggered. Now connect the load device by leads running from points A36 and G36 on the Trigger board. Small devices can be mounted directly on the board, with flying leads to these holes.

DIFFERENTIATOR

The Differentiator stripboard component layout and details of breaks required in the underside copper tracks are shown in Fig. 4.

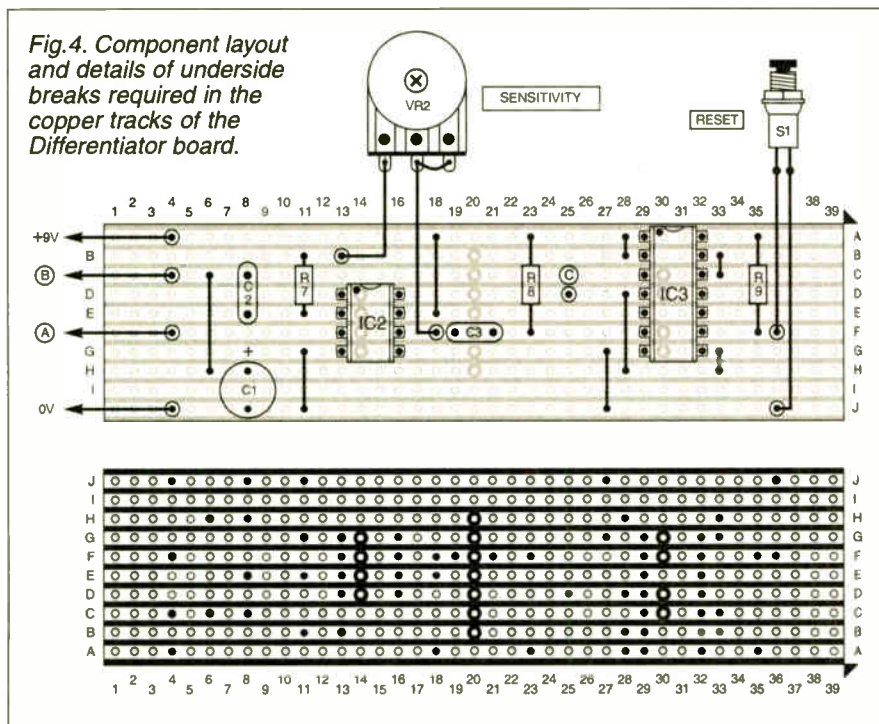
Assemble the differentiating section (all components in columns 1 to 19 in Fig. 4). Check it by connecting the power rails to the same supply as the Trigger board, and by connecting input pins (A) and (B) to identical points (F14 and F23) on the Trigger board.

Switch on the power and check that the output at pin 6 of IC2 is normally high (more than half the mid-rail voltage) but falls rapidly when the phototransistor TR1 is rapidly shaded or exposed. Also check that it does not fall with a slow change of light level. Adjust VR2 if necessary to increase sensitivity.

Next, add the flip-flop section. Note that two gates of IC3 are unused. The unused inputs at pins 1, 2, 12 and 13 *must* be connected to the positive rail as shown in Fig. 2. Apply power and confirm that the flip-flop is reset by briefly pressing pushswitch S1 and that the l.e.d. goes out. After this, a rapid change in incident light sets the flip-flop and the l.e.d. comes on. It stays on until the flip-flop is reset again.

If you had previously been using the basic trigger circuit (Fig.3), remove resistors R4 and R5. Now run a lead from point (C) (D25) on the Differentiator board back to point (C) (H27) on the Trigger board. Apply power. The l.e.d. should now light when there is a rapid change of light level on the sensor. Connect the load as previously described for the Trigger board. □

Fig. 4. Component layout and details of underside breaks required in the copper tracks of the Differentiator board.



MILLIPEDE RECORDING NEARS COMMERCIALISATION

Flat, non-rotating magnetic data storage and retrieval comes out of the lab.
Barry Fox reports.

MILLIPEDE, IBM's electromechanical data store, is close to commercialisation. IBM's researchers now feel confident to predict that future pocket phones and computers will use a single Millipede chip to store two full length movies, a week's worth of MP3 music or a 200-metre tall stack of printed paper.

IBM's Research Lab in Zurich believes its laboratory project can now be mass-produced at low-cost, within five years. This dovetails with the likely date when magnetic technology reaches its physical capacity limits.

Atomic Level Storage

"I can now dream of a new age when we store at atomic level, and process signals mechanically", says Peter Vettiger, the scientist who heads the Millipede project. "We will integrate as many mechanical devices on a single chip as we currently do by the million with transistors. And the chip can be of whatever size you want".

Magnetic discs can store around 15 Gigabits of data per square inch of surface area, and read it at around 200 Megabits a second. Optical discs store less than magnetic discs and read more slowly, but are cheaper. Solid state memory reads faster, but stores less. costs more and usually loses data when the power is switched off.

Advances in magnetic recording double capacity each year but this will stop around 2004 at 100 Gbits per square inch because of superparamagnetic effects; the magnetic domains, like tiny bar magnets, become so small and tightly packed that they interfere with each other, losing data unpredictably over time and with temperature changes.

In the mid-nineties Peter Vettiger and Gerd Binnig, Nobel prize-winner for his work on the scanning tunnelling microscope, looked at the possibility of using similar technology to store data. Instead of creating a magnified image with electrical readings taken by nanometer tip probes, IBM used the probes to indent a smooth surface. They proved the principle with a spinning polycarbonate disc, like a CD, coated with polymethylmethacrylate (PMMA), but dared not predict when – or even if – the technology might leave the Lab.

"The Millipede project now looks so promising that we are ready to talk about commercialisation within five years", says Vettiger, who now heads a team of ten researchers in Zurich, with more at IBM's Labs at Almaden in the US.

From Spinning to Linear

Confidence comes after IBM switched from using a spinning disc, to a flat plate of hard silicon substrate, spin-coated with PMMA. The probes are cantilever arms, arrayed in 32 rows of 32 probes on a silicon chip and doped to make them flex and conduct electricity. This heats the arms while moving them towards the plate to indent the coating, right down to the substrate. The substrate chip moves past the array chip while the probes write data line by line, much as a TV picture is scanned with a raster of lines.

For readout the probes are lightly warmed and the contact heat loss measured. This varies depending on whether the probe is in an indentation and thus touching the substrate, or only on the PMMA surface. Using a sliding plate instead of a spinning disc makes it easier to keep the surface perfectly flat, which improves write and read accuracy.

The early plan to erase data in bulk by heating the whole plate has now been changed to allow local erasure of targeted areas with a heated lever.

500Gb Per Square Inch

A single tip can already store up to 500 Gbits per square inch, writing data at 50

kilobits per second and reading 1 Megabit per second. When all the probes in a scanning line are working together, data speeds increase proportionally. There is a trade off between speed and power consumption. Mains-powered devices can deliver the high currents needed for rapidly heating and moving the probes and media; battery-powered portables will run at slower speeds.

"Ultimately there should be atomic resolution" says Vettiger. "What we have now is the tip of the iceberg.

"The technology is currently called MEMS, micro electro-mechanical system. But I would now like to start talking about NEMS, because we are approaching nanometre scaling.

"NEMS is a natural progression from magnetic recording. The price will be very competitive because hard discs need assembly. Millipede chips can be mass-produced like silicon chips, on the same fabrication lines", says Peter Vettiger.

Texas Instruments has already proved the viability of micromechanics by putting more than a million hinged mirrors on a single chip and using it to control the light in a video projector.

DRILL PLAN



MINICRAFT tell us that in their continuing efforts to improve their service, they have included two *free* project plans in their four most popular ready to use rotary tool kits.

The projects are intended to give users the necessary know-how required to create, repair and build. They include: refurbishing small metal objects, engraving glass, regrinding, sharpening, drilling and carving.

For more information contact Minicraft, Dept EPE, 1 & 2 Enterprise City, Meadowfield Avenue, Spennymoor, Co Durham DL16 6JF. Tel: 01388 420535.

Web: www.minicraft.co.uk.

AMSTRAD E-MAILER



AMSTRAD tell us that "the ideal alternative to the burden and expense of a new PC this Christmas" is their new e-m@iler.

Dubbed by some as "the phone with attitude", the equipment not only offers E-mail access but also provides a digital answering machine, 700 name address book, SMS text message and fax facilities, plus a portable data bank. It simply plugs in to your existing phone line and a power socket.

Amstrad founder, Sir Alan Sugar, said "The e-m@iler takes E-mail to the masses with its easy to use format and affordable pricing". The cost of the unit itself is £79.99, although there is a charge payable per usage session. The charges are subsidised by occasional adverts being displayed on the unit's screen.

The Amstrad e-m@iler is available from Dixons, Curry's, The Link and select retail outlets. For further stockist information call the Amstrad help line on 01277 208811 or visit www.amstrad.com.

FML Electronics

THE 2001 mail order catalogue for FML Electronics is now available. Split into eight sections the 26-page A4 size catalogue has its first section totally devoted to semiconductors, 13 pages of them. It appears to be one of the most comprehensive selections of semiconductors available to the hobbyist constructor.

The second section is crammed with hardware items while the other sections itemise computer and office products, surface mount devices, development and bulk purchase packs.

The catalogue is without illustrations and is set in a smaller type face than used by some other suppliers, although it is still easy to read. FML also do kits for selected EPE projects, for which a separate catalogue is available. They can also supply data sheets.

For more information contact FML Electronics, Dept EPE, The Business Centre, Bridge Street, Bedale, N. Yorks DL8 2AD. Tel: 01677 425840.

Greenweld's Bargains

GREENWELD'S Christmas 2000 32-page catalogue has arrived at HQ. Quite naturally part of it details seasonally-orientated products. The rest of it, though, contains the type of bargains that you have come to associate with Greenweld.

Greenweld say that they hold quite literally thousands of lines, from resistors and capacitors to power supplies and electric motors; from surplus electronic bargains, hardware and tools to radio controlled models and hobbyist equipment.

Interestingly, Greenweld say that they will produce a fuller catalogue next year, and that it will be a "truly bumper edition". They also periodically issue a free E-mail News and Latest Surplus Arrivals listing.

For more information contact Greenweld Ltd, Dept EPE, PO Box 144, Hoddesdon, Herts EN11 0ZG. Tel: 01277 811042. Fax: 01277 812 419.

E-mail: service@greenweld.co.uk.
Web: www.greenweld.co.uk.

CAR VOLTAGE TO BECOME 42V

By Barry Fox

EARLY motor cars used 6 volt batteries but over the last fifty years 12 volts (in practice usually 13.8 volts) has become the *de facto* standard. The motor industry is now on track to increase the working voltage from today's 12/13.8V to 42V. Philips has developed a range of 42V controllers in readiness for production line changes expected in 2003.

Cars are becoming mobile offices and entertainment centres, with the engine, brakes, steering, air-conditioning and safety systems all under electric and computer control. This has already pushed power consumption past one kilowatt and drains of around 4kW are expected in the near future.

Two years ago the Massachusetts Institute of Technology proposed a voltage hike to 36V. Now the manufacturers favour a larger leap, to 42V. Tripling the voltage reduces current flow to a third, letting thinner and less expensive wires carry the power needed without risk of overheating. The voltage change means a complete re-design of all the electronic and electromagnetic components. So the change will only affect new models.

EXPERIMENTING WITH BRUNNING

BRUNNING Software have announced the fourth release in their *Experimenting with . . .* series, titled *Experimenting with the PIC16F877*. It is a companion to their existing *Experimenting with PIC Microcontrollers*, but largely assumes no prior knowledge of PICs.

Peter Brunning tells us that he starts the discussion with the simplest of all experiments to provide you with a basic understanding before moving on to other programming techniques and demonstrations, including some based on the PIC16F877's 10-bit A/D converter. A new version of Brunning's PIC Assembler has also been created to complement the book.

The book together with the latest software suite is £45 inclusive. It is available from Brunning Software, Dept EPE, 138 The Street, Little Clacton, Clacton-on-Sea, Essex CO16 9LS. Tel: 01255 862308.

Sherwood Catalogue

REGULAR advertisers Sherwood Electronics have released their 2001 edition catalogue. Costing £1 and with around 100 A5 pages, it itemises a good variety of commonplace components needed by any regular hobbyist designer/constructor.

Whilst the ranges are not stocked "in-depth", if you are after "everyday" component types, this catalogue is worth adding to your library. There is £1 pound's worth of discount vouchers included to offset the cost of the catalogue.

For more information contact Sherwood Electronics, Dept EPE, 7 Williamson Street, Mansfield, Notts NG19 6TD.

CONTROL & ROBOTICS

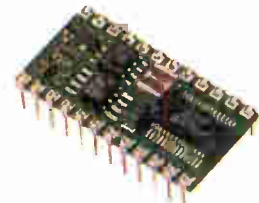
Milford Instruments

BASIC Stamp Microcontrollers

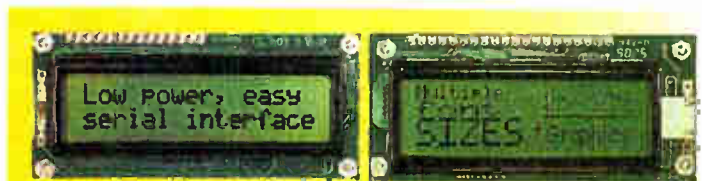
Still the simplest and easiest way to get your project or development work done. BASIC Stamps are small computers that run BASIC programmes. With either 8 or 16 Input-Output pins they may be connected directly to push-buttons, LEDs, speakers, potentiometers and integrated circuits such as digital thermometers, real-time clocks and analog-digital converters. BASIC Stamps are programmed using an ordinary PC running DOS or Windows. The language has familiar, easy-to-read instructions such as FOR...NEXT, IF...THEN and GOTO. Built-in syntax make it easy to measure and generate pulses, read push-buttons, send/receive serial data etc. Stamps from **£25** (single quantities), Full development kits from **£79**



Full information on using BASIC Stamps plus lots of worked projects and practical electronics help. CD-ROM also includes 30+ past magazine articles and Stamp software. **£29.95**

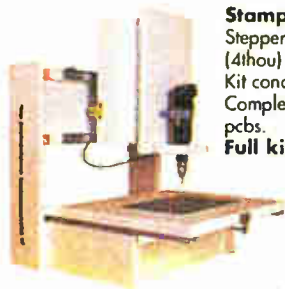


New to PICs or just wanting to learn more tricks? We stock the excellent PIC primer books from David Benson - suitable for the complete beginner to the advanced user.



SERIAL LCDs

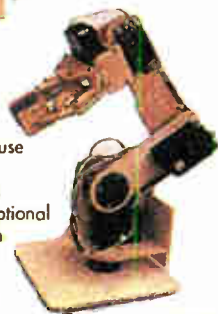
Banish the hassle of interfacing to LCD displays. We stock a comprehensive range of alphanumeric and Graphic LCDs - all with an easy-to-use standard RS232 serial Interface. Sizes from 2x16 to 4x40 plus 128x64 graphic panels. Prices start at **£25** (single quantity)



Stamp2 based 3-axis machine
Stepper drive to X, Y and Z axes with 0.1mm (41hou) resolution. Kit contains pre-machined frame components. Complete with Windows software for drilling pcbs. **Full kit at £249, Part kit at £189**

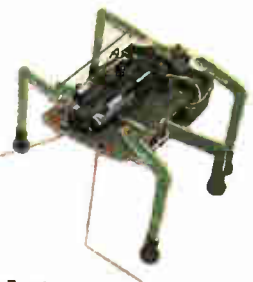
TecArm4

New range of robotic arms for educational and hobbyist use with super powerful servos. Controlled from PC (Windows freeware provided) or from optional keypad. Stands about 450mm high when fully extended. Kit includes all pre-cut body parts, servo controller board, servos and software. Requires 9v Dc. Kits start at **£189**



StampBug

Stamp1 based walking insect. Forwards, backwards and left/right turn when feelers detect object in path. Up to 2 hours roving from 4xAA Nicads. Chips pre-programmed but programme may be changed (software supplied). Body parts pre-cut. **Full kit £68**



BigFoot

Stamp1 based walking humanoid. Walks forwards/backwards with left and right turn when detects obstacles. Electronics pcb pre-built and tested. Programme pre-loaded but may be changed with supplied software. **Full kit £68**



Alex- Animated Head

Stamp2 based controller with voice record-playback capability, PIR input and/or random playback. 4-servo actions ore recorded/edited one track at a time. May also be controlled from PC. **Head kits start at £29. Controllers from £29**

On Screen Display

Superimpose text onto standard CCTV from simple RS232 serial line. Ready built/tested at **£59**



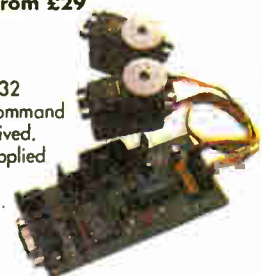
IR Decoder Board

Control your project using a standard domestic IR remote. 7 Output lines (5v @ 20mA) may be set to momentary or toggle action. Simple teaching routine. Requires 9-12vDC. Supplied built and tested. **£29 single quantity**



Servo Driver Board

Control up to 8 standard hobby servos from an RS232 serial data line using this controller board. Simple command structure holds servos in position until update is received. Fully built and tested- requires 9VDC and servos. Supplied with Windows freeware. **£29 single quantity.** Optional keypad available.



Milford Instruments

120 High Street, South Milford, LEEDS LS25 5AQ
Tel: 01977 683665 Fax: 01977 681465

All prices exclude VAT and shipping.

BASIC Stamp is the registered trademark of Parallax Inc. For further details on the above and other interesting products, please see our web site- www.milinst.demon.co.uk

Etch Tank/UV Light Box Control System – The Right Time

THE circuit diagram shown in Fig.2 is a combined circuit board etch tank and UV light box controller which may be of use to anybody who fabricates their own p.c.b.s (printed circuit boards) on a regular basis.

Etchant temperature is measured with a thermistor (R18), which is placed inside the tank and protected by a thick plastic bag. The single supply op.amp IC1 forms a simple comparator, with hysteresis provided by resistor R5 to ensure a clean switching action for the heater. Potentiometer VR1 controls the heater switching point and should be adjusted so that it switches off at approximately 40°C to 45°C. The heater is switched through transistor TR1 and relay RLA; i.e.d. D1 indicates that the unit is heating.

The etch tank temperature is displayed by the bargraph i.e.d. driver IC2 and i.e.d.s. D2 to D11, which are colour-coded yellow, green and red. Although a standard negative-temperature co-efficient (n.t.c.) thermistor is a non-linear device, the limited range in which it is used here provides adequate linearity.

Preset VR2 adjusts the temperature scale and should be set so that the heater switches off just before the green i.e.d. D9 illuminates. If either of the red i.e.d.s illuminates, then the heater switch-on point should be lowered using Temperature Set control VR1.

The UV light box controller uses a ready-made countdown timer for good accuracy and

versatility together with a built-in display. The prototype circuit utilised the Maplin RJ82D Timer, which must be carefully opened and modified by soldering an output lead to each connection on the piezo sounder. A small hole must then be drilled into the back and the leads pushed through so that they can access the outside world. *This will obviously invalidate any guarantee.*

The timer is interfaced with the circuit via the potential divider resistors R11 and R12, and is connected to an OR gate (IC3) constructed from a 74LS00 quad 2-input NAND gate (see inset). The positive feedback causes the output to latch when the countdown timer expires and the alarm sounds.

Capacitors C1 and C2 aid reliable operation and prevent spurious triggering, and the push-to-break switch S2 resets the latch. Transistor TR3 switches the normally closed relay contacts RLB, i.e.d. D12 illuminating when the light box has been switched off.

It should be noted that switching some types of load (e.g. an air pump aerator) on the same mains plug socket may cause unwanted triggering, however this can be remedied by using a mains-rated RC snubber or filter if necessary.

The circuit is powered by a 9V 500mA supply and regulated by IC4; preset VR3 being adjusted for a rail voltage of 6.25V. Resistor R15 and Zener diode D16 provide

**WHY NOT
SEND US YOUR
CIRCUIT IDEA
Earn some extra
cash and possibly
a prize!**



5.1V for the TTL logic chip, and can be omitted if a CMOS device is used for IC3 instead.

Power consumption is quite high when most of the i.e.d.s are on and both relays are energized, and the current drawn from the supply can exceed 300mA. Leave pin 9 of IC2 floating for a moving dot display which draws less current.

M. A. Jones,
Harrogate, North Yorks.

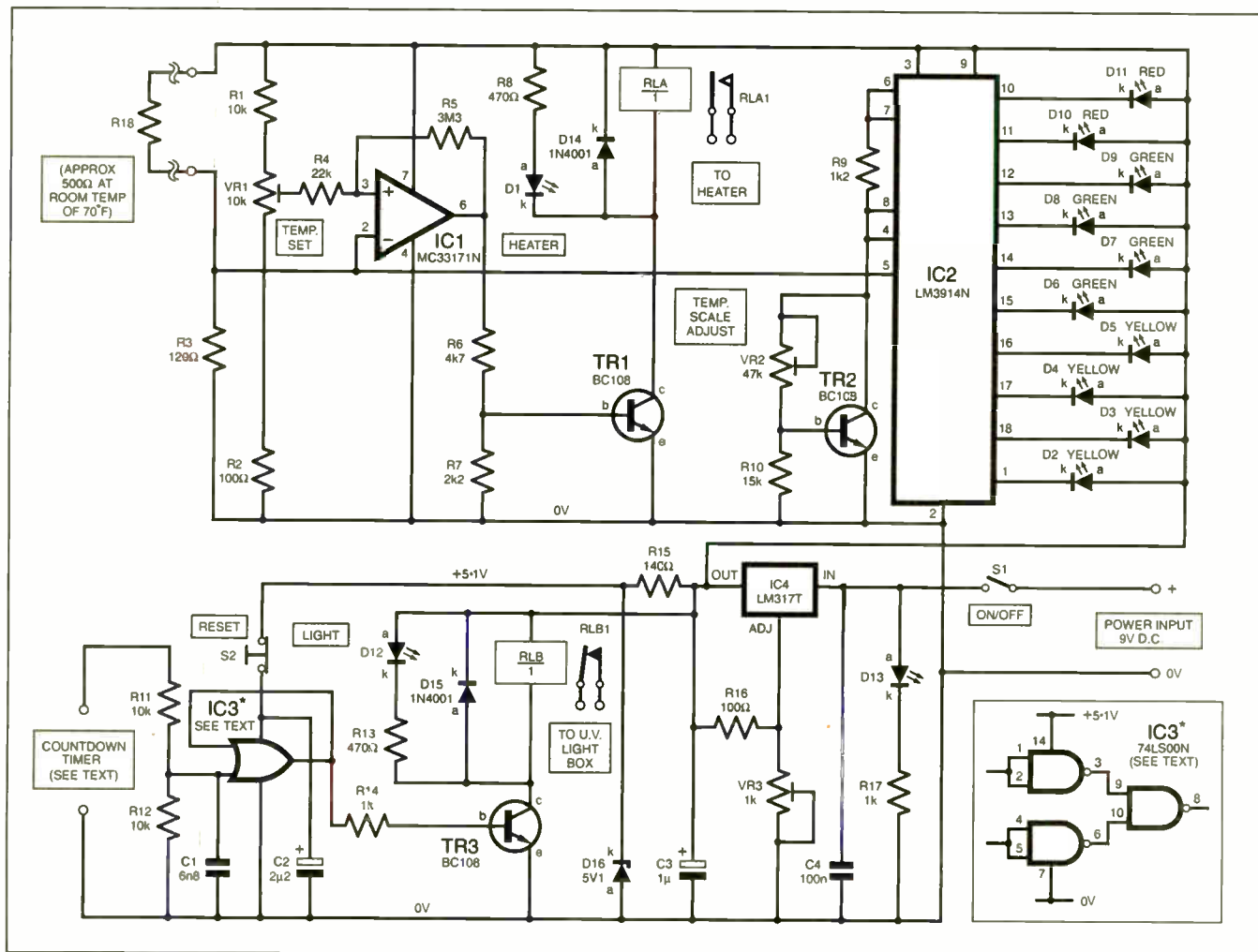
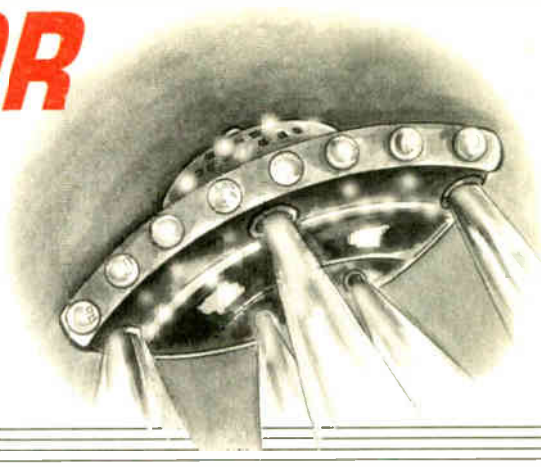


Fig.2. Circuit diagram for a combined Etch Tank/UV Light Box Control System.

Constructional Project

UFO DETECTOR AND EVENT RECORDER

RAYMOND HAIGH



Are you a die-hard disbeliever, or could alien space ships really be crossing the sky at night? This equipment might provide the proof you've been searching for (and detect "normal" magnetic field movements).

ALTHOUGH some ancient texts are said to contain references to spacecraft, the UFO (Unidentified Flying Object) enigma really began on the afternoon of June 24, 1947, when aircraft pilot Kenneth Arnold reported nine crescent-shaped objects crossing the sky at great speed near Mount Rainier in the State of Washington, USA.

Since then there have been countless sightings world-wide, and private and government organisations have been set up to investigate and report on the phenomena. And there has been no shortage of encounters to fill the researchers' files.

Whilst many incidents have been shown to have a terrestrial origin, there remains a solid core of cases where inexplicable phenomena and reliable witnesses combine to challenge our disbelief.

One thing running like a thread through many of the reports is the powerful magnetic disturbance which accompanies the craft. Car and aircraft ignition systems falter or fail (presumably the ignition coil core becomes saturated), and dashboard and navigation instruments behave erratically.

As recently as the 30 March 2000, a family travelling along the Klondike Highway in Canada claim to have observed a saucer-shaped UFO closing on their car. Headlights dimmed, the tape recorder stopped playing and battery operated watches malfunctioned.

The equipment described here will detect and record far weaker magnetic perturbations than these. Stand-by current is extremely low, and the battery powered units can be operated economically in remote locations.

DETECTION METHODS

Three methods of detecting changes in a magnetic field were explored during the development of the unit. First, Hall effect devices, in which the field induces

a voltage in a strip of semiconductor material. Second, an oscillator with a magnetically polarised ferrite core in its tuning inductor. Third, and the oldest of them all, the magnetic compass.

Experiments revealed that the best results could be obtained, with least complexity and cost, by adapting the traditional magnetic compass.

DETECTOR CIRCUIT

The complete circuit diagram of the equipment is shown in Fig.1. It comprises two units: a Detector which responds to changes in the ambient magnetic field, and a Chart Recorder with visual and audible alarms.

Infra-red (IR) light emitted by diode D1 is screened from the base of phototransistor TR1 by a vane attached to the end of a compass needle. With the vane blocking the radiation, the current through TR1 is extremely small, typically 5nA. When the compass is deflected by a magnetic disturbance, infra-red reaches TR1 and current flow increases dramatically.

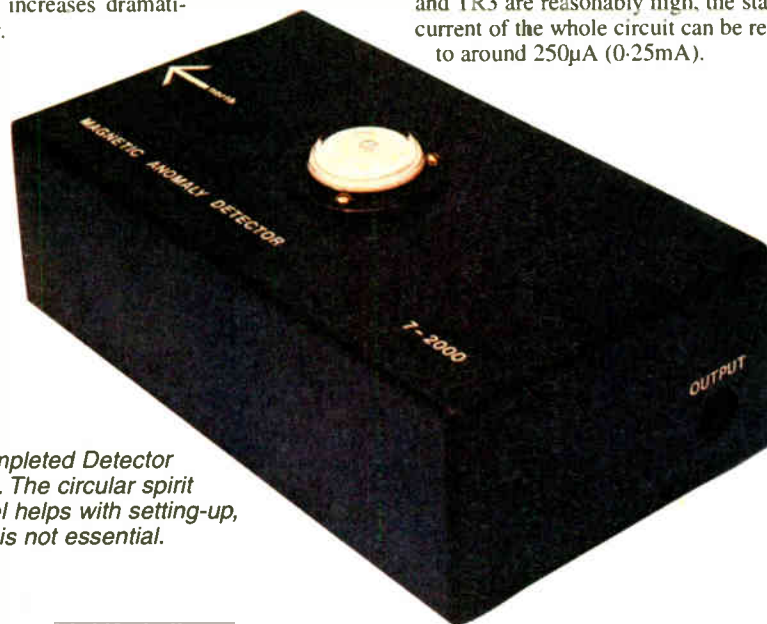
Transistors TR2 and TR3, configured as a Darlington pair, amplify this current to a level where it can actuate a relay (RLA).

The operating point of the circuit is controlled by preset potentiometer VR1, which enables the "on" current to be set so that the relay just triggers.

Diode D2, connected across the relay coil, clips the voltage spike which occurs when the current is switched off.

The combination of the phototransistor, TR1, and Darlington pair, TR2 and TR3, makes the circuit extremely sensitive. A phototransistor is around 100 times more sensitive than a photodiode, and the gain of a Darlington pair is equal to the product of the gains of its two transistors (i.e., $TR2 h_{FE} \times TR3 h_{FE}$).

This, together with the close proximity of the infra-red devices, enables the circuit to function with a low current through IR diode D1. Preset potentiometer VR2 enables it to be reduced to the lowest possible level consistent with reliable operation. If the gains of transistors TR2 and TR3 are reasonably high, the stand-by current of the whole circuit can be reduced to around 250 μ A (0.25mA).



Completed Detector unit. The circular spirit level helps with setting-up, but is not essential.

EVENT RECORDER

Being able to detect weak magnetic anomalies is not a lot of use without some means of recording them and the time when they occur. The event recorder comprises a paper chart wrapped around a drum (a Bird's Custard container!) which is rotated once every twenty-four hours by a quartz clock movement. Events are recorded on the chart by a pen driven across it by a small electric motor.

The circuit used to limit the travel of the pen and control the direction of the electric motor is similar to that used in satellite dish drives.

Reference to the photographs, and Fig.5 later, together with the circuit diagram, should help to make the following description clear.

When the relay (RLA) is actuated, current is applied to the motor (M1) which begins to turn a threaded rod anti-clockwise, drawing the pen carrier to the right. Diode D3, wired across limit switch S1, permits current to flow until the carrier has moved far enough for S1 to close.

On reaching the motor end of the rod, the carrier forces S2 open and, as diode D4 is connected to oppose the current flow, the motor is switched off.

When the detector stops activating the relay, the relay's changeover contacts reverse the polarity of the voltage to the motor. Diode D4, across the open contacts of S2, will now conduct and the motor begins to rotate the threaded rod clockwise, driving the pen towards the left until limit switch S1 is opened. The system has now

returned to its original "at rest" position, ready to be triggered by the next event.

The 4-pole 3-way rotary switch, S3, connects light emitting diode (l.e.d.) D5, together with its current limiting resistor, R3, into circuit in place of the relay coil. This permits the setting up and testing of the equipment without the pen being driven across the chart.

ALARM CALL

The pen driver operates fairly silently, and an audible warning of an event is desirable. A tone is provided by a 555 timer, IC1, connected as an astable multivibrator. Frequency of oscillation is determined by resistor R6 and capacitor C3, and the stated values produce a signal of around 800Hz.

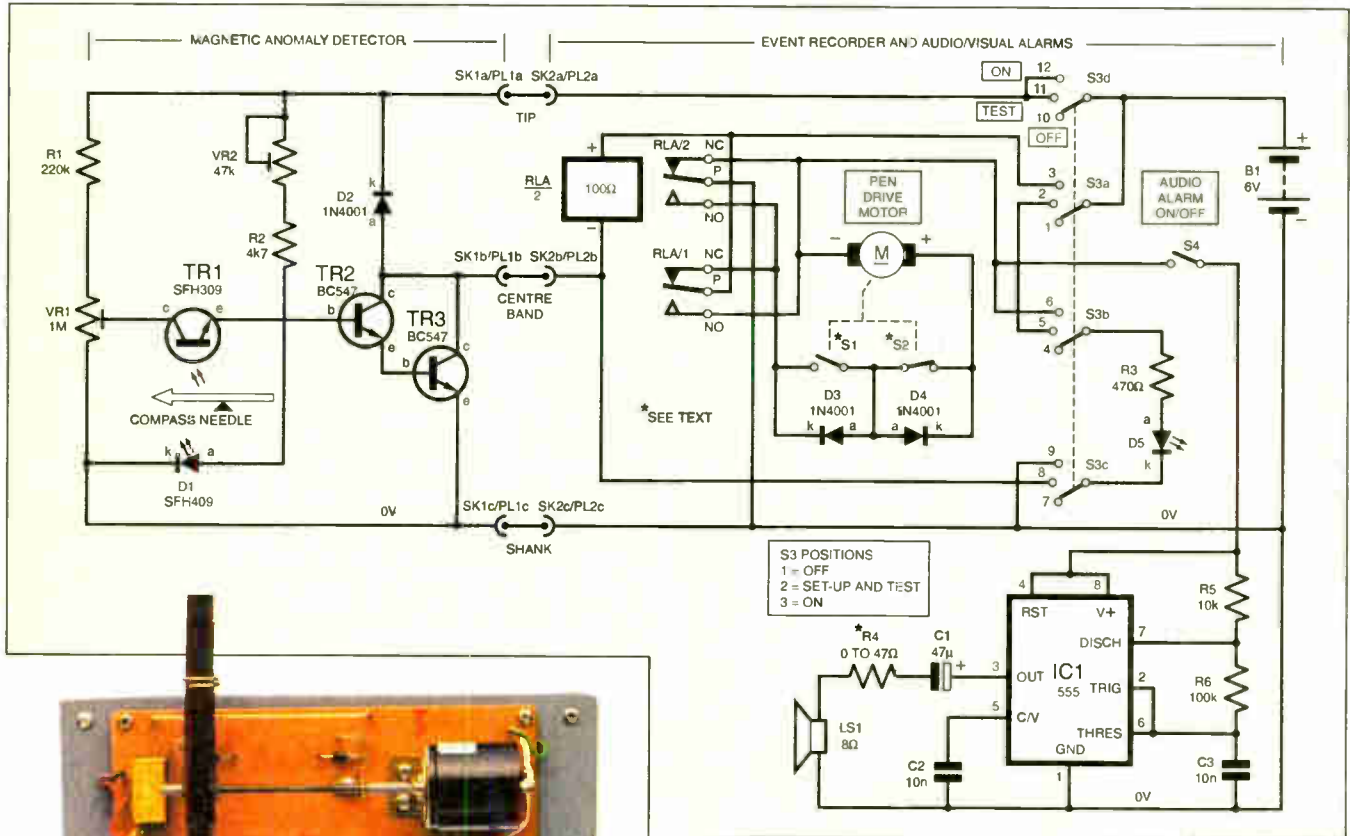
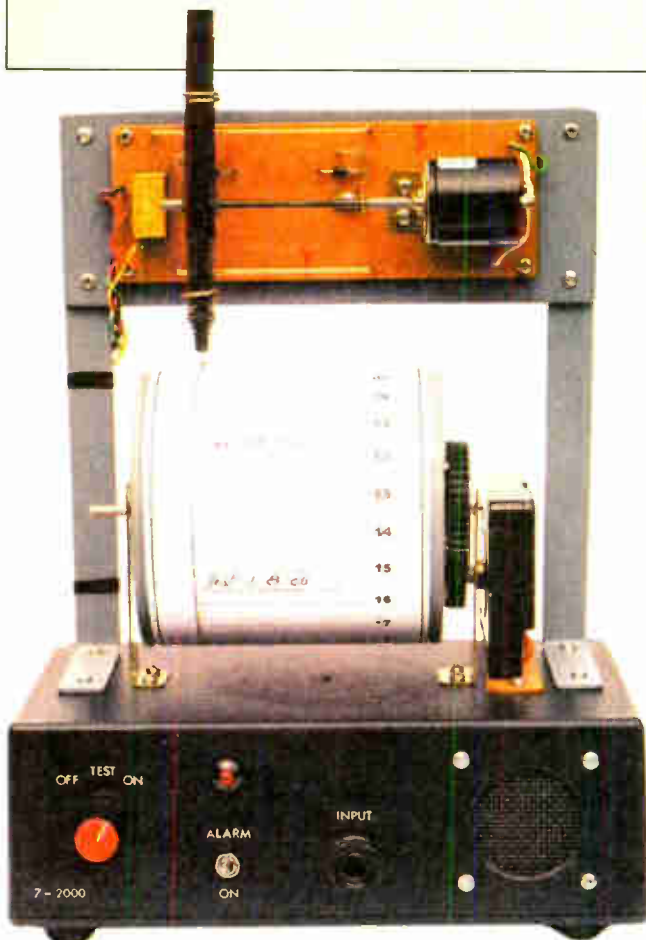


Fig.1. Complete circuit diagram of the UFO Detector and Event Recorder. The circuit consists of a Magnetic Anomaly Detector, 24-hour Event Recorder and Audio/Visual Alarms.

(Left). The completed Event Recorder and Alarm Unit.



The unused control voltage input, pin 5, is bypassed by C2, and blocking capacitor C1 prevents the flow of d.c. through the speaker coil, LS1.

Standard versions of the 555 (do *not* use the 7555 low power variant) can deliver up to 200mA at pin 3. This is more than sufficient to produce a loud tone in a small speaker operating at 800Hz.

Current drawn by IC1 with a 6V supply and an 8Ω speaker is around 50mA; well within the capabilities of the device. If higher supply voltages are used to suit a particular relay, a resistor, R4, should be connected in series with the speaker to limit current flow. A 22Ω resistor is suitable with 9V supplies, and a 47Ω component should be fitted when the supply is 12V. This limits the flow of current to about 50mA in all cases.

Control switch S3 connects l.e.d. D5 as a visual alarm when the system is "on". Visual and audio alarms are connected to the negative terminal of the motor and are triggered "on" immediately the relay activates the system.

They go off when there is no signal or voltage from the detector unit and the motor is driving the pen back to its "at rest" position.

The audio alarm is quite penetrating, and toggle switch S4 is included to disconnect it if required.

COMPONENT CONSIDERATIONS

The circuit is not critical, and the inclusion of presets VR1 and VR2 enable it to be adjusted to accommodate a wide range of transistor and diode types. Certain requirements must, however, be observed if the lowest levels of stand-by current are to be achieved.

The specified infra-red diode and phototransistor are manufactured by Siemens, but a variety of similar devices were tried in the circuit and they all worked well. Older phototransistors may have a base lead: it should be ignored.

For best results, transistors TR2 and TR3 must have a d.c. gain (h_{FE}) in excess of 120 when the collector current is no more than 2mA. They should also be capable of sinking the current needed to actuate the relay.

The BC547, BC239 and 2N3711 devices all worked well in the prototype.

Maximum collector current for the 2N3711 is, however, rather low (30mA), and the relay coil must be capable of working within this limit if this device is used.

Although not tried, the 2N3390, 2N3391, 2N3392 and 2N3395 should work well without this restraint. Case styles and base connections for the alternative devices will vary and should be checked.

Relay sensitivity will determine the "on" current of the circuit. A 4.5V to 6V unit is recommended, and its coil resistance should preferably be 100 ohms or higher. The recommended types will switch reliably with a current of around 30mA.

COMPONENTS

Approx. Cost
Guidance Only
£27
excluding cases, batt, hardware

Resistors

R1	220k	See SHOP TALK page
R2	4k7	
R3	470Ω (see text)	
R4	0Ω (wire link) or 22Ω or 47Ω (see text)	
R5	10k	
R6	100k	

All 0.25W, 5% carbon film or better.

Potentiometers

VR1	1M preset, round
VR2	47k preset, round

Capacitors

C1	47μ radial elect. 16V
C2, C3	10n ceramic (2 off)

Semiconductors

D1	SFH409 infra-red diode (see text)
D2 to D4	1N4001 rect. diode (3 off)
D5	red i.e.d.
TR1	SFH309 phototransistor (see text)
TR2, TR3	BC547 npn transistor (see text) (2 off)
IC1	555 timer (see text)

Miscellaneous

RLA	2-pole changeover, d.i.l., 4.5V to 6V coil, 100 ohms approx (see text)
S1, S2	see text

S3	4-pole 3-way, rotary switch
S4	min. s.p.d.t. toggle switch
SK1, SK2	stereo 6mm jack socket (non-magnetic, see text) (2 off)
PL1, PL2	stereo 6mm jack plug (non-magnetic, see text) (2 off)
LS1	8 ohm 38mm dia. loudspeaker

Printed circuit board set, available from the EPE PCB Service, codes, 283 (Mag. Det.), 284 (Event Rec.) and 285 (Alarm); plastic box, 191mm x 106mm x 52mm internally (2 off); 6V battery; 8-pin d.i.l. socket; 16-pin d.i.l. socket (to suit relay); i.e.d. holder, panel mounting; 1mm terminal pins; hook-up wire; 3-core connecting cable (approx. 2 metres).

HARDWARE

Quartz clock movement and 2:1 reduction gears; 4.5V to 12V d.c. motor (see text); control knob for rotary switch S3; optional circular spirit level (see text); piano wire, 24s.w.g. (approx. 0.5mm); brass wire, 18s.w.g. (approx. 1.2mm) and 24s.w.g.; brass and aluminium strip; brass nuts, bolts and stand-offs; threaded rod, 6BA; ball-point pen top; Bird's Custard tin(!) or similar; superglue; black plastic insulating tape; small piece of hardboard or plywood.

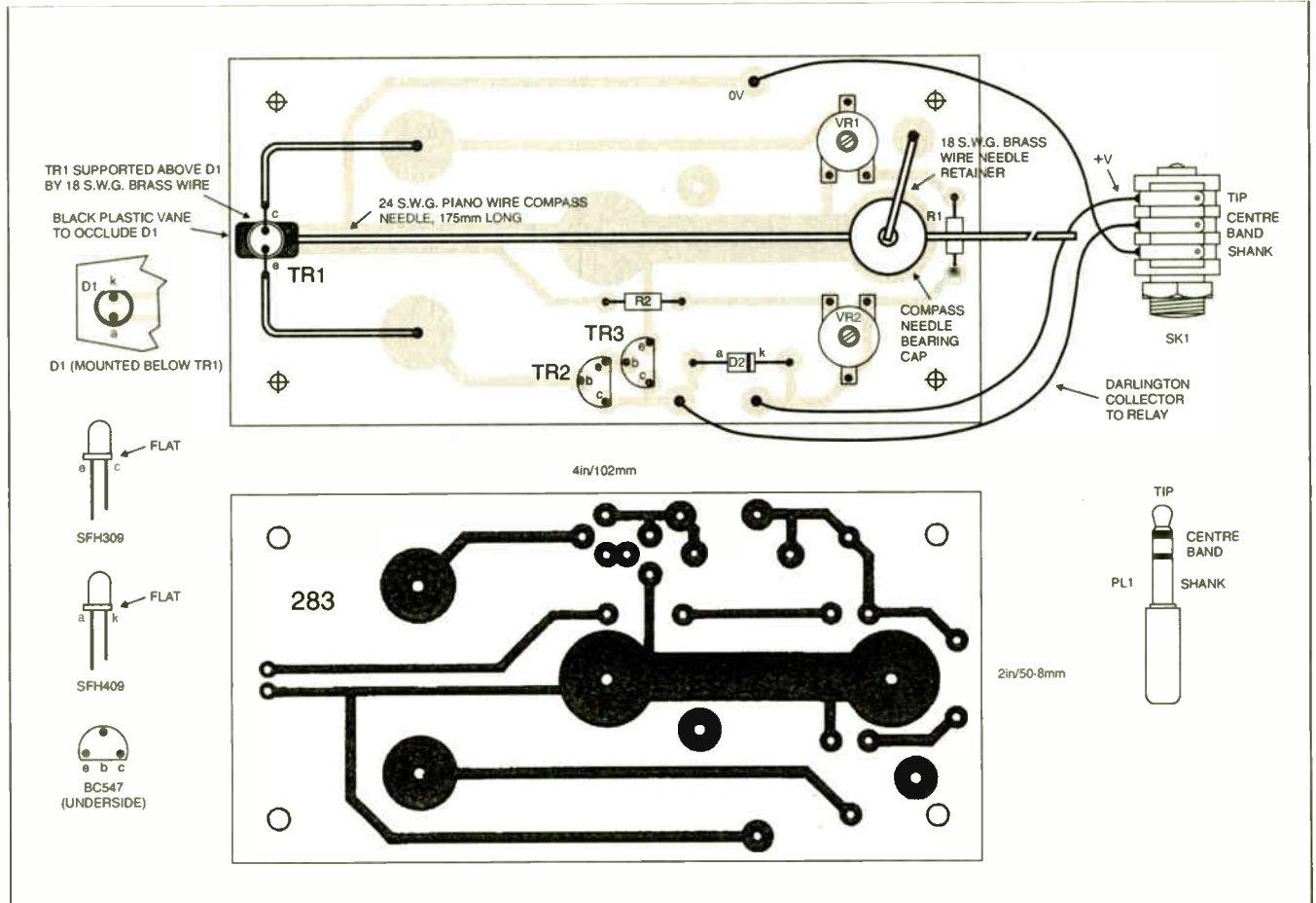


Fig. 2. Magnetic Anomaly Detector printed circuit board details and wiring. Provision is made for a shorter, 100mm, compass needle to reduce unit size.

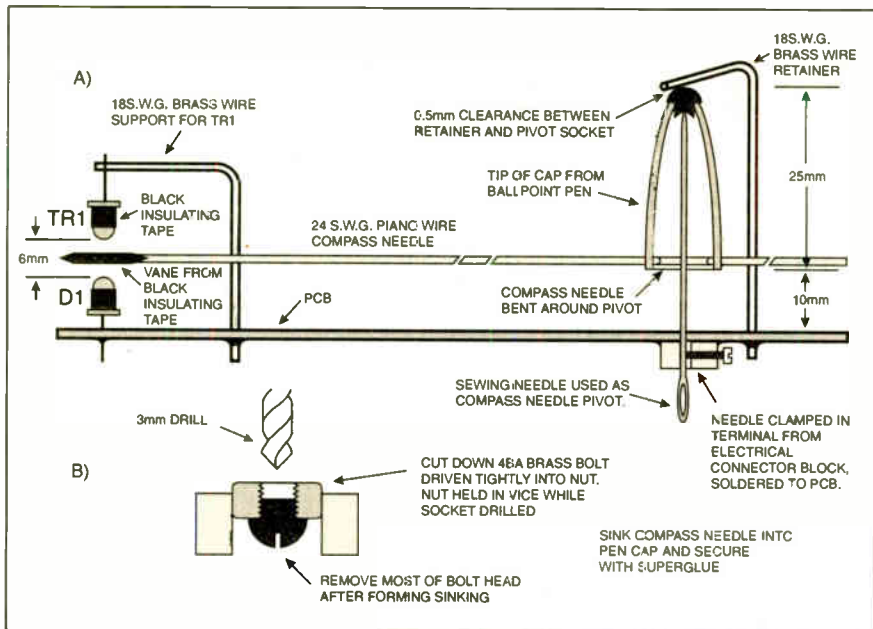


Fig. 3. Suspending the compass needle between the phototransistor and IR diode. (a) section through compass pivot and (b) how to centre the sinking for the pivot socket.

Most relays will operate at 75 per cent of their rated voltage, and a 9V supply should suffice if a 12V relay is fitted. Keeping the supply voltage as low as possible will help to minimise standby current.

Miniature relays are often polarised by the inclusion of a permanent magnet. They will only operate when the coil voltage is of the correct polarity.

MECHANICAL CONSIDERATIONS

Very little torque is needed to drive the pen carrier, and almost any small d.c. electric motor should be satisfactory. Motors salvaged from battery operated tape recorders have a low current drain and this makes them particularly suitable.

Relay and motor operating voltages should roughly match, but the demands on the motor are so light that a 12V unit will usually deliver sufficient torque when supplied with 6V or even less.

Brass wire is used for limit switches, guides and supports, and piano wire is used for the compass needle. Brass strip is ideal for the pen carrier and spindle brackets.

Materials of this kind, together with small motors and reduction gears, are retailed by most model shops. All of the other components required to construct the units, with the exception of brass and steel wire (and Bird's Custard), are readily obtainable from many electronic suppliers (this month's *Shoptalk* page discusses some options).

A permanent bar magnet is needed to magnetise the compass needle. The rectangular ferrite units in cheap door catches are ideal. They are usually mounted in a plastic housing which is easy to prise open. Note that one large face is the north seeking pole, the other the south. These catches are retailed by almost all DIY stores.

CONSTRUCTION

Most of the components, including the compass needle, relay and pen drive motor, are mounted on printed circuit boards (p.c.b.s). This makes the construction process easier and should ensure good results.

There are three p.c.b.s, one each for the Magnetic Anomaly Detector, Event Recorder and Audio Alarm. These boards are available, as a set, from the *EPE PCB Service*, codes 283, 284 and 285 respectively.

Terminal pins, inserted at the lead-out points, will simplify the task of inter-board wiring, and holders (sockets) for IC1 and the relay are recommended. Mount the smallest components first, and solder the transistors and diodes into place last.

DETECTOR BOARD

Ferrous metals must be avoided in the construction of the Detector unit.

The only exceptions are the compass needle itself and the sewing needle which acts as its vertical pivot. Check doubtful items with the cupboard catch magnet. If non-ferrous jack plugs and sockets (PL1/PL2, SK1/SK2) cannot be obtained, adopt some other plug and socket system, or simply connect the cable directly to the board.

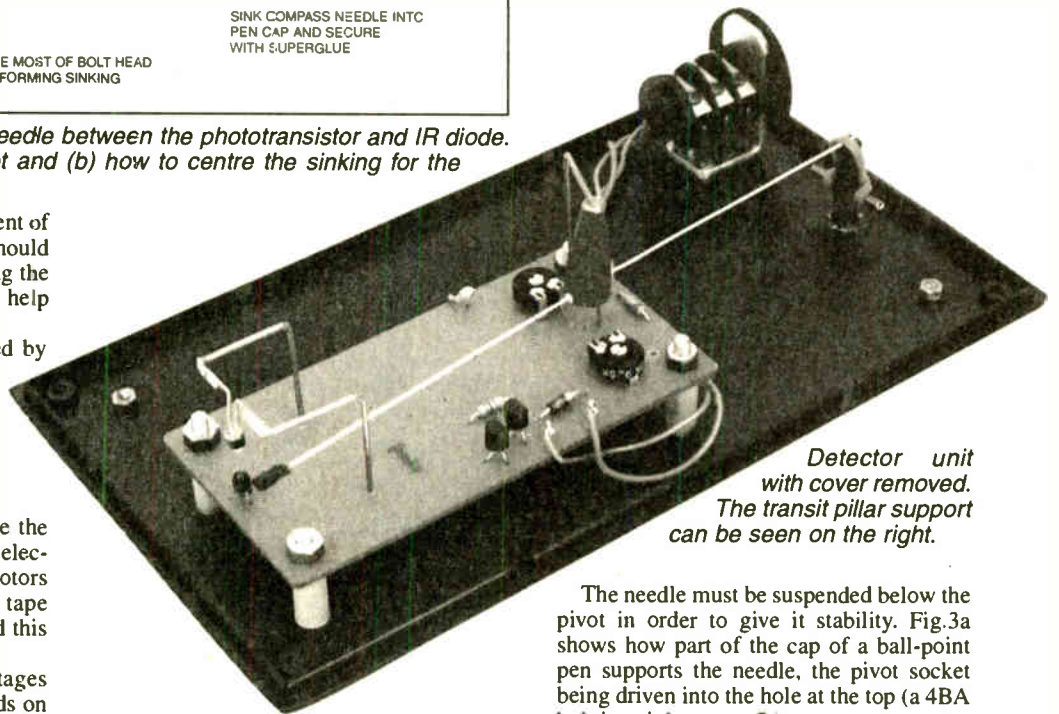
The component and track layout details of the Detector board are given in Fig. 2. Phototransistor TR1 is supported above infra-red diode D1 by brass wires, which also limit the swing of the compass needle. Ensure the correct orientation of the semiconductors.

The illustration in Fig. 3a shows how the vertical pivot is held in position by a grub screw and socket soldered to the underside of the p.c.b. The socket can be cut from an electrical terminal block (the type encased in polythene).

With this method of mounting, the height of the pivot is easy to adjust.

MAKING THE COMPASS

A long compass needle is more sensitive than a short one, and the prototype uses an 175mm length of 24s.w.g. piano wire. Thicker wire can be used, but this will increase the load (and the friction) on the pivot. Some readers may wish to construct a smaller unit, and a pivot point is provided on the p.c.b. for a shorter, 100mm needle.



Detector unit with cover removed. The transit pillar support can be seen on the right.

The needle must be suspended below the pivot in order to give it stability. Fig. 3a shows how part of the cap of a ball-point pen supports the needle, the pivot socket being driven into the hole at the top (a 4BA bolt is a tight screw fit).

Bend the compass needle around the pivot, sink it into two shallow slits cut into the pen cap, and secure it with superglue.

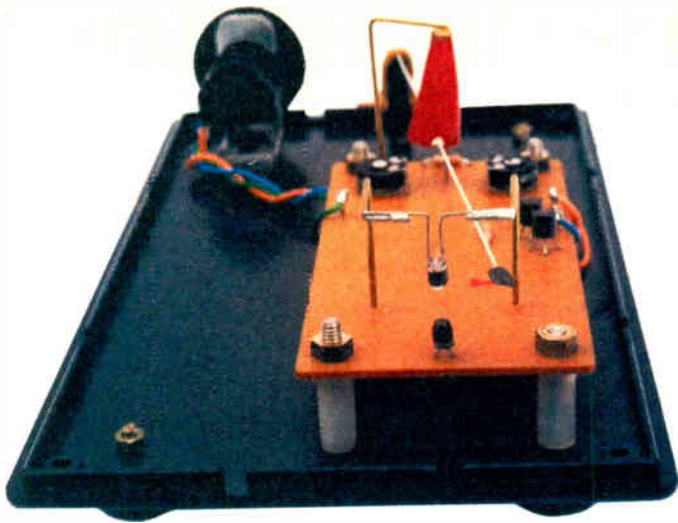
Centralising a socket in the end of a 4BA bolt can be tricky. Fig. 3b shows how this can be done. If a slight flat remains at the bottom of the socket after using the 3mm drill, gently, and briefly, apply a smaller drill to remove it. When the socket is satisfactory, file away the bulk of the bolt head to reduce weight.

If the needle dips, slide a 2mm length of insulation stripped from a thin wire along the high side to balance it. A brass wire retainer, bent over the pivot but kept just clear, holds the needle "cap" in place whilst the unit is in transit.

Draw one face (pole) of the cupboard catch magnet slowly down the compass needle, lift it well clear, then repeat the action, in the same direction. Piano wire is made from very hard steel which produces an excellent permanent magnet, and a dozen strokes should suffice.

BLOCKING INFRA-RED

Stick a fold (double thickness) of black plastic insulating tape at the north seeking end of the compass needle, and trim its width down to a little more than the diameter of the infra-red diode (D1).



Detector unit close-up, showing the phototransistor suspended above the infra-red diode.

It is a good idea to wind narrow strips of black tape around the bodies of the diode and phototransistor to ensure that the infra-red beam is contained within the diameter of the devices.

ENCLOSURE

The prototype is mounted in a 191mm x 106mm x 52mm (internally) black plastic box, and the finished unit is depicted in the photographs. The circular spirit level on top of the enclosure can be a help when setting up the unit, but is not essential.

In the photographed unit the compass needle has been painted white to make it stand out. In most of the shots it is secured by the rubber band, used to restrain it whilst the unit is in transit, to avoid a blurred image. The restraining arrangement comprises a short length of potentiometer spindle superglued to the base (see photos).

Note that quite low levels of light will raise the stand-by current appreciably, and may even trigger the relay. The enclosure must, therefore, be completely light-proof.

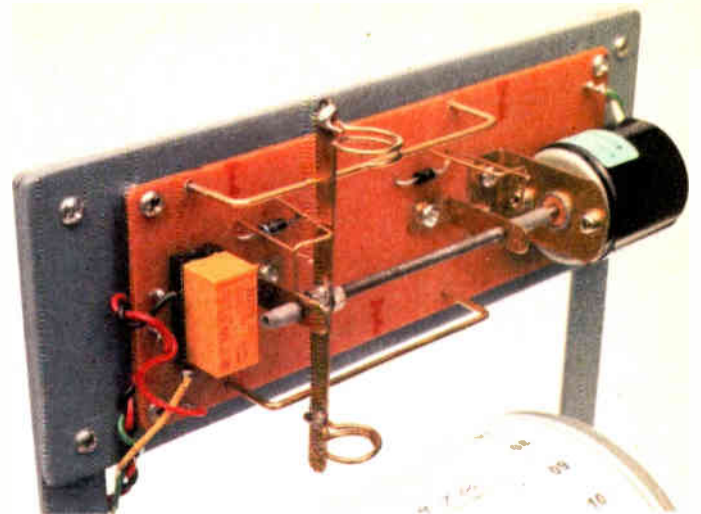
EVENT RECORDER

The component and track layout details of the p.c.b. for the Pen Drive unit are illustrated in Fig.5. There is sufficient space for a drive motor of any reasonable size, and the tracks will accommodate either of the standard dual-in-line (d.i.l.) relay bases illustrated in Fig.4. Other types of relay can be mounted on the p.c.b. and connected to it with hook-up wire.

Limit switches S1 and S2 are formed from 24s.w.g. brass wire. This material is springy and solders easily. After soldering into place, the switch leaves should be bent until they make a good, firm contact.

Nuts, soldered to the brass strip which carries the pen, enable the threaded rod to drive it from side to side. Clean and tin the strip and the faces of the nuts, then hold the items together on a greased 6BA bolt whilst the soldering iron is applied to sweat the items together. An 18 watt iron is more than capable of providing sufficient heat.

Support the rod with two angle brackets bolted to the p.c.b., and link the rod to the motor shaft with a short length of cable insulation. Care must, of course, be taken to ensure that rod and spindle are in alignment. Apply a little grease to the rod to ensure smooth operation.



Event Recorder pen drive printed circuit board and mechanical assembly.

Motor polarity (i.e., the supply connections for clockwise rotation), the orientation of the diodes, and the wiring to the relay which reverses the polarity of the supply, must all be carefully duplicated or the mechanism will not function.

DRUM AND DRIVE

The chart drum on the prototype is a Bird's Custard tin, but similar containers would be equally suitable. The drive gear is mounted on 6mm stand-offs to ensure that it clears the rim. Drum spindles are 6BA bolts with large washers to stiffen the fixings. Use drawing compasses to determine the precise centre of the lid and base.

Slots, cut down to the spindle holes in the brackets which support the drum, allow it to be lifted out for chart changing.

An inexpensive quartz clock movement drives the drum via 2:1 gearing to give a 24-hour rotation time. The spindle hole in the smaller gear must be gradually enlarged or reamed out until it is a good friction fit on the movement's hour shaft. Position the movement on the base box so that the gears mesh fully, but not tightly.

ENCLOSURE AND BASE

The Pen Drive unit p.c.b. is mounted on a hardboard panel supported above the drum by two brackets formed from 15mm x 2mm aluminium strip. The base of the unit is another 191mm x 106mm x 52mm plastic box. This houses the batteries, the Audio Alarm PCB, and the loudspeaker.

Control switch S3, toggle switch S4, indicator D5, and the input jack socket are mounted on one of the box sides. The arrangement is shown in the photographs.

Completed Event Recorder showing the pen drive assembly, chart drum and base containing the Audio/Visual Alarm components.

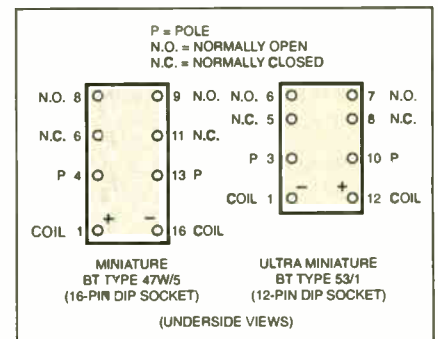
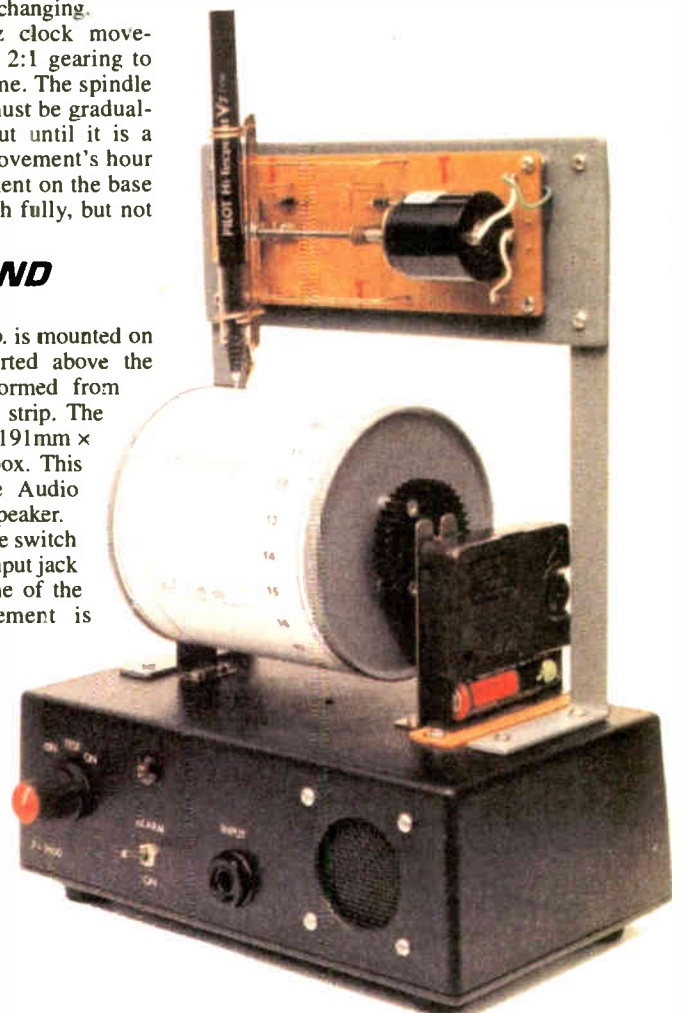


Fig.4. Relay pinout details.



EVENT RECORDER PEN DRIVE AND ALARM

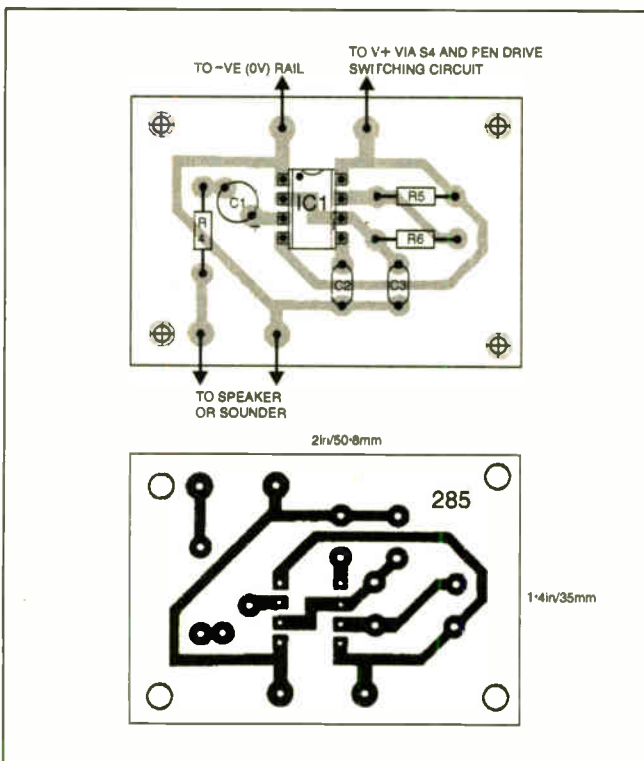
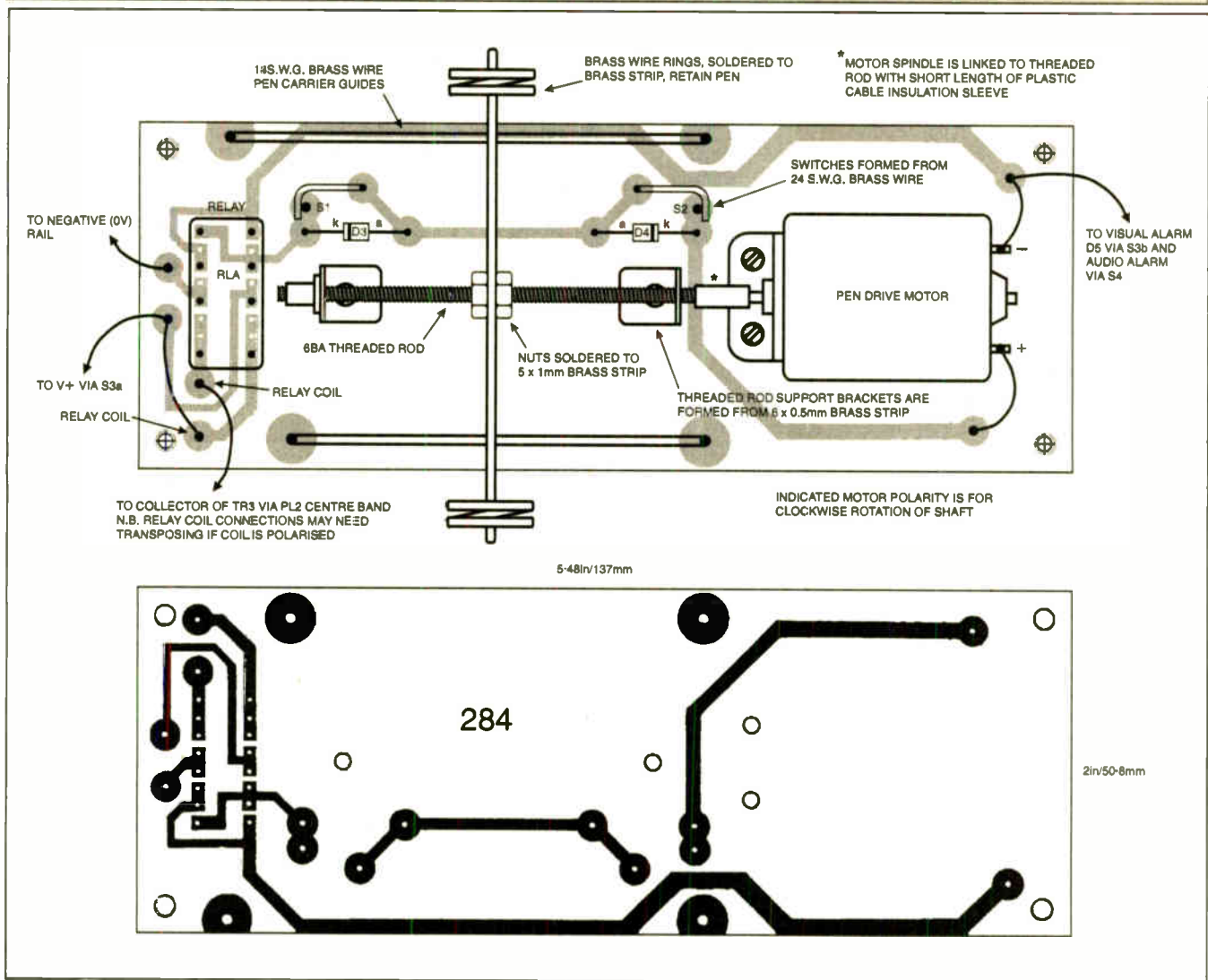


Fig.5 (above). Event Recorder printed circuit board wiring details, full-size foil master and pen drive mechanical assembly.

Fig.6 (left). Audio Alarm printed circuit board component layout, full size copper foil master and interwiring details.

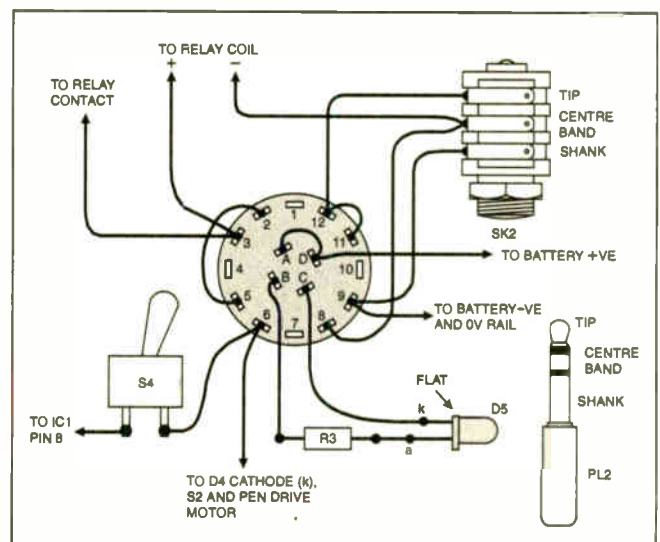


Fig.7. Interwiring details between switches, jack socket SK2 and alarm/diode D5.

ALARM UNIT AND SWITCHING

The Audio Alarm p.c.b. details are illustrated in Fig.6 and the wiring between switch S3 and other components in Fig.7. Switch contact numbering is that embossed in the switch's plastic case. Note that resistor R3 is mounted off-board between S3 and l.e.d. D5.

If a 12V supply is used, the value of the l.e.d.'s current limiting resistor, R3, should be increased to 1k2 ohms to avoid excessive dissipation.

SETTING UP

Power should be applied to the Pen Drive unit and the Audio Alarm to ensure that they are working correctly before building them into the recorder. Check the inter-board wiring and the wiring around S3. Remove the compass needle and disconnect the detector from the recorder, then proceed as follows:

1. Event Recorder

a. Switch the unit on (S3 fully clockwise), then temporarily link together the centre section and shank terminals of socket SK2 (connecting the negative pole of the relay to the 0V rail). Audio and visual alarms (LS1 and D5) should operate as the pen carrier moves to the right.

b. Remove the link. Alarms should cease when the carrier begins its return to the "at rest" position on the left.

c. Switch to the "test" position. The l.e.d. should light when the SK2 contacts are shorted as before. The pen carrier should remain stationary and the audio alarm silent.

2. Detector

a. Turn preset VR1 fully anti-clockwise (wiper to 0V rail) and VR2 clockwise (wiper to +VE), then connect the Detector to the Recorder. Switch the Recorder on.

b. With phototransistor TR1 illuminated (ambient light and infra-red from l.e.d. D1), advance VR1 until the relay is activated and the pen carrier moves to the right. Set VR1 as low as possible consistent with the reliable operation of the relay. Current drain with the relay on and l.e.d. D5 illuminated should be in the region of 40mA.



Audio Alarm p.c.b. Note the wire link replacing resistor R4.

c. Place a completely opaque barrier between D1 and TR1 and fix the cover over the detector to exclude all light. The relay should switch off and the pen carrier return to its rest position on the left. Current consumption should fall below 2mA.

d. Turn VR2 about 10 per cent anti-clockwise and remove the barrier between D1 and TR1. Replace the cover to check that the reduced infra-red level can actuate the relay. If it can't, advancing VR1 a little to increase detector sensitivity should make it trigger.

e. Continue this process until the unit will function reliably with both potentiometers turned as low (anti-clockwise) as possible. For a given set of transistors, there is a critical position for VR1 beyond which "on" current rises but sensitivity does not increase. Stand-by current should be no more than 250µA (0.25mA) when the procedure has been completed.

3. Full System

a. Place the compass needle on the pivot and orientate the detector so that the vane occludes IR l.e.d. D1. Replacing the cover will disturb the needle. With the unit switched to "test", l.e.d. D5 should flicker as the vane swings backwards and forwards over D1. When the needle settles, D5 should be extinguished (the 250µA stand-by current can produce a faint glow in sensitive l.e.d.s which is visible in low light levels).

b. Switch the system fully on. A weak magnet held 300mm to 600mm away from the

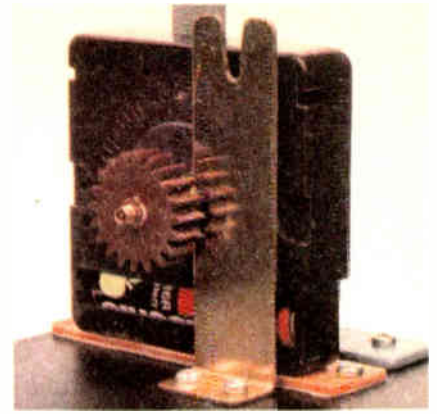


Chart drum removed to expose small gear on clock movement hour shaft.

detector should deflect the compass and trigger the relay.

c. Any failure of the compass needle to return to its original position when the magnet is removed will be due to imperfections in its pivot.

Select a sharp sewing needle for the pivot, and spin another needle inside the socket to polish it. Apply switch cleaner or lighter fuel to wash away debris. This will usually result in a satisfactory bearing.

d. Before orientating the detector, make sure the ambient magnetic field is stable. The slight movements of a typist's chair in front of the work bench were enough to trigger the prototype unit.

CHARTS

Wrap a strip of paper around the drum, mark the circumference, then divide it into 24 sections in order to produce a template for the charts. Two can be accommodated on a sheet of A4 paper for photocopying. Use the time setting wheel on the clock movement for the final positioning of the pen on the chart.

Connected to an appropriate detector, the unit can be used to record the time and duration of any event (frost, high or low water levels, intruders, etc.). If the events are infrequent, brief and random, the date can be written against the line on the chart and the same chart paper used for several days.

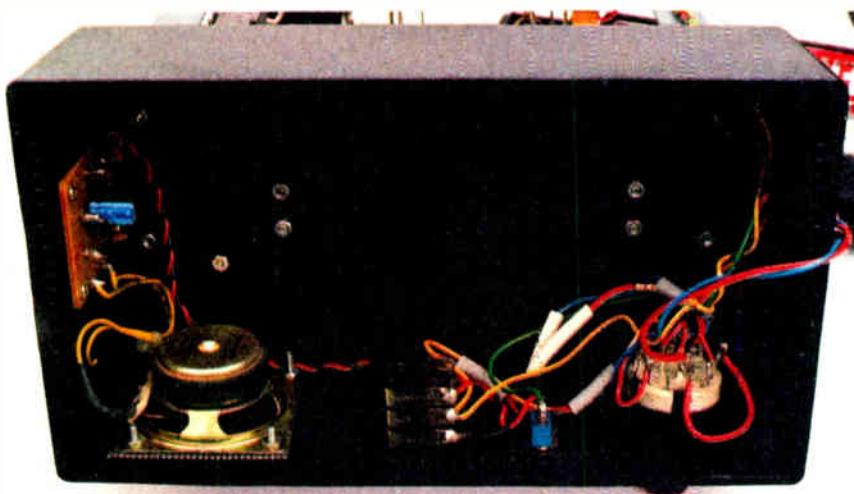
CONCLUSION

At the time of preparing this article, the unit has been operating constantly for several weeks. To date there have been no magnetic perturbations other than those induced for periodic testing. It would seem that aliens are currently missing out on the delights of South Yorkshire.

So called UFO "Hot Spots" in Great Britain include Warminster in Wiltshire (the self-declared UFO capital of the UK); Bonnybridge, Scotland; Grimsby, Lincolnshire; and Keighley and Scammonden, both in West Yorkshire.

Sightings have been reported recently in Abergavenny, Leeds, London, and Manchester. Details of "Hot Spots" worldwide, and recent sightings, can be gleaned from the many Internet web sites and magazines on the subject.

The equipment is relatively inexpensive and easy to construct. Keeping a round-the-clock watch with it could expose your town or village as another UFO "Hot Spot". □



Internal component layout inside the Event Recorder base.

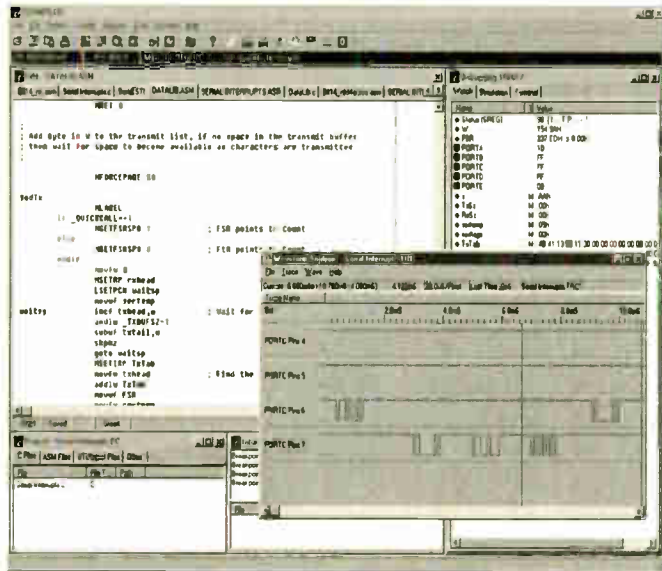
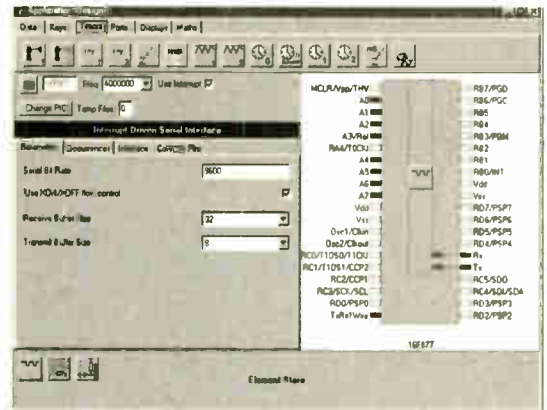
NEW From FED - PIXIE - Visual PIC C Development

Fully featured C Compiler with drag 'n drop components

PIXIE



- An application designer for the FED PIC C Compiler FULLY including the PIC C Compiler
- Drag a software component on to your design
- Set up the parameters using check boxes, drop down boxes and edit boxes (see shot right).
- Connect the component to the PIC pins using the mouse
- Select your own C functions to be triggered when events occur (e.g. Byte received, timer overflow etc.)
- Generate the base application automatically and then add your own functional code
- Supports all 14 bit core PICs, 16F87x, 16C55x, 16C6x, 16F8x, 16C7xx etc.
- Complete development environment includes editor, compiler, assembler, simulator, waveform analyser, and terminal emulator. (Screen below)

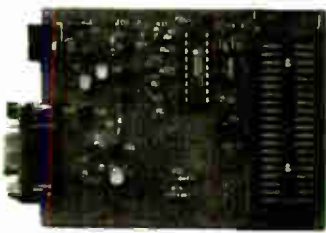


- Components include -
- Software driven serial interfaces
- Fully buffered hardware driven serial port with XON/XOFF signalling
- Display drivers - LCD, 7 Segment
- Switches and keypads with debounce/repeat
- Timers and clocks
- I²C, Clocked and Dallas 1 wire buses
- Component and event interfaces to PIC hardware
- Includes Element editor to create your own components
- C Compiler designed to ANSI C Standards
- Link into MPLAB

Prices

PIXIE with Introductory manual (C Manuals on CD) - £70
C Compiler with all manuals on CD ROM - £60,
C Compiler manuals (paper copy) - £10.00
 Buy PIXIE with WIZPIC or our Programmer - **£50.00** CD-ROM
Upgrade - C Compiler users, **£15.00**
Upgrade - WIZPIC/FED PIC Programmer users, **£50.00**

PIC & AVR Programmers



PIC Serial Programmer (Left) Including 18Cxxx

Handles serially programmed PIC devices in a 40 pin multi-width ZIF socket. 16C55X, 16C6X, 16C7X, 16C8x, 16F8X, 12C508, 12C509, 16C72XPIC 14000, 16F87X, 18Cxxx etc. Also In-Circuit programming. Operates on PC serial port
Price : £45/kit
£50/built & tested

PIC Introductory - Programs 8 and 18-pin devices : 16C505, 16C55X, 16C61, 16C62X, 16C71, 16C71X, 16C8X, 16F8X, 12C508/9, 12C671/2 **£25/kit**.

AVR - AVR1200,2313,4144,8515, 8535, 4434 etc. in ZIF. 4.5V battery powered. **Price: £40 for the kit or £45 built & tested.**

All our Programmers operate on PC serial interface. No hard to handle parallel cable swapping! Programmers supplied with instructions, + Windows 3.1/95/98/NT software. **Upgrade programmers from our web site!**

Forest Electronic Developments

60 Walkford Road, Christchurch, Dorset, BH23 5QG.
 Email - info@fored.co.uk, or sales@fored.co.uk

Web Site - <http://www.fored.co.uk>

01425-274068 (Voice/Fax)

Prices are fully inclusive, Add £3.00 for P&P and handling to each order. Cheques/POs payable to Forest Electronic Developments, or phone with credit card details.

WIZPIC now with 18Cxxx

PIC Visual Development



- Rapid Application Development for the PIC microcontroller
- Drag and drop your software component selections on to your design
- Included components support timers, serial interfaces, I²C, LCD, 7 Seg displays, keypads, switches, port controls, and many more.
- Connect software components to PIC pins by point and click using the mouse
- Set parameters for each component from drop down list boxes, check boxes, or text entry
- Links your code automatically into library events
- Up to 10 times faster than MPLAB
- Supports all 14 bit core PIC's - 12C67x, 16C55x, 16C6x, 16C7x, 16C8x, 16C87x, 18Cxxx, etc

Cost - CD-ROM with Data sheets and application notes - £35.00, Floppy version £30.00.

18C452

New architecture (more Instructions + Hardware multiply), 40MHz clock, 16K program words, 1536 bytes RAM. Easy to upgrade from 16F877

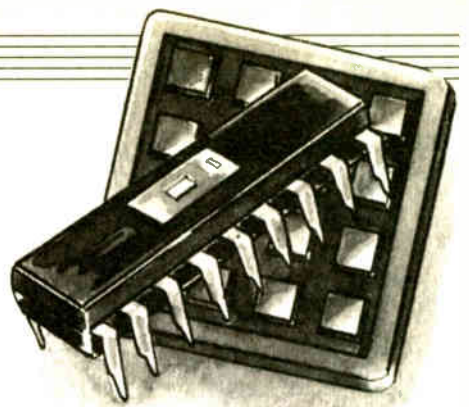
18C452/JW £20.00
 18C452/OTP £8.00



Special Feature

USING PICS AND KEYPADS

JOHN BECKER



How to interface your PIC to matrixed keypad switches plus an l.c.d.

READERS' questions about PICs cover many subjects but one that occurs with moderate repetition is how they can monitor matrixed keypad switches. Since for every question asked there are probably scores of readers who would also like it answered, we shall now attempt to do just that with this one!

MATRIX SWITCHES

Two of the matrix switch types readily available are those shown in the photographs. Photo 1 shows a standard 4 x 4 keypad, often referred to as being for "data entry". In Photo 2 is shown a 3 x 4 "self-adhesive membrane keypad", which is also available as 4 x 4 and 1 x 4.

A schematic diagram of the internal connections of the 3 x 4 keypad in Photo 2 is shown in Fig.1. The 4 x 4 self-adhesive version is the same with another column added.

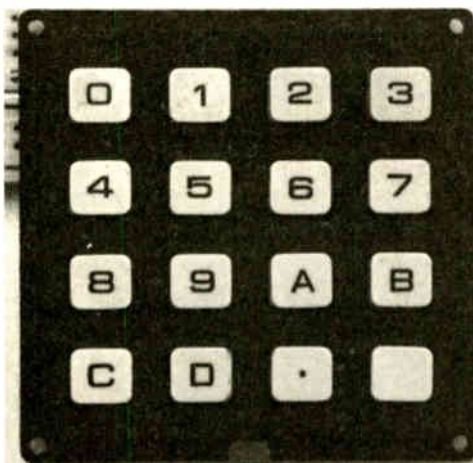


Photo 1. Standard "data entry" 4 x 4 keypad, with legends re-arranged by the author (see text).

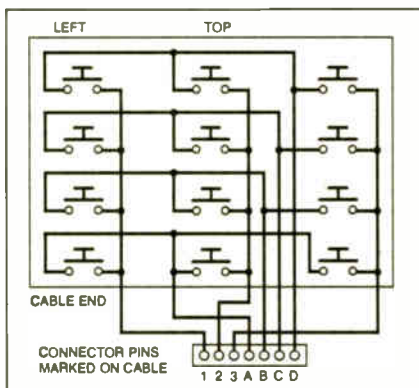


Fig. 1. Internal connections of the 3 x 4 keypad in Photo 2.

Each column has one side of its switches connected to a "bus" line common only to that column. Similarly, each row has the other side of its switches connected to a bus, one for each row. There are thus seven buses brought out to a connector for the 3 x 4 keypad, and eight for the 4 x 4. The "data entry" keypad has similar connections but also has a ninth connection, which is used to ground (earth) the frame of the assembly.

Membrane keypads use a special type of ribbon cable that integrally connects them to a 0.1 inch-pitch pin-header socket several centimetres from the pad. This is formed



Photo 2. A 3 x 4 self-adhesive membrane keypad. The legends can be customised using "slide-in" tabs.

from a tough plastic strip on which the tracks are "printed", column tracks on one side, row tracks on the other. They are numbered for the columns, and lettered for the rows (as in Fig.1).

Your own customised legend strips can be used to identify the individual keys, inserted between the covering surface and

a separating layer. The example in the photograph shows the legends for the author's EPE Time Machine (Nov '97).

Data entry keypads have their connections made to a 0.1 inch-pitch 9-pin connector block on the rear panel, numbered as shown in Fig.2a, and allocated as in Fig.2b.

The pads of the data entry type have legends moulded into their tops, probably the character set shown in the photograph. It is worth noting, though, that it is possible to carefully unscrew the rear panel of the keypad and rearrange the pad order. Such has been done with the pads in the photograph. Component catalogues typically show a different order.

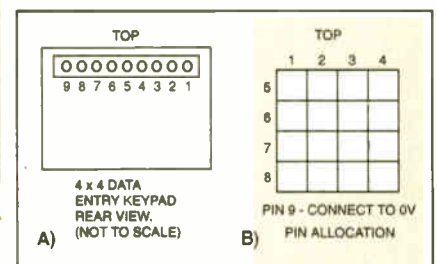


Fig. 2. Data entry keypad pin arrangement and numbering.

When any switch is pressed, it connects together one column track and one row track and an electrical current has to flow from one to the other. There is, however, no inhibiting arrangement to prevent two or more switches being pressed simultaneously, with consequent connection of several tracks.

In a normal paired connection, knowing the source of the current for one track and the destination of the other allows each key to be pressed and for circuitry to respond and recognise which key is active. This is where the problem lies for those readers who have queried the method required and how their PICs should be programmed to achieve it.

CIRCUIT CONSIDERATIONS

As with all programming problems, there are many ways in which a solution can be reached. We shall illustrate one way in which the keypad can be monitored by a PIC16x84, while it is additionally used to output data to an alphanumeric liquid crystal display (l.c.d.). The circuit diagram for the demo is given in Fig.3. Only the connections relevant to this discussion are shown.

Consequently, to allow the program to speedily resume its other activities if the keys are not pressed, the overall keypad status is first examined. If no keys are pressed, the routine is exited.

For this first check PORTA is set for all outputs low (even RA4 which is not used, although if it were used for some other purpose, it might be preferable to set low only RA0 to RA3, e.g. `MOVLW %000x1111`, `MOVWF PORTA` (where x can be 0 or 1)).

The PIC requires a delay of one clock cycle between ports being written to and then read, otherwise the read value could be erroneous, hence the NOP command following `CLRF PORTA`.

PORTB is read with the command `COMF PORTB,W` which pulls the data into the W register as an inverted value since the port is normally biased high. It is the low status of any PORTB pin which indicates a key press, but it is easier to check if none of the switches are pressed (all RB0 to RB3 high) by inverting the value and looking for a zero condition.

Bits 0 to 3 are isolated from the full 8-bit PORTB value with the `ANDLW %00001111` (decimal 15) command, and then the zero condition is looked for, with a return to the main program if it exists.

If the value is not zero, then at least one of the keys is pressed. The next routine then finds out which one.

There are many ways in which this can be done, for example:

- poll each pin in turn
- read both port values and use look-up tables
- a mixture of both

It is the latter process that is shown in Listing 2.

Adventurous readers might care to see if they can write a simpler routine to do the same thing, sending a listing to the Editorial office to possibly share with other readers through *Readout* – a nice challenge (but no prizes – just the satisfaction of achievement!)

GETTING KEYPRESS

The key-getting routine in Listing 2 starts off by setting RA0 to RA2 high and RA3 low. Column counter COL is then cleared.

Next starts a loop (GK2) that is repeated until either the pressed switch is found, or the limit of four cycles is reached. Note that although the test at GETKEY showed a key to be pressed, it is possible that it might have been released by the time GK2 is in progress.

PORTB is then read, as an inverted value. Its bits 0 to 3 are isolated and a check for zero is made. If the result is zero, the active row has not been found. In this case the loop has to be repeated. First the column count (COL) is incremented, and the value in PORTA rotated right by one place, on this occasion in the loop to allow RA2 to become an active control line.

It does not matter that RA3 remains low because its influence has already been proved to be ineffective.

It should be noted, however, that if RA4 is in use as an output in another application, the rotate right command affects that pin as well. Should this be significant, it would be better to use a named register to hold the value that needs to be output to

LISTING 2. Switch monitoring routines.

```

MAINPROG:
  CALL GETKEY           ;get keypress, if any
  GOTO MAINPROG

GETKEY:
  CLRF PORTA           ; all PORTA low
  NOP                  ; pause to allow PORTA to stabilise
  COMF PORTB,W         ; get & invert PORTB
  ANDLW %00001111     ; isolate bits 0-3
  BTFSC STATUS,Z      ; is result NOT zero (keys pressed)?
  RETURN               ; no, so return to main prog
  MOVLW %00000111     ; yes, a key is pressed so get it
  MOVWF PORTA         ; initial val for PORTA
  CLRF COL             ; clear col number count

GK2:
  COMF PORTB,W         ; get & invert PORTB
  ANDLW 15             ; isolate bits 0-3
  BTFSS STATUS,Z      ; is result NOT zero (keys pressed)?
  GOTO GK3             ; yes
  INCF COL,F           ; no, so increment col val
  RRF PORTA,F         ; rotate PORTA right
  BTFSC STATUS,C      ; is Carry zero?
  GOTO GK2             ; no, so repeat
  RETURN               ; yes, so return to main prog

GK3:
  MOVWF STORE         ; store isolated PORTB value
  CLRF ROW             ; clear row number count

GK4:
  RRF STORE,F         ; rotate right PORTB store val
  BTFSC STATUS,C      ; is carry flag set?
  GOTO SUMIT          ; yes so key pressed, go & finish answer
  MOVLW MATRIX        ; add matrix val to ROW count
  ADDWF ROW,F
  GOTO GK4

SUMIT:
  MOVF COL,W          ; reverse column notation order
  SUBLW 3              ; by subtracting from 3
  MOVWF COL           ; store as column
  MOVF ROW,W          ; sum up results to single answer
  ADDWF COL,W         ; add ROW to COL (total of 0-15)
  CALL VALUE           ; convert val to allocated table character
  MOVWF ANSWER        ; store it
  CALL SHOWIT         ; show it
  RETURN              ; return to main program

```

PORTA, and to perform the rotation on that. The register value would then be moved into W, and bit 4 corrected to suit the needs of RA4 before outputting the value to PORTA.

Following the rotation of PORTA, its value is checked for zero which, if true, causes a return to the main program (four loop cycles having been completed). Whilst the rotate command (RRF) does not affect the Zero flag, it does affect the Carry flag, which takes on the value of the bit just rotated into it from PORTA.

Since PORTA (normally) only has one bit set, then if the Carry flag becomes set, it is because PORTA's set bit has been rotated into it, leaving RA0 to RA3 at zero. Consequently if Carry is set, the loop cycle is complete.

WHICH ROW?

Going back a few program lines to the isolation of PORTB bits 0 to 3, a non-zero result means that an active column has been found. The next question is which row is active, answered through the routine starting at GK3, to which the action jumps.

At GK3, the first command stores the isolated PORTB value in STORE, then the ROW counter is reset, after which the loop at GK4 is entered. Here STORE's value is

repeatedly rotated until the set bit within it is rotated into Carry, signalling that the active row has been found, and a jump to the summing routine at SUMIT is made.

If Carry is not set, the loop has to repeat, but before doing so the ROW counter value has to be increased by the same amount as the number of keypad columns (3 for a 3 × 4 keypad and 4 for a 4 × 4). The value to be added is held in MATRIX and needs to be .EQUated at the head of the program according to the keypad used (e.g. `MATRIX .EQU 3`, for a 3 × 4).

When the active bit is found and a jump made to SUMIT, the COL value is subtracted from three to relate the answer to a left-to-right column order (0 to 3 instead of 3 to 0).

Next the COL and ROW values are added to produce an answer (held in W) between 0 and 15 for a 4 × 4 keypad, or 0 and 11 for a 3 × 4. This could be used by any program as the final value required. However, the value can be converted to any other in the range 0 to 255 via a 16-jump look-up table, named VALUE.

In the demo program, table values representing ASCII characters 0 to 9 and A to F are allocated in numerical order. The table is called, a jump is made according to the total row plus column value, and a

LISTING 3. Preparation for outputting value to l.c.d.

```
SHOWIT:
PAGE1
CLRFB TRISB      ; PORTB as output (for display use)
PAGE0
MOVFB ANSWER,W
CALL LCDOUT      ; show character result
PAGE1
MOVLW %00001111
MOVFB TRISB      ; reset RB0-RB3 as inputs
PAGE0
RETURN          ; end of display
```

return made with the equivalent character held in the W register. This is stored in ANSWER, and a call made to the l.c.d. output preparation routine, at SHOWIT (see Listing 3).

In Listing 3, PORTB is reset so that all pins are outputs, the ASCII character held in ANSWER is pulled into W and a call to routine LCDOUT is made. This outputs the character to the l.c.d. screen, following which RB0 to RB3 are reset as inputs, and a return to the main program is made. End of mission!

DEMO PROGRAM

In the demo program, the l.c.d. also displays COL and ROW information (see photo). COL is displayed as a value between 0 and 3. ROW is displayed in hexadecimal as its MATRIX-incremented value, e.g. 1, 4, 8, <. The converted ASCII value is shown below VAL.

The l.c.d. controlling routines in the demo are those frequently used in the author's published PIC projects. They are discussed at length in the PIC Tutorial series (Mar-May '98), and in the PICtutor CD-ROM.



Example l.c.d. display (but using a different look-up table to that in the demo for the "VAL" result).

The software is written in TASM and is available from the Editorial office on 3.5-inch disk (for which a nominal handling charge applies). It is also available for free download from the EPE web site. See this month's Shoptalk page for more details.

PIC Toolkit Mk2 (May-June '99) is an ideal programmer for loading the software into a PIC16x84 and viewing it on an l.c.d. Toolkit also allows external hardware (such as a keypad and its resistors) to be connected to the PIC16x84 port pins. □

SHOP TALK

with David Barrington

UFO Detector and Event Recorder

As there appears to be some "alien" components required for the UFO Detector and Event Recorder project we shall try to take some of the mystery out of where to find them. For starters, most of the "hard-to-find" parts seem to be listed by Maplin (☎ 0870 264 6000 or www.maplin.co.uk).

The Siemens SFH309 photo-Darlington transistor and matching SFH409 infra-red diode came from the above company, codes CY86T and CY84F respectively. Although, as pointed out in the article, a variety of similar devices were all tried successfully in this circuit. Older photo-transistors may have a base lead which should be ignored or snipped back close to its body. The transistors should be no problem, you have a choice of the BC547, BC239 and 2N3711 which all worked well in the model. However, the relay must be capable of working within the confines of the 2N3711 maximum collector current (30mA approx.).

For the UK, the 4.5V coil BT 16-pin 47W and 12-pin 45W d.i.l. type relays should be widely stocked. However, the one in the model came from Maplin (code GU35Q) and is of Matsushita manufacture. Other low-voltage coil types would be: Fujitsu FBR46NG005 (12-pin) and IMO-NEC MR62-4-5SB (16-pin).

The author used standard 6.35mm (¼in.) plastic-bodied (barrel) stereo jack sockets and plugs to interconnect the two units together. Of course, you may prefer to solder the cable directly to Detector p.c.b. and Recorder unit, avoiding any problems of finding non-ferrous materials.

The quartz clock movement (crystal frequency 32.768kHz) came from Maplin, code YU49D, together with the spur gear set, code WC81C, and the optional circular spirit level, code BP61R.

This just leaves us with the low-voltage d.c. motor, p.c.b.s and hardware. The printed circuit boards are available as a set of three from the EPE PCB Service, codes 283, 284 and 285 (see page 77). You should find that nearly all the hardware materials are stocked by your local model shop.

We do not have the complete answer to the low-voltage pen drive motor, except to reiterate the author's comments that with so little drive torque needed, almost any small d.c. electric motor should do the job. You could try contacting Bull Electrical, J&N Factors and Greenweld, who sometimes have small low-voltage d.c. motors on "special offer".

Two-Way Intercom

All the components called up for the Two-Way Intercom project should be readily available and most of our components advertisers should stock suitable parts. The "biased" toggle switches come in a variety of combinations and are usually found listed under sub-miniature or miniature types.

Just one small word of warning regarding the transistors. When ordering, be sure to specify the suffix L after the type number as the pinout arrangements of other BC184 and BC214s are different.

The LM386N-1 low-voltage audio amplifier chip is a National Semiconductor device and appears to be widely stocked. The small printed circuit board is available from the EPE PCB Service, code 282.

Versatile Optical Trigger

We do not expect any buying problems to be encountered when putting together parts for the Versatile Optical Trigger, this month's Top Tenner project. The MOSFET device should be widely stocked, but if any readers do have trouble finding the VNK10KM device it is currently listed by Electromall (☎ 01536 304555 or <http://rswwww.com>), code 655-537. The MEL12 photo-Darlington transistor is stocked by Maplin (☎ 0870 264 6000 or www.maplin.co.uk), code HQ16R.

Using PICs and Keypads

The software for the Using PICs and Keypads feature is written in TASM and is available on a 3.5in. PC-compatible disk (EPE Disk 4) from the EPE Editorial Office for the sum of £3 each (UK), to cover admin. costs. (For overseas charges see page 77). It is also available free via the EPE web site: [ftp://ftp.epemag.wimborne.co.uk/pubs/PICs/PICkeys](http://ftp.epemag.wimborne.co.uk/pubs/PICs/PICkeys).

PIC-Monitored Dual PSU – Part 2

All sourcing problems regarding components for the PIC-Monitored Dual PSU were ironed out and given in Part 1, last month. This month's article deals with final construction and running of the software, plus details of a Simple PSU.

For the Simple PSU version (without PIC monitoring), intended to supply a "down-rated" fixed or variable supply, a much less robust (cheaper) mains transformer, with a single 9V secondary winding, rated anywhere from 100mA up to about 250mA or even 1A, can be used. Likewise, the working voltage of the smoothing capacitor C1 can be reduced to around 25V in this version. Note, however, that the voltage regulator should still be bolted to the metal case, using a TO220 insulating kit, as in the "full" PSU model.

The same power supply board is used for the Simple PSU version as the main unit, except only about half the p.c.b. is populated with components. The code for this printed circuit board is 280 and is obtainable from the EPE PCB Service, see page 77.

PLEASE TAKE NOTE

Festive Fader (Christmas Supplement)

Dec '00

Page 8. Circuit diagram, Fig.3. The unconnected lead from the mains input "live" should run horizontally across the circuit to link up with the unconnected lead running down to the junction of R8/MT2. The p.c.b. is correct.

Also, the values of capacitors C3 and C6 on the circuit diagram should be 1µF multi-layer ceramic. The parts list is correct (also, see Shoptalk Dec '00). Although not listed by Farnell (☎ 0113 263 6311), we understand that they stock the Dagnell D3607 3VA, p.c.b. mounting, mains transformer as used in the prototype, code 330-3809.

High Performance Regenerative Receiver

March/April '00

Page 301, April '00. Main Receiver printed circuit board copper foil master, Fig.5. As shown, all the leadout pads for the dual-gate MOSFET (TR3) are connected together by the "circular track" (just above the p.c.b. number), shorting out all TR3's pins and stopping it operating. To remedy this error, the thin copper circle should be cut away, and the thicker tracks can be trimmed back to their first solder pads if you wish.

New Technology Update

"Going Organic", takes on a new meaning with the introduction of organic lasers. Ian Poole reports.

LASERS are now used in many areas of electronics technology. In consumer electronics some of the most widespread examples are in compact discs for hi-fi systems and computers and for the light pointers often used for giving presentations using overhead slides. They also find uses in medical surgery, and some areas of i.c. manufacture.

Lasers are also widely used for optical communications. Here they generate the coherent light that is sent along optical fibres enabling very wide data bandwidths to be achieved. In this respect they offer a much greater capacity than their radio frequency equivalents. Now with the increased requirements for data bandwidth and speed that has arisen from the use of the Internet, optical communications and hence lasers are in much greater demand.

Lasers operate by a phenomenon called "stimulated emission" that was first postulated by Albert Einstein before 1920. Although a number of mediums including gases, liquids and amorphous solids can be used for lasers the first ones were realised in 1960 using rubies. A helium-neon gas laser followed this in 1961 but it was not until 1970 that semiconductor lasers were made to run at room temperature.

Today semiconductor diodes are in widespread use, but new developments in semiconductor technology mean that new forms of diode are beginning to appear.

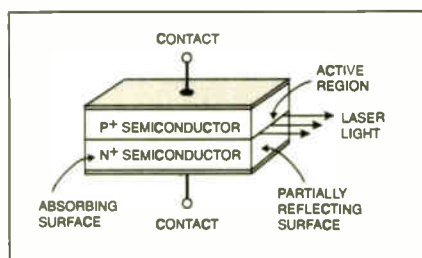


Fig. 1. Basic structure of a laser diode.

Semiconductor Diodes

Before looking at the new developments it is worth taking a view of today's traditional Gallium Arsenide diodes to see how they operate.

The semiconductor diode is constructed as shown in Fig.1. It consists of heavily doped $n+$ and $p+$ regions. For manufacture it is normal to start with an $n+$ substrate and then the top layer can be grown onto this. Doping can be introduced in a variety of ways, either by diffusion, ion implantation or deposited during the epitaxy process.

A variety of materials can be used for laser diodes, although the most common starting substrates are Gallium Arsenide

(GaAs) and Indium Phosphate (InP). These are known as type III-V compounds because of their places in the chemical periodic table of elements. Whatever material is used, it must be possible to heavily dope it as either a p type or n type semiconductor. This rules out most of the type II-VI materials, leaving the group III-V materials as the ideal option.

Apart from the basic semiconductor requirements, there are a number of optical requirements that are needed to enable the laser diode to operate. For starters, it needs an optical resonator. This must occur in the plane of the required light output. To achieve this the two walls of the diode that form the resonator must be almost perfectly smooth, forming a mirror surface from which the light can be reflected internally. One of the walls is made slightly less reflecting to enable the light to come out from the diode.

Another requirement is that the two mirror surfaces must be perfectly perpendicular to the junction, otherwise the laser action does not occur satisfactorily. The two other surfaces perpendicular to the one of the required light output are roughened slightly to ensure that the laser action does not occur in this plane as well. In this way a resonant optical cavity is created. Although it is many wavelengths long it still acts as a resonant cavity.

Going Organic

Today many new materials are being used in semiconductor devices. One exciting development being undertaken at Bell Labs in New Jersey USA is into the use of organic semiconductors.

Recently they announced that they have demonstrated the first laser using the organic semiconductor material Tetracene. It has been known for some time that this family of materials demonstrates some of the attributes required for laser action. However, this is the first time that it has been demonstrated.

This development is particularly important because it was previously thought that organic materials would not be capable of supporting the very high current densities required in laser diodes. Tetracene is a very suitable form of organic semiconductor because the electron and hole mobilities that it offers are particularly high – around $2\text{cm}^2/\text{Vs}$ at room temperature.

Its four benzene rings enable it to conduct electricity very well. A further advantage is that Tetracene absorbs very little light and this enhances the lasing effect and the light output.

In addition to this, they are cheaper to manufacture than their more traditional

counterparts. This means that once the development of these organic semiconductors is established the manufacture of lasers will be much cheaper. Currently laser diodes are quite expensive, as anyone replacing a laser diode in a CD player will be able to testify.

Manufacture and Operation

Tetracene is grown as a single crystal using vapour phase techniques. Field effect device structures are then grown onto the crystal surface as shown in Fig.2.

Source and drain structures are added with a channel length of about 25 microns and width of several hundred microns. An amorphous layer of aluminium oxide is then sputtered onto the crystal and then an aluminium doped zinc oxide gate is added on top of this.

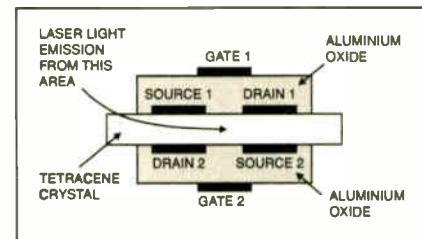


Fig.2. Tetracene laser diode structure.

Essentially the device consists of two field effect devices that enable holes and electrons to be injected into the Tetracene crystal. Carrier concentration in the channel region is determined by the voltage on the gate.

More specifically, holes are injected into the laser area of the device by applying a positive source-gate potential to the bottom of the device and a negative source-gate potential at the top. The potentials are also arranged so that a potential of approximately 5V is applied across the Tetracene crystal, whilst up to 50V can be applied to the gates. This enables carrier densities of about $10^{13}/\text{cm}^2$ to be achieved.

The current flowing across the Tetracene crystal causes light to be emitted. To enable laser light to be generated there are reflecting surfaces at either end of the device. In this way the light is reflected back inside the device causing it to become an optical resonator and this results in further coherent light being emitted.

In The Future

As the new organic lasers will be so much cheaper than their traditional counterparts it opens up many new areas in which they might be used. They could be tailor-made to suit individual applications.

For further information about these lasers refer to www.bell-labs.com.

*All in all, it can be
thoroughly recommended.*

Everyday Practical Electronics - 10/2000

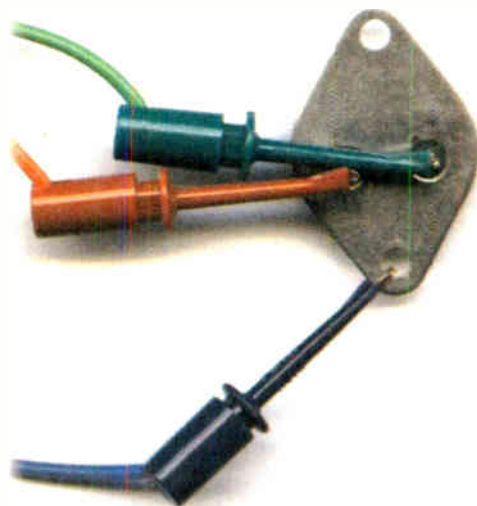
A must-try product

Farnell - 9/2000



What does it offer?

- Automatic component identification
- Pinout identification
- Important parameter measurement
- Clear scrollable pages
- No nonsense simplicity and power



What components are supported?

- Bipolar transistors
- Darlington transistors
- Diode protected transistors
- Resistor shunted transistors
- Enhancement mode MOSFETs
- Junction FETs
- Low power triacs and thyristors
- Diodes and diode networks
- LEDs including 2 lead and 3 lead bicolours

We just know you will fall in love with this thing.

We Guarantee it!!

Contact us for a comprehensive data pack. Alternatively, order a Peak Atlas and you can just send it back to us for a full refund if you are not happy for any reason.

You can pay using a cheque, postal order, credit or debit card. Please contact us for overseas or volume orders - you will be pleasantly surprised.

peak electronic design limited

From UK
Tel. 01298 70012
Fax. 01298 22044

From Outside UK
Tel. +44 1298 70012
Fax. +44 1298 22044

Internet
Web: www.peakelec.co.uk
Email: sales@peakelec.co.uk

West Road House,
West Road,
Buxton, Derbyshire,
SK17 6HF, UK.

SURVEILLANCE

Electronic Surveillance Equipment Kits from the UK's No.1 Supplier

SUMA DESIGNS has been supplying professional quality electronic surveillance equipment kits for over 20 years. Whether your requirement is hobbyist, amateur or professional you can be sure that you are buying from a company that knows the business. We ONLY sell surveillance products, no alarms, disco lights or computer bits. All of our kits are designed for self assembly and are well tried, tested and proven. All kits are supplied complete with top grade components, fibreglass PCB, full instructions, circuit diagrams and assembly details. Unless otherwise stated all transmitter kits are tuneable and can be received using an ordinary VHF FM radio.

UTX Ultra-miniature Room Transmitter

At less than 1/2 the size of a postage stamp the UTX is the smallest room transmitter kit in the world! Incredible 10mm x 20mm including microphone, 3-12V operation. Range up to 500m **£13.95**

MTX Micro-miniature Room Transmitter

Our best selling room transmitter kit. Just 17mm x 17mm including mic. Extremely sensitive. 3-12V operation. Range up to 1000m. . . **£14.95**

STX High-performance Room Transmitter

High performance transmitter with buffered output for greater stability and range. Measures just 22mm x 22mm including mic. 6-12V operation. Range up to 1500m. **£16.95**

VT500 High-power Room Transmitter

Our most powerful room transmitter with around 250mW of output power. Excellent range and penetration. Size 20mm x 40mm, 6-12V operation. Range up to 3000m. **£17.95**

VXT Voice-activated Room Transmitter

Triggers only when sounds are detected by on-board mic. Variable trigger sensitivity and on-time with LED trigger indicator. Very low standby current. Size 20mm x 67mm, 9V operation, range up to 1000m. **£21.95**

HVX400 Mains Powered Room Transmitter

Connects directly to 240V AC supply. Ideal for long-term monitoring. Size 30mm x 35mm, range up to 500m. **£21.95**

SCRX Subcarrier Scrambled Room Transmitter

To increase the security of the transmission the audio is subcarrier modulated. Receiver now requires the decoder module (SCDM) connected to allow monitoring. Size 20mm x 67mm, 9V operation, up to 1000m range. **£24.95**

SCDM Subcarrier Decoder for SCRX

Connects to earphone socket on receiver and provides decoded audio output to headphones. Size 32mm x 70mm, 9-12V operation. . . **£27.95**

UTLX Ultra-miniature Telephone Transmitter

Smallest kit available. Connects onto telephone line, switches on and off automatically as phone is used. All conversations transmitted. Size 10mm x 20mm, powered from line, up to 500m range. **£13.95**

TLX700 Micro-miniature Telephone Transmitter

Best selling kit. Performance as UTLX but easier to assemble as PCB is 20mm x 20mm. **£14.95**

STLX High-performance Telephone Transmitter

High-performance transmitter with buffered output for greater stability and range. Connects onto telephone line and switches on and off automatically as phone is used. Both sides of conversation transmitted up to 1000m. Powered from line. Size 22mm x 22mm. **£16.95**

PTS7 Automatic Telephone Recording Interface

Connects between telephone line (anywhere) and normal cassette recorder. Automatically switches recorder on and off as phone is used. Both sides of any conversation recorded. 9V operation, size 20mm x 67mm. **£21.95**

CD400 Pocket Size Bug Detector/Locator

LED and piezo bleeper pulse slowly. Pulse rate and tone pitch increase as signal source is approached. Variable sensitivity allows pinpointing of signal source. 9V operation, size 45mm x 54mm. **£34.95**

CD600 Professional Bug Detector/Locator

Multicolour bargraph LED readout of signal strength with variable rate bleeper and variable sensitivity allows pinpointing of any signal source. When found, unit is switched into AUDIO CONFIRM mode to distinguish between bugging devices and legitimate signals such as pagers, cellphones etc. Size 70mm x 100mm. 9V operation. **£59.95**

QTX180 Crystal Controlled Room Transmitter

Narrow band FM crystal transmitter for ultimate in privacy. Output frequency 173.225 MHz. Designed for use with QRX180 receiver unit. Size 20mm x 67mm, 9V operation, range up to 1000m **£44.95**

QLX180 Crystal Controlled Telephone Transmitter

Specifications as per QTX180 but connects onto telephone line to allow monitoring of both sides of conversations. **£44.95**

QSX180 Line Powered Crystal Telephone Transmitter

Connects onto telephone line, switches on and off as phone is used. Power is drawn from line. Output frequency 173.225 MHz. Designed for use with QRX180 receiver. Size 32mm x 37mm. Range up to 500m. **£39.95**

QRX180 Crystal Controlled FM Receiver

Specifically designed for use with any of the SUMA 'O' range kits. High sensitivity design. Complex RF front end section supplied as pre-built and aligned sub-assembly so no difficult setting up. Headphone output. PCB size 60mm x 75mm. 9V operation. **£69.95**

TKX900 Signalling/Tracking Transmitter

Transmits a continuous stream of audio bleeps. Variable pitch and bleep rate. Ideal for signalling, alarm or basic tracking uses. High power output. Size 25mm x 63mm, 9-12V operation, up to 2000m range. **£23.95**

MBX-1 Hi-Fi Micro Broadcaster

Connects to headphone socket of CD player, Walkman or Hi-Fi and broadcasts your favourite music around house and garden up to 250m. Size 27mm x 60mm, 9V operation. **£22.95**

DLTX/RX Radio Remote Switch System

Two kits, transmitter sends a coded signal (256 selectable codes) when button pressed. Receiver detects signal, checks code and activates relay. Can be set to be momentary or toggle (on/off) operation. Range up to 100m, 9V operation on both units. TX 45mm x 45mm, RX 35mm x 90mm. **£44.95**

TO ORDER:

Post, fax or telephone your order direct to our sales office. Payment can be Credit card (Visa or Mastercard), Postal Order, cash (please send registered) or cheques. Kits despatched same day (cheques need clearing). All orders sent by recorded or registered post. Please add postage as follows:

ORDER UP TO £30.00: To UK £2.50 To EUROPE £5.50 All other £7.50

ORDERS OVER £30.00: To UK £3.65 To EUROPE £7.50 All others call

Overseas customers please use credit cards or send sterling cheque or bank draft.



VISA

SEND 2 x 1st CLASS STAMPS FOR OUR 2000 KIT CATALOGUE CONTAINING FULL DETAILS OF THESE AND OTHER KITS.

A BUILD-UP SERVICE IS AVAILABLE ON ALL OF OUR KITS, DETAILS IN CATALOGUE. VISIT OUR WEBSITE: www.suma-designs.co.uk

Please note: Some of our part numbers are being unscrupulously used by other companies selling kits eg. MTX, VXT. DO NOT BE MISLEAD! These are NOT GENUINE SUMA KITS which are only available direct from us or our appointed distributors.

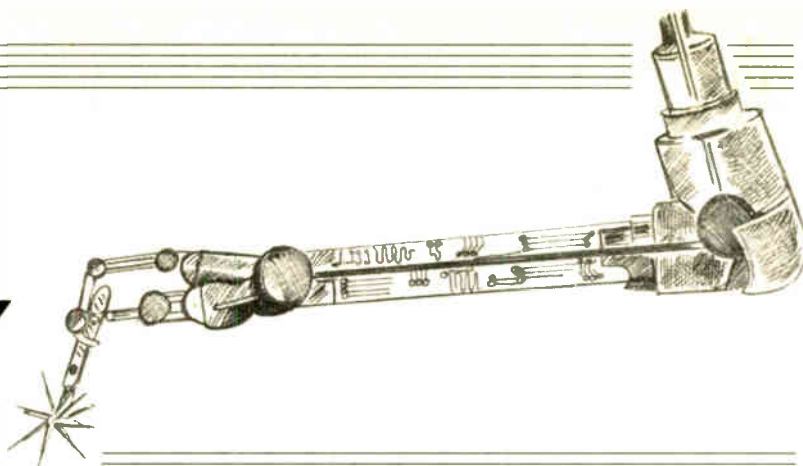
If you wish to collect kits direct from our office
PLEASE TELEPHONE

SUMA DESIGNS

Dept. EE, The Workshops, 95 Main Road,
Baxterley, Warwickshire, CV9 2LE, U.K.
Website: www.suma-designs.co.uk

TEL/FAX: 01827 714476
(24 HOUR ORDERLINE)
email: sales@suma-designs.co.uk

CIRCUIT SURGERY



ALAN WINSTANLEY
and IAN BELL

Our team of troubleshooters unravel the principles of voltage multiplier circuits.

LAST month we introduced a few ideas behind the use of simple inverter circuits including the Royer converter to produce higher voltages, and we outlined a few ways in which switched mode power supplies can be designed, highlighting the use of on-line design tools such as those provided by National Semiconductor (www.national.com/appinfo/power). In spite of the availability of these and other aids, designing a switched-mode power supply is not so easy especially if at the end of the day you're restricted to using off-the-shelf parts instead of expensive bespoke components.

Voltage Multipliers Analysed

Another way of generating higher voltages from a lower voltage source is to use a *voltage multiplier*. These are often easily spotted in circuit diagrams, as they typically consist of a network of diodes and capacitors which are used to step up the voltage in stages.

Voltage multiplying networks take an a.c. input and produce a d.c. output as a multiple of the peak a.c. voltage. Doublers, triplers, quadruplers etc. can be made, and they are most commonly used in very high voltage supplies.

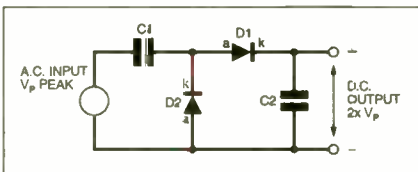


Fig.1. Circuit diagram for a half-wave or cascade voltage doubler.

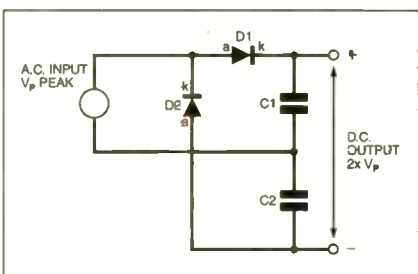


Fig.2. A full-wave voltage doubler circuit diagram. The d.c. output voltage is twice the a.c. peak input voltage.

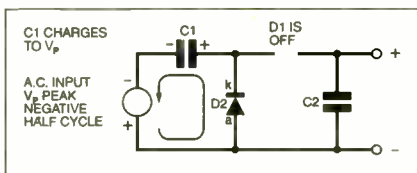


Fig.3a. During the negative half-cycle capacitor C1 charges to V_p via diode D2.

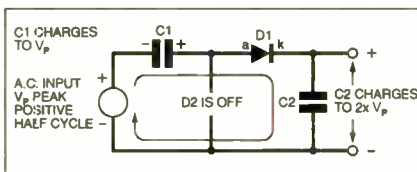


Fig.3b. During the positive half-cycle, capacitor C2 charges from C1 via diode D1 and the a.c. input to $2 \times V_p$.

However, they may seem a little difficult to understand at first. It helps to consider a couple of basic facts: first, an a.c. voltage connected to a capacitor, via a diode, will charge the capacitor to the **a.c. peak voltage** during one half cycle of the alternating cycle. The diode will be *reverse biased* in the other cycle and so the capacitor will *store the charge*, retaining the voltage across it.

Secondly, if we already have a capacitor which has been charged in one half-cycle, then (if we arrange the circuit correctly) the voltage stored on the capacitor will be **added** to the a.c. input voltage during the other half cycle. Thus, we obtain a maximum voltage in the circuit of **twice** the a.c. peak voltage – this is the basic operation of the *half-wave* or cascaded voltage doubler shown in Fig.1. Alternatively, we can charge two capacitors to the peak voltage, one in each half cycle – this is the basic operation of the *full-wave* voltage doubler shown in Fig.2.

Half-wave Doubler

The current “movements” in a half-wave doubler during the two half cycles of the a.c. input are shown in Fig.3.

In Fig.3a, capacitor C1 is charged to the peak a.c. voltage via diode D2 during the negative half cycle; D1 is off (reverse biased) because of the higher voltage that pre-exists on capacitor C2.

In Fig.3b, during the positive half cycle capacitor C2 (which carries the output voltage) is charged, via diode D1, **both** by the input voltage **and** the charge now stored on capacitor C1: these voltages sum to two times the peak voltage, rather like putting two batteries in series and applying them across C2.

Full-wave Doubler

In Fig. 4 we have shown how the currents flow in a full-wave doubler during the two half cycles of the a.c. input. Hopefully, this should make it clear that each capacitor is charged to the peak voltage, so that the output across the two capacitors in series is twice the peak voltage. In both these circuits the a.c. input usually comes from a transformer secondary, or even from the mains directly.

The half-wave circuit can be cascaded to give further multiples of input voltage, this in fact is the *Cockcroft-Walton* multiplier to which our reader, *Richard Tarpey*, referred last month. Fig.5 shows a voltage quadrupler of this form and Fig.6 shows a voltage

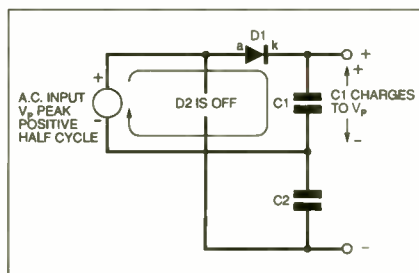


Fig.4a. In a full-wave doubler, during the positive half-cycle capacitor C1 charges to V_p via diode D1.

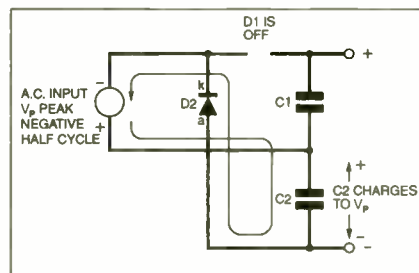


Fig.4b. During the negative half-cycle capacitor C2 charges to V_p via diode D2.

sextupler, no less, drawn in a format commonly used for this type of circuit. Considerable care must be taken when using voltage multipliers to make sure that the diodes and capacitors have sufficient voltage ratings to withstand the multiplied voltages.

Unfortunately, voltage multiplier circuits do not give very good regulation and they perform poorly with high loads. They are typically used for applications where very high voltages are required at reasonably low currents, or where some ripple can be tolerated, e.g. an ioniser circuit. Note that the multiplied voltage does not appear instantly at the output when power is applied – it takes several a.c. cycles to build up, and recovery from a loading peak will also take a while.

Clock this Clock

I bought an old American Howard Miller 1950's mains electric clock. The motor is 110V 60 cycles (Hz), 3 watts. I bought a Tacima voltage converter for small appliances rated at: input 220V/240V a.c. 50Hz/60Hz; output 110V/120V a.c. 50Hz/60Hz; maximum load 30VA.

The clock runs well but loses time at about 10 minutes every hour! I'm told this is because the US mains supply is 60 cycles (Hz), whilst UK mains is 50Hz. Is this correct? Thanks, from Peter Ball (by E-mail).

We're afraid so! Transformers are simply voltage-dropping or voltage-increasing devices which have no effect on the frequency of the alternating supply. The output frequency will be the same as the input,

Fig.5. Circuit diagram for a voltage quadrupler, this is a Cockroft-Walton multiplier.

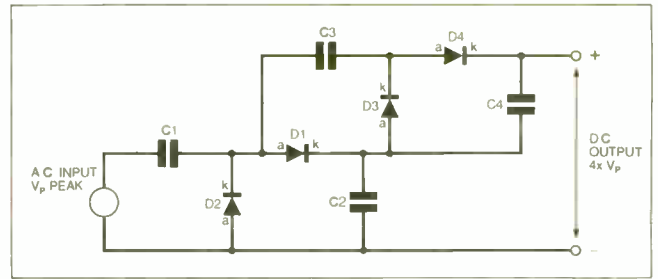
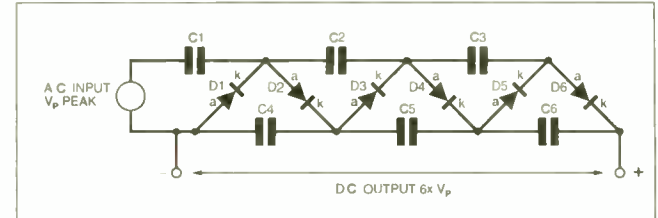


Fig.6. Cockroft-Walton voltage multiplier producing six times the a.c. peak input voltage.



so your clock will indeed run successfully at the UK voltage but also at its frequency.

The clock probably uses a "synchronous" shaded-pole motor – one whose speed is synchronised to the applied mains frequency. In the UK this is 50Hz (50 cycles per second) whilst in the USA it is 60Hz. So the clock is running slower by 10 cycles per second.

Running at 60Hz and ignoring any possible gearbox ratios, as far as the clock is concerned one minute equals 3,600 motor revolutions. Operating at 50Hz, one minute produces 3,000 revolutions. Running it on the UK supply over a period of an hour then, the clock will be slow by (216,000 – 180,000) = 36,000 revolutions, or ten "American" minutes. ARW.

CIRCUIT THERAPY

Circuit Surgery is your column. If you have any queries or comments, please write to: Alan Winstanley, *Circuit Surgery*, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. E-mail (no attachments) alan@epemag.demon.co.uk. Please indicate if your query is not for publication. A personal reply cannot be guaranteed but we will try to publish representative answers in this column.



A COMPLETE RANGE OF INVERTERS

150W TO 1000W - 12V & 24V

A Complete range of regulated inverters to power 220V and 240V AC equipment via a car, lorry or boat battery. Due to their high performance (>90%) the inverters generate very little heat. The high stability of the output frequency (+/-1%) makes them equally suitable to power sensitive devices.

These inverters generate a modified sine wave, which are considerably superior to the square waves which are produced by most other inverters. Due to this superior feature they are capable of powering electrical equipment such as TV,s, videos, microwave ovens, electrical lamps, pumps, battery chargers, etc.

Low Battery Alarm

The inverters give an audible warning signal when the battery voltage is lower than 10.5V (21V for the 24V version). The inverter automatically shuts off when the battery voltage drops below 10V (20V for the 24V version). Fuse protected input circuitry.

Order Code	Power	Voltage	Price
651.581	150W Continuous	12V	£38.49
651.578	150W Continuous	24V	£38.49
651.582	300W Continuous	12V	£54.36
651.585	300W Continuous	24V	£54.36
651.583	600W Continuous	12V	£118.42
651.593	600W Continuous	24V	£118.42
651.587	1000W Continuous	12V	£174.60
651.597	1000W Continuous	24V	£174.60



ILLUSTRATION SHOWN IS 651.583 600W VERSION

All prices are inclusive of VAT.
 Many uses include:- Fetes · Fairgrounds · Airshows · Picnics · Camping · Caravans · Boats · Carnivals · Field Research and Amateur Radio field days.

DELIVERY CHARGES ARE £6-00 PER ORDER. OFFICIAL ORDERS FROM SCHOOLS, COLLEGES, GOVT. BODIES, PLC,S ETC. PRICES ARE INCLUSIVE OF V.A.T. SALES COUNTER. VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX, OR EMAIL US AT SALES@BKELEC.COM ALTERNATIVELY SEND CHEQUE OR POSTAL ORDERS MADE PAYABLE TO BK ELECTRONICS.

B.K. ELECTRONICS
 UNIT 1, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR
 TEL.: +44(0)1702-527572 FAX.:+44(0)1702-420243

For Full Specifications View our web site at:-
WWW.BKELEC.COM/INVERTERS.HTM

I bet I know what you'd like for Christmas...

What, so you've been reading Maplin's new Christmas Catalogue too?



To receive your free copy of the Maplin Christmas Catalogue, full of the latest technology products and gift ideas, simply fill in your name and contact details and send this coupon to Maplin Electronics. **FREEPOST** NEA 9433, Barnsley S73 0BR. Offer ends 24/12/2000

Please tick your main areas of interest:

- Communications Computers Tools
Components and Cables Sound and Vision
Electrical Leisure and Hobbies

Other (please specify) _____

Name _____

Address _____

Postcode _____

Tel _____

Fax _____

If you would prefer not to receive further offers from Maplin Electronics, or companies we recommend, please tick box.

GET YOUR
FREE
24-PAGE XMAS
CATALOGUE

MAPLIN
ELECTRONICS

Order yours today! call

0870 264 6000

quoting ref AD046 or return the form opposite. Also available from Maplin stores and from our web site at www.maplin.co.uk. We accept the following cards for telephone orders



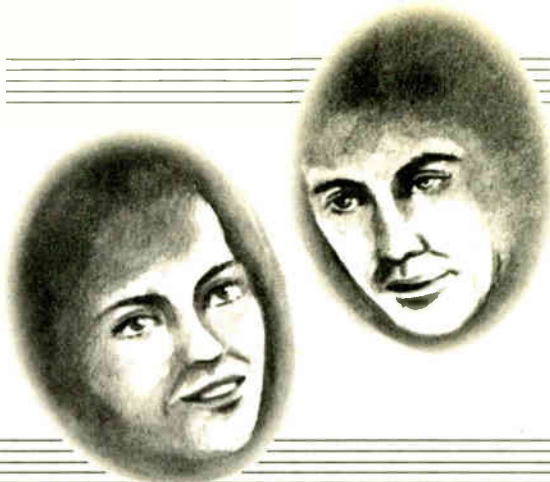
© & CE All trademarks acknowledged. All prices inc. VAT. All prices correct at time of going to press. All prices are subject to change without notice. All offers are subject to availability.

Constructional Project

TWO-WAY INTERCOM

ANDY FLIND

How to create your own local two-way chat zone.



these are readily available and easy to fit, but they normally have a maximum of just two poles.

SWITCH ROUTING

The aim with this design, therefore, was to accomplish the signalling with simple 2-pole switches. As this switching is a little difficult to follow, some simplified diagrams of the operation are included here to explain it.

Shown in Fig.2 is a simplified version of the whole circuit with the amplifier and signalling tone generator shown as symbols and all the coupling capacitors omitted.

The base (b) drive resistor for transistor TR1 is also not shown. The switches are labelled in the same way as those of the full circuit diagram and all are shown in the "off" position.

Since connections to normally-open poles of the switches are not doing anything useful, Fig.3 shows the same circuit with all these inactive connections omitted. It is now easy to see that the Remote speaker is connected to the input of the amplifier, although even this is not actually doing anything useful.

The Base speaker, however, is connected to the output of the tone generator via S2b, which is one side of the "call Remote" switch and S4b, part of the "on-off" switch.

The two inputs to the tone generator are both "active low", in that negative inputs activate them, so when the Base unit is

INTERCOM projects used to be part of the staple diet of electronic construction enthusiasts with at least one appearing somewhere in publication every year.

Over time they seem to have become less common, perhaps because they can be bought quite cheaply nowadays, so when a reader asked if *EPE* had recently published one, Editorial eyebrows rose at the discovery that some eight years had passed since the last appeared. It seemed timely, therefore, to present a new intercom design.

VOICING QUERIES

It might be asked why anyone would build an intercom when they can be bought cheaply. In fact, there are several reasons.

A home-built design can be customised, built into other projects, modified and used in ways its original designer never intended. Parts of the circuit might be adapted for use in other projects. The constructor can easily repair it if it goes wrong and an intercom is a good starter project for those seeking electronics experience.

Last, but by no means least, constructors with children will probably find that an intercom's entertainment potential will earn them lots of brownie points with the kids! Given all this, a new design seems well worth while.

INTERCOM PRINCIPLES

The basic principle of an intercom circuit is simple. As many readers will know, a loudspeaker can function as a moving-coil microphone, so all that is required are two speakers and an amplifier with a 2-pole 2-way switch for the "listen-talk" function, as shown in Fig.1.

With the switch in the position shown, the Remote station acts as a microphone with its speaker connected to the amplifier input whilst the Base station's speaker is connected to the output, allowing the user at the Remote end to talk to the Base. Operating the switch reverses these connections to allow the Base user to speak to the Remote. Only two wires are required to link the two stations, cheap "bell wire" usually being adequate.

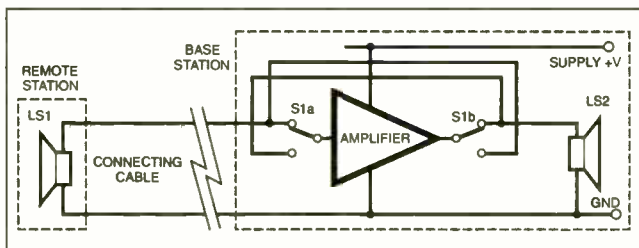


Fig. 1. Basic principle of Intercom operation.

If only it were so simple! Before the users can speak to each other they must be present at the two ends and the Base unit must be switched on. This requires a means of sending a signalling tone from either end, and in the case of the Remote this must work when the Base unit is switched off.

Of course this would be simple if there were more connections between the two ends but most users would like to continue using just the two cores of cheap bell wire to link them. This adds extra complexity to the circuit but if it results in cheap and easy connection it is worthwhile.

Commercially produced intercoms often use biased switches with as many as four poles. Designs for home construction usually use panel-mounted switches because

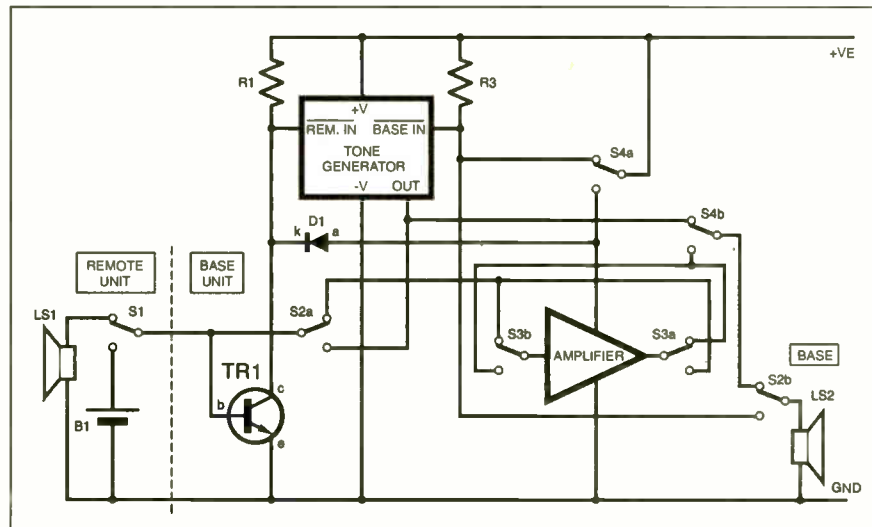


Fig. 2. Simplified circuit diagram of the Two-Way Intercom, with tone signalling.

switched off S4a forces the Base unit's input high to prevent inadvertent calling of the Remote.

CALLING BASE

In Fig.4 is shown the Remote user calling the Base with switch S1, a biased single-pole changeover switch fitted in the Remote unit. This disconnects the speaker and instead connects the line to a battery which turns on transistor TR1, which in turn switches on the tone generator. (The transistor's base resistor is again omitted for illustrative clarity.) The tone output goes to the Base's speaker via S4b and S2b.

In Fig.5 the Base unit has been switched on with S4. S4a applies power to the amplifier and S4b connects the Base speaker to its output, via S2b. The Remote speaker is still connected to the amplifier input via S1, S2a and S3b so if the user at the Remote end speaks they will now be heard at the Base.

When the amplifier is powered, a "high" signal from the diode D1 is used to force the Remote's tone generator input high so that inadvertent operation of S1 will not give the user at the Base an unpleasant surprise! Note that in the final circuit, a current limiting resistor is used in the transistor's collector path, to prevent excess current from the powered diode ever being shorted to ground.

CALLING REMOTE

If the Remote user is not present when the Base is switched on the Base user will want to signal them. Fig.6 shows how this works. S2b disconnects the Base speaker and uses it to pull the Base tone generator input low.

Meanwhile S2a disconnects the Remote speaker from the amplifier input and



couples it to the Base tone generator output, so the signalling tone will be heard at the Remote unit.

The action of S3, the "listen-talk" switch, is not shown in these drawings because its operation should be clear from Fig.1. All the switches with the exception of the on-off switch are biased types, so the user at the Base has "on-off", "press to call" and "press to talk" functions which are easy to understand. The Remote user has simply "press to call".

The arrangement provides a couple of useful interlocks in that the Base cannot call the Remote unless it is switched on and the Remote cannot call the Base unless it is switched off.

POWERING REMOTE

The decision to use a battery in the Remote unit came about as follows. The most practical way to signal without it would be to place a large electrolytic capacitor in series with the speaker, energise the line with a positive voltage through a resistor, and short this voltage to ground with a switch to initiate signalling at the Base.

However, this capacitor would then appear in series with the input and output coupling capacitors of the amplifier and these would also be exposed to polarity reversals between "talk" and "listen". Overcoming these problems would give

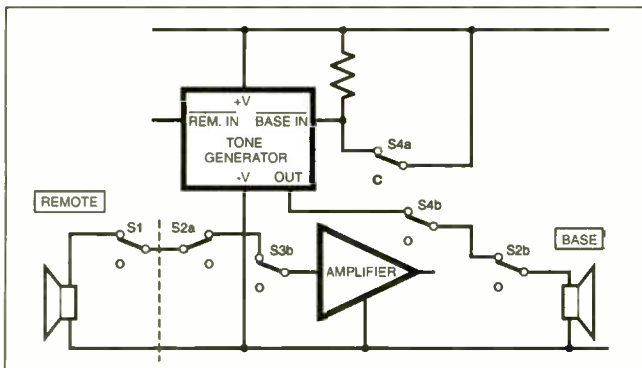


Fig.3. Base station switched off.

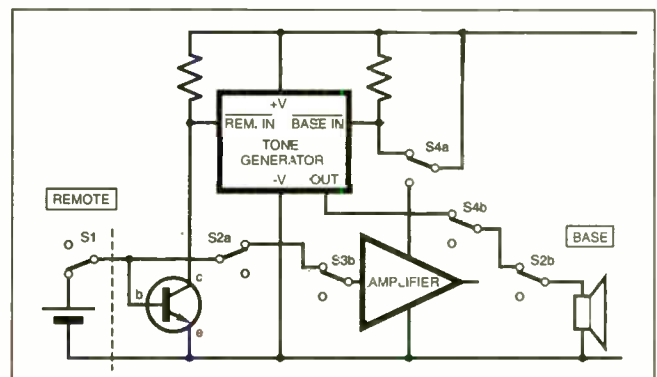


Fig.4. Remote unit calls Base.

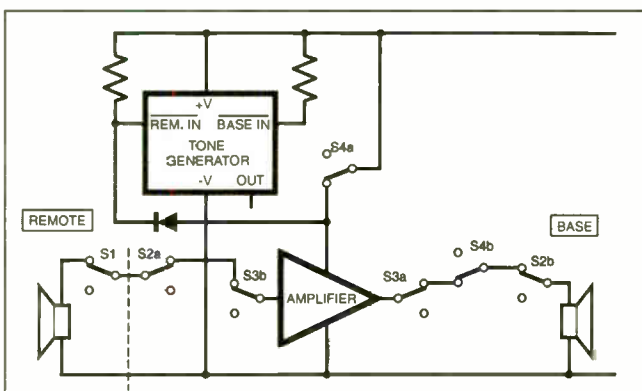


Fig.5. Base unit switched on.

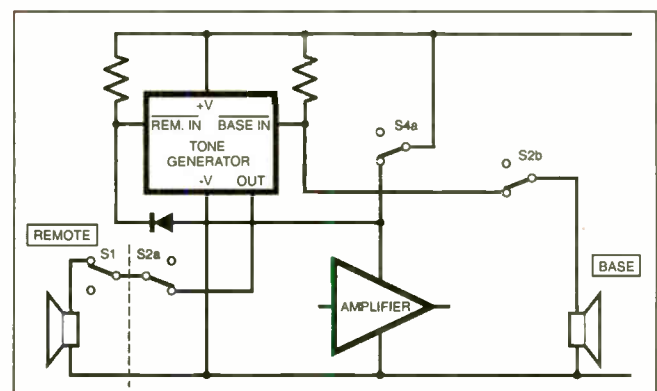


Fig.6. Base station calls Remote unit.

COMPONENTS

Resistors

R1, R3, R16	1k (3 off)
R2, R4, R7	10k (3 off)
R5	100k
R6	39k
R8, R10	2k2 (2 off)
R9, R13	22k (2 off)
R11	100Ω
R12	15k
R14	47Ω
R15	470Ω
R17	1k5
R18	10Ω

All 0.6W 1% metal film

See
SHOP
TALK
page

Potentiometer

VR1	10k round, cermet preset horizontal
-----	-------------------------------------

Capacitors

C1	47μ radial elect. 10V
C2, C3	10n resin-dipped ceramic (2 off)
C4, C9, C16	100n resin-dipped ceramic (3 off)
C5	1n resin-dipped ceramic
C6, C10, C11	10μ radial elect. 63V (3 off)
C7, C13	470n resin-dipped ceramic (2 off)
C8, C12, C14, C15	220μ radial elect. 10V (4 off)

Semiconductors

D1	1N4148 silicon diode
TR1, TR3	BC184L <i>npn</i> transistor (2 off)
TR2	BC214L <i>pnp</i> transistor
IC1	4011B quad 2-input NAND gate
IC2	LM386-N1 audio amplifier

Miscellaneous

S1	s.p.d.t. min. toggle switch, biased one way
S2, S3	d.p.d.t. min. toggle switch, biased one way (2 off)
S4	d.p.d.t. min. toggle switch
LS1, LS2	8 ohm 0.3W loudspeaker, 66mm (2.5in.) diameter (2 off)
B1	1.5V AAA cell, plus holder, for Remote unit
B2	1.5V AAA cell (4 off), plus holder, for Base unit
SK1	3mm mono jack socket and plug, or similar

Printed circuit board, available from the EPE PCB Service, code 282; 8-pin d.i.l. socket; 14-pin d.i.l. socket; plastic case, 120mm x 100mm x 45mm for Base unit (see text); plastic case, 145mm x 90mm x 30mm for Remote unit (see text); connecting wire; solder etc.

Approx. Cost
Guidance Only

£20
excluding batts.

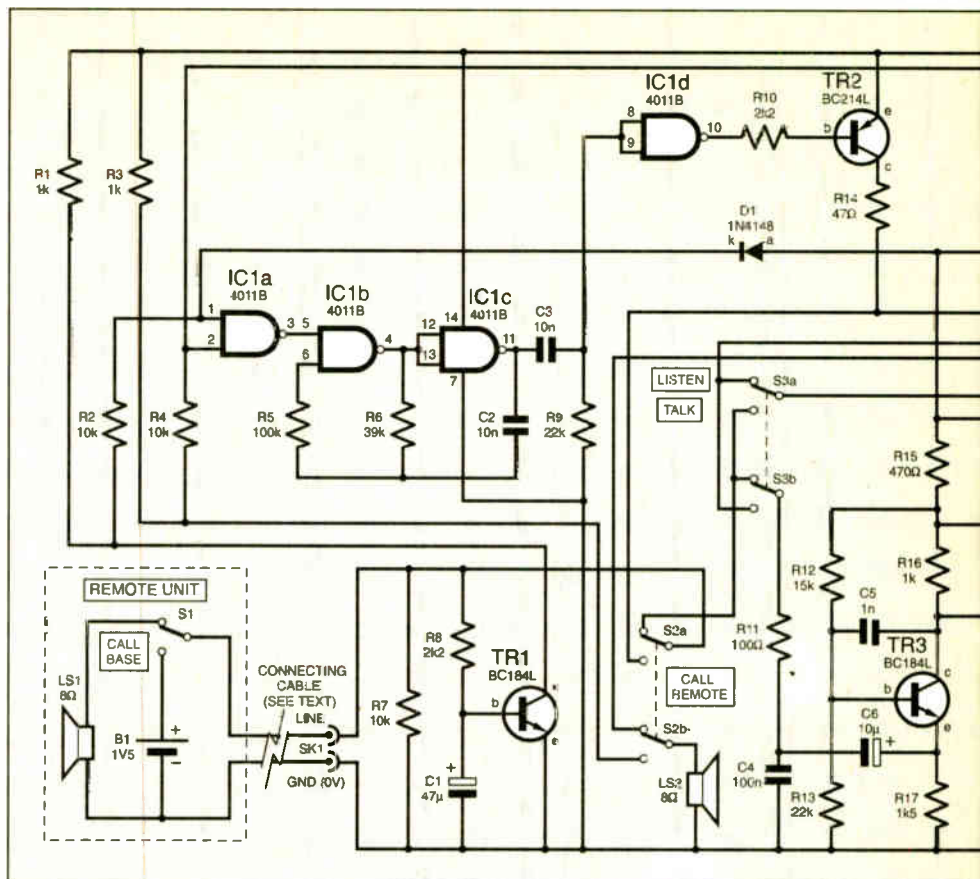


Fig.7. Complete circuit diagram for the Two-Way Intercom.

rise to quite a lot of additional complexity, all of which can be removed at a stroke by the use of a battery at the Remote end.

A potential of just 1.5V is quite sufficient to turn on a transistor in the Base unit. As only a tiny intermittent current is needed, a single AAA cell will last almost indefinitely. Its voltage is less than that at the input and output of the amplifier when switched on so their coupling capacitors are always correctly polarised.

The only time reverse polarity occurs is when the Remote unit calls the Base whilst it is switched off. This involves only the 1.5V battery across the small (10μF) capacitor, C6, which is in series with a resistance of at least 1.5kΩ so it is unlikely to cause problems.

FULL CIRCUIT

Moving to the full circuit diagram shown in Fig.7, the amplifier part of this is at the bottom right. When used as a microphone a loudspeaker has a very low output impedance which should be matched by the amplifier input, so the input stage is built around transistor TR3 using a common-base arrangement.

The signal is applied to the emitter (e) through coupling capacitor C6 and the output is taken from the collector (c). This stage has additional supply decoupling in the form of resistor R15 and capacitors C8 and C9.

Its output passes through the preset gain control VR1 to the input of IC2, an LM386-N1 which is an inexpensive audio amplifier i.c. The output is delivered through coupling capacitor C12.

The power supply to the amplifier circuit, from S4a, is decoupled by capacitors C15 and C16. Switch S3 provides the "talk-listen" changeover function. The

voltage gain of the transistor stage is about five, whilst the overall voltage gain of the complete amplifier is about 1000, although this depends upon the setting of VR1. The frequency response extends from about 200Hz to 2kHz which is adequate for speech communication.

SIGNALLING FREQUENCY

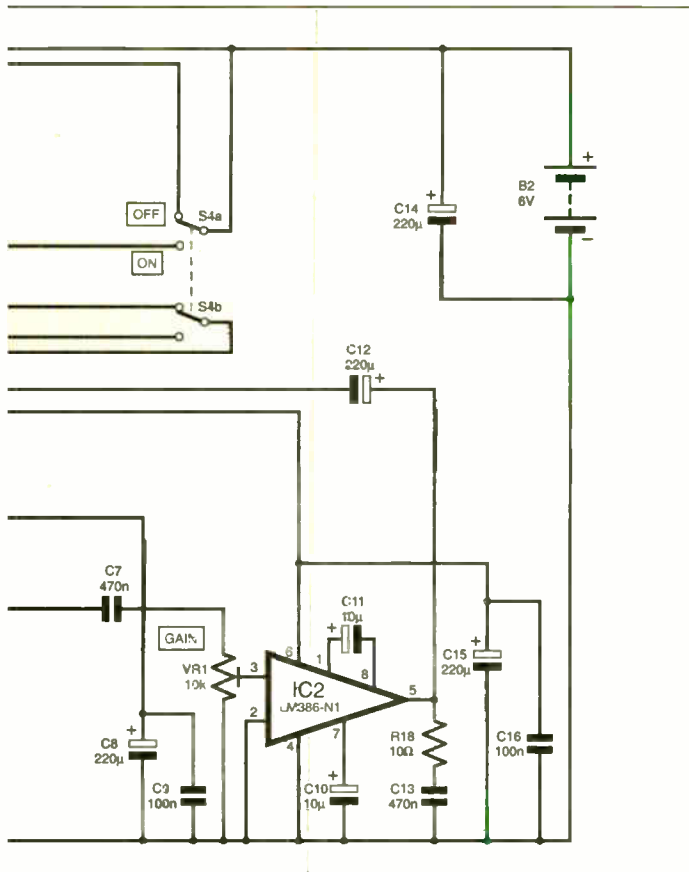
The signalling tone has a frequency of about 1kHz and is generated by an astable oscillator built from the two CMOS NAND gates IC1b and IC1c, with R6 and C2 being the frequency determining components. The oscillator is controlled by NAND gate IC1a. Its output passes to NAND gate IC1d through capacitor C3, which with R9 ensures that the output from this gate consists of a stream of negative-going pulses with a width of about 120μs.

This drives transistor TR2, whose collector output drives the speakers via the switches as described earlier. Resistor R14 sets the volume of the tone and its value may be altered if required.

Moving to the tone generator controlling gate IC1a, both inputs to this are normally pulled high by resistors R1 and R3. Operation of switch S1 in the Remote causes battery B1 to turn on transistor TR1 by supplying bias current through resistor R8.

The collector of TR1 then pulls the input to pin 1 of IC1a low so that its output pin 3 goes high, allowing the tone oscillator to operate. Capacitor C1 prevents the transistor being turned on by large transients in the audio signals when these are present on the line, and R7 ensures TR1 turns off rapidly when S1 is released.

When the Base unit is switched on, S4a applies positive voltage to pin 1 of IC1a via



Switches S1 to S3 must be biased one way types.

the diode D1 to block the oscillator's action, preventing the Remote from activating the signalling tone. If S2 is operated its S2b section applies the negative voltage to pin 2 from the Base speaker LS2.

This again activates tone generation which is now applied to the line via S2a to call the Remote. When the Base is switched off S4a applies a positive voltage directly to pin 2 to prevent signalling of the Remote from taking place.

CONSTRUCTION

Construction of the printed circuit board (p.c.b.) for this project should prove straightforward. Its component and track layout details are shown in Fig. 8. It is available from the *EPE PCB Service*, code 282.

Start by inserting the ten pins for external connections since these sometimes require a fair amount of insertion force. These should be followed by the eighteen resistors and the diode, then the eight small ceramic capacitors, the three transistors and two dual-in-line (d.i.l.) sockets for IC1 and IC2. These can be followed by preset VR1 and the eight electrolytic capacitors, which all have their positive connections uppermost.

Following a careful check of the soldering, especially around the "between pins" areas beneath IC1, the board should be ready for testing.

FIRST TESTS

For test purposes the connections on the board are all labelled with letters in Fig. 8.

The first test is to connect a supply of +6V to point I with negative to point J and check that +6V appears at pins 1, 2 and 14 of the socket for IC1. At this point the current taken from the supply should be zero though there will be an initial surge as capacitor C14 charges.

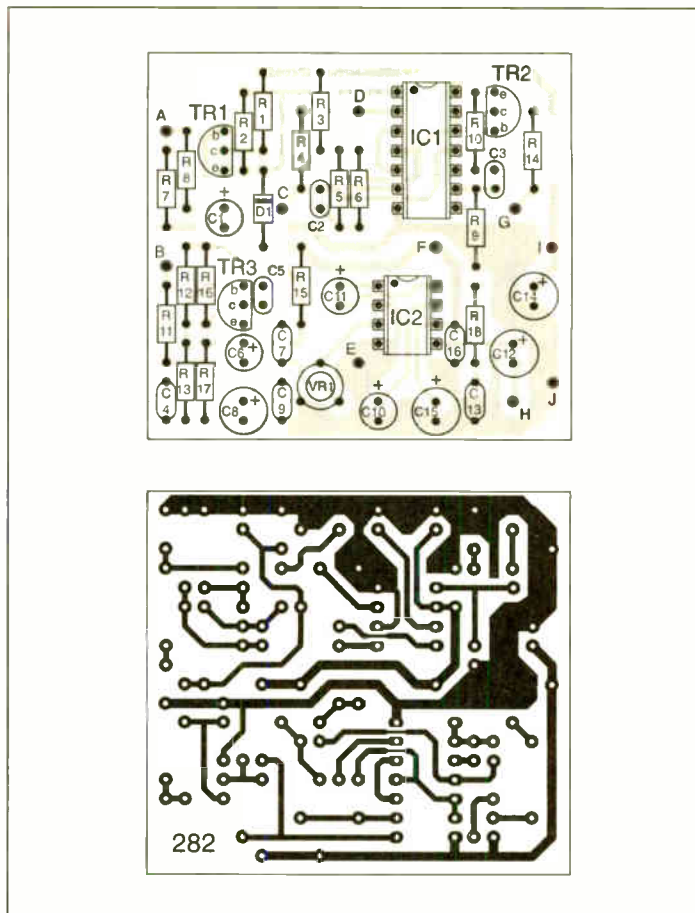


Fig. 8. Component layout and full-size foil master for the Base station printed circuit board (p.c.b.).

Next the amplifier part of the board should be powered by connecting +6V to point F with the negative still on J. The positive supply should now appear at pin 6 of the socket for IC2 and there should be about 4V at the collector of TR3, which can be measured at the top of C7. The supply current should be about 1.5mA.

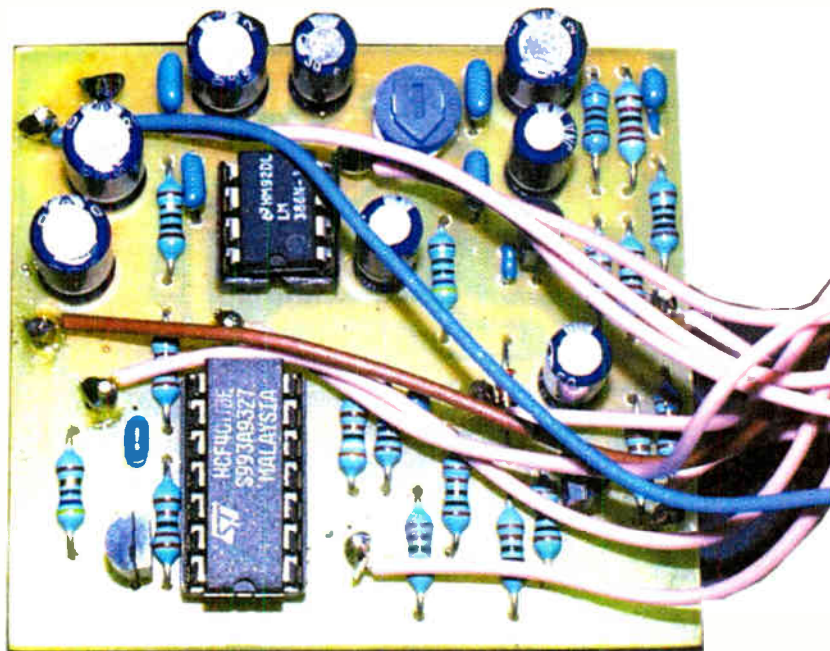
OSCILLATOR TESTING

Now the signalling oscillator can be tested. IC1 should be inserted in its socket,

and the +6V supply connected to point I again. Discharge static electricity from yourself by touching a grounded item before handling IC1 as it is a CMOS device.

A meter should reveal pins 1 and 2 of IC1 high (positive), pin 3 low, pin 4 high, pin 11 low and pin 10 high. The supply current should be zero.

If the +6V supply is now linked to point A, pin 3 should go high and pins 4 and 11 should indicate about 3V (actually



Components mounted on the completed Base unit p.c.b.

oscillating with 50 per cent duty cycle). Pin 10 will probably indicate about 5.4V since the narrow pulse output means that it spends most of its time at positive supply potential. The supply drain should rise to about 10mA.

If a speaker is connected across points G and E, making point A high, this should produce the signalling tone from it with a supply drain of about 25mA.

AMPLIFIER TEST

Testing of the amplifier can now be completed. IC2 should be inserted and the +6V supply again applied to point F. The supply current should be about 6mA and there should be about 3V present at the output of IC2, pin 5.

A speaker should be connected across points H (output via C12) and E (ground). Touching point B (input) should result in audible hum, the level of which will be adjustable with VR1. This completes the basic testing of the board. VR1 should be left at about half-travel.

ENCLOSURES AND WIRING

The cases for both parts of this project were ones that were already to hand in the author's workshop, and are by no means critical. Any cases of the constructor's choice may be used. A pattern of holes should be drilled in the front of each to act as a speaker "grille", the holes for the switches drilled, and these and the speakers secured in position.

The speakers can be simply glued into place with some "Evo-stick" or similar adhesive.

The next task is to complete the wiring between the switches and the p.c.b. and, as readers may have gathered from the earlier descriptions, this can be fun! The best

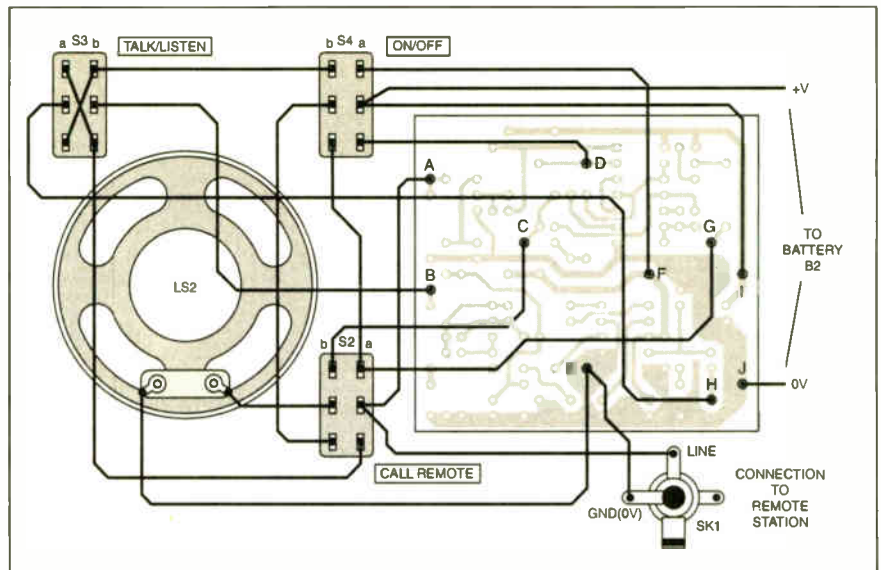


Fig.9. Base unit interwiring from the p.c.b. to off-board components.

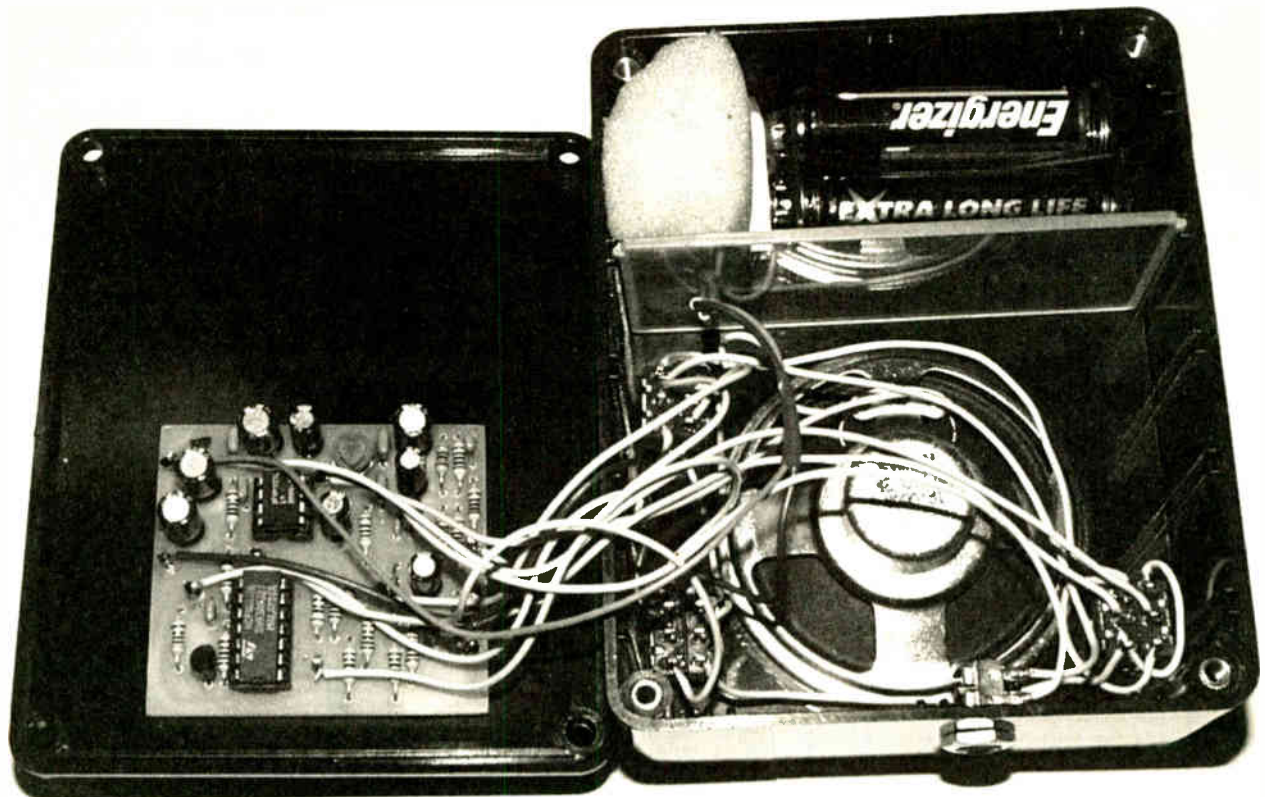
method is probably to follow the wiring diagram in Fig.9 as closely as possible and perhaps tick off each connection as it is made.

Note that it is essential to connect the "ground" side of the speaker and line connections to the point just below IC2 as shown. Connecting them to the negative rail at any other point can result in output signal current sharing a path with the input which may cause severe instability.

The illustration shows the switches and speaker in their approximate actual positions as fitted in the prototype with the p.c.b. to the right, this being how they were arranged for wiring. The p.c.b. was attached to the case lid with the author's favourite adhesive, Blu-Tack! Double-sided adhesive foam would do as well.

Just enough length was given to the p.c.b. leads to allow the lid to be folded into place. The switches are all of the type having the normally-open (n.o.) contact at the top and the normally-closed (n.c.) one at the bottom so this should be checked before wiring is commenced.

Battery B2 consists of four AA cells in a holder, fitted into a compartment made inside the case by placing a piece of sheet plastic into the moulded guides provided. In the prototype a 3.5mm mono jack socket was fitted to the bottom of the case for the connection lead to the Remote unit, although readers may prefer to hard-wire the connections since this will prevent inadvertent disconnection between the units.



Layout of components inside the completed "master" unit showing the p.c.b. mounted on the lid and the battery compartment divider wall. If possible use multicoloured wires to help identify each lead.

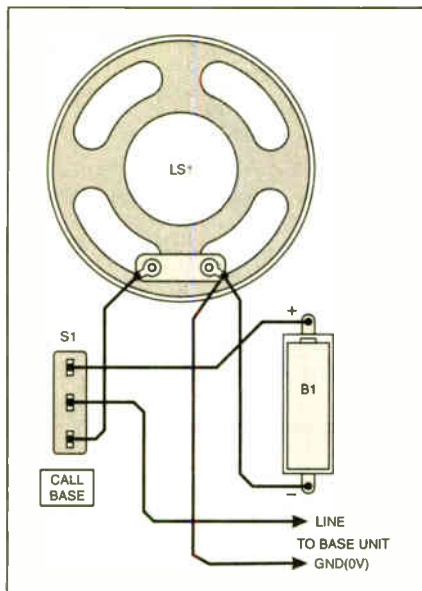


Fig. 10. Remote unit interwiring.

SIMPLY REMOTE

The layout of the Remote Unit is shown in Fig. 10. This is extremely simple to wire as it has only three components! The connecting lead was soldered directly to the unit, although a second jack socket could be used if preferred.

The battery is a single AAA cell fitted in a holder glued to the case, though it should last indefinitely so connections can be soldered directly to it if preferred.

The switch shown in the drawing is another biased toggle type though sharp-eyed readers may notice that this is not the case in the photograph.

Originally the case was drilled for a large press-to-make pushbutton but this had to be abandoned when the battery and changeover switch were brought in.

Unfortunately, the hole left by the pushbutton was too large for a toggle switch and anyway the author rather liked the appearance of the large red button! To get around the problem without scrapping the case the button's innards were drilled out, a return spring inserted into it, and a micro-switch from the junk box was modified by bending its operating lever to work from the button. It looks nice but was tricky to

do so the toggle switch is recommended for "production" versions.

JOINT VENTURE

With both units built it remains only to connect them together, test them and set the volume level with VR1. A point here is that early testing of the prototype amplifier was carried out with both speakers uncased and in the same room. The sound quality was so "boomy" that initially it was thought that the amplifier circuit had unwittingly been designed with a bandpass characteristic!

Investigation revealed the cause of the problem to be the resonant frequency of the loudspeakers which, dangling in free air at the ends of their leads, had virtually no mechanical damping. Being in the same room meant that a degree of acoustic feedback between them was inevitable and this of course also centred around their resonant frequency.

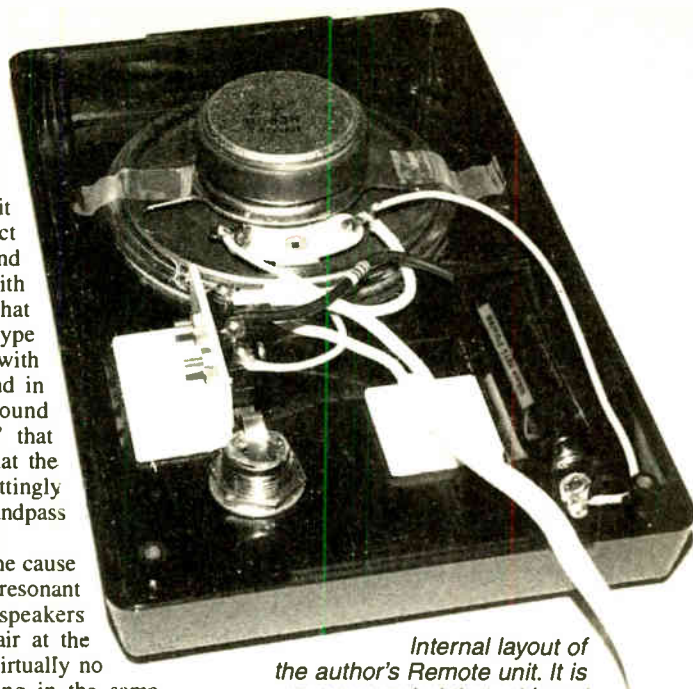
Fitting one of them into a small case improved the quality considerably and testing the project with them in different rooms helped even more. The use of loudspeakers as microphones means that this project will never deliver Hi-Fi results, but when the speakers are fitted into their cases it will be more than adequate for its purpose.

However, if large cases are used it may be an idea to put some wadding in them to improve the acoustic damping of the speakers, and testing in the same room will probably produce sound inferior to that which will be obtained when they are used as intended, over a distance.

OTHER OPTIONS

The amplifier of this project is fairly sensitive so it may well find uses as a baby monitor, a doorphone or in other applications where audio monitoring or communication is required.

It can operate from supplies down to 4V and draws surprisingly little current, so the pack of four AA batteries specified should



Internal layout of the author's Remote unit. It is recommended that a biased toggle switch is used here.

give a fair amount of use. Alternatively a 9V supply can be used, which will last even longer, or a small mains powered supply could be built to power it.

Hopefully, constructors will find it both interesting to construct and a useful addition to the home or workshop. □



EPE BINDERS

KEEP YOUR ISSUES SAFE – RING US NOW!

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

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

The price is £5.95 plus £3.50 post and packing. If you order more than one binder add £1 postage for each binder after the initial £3.50 postage charge (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 card), to **Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Fax: 01202 841692.**

E-mail: editorial@epemag.wimborne.co.uk.

Web site: http://www.epemag.wimborne.co.uk



We also accept card payments. Mastercard, Visa or Switch (minimum card order £5). Send your card number and card expiry date plus Switch Issue No.



NEW

EPE TEACH-IN 2000

Now on CD-ROM



The whole of the 12-part *Teach-In 2000* series by John Becker (published in EPE Nov '99 to Oct 2000) is now available on CD-ROM. Plus the *Teach-In 2000* software covering all aspects of the series and Alan Winstanley's *Basic Soldering Guide* (including illustrations and Desoldering).

Teach-in 2000 covers all the basic principles of electronics from Ohm's Law to Displays, including Op.Amps, Logic Gates etc. Each part has its own section on the interactive software where you can also change component values in the various on-screen demonstration circuits.

The series gives a hands-on approach to electronics with numerous breadboarded circuits to try out, plus a simple computer interface which allows a PC to be used as a basic oscilloscope.

ONLY £12.45 including VAT and p&p

NOTE: This mini CD-ROM is suitable for use on any PC with a CD-ROM drive. It requires Adobe Acrobat Reader (available free from the Internet – www.adobe.com/acrobat)

Order on-line from www.epemag.com or by Phone, Fax, E-mail or Post

TEACH-IN 2000 CD-ROM ORDER FORM

Please send me (quantity) TEACH-IN 2000 CD-ROM
Price £12.45 (approx \$20) each – includes postage to anywhere in the world.

Name

Address

..... Post Code

I enclose cheque/P.O./bank draft to the value of £

Please charge my Visa/Mastercard/Switch £

Card No.

Expiry Date Switch Issue No.

Note: Minimum order for cards £5.

SEND TO: Everyday Practical Electronics, Allen House,

East Borough, Wimborne, Dorset BH21 1PF.

Tel: 01202 881749. Fax: 01202 841692.

E-mail: orders@epemag.wimborne.co.uk

Payments must be by card or in £ Sterling – cheque or bank draft drawn on a UK bank.
Normally supplied within seven days of receipt of order.

Send a copy of this form, or order by letter if you do not wish to cut your issue.

Radio Bygones

The leading magazine for vintage radio enthusiasts



Now Also Available To
BUY ONLINE
www.radiobygones.com
Log on, pay by credit card and download the magazine to your PC
ONLY \$9.99 (US dollars)
FOR 6 ISSUES
A free issue is available

WHETHER your interest is in domestic radio and TV or in amateur radio, in military, aeronautical or marine communications, in radar and radio navigation, in instruments, in broadcasting, in audio and recording, or in professional radio systems fixed or mobile. RADIO BYGONES is the magazine for you.

ARTICLES on restoration and repair, history, circuit techniques, personalities, reminiscences and just plain nostalgia – you'll find them all. Plus features on museums and private collections and a full-colour photo-feature in every issue.

IT'S MOSTLY about valves, of course, but 'solid-state' – whether of the coherer and spark-gap variety or early transistors – also has a place. FROM THE DAYS of Maxwell, Hertz, Lodge and Marconi to what was the state-of-the-art just a few short years ago . . .

THERE IS ALSO a selection of free readers' For Sale and Wanted advertisements in every issue.

Radio Bygones covers it all!

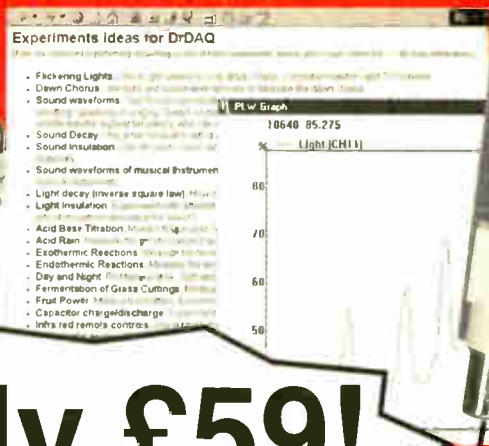
THE MAGAZINE is published six times a year, and is only available by postal subscription. It is not available at newsagents.

TO TAKE OUT a subscription, or to order a sample copy, please contact:

RADIO BYGONES, Allen House, East Borough, Wimborne, Dorset BH21 1PF.

Tel: 01202 881749. Fax 01202 841692. Web sites: www.radiobygones.co.uk www.radiobygones.com

The science lab in a PC



- Output
- Voltage
- Resistance
- Light level
- Temperature
- External sensors
- pH
- Microphone

Only £59!

+VAT

The DrDAQ is a low cost data logger from Pico Technology. It is supplied ready to use with all cables, software and example science experiments.

DrDAQ represents a breakthrough in data logging. Simply plug DrDAQ into any Windows PC, run the supplied software and you are ready to collect and display data. DrDAQ draws its power from the parallel port, so no batteries or power supplies are required.

- ✓ Very low cost
- ✓ Built in sensors for light, sound (level and waveforms) and temperature
- ✓ Use DrDAQ to capture fast signals (eg sound waveforms)
- ✓ Outputs for control experiments
- ✓ Supplied with both PicoScope (oscilloscope) and PicoLog (data logging) software

FREE Science Experiments Over The Web!

The Pico Technology Library of Science Experiments contains a number of educational experiments suitable for use with oscilloscope and data logging products.

The experiments are written by science teachers and industry experts. So that you can find an experiment of interest easily, we have divided them into five subjects: biology, chemistry, physics, electronics and general science. You can find these experiments at: www.picotech.com/experiments/index.html



To order the DrDAQ please choose one of the following guidelines:

- i) Fill out the order form and either fax it, or post it back to Pico Technology.
- ii) Visit our web site and place an order over the internet, or,
- iii) Place an order over the phone by ringing the number below.

DrDAQ Order Form:			
Quantity	Package	Price inc VAT	Total
	DrDAQ + Software	£69.32	
	DrDAQ + 2 Temperature Sensors	£92.85	
	DrDAQ + 2 Temperature Sensors + pH Electrode	£116.32	
	Delivery (per item)	£4.11	
Grand Total		£	

Name			
Address			
Post code			
Phone			
Credit Card	<input type="checkbox"/> Visa / Mastercard / Switch / Amex		
Card Number			
Expiry Date	/	Start Date & or Issue No.	
Cheque with order	<input type="checkbox"/>		

pico
 Technology Limited

READOUT

E-mail: editorial@epemag.wimborne.co.uk

John Becker addresses some of the general points readers have raised. Have you anything interesting to say? Drop us a line!

WIN A DIGITAL MULTIMETER

A 3½ digit pocket-sized l.c.d. multimeter which measures a.c. and d.c. voltage, d.c. current and resistance. It can also test diodes and bipolar transistors.

Every month we will give a Digital Multimeter to the author of the best Readout letter.



★ LETTER OF THE MONTH ★

QBASIC AND WINDOWS 2000

Dear EPE,

I've been following the discussion regarding QBasic and Windows and felt it was my turn to "throw my penny's worth in", so to speak. First, QBasic does not seem to be on the Windows 2000 Server edition CD-ROM and it doesn't seem to ship with Service Pack #1 either. I copied a version from my Win98 PC and it runs just fine under Windows 2000.

I do question, though, if QBasic and other programming languages that were originally designed to run under DOS are the way forward. Looking through back issues of EPE, I see projects that connect to the user's PC via the serial or parallel port and I'm wondering how much longer this can go on from the DOS world.

Getting a Windows programming language like VisualBASIC to talk directly to the parallel port is difficult enough (it requires drivers or a special DLL). I don't know how difficult it is from QBasic but I'm sure you won't be able to keep doing it for much longer. I read with interest that the only way to use DOS on a PC with Windows ME (Millennium Edition) installed is to boot from the emergency repair disk.

I see a time when the majority of people are running Windows, and languages like QBasic just won't cut it. I do appreciate that people out there are still using '486 PCs or older and for these people, upgrading to Windows is difficult if not impossible.

What I would like to suggest is that we start to look at perhaps making available a Windows and a DOS version of PC software for projects that require interfacing to a PC. What would be a good starting point is when DOS/QBasic software is released for a project, a document describing how it interfaces to the hardware is also released. This would make it simpler for people like me to write an equivalent Windows version of the software.

What would be even nicer is a place on your web site where we could drop off our Windows code so other enthusiasts could use it. I for one love writing Windows software and would be only too happy to let other people use and play with my attempts.

Joe Farr, via the Net

I thoroughly agree with you Joe, DOS-based codes are now something of an anachronism. But, as I have said before, in matters such as software we must try to cater for those who have not yet upgraded, as well as for those who have.

In catering for the latter, the problem is that those who submit software projects must themselves be familiar with the higher level languages such as VisualBASIC and Delphi. Whilst we are receiving a trickle of such offerings, it cannot yet be called a flood.

We will be only too happy to publish suitable VB-based designs if we are offered them. We must emphasise, though, authors who do offer them must also make available ALL code involved, including source files. We have built a reputation on providing free software for published projects so that people can not only build the design as published, but also study the software and learn programming techniques from it as well.

It is appreciated that some authors may wonder why they should release source code upon which they have spent many hours of development. But then, so too might authors argue about circuit diagrams, the same principle applies.

Authors whose projects are published do receive payment for them, pro-rata to the number of pages printed, and do receive a small additional payment for software, even when the software is not actually printed in the magazine. We willingly admit, though, that no designer/author will ever make a fortune through having their creations published.

However, to my mind (and speaking as a frequent designer/author), it is not for the money that most people offer us projects. In most cases the reason is due to the sheer driving force of a desire to solve a problem in electronic or software terms and to then share with others the pleasure and satisfaction of having achieved that target. It is not feasible, though, for authors to generate two versions of software.

Regarding a site for software exchange, we feel that this could be a dangerous move – too many options for virus writers to wreak havoc with their criminal wares, and possible problems with passing on patented or copyright code.

CONGRATS

Dear EPE,

I would like to thank you for the PIC Tutorial series (Mar-May '98). I followed it with great interest, as it enabled me to baffle the lecturers in college (!) and helped me obtain my degree, and my first job. So keep up the good work! Thanks, and thanks for a great mag.

John Rees, via the Net

That's great news John, congratulations. I am pleased to add that other readers have achieved similar success by following that series. It's rewarding to know that I've been able to help so many of you.

INCORRECT INFO

Dear EPE,

In Barry Fox's news item *Analogue Frequency Sell-Off Unlikely* of Nov '00, factually incorrect information was given on the mux equalisation project in the Crystal Palace area.

Crown Castle International, formerly part of the BBC, is equalising the Crystal Palace transmitter along with four more at Hannington, Oxford, Hemel and Sandy Heath. These are in fact our sites. NTL does not provide a DTT service for ONdigital because Crown Castle built and operates the ONdigital network.

We would be pleased to invite Barry Fox to our premises to understand what Crown Castle does.

**Melanie Dunnett,
Marketing Manager,
Broadcast, Crown Castle UK Ltd**

Thank you for informing us. We have forwarded your E-mail and invitation to Barry.

Readers who wish to know more about Crown Castle can access the web site at: www.crown-castle.com. Crown Castle also invites you to visit the Third Generation Mobile Multimedia web site at www.3g.thefuture.com.

TURBO BASIC

Dear EPE,

Regarding *Readout* Oct '00, G.A. Bobker referred to Borland Turbo Basic being no longer available. Strictly speaking this is true. However, the product was sold off to the author R.S. Zaie who has since produced it under the name of PowerBasic. The contact details I have are:

PowerBasic Inc., 316 Mid Valley Centre, Carmel, CA 93923, USA.

Tel: (408) 659 8000. Fax: (408) 659 8008.

Web: www.powerbasic.com

On the website, the UK suppliers are listed as: GreyMatter Ltd., Prigg Meadow, Ashburton, Devon TQ13 7DF. Tel: 01364 654 100.

E-mail: maildesk@greymatter.co.uk.

Web: www.greymatter.co.uk.

QBS Software, 11 Barley Mow Passage, Chiswick W4 4PH. Tel: 020 8956 8000. Web: <http://www.qbss.com>

PowerBASIC (cc 1994 V3.1) has machine code mnemonics as part of the language, is compatible with both C and Pascal and has a "bolt-on" program (PBDK) that makes your program run as a Windows program. This Basic is very powerful. If you can do it in "C", then you can do it in PowerBasic.

However, I tried to convert your PIC Programmer software to it, but gave up as most of the variable names used were keywords in PowerBASIC! There is no 64K memory limitation in PowerBasic and it would have been nice to have it as one program. I still use the PIC programmer software . . . a little bit of magic, and great fun!

Ivor Matell, via the Net

Thanks Ivor for your observations and the source details. As has been said on other occasions in various ways, however, we believe that we should go down the VisualBASIC route, with possible excursions into Delphi as well.

QBASIC, AGAIN!

Dear EPE,

I just thought you might like to know that the CD-ROM of Windows ME contains QBasic in the `Tools\Oldmsdos` directory/folder just like the earlier Windows CD-ROM. So you can happily carry on using QBasic programs for a few more years!

P.S. Does ME stand for Millstone Edition?

Alan S. Raistrick, via the Net

Highly useful info Alan, thanks. Whilst I am "well into" VB, I still see a medium-term use for QB as well.

As regards your query, perhaps other readers might care to answer it!

HONOURED

Dear EPE,

I am pleased to inform you that, with the help of *EPE*, I have gained a first class honours degree in Electronics and Instrumentation Systems from the University of Wales College, Newport.

As a subscriber, I always look forward to the magazine dropping on the doormat for the news, series and projects. On many occasions, articles seemed to be perfectly timed with lectures and assignments, helping my understanding of many topics. It was thanks to *EPE* that my final year project featured a PIC microcontroller, saving much time and effort over conventional logic methods.

**Lyn Jones B.Eng. (Hons),
Gilwern, Abergavenny, Gwent, Wales**

We are delighted to hear of your success Lyn. Congratulations and thanks for your kind words.

BLASTING CONFUSION

Dear EPE,

Thank you very much for your absolutely brilliant, confusion-blasting *Teach-In* series. I am now "hooked" – or more relevantly, I am clamped up as close to the supply rails as it is possible to be! My interest is not just some temporary "impulse response", soon to suffer exponential decay... It is more like the response of an op.amp integrator whose offset has not been zeroed – forcing its output to sum indefinitely up to an infinite supply rail!

More seriously, it is going to prove extremely valuable to myself and my course-mates on the second year electronics degree at Birmingham University.

I was wondering if a list of our practicals for the second year may help you to decide on future articles as there may be similarities across the country?

**Andrew Massey,
University of Birmingham**

Thanks Andrew for your enthusiastic words!

*Editor Mike comments that the subjects listed in the rest of your letter show that the course you are on goes above the theory level that we cover in *EPE*. We are also not in a position to produce and publish projects to fit in with specific courses. However, we will keep your suggestions in mind.*

VB ENCOURAGEMENT

Dear EPE,

To encourage people to use VisualBASIC, Microsoft allow any student following a course which leads to a nationally recognised qualification, primary, secondary, tertiary, or any lecturer or teacher to buy some of its products under the "educational license". This is different to the VB Learning Edition, and would be well worth starting an evening A level course for.

I believe the three products are Office 2000 (Premium costs about £145), Windows 98/NT4 (costs under £100), and Visual Studio Professional (costs about £75). To make use of this facility you have to pay the money up front, then have an educational establishment counter-sign a form, which in turn is sent to Belgium. About three weeks later the CDs arrive. Install the software and you are up and running the latest Microsoft software at a fraction of the recommended retail price. Love him or hate him, Bill Gates certainly knows how to entice.

I took advantage of the deal and now have more programming languages (Visual C++, Visual J, Interdev, Visual Basic) than I can learn this winter! What is even sweeter is they are totally legitimate and I am registered with Microsoft as a programmer.

I hope the information allows others to investigate and make use of this fantastic deal.

**Mike Halliday, Neston, Cheshire,
via the Net**

Thanks Mike, this is obviously an offer well worth following up if you have educational connections.

PICS vs 8051

Dear EPE,

I am enjoying the Online version of your magazine and was wondering why you focus exclusively on the PIC microcontroller? Here in the USA, in industry the 8051 is the most used microcontroller as it's been around a long time and has so many companies that make different versions of it.

I finally found a book that was written by practicing teachers, not engineers! The book is *The 8051 Microcontroller and Embedded Systems* by Muhammed Ali Mazidi and Janice Gillispie Mazidi. Mr Mazidi is a teacher at DeVry Institute in Texas and this textbook is used there (of course).

My background is 22 years in Analog/RF and so learning microcontrollers was a bit of a challenge and frankly didn't make much sense until this book came along. Also, I frequent the **8052.com** website's Forum, and it was brought to the groups' attention that there's a new 8051 chip out that has 20MIPS throughput. The company's web address is **www.cygnal.com**. The features that are packed on that chip put any PIC to shame.

The Atmel 8051 chips are easily programmed using the simple programmer schematic on the Atmel applications notes page, so that should set someone back between \$15-\$20 US. Secondly, there is a free ANSI C compiler available on the web at **http://sdcc.soundforge.net**. For those who want to program in BASIC, the 8052 chip has a BASIC interpreter built in.

I would also like to see articles on designing and building a DSP (digital signal processor) circuit, maybe using a microcontroller.

Keep up the good work on your excellent magazine.

**Randall Seden,
Simi Valley, California, USA,
via the Net**

Editor Mike replied to Randall, saying that:

EPE is essentially a hobby/educational magazine and the PIC is much more suited to such users. PIC programmers cost about \$20 US (in kit form) with in-circuit emulators for around \$60 US in kit form. There is also plenty of free software around for these chips. The chips themselves are very cheap (starting at around \$3) and relatively easy to learn how to program. Hence their popularity in this area of the market.

The 8051 may well be the industry standard but because of the relative complexity and cost, it is not popular with the hobbyist or in schools, and frankly its extensive features are rarely required for the type of project most readers want to build.

WIND-UP TORCH

Dear EPE,

I would like to thank you for the *Wind-up Torch* of Oct '00. It's my first project that I am attempting. I have only been studying electronics over the past few months, and find it more and more fascinating every day.

I wondered if you could perhaps help me with a couple of queries. I have received all of the components, which I might add came close to £18 as stated in your approximate costing. I have also managed to get hold of an old photocopy machine which had lots of goods inside such as lenses and motors. Some of these motors have six, seven and even eight wires to them, I'm not quite sure how to wire them to the bridge rectifiers. Can you help?

**Darran McGee,
via the Net**

We are very pleased to learn that you have discovered the pleasures of our hobby Darren. Regrettably, though, we can never offer advice on modifying published projects to suit constructor's needs. Basically this is because we simply do not have the time to do so, but in this case is also due to us being unfamiliar with photocopier motors!

FLIGHT LOGGER

Dear EPE,

I am a disabled person due to an RTA some years ago but am, however, a keen microlighter. Due to my disability I have difficulty in turning around whilst in flight in order to see the contents of the fuel tank. As I have a keen interest in electronics, I thought I would build a microlight microprocessor design to overcome this, but am finding it too difficult to write the software.

You can imagine how excited I was on reading about your *8-Channel Data Logger* of Sept '99 which uses the PIC16F877 microcontroller. I am looking for some software for this range of PIC that would give me five A/Ds, with an external interrupt, outputting to an l.c.d. It should be capable of toggling through the l.c.d. displays – engine temp, fuel flow, air speed, r.p.m., etc.

Mike Woodmansey, via the Net

So sorry Mike, but I don't have the time to write the software for you. However, my Data Logger already shows how PICs can do A/D, although the interfacing to the various sensors you need would seem complex.

You might care to give thought to another option, though. I recently bought a new car that has the majority of the functions you need built into its dashboard. It might be worth enquiring of a car dealer if such equipment can be bought separately.

IR HEADPHONES

Dear EPE,

I am looking to make infra-red headphones/speakers for my A-level major project. I wrote off to Sanyo and they sent me a service manual of one of their models but it is very complicated. Have you published any such designs?

Chris Logan, via the Net

We published Mono Cordless Headphones in Aug '96 and Stereo Cordless Headphones in Dec '95. See our back issues page for details on purchasing copies of them.

ACTIVE PORT FINDING

Dear EPE,

Printer and serial port addresses have often caused much consternation and confusion when accessed directly by programs used to control hardware connected to the port, mainly because not all PCs use the same port addresses.

The usual base addresses for printer ports LPT1 to LPT3 are H378, H278 and H3BC respectively but this cannot be guaranteed.

Hardware addresses are of no consequence to the user if the PC is used as was intended, i.e. using calls to the BIOS. But how does the BIOS know the port addresses? Simple, they are stored in RAM.

To find the addresses in your computer open a DOS Window or shut down Windows to DOS mode. At the command prompt type **debug**. Then type **d0000:0400**. This command will print on screen a hex dump starting at the specified address. The printer and serial port base addresses will appear on the first line, for example:

```
COM1 COM2 COM3 COM4
0000:0400 F8 03 F8 02 00 00 00 00
          LPT1 LPT2 LPT3
          78 03 00 00 00 00 13 02
```

If the hardware does not exist or is disabled the address is zero. As you can see from the above my computer has two serial ports and one printer port. Any programming language that has a PEEK function (or equivalent) can access this memory. QuickBASIC has PEEK and DEFSEG. This makes it very easy to write a setup program to determine port addresses by asking the user which port number to use.

Peter Hemsley, via the Net

Hello again Peter, and yet more thanks! (Keep your useful suggestions coming...)

More letters on page 49

KITMASTER EDUCATIONAL KITS FROM GREENWELD

RADIO CLUBS – NOVICES – COLLEGES – SCHOOLS

www.greenweld.co.uk

SOLID STATE KITS

ALL KITS BUILT ON TRIPAD PCB
BUILD AS YOU SEE SYSTEM

FULL KIT &
INSTRUCTIONS

PERFECT FOR NOVICE FIRST TIME
BUILDERS IN ELECTRONICS

KMX1 2-IC MK484 MW RADIO	£11.50	KMB43 AUDIO NOISE GENERATOR	£11.50
KMX3 1-IC + TRAN MW RADIO	£11.50	KMB45 GENERAL 3 TRANSISTOR AMP	£6.75
KMX5 MK484 + 2030 MW RADIO	£21.95	KMB46 LM386 AMPLIFIER GENERAL	£6.75
KMX7 MK484 TUNER MW, NO AMP	£7.50	KMB48 COMMON PRE-AMP RADIO	£6.75
KMB2 BASIC CRYSTAL SET AMPLIFIED	£11.50	KMB49 PEST SCARER HIGH PITCH	£14.99
KMB4 WORKSHOP AMPLIFIER	£11.50	KMB50 VARIABLE FREQ. OSCILLATOR	£6.75
KMX11 S. METER	£11.95	KMB51 AUTOMATIC NIGHT LIGHT	£6.75
KMB44 SIMPLE HF MW ATU	£9.25	KMB52 FROST ALARM	£6.99
KMB8 SW TUNER GENERAL	£11.50	KMB53 PRESSURE MAT & ALARM	£16.50
KMC1 BASIC CRYSTAL SET MW	£7.95	KMB54 GUITAR TUNER	£11.50
KMB61 MW SIGNAL BOOSTER	£14.99	KMB55 TOUCH ALARM	£6.99
KMB9 FAKE CAR ALARM FLASHER	£6.30	KMB56 SIMPLE LIGHT METER	£16.50
KMB10 2 L.E.D. FLASHER	£5.95	KMB57 L.E.D. CONTINUITY METER	£5.50
KMB11 LOW VOLTS L.E.D. ALARM 9-12V	£6.30	KMB58 SOUND-OPERATED SWITCH	£7.95
KMB12 LIE DETECTOR WITH METER	£11.50	KMB58A 8 FLASHING L.E.D.s	£8.25
KMB13 TOY ORGAN	£7.95	KMB59 TBA 820M AUDIO AMP	£12.75
KMB14 METRONOME IC CONTROL	£6.30	KMB60 TDA 2030 AUDIO AMP	£11.50
KMB15 TOUCH SWITCH	£6.30	KMB62 ELECTRONIC DICE GAME	£10.30
KMB16 HEADS OR TAILS GAME	£6.30	KMB63 ADVANCED THERAMIN-MUSIC	£12.75
KMB17 SIREN	£5.95	KMB64 TOUCH DELAY LAMP	£7.95
KMB18 RAIN DETECTOR	£5.95	KMB65 FISHERMAN'S ROD BITE ALARM	£5.99
KMB19 CONTINUITY TESTER	£5.50	KMB66 BEAM BREAK DETECTOR ALARM	£9.75
KMB20 MORSE CODE OSCILLATOR	£5.95	KMB67 LATCHING BURGLAR ALARM	£9.25
KMB21 BURGLAR ALARM L.E.D. & SPEAKER	£6.30	KMB68 LIGHT-OPERATED RELAY	£9.25
KMB22 LOOP SECURITY ALARM	£6.30	KMB69 MICROPHONE PRE-AMP	£9.25
KMB23 VIBRATION ALARM	£5.95	KMB70 MAGNETIC ALARM-MODELS	£9.25
KMB25 HAND TREMOR GAME	£5.95	KMB72 BATH OR WATER BUTT ALARM	£8.25
KMB26 RAIN SYNTHESIZER - NOISE	£11.95	KMB73 0-18 VOLT POWER SUPPLY UNIT	£8.25
KMB27 AUTO LIGHT DARK INDICATOR	£5.95	KMB74 FM BUG POWER SUPPLY 0-9V	£7.99
KMB28 ADJ LOW LIGHT INDICATOR	£5.95	KMB76 2 TRANSISTOR FM BUG	£9.95
KMB29 DARK ACTIVATED L.E.D. FLASHER	£5.95	KMB77 CHIRP GENERATOR	£8.25
KMB30 LIGHT ACTIVATED TONE ALARM	£5.95	KMB78 TONE BURST GENERATOR	£8.25
KMB31 CAR ELECTRIC PROBE	£5.75	KMB79 SOUND EFFECTS GENERATOR	£11.95
KMB32 SIGNAL INJECTOR	£5.75	KMB80 LIGHT METER - PHOTOGRAPHY	£11.95
KMB33 MOISTURE METER - L.E.D.	£5.95	KMB81 LIGHT OSCILLATOR - PHOTOGRAPHY	£11.50
KMB34 L.E.D. TRANSISTOR TESTER NPN	£5.75	KMB82 LIGHT-ACTIVATED RELAY	£11.50
KMB35 DIODE TESTER - L.E.D.	£5.75	KMB83 DARK-ACTIVATED RELAY	£11.50
KMB36 L.E.D. TRANSISTOR TESTER PNP	£5.75	KMB84 SOUND SIREN + LOUD AMPLIFIER	£13.95
KMB37 IC 555 TESTER - L.E.D.	£6.75	KMX12 AUDIO PROBE	£11.95
KMB38 0-18 MIN TIMER L.E.D. & SPEAKER	£6.75	KMX14 CHILD SPEAK LAMP	£8.25
KMB39 TOY THERAMIN MUSIC	£8.25	KMZ1 SW GEN RECEIVER	£16.50
KMB40 AMPLIFIED RF PROBE + METER	£11.95		
KMB41 TRANSMITTER RF INDICATOR L.E.D.	£5.95		

ALL KITMASTER KITS DESIGNED



BY DAVID JOHNS



FREE CATALOGUE

GREENWELD OFFERS A MASSIVE RANGE OF LOW COST ELECTRONIC COMPONENTS, NEW AND SURPLUS. WHETHER YOUR INTEREST IS IN ELECTRONICS, MODEL ENGINEERING, AUDIO, COMPUTERS OR ROBOTS, WE HAVE SOMETHING FOR YOU.

LOOK! NEW BATTERY VALVE KITS YES, THEY'RE HERE. IF YOU'RE LIKE US AND DON'T WANT TO BOTHER WITH BATTERIES, WE SUGGEST YOU BUILD T1 BATTERY ELIMINATOR FIRST THEN YOU CAN CHOOSE WHICH RADIO TO START ON. WE WILL ADD THAT T2 IS AN EXCELLENT LITTLE MEDIUM WAVE SET, IT'S WORTH CONSIDERING AND IT'S GOT GOOD VOLUME, EASY TO BUILD.

Send now for our comprehensive
FREE catalogue



NEW RADIO VALVE KITS

LOW PRICED ECONOMY RANGE

ALL ESSENTIAL PARTS SUPPLIED - VALVES - TRANSFORMERS - SPEAKERS - TAGSTRIP - POTENTIOMETERS - KNOBS - TUNING CAPACITORS - AERIAL FORMERS - VALVE HOLDERS - RADIO CHASSIS - CAPACITORS - RESISTORS - SOLDER - WIRE - PLUS FULL INSTRUCTIONS

PLEASE NOTE: CASES ARE NOT INCLUDED

KMK1 VALVE RADIO POWER SUPPLY UNIT, IDEAL FOR MOST OF OUR KITS. HT 210 VOLTS D.C. AND LT 6-3 VOLTS A.C.	£26.00
KMK2 VALVE PSU HIGHER OUTPUT, OK FOR MOST OF OUR KITS. HT 250 VOLTS D.C. AND LT 6-3 VOLTS A.C. BOTH PSUs HAVE 100 mA TRANSFORMERS	£28.00
KMK3 TWO VALVE REGEN RADIO, WORKS ON MW OR SW INTERCHANGEABLE AERIAL COIL FORMER. COMES WITH SPEAKER - OUR BEST SELLER	£31.50
KMK4 ONE VALVE AMPLIFIER USES THE EL84 VALVE STILL MADE TODAY. IDEAL SHACK PROJECT. EASY TO BUILD, GOOD SPEAKER VOLUME	£16.50
KMK6 ONE VALVE REGEN RADIO. THIS KIT COMES WITH GOOD QUALITY EARPIECE. CAN BE USED EITHER MW OR SW. GIVES GOOD RESULTS	£18.50
KMK7 THIS VERY GOOD AMPLIFIER USES THE EL84 AND ECL83 VALVES. A VERY VALUABLE TWO VALVE AMP IN THE SHACK. GOOD SPEAKER VOLUME	£23.00
KMK8 ONE VALVE EXPERIMENTAL CRYSTAL SET WITH SOLID STATE INCORPORATED. IDEAL FOR HAM EXPERIMENTS. GOOD SPEAKER VOLUME	£22.00
KMK9 ONE VALVE MW RADIO THIS ONE IS NOT REGEN. INSTEAD IT HAS SOLID STATE AS WELL. GOOD SPEAKER VOLUME, EASY TO BUILD	£26.00
KMK10 MODERN TWO VALVE MW RADIO WITH SOLID STATE. USES TWO VALVES MADE TODAY. NO COILS TO WIND, GOOD SPEAKER VOLUME	£31.50
KMK11 ANOTHER TYPE OF DESIGN TWO VALVE SW RADIO. OPERATES APPROX. 6MHz TO 14MHz. IDEAL GENERAL SW SET, GOOD SPEAKER VOLUME	£33.50
KMK12 TWO VALVE AMPLIFIED CRYSTAL SET, MW OR SW. IDEAL HAM KIT INCORPORATES OA90 DIODE WITH EL84 AND ECC83 VALVES, LOUDSPEAKER	£31.50
KMK13 TRY BUILDING THIS TWO VALVE REGEN RADIO. USES THE EF91 AND ECL80 VALVES, GOOD SPEAKER VOLUME, REGEN MW OR SW	£31.50
KMK14 LOOK AT THIS ONE, IT'S A THREE VALVE MW OR SW REGEN SET WITH RF STAGE, GOOD SELECTIVITY, GOOD SPEAKER VOLUME	£39.95
KMK15 MW OR SW THREE VALVE REGEN RADIO USING A DIFFERENT SYSTEM, THIS USES EF91, EF80, EL84, VERY LOUD SPEAKER	£39.95
KMK16 FOUR VALVE MW OR SW TOP OF THE RANGE, DESIGNED FOR EASY BUILDING NOVICES, GOOD SELECTIVITY, GOOD SPEAKER VOLUME	£55.00

LOOK! NEW BATTERY VALVE KITS - RADIOS - AMPLIFIERS ALL THESE BATTERY KITS WORK AT JUST 9VOLTS D.C.

KMT1 BATTERY ELIMINATOR - DON'T WANT TO USE A BATTERY? USE OUR PSU, GIVES 9VOLTS D.C. AND 1-5 VOLTS D.C. FOR ALL BATTERY KITS	£27.95
KMT2 BATTERY MW THREE VALVER AND A GOOD ONE, USES TWO IT4 VALVES WITH A DL96, VERY LOUD SPEAKER, GOOD PROJECT	£39.95
KMT3 SHORT WAVE BATTERY THREE VALVER, COMES WITH THREE AERIAL FORMERS, IDEAL HAM PROJECT, GOOD SPEAKER VOLUME	£44.99
KMT4 WANT A BATTERY VALVE AMPLIFIER? TRY THIS TWO VALVE AMPLIFIER, IDEAL FOR THE SHACK, MANY USES, VERY LOUD SPEAKER	£26.50
KMT5 BATTERY TWO VALVE MW CRYSTAL SET, STRICTLY FOR THE HAM EXPERIMENTER. USES IT4 AND DL96 WITH OA90, GOOD SPEAKER VOLUME	£33.95
KMT6 BATTERY TWO VALVE MW RADIO INCORPORATING SOLID STATE, NO OUTSIDE AERIAL NEEDED, GOOD SPEAKER VOLUME, GOOD PROJECT	£39.99
KMT7 BATTERY TWO VALVE GENERAL SW RADIO, 6MHZ TO 14MHZ APPROX. NO REGEN, VERY LOUD SPEAKER, EASY TO BUILD	£39.95

ALL RADIO CHASSIS PRE-DRILLED AND VALVE BASES FITTED READY
FOR QUICK ASSEMBLY

Visit our new web site: <http://www.kit-master.co.uk>
<http://www.greenweld.co.uk>

For our FREE catalogue E-mail: service@greenweld.co.uk

P&P £3.00
£10 OVERSEAS AND NEXT DAY

MAIL ORDER ONLY
PLEASE ALLOW UP TO
28 DAYS FOR DELIVERY

MERRY CHRISTMAS TO ALL OUR CUSTOMERS



WE ACCEPT PAYMENT BY
CHEQUE, POSTAL ORDER
AND CREDIT CARD



UNIT 24, WEST HORNDON
INDUSTRIAL PARK
WEST HORNDON, BRENTWOOD,
ESSEX CM13 3XD



TEL: 01277 811042
FAX: 01277 812419

NEW OLD READER

Dear EPE,

Would you believe that the *EPE* November issue is the first electronics mag I have bought since 1995! Although I have been an electronics "nut" for 30+ years and have over this time had most of the electronics mags (I still have some 1960's issues of *PE*).

I generally build with a specific purpose in mind, and use a lot of recovered parts from old boards. My last major project revolved around a Maplin Z80 development board, driving a MIDI keyboard interface for my Elka E19 Electronic Organ, some 20+ i.c.s. It has RS232 PC connection for download of .OBJ files. I now find I can do the same thing with a PIC and a couple of i.c.s.

The web support from Microchip is excellent, especially for MPLAB. I am now building a PIC16F874 version of my MIDI interface, so was pleased to read *EPE*'s articles. I'm considering building the *Pulsometer* (Nov '00) as I have most of the components. The other articles will be useful for pinching a few circuit ideas, keep it up!

I also run a components swap site, at oldicbank@b980qp.freemove.co.uk.

Les Clarke, via the Net

Welcome back, Les. Keep up your enterprises too!

PIC TUTOR

Dear EPE,

I purchased the *PICtutor* CD-ROM and deluxe development kit from you a few months ago. The board and software are very good, but now I have programmed the PIC16F84, I need to go the next step further. I am designing a program which needs around 30 outputs. The ideal chip I need is the PIC16F877, which is a 40-pin i.c. *PICtutor* only programs the PIC16x84. How can I now get hardware and software to program the PIC16F87x range?

I like the way you can program and use the i.e.d.s and switches to test the program after you have finished programming it. Is there a kit like *PICtutor* for the PIC16F877 where I can do all this?

Rob P. Via the Net

My PIC Toolkit Mk2 of May/June '99 (updated to V2.4 Nov '00) handles PIC16x84 and PIC16F87x devices, although it does not have development switches and i.e.d.s such as are included on *PICtutor*. I am not aware of any programmer that does offer all the features you require. Nonetheless, I am sure that Toolkit's additional features, such as automatic control of program voltages and the ease of code assembly and programming, will be of great use to you.

DELPHI POWER

Dear EPE,

Further to the on-going BASIC discussion, why not use Delphi 2 or 3 where you can access the ports through simple in-line assembler routines, easy to write and implement. No need for DLL and runtime modules, etc. If you use Delphi 1 you can access the ports directly.

Anyway, I think that Delphi is more powerful than VB, more "modern" and through its educational value would yield more knowledge to the user for PC interface projects.

Alexandre Cazin, via the Net

It's a good recommendation you make Alexandre, and which may sway other readers. For myself, though, I am now so far advanced into using VB6 that the steepness of yet another learning curve to come to grips with makes me reluctant to examine Delphi as well. It is obvious, however, that Delphi has many attractions, and devotees.

Incidentally, thanks to all of you who have been entering into this interesting discussion, and for the helpful comments made, not only here in Readout, but also through our Chat Zone.

DELPHI AND PORTS

Dear EPE,

This little bit of in-line assembly should allow you to use Delphi to read any port. I currently use it in Delphi 5 Pro and find that converting some functions into assembly can really speed things up.

```
function ReadPort(nPort : Word) Byte;
begin
PortNumber:=nPort;
var nByte,PortNumber,DataPort dWord;
asm
    mov dx,word ptr PortNumber
    in al,dx
    mov byte ptr DataPort,al
end;
Result:=Lo(LoWord(DataPort));
end;
```

Feel free to use this code in anything. Also could you please consider AVR's instead of PIC's sometime. I do use PIC's a lot for embedded stuff interfaced with Delphi. But I do prefer using AVR's as they're faster and simpler to use.

Jamie Dainton, via the Net

Thanks, Jamie. It's interesting how we as an electronics magazine find that so much of the correspondence is about programming aspects.

As I know from my own personal experience, of course, there are so many electronics designs that can be simplified through using programmable devices. It is understandable that many readers feel similarly (although we recognise that many do not, and we would reassure them that we have no intention of ever ignoring their interests.)

As we have previously said in Readout, it's PIC's that most readers are interested in.

TRANSLATION

Dear EPE,

I am interested in building the *Rev Counter* of Dec '96. I have built the *PIC Tutorial* board, and have programmed several PIC's with it and find it really good.

I am having problems programming a PIC with the program from your FTP site. I know that it is meant for a PIC16C54 but I want to use a PIC16F84 because I have it available. I am having problems modifying the code for this PIC, even though the published text says that it is possible. What do I do?

Also, my technology teacher would like to know if there is any difference between the PIC16C84 and the PIC16F84.

William Quinn, via the Net

Sorry to disappoint you William, but we cannot offer advice on translation of code to suit different PIC variants. This is a matter to which readers must pit their own capabilities at logical analysis of a programming problem.

In fact there is little difference between the code required for PIC16C54 and PIC16x84 devices. We suggest you obtain the (free) data sheet for both devices from Microchip's web site at www.microchip.com. In the long run, if you have programming ambitions, by solving this problem for yourself, you will be well on the way to understanding how to fully apply logical thinking to all manner of computing problems.

On your other query, any code written for the 'C84 will run on the 'F84. However, this is not necessarily true the other way round since the 'F84 has more registers than the 'C84. Having just received Microchip's latest CD-ROM, though, it seems that the 'C84 is no longer in production, having been entirely replaced by the 'F84.

Incidentally, it seems likely that Toolkit can also program PIC16F83 devices, these having the same basic specs as the '84 except that the '83 only has 512 bytes of program memory compared to the 1024 bytes of the '84. The EEPROM data memory is the same.

PIC TRASHED?

Dear EPE,

I've been using your excellent (original) programmer for over a year. Just recently an odd thing happened. I decided to change the PIC factors in a working PIC to allow flash programming. By accident I selected an '84 (I only use F874) and hit Return - BANG! the PIC will no longer run. I've tried resetting the PIC factors, but it still won't play. What have I done? Luckily I had a spare which I successfully programmed and factored (more care taken this time!) Have I made a duff item?

Chris Jones,
via the Net

I don't know, Chris. Similar problems have been reported by readers using other types of programmer too. It is not specific to Toolkit (to which I assume you refer).

However, I have only heard of it occurring with PIC16F87x devices, not with the PIC16x84 - you are the first to report the problem with this device.

It seems that PIC16F87x devices in such circumstances have had one or more Code Protect flags unintentionally set as active and which cannot be deactivated, even though this protection is normally under the control of the Configuration Word settings sent by the user through the Config option.

I suspect that one of my PIC16F877 chips has suffered similarly, but I have not yet looked into it, although I shall in due course. If I solve it, I'll report the method through Readout. Do any readers know the answer already?

TOOLKIT V2.4 AND V3.1

Dear EPE,

After following the excellent *PIC Tutorial* series and subsequent articles, I am hooked on PIC programming. Indeed it has found many uses in my job as a faulting Engineer with Racal. Unfortunately I am experiencing a problem when I try to assemble a particular file I am working on using *PIC Toolkit V2.4*. This displays the message "String space corrupt in line 100 of module TKPROG02 at address 15f8:0E2E".

The same message has appeared with different line numbers and addresses. The problem seems to be experienced as soon as I include any additional line in the program. If I add data after line 1827 the error is flagged when the .ASM file is assembled. The data after line 1827 is no different to data elsewhere in the program. Any help you can give me will be much appreciated.

Stuart Pearson, via the Net

Stuart attached his program file to his E-mail and running it on my computer caused Toolkit to crash as well. Examination showed that he was using too many definitions (the limit is set at 20) and too many jump calls (a limit of 1000).

Both limits were set based upon my experience at writing programs and both seemed reasonable values. I suggested to Stuart that if he had QBasic (or QuickBASIC) he could increase the limits as set by the DIM statements for DEFINE() and JUMP() near the head of TKPROG02.BAS.

Stuart then E-mailed back to me, saying that he had changed the DIM parameters and the .ASM file now assembled correctly. Great!

It's a lesson, though, which many of us programmers can learn from. We need to periodically make assumptions about how others are going to use our software, and inevitably there will be occasions when we do not necessarily recognise all the permutations of use!

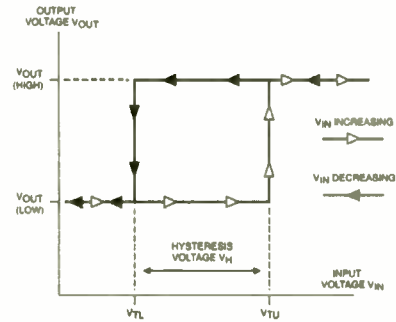
By the way, I am well advanced into writing Toolkit for Windows using VB and taken feedback as provided by Stuart will be taken into account. If you would like any features added to this developing software, let me know (it won't see publication until well into 2001, though). A new p.c.b. will also be developed - any suggestions for this too will be welcomed.

THE SCHMITT TRIGGER

ANTHONY H. SMITH

Part 3

In this short series, we investigate the Schmitt trigger's operation; explore the various ways of implementing its special characteristics and also look at how we can use it to create oscillators and pulse width modulators.



Precision Schmitt Triggers and Multivibrators

WE saw in Part Two of this series how operational amplifiers and comparators can be used as the active elements in Schmitt trigger circuits. By treating the op.amp or comparator as a "black box", the design process is often much simpler than the methods needed to design "discrete" Schmitt triggers using bipolar transistors and f.e.t.s.

Furthermore, the combination of high gain, small offset voltages and low input bias currents common to most op.amps and comparators usually results in a Schmitt trigger with superior performance to those built using transistors.

However, even when good quality op.amps or comparators are used, factors such as resistor tolerance and variations in output saturation levels can lead to ambiguities in the desired threshold levels. Furthermore, altering the value of one threshold by changing a resistor value can result in an unwanted change in the other threshold due to the interdependence of the switching levels.

This month, therefore, we take a look at methods that can reduce or even eliminate these uncertainties, resulting in precision Schmitt triggers with highly accurate threshold levels which in most cases can be varied independently of each other. We end this part by introducing two useful circuits, the monostable and bistable multivibrator, which are both based on the Schmitt trigger function.

SWITCHING OUT UNCERTAINTY

The circuit shown in Fig.3.1 uses an analogue switch, IC1, and a comparator, IC2, to form a single-supply, semi-precision, inverting Schmitt trigger. The switch (one quarter of a 74HC4066) is controlled by the logic level signal at pin 13: when this signal is "low", the switch is open; when it is "high", the switch is closed.

As shown by the circuit waveforms, the inverting nature of the circuit means that the comparator output, V_{OUT} , is at its high level, V_{OH} , when V_{IN} is more negative than the voltage $V+$ at the non-inverting input. Therefore, the switch is closed and the non-inverting input voltage is given by:

Non-inverting input voltage,

$$V+ = V_{REF} \times \frac{R2}{R2 + R1/R_{ON}} \quad (\text{switch closed})$$

where $R1/R_{ON}$ is the parallel combination of $R1$ and the switch "on" resistance.

For the 74HC4066, R_{ON} is typically around 100Ω . Therefore, since R_{ON} is much less than $R1$ and $R2$, the expression may be simplified to $V+ = V_{REF}$, and so ignoring the comparator's offsets (typically just a few millivolts) we can say that the Upper Threshold Voltage, $V_{TU} = V_{REF}$.

When V_{IN} becomes more positive than V_{TU} , V_{OUT} goes to its low level, V_{OL} , causing the switch to open. The non-inverting input voltage is now given by:

Non-inverting input voltage,

$$V+ = V_{REF} \times \frac{R2}{R2 + R1} \quad (\text{switch open})$$

and again ignoring offsets, we can say that the Lower Threshold Voltage, $V_{TL} = V_{REF} \times R2 / (R2 + R1)$.

Beware that these equations ignore the effects of switch leakage currents and comparator input bias current which can result in significant errors if $R1$ and $R2$ are very large. However, $R1$ and $R2$ should not be too small or R_{ON} must be taken into consideration.

COMMON MODE RANGE

CMOS comparators like the TLC3702 are ideal for this kind of application. When operating on a single +5V supply, the input common mode range is 0V to 4V; therefore, V_{IN} , V_{TU} and V_{TL} can lie anywhere within this range.

The extremely low input bias current (typically just 5pA at room temperature) not only allows for large values of $R1$ and $R2$, but also reduces the loading on V_{IN} to a negligible level.

The TLC3702's output swings to within a few hundred millivolts of its supply rails. Therefore, provided the output is lightly loaded, and with a supply voltage $+V_S = 5V$, we can assume $V_{OL} = 0V$ and $V_{OH} = +5V$. These levels are ideal for controlling the 74HC4066, which typically requires a minimum high level control voltage of 3.5V and a low level control voltage no greater than 1.5V.

Since $V_{TU} = V_{REF}$, it is possible to set the upper threshold level very accurately. For example, V_{REF} could be a precision voltage

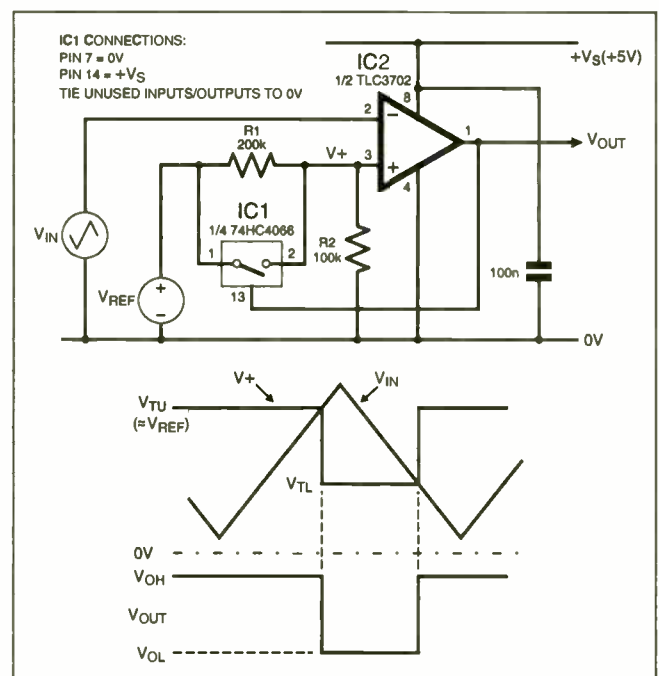


Fig.3.1. An analogue switch (IC1) allows for precise control of the Upper Threshold Level.

reference. Alternatively, V_{REF} could be derived from a DAC (Digital-to-Analogue Converter) allowing precise, digital control of the upper threshold.

The circuit can only be considered "semi-precision" because V_{TL} is influenced by the tolerances of R1 and R2, and will vary if V_{REF} is changed (i.e., V_{TL} is dependent on V_{TU}). Nevertheless, for applications that require only one accurate threshold, and where the other threshold is needed only to introduce hysteresis for noise-immunity, this circuit could be ideal.

A test circuit was built using 1% tolerance resistors and V_{REF} set to 3.0V to give nominal thresholds of $V_{TU} = 3.0V$ and $V_{TL} = 1.0V$. The actual values measured using a low-frequency triangle wave for V_{IN} were $V_{TU} = 3.0V$ and $V_{TL} = 0.94V$.

TWO REFERENCES

For applications requiring precise control of both switching levels, the circuit in Fig.3.2 can be used to provide accurate and independent control of each threshold. This circuit is a bipolar, inverting Schmitt trigger, in that the input voltage and threshold levels may be positive or negative, and the output is "inverted" relative to the input signal – see the waveforms.

A two-channel analogue switch, IC1, and two reference voltages, V_{HIGH} and V_{LOW} , are used to set the thresholds. The switch implements a "single-pole, double-throw" (s.p.d.t.) action (also known as single-pole change-over), such that when the output of the comparator, IC2, is high, the switch selects V_{HIGH} and connects it to the non-inverting input via R1. Therefore, ignoring comparator offsets, the Upper Threshold Voltage, $V_{TU} = V_{HIGH}$.

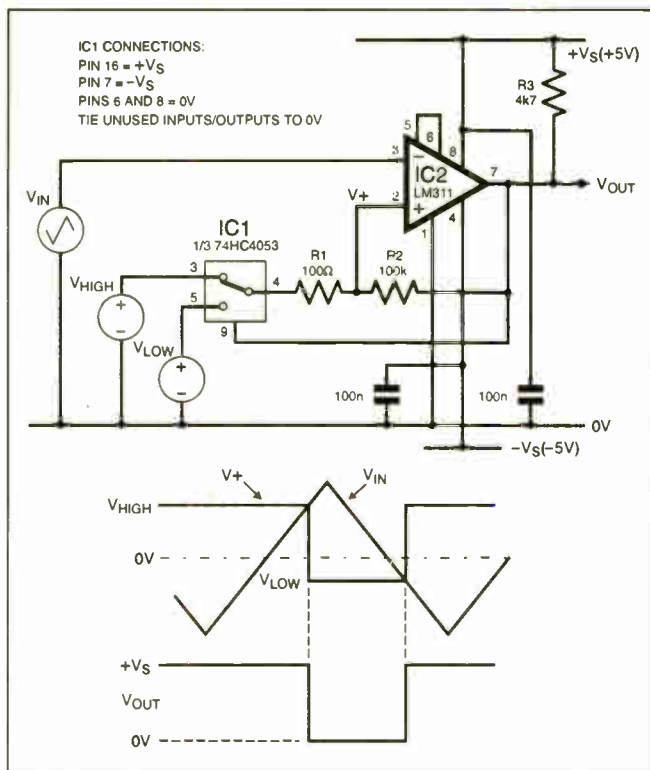


Fig.3.2. A two-channel analogue switch provides precise control of both thresholds.

When V_{IN} crosses this level, V_{OUT} goes low and the switch changes state and connects V_{LOW} to the non-inverting input. Therefore, the Lower Threshold Level, $V_{TL} = V_{LOW}$, and the circuit will remain in this state until V_{IN} goes negative and crosses V_{TL} . Clearly, the thresholds may be set accurately and independently by using suitable reference voltages for V_{HIGH} and V_{LOW} .

Depending on the comparator type and circuit layout, it may be necessary to introduce a small amount of additional hysteresis around the comparator to prevent "chatter". This is achieved by resistors R1 and R2; provided R2 is much larger than R1, the resulting hysteresis is very small (typically just a few millivolts) and has negligible effect on the thresholds set by V_{HIGH} and V_{LOW} . In certain cases, R1 may not be needed, since the switch "on" resistance alone (typically around 40Ω for the 74HC4053) may be sufficient.

ANALOGUE SWITCH TYPES

As well as having low "on" resistance, the 74HC4053 is relatively inexpensive and is well suited to this application. The 4000-

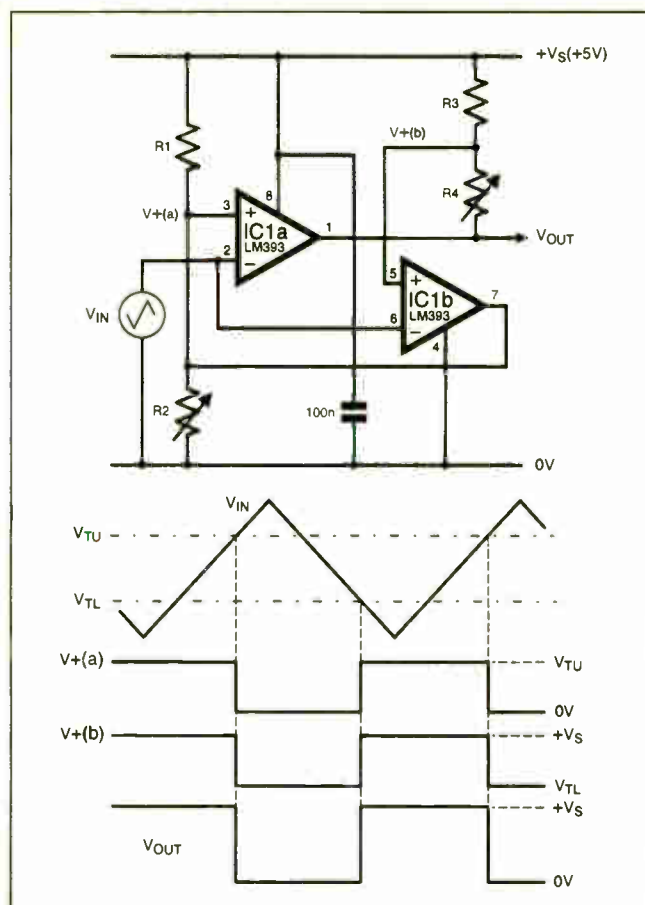


Fig.3.3. Circuit for a dual comparator Schmitt trigger having independent threshold adjustment.

series version, the 4053, could also be used if preferred. Both types typically have very low leakage currents, usually less than 1nA, although the maximum leakage can be as high as 1μA. However, even this is unlikely to cause problems unless V_{HIGH} and V_{LOW} are derived from sources with high output resistances.

When used in bipolar applications like this one, the 74HC4053 supply rails are limited to around ±6V (the 4053 can usually tolerate slightly greater supplies, around ±8V). With the V_{SS} or "GND" terminal (pin 8) connected to 0V, the logic level control voltage at pin 9 must swing between 0V and the positive supply.

This is readily achieved using the LM311 comparator which has an open-collector output and an "uncommitted" emitter terminal (pin 1). Therefore, by connecting pin 1 to 0V, and connecting pull-up resistor R3 between the output and +V_S, V_{OUT} will swing between 0V and +V_S.

When operating on ±5V supplies, the LM311 common-mode input range is typically -4.7V to +3.5V. Therefore, V_{IN} , V_{HIGH} and V_{LOW} can lie anywhere within this range, provided, of course, that V_{HIGH} is more positive than V_{LOW} .

Alternative analogue switch types are available which enable operation at higher voltages. For example, by combining two complementary, single-pole, single-throw switches from the DG403 analogue switch i.c. to implement the s.p.d.t. function, voltages in the range ±15V can be accommodated.

Whichever type of switch package is used, always check the data sheet to determine the maximum operating voltage range, and the corresponding values of switch control levels.

DUAL COMPARATOR

For applications requiring reasonably accurate, independent adjustment of the thresholds, the circuit of Fig.3.3 forms a Schmitt trigger built using a dual, open-collector comparator. Notice how each comparator provides positive feedback for the other, resulting in overall positive feedback (essential to Schmitt trigger behaviour) around the entire circuit.

To understand how the circuit works, assume $V_{IN} = 0V$ (the lowest point of the triangular waveform). The non-inverting input of each comparator is more positive than its inverting input, and so the internal output transistors are "off" and the open-collectors are pulled high by the respective resistors.

Under these conditions, IC1b's output has no effect on the R1-R2 potential divider, and so the potential at IC1a's non-inverting input is:

$$V+(a) = +V_S \times R2 / (R1 + R2).$$

Ignoring offsets in IC1a, this voltage defines the Upper Threshold Voltage:

$$\text{Upper Threshold Voltage, } V_{TU} = +V_S \times \frac{R2}{R2 + R1} \quad (\text{volts})$$

The circuit output, V_{OUT} , is at its high level, $+V_S$, pulled up by R3 and R4. When V_{IN} goes more positive than V_{TU} , IC1a's output goes low, and provided R3 and R4 are not too small, we can assume that IC1a's negative saturation voltage = 0V. In other words, when IC1a's output transistor turns "on", its collector pulls V_{OUT} down to 0V.

The non-inverting input of IC1b (which was previously pulled up to $+V_S$ via R3) is now pulled down to a voltage given by:

$$V+(b) = +V_S \times R4 / (R3 + R4)$$

Again, ignoring offsets in IC1b, this potential defines the Lower Threshold Voltage:

$$\text{Lower Threshold Voltage, } V_{TL} = +V_S \times \frac{R4}{R3 + R4} \quad (\text{volts})$$

Now, at the instant of switching, the value of V_{IN} at IC1b's inverting input will be just slightly greater than V_{TU} . Therefore, provided V_{TL} is set lower than V_{TU} , IC1b's output will go low, pulling $V+(a)$ down to 0V. This positive feedback enhances the overall switching action, and we see the regenerative behaviour essential to the Schmitt trigger function.

V_{OUT} is now at its low level (approximately 0V), and the circuit remains in this state until V_{IN} falls below V_{TL} , at which point IC1b's output transistor turns "off", and $V+(a)$ returns to its initial value of V_{TU} .

Since this is greater than the present value of V_{IN} , IC1a's output goes high as its output transistor turns "off", and $V+(b)$ is pulled up to $+V_S$ via R3. Again, positive feedback around the comparators enhances the switching action and rapidly forces the circuit back into its original, stable state.

RESISTOR TOLERANCE

The equations for V_{TU} and V_{TL} show that both thresholds are dependent on $+V_S$, and will be affected by resistor tolerance and by any other change in resistor values, such as temperature drift. The effects of changes in $+V_S$ could be eliminated by connecting R1 and R3 to a precision reference voltage, V_{REF} , such that:

$$V_{TU} = +V_{REF} \times R2 / (R1 + R2), \text{ and}$$

$$V_{TL} = +V_{REF} \times R4 / (R3 + R4)$$

In spite of the dependence on resistor values, the equations show that the thresholds can be set and adjusted completely independently of each other. This could be achieved, for example, by using variable resistors for R2 and R4 as shown in Fig.3.3.

A test circuit was built using the popular LM393 dual comparator for IC1a and IC1b (open-collector comparators are essential) which has an input common-mode range of 0V to 3.5V when powered from a 5V supply. With $+V_S = 5.0V$, and $R1 = 20k\Omega$, $R2 = 30k\Omega$, $R3 = 120k\Omega$, and $R4 = 30k\Omega$, the nominal thresholds are $V_{TU} = 3.0V$ and $V_{TL} = 1.0V$.

Using a low frequency, triangular wave input voltage, the actual threshold levels were measured as $V_{TU} = 3.0V$ and $V_{TL} = 1.0V$, but some "chatter" was noticeable on V_{OUT} as V_{IN} crossed V_{TL} .

It was found that this could be eliminated either by reducing the resistor values (which minimises the effects of stray capacitive coupling), or by connecting a small capacitor (around 33pF) between the non-inverting input and output of IC1a.

OUTPUT LOADING

Any load connected between V_{OUT} and 0V will form a potential divider with R3 and R4, and will "pull down" $V+(b)$ when IC1a's output transistor is "off". However, this will not affect circuit operation, provided $V+(b)$ is not pulled below the level of V_{TU} . In most cases, a light load such as the input(s) to one or more CMOS logic gates will have negligible effect on V_{OUT} .

Heavier loads which require significant current must be connected between V_{OUT} and the supply voltage: this is the common configuration for loads connected to *npn* open-collector outputs. Two examples are shown in Fig.3.4.

Comparators like the LM311 can sink up to 40mA or so, and are thus capable of driving relays as shown in Fig.3.4a. (The diode must be included to protect the comparator output against inductive "spikes" occurring when the relay coil de-energises).

The circuit diagram in Fig.3.4b shows an l.e.d. (light-emitting diode) load. The series resistor should be chosen to give adequate light output for a given l.e.d. type. Since the circuit is an inverting Schmitt trigger (i.e., V_{OUT} goes low when V_{IN} is more positive than V_{TU}), the l.e.d. will be illuminated when V_{IN} exceeds the upper threshold and will remain "on" until the input voltage falls below V_{TL} .

Beware that high-current loads may cause a significant increase in the comparator's negative saturation voltage, which has been assumed equal to 0V in the calculations for V_{TU} and V_{TL} . For example, with one of the LM311 comparators loaded only with a 15k Ω pull-up resistor, a negative saturation voltage of just 31mV was measured.

However, with an l.e.d. and 560 Ω series resistor connected as shown in Fig.3.4b, the 5mA l.e.d. current resulted in a negative saturation voltage of 236mV. Clearly, for loads such as relays, which require several tens of milliamps, the saturation voltage could rise toward half a volt, or so.

Although the circuit in Fig.3.3 is shown with a 5V supply, higher supply voltages can be used if the comparators are rated accordingly. The LM311, for instance,

can be powered by voltages as high as 36V. As well as providing for a much greater input common-mode voltage range, the higher supply voltage also means there is more power available to the load.

COMPLEMENTARY PRECISION

The Schmitt trigger shown in Fig.3.5 is ideally suited to digital systems in which an analogue input signal must be converted accurately into two, complementary digital outputs. Although a dual op.amp, the ST Microelectronics TS912, is shown, a dual comparator with suitable input and output characteristics could be used equally well.

The TS912 is a CMOS device with "rail-to-rail" input and output voltage ranges. This means that the voltage applied to the inputs can take any value between the negative and positive supply rails (in this case, 0V and +5V, respectively), and the output voltage will swing to within 50mV of each supply rail when lightly loaded.

However, when used as a comparator, an essential feature of the TS912 is the fact that the *differential* input voltage range, that is, the voltage between the inputs, can be as much as $\pm V_S$ without causing damage or malfunction.

Not all op.amps have this capability. For instance, the TS922 is also a rail-to-rail op.amp, but is not suitable for use as a comparator since its differential input range is limited to just $\pm 1V$. If you wish to use an op.amp as a comparator in an application where the inputs may differ by several volts, always check the specifications to ensure the differential input range is adequate.

S-R LATCH

The NOR gates (IC2) function as a simple S-R latch with complementary outputs. NAND gates could also be used, but the input connections to IC1a and IC1b would need to be swapped over. Circuit operation can be understood by referring to the waveforms and assuming V_{IN} and V_{OUT} are at 0V, and that op.amp offsets are so small as to be negligible.

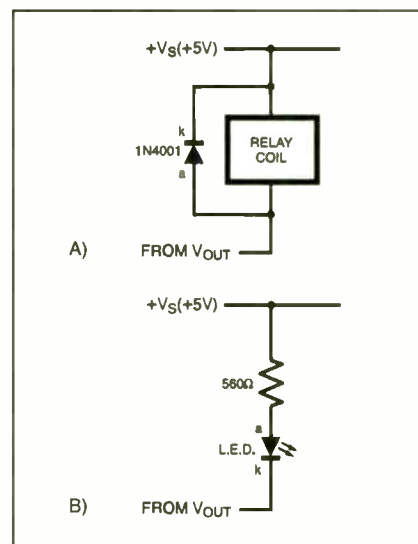


Fig.3.4. Open-collector loads: (a) relay; (b) l.e.d.

As V_{IN} rises above V_{LOW} , IC1b's output changes state and goes low, but this has no effect on the latch which remains in its "reset" state. Now, when V_{IN} rises above the upper threshold established by V_{HIGH} at IC1a's inverting input, IC1a's output responds by going high and "sets" the latch, causing V_{OUT} to go high, also.

The latch remains "set" until V_{IN} falls low enough to cross the lower threshold set by V_{LOW} at IC1b's non-inverting input. At this point, IC1b's output goes high and resets the latch, causing V_{OUT} to go low. For low frequency input signals, the accuracy of the thresholds depends only on V_{HIGH} , V_{LOW} and the op.amps' input offset voltage.

At high frequencies, however, the op.amps' response time introduces delays t_{DR} and t_{DF} before the rising and falling edges, respectively, of V_{OUT} . When V_{IN} crosses the upper threshold set by V_{HIGH} , IC1a takes a finite time to come out of negative saturation.

There is then a further delay caused by its limited slew rate (indicated by the sloping edges of its output waveform) before its output voltage reaches IC2a's input high logic level, at which point the latch is set and V_{OUT} goes high.

The overall delay, t_{DR} , means that the *apparent* upper threshold level is higher than the nominal level set by V_{HIGH} . A similar delay, t_{DF} , caused by IC1b, results in the *apparent* lower threshold level being less than the nominal value set by V_{LOW} .

CIRCUIT TESTS

With $V_{LOW} = 1.0V$ and $V_{HIGH} = 4.0V$, the circuit was tested using a 70Hz input signal and the thresholds were found to be 1.0V and 4.0V, respectively. However, with the input frequency increased to 6kHz, the t_{DR} and t_{DF} delays (each around 46µs) caused a shift in the apparent thresholds:

$$V_{LOW} = 0.57V \text{ and } V_{HIGH} = 4.6V.$$

Consequently, for precision operation at high frequencies, it would be necessary to replace the TS912 with a faster dual device. For low frequency applications, however, the TS912's very low input current (typically just a few picoamps) makes it ideal for use with high-impedance voltage sources.

As it stands, the circuit is restricted to single-rail operation, since the op.amp outputs must not swing below the NOR gates' negative rail, which in this case is 0V. For bipolar operation, the TS912 op.amps could be replaced with two LM311 comparators, with the emitter terminals (pin 1) connected to 0V as shown in Fig.3.2.

Although it is not essential for IC1a and IC1b to have rail-to-rail outputs, their output swing must satisfy the input logic level requirements of the NOR gates. For a 74HC02 working on a 5V supply, this means the comparator outputs must swing lower than 1.5V, and higher than 3.5V.

Without realising it, you might have used a modified version of this circuit many times already – it forms the heart of the ubiquitous 555 timer! Unfortunately, however, the 555 doesn't provide access to all the comparator inputs, and two of them are connected by an on-chip resistor network, so it isn't possible to use it as a precision Schmitt trigger.

VERSATILE CIRCUIT ELEMENT

As well as being essential for converting analogue signals to digital levels, the Schmitt trigger's versatility means that it can be adapted to implement a variety of other functions.

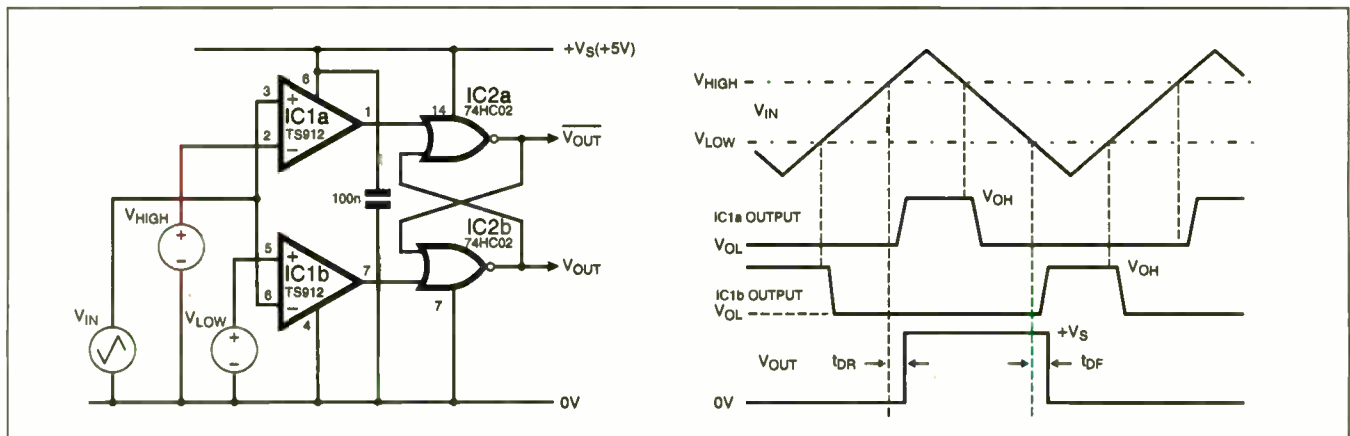


Fig.3.5. Circuit diagram for a precision Schmitt trigger with complementary outputs.

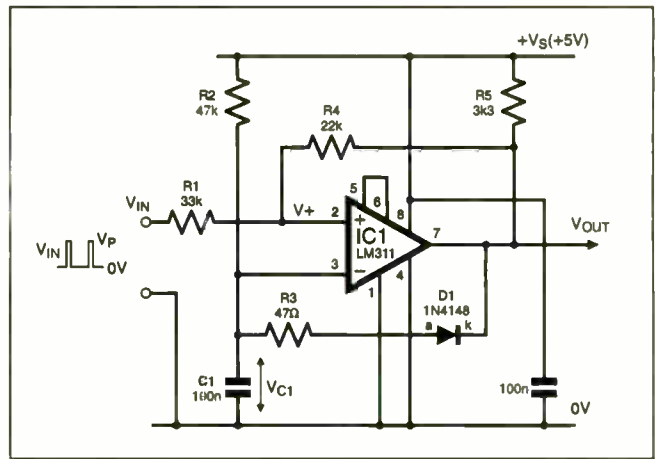


Fig.3.6. Monostable multivibrator circuit based on a Schmitt trigger.

The circuit diagram in Fig.3.6, for example, shows a *monostable multivibrator* (also known as a "one-shot"), in which a narrow input pulse, sometimes of varying width, must be "stretched" into a much wider pulse of specific duration.

There are many "flavours" of monostable: it can be implemented using transistors, op.amps and comparators, and we'll see in a later article how it can be built using "digital" Schmitt triggers. The comparator-based one-shot in Fig.3.6 is just one of many different types. The monostable can be inverting or non-inverting, retriggerable or non-retriggerable, and can be triggered with positive- or negative-going pulses.

The monostable has one stable, and one unstable state. It remains in its stable state until a trigger pulse is applied which initiates switching to the unstable state, where it remains for a period of time determined by the timing components.

To understand how the circuit in Fig.3.6 works, assume V_{IN} is at 0V and V_{OUT} is in negative saturation (we can take this to be 0V provided pull-up resistor R5 is not too small in value). Diode D1 is forward biased, so V_{C1} , the voltage on timing capacitor C1, is roughly 700mV.

If a narrow input pulse of amplitude V_p is applied to resistor R1, the voltage at the non-inverting input, V_+ , will rise to a positive level. Provided V_p is large enough, V_+ will go more positive than the 700mV at the inverting input and the comparator will trip. V_{OUT} now goes high and remains there even when V_{IN} has returned to 0V, since the positive feedback via R4 holds V_+ at a voltage greater than V_{C1} . The circuit is now in its "unstable" state, where the non-inverting voltage is given by:

Non-inverting input voltage,

$$V_+ = +V_s \times \frac{R1}{R1 + R4 + R5}$$

when $V_{IN} = 0V$ and $V_{OUT} = \text{high}$.

Since V_{OUT} is now high, D1 is reverse biased, so V_{C1} is no longer clamped at 700mV and C1 is free to charge via timing resistor R2. As C1 charges, V_{C1} rises until it just exceeds the value of V_+ given by the equation above. At this point, the comparator trips again,

V_{OUT} goes low, and the monostable returns to its stable state. Since D1 is now forward biased, C1 rapidly discharges via R3 which limits the discharge current to a reasonable value.

PULSE STRETCHING

The circuit's waveforms are shown in Fig.3.7, where the voltage on C1 (middle trace) starts to rise as soon as the narrow input pulse (top trace) is applied. With $R1 = 33k\Omega$, $R4 = 22k\Omega$, $R5 = 3.3k\Omega$ and $+V_S = 5.0V$, the value of $V+$ given by the equation above is 2.83V. V_{C1} can be seen to rise exponentially until it just exceeds 2.83V, at which point the comparator changes state and V_{OUT} immediately goes low.

Although the main timing components are C1 and R2, the values of R1, R4 and R5 also influence the output pulse width since they determine the voltage to which V_{C1} must rise in order to trip the comparator. Also, in the stable state, where $V_{OUT} = 0V$, R1 and R4 form a potential divider which determines the minimum pulse amplitude, V_p , sufficient to take $V+$ above 700mV and initiate the output pulse. With $R1 = 33k\Omega$ and $R4 = 22k\Omega$, the circuit can be triggered with a pulse amplitude as low as 1.75V.

Note that the monostable in Fig.3.6 is non-inverting and non-retriggerable. "Non-inverting" simply means that the positive-going trigger pulse produces a positive-going output pulse. The term "non-retriggerable" means that once the monostable has been triggered, any further input pulses arriving while the output is high will have no effect on the output pulse; in other words, the output pulse width cannot be "extended" by applying further input pulses.

When using a comparator like the LM311 having an open-collector output, the high level output voltage, V_{OH} , is given by:

High Level Output Voltage,

$$V_{OH} = +V_S \times \frac{R1 + R4}{R1 + R4 + R5} \quad (\text{volts})$$

Therefore, in order to maximise V_{OH} , the value of pull-up resistor R5 should be much smaller than R1 and R4. For the values given in Fig.3.6, $V_{OH} = 4.7V$. Clearly, any load connected between the output and 0V will tend to "pull down" V_{OH} , and will also affect the timing by reducing the high level of $V+$, although "light" loads such as CMOS logic gates will have negligible effect.

To some extent, these problems can be mitigated by replacing the LM311 with a comparator like the dual TLC3702, which has a "push-pull" output stage. Since the output pull-up resistor is no longer required, R5 may be removed from the above equations. As well as simplifying the calculations, this also has the significant benefit of reducing the circuit's power consumption, since an open-collector comparator like the LM311 sinks significant current through its pull-up resistor when $V_{OUT} = 0V$.

A further disadvantage of bipolar comparators like the LM311 is their relatively large input bias current. When V_{OUT} goes high and C1 starts to charge, the rate of charge should be controlled *only* by the current flowing in timing resistor R2. In practice, the charging current will be affected by the current flowing into (or out of) the comparator's inverting input, which will decrease (or increase) C1's charging current.

With $R2 = 47k\Omega$, the average charging current is around $50\mu A$, and so the LM311's input bias current, which can be as high as 250nA, will have negligible effect on the 5ms output pulse width. However, for long-duration output pulses requiring large values of R2, the input bias current can have a significant and unpredictable effect on pulse width.

Fortunately, these problems can be eliminated by replacing the bipolar comparator with a CMOS device like the TLC3702 (typical input bias current = 5pA). To illustrate how a CMOS comparator can be used to produce very wide output pulses, the comparator in Fig.3.6 was replaced with a TLC3702, R2 changed to 4.7M Ω , and C1 increased to 1 μF . The resulting output pulse duration was measured at just over six seconds, some *thirty million* times greater than the 200ns trigger pulse!

READY, SET . . . LATCH

The second member of the multivibrator family, the *bistable* multivibrator, can also be built using a comparator or an op.amp; an example is shown in Fig.3.8.

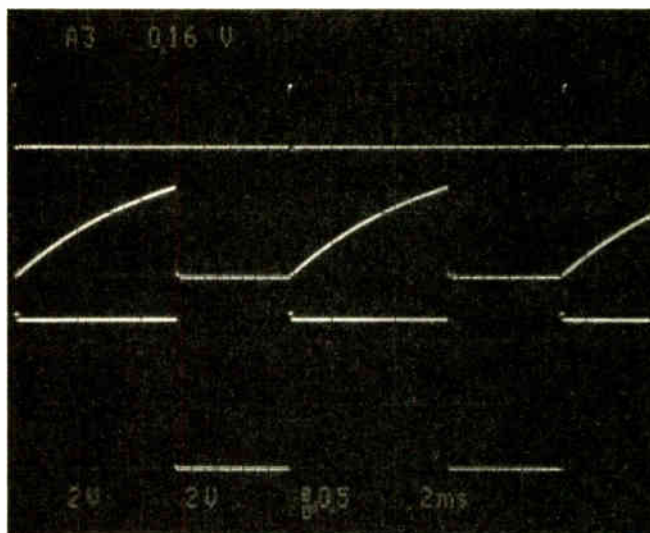


Fig.3.7. Monostable Waveforms. Top Trace: V_{IN} (5V/div.). Middle Trace: Timing Capacitor Voltage, V_{C1} (2V/div.). Bottom Trace: Output Voltage, V_{OUT} (2V/div.). Timebase: 2ms/div.

All Schmitt trigger circuits are effectively "bistable" elements, since their outputs can occupy one of two stable states. However, the circuit in Fig.3.8 is a "proper" bistable in that it has two complementary inputs, SET and RESET. Applying a positive-going pulse to the SET input causes V_{OUT} to go high: the circuit is now "latched" in one of its stable states, and will remain that way until a pulse is applied to the RESET input.

This pulse resets the latch by forcing V_{OUT} low, and the circuit returns to its alternative state. The positive feedback via resistor R4 provides the regenerative switching action necessary to "flip" the circuit rapidly from one state to the other.

Bistables, or "S-R Latches" as they are often called, are familiar circuit elements in digital systems. The function can be implemented with NAND or NOR gates (as in Fig.3.5), or as an integrated function with many variants. Devices like the 4013, 4044, 74HC74 and 74HC112 are just a few of the many devices which implement the S-R latch function in different ways.

However, latches from the 4000 and 74HC CMOS families require logic levels that occupy a specific, narrow range. The circuit of Fig.3.8, on the other hand, offers some flexibility in the magnitude of the pulses needed to set and reset the latch.

IC1 is one half of a dual, micropower, rail-to-rail CMOS comparator. The LMC6762 is not a fast device; its response time is typically around 4 μs . Nevertheless, its minuscule input bias current (typically just 0.04pA), rail-to-rail input voltage range, and wide output voltage range (the output swings to within 100mV of the supply rails for light loads) allows us to view it as an "ideal" device when analysing the circuit's behaviour.

If we assume that SET, RESET and V_{OUT} are all at 0V, the potential $V-$ at the inverting input is determined by the R2-R3 potential divider:

Inverting input voltage,

$$V- = +V_S \times \frac{R2}{R2 + R3}$$

when SET, RESET and $V_{OUT} = 0V$.

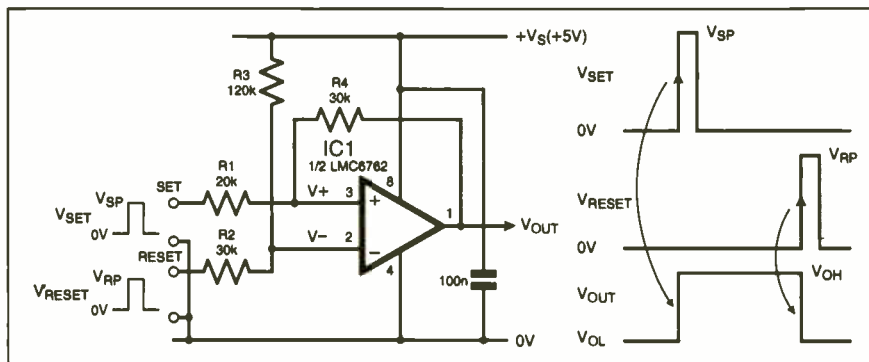


Fig.3.8. Circuit for a bistable multivibrator based on a Schmitt trigger.

Now, if a voltage pulse, V_{SET} , is applied to the SET input, the potential $V+$ at the non-inverting input will rise to:

Non-inverting input voltage,

$$V+ = +V_{SET} \times \frac{R4}{R1 + R4}$$

when $SET = V_{SET}$; RESET and $V_{OUT} = 0V$.

If this value of $V+$ is greater than the level of $V-$ given earlier, the comparator will trip and V_{OUT} will go to its high level, V_{OH} : the bistable is now latched. So far, the circuit has behaved like a simple, non-inverting Schmitt trigger with positive feedback provided by resistor $R4$.

Now, when the pulse at SET returns to zero, the non-inverting input voltage will be:

Non-inverting input voltage,

$$V+ = +V_{OH} \times \frac{R1}{R1 + R4}$$

when $V_{OUT} = V_{OH}$; SET and RESET = 0V.

In order for the bistable to remain latched, this voltage must be greater than the level of $V-$ given earlier. Therefore, provided $R1$ and $R4$ are chosen correctly, V_{OUT} will remain high even when SET has returned to 0V. If we now apply a voltage, V_{RESET} , to the RESET input, the inverting input voltage will rise to:

Inverting input voltage,

$$V- = +V_S \times \frac{R2}{R2 + R3} + V_{RESET} \frac{R3}{R2 + R3}$$

when $RESET = V_{RESET}$.

If this voltage is greater than the value of $V+$ given above for $V_{OUT} = V_{OH}$, the comparator will trip and the output will return to 0V. Clearly, the resistor values must be chosen carefully to ensure

that the circuit will remain latched when the SET pulse has returned to zero, and also to ensure that it can be reset properly when a pulse is applied to RESET.

Also, it is important to select resistor values which will provide adequate noise immunity, such that the circuit can operate correctly even when significant noise voltage is present at SET and RESET.

DESIGN EXAMPLE

The best way to illustrate the design procedure is to work through an example. When SET and RESET are both zero, and V_{OUT} is at its low level, V_{OL} , the non-inverting input voltage, $V+$, will be a minimum. If we assume, as we did previously, that $V_{OL} = 0V$, then the minimum value of $V+$ will also be 0V.

If we know that the inputs may be subject to noise voltage as large as, say, 1V, we must choose $R2$ and $R3$ to ensure the quiescent voltage at the inverting input is at least 1V when $V_{RESET} = 0V$. Values of $R2 = 30k\Omega$ and $R3 = 120k\Omega$ are suitable.

When V_{OUT} goes high, $R1$ and $R4$ should be selected not only to ensure the comparator remains latched, but also to ensure that the difference between the comparator's input voltages is greater than the noise voltage. In other words, the non-inverting input voltage, $V+$, should be at least 1V higher than the quiescent level of the inverting input voltage, $V-$.

Since we have chosen the quiescent value of $V-$ to be 1V, we require $V+$ to be at least 2V. This is satisfied by making $R1 = 20k\Omega$ and $R4 = 30k\Omega$, which makes $V+ = 2V$ when $V_{OH} = 5V$. If the circuit is built using these values, the minimum SET pulse amplitude, V_{SP} , needed to latch the bistable will be around 1.63V, and the minimum RESET pulse amplitude, V_{RP} , required to reset the latch will be around 1.23V.

If necessary, the resistor values could be changed to provide greater noise immunity, although the resulting pulse amplitudes needed to set and reset the latch would also be greater.

In Part Four next month, we'll see how the Schmitt trigger can be adapted to form the third member of the multivibrator family, the *astable* multivibrator, and we'll examine other useful functions which depend upon the Schmitt Trigger's unique behaviour.

★ MAKE IT A SPECIAL GIFT EVERY MONTH ★

NEXT ISSUE . . . FEBRUARY '01

SPECIAL SUPPLEMENT

HOW TO USE
GRAPHICS LIQUID CRYSTAL DISPLAYS

EVERYDAY
PRACTICAL
ELECTRONICS

INCORPORATING **ELECTRONICS TODAY INTERNATIONAL**
THE No. 1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

Annual subscription rates (2001):

6 Months: UK £14.50, Overseas £17.50 (standard air service),
£27 (express airmail)

1 Year: UK £27.50, Overseas £33.50 (standard air service)
£51 (express airmail)

2 Years: UK £50.00, Overseas £62.00 (standard air service)
£97 (express airmail)

To: Everyday Practical Electronics,
Allen House, East Borough, Wimborne, Dorset BH21 1PF
Tel: 01202 861749 Fax: 01202 841692
E-mail: subs@epemag.wimborne.co.uk

Plus

- PC AUDIO POWER METER
- ICE ALERT

SUBSCRIPTION ORDER FORM



I enclose payment of £..... (cheque/PO in
£ sterling only),



payable to Everyday Practical Electronics



My card number is:

.....
Please print clearly, and check that you have the number correct

Signature.....

Card Ex. Date..... Switch Issue No.

Subscriptions can only start with the next available issue.
For back numbers see the Back Issues page.

Name

Address

..... Post code

01/01

We can supply back issues of *EPE* by post, most issues from the past five years are available. An *EPE* index for the last five years 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. Issues from Nov. 98 onwards are also available to download from www.epemag.com.

DID YOU MISS THESE?

SEPT '99

PROJECTS • Loop Aerial SW Receiver • Child Guard • 8-Channel Analogue Data Logger-2 • Variable Dual Power Supply.
FEATURES • Practical Oscillator Designs-3 • Power Generation from Pipelines to Pylons-2 • Practically Speaking • Circuit Surgery • Ingenuity Unlimited • New Technology Update • Net Work.

OCT '99

PROJECTS • Interior Lamp Delay • Mains Cable Detector • QWL Loudspeaker System • Micro Power Supply.
FEATURES • PIC16F87x Mini Tutorial • Practical Oscillator Designs-4 • Circuit Surgery • Interface • Ingenuity Unlimited • Net Work – The Internet.

NOV '99

PROJECTS • Acoustic Probe • Vibralarm • Ginormous Stopwatch-1 • Demister One-Shot.
FEATURES • Teach-In 2000-Part 1 • Ingenuity Unlimited • Practically Speaking • Practical Oscillator Designs-5 • Circuit Surgery • New Technology Update • Net Work – The Internet **FREE** Identifying Electronic Components booklet.

DEC '99

PROJECTS • PIC Micro-Probe • Magnetic Field Detector • Loft Guard • Ginormous Stopwatch – Giant Display-2.
FEATURES • Teach-In 2000-Part 2 • Practical Oscillator Designs-6 • Interface • Ingenuity Unlimited (Special) • Circuit Surgery • Network-The Internet • 1999 Annual Index.

JAN '00

PROJECTS • Scratch Blanker • Versatile Burglar Alarm • Flashing Snowman • Vehicle Frost Box.
FEATURES • Ingenuity Unlimited • Teach-In 2000-Part 3 • Circuit Surgery • Practically Speaking • Tina Pro Review • Net Work – The Internet.



FEB '00 Photostats Only

PROJECTS • PIC Video Cleaner • Voltage Monitor • Easy-Typist Tape Controller • Find It – Don't Lose It!
FEATURES • Technology Timelines-1 • Circuit Surgery • Teach-In 2000-Part 4 • Ingenuity Unlimited • Interface • Net Work – The Internet.

MAR '00

PROJECTS • EPE ICEbreaker • High Performance Regenerative Receiver-1 • Parking Warning System • Automatic Train Signal.
FEATURES • Teach-In 2000 – Part 5 • Practically Speaking • Technology Timelines-2 • Ingenuity Unlimited • Circuit Surgery • New Technology Update • Net Work – The Internet.

APRIL '00

PROJECTS • Flash Slave • Garage Link • Micro-PICscope • High Performance Regenerative Receiver-2.
FEATURES • Teach-In 2000-Part 6 • Ingenuity Unlimited • Technology Timelines-3 • Circuit Surgery • Interface • Telcan Home Video • Net Work – The Internet.

MAY '00

PROJECTS • Versatile Mic/Audio Pre-amplifier • PIR Light Checker • Low-Cost Capacitance Meter • Multi-Channel Transmission System-1.
FEATURES • Teach-In 2000-Part 7 • Technology Timelines-4 • Circuit Surgery • Practically Speaking • Ingenuity Unlimited • Net Work – The Internet • **FREE** Giant Technology Timelines Chart.

JUNE '00

PROJECTS • Atmospheric Electricity Detector-1 • Canute Tide Predictor • Multi-Channel Transmission System-2 • Automatic Nightlight.
FEATURES • Teach-In 2000 – Part 8 • Technology Timelines-5 • Circuit Surgery • Interface • New Technology Update • Ingenuity Unlimited • Net Work – The Internet.



JULY '00

PROJECTS • g-Meter • Camera Shutter Timer PIC-Gen Frequency Generator/Counter • Atmospheric Electricity Detector-2.
FEATURES • Teach-In 2000-Part 9 • Practically Speaking • Ingenuity Unlimited • Circuit Surgery • PICO DrDAQ Reviewed • Net Work – The Internet.

AUG '00

PROJECTS • Handy-Amp • EPE Moodloop • Quiz Game Indicator • Door Protector
FEATURES • Teach-In 2000-Part 10 • Cave Electronics • Ingenuity Unlimited • Circuit Surgery • Interface • New Technology Update • Net Work – The Internet.



SEPT '00

PROJECTS • Active Ferrite Loop Aerial • Steeplechase Game • Remote Control IR Decoder • EPE Moodloop Power Supply.
FEATURES • Teach-In 2000-Part 11 • New Technology Update • Circuit Surgery • Ingenuity Unlimited • Practically Speaking • Net Work – The Internet Page.

OCT '00

PROJECTS • Wind-Up Torch • PIC Dual-Chan Virtual Scope • Fridge/Freezer Alarm • EPE Moodloop Field Strength Indicator.
FEATURES • Teach-In 2000-Part 12 • Interface • Ingenuity Unlimited • New Technology Update • Circuit Surgery • Peak Atlas Component Analyser Review • Net Work – The Internet Page.

NOV '00

PROJECTS • PIC Pulsometer • Opto-Alarm System • Sample-and-Hold • Handclap Switch.
FEATURES • The Schmitt Trigger-Part 1 • Ingenuity Unlimited • PIC Toolkit Mk2 Update V2.4 • Circuit Surgery • New Technology Update • Net Work – The Internet • **FREE** Transistor Data Chart.

DEC '00

PROJECTS • PIC-Monitored Dual PSU-Part 1 • Static Field Detector • Motorists' Buzz-Box • Twinkling Star • Christmas Bubble • Festive Fader • PICtogram.
FEATURES • The Schmitt Trigger-Part 2 • Ingenuity Unlimited • Interface • Circuit Surgery • New Technology Update • Quasar Kits Review • Net Work – The Internet • 2000 Annual Index.

BACK ISSUES ONLY £3.00 each inc. UK p&p.
 Overseas prices £3.50 each surface mail, £4.95 each airmail.

We can also supply issues from earlier years: 1992 (except March, April, June to Sept. and Dec.), 1993 (except Jan. to March, May, Aug., Dec.), 1994 (except April to June, Aug., Oct. to Dec.), 1995 (No Issues), 1996 (except Jan. to May, July, Aug., Nov.), 1997 (except Feb. and March), 1998 (except Jan., March to May, July, Nov., Dec.), 1999.

We can also supply back issues of *ETI* (prior to the merger of the two magazines) for 1998/9 – Vol. 27 Nos 1 to 13 and Vol. 28 No. 1. We are not able to supply any material from *ETI* prior to 1998. Please put *ETI* clearly on your order form if you require *ETI* issues.

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 dates
- Send photostats of (article title and issues date)
- Send copies of last five years indexes (£3.00 for five inc. p&p – Overseas £3.50 surface, £4.95 airmail)

Name

Address

.....

I enclose cheque/P.O./bank draft to the value of £

Please charge my Visa/Mastercard/Switch £ Switch Issue No.

Card No. Card Expiry Date

Note: Minimum order for credit cards £5. Please supply name and address of cardholder if different from that shown above.

SEND TO: Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF.

Tel: 01202 881749. Fax: 01202 841692.

E-mail: orders@epemag.wimborne.co.uk

Payments must be in £ sterling – cheque or bank draft drawn on a UK bank. Normally supplied within seven days of receipt of order.

Send a copy of this form, or order by letter if you do not wish to cut your issue.

M01/01

STORE YOUR BACK ISSUES IN YOUR WALLET!



**VOL 3
NOW AVAILABLE**

**ONLY
£12.45** each
including VAT
and p&p



A great way to buy *EPE* Back Issues – our wallet-sized CD-ROMs contain back issues from our *EPE Online* website plus bonus articles, all the relevant PIC software and web links. All this for just £12.45 each including postage and packing.

VOL 1 CONTENTS

BACK ISSUES – November 1998 to June 1999 (all the projects, features, news, IUs etc. from all eight issues). Note: No advertisements or Free Gifts are included.

PIC PROJECT CODES – All the available codes for the PIC based projects published in issues from November 1998 to June 1999.

EPE ONLINE STORE – Books, PCBs, Subscriptions, etc.

VOL 2 CONTENTS

BACK ISSUES – July 1999 to December 1999 (all the projects, features, news, IUs, etc. from all six issues). Note: No advertisements or Free Gifts are included.

PIC PROJECT CODES – All the available codes for the PIC-based projects published in issues from July to December 1999.

EPE ONLINE STORE – Books, PCBs, Subscriptions, etc.

VOL 3 CONTENTS

BACK ISSUES – January 2000 to June 2000 (all the projects, features, news, IUs, etc. from all six issues). Note: No advertisements or Free Gifts are included.

PIC PROJECT CODES – All the available codes for the PIC-based projects published in issues from January to June 2000.

EXTRA ARTICLES – ON ALL VOLUMES

BASIC SOLDERING GUIDE – Alan Winstanley's internationally acclaimed fully illustrated guide.

UNDERSTANDING PASSIVE COMPONENTS – Introduction to the basic principles of passive components.

HOW TO USE INTELLIGENT L.C.D.s, By Julian Ilett – An utterly practical guide to interfacing and programming intelligent liquid crystal display modules.

Phyzyb COMPUTERS BONUS ARTICLE 1 – Signed and Unsigned Binary Numbers. By Clive "Max" Maxfield and Alvin Brown.

Phyzyb COMPUTERS BONUS ARTICLE 2 – Creating an Event Counter. By Clive "Max" Maxfield and Alvin Brown.

INTERGRAPH COMPUTER SYSTEMS 3D GRAPHICS – A chapter from Intergraph's book that explains computer graphics technology in an interesting and understandable way with full colour graphics.

EXTRA ARTICLE ON VOL 1 & 2

THE LIFE & WORKS OF KONRAD ZUSE – a brilliant pioneer in the evolution of computers. A bonus article on his life and work written by his eldest son, including many previously unpublished photographs.

NOTE: This mini CD-ROM is suitable for use on any PC with a CD-ROM drive. It requires Adobe Acrobat Reader (available free from the Internet – www.adobe.com/acrobat)

Order on-line from www.epemag.com or by Phone, Fax, E-mail or Post

BACK ISSUES CD-ROM ORDER FORM

Please send me (quantity) BACK ISSUES CD-ROM VOL 1

Please send me (quantity) BACK ISSUES CD-ROM VOL 2

Please send me (quantity) BACK ISSUES CD-ROM VOL 3

Price £12.45 (approx \$20) each – includes postage to anywhere in the world.

Name

Address

..... Post Code

I enclose cheque/P.O./bank draft to the value of £

Please charge my Visa/Mastercard/Switch £

Card No.

Expiry Date Switch Issue No.

Note: Minimum order for cards £5.

SEND TO: Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF.

Tel: 01202 881749. Fax: 01202 841692.

E-mail: orders@epemag.wimborne.co.uk

Payments must be by card or in £ Sterling – cheque or bank draft drawn on a UK bank.

Normally supplied within seven days of receipt of order. Send a copy of this form, or order by letter if you do not wish to cut your issue.

PRACTICALLY SPEAKING

Robert Penfold looks at the Techniques of Actually Doing It!

OLD HANDS at electronic project construction can look at practically any component and know whether or not it has to be connected a certain way around, and if so, which way around. For the beginner it can take a while to become familiar with the components and their characteristics.

Capacitors are potentially a source of confusion since some have to be connected the right way round, but most do not. The lower values of about less than about $1\mu\text{F}$ are mostly non-polarised, but components having a value of about $1\mu\text{F}$ or more are nearly all polarised.

Electrolytics

By far the most common type of polarised capacitor is the *electrolytic* type. An ordinary capacitor is basically just two metal plates with a layer of insulation in between.

Practical components are almost invariably in the form of two pieces of metal foil. The insulation is often in the form of plastic foils or a plastic coating on the metal foils, but other materials can be used. The insulating layer is called the *dielectric*.

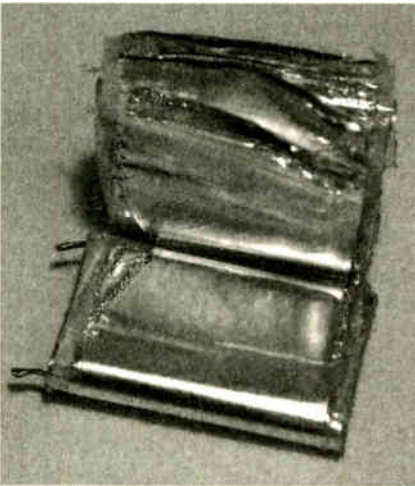


Fig.1. Ultra-thin metal foil is used in most types of capacitor.

The pieces of foil are placed one on top of the other and then rolled up or folded in some way so as to give a large plate area (and capacitance) in a small physical volume. Fig.1 shows a defunct capacitor that has been cut open, and some of the numerous layers of foil can be clearly seen.

Electrolytic capacitors take a similar form, but thin layers of an absorbent material impregnated with an electrolyte replace the plastic foils. This enables extremely high values to be obtained from tiny components, but at least a small d.c. potential of the correct polarity is needed for this type of capacitor to work properly.

Unfortunately, if an electrolytic

capacitor is connected the wrong way round the electrolyte will provide a low resistance path. In the case of a capacitor connected across the supply lines this can result in a large current flow, rapid overheating and the component bursting with a loud "crack". If the capacitor is used in a low current part of a circuit it is unlikely that anything will be damaged if its polarity is incorrect, but the high leakage current will almost certainly prevent the circuit from working properly.

Beads

Electrolytics are not the only type of polarised capacitor, but they are probably the only type you will normally use. *Tantalum* capacitors are the only possible exception, and these are sometimes used where an electrolytic capacitor is inadequate.

Electrolytic capacitors combine very high values with small physical dimensions, but that is about all that they have going for them. Their value changes significantly with variations in temperature and over a period of time. The tolerances of these components are quite high at plus and minus 20 per cent or more.

The leakage currents also tend to be relatively high. Also, they do not work well at high frequencies, although this is often unimportant. Ordinary electrolytic capacitors are only suitable for undemanding applications.

Tantalum capacitors are often referred to as tantalum "beads", due to their almost spherical, bead-like shape. They provide very high values together with small physical size, but they are superior to normal electrolytics in most if not all respects. Their price, of course, tends to be relatively high, so there is no point in using a tantalum capacitor if an electrolytic will do. Tantalums are perhaps used rather less than was once the case, due to the various superior grades of electrolytic that are now available. These offer similar characteristics to tantalum capacitors, and can be found in any of the larger component catalogues.

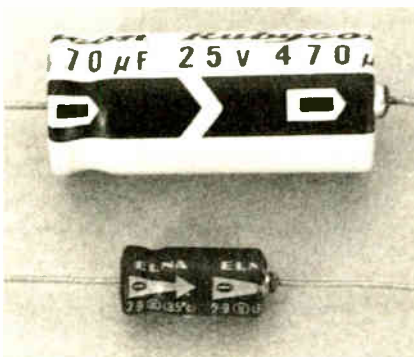


Fig.2. Axial electrolytics have polarity markings, but the ridge indicates the positive end of these components.

Being Superior

Where a project requires a superior grade electrolytic or tantalum capacitor, the components list and (or) the text should point out exactly what is required and why. Usually a superior grade component is needed for a timing circuit or for a switch-mode power supply.

In a timing circuit it is a closer tolerance and lower leakage level that are needed. Using a lower grade component will give poor timing accuracy or will simply result in the circuit failing to operate at all.

In the case of switch mode power supplies it is usually the high frequency performance that is of prime importance. A "bog standard" component can result in damage to a switch-mode circuit, so do not go in for "penny pinching" with this type of project.

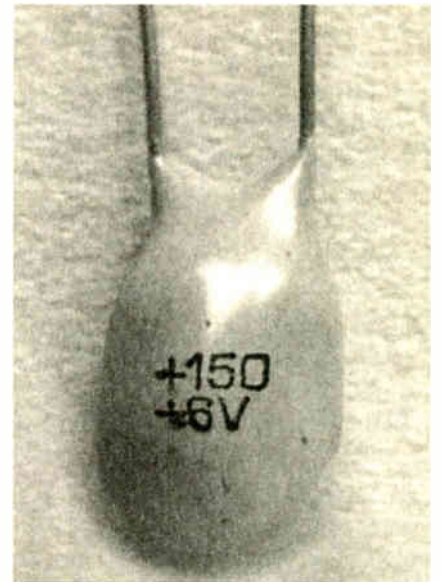


Fig.3. Modern tantalum capacitors have normal value and polarity markings.

Getting It Right

Printed circuit mounting capacitors, which are also known as "radial" capacitors, have the polarity indicated by "+" and "-" signs on their bodies, near the leadout wires. Actually, most modern components only have the "-" sign, but provided at least one of the leads is clearly marked there is no excuse for getting it wrong.

In days gone by axial lead electrolytics had their polarities marked using "+" and "-" signs, but these days it is more common for them to have more fancy markings with "-" signs and arrows pointing to the negative lead, see Fig.2. These markings are not strictly necessary anyway, since there is always a narrowing of the body near the positive leadout wire. The polarity is always readily apparent at a glance, even if the markings are badly worn or have rubbed off altogether.

Early tantalum capacitors used a system of colour coding to indicate the value and polarity. This system is now long obsolete, and any components of this type should now have the polarity and value marked on the body in much the same way as a radial electrolytic, see Fig.3.

As pointed out previously, getting a polarised capacitor connected the wrong way round can result in its destruction in some circumstances. It is also worth pointing out that relatively small reverse voltages and current flows can damage some polarised capacitors.

There will not be any sign of external damage, but the component will provide substandard performance if it is now used in the circuit the correct way round. Tantalum capacitors and some high-grade electrolytics are the most at risk from reverse voltages.

One-way Only

The only other common two-lead polarised component is the *diode*. A diode is a sort of electronic equivalent to a mechanical valve, and it only allows a current to flow in *one* direction. Connect a diode with the wrong polarity and it will block currents it should allow to pass, and permit current flows that it should block.

With small diodes this is unlikely to cause any damage, but it can do so in the case of something like a protection diode across a relay coil. Instead of the relay being switched on, the diode would instead be fed with a high current.

With high power diodes (called *rectifiers*) there is a high risk of something being damaged if the polarity is wrong. It is definitely a good idea to check and double-check that diodes and rectifiers are connected correctly.

Most diodes and rectifiers have their polarity indicated by a band around the end of the body that carries the cathode (k) leadout wire. There are a few variations on this, but the only common one is a narrowing of the body at the cathode end of the component. This method is now used quite a lot for higher power rectifiers.

A few years ago it was quite common for some diodes to have several coloured bands, which made it necessary to take a careful look at the component in order to identify the cathode leadout. The idea of the coloured bands was to indicate the type number using a system of colour coding based on resistor colour codes. This meant having three or four bands instead of one.

These days most diodes have a single band and the type number marked using text characters. Due to the small size of modern diodes you will probably need a magnifier to read the type numbers. The system of colour coding may make it easy to read the type number, but it also makes it far easier to fit the diodes the wrong way round.

Diodes of this type have become less common in recent years, but they are by no means extinct. The polarity of multi-band diodes is indicated by

having the band nearest the cathode lead wider than the other two or three bands. Unfortunately, the difference in width is often something less than obvious, so it is essential to look carefully at these diodes before fitting them onto a circuit board.

L.E.D. Astray

Light emitting diodes (l.e.d.s) are undoubtedly the type of diode that gives the most problems. This situation occurred due to a lack of standardisation when these components were first introduced. It has been sustained and even amplified by the enormous range of different shapes, sizes, and types of l.e.d. that have evolved over the years.

By far the most common method of indicating the polarity is to have the cathode (k) lead slightly shorter than the anode (a) lead. More often than not the leads of an l.e.d. have to be trimmed prior to connecting the component into circuit. It is, therefore, a good idea to keep the cathode lead fractionally shorter even after trimming so that you still know which lead is which.

Unfortunately, a few l.e.d.s seem to be supplied with two leads of equal length. In these cases the cathode is normally indicated by the case being flattened slightly next to the cathode lead. This "flat" is often present in addition to the shorter cathode lead, but it is not the universal feature that it once was.

So how do you determine the polarity of a l.e.d. if the flat is absent, and either the leads were originally the same length or you have trimmed them to the same length? A method used by many is to look at the two electrodes inside the case. These are usually different sizes and shapes (Fig.4), and the larger electrode *usually* connects to the cathode (k) lead.

Although this method works very well with "run of the mill" l.e.d.s, it is far from 100 per cent reliable with the more exotic types. The "jumbo" high-brightness l.e.d. shown in Fig.4 proves this point, and has its *anode* lead connected to the larger electrode.

In Reverse

The only sure way is the "suck it and see" approach. If connecting an l.e.d. one way round does not give the desired result, simply reverse the connections and it should work fine.

Readers sometimes point out to me that connecting an l.e.d. around the wrong way will result in it receiving a potential that is in excess of its reverse breakdown voltage, and that it could be "zapped". It is true that the reverse breakdown voltage of l.e.d.s is quite low, at typically about five to seven volts. It is also true that even marginally exceeding the maximum voltage ratings of semiconductors can often have dire results.

However, exceeding some voltage ratings does not in itself cause any damage. The reverse breakdown voltage of an l.e.d. and the base-to-emitter breakdown voltage of a transistor are two examples of this. In both cases the

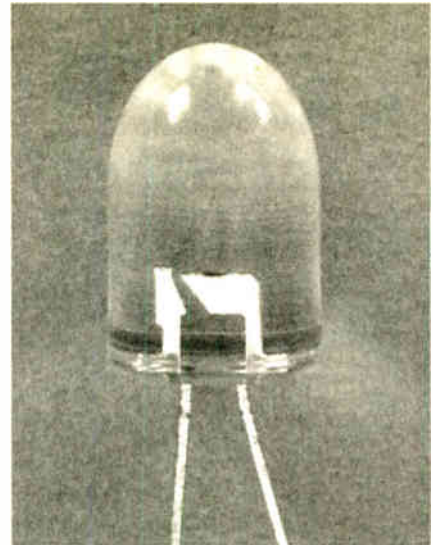


Fig.4. The larger electrode of an l.e.d. usually connects to the cathode, but not in the case of this "jumbo" l.e.d., where it connects to the anode.

component acts a bit like a low voltage Zener diode.

Provided the current flow is limited to a safe level no damage will result. The resistor that limits the forward current to a safe level will continue to do so if the l.e.d. is connected the wrong way around.

In some instances it will be difficult to alter the connections to an l.e.d. if it is connected with the wrong polarity, or there may simply be too many l.e.d.s to make the "suck it and see" approach viable. Most multimeters have a facility to test diodes and find their polarity, but not all of these operate with l.e.d.s due to their high forward threshold voltage of about 1.8V or more.

This is about three times higher than that of an ordinary silicon diode. If it comes to it, the simple test set up of Fig.5 can be used to check the polarity of l.e.d.s that produce light in the visible part of the spectrum.

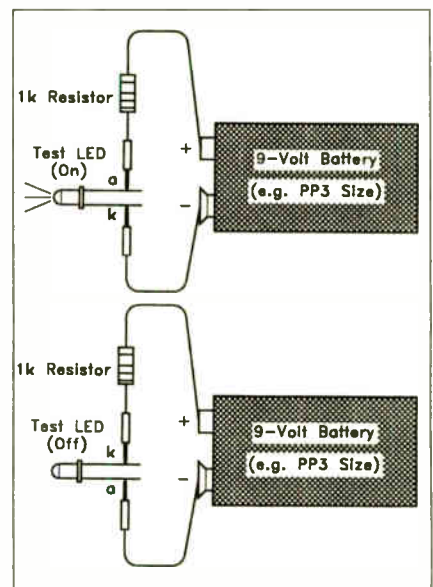


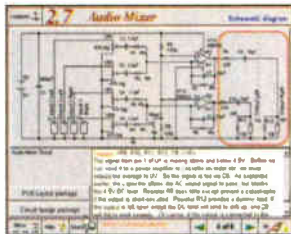
Fig.5. Simple test set-up for checking the polarity of l.e.d.s that produce light in the visible spectrum.

Everyday Practical Electronics are pleased to be able to offer all readers these **ELECTRONICS CD-ROMS**

NEW ELECTRONICS PROJECTS



Logic Probe testing

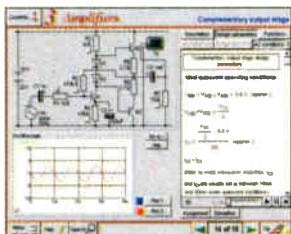


Audio Mixer circuit description

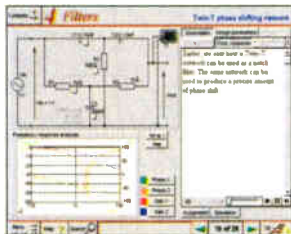
Electronic Projects is split into two main sections: **Building Electronic Projects** contains comprehensive information about the components, tools and techniques used in developing projects from initial concept through to final circuit board production. Extensive use is made of video presentations showing soldering and construction techniques. The second section contains a set of ten projects for students to build, ranging from simple sensor circuits through to power amplifiers. A shareware version of Matrix's CADPACK **schematic capture, circuit simulation and p.c.b. design** software is included.

The projects on the CD-ROM are: Logic Probe; Light, Heat and Moisture Sensor; NE555 Timer; Egg Timer; Dice Machine; Bike Alarm; Stereo Mixer; Power Amplifier; Sound Activated Switch; Reaction Tester. Full parts lists, schematics and p.c.b. layouts are included on the CD-ROM.

ANALOGUE ELECTRONICS



Complimentary output stage

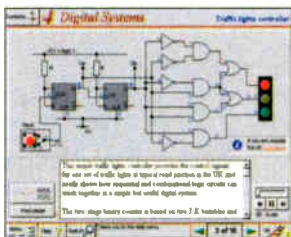


Twin-T phase shifting network

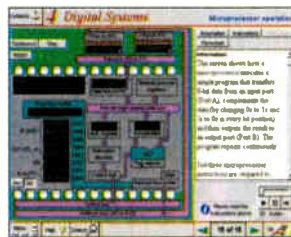
Analogue Electronics is a complete learning resource for this most difficult branch of electronics. The CD-ROM includes a host of virtual laboratories, animations, diagrams, photographs and text as well as a SPICE electronic circuit simulator with over 50 pre-designed circuits.

Sections on the CD-ROM include: **Fundamentals** – Analogue Signals (5 sections), Transistors (4 sections), Waveshaping Circuits (6 sections). **Op.Amps** – 17 sections covering everything from Symbols and Signal Connections to Differentiators. **Amplifiers** – Single Stage Amplifiers (8 sections), Multi-stage Amplifiers (3 sections). **Filters** – Passive Filters (10 sections), Phase Shifting Networks (4 sections), Active Filters (6 sections). **Oscillators** – 6 sections from Positive Feedback to Crystal Oscillators. **Systems** – 12 sections from Audio Pre-Amplifiers to 8-Bit ADC plus a gallery showing representative p.c.b. photos.

DIGITAL ELECTRONICS



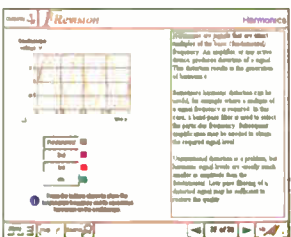
Virtual laboratory – Traffic Lights



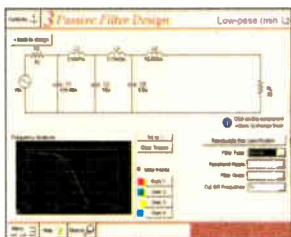
Microprocessor

Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (opposite), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen. Covers binary and hexadecimal numbering systems, ASCII, basic logic gates and their operation, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters and their parameters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units.

FILTERS



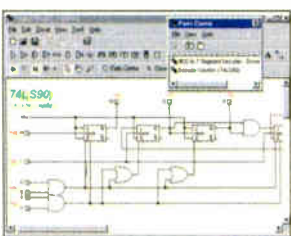
Filter Theory



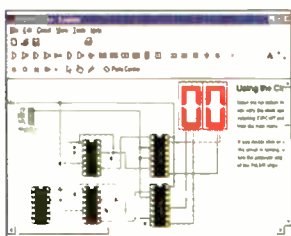
Active filter synthesis

Filters is a complete course in designing active and passive filters that makes use of highly interactive virtual laboratories and simulations to explain how filters are designed. It is split into five chapters: **Revision** which provides underpinning knowledge required for those who need to design filters. **Filter Basics** which is a course in terminology and filter characterization, important classes of filter, filter order, filter impedance and impedance matching, and effects of different filter types. **Advanced Theory** which covers the use of filter tables, mathematics behind filter design, and an explanation of the design of active filters. **Passive Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev ladder filters. **Active Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev op.amp filters.

DIGITAL WORKS 3.0



Macro screen



Counter project

Digital Works Version 3.0 is a graphical design tool that enables you to construct digital logic circuits and analyze their behaviour. It is so simple to use that it will take you less than 10 minutes to make your first digital design. It is so powerful that you will never outgrow its capability.

- Software for simulating digital logic circuits
- Create your own macros – highly scalable
- Create your own circuits, components, and i.c.s
- Easy-to-use digital interface
- Animation brings circuits to life
- Vast library of logic macros and 74 series i.c.s with data sheets
- Powerful tool for designing and learning

PRICES

Prices for each of the CD-ROMs above are:

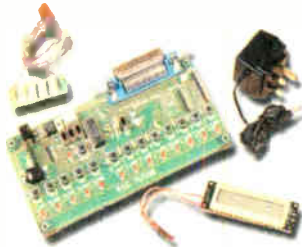
Hobbyist/Student£45 inc VAT
 Institutional (Schools/HE/FE/Industry).....£99 plus VAT
 Institutional 10 user (Network Licence)£199 plus VAT

(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

Interested in programming PIC microcontrollers? Learn with **PICtutor** by John Becker



The Virtual PIC



Deluxe PICtutor Hardware

This highly acclaimed CD-ROM, together with the PICtutor experimental and development board, will teach you how to use PIC microcontrollers with special emphasis on the PIC16x84 devices. The board will also act as a development test bed and programmer for future projects as your programming skills develop. This interactive presentation uses the specially developed **Virtual PIC Simulator** to show exactly what is happening as you run, or step through, a program. In this way the CD provides the easiest and best ever introduction to the subject.

Nearly 40 Tutorials cover virtually every aspect of PIC programming in an easy to follow logical sequence.

HARDWARE

Whilst the CD-ROM can be used on its own, the physical demonstration provided by the **PICtutor Development Kit**, plus the ability to program and test your own PIC16x84s, really reinforces the lessons learned. The hardware will also be an invaluable development and programming tool for future work.

Two levels of PICtutor hardware are available – Standard and Deluxe. The **Standard** unit comes with a battery holder, a reduced number of switches and no displays. This version will allow users to complete 25 of the 39 Tutorials. The **Deluxe** Development Kit is supplied with a plug-top power supply (the **Export** Version has a battery holder), all switches for both PIC ports plus l.c.d. and 4-digit 7-segment l.e.d. displays. It allows users to program and control all functions and both ports of the PIC. All hardware is supplied **fully built and tested** and includes a PIC16F84.

PICtutor CD-ROM

Hobbyist/Student £45 inc. VAT
 Institutional (Schools/HE/FE Industry) ... £99 plus VAT
 Institutional 10 user (Network Licence) .£199 plus VAT

HARDWARE

Standard PICtutor Development Kit £47 inc. VAT
 Deluxe PICtutor Development Kit £99 plus VAT
 Deluxe Export Version £96 plus VAT

(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

ELECTRONIC COMPONENTS PHOTOS

A high quality selection of over 200 JPG images of electronic components. This selection of high resolution photos can be used to enhance projects and presentations or to help with training and educational material. They are royalty free for use in commercial or personal printed projects, and can also be used royalty free in books, catalogues, magazine articles as well as worldwide web pages (subject to restrictions – see licence for full details). Also contains a **FREE** 30-day evaluation of Paint Shop Pro 6 – Paint Shop Pro image editing tips and on-line help included!

Price **£19.95 inc. VAT**

ELECTRONIC CIRCUITS & COMPONENTS + THE PARTS GALLERY

Provides an introduction to the principles and application of the most common types of electronic components and shows how they are used to form complete circuits. The virtual laboratories, worked examples and pre-designed circuits allow students to learn, experiment and check their understanding. Sections include: **Fundamentals:** units & multiples, electricity, electric circuits, alternating circuits. **Passive Components:** resistors, capacitors, inductors, transformers. **Semiconductors:** diodes, transistors, op.amps, logic gates. **Passive Circuits . Active Circuits**

The **Parts Gallery** will help students to recognise common electronic components and their corresponding symbols in circuit diagrams. Selections include: **Components, Components Quiz, Symbols, Symbols Quiz, Circuit Technology**

Hobbyist/Student.....£34 inc VAT
 Institutional (Schools/HE/FE/Industry).....£89 plus VAT
 Institutional 10 user (Network Licence).....£169 plus VAT

(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

MODULAR CIRCUIT DESIGN

This CD-ROM contains a range of tried and tested analogue and digital circuit modules, together with the knowledge to use and interface them. Thus allowing anyone with a basic understanding of circuit symbols to design and build their own projects.

Essential information for anyone undertaking GCSE or "A" level electronics or technology and for hobbyists who want to get to grips with project design. Over seventy different Input, Processor and Output modules are illustrated and fully described, together with detailed information on construction, fault finding and components, including circuit symbols, pinouts, power supplies, decoupling etc.

Single User Version **£19.95 inc. VAT**

Multiple User Version **£34 plus VAT**

(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

Minimum system requirements for these CD-ROMs: PC with 486/166MHz, VGA+256 colours, CD-ROM drive, 32MB RAM, 10MB hard disk space. Windows 95/98, mouse, sound card, web browser.

CD-ROM ORDER FORM

Please send me:

Electronic Projects

Analogue Electronics

Digital Electronics

Filters

Digital Works 3.0

PICtutor

Electronic Circuits & Components +The Parts Gallery

PICtutor Development Kit – Standard

PICtutor Development Kit – Deluxe

Electronic Components Photos

Modular Circuit Design – Single User

Modular Circuit Design – Multiple User

Version required:

Hobbyist/Student

Institutional

Institutional 10 user

Deluxe Export

Note: The software on each version is the same, only the licence for use varies.

Note: The PICtutor CD-ROM is not included in the Kit prices.

Note: The software on each version is the same, only the licence for use varies.

Full name:

Address:

..... Post code: Tel. No:

Signature:

I enclose cheque/PO in £ sterling payable to WIMBORNE PUBLISHING LTD for £

Please charge my Visa/Mastercard/Switch: £ Card expiry date:

Card No: Switch Issue No.

ORDERING

ALL PRICES INCLUDE UK POSTAGE

Student/Single User/Standard Version price includes postage to most countries in the world
 EU residents outside the UK add £5 for airmail postage per order

Institutional, Multiple User and Deluxe Versions – overseas readers add £5 to the basic price of each order for airmail postage (do not add VAT unless you live in an EU country, then add 17½% VAT or provide your official VAT registration number).

Send your order to:
Direct Book Service
 Allen House, East Borough, Wimborne Dorset BH21 1PF

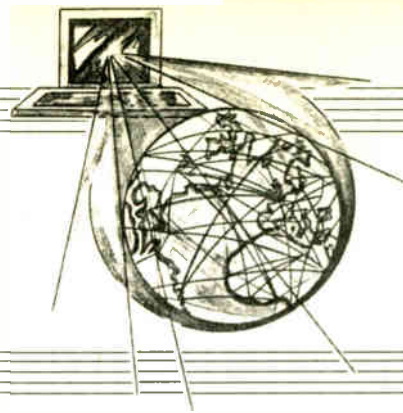
Direct Book Service is a division of Wimborne Publishing Ltd. To order by phone ring
01202 881749. Fax: 01202 841692

Goods are normally sent within seven days
 E-mail: orders@epemag.wimborne.co.uk

SURFING THE INTERNET

NET WORK

ALAN WINSTANLEY



Happy Christmas to you too

A STUDENT acquaintance recently graduated from University, but only just in the nick of time: her entire computer system together with her entire course work were stolen. It contained four years of hard work but no backup disks were kept "off site", and the heartless thieves ignored her plea just to return the disks if nothing else. It is now an accepted fact of life that University student "digs" can be rich pickings for thieves, as they can be a prime source for a variety of computer hardware.

With new computer equipment presently being purchased for Christmas, it's worth reminding school pupils, students and home users to take some sensible precautions to guard equipment and the important data it may contain. Removable disks, especially CD-ROMs, are a good idea.

However, even if you have accumulated many years of work and retained it on disk, the Internet now offers more secure ways of backing up important data "off site". Furthermore, you can use special Internet access software to help identify modem calls made when a career criminal uses a stolen computer to dial into the Internet.

There are a few fundamental things you can do to guard against computer theft. Obvious precautions include the use of anti-theft devices that lock into the oval keyhole slots located on many computers and laptops for this purpose: mail order and retail sources (e.g. Inmac, see www.inmac.co.uk) provide a full range that enable you to secure hardware in place to frustrate the would-be thief.

ET Phone Home

A couple of "E.T." software products are also available, so called because they "phone home" when a thief connects a stolen computer (yours) to a phone line and tries to dial out. The modem will actually make a phone call to your selected number, affording you an opportunity to obtain the caller's phone number using Caller Line ID (if enabled). One such product is Phone Home Millennium Edition by UK Software (www.uk-software.com/phonehome/) who say that this invisible software device will, at a user-defined time, dial a number of your choice, e.g. your own phone number.

Another package is E.T. Version 3.3 by Kestrel Software Systems (www.ksoft.demon.co.uk) – your computer could, when stolen, dial say your mobile phone, either at a preset time or whenever the PC is booted! A demo is available from their web site.

There are certain obvious drawbacks to using these systems which make them less than fool-proof, but they may help to foil an unsophisticated thief, always assuming you can enlist the support of the Police. Neither software package has been tested or endorsed by the writer.

Back Up or Else

Everyone knows the importance of keeping a backup to guard against disasters such as theft, fire or total hard disk failure. As my student friend discovered, even if you *do* back up four years' worth of University coursework onto removable disks, it's no good if the disks are themselves stolen. Storing a copy safely off-site is the best protection, hence a number of web sites which have sprung up that enable you to back up your files remotely onto the Internet. The University student would have saved herself considerable grief if one of these web disk space providers had been used.

One example is Driveway (www.driveway.com). This web-based file storage service is easy to

set up and is reasonably fast, and it enables you to categorise your data into folders. You're given 25MB of space for free (a fuel gauge shows how much is left), and this is yours for archiving, backing up or for sharing data amongst friends or colleagues. You can E-mail an invitation to other users to access or share your drive space using a password, and it has several Windows-like features which make the job easier.

Each Driveway customer is provided with a username and password for security, although the system can never be totally impregnable. Any sensitive files are best password-protected as well: consider zipping files together, adding a password and then upload them to your Driveway space. You can delete files using drag and drop, and can also upload a number of files in small batches (see screenshot) – a progress meter is provided.

Readers in the UK might consider The Elephant (www.elephant365.co.uk) backup web site which uses its own free software and provides 50MB free, claiming to be secure. More space is available for a small monthly cost.

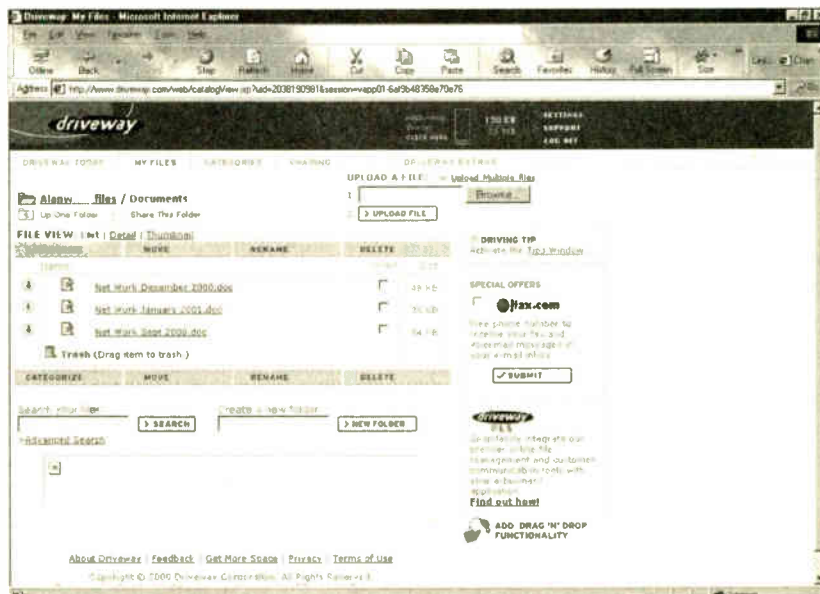
Furthermore, in the event of total system data loss, The Elephant offers to send you a CD of your archived data in the post for a fee. Now even if your computer hardware is pinched, at least you stand a chance of recovering data from the Internet afterwards.

Unwilling Partners

Last month I complained that my line speed had dropped drastically, due to BT "partnering" my modem line with another, using a DACS (Digital Access Carrier Service) box. There is hope yet: up the telegraph pole once again I spotted two BT engineers, who confirmed that they were un-DACSing my line as requested and finding another "partner" instead.

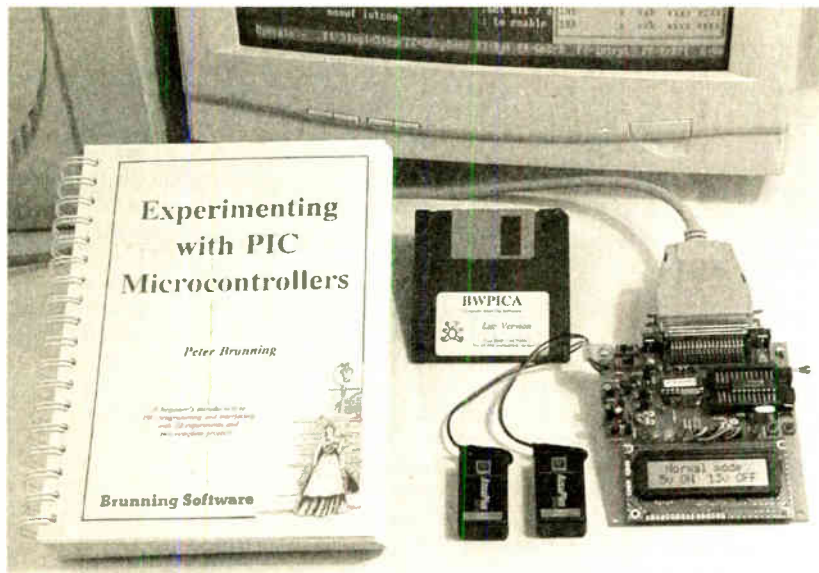
So, if DACSing happens to you, and you suddenly suffer slow speeds or difficult modem negotiations regardless of which ISP you use, complain long and hard, or threaten to close the account. Before going to war, though, have BT check the line gain, and maybe get it turned up.

That wraps up the year 2000. I wish readers around the world a peaceful Christmas and a Happy New Year. (You can E-mail me at alan@epemag.demon.co.uk.)



You can back up your files on the Internet using services such as Driveway.

Learn The Easy Way!



Experimenting with PIC Microcontrollers

This is the easiest way to start programming and interfacing the PIC16F84 and PIC16C711 microcontrollers. The system consists of the book, a programmer/experimental module, and an integrated suite of programmes to run on a PC.

The importance of the information being in a real book cannot be over emphasised. The book lies open on your desk while you use the computer to work through the experiments. We start with the simplest possible experiment. As we finish typing each line it is tested by the programme to ensure that it can be assembled so that errors are immediately highlighted. Then without leaving the programme we assemble the text into PIC code, and use the simulator to single step the programme. Watching the data in the registers change solves the problems at a stroke. We see it happen and understand, and when our programmes use the alphanumeric liquid crystal display the simulator shows what will be displayed. Then we write the code into the test PIC and run the programme in the real world. BWPICA does it all there are not three programmes.

The 24 experiments are performed using the programmer/experimental module. Flashing LEDs, text display, real time clock, period timer, beeps and music, including a rendition of Beethoven's *Für Elise*. Then there are two projects to work through; building a sinewave generator covering 0.2Hz to 20kHz, and investigating measurement of the power taken by domestic appliances. The system works through from absolute beginner.

Programming PICs

The assembler understands PIC16F84 and PIC16C711 terminology so it is not necessary to start programmes with a list of definitions, and the assembler recognises silly errors such as *call intcon* because it knows that INTCON is a register not a subroutine name.

The programming is performed and verified at 5 volts, then verified with $\pm 10\%$ applied to ensure that the device is programmed with a good margin and not poised on the edge of failure. The system will also programme similar PICs (83, 710, 71, 620, 621 etc). The module is supplied with a test PIC fitted, and requires two PP3 batteries which are not supplied.

Book Experimenting with PIC Micros . £23.99
 Book with 16F84/C711 software £40.00
 Programmer with 84/711 software . . . £62.51

Ordering Information

Telephone with Visa, Mastercard or Switch, or send cheque/PO for immediate despatch. All prices include VAT if applicable. Postage must be added to all orders. UK postage £2.50 per book, £1.00 per kit, maximum £7.50. Europe postage £3.50 per book, £1.50 per kit. Rest of world £6.50 per book, £2.50 per kit.

Assembler

Experimenting with PC Computers with its kit is the easiest way ever to learn assembly language programming, simple circuit design and interfacing to a PC. If you have enough intelligence to understand the English language and you can operate a PC computer then you have all the necessary background knowledge. Flashing LEDs, digital to analogue converters, simple oscilloscope, charging curves, temperature graphs and audio digitising.

Book Experimenting with PCs £21.50
 Kit 1a 'made up' with software £45.00
 Kit 1u 'unmade' with software £38.00

C & C++

Experimenting with C & C++ Programmes uses a similar approach. It teaches us to programme by using C to drive the simple hardware circuits built using the materials supplied in the kit. The circuits build up to a storage oscilloscope using relatively simple C techniques to construct a programme that is by no means simple. When approached in this way C is only marginally more difficult than BASIC and infinitely more powerful. C programmers are always in demand. Ideal for absolute beginners and experienced programmers.

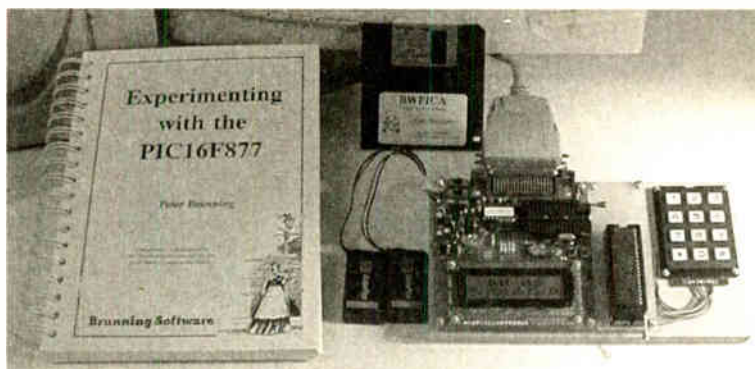
Book Experimenting with C & C++ . £24.99
 Kit CP2a 'made up' with software . . £32.51
 Kit CP2u 'unmade' with software . . . £26.51
 Kit CP2t 'top up' with software £12.99

The Kits

The assembler and C & C++ kits contain the prototyping board, lead assemblies, components and programming software to do all the experiments. The 'made up' kits are supplied ready to start. The 'unmade' Kits require the prototyping board and leads to be assembled and soldered. The 'top up' kit CP2t is for readers who have purchased a kit to go with the first book. The kits do not include the book.

Hardware required

All four systems assume you have a PC (386 or better) and a printer lead. The experiments require no soldering.



Experimenting with the PIC16F877

We start with the simplest of experiments to get a basic understanding then look at the 16 bit timer, efficient storage of text messages, simple frequency counter, use a keypad for numbers, letters and security codes, and examine the 10 bit A/D converter. The software suite has been expanded to understand the terminology of virtually all mid range 18 pin, 28 pin and 40 pin PICs, and standard .HEX files can be created to allow programming via almost any PIC programmer. For greatest convenience the Brunning Software programmer should be used. Instructions to build the 28/40 pin adaptor with keypad are included.

Book Experimenting with the PIC16F877 with full software. . . £45.00

Mail order address:-

Brunning Software 138 The Street, Little Clacton, Clacton-on-sea,
 Essex, CO16 9LS. Tel 01255 862308.

PIC-MONITORED DUAL PSU



JOHN BECKER

Part Two

LAST month the principle of operation for this dual power supply (PSU) was discussed and details of the circuit and printed circuit boards were given. We now describe the completion of the unit, discuss shortened versions of it, and tell you about running the software.

WIRING-UP

Before wiring up is commenced, thoroughly check all the soldered connections and component positions on the p.c.b.s. Use a magnifying glass to check for short circuits and missed soldering joints.

Details for the mains power connections are shown in Fig.11. Once they have been satisfactorily made, completely surround them with heavy duty insulating tape or heatshrink sleeving. Solder the mains Earth lead to an eyelet tag mounted via one of the bolts securing the transformer to the base of the case.

There is at least one occasion on which you might need to make an adjustment inside the case when the power is switched on – when adjusting the l.c.d. contrast preset VR3 (but see later). You may also need

to take voltage readings should any trouble-shooting be required (unlikely if you've assembled it all correctly, but still possible).

The insulating tape is intended to prevent inadvertent contact with any mains powered connections. As a further safety precaution, always work with one hand in your pocket when making adjustments or measurements inside mains powered equipment. This will minimise the risk of mains power passing from one hand to the other via your heart. This and the hand-to-foot routes are probably the most dangerous in an electrical shock situation.

Connections between the boards and the panel mounted components are shown in Fig.12. All connection points are numbered. Like-numbers should be connected together, other connections should be made according to the table in the monitor p.c.b. diagram of Fig.10 in Part 1. Numbers prefixed by A or B indicate connection to power supply board A or B as indicated.

Preferably leave wiring longer than is really necessary until full checking of the

unit has been satisfactorily completed. When that has been done, the wiring can be suitably shortened and grouped into several harnesses using cable ties.

DO NOT make any wiring connection between the circuits inside the case and the mains earth. As will be seen later, external circuit connections can be made to earth, depending on what configuration of outputs is used, especially in the series connection mode. Any internal earthed connection could cause large short circuit currents to flow.

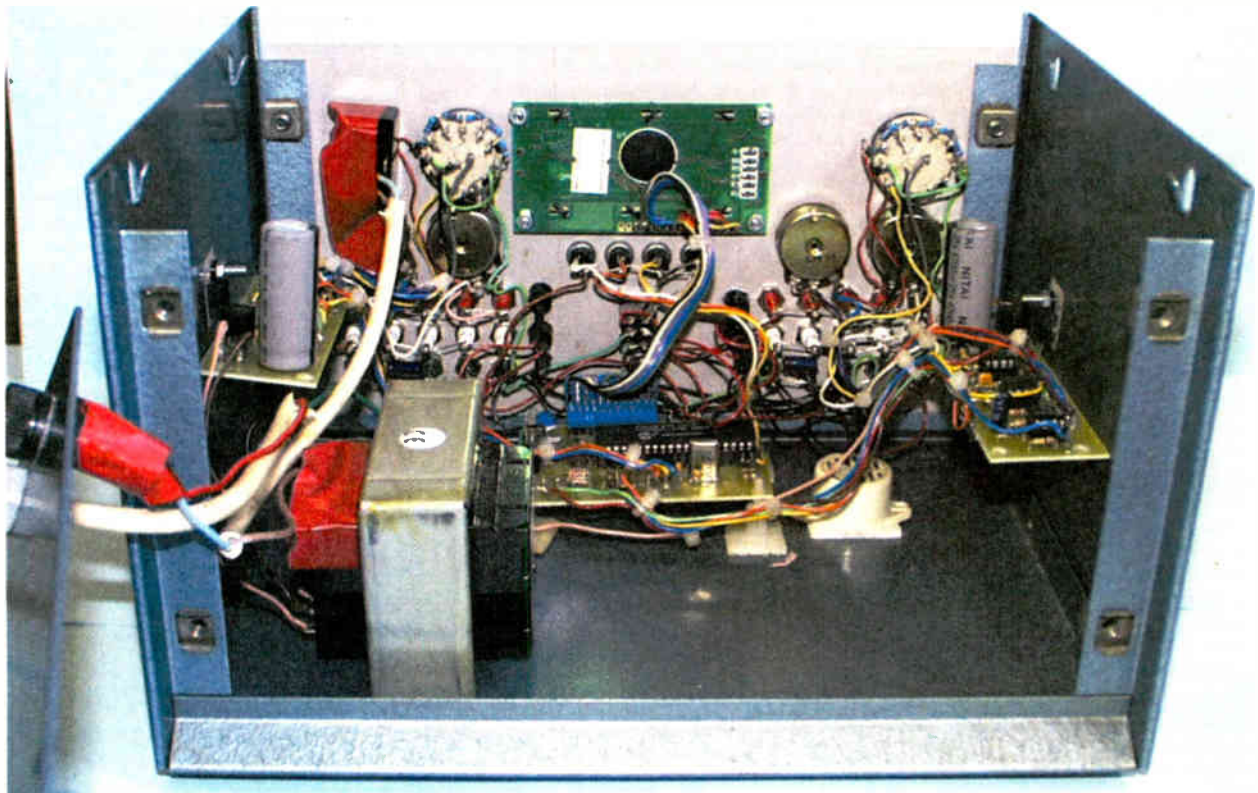
CHECKING OUT

It is recommended that if an existing power supply is available, it should be used to perform preliminary checking of the low voltage circuits before mains connections are made.

Should any fault become apparent during checking, immediately switch off, disconnect from the mains or other power supply and recheck your assembly.

Do not insert the PIC or l.c.d. yet.

Rotate all controls fully anti-clockwise, setting the switched outputs for 5V, and the



variable outputs to 0V. Set switch S7 to Parallel mode.

If you have to check the circuits using the mains power supply, immediately at switch-on check the voltage present on both power supply boards at terminal point 3 (junction of capacitor C1 and the positive output of rectifier REC1).

There should be a voltage of at least 20V d.c. at this point, probably nearer to 22V d.c.

Then check that 5V is present at the output of regulator IC1 on both power supply boards, and at the output of regulator IC5 on the monitor board.

Once the monitor's 5V has been proved, the l.c.d. module can be connected and its contrast adjusted using preset VR3 (although you will only see the top line until the PIC is inserted and running).

Next check that switches S2 select between the six voltage output options (listed earlier) for both channels. Also check that the variable output voltages can be changed by both VR1 potentiometers. The voltage available should be variable

between just over 0V (0.2V in the prototype) and about 1V below the fixed voltage selected by switches S2.

With your voltmeter's common (0V) probe connected to the common output (0V) of Channel A, switch on S7, observe that l.e.d. D7 turns on, and that the output voltages from Channel B are raised by the same amount as selected for the fixed voltage of Channel A.

For example, if output 1 (Channel A) is at 5V and output 3 (Channel B) is selected for 5V, then the voltage between output 3 and the 0V sockets of Channel A should read as 10V. Check the situation for all settings of both channels. The maximum voltage available from output 3 with reference to Channel A's common output should be about 36V.

When in series mode, the voltage at Channel B's common output sockets should be the same as that at Channel A's switched output sockets.

The block diagrams in Fig.13 illustrate the three maximum output voltages obtainable with parallel and series connection.

SOFTWARE

The software for this design was written in TASM and is available from the Editorial office on 3.5-inch disk, for which a nominal handling charge applies. It is also available *free* via the *EPE* web site. For details on both options see this month's *Shoptalk* page, which also gives details on obtaining pre-programmed PICs.

The PIC16F877's configuration must be set according to Table 5. The settings are the same as the default values in the *PIC Toolkit Mk2* programmer.

Table 5

CP1	CP0	DBG	NIL	WRT	CPD	LVP
1	1	1	1	1	1	0
BOR	CP1	CP0	POR	WDT	OS1	OS0
0	1	1	0	0	0	1

With one exception, there is nothing significantly different about the program routines compared to many of the author's recent PIC designs.

The exception is the binary-to-decimal routine, which was kindly sent to the author by *EPE* reader Peter Hemsley.

It is shorter than the author's original "library" routine, fast and 24-bit but easily modified to 16 or 32-bit. Execution time is

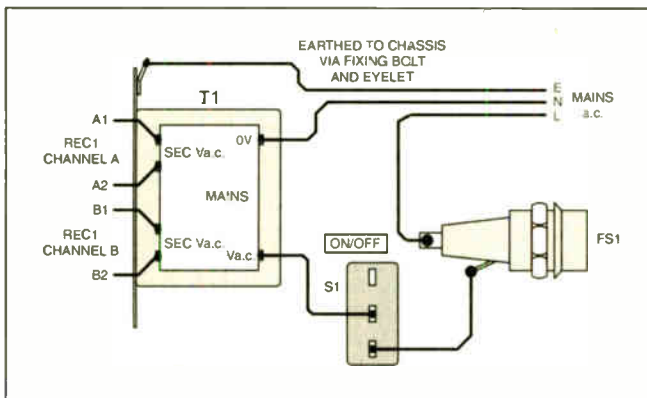


Fig.11. Mains power connections.

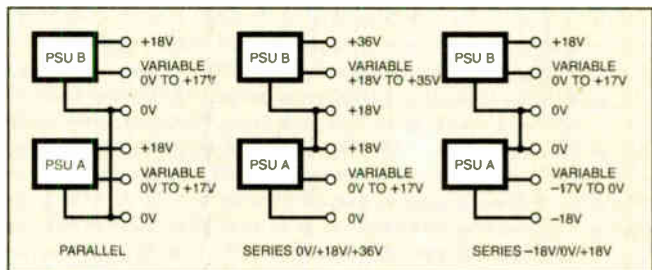


Fig.13. Maximum output voltages obtainable with parallel and series connection.

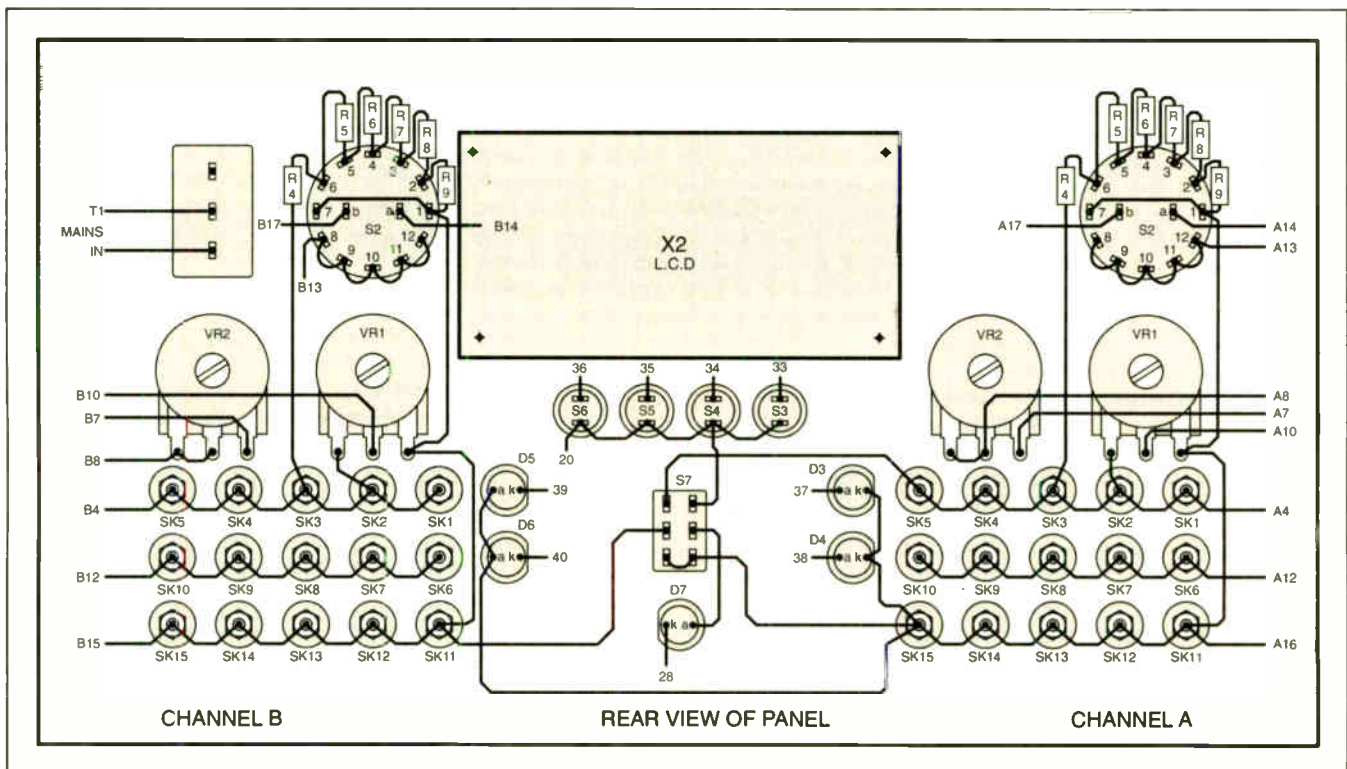
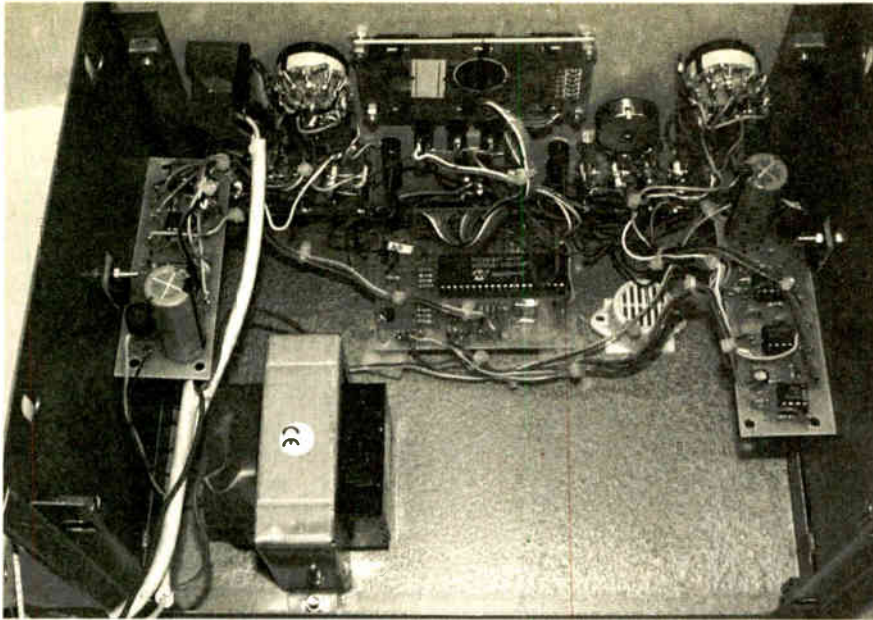


Fig.12. Front panel wiring details, viewed from inside.



HEATSINKING

This power supply can cause a considerable amount of heat to be generated across regulators IC1 and op.amp IC3. As an example, if IC1 supplies 5V to a 1A load, it can have a voltage drop across it of at least 15V, representing a heating power of 15W. The 7805 data sheet quotes a maximum power dissipation of about 2W without a heatsink and the device internally shuts down if it gets too hot.

Although both IC1 regulators are bolted to the case, which acts as a heatsink, 15W is a large amount of heat to dissipate. If you intend to use the power supply for prolonged periods at such levels, external finned heatsinks should be bolted to the case in the region of the regulators. An example of this technique is shown in Andy Flind's *Moodloop Power Supply* of September '00.

It might also be worth considering gluing a small finned heatsink to each rectifier. Drilling ventilation holes in the case could be useful as well.

Op.amp IC3 could also be overheated at higher currents when a low voltage is being output. If you need to use the variable voltage outputs at low voltages and higher currents, switch IC1 so that it supplies IC3 with a lower voltage.

The maximum power that the L272 (IC3) can dissipate is 5W, and it too features thermal shutdown. Should you find that it does become overheated, consider gluing a small finned heatsink to it, as is suggested for the rectifiers.

It is for heatsinking reasons that the specifications given in Part 1 quote normal operational current values well below 1A.

To expand further on this, the suggested maximum currents versus output voltages from the 7805 regulator are given in Table 6. The values are calculated on the assumption that the rectified voltage is 20V d.c. and that the case probably dissipates about 5W. Note that the 7805 feeds the L272 op.amp and its output current must therefore be taken into account as well.

For the L272, the maximum output current is limited to about 350mA due to the action of the circuit around IC4a. However, be wary of powering it at 18V when the output voltage is set below about 6V, since the op.amp's wattage rating could be exceeded even at modest currents.

constant and so can be used where timing is critical. Thank you Peter (and to all readers who contributed to the *Readout* discussion).

PIC CHECK

Once voltages have been checked, the PIC microcontroller (IC6) can be inserted.

If you wish to program your own PIC, it can be done *in situ* on the Monitor board using the *PIC Toolkit Mk2* programmer. The connection points are at terminal pin block TB2, in the same order as for the author's recent PIC designs. *Toolkit* can be powered at 9V via the Power Supply's Channel A Output 1 sockets.

When the programmed PIC is running, the first thing the program does is to recall the current limit values from the EEPROM data memory. On the first occasion the PIC is run, these values could be any random number from 0 to 255.

If the program finds that a value is zero it sets it for a 10mA limit. If a value is greater than 100 then the limit is set at 1000mA. To set different current limits use switches S3 to S5 as described in Part 1 (Control Switches). The new values are automatically stored in the EEPROM.

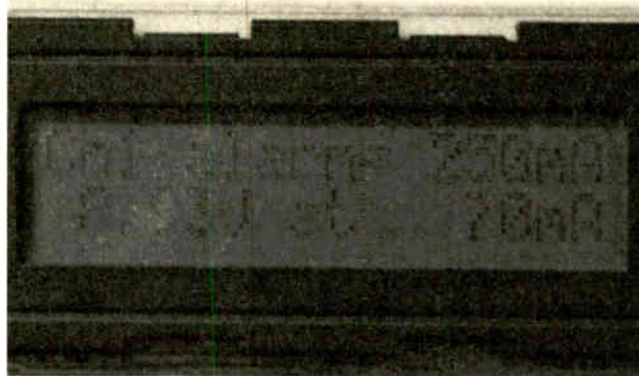
On this first occasion, again perform all the checks outlined earlier, observing the l.c.d.

screen results. You may need to readjust VR3 to optimise the l.c.d. screen contrast.

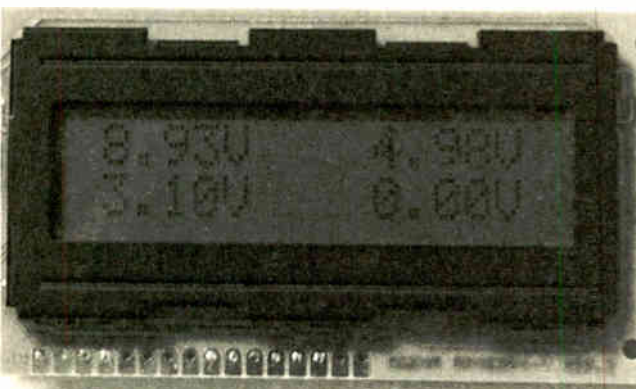
If all is well, the power supply is ready for the final checks. These simply entail connecting varying loads to each of the outputs and checking that the current values are shown and that the alarm l.e.d.s are turned on if the current drawn is greater than the preset output limit.

If possible, briefly load the outputs so that more than 1A is drawn, in which case the buzzer should sound. Do not sustain this condition, which could cause some components to overheat.

Once all the checks have been completed, the panel can be calibrated around VR1, VR2 and switch S2.



Typical display when monitoring a single output.



Typical display when monitoring voltage at all four outputs.



Typical display when monitoring current at all four outputs.

Table 6. Maximum output current versus voltage for 7805.

5V	450mA
6V	500mA
9V	630mA
12V	875mA
15V	1A
18V	1A

Apart from testing the power supply at higher currents, the author has not had practical experience of using it for supplying high-current loads in "active service". Most circuits published in *EPE* these days (including this author's designs) only require small supply currents. Feedback from readers on using this power supply at higher currents would be appreciated, addressed to the Editorial office, for possible inclusion in *Readout*.

SIMPLE POWER SUPPLY

It was said in Part 1 that a simplified version of a single power supply channel could be constructed according to Fig.3.

For this version, which is intended to supply either a fixed 5V or a variable supply of approximately 6V to just over 9V, it is suggested that a transformer having a single secondary of 9V a.c. is used, rated at about 250mA maximum. For this supply the working voltage of capacitor C1 can be reduced to 25V, the rectified voltage being about 9V a.c. $\times 1.414 - 1.4V = 11.3V$.

The amended p.c.b. component layout and wiring details are shown in Fig.14. Note that the regulator is bolted to the case, as is done with the full power supply design.

Once constructed and thoroughly checked for assembly errors, simply check with your voltmeter that the correct voltages are available at the output socket. It is suggested that you calibrate the front panel around potentiometer VR1, showing the settings for different voltages.

OTHER VERSIONS

If a single channel version of the PIC-monitored supply is preferred, use Channel A. Channel B's inputs on the monitor p.c.b. can have their attenuation resistors omitted, but the associated PIC inputs should be linked to 0V (via positions R30 to R33).

A lower voltage and/or current version can be constructed, single or dual channel. However, if a lower voltage version is built, note that switch S2's divider resistor chain should remain as shown and discussed, or recalculated for fewer resistors.

If current monitoring is not required, the unused PIC inputs (RA1, RA3, RE0, RE2) should be linked to their voltage input partners (RA1 to RA0, RA3 to RA2, RE0 to RA5, RE2 to RE1). The l.c.d. screen will show that zero current is being drawn.

POWERFUL INFO

If you would like to learn more about power supplies, a general uncomplicated discussion was included with *Teach-In 2000* Parts 10 and 11 (Aug/Sept 2000). See the *Back Issues* page for more details.

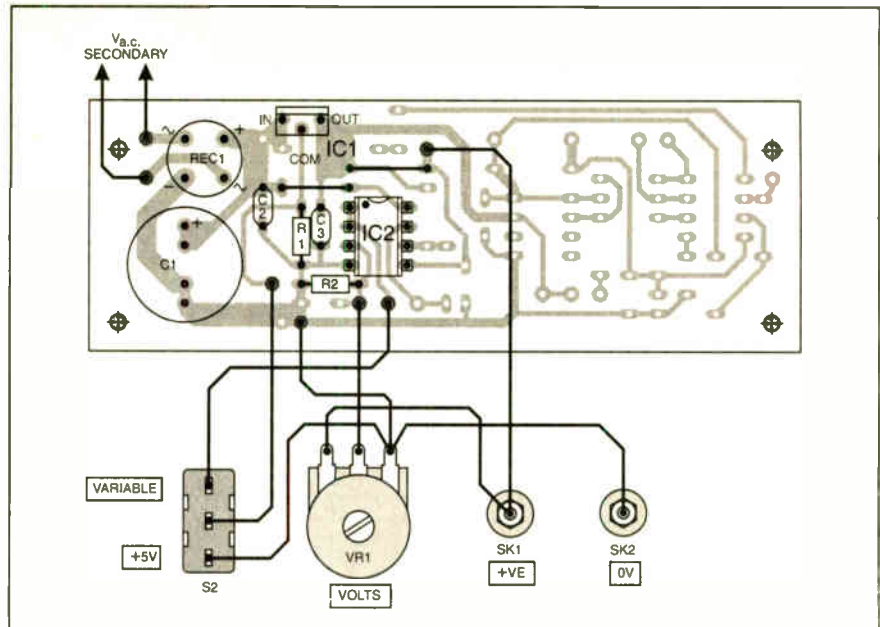


Fig. 14. Component layout and wiring details for the suggested simple power supply.

COMPONENTS

Approx. Cost
Guidance Only

£15
excluding case

SIMPLE PSU

Resistor

R1 1k 0.25W 5%

Potentiometer

VR1 10k rotary carbon, lin

Capacitors

C1 4700 μ F radial elect. (see text)
C2 220n ceramic disc, 5mm pitch
C3 100n ceramic disc, 5mm pitch

Semiconductors

IC1 7805 +5V 1A voltage regulator
IC2 LM358 dual op.amp

Miscellaneous

FS1 20mm fuseholder, panel

mounting, with 1A 20mm fuse, slow blow

REC1 W005 50V 1A bridge rectifier, or similar

S1 s.p.d.t. switch, mains rated

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

SK1 2mm socket, red (see text)

SK2 2mm socket, black (see text)

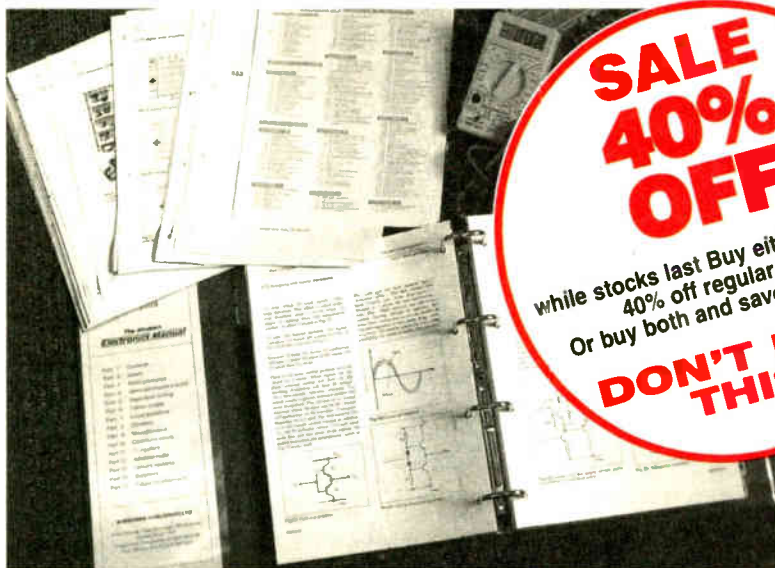
T1 mains transformer, 9V secondary, 250mA (see text)

Printed circuit board, available from the *EPE PCB Service* code 280 (power supply); knob; TO220 insulating washer kit for IC1; 8-pin d.i.l. socket; metal case to suit (see text); heatsink compound (see text); eyelet tag; mains cable clamping grommet; nuts and bolts for mounting transformer (2 off each); cable ties; 1mm terminal pins; 3-core mains cable, 5A; connecting wire; solder, etc.



**WHETHER ELECTRONICS IS YOUR HOBBY
OR YOUR LIVELIHOOD . . .
YOU NEED THE MODERN ELECTRONICS MANUAL
and the ELECTRONICS SERVICE MANUAL**

THE MODERN ELECTRONICS MANUAL



**SALE
40%
OFF**
while stocks last Buy either Manual at
40% off regular price.
Or buy both and save even more.
**DON'T MISS
THIS!**

*The essential reference
work for everyone
studying electronics*

- Over 900 pages
- In-depth theory
- Projects to build
- Detailed assembly instructions
- Full components checklists
- Extensive data tables
- Detailed supply information
- Easy-to-use format
- Clear and simple layout
- Comprehensive subject range
- Professionally written
- Regular Supplements
- Sturdy gold blocked ring-binder

EVERYTHING YOU NEED TO GET STARTED AND GO FURTHER IN ELECTRONICS!

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

BASIC PRINCIPLES: Electronic Components and their Characteristics (16 sections from Resistors and Potentiometers to Crystals, Crystal Modules and Resonators), Circuits Using Passive Components (9 sections), Power Supplies, The Amateur Electronics Workshop, The Uses of Semiconductors, Digital Electronics (6 sections), Operational Amplifiers, Introduction to Physics, Semiconductors (6 sections) and Digital Instruments (5 sections).

CIRCUITS TO BUILD: There's nothing to beat the satisfaction of creating your own project. From basic principles, like soldering and making printed circuit boards, to circuit-building, the Modern Electronics Manual and its Supplements describe clearly, with appropriate diagrams, how to assemble radios, loudspeakers,

amplifiers, car projects, computer interfaces, measuring instruments, workshop equipment, security systems, etc. The Base Manual describes 13 projects including a Theremin and a Simple TENS Unit.

ESSENTIAL DATA: Extensive tables on diodes, transistors, thyristors and triacs, digital and linear i.c.s.

EXTENSIVE GLOSSARY: Should you come across a technical word, phrase or abbreviation you're not familiar with, simply turn to the glossary included in the Manual and you'll find a comprehensive definition in plain English.

The Manual also covers **Safety** 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.

THE MODERN ELECTRONICS MANUAL

Revised Edition of Basic Work: Contains over 900 pages of information. Edited by John Becker.

Regular Supplements: Approximately 160-page Supplements of additional information which, if requested, are forwarded to you immediately on publication (four times a year). These are billed separately and can be discontinued at any time.

Presentation: Durable looseleaf system in large A4 format

Price of the Basic Work: ~~£39.95~~ **SALE PRICE £23.97** (to include a recent Supplement **FREE**)

Guarantee

Our 30 day money back guarantee gives you **complete peace of mind**. If you are not entirely happy with either 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 overseas postage charge)

ELECTRONICS SERVICE MANUAL

EVERYTHING YOU NEED TO KNOW TO GET STARTED IN REPAIRING AND SERVICING ELECTRONIC EQUIPMENT

SAFETY: Be knowledgeable about Safety Regulations, Electrical Safety and First Aid.

UNDERPINNING KNOWLEDGE: Specific sections enable you to Understand Electrical and Electronic Principles, Active and Passive Components, Circuit Diagrams, Circuit Measurements, Radio, Computers, Valves and manufacturers' Data, etc.

PRACTICAL SKILLS: Learn how to identify Electronic Components, Avoid Static Hazards, Carry Out Soldering and Wiring, Remove and Replace Components.

TEST EQUIPMENT: How to Choose and Use Test Equipment, Assemble a Toolkit, Set Up a Workshop, and Get the Most from Your Multimeter and Oscilloscope, etc.

SERVICING TECHNIQUES: The regular Supplements include vital guidelines on how to Service Audio Amplifiers, Radio Receivers, TV Receivers, Cassette Recorders, Video Recorders, Personal Computers, etc.

TECHNICAL NOTES: Commencing with the IBM PC, this section and the regular Supplements deal with a very wide range of specific types of equipment – radios, TVs, cassette recorders, amplifiers, video recorders etc..

REFERENCE DATA: Detailing vital parameters for Diodes, Small-Signal Transistors, Power Transistors, Thyristors, Triacs and Field Effect Transistors. Supplements include Operational Amplifiers, Logic Circuits, Optoelectronic Devices, etc.

The essential work for servicing and repairing electronic equipment

- Around 900 pages
- Fundamental principles
- Troubleshooting techniques
- Servicing techniques
- Choosing and using test equipment
- Reference data
- Easy-to-use format
- Clear and simple layout
- Vital safety precautions
- Professionally written
- Regular Supplements
- Sturdy gold blocked ring-binder

ELECTRONICS SERVICE MANUAL

Basic Work: Contains around 900 pages of information. Edited by Mike Tooley BA

Regular Supplements: Approximately 160-page Supplements of additional information which, if requested, are forwarded to you immediately on publication (four times a year). These are billed separately and can be discontinued at any time.

Presentation: Durable looseleaf system in large A4 format

Price of the Basic Work: ~~£39.95~~ **SALE PRICE £23.97** (to include a recent Supplement FREE)

ORDER BOTH MANUALS TOGETHER AND SAVE ANOTHER £8

A mass of well-organised and clearly explained information is brought to you by expert editorial teams whose combined experience ensures the widest coverage
Regular Supplements to these unique publications, each around 160 pages, keep you abreast of the latest technology and techniques if required

REGULAR SUPPLEMENTS

Unlike a book or encyclopedia, these Manuals are living works – continuously extended with new material. If requested, Supplements are sent to you approximately every three months. Each Supplement contains around 160 pages – all for only £23.50+£2.50 p&p. You can, of course, return any Supplement (within ten days) which

you feel is superfluous to your needs. You can also purchase a range of past Supplements to extend your Base Manual on subjects of particular interest to you.

RESPONDING TO YOUR NEEDS

We are able to provide you with the most important and popular, up to date, features in our

Supplements. Our unique system is augmented by readers' requests for new information. Through this service you are able to let us know exactly what information you require in your Manuals.

You can also contact the editors directly in writing if you have a specific technical request or query relating to the Manuals.

PLEASE send me

- THE MODERN ELECTRONICS MANUAL plus a FREE SUPPLEMENT
- ELECTRONICS SERVICE MANUAL plus a FREE SUPPLEMENT

I enclose payment of £23.97 (for one Manual) or £39.94 for both Manuals (saving another £8 by ordering both together) plus postage if applicable.

I also require the appropriate Supplements four times a year. These are billed separately and can be discontinued at any time. (Please delete if not required.)

Should I decide not to keep the Manual/s I will return it/them 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/Switch Switch Issue No.

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. Y1, Allen House, East Borough, Wimborne, Dorset BH21 1PF

We offer a 30 day MONEY BACK GUARANTEE

– if you are not happy with either Manual simply return it to us in good condition within 30 days for a full refund.

Overseas buyers do have to pay the overseas postage – see below.

POSTAGE CHARGES

Postal Region	Price PER MANUAL	
	Surface	Air
Mainland UK	FREE	–
Scottish Highlands, UK Islands & Eire	£5.50 each	–
Europe (EU)	–	£20 each
Europe (Non-EU)	£20 each	£26 each
USA & Canada	£25 each	£33 each
Far East & Australasia	£31 each	£35 each
Rest of World	£25 each	£45 each

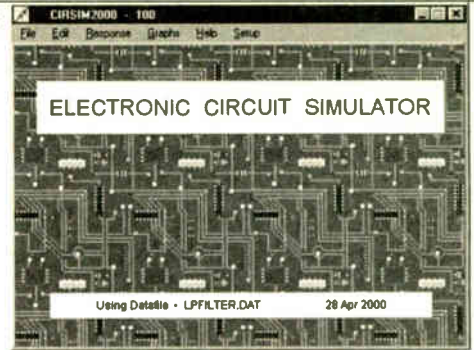
Please allow four working days for UK delivery.
 NOTE: Surface mail can take over 10 weeks to some parts of the world. Each Manual weighs about 4kg when packed.

esm2

Special Review

CIRSIM SHAREWARE

COLIN SLOAN



A Circuit Simulation Program for the PC.

COMPUTER-BASED circuit simulation programs are now used extensively as an aid to circuit design. These programs do not actually design circuits but save time by enabling engineers to try out ideas by simulation before actually constructing hardware. There are some quite sophisticated packages on the market, such as Analyser III, MicroCap-V, Electronics Workbench and Tina Pro. The latter was reviewed in *EPE* last year.

These more expensive programs, which range in price from £100 upwards, are used in industry and by colleges for teaching purposes. They can handle a mixture of both analogue and digital circuits and even allow one to connect virtual instruments, such as an oscilloscope with appropriate controls, to view waveforms. A much cheaper but quite powerful simulation program called CIRSIM, which can analyse any linear analogue circuit, is now available and is the subject of this review.

ON ADMITTANCE

How do these programs work? Well, linear circuit analysis programs, such as CIRSIM, function by setting up a matrix of admittance values for each frequency at which the circuit response is required, these being derived from the component values defined for the circuit. It is essential to work with admittances rather than impedances (admittance is the reciprocal of impedance), as if there is no connection between two nodes of a circuit then the admittance of the path is zero, whereas the impedance would be infinity – a difficult value for computers to handle!

This matrix is known as the “indefinite admittance matrix” and relates the total current at any node in the circuit to the voltages at the nodes. The matrix is easy to set up as it exhibits a great deal of symmetry and would be of size $n \times n$ for a circuit containing n nodes. For three and four terminal components (such as transistors, op.amps and transformers), their own individual admittance matrices are derived and then added in to the main matrix – this is justified by the principle of superposition.

Having been set up, the complete matrix is then reduced to a 2×2 matrix representing the two-port blackbox equivalent

network of the circuit, from which the usual parameters may easily be derived; i.e., gain, phase shift, input and output impedances. For more details of the theory see the articles given in refs. 1, 2 and 3.

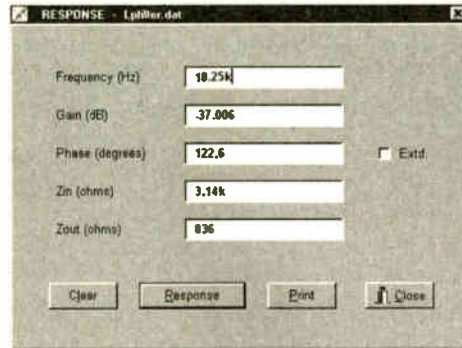


Fig.1. Results of analysis at a single frequency.

CIRSIM

CIRSIM itself is written in Pascal, using Borland Delphi, employing 32-bit code which will run under Windows 95, 98 and NT. It is capable of analysing circuits with up to 100 nodes and containing any mixture of resistors, capacitors, inductors, mutual inductors, transistors (both bipolar and f.e.t.), op.amps and thermionic valves. The high frequency parameters of both transistors and op.amps can be defined and there is no restriction on the total number of components.

In use a number is allocated to each nodal connection point on the circuit diagram (including earth) and then the component details and nodal connection numbers are input to the program. A simple text editor, with the usual cut and paste facilities, is incorporated in the program for this purpose. One can also add comments and circuit diagrams by using standard text characters, a facility which will be enhanced with appropriate circuit symbols in proposed later editions.

IN RESPONSE

Having defined the circuit, the simulator can calculate the response at any frequency. To do this, choose the appropriate menu item and type in the required frequency

value. The screen will then display the gain in dB, the phase shift in degrees between input and output nodes, the input impedance and the output impedance at the specified frequency, as shown in Fig.1. With the ‘Ext’d’ box ticked, the results are displayed with much greater precision in floating point format.

The circuit definition is stored on disk so the analysis can be repeated at other frequencies or you can return to the editor to make circuit changes, adding or deleting components, to see how these affect the response. You can also change the input or output nodes so the response can be calculated at any intermediate point in the circuit. A listing of the component values and the results of the analysis can be output to the printer at any time.

It is possible to determine the stability criteria of oscillators by breaking the circuit loop at an appropriate point and finding that frequency at which there is zero phase shift between input and output. Provided the gain is greater than unity at this frequency, the circuit will oscillate when the loop is closed.

The simulator can plot the amplitude response of your circuit over a defined frequency range. Some 50 preset frequency scales are provided, ranging from 0.03Hz to 3GHz with each spanning 1, 2, 3 or 5 decades. A user-defined frequency scale is also available covering any range you care to define.

Progress is indicated by a horizontal bargraph while the results are being computed. On completion, another menu allows you to set the amplitude scale appropriately, after which the response is displayed on the screen in a 640×480 format.

After examining the result, you can return to the amplitude setting menu, revise the scale if required, and then display again. If you want a hard copy of the plot, a printer setup menu is provided which makes it possible to position the graph on the paper and to scale the plot. A typical result, Fig.2, shows the response of a low pass Chebyshev filter, and Fig.3 shows the response of a mutually coupled tuned circuit (as might be used in an i.f. amplifier) with various degrees of coupling; namely, undercoupled, critically coupled and overcoupled.

One unique feature of this program is that plots can be superimposed – a facility often not found in more expensive packages. Thus, one can plot and save a

response, return to the editor to make circuit changes, and then superimpose the revised response on the first – repeating this as many times as required.

The impressive result in Fig.4 shows the response of a seven-band graphic equaliser circuit. The various boost/cut potentiometers (sliders) were set to flat and the response plotted. The response was then plotted with each in turn set first to maximum and then to minimum positions. The resultant 15 plots were superimposed on one graph as shown.

It can also calculate the squarewave response of a circuit at any given frequency. This can be rather time consuming so to speed things up, with a slight loss of accuracy, one can restrict the number of harmonics used in the calculation. The squarewave response of the low pass Chebyshev filter plotted on the printer in the same way as the amplitude response is shown in Fig.5.

IN USE

CIRSIM is easy to install and use. It is robust, it doesn't crash if you type in silly values, and it appears to be accurate. The program designer claims to have compared the results obtained from CIRSIM with those using PCSPICE analysing the same circuit and found there was exact agreement.

It is very fast in operation with smaller circuits but slows up rapidly as the number of nodes increases. To analyse a circuit

containing 100 nodes (which is quite large) takes about one second using a, now fairly ancient, 100MHz Pentium. As you would expect, graphs take longer to compute since 400 data points are involved.

Detailed documentation is provided which can be displayed on the screen using a simple menu system and more than 20 circuit examples are included in the package. These include simple active and passive filters, a loudspeaker crossover network, a cascode circuit, various audio amplifiers (including a valve amplifier), a Baxandall tone control, a gyrator and a 47-section transmission line.

The simulator is very useful for analysing linear circuits and can save a lot of time by resolving problems before actually building any hardware. At lower frequencies, up to about 10MHz, circuits perform as predicted by CIRSIM within the limits of experimental accuracy. At higher frequencies there are some discrepancies which are probably caused by inaccurate modelling of components – more especially stray capacitance and inductance not being included in the simulated circuit.

SUMMING UP

To sum up, in terms of accuracy and speed CIRSIM is as good as other more expensive programs designed to simulate linear analogue circuits while the graphical output is well presented with the advantage of superposition. It is also capable of

analysing circuits containing thermionic valves, which is a bonus.

The program does have its limitations – it does not have all the bells and whistles of its more expensive counterparts, there are no facilities to import component data from files and it cannot handle logic circuits. However, for the price, just £10, it represents excellent value for money and is a good low-cost introduction to the art of linear circuit simulation.

A free evaluation version of the software, providing all the facilities of the program but handling a limited number of nodes, can be downloaded from the website <http://www.bells-hill.freemove.co.uk>. This downloaded file contains full documentation and examples. The purchase price of £10 applies only to the version of the program handling the full number of nodes.

CIRSIM can be obtained from:

Peter Montgomery, Downings, Bells Hill, Stoke Poges, Slough SL2 4EG.

Tel: 01753 643384.

E-mail: cirsim@bells-hill.freemove.co.uk

References

1. Network Analysis and Synthesis by F. F. Kuo – J. Wiley and Sons.
2. Semiconductor Device Modeling for Computer-Aided Design by G. A. Herskowitz and R. B. Schilling – McGraw-Hill.
3. Computer Circuit Simulation by W. Blume – Byte July 1986.

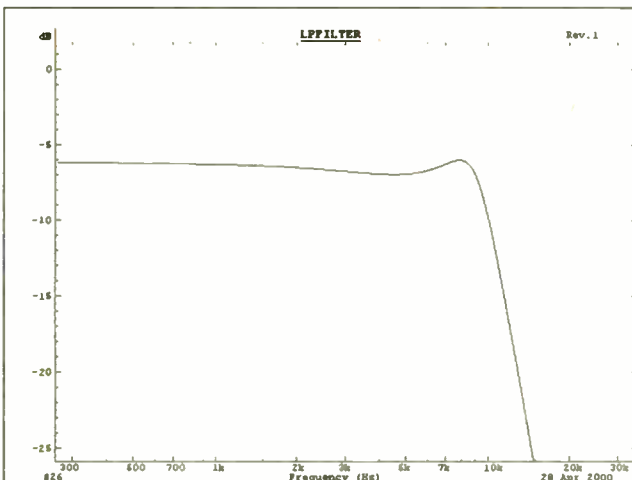


Fig.2. Amplitude response of a low pass filter.

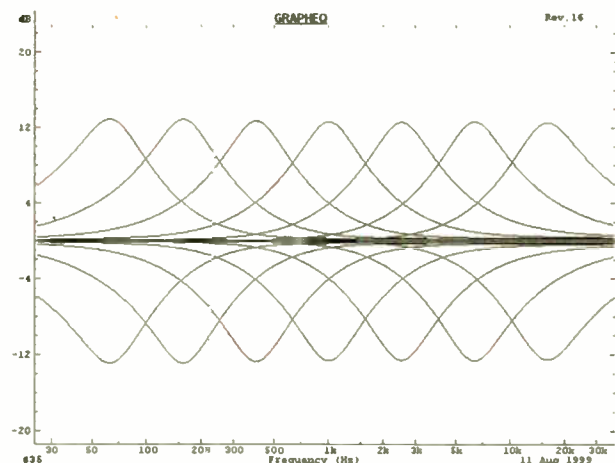


Fig.4. Amplitude response of a seven-band graphic equaliser circuit.

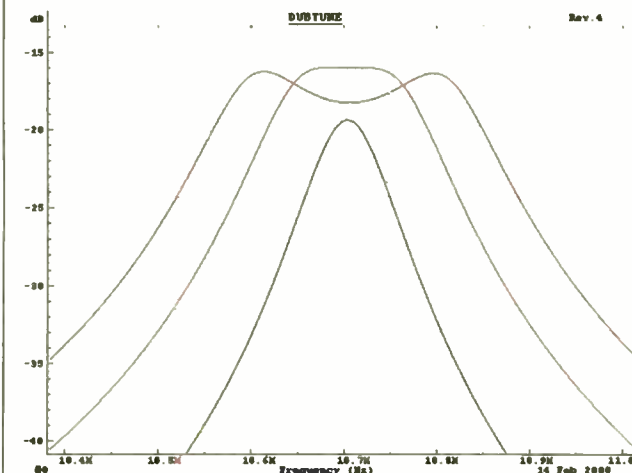


Fig.3. Response of mutually coupled tuned circuits.

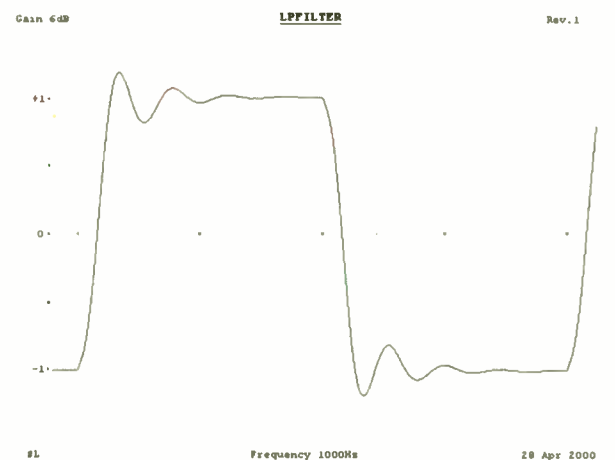


Fig.5. Squarewave response of the low pass filter, showing ringing around the cut-off frequency.

Everyday Practical Electronics Books

TEACH-IN No. 7

ANALOGUE AND DIGITAL ELECTRONICS COURSE

(published by *Everyday Practical Electronics*)

Alan Winstanley and Keith Dye B.Eng(Tech)AMIEE

This highly acclaimed *EPE 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.

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 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

Order code TI7

£3.95

TEACH-IN 2000 plus FREE software

John Becker

NEW

The *Teach-In 2000* series is now available on CD-ROM, see advert elsewhere in this issue.



DIRECT BOOK SERVICE

The books listed have been selected by *Everyday Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order to your door. Full ordering details are given on the last book page.

For a further selection of books see the next two issues of *EPE*.

Robotics

INTRODUCING ROBOTICS WITH LEGO MINDSTORMS

Robert Penfold

Shows the reader how to build a variety of increasingly sophisticated computer controlled robots using the brilliant Lego Mindstorms Robotic Invention System (RIS). Initially covers fundamental building techniques and mechanics needed to construct strong and efficient robots using the various "click-together" components supplied in the basic RIS kit. Then explains in simple terms how the "brain" of the robot may be programmed on screen using a PC and "zapped" to the robot over an infra-red link. Also, shows how a more sophisticated Windows programming language such as Visual BASIC may be used to control the robots.

Details building and programming instructions provided, including numerous step-by-step photographs.

288 pages - large format

Order code BP901

£12.99

ANDROIDS, ROBOTS AND ANIMATRONS

John Lovine

Build your own working robot or android using both off-the-shelf and workshop constructed materials and devices. Computer control gives these robots and androids two types of artificial intelligence (an expert system and a neural network). A lifelike android hand can be built and programmed to function doing repetitive tasks. A fully animated robot or android can also be built and programmed to perform a wide variety of functions.

The contents include an Overview of State-of-the-Art Robots; Robotic Locomotion; Motors and Power Controllers; All Types of Sensors; Tilt; Bump; Road and Wall Detection; Light; Speech and Sound Recognition; Robotic Intelligence (Expert Type) Using a Single-Board Computer Programmed in BASIC; Robotic Intelligence (Neural Type) Using Simple Neural Networks (Insect Intelligence); Making a Lifelike Android Hand; A Computer-Controlled Robotic Insect Programmed in BASIC; Telepresence Robots With Actual Arcade and Virtual Reality Applications; A Computer-Controlled Robotic Arm; Animated Robots and Androids; Real-World Robotic Applications.

224 pages

Order code MGH1

£20.99

Radio

BASIC RADIO PRINCIPLES AND TECHNOLOGY

Ian Poole

Radio technology is becoming increasingly important in today's high technology society. There are the traditional uses of radio which include broadcasting and point to point radio as well as the new technologies of satellites and cellular phones. All of these developments mean there is a growing need for radio engineers at all levels.

Assuming a basic knowledge of electronics, this book provides an easy to understand grounding in the topic.

Chapters in the book: Radio Today, Yesterday, and Tomorrow; Radio Waves and Propagation; Capacitors, Inductors, and Filters; Modulation; Receivers; Transmitters; Antenna Systems; Broadcasting; Satellites; Personal Communications; Appendix - Basic Calculations.

263 pages

Order code NE30

£14.99

PROJECTS FOR RADIO AMATEURS AND S.W.L.S.

R. A. Penfold

This book describes a number of electronic circuits, most of which are quite simple, which can be used to enhance the performance of most short wave radio systems.

The circuits covered include: An aerial tuning unit; A simple active aerial; An add-on b.f.o. for portable sets; A wavetramp to combat signals on spurious responses; An audio notch filter; A parametric equaliser; C.W. and S.S.B. audio filters; Simple noise limiters; A speech processor; A volume expander.

Other useful circuits include a crystal oscillator, and RTTY/C.W. tone decoder, and a RTTY serial to parallel converter. A full range of interesting and useful circuits for short wave enthusiasts.

92 pages

Order code BP304

£3.95

AN INTRODUCTION TO AMATEUR RADIO

I. D. Poole

Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century. This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.

150 pages

Order code BP257

£4.99

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

Computers and Computing

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

HOW TO BUILD YOUR OWN PC

Morris Rosenthal

More and more people are building the own PCs. They get more value for their money, they create exactly the machine they want, and the work is highly satisfying and actually fun. That is, if they have a unique beginner's guide like this one, which visually demonstrates how to construct a state-of-the-art computer from start to finish.

Through 150 crisp photographs and clear but minimal text, readers will confidently absorb the concepts of computer building. The extra-big format makes it easy to see what's going on in the pictures. For non-specialists, there's even a graphical glossary that clearly illustrates technical terms. The author goes "under the hood" and shows step-by-step how to create a socket 7 (Pentium and non-intel chipsets) and a Slot 1 (Pentium II) computer, covering: What first-time builders need to know; How to select and purchase parts; How to assemble the PC; How to install Windows 98. The few existing books on this subject, although badly outdated, are in steady demand. This one delivers the expertise and new technology that fledgling computer builders are eagerly looking for.

224 pages - large format

Order code MGH2

£19.99

UNDERSTANDING PC SPECIFICATIONS

R. A. Penfold (Revised Edition)

If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous

range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleaved 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!

128 pages

Order code BP282

£4.95

Theory and Reference

Bebop To The Boolean Boogie

By Clive (call me Max) Maxfield

Specially imported by EPE – Excellent value

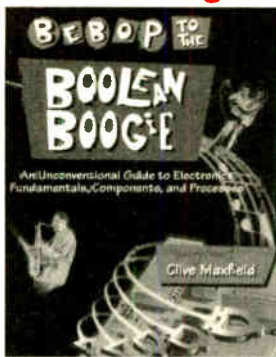
An Unconventional Guide to Electronics Fundamentals, Components and Processes

This book gives the "big picture" of digital electronics. This indepth, highly readable, up-to-the-minute guide shows you how electronic devices work and how they're made. You'll discover how transistors operate, how printed circuit boards are fabricated, and what the innards of memory ICs look like. You'll also gain a working knowledge of Boolean Algebra and Karnaugh Maps, and understand what Reed-Muller logic is and how it's used. And there's much, MUCH more (including a recipe for a truly great seafood gumbo!). Hundreds of carefully drawn illustrations clearly show the important points of each topic. The author's tongue-in-cheek British humor makes it a delight to read, but this is a REAL technical book, extremely detailed and accurate. A great reference for your own shelf, and also an ideal gift for a friend or family member who wants to understand what it is you do all day. . . .

470 pages – large format

Order code BEB1

£24.95



Bebop Bytes Back

By Clive "Max" Maxfield and Alvin Brown

Specially imported by EPE – Excellent value

An Unconventional Guide To Computers

Plus FREE CD-ROM which includes: Fully Functional Internet-Ready Virtual Computer with Interactive Labs

This follow-on to *Bebop to the Boolean Boogie* is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design. . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the accompanying CD-ROM (for Windows 95 machines only) contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the book contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers.



FREE CD-ROM

DIGITAL ELECTRONICS – A PRACTICAL APPROACH With FREE Software: Number One Systems – EASY-PC Professional XM and Pulsar (Limited Functionality)

Richard Monk

Covers binary arithmetic, Boolean algebra and logic gates, combination logic, sequential logic including the design and construction of asynchronous and synchronous circuits and register circuits. Together with a considerable practical content plus the additional attraction of its close association with computer aided design including the FREE software.

There is a 'blow-by-blow' guide to the use of EASY-PC Professional XM (a schematic drawing and printed circuit board design computer package). The guide also conducts the reader through logic circuit simulation using Pulsar software. Chapters on p.c.b. physics and p.c.b. production techniques make the book unique, and with its host of project ideas make it an ideal companion for the integrative assignment and common skills components required by BTEC and the key skills demanded by GNVQ. The principal aim of the book is to provide a straightforward approach to the understanding of digital electronics.

Those who prefer the 'Teach-In' approach or would rather experiment with some simple circuits should find the book's final chapters on printed circuit board production and project ideas especially useful.

250 pages

Order code NE28

£16.99

FREE SOFTWARE

Over 500 pages – large format

Order code BEB2

£29.95

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

Music, Audio and Video

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

Temporarily out of print

ELECTRONIC MUSIC AND MIDI PROJECTS

R. A. Penfold

Whether you wish to save money, boldly go where no musician has gone before, rekindle the pioneering spirit, or simply have fun building some electronic music gadgets, the designs featured in this book should suit your needs. The projects are all easy to build, and some are so simple that even complete beginners at electronic project construction can tackle them with ease. Stripboard layouts are provided for every project, together with a wiring diagram. The mechanical side of construction has largely been left to individual constructors to sort out, simply because the vast majority of project builders prefer to do their own thing in this respect.

None of the designs requires the use of any test equipment in order to get them set up properly. Where any setting up is required, the procedures are very straightforward, and they are described in detail.

Projects covered: Simple MIDI tester, Message grabber, Byte grabber, THRU box, MIDI auto switcher, Auto/manual switcher, Manual switcher, MIDI patchbay, MIDI controlled switcher, MIDI lead tester, Program change pedal, Improved program change pedal, Basic mixer, Stereo mixer, Electronic swell pedal, Metronome, Analogue echo unit.

138 pages

Order code PC116

£9.95

VIDEO PROJECTS FOR THE ELECTRONICS CONSTRUCTOR

R. A. Penfold

Written by highly respected author R. A. Penfold, this book contains a collection of electronic projects specially designed for video enthusiasts. All the projects can be simply constructed, and most are suitable for the newcomer to project construction, as they are assembled on stripboard.

There are faders, wipers and effects units which will add sparkle and originality to your video recordings, an audio mixer and noise reducer to enhance your soundtracks and a basic computer control interface. Also, there's a useful selection on basic video production techniques to get you started.

Complete with explanations of how the circuit works, shopping lists of components, advice on construction, and guidance on setting up and using the projects, this invaluable book will save you a small fortune.

Circuits include: video enhancer, improved video enhancer, video fader, horizontal wiper, improved video wiper, negative video unit, fade to grey unit, black and white keyer, vertical wiper, audio mixer, stereo headphone amplifier, dynamic noise reducer, automatic fader, pushbutton fader, computer control interface, 12 volt mains power supply.

124 pages

Order code PC115

£9.95

COMPUTERS AND MUSIC – AN INTRODUCTION

R. A. Penfold

Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone.

If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.

This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This

book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully.

174 pages

Temporarily out of print

THE INVENTOR OF STEREO – THE LIFE AND WORKS OF ALAN DOWER BLUMLEIN

Robert Charles Alexander

This book is the definitive study of the life and works of one of Britain's most important inventors who, due to a cruel set of circumstances, has all but been overlooked by history.

Alan Dower Blumlein led an extraordinary life in which his inventive output rate easily surpassed that of Edison, but whose early death during the darkest days of World War Two led to a shroud of secrecy which has covered his life and achievements ever since.

His 1931 Patent for a Binaural Recording System was so revolutionary that most of his contemporaries regarded it as more than 20 years ahead of its time. Even years after his death, the full magnitude of its detail had not been fully utilized. Among his 128 patents are the principal electronic circuits critical to the development of the world's first electronic television system. During his short working life, Blumlein produced patent after patent breaking entirely new ground in electronic and audio engineering.

During the Second World War, Alan Blumlein was deeply engaged in the very secret work of radar development and contributed enormously to the system eventually to become 'H2S' – bomb-bombing radar. Tragically, during an experimental H2S flight in June 1942, the Halifax bomber in which Blumlein and several colleagues were flying, crashed and all aboard were killed. He was just days short of his thirtieth birthday.

420 pages

Order code NE32

£14.99

HIGH POWER AUDIO AMPLIFIER CONSTRUCTION

R. A. Penfold

Practical construction 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

£3.99

Circuits, Data 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** £4.99

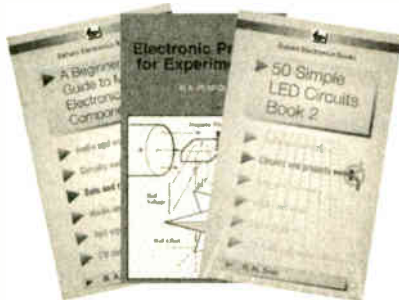
ELECTRONIC HOBBYISTS DATA BOOK

R. A. Penfold

This book should tell you everything you are ever likely to want to know about hobby electronics, but did not know where to ask or refer. Comprehensive contents pages makes it easy to quickly locate the data you require.

The subjects covered include: Common circuits, and related data (including helpful graphs and tables of values); Colour codes for resistors, capacitors and inductors; Pinout details for a wide range of CMOS and TTL devices, plus basic data on the various logic families; Pinout details and basic data for a wide range of operational amplifiers; Data and leadout information for a wide range of transistors, FETs, power FETs, triacs, thyristors, diodes, etc; General data including MIDI message coding, radio data, ASCII/Baudot coding, decibel ratios, etc.

242 pages **Order code BP396** £5.95



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 **Temporarily out of print**

BOOK 2 50 more l.e.d. circuits.

50 pages **Order code BP87** £2.99

CIRCUIT SOURCE BOOK 1

A. Penfold

Written to help you create and experiment with your own electronic designs by combining and using the various standard "building block" circuits provided. Where applicable, advice on how to alter the circuit parameters is given.

The circuits covered in this book are mainly concerned with analogue signal processing and include: Audio amplifiers (op.amp and bipolar transistors); audio power amplifiers; d.c. amplifiers; highpass, lowpass, bandpass and notch filters; tone controls; voltage controlled amplifiers and filters; triggers and voltage comparators; gates and electronic switching; bargraphs; mixers; phase shifters, current mirrors, hold circuits, etc.

Over 150 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.

182 pages **Order code BP321** £4.99

A BEGINNER'S GUIDE TO TTL DIGITAL ICs

R. A. Penfold

This book first covers the basics of simple logic circuits in general, and then progresses to specific TTL logic integrated circuits. The devices covered include gates, oscillators, timers, flip/flops, dividers, and decoder circuits. Some practical circuits are used to illustrate the use of TTL devices in the "real world".

142 pages **Order code BP332** £4.95

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** £3.99

CIRCUIT SOURCE BOOK 2

R. A. Penfold

This book will help you to create and experiment with your own electronic designs by combining and using the various standard "building blocks" circuits provided. Where

applicable, advice on how to alter the circuit parameters is provided.

The circuits covered are mainly concerned with signal generation, power supplies, and digital electronics.

The topics covered in this book include: 555 oscillators; sinewave oscillators; function generators; CMOS oscillators; voltage controlled oscillators; radio frequency oscillators; 555 monostables; CMOS monostables; TTL monostables; precision long timers; power supply and

regulator circuits; negative supply generators and voltage boosters; digital dividers; decoders, etc; counters and display drivers; D/A and A/D converters; opto-isolators, flip/flops, noise generators, tone decoders, etc.

Over 170 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.

192 pages **Order code BP322** £4.99

Project Building & Testing

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

ELECTRONIC PROJECT BUILDING FOR BEGINNERS

R. A. Penfold

This book is for complete beginners to electronic project building. It provides a complete introduction to the practical side of this fascinating hobby, including the following topics:

Component identification, and buying the right parts; resistor colour codes, capacitor value markings, etc;

advice on buying the right tools for the job; soldering; making easy work of the hard wiring; construction methods, including stripboard, custom printed circuit boards, plain matrix boards, surface mount boards and wire-wrapping; finishing off, and adding panel labels; getting "problem" projects to work, including simple methods of fault-finding.

In fact everything you need to know in order to get started in this absorbing and creative hobby.

135 pages **Order code BP392** £4.95

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** £4.99

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

BOOK ORDERING DETAILS

Our postage price is the same no matter how many books you order, just add £2.00 to your total order for postage and packing (overseas readers add £4 for countries in the EEC, or add £7 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, Visa, Mastercard or Switch - minimum card order is £5 - to:

DIRECT BOOK SERVICE, ALLEN HOUSE, EAST BOROUGH, WIMBORNE, DORSET BH21 1PF
Books are normally sent within seven days of receipt of order, but please allow 28 days for delivery (more for overseas orders). Please check price and availability (see latest issue of *Everyday Practical Electronics*) before ordering from old lists.

For a further selection of books see the next two issues of *EPE*.

DIRECT BOOK SERVICE IS A DIVISION OF WIMBORNE PUBLISHING LTD.

Tel 01202 881749 Fax 01202 841692.

E-mail: dbb@epemag.wimborne.co.uk

BOOK ORDER FORM

Full name:

Address:

.....

..... Post code: Telephone No:

Signature:

I enclose cheque/PO payable to DIRECT BOOK SERVICE for £

Please charge my Visa/Mastercard/Switch £ Card expiry date.....

Card Number Switch Issue No.....

Please send book order codes:

Please continue on separate sheet of paper if necessary

SQUIRES

MODEL & CRAFT TOOLS

A COMPREHENSIVE RANGE OF MINIATURE HAND AND POWER TOOLS AND AN EXTENSIVE RANGE OF

ELECTRONIC COMPONENTS

FEATURED IN A FULLY ILLUSTRATED

432-PAGE MAIL ORDER CATALOGUE

2001 ISSUE

**SAME DAY DESPATCH
FREE POST AND PACKAGING**

Catalogues: FREE OF CHARGE to addresses in the UK.
Overseas: CATALOGUE FREE, postage at cost charged to credit card

**Squires, 100 London Road,
Bognor Regis, West Sussex, PO21 1DD**

TEL: 01243 842424

FAX: 01243 842525

SHOP NOW OPEN



VISA

Watch Slides on TV.

Make videos of your slides. Digitise your slides (using a video capture card) "Liesgang diatv" automatic slide viewer with built in high quality colour TV camera. It has a composite video output to a phono plug (SCART & BNC adaptors are available). They are in very good condition with few signs of use. More details see www.diatv.co.uk.
£91.91 + VAT = £108.00



Board cameras all with 512 x 582 pixels 8.5mm 1/3 inch sensor and composite video out. All need to be housed in your own enclosure and have fragile exposed surface mount parts. They all require a power supply of between 10V and 12V DC 150mA.
47MIR size 60 x 36 x 27mm with 6 infra red LEDs (gives the same illumination as a small torch but is not visible to the human eye) £37.00 + VAT = £43.48
30MP size 32 x 32 x 14mm spy camera with a fixed focus pin hole lens for hiding behind a very small hole £35.00 + VAT = £41.13
40MC size 39 x 38 x 27mm camera for 'C' mount lens these give a much sharper image than with the smaller lenses £32.00 + VAT = £37.60
Economy C mount lenses all fixed focus & fixed iris
VSL1220F 12mm F1.6 12 x 15 degrees viewing angle £15.97 + VAT £18.76
VSL4022F 4mm F1.22 63 x 47 degrees viewing angle £17.65 + VAT £20.74
VSL6022F 6mm F1.22 42 x 32 degrees viewing angle £19.05 + VAT £22.38
VSL8020F 8mm F1.22 32 x 24 degrees viewing angle £19.90 + VAT £23.38

Better quality C Mount lenses

VSL1614F 16mm F1.6 30 x 24 degrees viewing angle £26.43 + VAT £31.06
VWL813M 8mm F1.3 with iris 56 x 42 degrees viewing angle £77.45 + VAT = £91.00
1206 surface mount resistors E12 values 10 ohm to 1M ohm
100 of 1 value £1.00 + VAT 1000 of 1 value £5.00 + VAT

866 battery pack originally intended to be used with an orbital mobile telephone it contains 10 1.6Ah sub C batteries (42 x 22 dia. the size usually used in cordless screwdrivers etc.) the pack is new and unused and can be broken open quite easily
£7.46 + VAT = £8.77



Please add £1.66 + vat = £1.95 postage & packing per order

JPG Electronics

276-278 Chatsworth Road, Chesterfield, S40 2BH.

Tel 01246 211202 Fax 01246 550959

Mastercard/Visa/Switch

Callers welcome 9.30 a.m. to 5.30 p.m. Monday to Saturday



PLASTIC BOXES & ENCLOSURES

Contact us for your free catalogue

S.L.M. (Model) Engineers Ltd

Chiltern Road

Prestbury

Cheltenham

GL52 5JQ

Website: www.slm.uk.com

Telephone 01242 525488

Fax 01242 226288

Bell College
Almada Street
Hamilton
Scotland ML3 0JB
Tel: 01698 283100
Fax: 01698 282131



Make your Expertise pay!

In today's world you need qualifications to obtain and keep employment. Our open learning courses make obtaining those qualifications as convenient as possible.

Choose from our dozens of SQA accredited units, either singly to **update your skills** or as a group to obtain a **Higher National Certificate**.

- Learn at your own pace in your own home
- Support from professional engineers via phone, FAX and the Internet
- Courses from Introductory Bridging Modules to HNC Electronics
- Units from Programmable Logic Controllers to Engineering Computing

DONT DELAY - we are waiting to hear from you.

Contact Laura Murdoch, Open Learning Co-ordinator

Tel 01698 283100 Ext. 214.

E-mail l.murdoch@bell.ac.uk

Web: <http://floti.bell.ac.uk/openlearning>

Member of the British Association for Open Learning
Preview Centre for FT Knowledge



Bell College of Technology
is a registered charity No. Sc 021170,
providing quality Higher Education and
Training opportunities for all.



VIDEOS ON ELECTRONICS

A range of videos selected by *EPE* and designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They have proved particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc



BASICS

VT201 to VT206 is a basic electronics course and is designed to be used as a complete series, if required.

VT201 54 minutes. Part One; D.C. Circuits. This video is an absolute must for the beginner. Series circuits, parallel circuits, Ohms law, how to use the digital multimeter and much more.

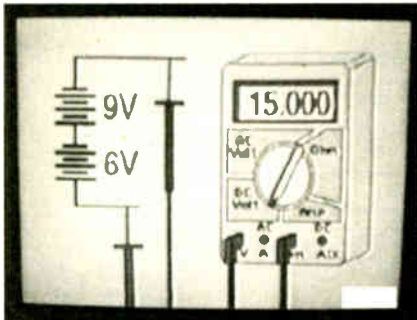
Order Code VT201

VT202 62 minutes. Part Two; A.C. Circuits. This is your next step in understanding the basics of electronics. You will learn about how coils, transformers, capacitors, etc are used in common circuits.

Order Code VT202

VT203 57 minutes. Part Three; Semiconductors. Gives you an exciting look into the world of semiconductors. With basic semiconductor theory. Plus 15 different semiconductor devices explained.

Order Code VT203



VT204 56 minutes. Part Four; Power Supplies. Guides you step-by-step through different sections of a power supply.

Order Code VT204

VT205 57 minutes. Part Five; Amplifiers. Shows you how amplifiers work as you have never seen them before. Class A, class B, class C, op.amps. etc.

Order Code VT205

VT206 54 minutes. Part Six; Oscillators. Oscillators are found in both linear and digital circuits. Gives a good basic background in oscillator circuits.

Order Code VT206

£34.95 each
inc. VAT & postage

Order 8 or more get one extra FREE
Order 16 get two extra FREE

VCR MAINTENANCE

VT102 84 minutes: Introduction to VCR Repair. Warning, not for the beginner. Through the use of block diagrams this video will take you through the various circuits found in the NTSC VHS system. You will follow the signal from the input to the audio/video heads then from the heads back to the output.

Order Code VT102

VT103 35 minutes: A step-by-step easy to follow procedure for professionally cleaning the tape path and replacing many of the belts in most VHS VCR's. The viewer will also become familiar with the various parts found in the tape path.

Order Code VT103

DIGITAL

Now for the digital series of six videos. This series is designed to provide a good grounding in digital and computer technology.

VT301 54 minutes. Digital One; Gates begins with the basics as you learn about seven of the most common gates which are used in almost every digital circuit, plus Binary notation.

Order Code VT301

VT302 55 minutes. Digital Two; Flip Flops will further enhance your knowledge of digital basics. You will learn about Octal and Hexadecimal notation groups, flip-flops, counters, etc.

Order Code VT302

VT303 54 minutes. Digital Three; Registers and Displays is your next step in obtaining a solid understanding of the basic circuits found in today's digital designs. Gets into multiplexers, registers, display devices, etc.

Order Code VT303

VT304 59 minutes. Digital Four; DAC and ADC shows you how the computer is able to communicate with the real world. You will learn about digital-to-analogue and analogue-to-digital converter circuits.

Order Code VT304

VT305 56 minutes. Digital Five; Memory Devices introduces you to the technology used in many of today's memory devices. You will learn all about ROM devices and then proceed into PROM, EPROM, EEPROM, SRAM, DRAM, and MBM devices.

Order Code VT305

VT306 56 minutes. Digital Six; The CPU gives you a thorough understanding in the basics of the central processing unit and the input/output circuits used to make the system work.

Order Code VT306

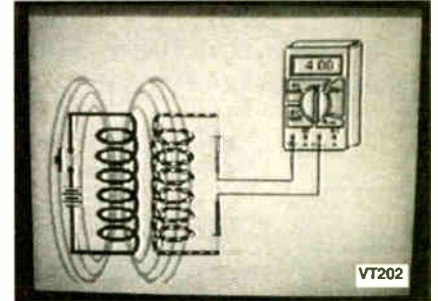
RADIO

VT401 61 minutes. A.M. Radio Theory. The most complete video ever produced on a.m. radio. Begins with the basics of a.m. transmission and proceeds to the five major stages of a.m. reception. Learn how the signal is detected, converted and reproduced. Also covers the Motorola C-QUAM a.m. stereo system.

Order Code VT401

VT402 58 minutes. F.M. Radio Part 1. F.M. basics including the functional blocks of a receiver. Plus r.f. amplifier, mixer oscillator, i.f. amplifier, limiter and f.m. decoder stages of a typical f.m. receiver.

Order Code VT402



VT403 58 minutes. F.M. Radio Part 2. A continuation of f.m. technology from Part 1. Begins with the detector stage output, proceeds to the 19kHz amplifier, frequency doubler, stereo demultiplexer and audio amplifier stages. Also covers RDS digital data encoding and decoding.

Order Code VT403

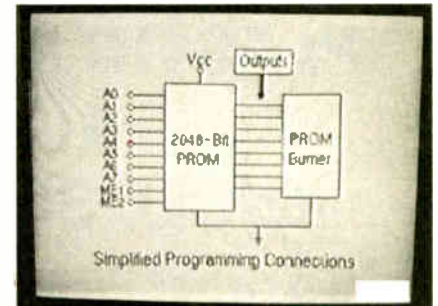
MISCELLANEOUS

VT501 58 minutes. Fibre Optics. From the fundamentals of fibre optic technology through cable manufacture to connectors, transmitters and receivers.

Order Code VT501

VT502 57 minutes. Laser Technology A basic introduction covering some of the common uses of laser devices, plus the operation of the Ruby Rod laser, HeNe laser, CO₂ gas laser and semiconductor laser devices. Also covers the basics of CD and bar code scanning.

Order Code VT502



Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier. We are the worldwide distributors of the PAL and SECAM versions of these tapes. (All videos are to the UK PAL standard on VHS tapes unless you specifically request SECAM versions.)

ORDERING: Price includes postage to anywhere in the world.

OVERSEAS ORDERS: We use the VAT portion of the price to pay for *airmail* postage and packing, wherever you live in the world. Just send £34.95 per tape. All payments in £ sterling only (send cheque or money order drawn on a UK bank). Make cheques payable to Direct Book Service.

Visa, Mastercard and Switch orders accepted - please give card number, card expiry date and Switch Issue No.

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, Allen House, East Borough, Wimborne, Dorset BH21 1PF

Direct Book Service is a division of Wimborne Publishing Ltd., Publishers of *EPE*

Tel: 01202 881749. Fax: 01202 841692

E-mail: dbs@epemag.wimborne.co.uk

PCB SERVICE

Printed circuit boards for most recent *EPE* constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to **The PCB Service, Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749; Fax 01202 841692; E-mail: orders@epemag.wimborne.co.uk.** Cheques should be crossed and made payable to *Everyday Practical Electronics* (Payment in £ sterling only).

NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail. Back numbers or photostats of articles are available if required – see the *Back Issues* page for details.

Please check price and availability in the latest issue. Boards can only be supplied on a payment with order basis.

PROJECT TITLE	Order Code	Cost
★ RC-Meter	APR'98 188	£7.66
Security Auto-Light	MAY'98 189	£8.10
Stereo Tone Control plus 20W Stereo Amplifier		
Tone Control	190	£7.78
20W Amplifier	191	£8.58
★ Dice Lott	192	£8.05
EPE Mood Changer	JUNE'98 193	£7.75
• AT89C2051/1051 Programmer		
Main Board	194	£8.50
Test Board	195	£8.69
★ Reaction Timer	Software only	–
★ PIC16x84 Toolkit	JULY'98 196	£6.96
★ Greenhouse Computer		
Control Board	197	£9.08
Float Charger	AUG'98 199	£6.59
Lightbulb Saver	202	£3.00
Personal Stereo Amplifier (Multi-project PCB)	SEPT'98 932	£3.00
★ Greenhouse Radio Link	200	£8.32
★ PIC Altimeter	201	£8.15
Voice Processor	CCT'98 203	£7.18
IR Remote Control		
– Transmitter	205	£3.00
– Receiver	206	£3.50
★ PIC Tape Measure	NOV'98 207	£6.82
Electronic Thermostat – T-Stat	208	£4.00
PhizzyB		£14.95
A – PCB B – CD-ROM C – Prog. Microcontroller	Bee (A)(B)(C)	each
15-Way IR Remote Control		
Switch Matrix	211	£3.00
15-Way Rec/Decoder	212	£4.00
Damp Stat	DEC'98 209	£4.50
Handheld Function Generator	213	£4.00
★ Fading Christmas Lights	215	£5.16
PhizzyB I/O Board (4-section)	216	£3.95
Twinkle Twinkle Reaction Game	JAN'99 210	£7.55
★ EPE Mind PiCkter	214	£6.30
PhizzyB I/O Board (4-section)	216	£3.95
Alternative Courtesy Light Controller	217	£6.72
Light Alarm	FEB'99 218	£6.78
★ Wireless Monitoring System	Transmitter 219+a	£9.92
Receiver	220+a	£8.56
★ PIC MIDI Sustain Pedal	Software only	–
★ Wireless Monitoring System-2	MAR'99	See
F.M. Trans/Rec Adaptors	219a/220a	Feb'99
★ Time and Date Generator	221	£7.37
Auto Cupboard Light	222	£6.36
Smoke Absorber	223	£5.94
Ironing Board Saver	APR'99 224	£5.15
Voice Record/Playback Module	225	£5.12
Mechanical Radio (pair)	226A&B	£7.40
★ Versatile Event Counter	207	£6.82
PIC Toolkit Mk2	MAY'99 227	£8.95
A.M./F.M. Radio Remote Control		
Transmitter	228	£3.00
Receiver	229	£3.20
★ Musical Sundial	JUNE'99 231	£9.51
PC Audio Frequency Meter	232	£8.79
★ EPE Mood PiCkter	JULY'99 233	£6.78
12V Battery Tester	234	£6.72
Intruder Deterrent	235	£7.10
L.E.D. Stroboscope (Multi-project PCB)	932	£3.00
Ultrasonic Puncture Finder	AUG'99 236	£5.00
★ 8-Channel Analogue Data Logger	237	£8.88
Buffer Amplifier (Oscillators Pt 2)	238	£6.96
Magnetic Field Detective	239	£6.77
Sound Activated Switch	240	£6.53
Freezer Alarm (Multi-project PCB)	932	£3.00
Child Guard	SEPT'99 241	£7.51
Variable Dual Power Supply	242	£7.64
Micro Power Supply	OCT'99 243	£3.50
★ Interior Lamp Delay	244	£7.88
Mains Cable Locator (Multi-project PCB)	932	£3.00
Vibralarm	NOV'99 230	£6.93
Demister One-Shot	245	£6.78
★ Ginormous Stopwatch – Part 1	246	£7.82

PROJECT TITLE	Order Code	Cost
★ Ginormous Stopwatch – Part 2	DEC'99	
Giant Display	247	£7.85
Serial Port Converter	248	£3.96
Loft Guard	249	£4.44
Scratch Blanker	JAN'00	£4.83
Flashing Snowman (Multi-project PCB)	932	£3.00
★ Video Cleaner	FEB'00	£5.63
Find It	251	£4.20
252	253	£4.52
★ Teach-In 2000 – Part 4		
High Performance	MAR'00	254, 255 } £5.49
Regenerative Receiver	256 Set	
★ EPE Icebreaker – PCB257, programmed PIC16F877 and floppy disc	Set Only	£22.99
Parking Warning System	258	£5.08
★ Micro-PiCScope	APR'00	259
Garage Link – Transmitter	261	£4.99
Receiver	262	Set £5.87
Versatile Mic/Audio Preamp	MAY'00	260
PIR Light Checker	263	£3.33
★ Multi-Channel Transmission System		
Transmitter	264	
Receiver	265	Set £6.34
Interface	266	
★ Canute Tide Predictor	JUNE'00	267
★ PIC-Gen Frequency Generator/Counter	JULY'00	268
q-Meter	269	£3.05
★ EPE Moodloop	AUG'00	271
Quiz Game Indicator	272	£5.47
Handy-Amp	273	£4.52
Active Ferrite Loop Aerial	SEPT'00	274
★ Remote Control IR Decoder	Software only	–
★ PIC Dual-Channel Virtual Scope	OCT'00	275
Handclap Switch	NOV'00	270
★ PIC Pulsometer	Software only	–
Twinkling Star	DEC'00	276
Festive Fader	277	£4.28
Motorists' Buzz-Box	278	£5.71
★ PiCtogram	279	£5.39
★ PIC-Monitored Dual PSU-1		
PSU	280	£4.75
Monitor Unit	281	£5.23
Static Field Detector (Multi-project PCB)	932	£3.00
Two-Way Intercom	JAN'01	282
UFO Detector and Event Recorder		
Magnetic Anomaly Detector	283	
Event Recorder	284	Set £6.19
Audio Alarm	285	
★ Using PICs and Keypads	Software only	–

EPE SOFTWARE

Software programs for *EPE* projects marked with an asterisk ★ are available on 3.5 inch PC-compatible disks or free from our Internet site. The following disks are available: **PIC Tutorial** (Mar-May '98 issues); **PIC Toolkit Mk2** (May-Jun '99 issues); **EPE Disk 1** (Apr '95-Dec '98 issues); **EPE Disk 2** (Jan-Dec '99); **EPE Disk 3** (Jan-Dec '00); **EPE Disk 4** (Jan '01 issue to current cover date); **EPE Teach-In 2000**; **EPE Interface Disk 1** (October '00 issue to current cover date). The disks are obtainable from the *EPE PCB Service* at £3.00 each (UK) to cover our admin costs (the software itself is free). Overseas (each): £3.50 surface mail, £4.95 each airmail. All files can be downloaded free from our Internet FTP site. <ftp://ftp.epemag.wimborne.co.uk>.

EPE PRINTED CIRCUIT BOARD SERVICE

Order Code Project Quantity Price

Name

Address

I enclose payment of £..... (cheque/PO in £ sterling only) to:

Everyday Practical Electronics

MasterCard, Visa or Switch No.

Minimum order for cards £5 Switch Issue No.

Card No.

Signature..... Card Exp. Date.....

NOTE: You can also order p.c.b.s by phone, Fax, E-mail or via our Internet site on a secure server:

<http://www.epemag.wimborne.co.uk>

Everyday Practical Electronics reaches twice as many UK readers as any other UK monthly hobby electronics magazine, our audited sales figures prove it. We have been the leading monthly magazine in this market for the last sixteen years.

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £8 (+VAT) per single column centimetre (minimum 2.5cm). The prepaid rate for classified adverts is 30p (+VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Practical Electronics. VAT must be added. Advertisements, together with remittance, should be sent to Everyday Practical Electronics Advertisements, Mill Lodge, Mill Lane, Thorpe-le-Soken, Essex CO16 0ED. Phone/Fax (01255) 861161.

For rates and information on display and classified advertising please contact our Advertisement Manager, Peter Mew as above.

Valve Output Transformers: Single ended 50mA, £4.50; push/pull 15W, £27; 30W, £32; 50W, £38; 100W, £53. Mains Transformers: Sec 220V 30mA 6V 1A, £3; 250V 60mA 6V 2A, £5; 250V 80mA 6V 2A, £6. High Voltage Caps: 50µF 350V, 68µF 500V, 150µF 385V, 330µF 400V, 470µF 385V, all £3 ea., 32+32µF 450V £5. Postage extra.
Record Decks and Spares: BSR, Garrard, Goldring, motors, arms, wheels, headshells, spindles, etc. Send or phone your want list for quote.

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON SURREY, CR0 2HS. Tel: (020) 8684 1865
Lots of transformers, high volt caps, valves, output transformers, speakers, in stock. Phone or send your wants list for quote.

Z88 NOW AVAILABLE WITH 128K AND 512K - OZ4

ALSO SPECTRUM AND QL PARTS

W. N. RICHARDSON & CO.

PHONE/FAX 01494 871319

E-mail: wnr@compuserve.com

RAVENSMED, CHALFONT ST PETER, BUCKS, SL9 0NB

TIS - Midlinbank Farm Ryeland, Strathaven ML10 6RD
Manuals on anything electronic

Circuits - VCR £8, CTV £6

Service Manuals from £10

Repair Manuals from £5

P&P any order £2.50

Write, or ring 01357 440280 for full details of our lending service and FREE quote for any data

BTEC ELECTRONICS TECHNICIAN TRAINING

GNVQ ADVANCED ENGINEERING (ELECTRONIC) - PART-TIME

HND ELECTRONICS - FULL-TIME

B.Eng FOUNDATION - FULL-TIME

Next course commences

Monday 29th January 2001

FULL PROSPECTUS FROM

LONDON ELECTRONICS COLLEGE

(Dept EPE) 20 PENYWERN ROAD

EARLS COURT, LONDON SW5 9SU

TEL: (020) 7373 8721

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. M. P. Moses,

5 Park View, Cwmaman,

Aberdare CF44 6PP

Space donated by

Everyday Practical Electronics

Miscellaneous

X-10® Home Automation
We put you in control™

Why tolerate when you can automate?

An extensive range of 230V X-10 products and starter kits available. Uses proven Power Line Carrier technology, no wires required.

Products Catalogue available Online.

Worldwide delivery.

Laser Business Systems Ltd.

E-Mail: info@laser.com

http://www.laser.com

Tel: (020) 8441 9788

Fax: (020) 8449 0430

Mixed Transistors (BC types) £1.25/pack
Mixed Transistors (inc. power types, BD, TIP etc.) £1.75/pack
Mixed CMOS (gates 4011, 4070 etc.) £1.45/pack
Mixed CMOS (gates, decoders, counters etc.) £1.90/pack
Mixed Semiconductors (inc. i.e.d.s, trans, CMOS) £1.90/pack
Mixed Semiconductors (inc. power trans, op.amps) £1.90/pack
Bumper component parcel £3.25 + £1.40 post
78L12 - 480p, 7812 - 360p, C106D THY - 33p, BD135 - 2/45p, BD136 - 2/45p, TIP31B - 2/45p, TIP41C - 40p, NE555N - 3/55p, LM358N - 2/45p, TL061 - 2/50p, TL062 - 45p, TL084 - 60p, MJE340 - 50p, CMOS 4066 - 30p, 4017 - 2/50p, 4520 - 2/50p.
OFFER: P8048 single chip computer £2.35 each or 3 for £8.

TM INDUSTRIES (SURPLUS DEALER)

TM Industries, 15 Wimberley Way, South Witham,

Grantham, Lincs NG33 5PL. Tel: 01572 767754

Min. order £2.00, carriage 95p. Contact us for surplus requirements.

PRINTED CIRCUIT BOARDS - QUICK SERVICE. Prototype and production artwork raised from magazines or draft designs at low cost. PCBs designed from schematics. Production assembly, wiring and software programming. For details contact Patrick at Agar Circuits, Unit 5, East Belfast Enterprise Park, 308 Albertbridge Road, Belfast, BT5 4GX. Phone 028 9073 8897, Fax 028 9073 1802, E-mail agar@argonet.co.uk.

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/fax Brighton 883871, Mobile 07949 598309. E-mail b.m.a@cwctv.net.

FREE PROTOTYPE PRINTED CIRCUIT BOARDS! Free prototype p.c.b. with quantity orders. Call Patrick on 028 9073 8897 for details. Agar Circuits, Unit 5, East Belfast Enterprise Park, 308 Albertbridge Road, Belfast BT5 4GX.

G.C.S.E. ELECTRONIC KITS, at pocket money prices. S.A.E. for FREE catalogue. SIR-KIT Electronics, 52 Severn Road, Clacton, CO15 3RB.

VALVE ENTHUSIASTS: Capacitors and other parts in stock. For free advice/lists please ring, Geoff Davies (Radio), Tel. 01788 574774.

BUILDING OR PURCHASING AN AUDIO MIXING DESK? Specialists in custom built fully modular mixing desks for hospital radio, talking newspapers for the blind, amateur dramatic groups, local shopping centres, theatres etc., to see and read all about our products visit our pictorial web site at: <http://www.partridgeelectronics.co.uk> or phone 01268 793256.

NEW LISTINGS! Build projects that work with non-soldering kits at unbeatable prices! Power crystal sets, TRF, shortwave radio, audio amplifiers, power boosters, experimenters' kits plus plenty more... Full instructions and components supplied. Free new catalogue for sae: QRP, 27 Amberley Street, Bradford, West Yorkshire BD3 8QZ.

BRIGHTEN YOUR CHRISTMAS with 6 assorted coloured i.e.d. + projects and catalogue. Enclose sae: K.I.A., 1 Regent Road, Ilkley LS29.

ELECTRONIC CHARTERED ENGINEER CONSULTANT available for circuit design, EMC and problem solving. 07940 705496, 01525 220722, quantek@pobox.com.

EPE NET ADDRESSES

EPE FTP site: <ftp://ftp.epemag.wimborne.co.uk>

Access the FTP site by typing the above into your web browser, or by setting up an FTP session using appropriate FTP software, then go into quoted sub-directories:

PIC-project source code files: /pub/PICS

PIC projects each have their own folder; navigate to the correct folder and open it, then fetch all the files contained within. Do not try to download the folder itself!

EPE text files: /pub/docs

Basic Soldering Guide: solder.txt

Ingenuity Unlimited submission guidance: ing_unlt.txt

New readers and subscribers info: epe_info.txt

Newsgroups or Usenet users advice: usenet.txt

Ni-Cad discussion: nicadfaq.zip and nicad2.zip

Writing for EPE advice: write4us.txt

On-line readers! Try the EPE Chat Zone - a virtually real-time Internet "discussion board" in a simple to use web-based forum!

<http://www.epemag.wimborne.co.uk/wwwboard>

Or buy EPE Online: www.epemag.com

Ensure you set your FTP software to ASCII transfer when fetching text files, or they may be unreadable.

Note that any file which ends in .zip needs unzipping before use. Unzip utilities can be downloaded from:

<http://www.winzip.com> or <http://www.pkware.com>

TRAIN TODAY FOR A BETTER FUTURE

Now you can get the skills and qualifications you need for career success with an ICS Home Study Course. Learn in the comfort of your own home at the pace and times that suit you. ICS is the world's largest, most experienced home study school. Over the past 100 years ICS have helped nearly 10 million people to improve their job prospects. Find out how we can help YOU. Post or phone today for FREE INFORMATION on the course of your choice

Electrical Contracting & Installation
Electrical Engineering
C&G/ICS Basic Electronic Engineering
C&G/ICS Basic Mechanical Engineering
TV and Video Servicing
Radio and Hi-Fi Servicing
Refrigeration Heating & Air Conditioning
Motorcycle Maintenance

FREEPHONE 0500 581 557

Or write to: International Correspondence Schools, FREEPOST 882, 8 Elliot Place, Clydeaway Skypark, Glasgow, G3 8BR. Tel: 0500 581 557 or Tel/Fax: Dublin 285 2533.

Please send me my Free Information on your Electronics Courses.

Mr/Mrs/Ms/Miss (BLOCK CAPITALS PLEASE) _____ Date of Birth / / _____
Address _____
Postcode _____
Occupation _____ Tel. No. _____
From time to time, we permit other carefully screened organisations to write to you about products and services if you would prefer not to hear from such organisations please tick box Dept. ZEEVC10

Professional 88-108MHz FM Broadcasting Kits

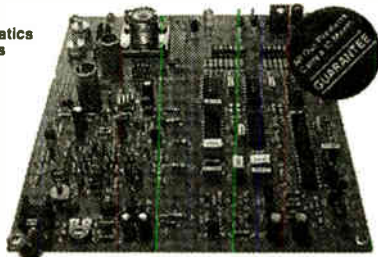
All Our Kits Include

Detailed Instructions with Schematics
High Quality Screen Printed PCBs
High Quality Components

Our Product Range Includes

Transmitters from 0.05W to 35W
FM Stereo Coders
Audio Compressor Limiters
Antennas
RF Power Amps

Our Kits Are Also Available Fully Assembled And Tested



1W Professional PLL FM Transmitter for Licensed Use in the UK

Visit our Website at <http://www.veronica.co.uk>



Contact Us Now For A Free Brochure

Tel 01274 883434 Fax 01274 428665

email info@veronica.co.uk

Unit 5/6 1A Sandbeds/Albair Rd Queensbury BRADFORD BD13 1AA

VARIABLE VOLTAGE TRANSFORMERS

INPUT 220V/240V AC 50/60Hz OUTPUT 0V-260V PANEL MOUNTING

	Price	P&P
0.5KVA 2.5 amp max	£33.00	£8.00
	(£45.84 inc VAT)	£7.00
1KVA 5 amp max	£45.25	£7.00
	(£61.39 inc VAT)	

SHROUDED

0.5KVA 2.5 amp max	£34.00	£6.00
	(£47.00 inc VAT)	£7.00
1KVA 5 amp max	£46.25	£7.00
	(£62.57 inc VAT)	£8.50
2KVA 10 amp max	£65.00	£8.50
	(£94.36 inc VAT)	£8.50
3KVA 15 amp max	£86.50	£8.50
	(£111.63 inc VAT)	

5KVA 25 amp max £150.00 (+ Carriage & VAT)
Buy direct from the Importers. Keenest prices in the country.

500VA ISOLATION TRANSFORMER

Input lead 240V AC. Output via 3-pin 13A socket. 240V AC continuously rated. Mounted in fibreglass case with handle. Internally fused. Price £35.00 carriage paid + VAT (£41.13)

TOROIDAL L.T. TRANSFORMER

Primary 0-240V AC Secondary 0-30V + 0-30V 600VA. Fixing bolt supplied. Price £25.00 carriage paid + VAT (£29.38)

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.

ULTRA VIOLET BLACK LIGHT BLUE FLUORESCENT TUBES

4ft. 40 watt	£14.00 (callers only)	(£16.45 inc VAT)
2ft 20 watt	£9.00 (callers only)	(£10.58 inc VAT)
12in 8 watt	£4.80 + 75p p&p	(£5.52 inc VAT)
9in 6 watt	£3.96 + 50p p&p	(£5.24 inc VAT)
6in 4 watt	£3.96 + 50p p&p	(£5.24 inc VAT)

230V AC BALLAST KIT

For either 9in. 9in or 12in Tubes £5.05-£11.40 p&p (£9.75 inc VAT)
The above Tubes are 3500/4000 angstrom (350-400nm) ideal for detecting security markings, effects lighting & Chemical applications.
Other Wavelengths of UV TUBE available for Germicidal & Photo Sensitive applications. Please telephone your enquiries

400 WATT BLACK LIGHT BLUE UV LAMP

GES Mercury Vapour lamp suitable for use with a 400W P.F. Ballast. Only £39.95 incl. p&p & VAT



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 18cm. Weight 42 kilos. Price £120 + VAT. Ex-warehouse. Carriage on request.

24V DC SIEMENS CONTACTOR
Type 3TH40022-03 2 x NO and 2 x NC 230V AC 10A. Contacts. Screw or On Rail Fixing. Size H 120mm x W 45mm x D 75mm. Brand New Price £7.63 incl. p&p and VAT.

240V AC WESTOOL SOLENOIDS
Model TT2 Max. stroke 16mm, 5lb. pull. Base mounting. Rating 1. Model TT6 Max. stroke 25mm, 15lb. pull. Base mounting. Rating 1. Series 400 Max. stroke 28mm, 15lb. pull. Front mounting. Rating 2. Prices incl. p&p & VAT. TT2 £5.88, TT6 £8.81, Series 400 £6.64.

AXIAL COOLING FAN
230V AC 120mm square x 38mm 3 blade 10 watt Low Noise fan. Price £7.29 incl. p&p and VAT. Other voltages and sizes available from stock. Please telephone your enquiries.

INSTRUMENT CASE
Brand new. Manufactured by Imhof. L 31cm x H 18cm x 19cm Deep. Removable front and rear panel for easy assembly of your components. Grey textured finish, complete with case feet. Price £16.45 incl. p&p and VAT. 2 off £28.20 inclusive.

DIECAST ALUMINIUM BOX
with internal PCB guides. Internal size 265mm x 165mm x 50mm deep. Price £9.93 incl. p&p & VAT. 2 off £17.60 incl.

230V AC SYNCHRONOUS GEARED MOTORS
Brand new. Manufactured by Imhof. L 31cm x H 18cm x 19cm Deep. Removable front and rear panel for easy assembly of your components. Grey textured finish, complete with case feet. Price £16.45 incl. p&p and VAT. 2 off £28.20 inclusive.

16 RPM REVERSIBLE Crouzet 220V/230V 50Hz geared motor with ovoid geared box. 4mm dia. shaft. New manuf. surplus. Sold complete with reversing capacitor, connecting block and circ. Overall size: h 68mm x w 52mm x 43mm deep. PRICE incl. P&P & VAT £9.99

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. 8watt 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. £17.20 each or 2 for £20.50 inclusive.



SERVICE TRADING CO

57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB

Open Monday/Friday

Tel: 0181-995 1560

FAX: 0181-995 0549



Ample Parking Space

2001 CATALOGUE

25 PAGES, FREE OF CHARGE, PLEASE SEND SAE+2 STAMPS. KITS AVAILABLE FOR MOST EPE PROJECTS. PLEASE SEND SAE FOR DETAILS OF ANY PROJECT THAT INTERESTS YOU.

OUR BEST BUY BRANDS ON PAGE 1 OF OUR 2001 CATALOGUE INCLUDE:

7805, 7812 or 7815 1A Voltage Regulators 33p each	BFY50 35p, BFY51 28p, BFY52 33p each
78L05 100mA 5V Pos Voltage Regulator 24p each	CA741 Op amp 29p, CA747 Dual op.amp 46p each
78L12 or 78L15 Pos. Voltage Regulators 29p each	ICL7611DCPA 88p, ICL7621DCPA 113p each
78S12 2A 12V Pos. Voltage Regulators 62p each	LM301AN Op amp 47p, LM311 Comparator 29p each
7905, 7912 or 7915 Neg. Voltage Regulators 33p each	LM319N Dual High Speed Comparator 106p each
79L05, 79L12 or 79L15 Neg Voltage Regulators 33p each	LM324N 31p, LM386N 53p, LM723N 35p each
L200CV 2A Adjustable Regulator (vertical) 176p each	Zener Diodes 400mW in range 2V to 33V 7p each
LM317T 1.5A 1.2V to 37V Adjust. Voltage Reg. 51p each	555 Timer 25p, 556 Dual 34p, 7555 CMOS 45p each
BC107, BC108 or BC109 Transistor only 11p each	W005 1.5A 50V Bridge Rect. 22p, W08 800V 31p each
BC1184L or BC337 12 each, BC212L 8p each	3A 40V in-Line Bridge Rect. 39p, 3A 400V Square 47p each
BC547A or BC558B 11p each, BC338 14p each	HT116-70 16K (2Kx8 70ns) CMOS RAM 199p each
BC548B or BC548 9p each, BC549C 12p each	

PRICE INCLUDES VAT. CLAIM YOUR FREE GIFT WITH ALL ORDERS OVER £10 IN VALUE WITH THIS ADVERT. MAJOR CREDIT CARDS, CHEQUES AND PO'S ACCEPTED. MAIL ORDER ONLY. UK MAINLAND P&P ONLY £1 (EXPORT AT COST MIN. £2).

FML ELECTRONICS

FREEPOST NEA 3627, BEDALE, NORTH YORKSHIRE DL8 2BR

TEL: 01677 425840



MANUFACTURER OF HIFI AUDIO MODULES AND TOROIDAL TRANSFORMERS SINCE 1971

CONTACT US NOW FOR A FREE CATALOGUE

ILP DIRECT LTD.

SPONG LANE, ELMSTED, ASHFORD, KENT TN25 5JU

TEL +44 1233 750481 FAX +44 1233 750578



N. R. BARDWELL LTD (EPE)

100 Signal Diodes 1N4148	£1.00	200 Asstd. disc ceramic capacitors	£1.00
75 Rectifier Diodes 1N4001	£1.00	50 Asstd. Skel Presets (sm, stand, cermet)	£1.00
50 Rectifier Diodes 1N4007	£1.00	50 Asstd. RF chokes (Inductors)	£1.00
10 W01 Bridge Rectifiers	£1.00	50 Asstd. grommets	£1.00
10 555 Timer I.C.s	£1.00	80 Asstd. solder lags, p/conn, terminals	£1.00
4 741 Op Amps	£1.00	Asstd. crystals - plug in	£1.00
50 Assorted Zener Diodes 400mW	£1.00	24 Asstd. coil formers	£1.00
12 Assorted 7-segment Displays	£1.00	8 Asstd. diil switches	£1.00
25 5mm i.e.d.s, red, green or yellow	£1.00	20 Miniature slide switches sp/co	£1.00
25 3mm i.e.d.s, red, green or yellow	£1.00	10 Standard slide switches dp/dt	£1.00
50 Axial i.e.d.s, 2mcd red Diode Package	£1.00	100 Asstd. beads (ceramic, teflon, fish spine)	£1.00
25 Asstd. High Brightness i.e.d.s, var coils	£1.00	80 Asstd. small stand offs, throughs etc	£1.00
20 BC182L Transistors	£1.00	Asstd. diil sockets up to 40 way	£1.00
25 BC212L Transistors	£1.00	10 TV coax plugs, plastic	£1.00
30 BC237 Transistors	£1.00	40 metres very thin connecting wire, red	£1.00
20 BC327 Transistors	£1.00	20 1in. glass reed switches	£1.00
30 BC328 Transistors	£1.00	20 Magnetic ear pips with lead and plug	£1.00
30 BC547 Transistors	£1.00	100 Any one value 1/4W 5% of resistors range	
30 BC548 Transistors	£1.00	1R to 10M	£0.45
30 BC549 Transistors	£1.00	10 7812 Voltage Regulators	£1.00
25 BC557 Transistors	£1.00		
30 BC558 Transistors	£1.00		
30 BC559 Transistors	£1.00		
20 2N3904 Transistors	£1.00		
100 1nF 50V wkg Axial Capacitors	£1.00		
100 4n7 50V wkg Axial Capacitors	£1.00		
12 1uf 250V encapsulated radial plastic cased capacitors	£1.00		
80 Asstd capacitors electrolytic	£1.00		
80 Asstd. capacitors 1nF to 1uF	£1.00		

288 Abbeydale Road, Sheffield S7 1FL

Phone: 0114 255 2886 ★ Fax: 0114 250 0689

e-mail: sales@bardwells.co.uk ★ Web: www.bardwells.co.uk

Prices include VAT. Postage £1.65

44p stamp for liats or disk



DIGITAL TEST METER

Built-in transistor test socket and diode test position.
DC volts 200mV to 1000V.
AC volts 200V to 750V.
DC current 200mA to 10A.
Resistance 200 ohms to 2000K ohms.

£6.99 incl. VAT

**FREE 240-page
colour catalogue**

Great value for Speakers, Microphones, Aerials, Headphones, TV Amps, Transmitters, Plugs, Sockets, Leads, CD Storage Cases, CCTV, Security, Connectors, Adaptors, Switch Boxes, Gadgets, Disco Lighting & Effects, Mixers, Amplifiers, Turntables, Musicians' Leads, Car Audio, Test Equipment, Hobby Kits, Computer Leads & Accessories, Power Supplies, Inverters, Transformers, Battery Chargers, Tools, Soldering, Switches, Fuses, Indicators, Cable & Wire, Crossovers, Speaker Hardware, PA Amps, and a great deal more... all for the price of a stamp.



2000
2001

SKY ELECTRONICS
Tel: 020 8450 0995
Fax: 020 8208 1441

Sky Electronics

40-42 Cricklewood Broadway London NW2 3ET
Tel: 020 8450 0995 Fax: 020 8208 1441
www.skyelectronics.co.uk

The Catalogue is FREE to callers or send stamps to the value of £1.85 to cover postage.

ELECTRONICS 2001

Millions of quality components at lowest ever prices!

Plus anything from bankruptcy – theft recovery
– frustrated orders – over productions etc.
Send 54p stamped self-addressed label or
envelope for clearance lists.

Brian J Reed

**6 Queensmead Avenue, East Ewell,
Epsom, Surrey KT17 3EQ
Tel: 07775 945386 or 0208 393 9055
Mail Order UK only.**

Lists are updated and only 40 are sent out every 2 weeks. This normally ensures that orders can be fulfilled where only a few thousands of an item is available. (Payment is returned if sold out. I do not deal in credit notes).

COVERT VIDEO CAMERAS

Black and White Pin Hole Board Cameras
with Audio. Cameras in P.I.R., Radios,
Clocks, Briefcases etc. Transmitting
Cameras with Receiver (Wireless).
Cameras as above with colour.
Audio Surveillance Kits and Ready Built
Units, Bug Detector etc.

A.L. ELECTRONICS

Please phone 0181 203 6008 for free catalogue.
Fax 0181 201 5359

E-mail: surveillance@btclick.com www.uspy.com

New DTI approved Video Transmitters and Receivers (Wireless)
Major credit cards now taken

SHERWOOD ELECTRONICS

FREE COMPONENTS

Buy 10 x £1 Special Packs and choose another one FREE

SP1	15 x 5mm Red LEDs	SP133	20 x 1N4004 diodes
SP2	12 x 5mm Green LEDs	SP134	15 x 1N4007 diodes
SP3	12 x 5mm Yellow LEDs	SP136	3 x BFY50 transistors
SP6	15 x 3mm Red LEDs	SP137	4 x W005 1.5A bridge rectifiers
SP7	12 x 3mm Green LEDs	SP138	20 x 2.2/63V radial elect. caps.
SP8	10 x 3mm Yellow LEDs	SP140	3 x W04 1.5A bridge rectifiers
SP10	100 x 1N4148 diodes	SP142	2 x CMOS 4017
SP11	30 x 1N4001 diodes	SP143	5 Pairs min crocodile clips (Red & Black)
SP12	30 x 1N4002 diodes	SP145	6 x ZTX300 transistors
SP20	20 x BC184 transistors	SP146	10 x 2N3704 transistors
SP21	20 x BC212 transistors	SP147	5 x Stripboard 9 strips x 25 holes
SP23	20 x BC549 transistors	SP151	4 x 8mm Red LEDs
SP24	4 x CMOS 4001	SP152	4 x 8mm Green LEDs
SP25	4 x 555 timers	SP153	4 x 8mm Yellow LEDs
SP26	4 x 741 Op.Amps	SP154	15 x BC548 transistors
SP28	4 x CMOS 4011	SP156	3 x Stripboard, 14 strips x 27 holes
SP29	3 x CMOS 4013	SP160	10 x 2N3904 transistors
SP31	4 x CMOS 4071	SP161	10 x 2N3906 transistors
SP36	25 x 10/25V radial elect. caps.	SP165	2 x LF351 Op.Amps
SP37	15 x 100/35V radial elect. caps	SP166	20 x 1N4003 diodes
SP39	10 x 470/16V radial elect. caps	SP167	6 x BC107 transistors
SP40	15 x BC237 transistors	SP168	6 x BC108 transistors
SP41	20 x Mixed transistors	SP172	4 x Standard slide switches
SP42	200 x Mixed 0.25W C.F. resistors	SP175	20 x 1/63V radial elect. caps.
SP47	5 x Min. PB switches	SP177	10 x 1A 20mm quick blow fuses
SP102	20 x 8-pin DIL sockets	SP182	20 x 4.7/63V radial elect. caps.
SP103	15 x 14-pin DIL sockets	SP183	20 x BC547 transistors
SP104	15 x 16-pin DIL sockets	SP187	15 x BC238 transistors
SP105	4 x 74LS00	SP189	3 x CMOS 4023
SP109	15 x BC557 transistors	SP192	3 x CMOS 4066
SP111	12 x Assorted polyester caps	SP193	20 x BC213 transistors
SP112	4 x CMOS 4093	SP195	3 x 10mm Yellow LEDs
SP115	3 x 10mm Red LEDs	SP197	6 x 20 pin DIL sockets
SP116	3 x 10mm Green LEDs	SP198	5 x 24 pin DIL sockets
SP118	2 x CMOS 4047	SP199	5 x 2.5mm mono jack plugs
SP120	3 x 74LS93		
SP124	20 x Assorted ceramic disc caps		
SP130	100 x Mixed 0.5W C.F. resistors		
SP131	2 x TL071 Op.Amps		

RESISTOR PACKS – C.Film

RP3	5 each value – total 365 0.25W	£2.95
RP7	10 each value – total 730 0.25W	£4.20
RP10	1000 popular values 0.25W	£5.95
RP4	5 each value-total 365 0.5W	£3.90
RP8	10 each value-total 730 0.5W	£6.55
RP11	1000 popular values 0.5W	£8.25

2001 Catalogue now available £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.**

ADVERTISERS INDEX

A.L. ELECTRONICS	80
N. R. BARDWELL	79
BELL COLLEGE OF TECHNOLOGY	75
B.K. ELECTRONICS	Cover (iii)/36
BRIAN J. REED	80
BRUNNING SOFTWARE	63
BULL ELECTRICAL	Cover (ii)
CRICKLEWOOD ELECTRONICS	6
DISPLAY ELECTRONICS	2
EPTSOFT	Cover (iv)
ESR ELECTRONIC COMPONENTS	10
FML ELECTRONICS	79
FOREST ELECTRONIC DEVELOPMENTS	27
GREENWELD	48
ICS	79
ILP DIRECT	79
J&N FACTORS	7
JPG ELECTRONICS	75
MAGENTA ELECTRONICS	8/9
MAPLIN ELECTRONICS	37
MILFORD INSTRUMENTS	17
NATIONAL COLLEGE OF TECHNOLOGY	6
PEAK ELECTRONIC DESIGN	33
PICO TECHNOLOGY	45
QUASAR ELECTRONICS	4/5
SERVICE TRADING CO	79
SHERWOOD ELECTRONICS	80
SKY ELECTRONICS	80
SLM (MODEL) ENGINEERS	75
SQUIRES	75
STEWART OF READING	6
SUMA DESIGNS	34
VERONICA KITS	79

ADVERTISEMENT MANAGER: PETER J. WEW

ADVERTISEMENT OFFICES:

EVERYDAY PRACTICAL ELECTRONICS, ADVERTISEMENTS,

MILL LODGE, MILL LANE, THORPE-LE-SOKEN,

ESSEX CO16 0ED.

Phone/Fax: (01255) 861161

For Editorial address and phone numbers see page 11



POWER AMPLIFIER MODULES-LOUDSPEAKERS-MIXERS 19 INCH STEREO AMPLIFIERS-ACTIVE CROSS/OVERS.

* PRICES INCLUDE V.A.T.
* PROMPT DELIVERY

OMP MOS-FET POWER AMPLIFIERS HIGH POWER, TWO CHANNEL 19 INCH RACK

10,000's
SOLD
TO PRO
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 ARE R.M.S. INTO 4 OHMS, WITH BOTH CHANNELS DRIVEN
FEATURES:- * Independent power supplies with two toroidal transformers
* Twin L.E.D. Vu Meters * Level controls * Illuminated on/off switch * Jack / XLR inputs *
* Speakon Outputs * Standard 775mV inputs * Open and Short circuit proof * Latest Mos-Fets
for stress free delivery into virtually any load * High slew rate * Very low distortion * Aluminium
cases * MXF600 & MXF900 fan cooled with D.C. Loudspeaker anc thermal protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC

SIZES:-
MXF200 W19" D11" H3 1/2" (2U)
MXF400 W19" D12" H5 1/2" (3U)
MXF600 W19" D13" H5 1/2" (3U)
MXF900 W19" D14" H5 1/2" (3U)

PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15
SPECIALIST CARRIER DEL £12.50 Each



OMP XO3-S STEREO 3 WAY ACTIVE CROSSOVER SWITCHABLE 2-WAY



CONFIGURED 3 WAY 2 WAY BASS/MID COMBINED 2 WAY MID/TOP COMBINED

FEATURES:-

Advanced 3-Way Stereo Active Cross-Over (Switchable two way), 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: There are two versions available:-
XO3-S Bass-Mid 125/250/500Hz, Mid-Top 1.8/3/5kHz, all at 24 dB per octave.
XO3 Bass-Mid 250/500/800Hz, Mid-Top 1.8/3/5kHz, all at 24 dB per Octave.
Please make sure you ask for the correct model when ordering.
The 2/3 way selector switches are also accessed by removing the front fascia. Each stereo channel can be configured separately. Bass Invert Switches are incorporated on each channel. Nominal 775mV input/output. Fully compatible with the OMP Rack Amplifier and Modules.

BOTH MODELS PRICED AT :- £117.44 + £5.00 P&P

STEREO DISCO MIXER MPX-2005



- * 4 STEREO INPUT CHANNELS
- * 2 DJ MIC INPUTS
- * SEPARATE TONE CONTROLS FOR EACH CHANNEL
- * HEADPHONE MONITOR WITH PFL
- * ASSIGNABLE CROSSFADE
- * 2 MASTER OUTPUTS WITH INDIVIDUAL GAIN CONTROLS
- * REMOVABLE CROSSFADE

STEREO DISCO MIXER WITH:- * SEPARATE TONE CONTROLS FOR EACH CHANNEL * 2 DJ MIC INPUTS * DJ MIC HAS ITS OWN TONE CONTROL, GAIN AND AUTO TALK OVER * 4 STEREO CHANNELS WITH INDIVIDUAL FADERS AND ASSIGNABLE CROSSFADE * CHANNELS SWITCHABLE TURNTABLE * MAG CARTRIDGE, CD, LINE, TAPE ETC. * HEADPHONE MONITOR WITH PREFADE LISTEN * 2 OUTPUTS WITH SEPARATE GAIN CONTROLS * EFFECTS SEND AND RETURN * 2 X LED VU METERS CAN MONITOR MASTER CHANNELS A OR B OR PFL LEVEL
SIZE : 482 X 222 X 110mm PRICE :- £169.00 + £5.00 P&P

100 WATT ACTIVE SUB BASS AMPLIFIER PANEL



AN ACTIVE SUB BASS AMPLIFIER WITH A TRUE 100W RMS OUTPUT. SUPERB CONSTRUCTION WITH THE FACILITIES TO INTEGRATE SEAMLESSLY INTO MOST HI-FI OR HOME CINEMA SETUPS. USE THIS PANEL PLUS ONE OF OUR LOUDSPEAKERS TO MAKE YOUR OWN SUB WOOFER THAT WILL MATCH OR BEAT MOST COMMERCIALY AVAILABLE SUB WOOFERS.

FEATURES:- * 100W RMS INTO 8 OHMS * HIGH AND LOW LEVEL INPUTS * TOROIDAL TRANSFORMER SHORT CIRCUIT PROTECTION * D.C. SPEAKER PROTECTION * FREQUENCY ROLL OFF, LOWER 10Hz, UPPER 60Hz TO 240Hz (FULLY ADJUSTABLE) * AC3 COMPATIBLE FILTER CAN BE BYPASSED FOR 5-1 FORMATS. * AIRTIGHT CONSTRUCTION * TENS OF THOUSANDS OF OUR PANELS ALREADY IN USE. * COMPLETE WITH LEADS

SPECIFICATIONS:- * POWER 100W RMS @ 8 OHMS * FREQ RESP. 10Hz 15kHz -3dB * DAMPING FACTOR >200 * DISTORTION 0.05% * S/N A WEIGHTED >100dB * SUPPLY 230V A.C. * WEIGHT 2.7Kg * SIZE H254 X W254 X D94mm

THERE ARE 2 VERSIONS OF THE ABOVE PANEL AVAILABLE :-BSB100/8 8 OHM VERSION BSB100/4 4 OHM VERSION BOTH PANELS ARE PRICED AT £117.44 + £5.00 P&P INCL. V.A.T

FLIGHTCASED LOUDSPEAKERS

A new range of quality loudspeakers, designed to take advantage of latest loudspeaker technology and enclosure designs. All models utilise high quality studio cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands. The FC15-300 incorporates a large 16 X 6 inch horn. All cabinets are fitted with the latest Speakon connectors for your convenience and safety. Five models to choose from.



PLEASE NOTE: POWER RATINGS QUOTED ARE IN WATTS R.M.S. FOR EACH INDIVIDUAL CABINET ALL ENCLOSURES ARE 8 OHMS

15=15 Inch speaker
12=12 Inch speaker

- ibl FC15-300 WATTS Freq Range 35Hz-20kHz, Sens 101dB, Size H695 W502 D415mm Price:- £299.00 per pair
- ibl FC12-300 WATTS Freq Range 45Hz-20kHz, Sens 96dB, Size H600 W405 D300mm Price:- £249.00 per pair
- ibl FC12-200 WATTS Freq Range 40Hz-20kHz, Sens 97dB, Size H600 W405 D300mm Price:- £199.00 per pair
- ibl FC12-100 WATTS Freq Range 45Hz-20kHz, Sens 100dB, Size H546 W380 D300mm Price:- £179.00 per pair
- ibl WM12-200 WATTS Freq Range 40Hz-20kHz, Sens 97dB, Size H418 W600 D385mm Price:- £125.00 Each

SPECIALIST CARRIER DEL £12.50 per pair, wedge monitor £7.00 each
Optional Metal Stands PRICE £49.00 per pair Delivery:- £6.00

10 INCH AND 12 INCH 100W RMS SUB BASS LOUDSPEAKERS

TWO SUPERB SUB WOOFER LOUDSPEAKER DRIVERS TO ACCOMPANY OUR SUB BASS AMPLIFIER PANEL BELOW. BOTH DRIVERS OFFER GOOD BASS RESPONSE AT A REASONABLE COST. THE BSB12 100 HAS BEEN USED FOR MANY YEARS IN AN AWARD WINNING SUB BASS SYSTEM

FOR TH/SM SPECIFICATIONS VIEW OUR WEB SITE AT <http://www.bkelec.com>

12 INCH LOUDSPEAKER	BSB12-100	10 INCH LOUDSPEAKER	BSB10-100
POWER	100W	POWER	100W
IMPEDANCE	8 OHMS	IMPEDANCE	8 OHMS
SENSITIVITY	90dB	SENSITIVITY	89dB
WEIGHT	3.0Kg	WEIGHT	2.3Kg
PRICE	£24.95	PRICE	£19.95
CARRIAGE	£5.00	CARRIAGE	£5.00

OMP MOS-FET POWER AMPLIFIER MODULES

SUPPLIER 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 ie. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heatsink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP/MF 100 Mos-Fet Output Power 100 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. 110dB, Size 300 x 123 x 60mm. Price:- £42.85 + £4.00 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. 110dB, Size 300 x 155 x 100mm. Price:- £66.35 + £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. 110dB, Size 330 x 175 x 100mm. Price:- £83.75 + £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. 110dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti Thump Delay, Size 385 x 210 x 105mm. Price:- £135.85 + £6.00 P&P

OMP/MF 1000 Mos-Fet Output Power 1000 watts R.M.S. into 2 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. 110dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti Thump Delay, Size 422 x 300 x 125mm. Price:- £261.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS. STANDARD - INPUT SENS 500mV/BANDWIDTH 100kHz, OR PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BANDWIDTH 50kHz ORDER STANDARD OR PEC

B.K. ELECTRONICS

UNIT 1 COMET WAY, SOUTHEND-ON-SEA,
ESSEX, SS2 6TR.

TEL.: 01702-527572 FAX.: 01702-420243
Web:- <http://www.bkelec.com> E-Mail sales@bkelec.com

REF D2

'Electronics and Computing Principles V7'

'95, '98, NT or 2000

Principles V7'

Studying electronics or computing or just want to keep up-to-date in a easy and enjoyable way, then this fully interactive software is for you.

Visit eptsoft.com or telephone for full details of more than a thousand menu items.

Personal user £99.95 +VAT
 Education £299.95 +VAT
 (Includes unlimited multi-user site licence.)

Electronics:-

Atomic Structures, DC Current flow, Basic Electronics, Simple DC Circuits, Types of Switching, Variable Voltages, Ohm's Law, DC Voltage, DC Current, Series/Parallel Resistors, AC Measurements, AC Voltage and Current, AC Theory, RCL Series/Parallel Circuits, Capacitance, Capacitors, Inductance, Inductors, Impedance, Communication System, Signals, Attenuators, Passive/Active Filters, Tuned Circuits, Coupling and Selectivity, Oscillators, Circuit Theorems, Diode Theory, Diode Applications, Transistor Theory, Bipolar Transistor, Transistor Configurations, Transistor Circuits, Field Effect Transistors, Operational Amplifier Theory and Applications, Sum and Difference Amplifiers.

Electrical:-

DC and AC Power, SCR, Power Supplies, Voltage Regulators, Magnetism, Motors/Generators, Transformers, Three Phase Systems.

Digital Techniques:-

Logic Gates, Flip Flops, Combinational Logic, Counters, Counting, Shift Registers, Logic Interfacing, Timers, Boolean Algebra and DeMorgan's Theorems.

Microprocessors and PIC Microcontrollers:-

8086 Micro-Computer, Busses, A.L.U, Clock and Reset, Instructions and Control, Memory Cells, ROM and RAM, Memory Addressing, Instructions, PIC Introduction, PIC16F84 Architecture, PIC16C71 A/D, Binary, Bit, Literal and Control Instructions.

Measurement and Component Testing:-

Analogue multi-meter, Measurement, Component Testing.

Mathematics:-

Simple Numbers, Number Types, Roots, Triangle Ratio's, Triangle Angles, Area, Surface Area and Symmetry, Volume, Percentages, Ratio's, Fractions, Vectors, Circle Angles, Laws, Algebra Rules, Powers, Simplifying, Equations, Graphing, Slope and Translation, Angles, Complex Numbers, Statistics, Lottery Number Problems, Physical Science.

Computer Science:-

Hardware Devices, Data Structures, Data Files, Binary Numbers, Binary Arithmetic.

Toolbox:-

DC Calculations, AC Calculations, Numbers, Applications.

Self-Assessment Questions:-

DC, AC, Power, Semi-Conductors, Op-Amps, Digital, Mathematics.

Components and Equipment Picture Dictionary:-

High quality digital camera images and explanatory text.

ELECTRONICS LAB (Optional add-on hardware).

eptsoft limited, Pump House, Lockram Lane, Witham, Essex. UK. CM8 2BJ.
 Tel: +44 (0)1376 514008. Fax: +44 (0)870 0509660. Email: info@eptsoft.com.
 Switch, Delta, Visa and MasterCard accepted.
 No additional postage or airmail charges.