

EVERYDAY
WITH **PRACTICAL**

AUGUST 1994

ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

FULLY S.O.R. £1.95

**EXPERIMENTAL
NOISE CANCELLING
UNIT**

**ATTACK NOISE
POLLUTION**

**6802
DEVELOPMENT
BOARD**

**DEVELOP YOUR OWN
PROJECTS USING
MICROPROCESSORS**

**DANCING FOUNTAINS
WATER DISPLAY TO THE SOUND OF MUSIC**

**I'LL BE SEEING YOU
MULTIMEDIA COMMUNICATIONS
IN THE 21ST CENTURY**



THE No. 1 INDEPENDENT MAGAZINE for ELECTRONICS, TECHNOLOGY and COMPUTER PROJECTS

SEALED LEAD ACID BATTERY, 6v 80/100 AH made for BT, ex equipment but ok £45 each ref APR47. Ideal electric vehicle etc. **ASTEC SWITCHED MODE PSU** Gives +5 @ 3.75A, +12 @ 1.5A, -12 @ .4A. 230V/110, cased, BMA1012. £9.99 ref APR10P3.

TORRODIAL TX 30-0-30 480VA. Perfect for Mosfet amplifiers etc. 120mm dia 55mm thick. £18.99 ref APR19.

MOD WIRE Perfect for repairing PCB's, wire wrap etc. Thin insulated wire on 500m reels. Our price just £9.99 ref APR10P8.

12v MOVING LIGHT CONTROLLER. Made by Hella, 6 channels rated at 90watts each. Speed control, cased. £34.99 ref APR35.

ELECTRON FLASH TUBE AS Used in police car flashing lights etc, full spec supplied, 60-100 flashes a min. £9.99 ref APR10P5.

24v 96WATT Cased power supply. New. £13.99 ref APR14.

STETHOSCOPE Fully functioning stethoscope, ideal for listening to hearts, pipes, motors etc. £6 ref MAR6P6.

OUTDOOR SOLAR PATH LIGHT Captures sunlight during the day and automatically switches on a built in lamp at dusk. Complete with sealed lead acid battery etc. £19.99 ref MAR20P1.

ALARM VERSION Of above unit comes with built in alarm and pir to deter intruders. £24.99 ref MAR25P4.

CLOCKMAKER KIT Hours of fun making your own clock, complete instructions and everything you need. £7.99 ref MAR8P2.

CARETAKER VOLUMETRIC Alarm, will cover the whole of the ground floor against forced entry. Includes mains power supply and integral battery backup. Powerful internal sounder, will take external bell if req'd. Retail £150+, ours £49.99 ref MAR50P1.

TELEPHONE CABLE White 6 core 100m reel complete with a pack of 100 clips. Ideal phone extns etc. £7.99 ref MAR8P3.

VIEWDATA RETURNS £6 made by Tandata, includes 1200.75 modem, k/bd, RGB and comp o/p, printer port. No PSU. £6 MAG6P7.

IBM PC CASE AND PSU Ideal base for building your own PC. Ex equipment but OK. £14.00 each REF: MAG14P2.

SOLAR POWER LAB SPECIAL You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire, buzzer, switch plus 1 relay or motor. Superb value kit just £5.99 REF: MAG6P8.

SOLID STATE RELAYS Will switch 25A mains. Input 3.5-26V DC 57x43x21mm with terminal screws £3.99 REF: MAG4P10.

300DPI A4 DTP MONITOR Brand new, TTL/ECL inputs, 15" landscape, 1200x1664 pixel complete with circuit diag to help you interface with your projects. JUST £24.99. REF: MAG25P1.

ULTRAMINI BUG MIC 6mmx3.5mm made by AKG, 5-12v electret condenser. Cost £12 ea, Our? four for £9.99 REF: MAG10P2.

RGB/CGA/EGA/TTL COLOUR MONITORS 12" in good condition. Back analysed metal case. £99 each REF: MAG99P1.

GX4000 GAMES MACHINES returns so ok for spares or repair £9 each (no games). REF: MAG9P1.

C64 COMPUTERS Returns, so ok for spares etc £9 ref MAG9P2.

FUSELAGE LIGHTS 3 foot by 4" panel 1/8" thick with 3 panels that glow green when a voltage is applied. Good for night lights, front panels, signs, disco etc. 50-100v per strip. £25 ref MAG25P2.

ANSWER PHONES Returns with 2 faults, we give you the bits for 1 fault, you have to find the other yourself. BT Response 200's £18 ea REF: MAG18P1. PSU £5 ref MAG6P12.

SWITCHED MODE PSU ex equip, 60w +5v @5A, -5v @.5A, +12v @2A, -12v @.5A 120/220v cased 245x88x55mm IEC input socket £6.99 REF: MAG7P1.

PLUG IN PSU 9V 200mA DC £2.99 each REF: MAG3P9.

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

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

ACORN ARCHIMEDES PSU +5v @ 4.4A, on/off sw uncased, selectable mains input, 145x100x45mm £7 REF: MAG7P2.

GEIGER COUNTER KIT Low cost professional twin tube, complete with PCB and components. £29 REF: MAG29P1.

SINCLAIR C6 13" wheels complete with tube, tyre and cyde style bearing £6 ea REF: MAG6P10.

AA NICAD PACK encapsulated pack of 8 AA nicad batteries (tagged) ex equip, 55x32x32mm, £3 a pack REF: MAG3P11.

13.8v 1.9A psu cased with leads. Just £9.99 REF: MAG10P3.

360K 5.25 brand new half height floppy drives IBM compatible industry standard. Just £6.99 REF: MAG7P3.

PPCMODEM CARDS. These are high spec plug in cards made for the Amstrad laptop computers. 2400 baud dial up unit complete with leads. Clearance price is £5 REF: MAG5P1.

INFRA RED REMOTE CONTROLLERS Originally made for hi spec satellite equipment but perfect for all sorts of remote control projects. Our clearance price is just £2 REF: MAG2.

TOWERS INTERNATIONAL TRANSISTOR GUIDE. A very useful book for finding equivalent transistors, leadouts, specs etc. £20 REF: MAG20P1.

SINCLAIR C6 MOTORS We have a few left without gearboxes. These are 12v DC 3,300 rpm 6"x4", 1/4" OP shaft. £25 REF: MAG25.

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

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

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

LOW COST WALKIE TALKIES Pair of battery operated units with a range of about 200'. Ideal for garden use or as an educational toy. Price is £8 a pair REF: MAG8P1 2 x PP3 req'd.

***MINIATURE RADIO TRANSCIEVERS** A pair of walkie talkies with a range of up to 2 kilometres in open country. Units measure 22x52x155mm. Complete with cases and earpieces. 2xPP3 req'd £30.00 pair REF: MAG30.

COMPOSITE VIDEO KIT. Converts composite video into separate H sync, V sync, and video. 12v DC. £8.00 REF: MAG8P2.

LQ3600 PRINTER ASSEMBLIES Made by Amstrad they are the mechanical printer assemblies including printhead, stepper motors etc in fact everything but the case and electronics, a good stripper £5 REF: MAG5P3 or 2 for £8 REF: MAG8P3.

NEW BULL ELECTRICAL STORE WOLVERHAMPTON BRANCH

NOW OPEN AT 55A WORCESTER
ST TEL 0902 22039

100MHZ OSCILLOSCOPES now in stock, 12x10cm screen, delayed sweep, 1Mohm/25pf inputs, modes-ch1, ch2, add, chop, alt, dual. 460 x 305 x 200mm, 17kgs, £267+Vat includes insurance and carriage.

INFRARED LASER NIGHT SCOPES Second generation image intensifier complete with hand grip attachment with built in laser lamp for zero light conditions. Supplied with Pentax 42mm camera mount, 1.6kg, uses 1xPP3, 3xAA's (all supplied) £245+Vat

NEW HIGH POWER LASERS 15mW, Helium neon, 3 switchable wave lengths .63um, 1.15um, 3.39um (2 of them are infrared) 500:1 polarizer built in so good for holography. Supplied complete with mains power supply. 790x65mm. Use with EXTREME CAUTION AND UNDER QUALIFIED GUIDANCE. £349+Vat.

'PC PAL' VGA TO TV CONVERTER Just plug in and it converts your colour television into a basic VGA screen, perfect for laptops, saves lugging monitors about or just as a cheap upgrade. Intro price £49.99 +Vat.

AMSTRAD 1512DD

1512 BASE UNIT AND KEYBOARD AND TWO 5.25" 360K DRIVES. ALL YOU NEED IS A MONITOR AND POWER SUPPLY WAS £69.00

NOW ONLY **£39.00**
REF: MAG39

3FT X 1FT 10WATT SOLAR PANELS
14.5v/700mA
NOW AVAILABLE BY MAIL ORDER
£33.95

(PLUS £2.00 SPECIAL PACKAGING CHARGE)

TOP QUALITY AMORPHOUS SILICON CELLS HAVE ALMOST A TIMELESS LIFESPAN WITH AN INFINITE NUMBER OF POSSIBLE APPLICATIONS, SOME OF WHICH MAY BE CAR BATTERY CHARGING, FOR USE ON BOATS OR CARAVANS, OR ANYWHERE A PORTABLE 12V SUPPLY IS REQUIRED. REF: MAG34

*****WE BUY SURPLUS STOCK*****
TURN YOUR SURPLUS STOCK INTO CASH.
IMMEDIATE SETTLEMENT. WE WILL ALSO QUOTE FOR COMPLETE FACTORY CLEARANCE.

1994 CATALOGUE.

PLEASE SEND 45P, A4 SIZED SAE FOR YOUR FREE COPY.
MINIMUM GOODS ORDER £5.00 TRADE ORDERS FROM GOVERNMENT, SCHOOLS, UNIVERSITIES & LOCAL AUTHORITIES WELCOME. ALL GOODS SUPPLIED SUBJECT TO OUR CONDITIONS OF SALE AND UNLESS OTHERWISE STATED GUARANTEED FOR 30 DAYS. RIGHTS RESERVED TO CHANGE PRICES & SPECIFICATIONS WITHOUT PRIOR NOTICE. ORDERS SUBJECT TO STOCK. QUOTATIONS WILL ONLY BE GIVEN FOR QUANTITIES HIGHER THAN THOSE STATED.

*SOME OF OUR PRODUCTS MAY BE UNLICENSED IN THE UK

BULL ELECTRICAL
250 PORTLAND ROAD HOVE SUSSEX
BN3 5QT
MAIL ORDER TERMS: CASH PO OR CHEQUE
WITH ORDER PLUS £3.00 POST PLUS VAT.
PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY
TELEPHONE ORDERS WELCOME
TEL: 0273 203500
FAX: 0273 323077

SPEAKER WIRE Brown 2 core 100 foot hank £2 REF: MAG3P4.

LED PACK of 100 standard red 5m leds £5 REF: MAG5P4.

UNIVERSAL PC POWER SUPPLY complete with flyback switch, fan etc. Two types available 150w at £15 REF: MAG15P5 (23x23x23mm) and 200w at £20 REF: MAG20P3 (23x23x23mm).

***FM TRANSMITTER** housed in a standard working 13A adapter! The bug runs directly off the mains so lasts forever! why pay £700? or price is £26 REF: MAG26 Transmits to any FM radio.

***FM BUG KIT** New design with PCB embedded coil for extra stability. Works to any FM radio. 9v battery req'd. £5 REF: MAG5P5

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

TALKING COINBOX STRIPPER originally made to retail at £79 each, these units are designed to convert and ordinary phone into a payphone. The units have the locks missing and sometimes broken hinges. However they can be adapted for their original use or used for something else? Price is just £3 REF: MAG3P1

100 WATT MOSFET PAIR Same spec as 2SK343 and 2SJ413 (8A, 140v, 100w) 1 N channel, 1 P channel, £3 a pair REF: MAG3P2

TOP QUALITY SPEAKERS Made for Hi Fi televisions these are 10 watt 4R Jap made 4" round with large shielded magnets. Good quality. £2 each REF: MAG2P4 or 4 for £6 REF: MAG2P2

TWEETERS 2" diameter good quality tweeter 140R (ok with the above speaker) 2 for £2 REF: MAG2P5 or 4 for £3 REF: MAG3P4

AT KEYBOARDS Made by Apricot these quality keyboards need just a small mod to run on any AT, they work perfectly but you will have to put up with 1 or 2 foreign keycaps! Price £6 REF: MAG6P3

PC CASES Again mixed types so you take a chance next one off the pile £12 REF: MAG12 or two the same for £20 REF: MAG20P4

COMMODORE MICRODRIVE SYSTEM mini storage device for C64's 4 times faster than disc drives, 10 times faster than tapes. Complete unit just £12 REF: MAG12P1

SCHOOL STRIPPERS We have quite a few of the above units which are 'returns' as they are quite comprehensive units they could be used for other projects etc. Let us know how many you need at just 50p a unit (minimum 10).

HEADPHONES Ex Virgin Atlantic. 8 pairs for £2 REF: MAG2P8

PROXIMITY SENSORS These are small PCB's with what look like a source and sensor LED on one end and lots of components on the rest of the PCB. Complete with flyleads. Pack of 5 £3 REF: MAG3P5 or 20 for £8 REF: MAG8P4

SNOOPERS EAR? Original made to clip over the earpiece of telephone to amplify the sound-it also works quite well on the cable running along the wall! Price is £5 REF: MAG5P7

DOS PACKS Microsoft version 3.3 or higher complete with all manuals or price just £5 REF: MAG5P8 Worth it just for the very comprehensive manual! 5.25" only.

DOS PACK Microsoft version 5 Original software but no manuals hence only £3 REF: MAG3P8 5.25" only.

CTM644 COLOUR MONITOR Made to work with the CPC464 home computer. Standard RGB input so will work with other machines. Refurbished £59.00 REF: MAG59

PIR DETECTOR Made by famous UK alarm manufacturer these are hi spec, long range internal units. 12v operation. Slight marks on case and unboxed (although brand new) £8 REF: MAG8P5

WINDUP SOLAR POWERED RADIO AM/FM radio complete with hand charger and solar panel £14 REF: MAG14P1

COMMODORE 64 TAPE DRIVES Customer returns at £4 REF: MAG4P9 Fully tested units are £12 REF: MAG12P5.

MAINS CABLES These are 2 core standard black 2 metre mains cables fitted with a 13A plug on one end, cable the other. Ideal for projects, low cost manufacturing etc. Pack of 10 for £3 REF: MAG3P8 Pack of 100 £20 REF: MAG20P5

MICROWAVE TIMER Electronic timer with relay output suitable to make enlarger timer etc £4 REF: MAG4P4

MOBILE CAR PHONE £6.99 Well almost! complete in car phone excluding the box of electronics normally hidden under seat. Can be illuminated with 12v also has built in light sensor so display only illuminates when dark. Totally convincing! REF: MAG6P6

ALARM BEACONS Zenon strobe made to mount on an external bell box but could be used for caravans etc. 12v operation. Just connect up and it flashes regularly! £5 REF: MAG5P11

FIRE ALARM CONTROL PANEL High quality metal cased alarm panel 350x165x80mm. With key. Comes with electronics but no information. sale price 7.99 REF: MAG8P6

REMOTE CONTROL PCB These are receiver boards for garage door opening systems. Another use? £4 ea REF: MAG4P5

6"x12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA. Bargain price just £5.99 ea REF: MAG6P12.

FIBRE OPTIC CABLE BUMPER PACK 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

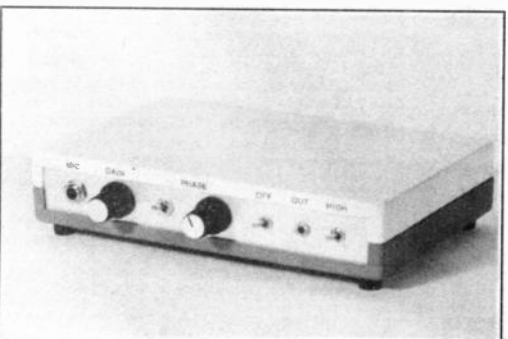
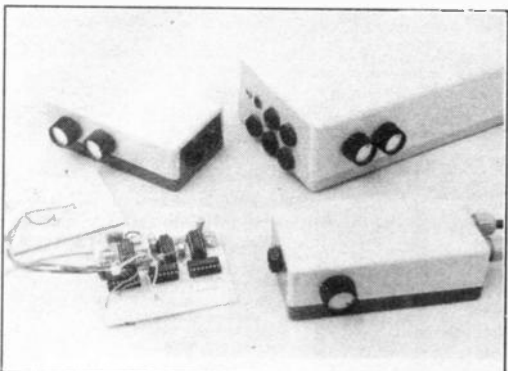
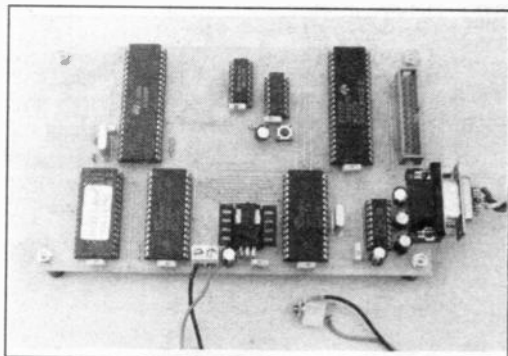
LOPTX Line output transformers believed to be for hi res colour monitors but useful for getting high voltages from low ones! £2 each REF: MAG2P12 bumper pack of 10 for £12 REF: MAG12P3.

**BOTH SHOPS OPEN 9-5.30
SIX DAYS A WEEK**

PORTABLE RADIATION DETECTOR
£49.99

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

REF: MAG50



Projects

- EXPERIMENTAL NOISE CANCELLING UNIT** 574
by Robert Penfold
Attack noise pollution with this straightforward design
- DANCING FOUNTAINS - 1** by John Becker 590
Let your fountain play to the sound of music
- CHARGED-UP** by Ken Lee 596
A battery charging tip for computer enthusiasts
- 6802 DEVELOPMENT BOARD** by Richard Stone 608
An inexpensive design to allow development of microprocessor projects
- TV CAMERA UPDATE** by John Becker 618
Using the CCD TV Camera project for astronomy, plus readers queries
- STEREO HiFi CONTROLLER - 2** by David Geary 628
Automatic fade system for background music

Series

- CALCULATION CORNER - 8** by Steve Knight 598
Removing the fear from circuit design calculations
- CIRCUIT SURGERY** by Alan Winstanley 605
Marine Battery Back-up; Capacitor markings; Readers Bright Ideas
- INTERFACE** by Robert Penfold 616
The page for computer enthusiasts - speech synthesis
- BEST OF BRITISH - 5** by Terry de Vaux - Balbirnie 622
British companies in the electronics market place
- TECHNIQUES - ACTUALLY DOING IT** by Robert Penfold 624
Double take on diodes
- AMATEUR RADIO** by Tony Smith G4FAI 640
IARU to Consider Morse Issues; Call Book on Disk; Summer Broadcast Guide

Features

- EDITORIAL** 573
- SHOPTALK** with David Barrington 581
Component buying for EPE projects
- INNOVATIONS** 582
Everyday news from the world of electronics
- NEW TECHNOLOGY UPDATE** by Ian Poole 584
Digital correction for c.r.t.s and 50V CMOS semiconductors
- I'LL BE SEEING YOU** by Alan W. Rudge 586
Multimedia communications into the 21st century
- ELECTRONICS VIDEOS** 604
Our range of educational videos to complement your studies
- HOMEBASE** by Terry Pinnell 625
Jottings of an electronics hobbyist
- ELECTRONICS PRINCIPLES II SOFTWARE** 634
Educational software - plus Electronics PC Toolbox 2.0 and GCSE Mathematics
- DIRECT BOOK SERVICE** 635
A wide range of technical books available by mail order
- PRINTED CIRCUIT BOARD SERVICE** 638
PCBs for EPE projects - some at sale prices
- ADVERTISER'S INDEX** 644

Surplus always
wanted for cash!

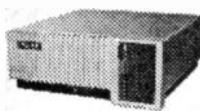
THE ORIGINAL SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always
wanted for cash!

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

THE OFFER OF 1994!



SPECIAL BUY

AT 286

40Mb HD + 3Mb Ram

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

ONLY £169.00 (E)

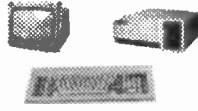
| | |
|---|--------|
| Optional Fitted extras: VGA graphics card | £29.00 |
| 1.44Mb 3 1/2" floppy disk drive (instead of 1.2 Mb) | £32.95 |
| NEZ000 Ethernet (thick, thin or twisted) network card | £49.00 |

PC SCOOP

COMPLETE

COLOUR SYSTEM

ONLY £99.00



A massive bulk purchase enables us to bring you a COMPLETE ready to run colour PC system at an unheard of price! The Display Electronics PC99 system comprises of fully compatible and expandable XT PC with 550k of RAM, 5 1/4" 360k floppy disk drive, 12" CGA colour monitor, standard 84 key keyboard, MS DOS and all connecting cables - just plug in and go! Ideal students, schools or anybody wishing to learn the world of PC's on an ultra low budget. Don't miss this opportunity. Fully guaranteed for 90 Days.

Order as PC99COL **£99.00 (E)**

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



Computer Controlled Laser Video Disk Player

One of the most amazing surplus deals that we ever been able to offer you! The Philips VP410 LaserVision player, in as new condition, unit features full computer control. Plays standard 12" LaserVision disks with starting visual and audio quality in two channel stereo or mono. When controlled by a computer, it may also be used as a versatile high quality storage / retrieval medium. It will play back either LaserVision CAV (active play) or CLV (Long Play) discs (which covers most types of commercially available video discs). Some of the many features of this incredible machine are:

- RS-232 INTERFACE
- RGB / COMPOSITE VIDEO OUTPUT
- BNC+SCART INTERFACE
- PAL / RGB DECODER
- IR+WIRE REMOTE CONTROL
- FAST RANDOM ACCESS

SPECIAL PURCHASE Only **£399.00 (F)**

FLOPPY DISK DRIVES 3.5" - 8"

5.25" from £22.95 - 3.5" from £24.95
Massive purchases of standard 5.25" and 3.5" drives enables us to present prime product at industry beating low prices! All units (unless stated) are BRAND NEW or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. All are IBM-PC compatible (if 3.5" supported on your PC).

| | |
|--|-------------|
| 3.5" Panasonic JU633/4 720K or equivalent | £24.95 (B) |
| 3.5" Mitsubishi MF355C-L 1.4 Meg. Laptops only * | £36.95 (B) |
| 3.5" Mitsubishi MF355C-D 1.4 Meg. Non laptop | £29.95 (B) |
| 5.25" Teac FD-55GFR 1.2 Meg | £22.95 (B) |
| 5.25" BRAND NEW Mitsubishi MF501B 360K | £22.95 (B) |
| * Data cable included in price. | |
| Shugart 800/801 8" SS refurbished & tested | £195.00 (E) |
| Shugart 851 8" double sided refurbished & tested | £250.00 (E) |
| Mitsubishi M2894-63 8" sided switcheable NEW | £250.00 (E) |
| Mitsubishi M2896-63-02U 8" DS slimline NEW | £285.00 (E) |
| Dual 8" drives with 2 20Mb capacity housed in a smart case with built in power supply. Ideal as exterior drives! | £499.00 (F) |

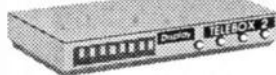
HARD DISK DRIVES

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

| | |
|--|-------------|
| 3.5" FUJIK FK-309-26 20Mb MFM W/ RFE | £59.95 (C) |
| 3.5" CONNER CP3024 20 Mb IDE W/ RFE | £69.95 (C) |
| 3.5" CONNER CP3044 40Mb IDE W/ RFE (or equiv.) RFE | £99.00 (C) |
| 3.5" RODIME RC30575 45Mb SCSI W/ (Mac & COM) | £99.00 (C) |
| 5.25" MINISCRIBE 3425 20Mb MFM W/ RFE (or equiv.) RFE | £49.95 (C) |
| 5.25" SEAGATE ST-238R 30 Mb RLL W/ RFE | £69.95 (C) |
| 5.25" CDC 94205-51 40Mb HH MFM W/ RFE tested | £89.95 (C) |
| 8" FUJITSU M2322K 160Mb SMD W/ RFE tested | £195.00 (E) |
| Hard disc controllers for MFM, IDE, SCSI, RLL etc. from £16.95 | |

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER!

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

| | |
|---|--------|
| TELEBOX ST for composite video input type monitors | £32.95 |
| TELEBOX ST as ST but with integral speaker | £36.50 |
| TELEBOX MB Multiband VHF-UHF-Cable-Hyperband tuner | £69.95 |
| For overseas PAL versions state 5.5 or 6Hz sound specification. | |
| *For cable / hyperband reception Telebox MB should be connected to cable type socket. Shipping code on all Teleboxes is (B) | |

FANS & BLOWERS

| | |
|--|----------------|
| MITSUBUSHI MMF-D6D12DL 60 x 25 mm 12v DC | £4.95 10 / £42 |
| MITSUBUSHI MMF-09B12DH 92 x 25 mm 12v DC | £5.95 10 / £53 |
| PANCAKE 12-3.5 92 x 18 mm 12v DC | £7.95 10 / £69 |
| EX-EQUIP 120 x 38mm AC fans - tested specify 110 or 240 v | £5.95 |
| EX-EQUIP 80 x 38mm AC fans - tested specify 110 or 240 v | £5.95 |
| VERO rack mount 1U x 19" fan tray specify 110 or 240v | £45.95 |
| IMHOFF B26 1900 rack mt 3U x 19" Blower 110/240V NEW | £79.95 |
| Shipping on all fans (A). Blowers (B). 50,000 Fans Ex Stock CALL | |

IC's TRANSISTORS DIODES

OBSOLETE - SHORT SUPPLY - BULK

5,000,000 items EX STOCK

For MAJOR SAVINGS - SAE or CALL FOR LATEST LIST

Issue 12 of Display News

now available - send large SAE - PACKED with bargains!



LONDON SHOP
Open Mon-Sat 9:00-5:30
215 Whitehorse Lane
South Norwood
LONDON SE25

DISTEL © The Original
FREE On line Database
Info on 1000's of Items
V21, V22, V23
081 679 1888

ALL MAIL & OFFICES
Open Mon-Fri 9:00-5:30
Dept EE - 32 Biggin Way
Upper Norwood
LONDON SE19 3XF

ALL ENQUIRIES
081 679 4414
FAX 081 679 1927



All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bona Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Carriage charges (A)=£3, (A1)=£4.00, (B)=£5.50, (C)=£3.50, (D)=£12.00, (E)=£15.00 and (F)=£18.00. (G)=CALL. Allow approx 6 days for shipping - faster CALL! Scotland surcharge CALL. All goods supplied to our Standard Conditions of Sale and unless stated guaranteed for 90 days. All guarantees on a return to base basis. All rights reserved to change prices / specifications without prior notice. Orders subject to stock. Discounts for volume. Top CASH prices paid for surplus goods. All trademarks etc acknowledged. © Display Electronics 1994. E & O E.

EXPERIMENTAL SEISMOGRAPH



Tune in your computer to the seismic singing of intra-planetary rock and roll.

Back in '89 we published a design for a single seismographic sensor whose output was monitored by a pen recorder. The authors commented on the possible difficulty of recording data on a computer and speculated about the use of Hall effect sensors instead of tuned coils. Reference was also made to the wide range of frequencies generated by earthquakes and other land movements, both natural and man-made.

Inspired by their article, John Becker designed the seismograph described next month to explore the earth movements referred to and the implications of the authors' comments. Throughout the design, much emphasis has been placed on versatility and adaptability.

Although the term seismograph literally refers to the recording of earthquake activity, the scope of this design allows the recording and examination of a whole range of ground vibrations, including those generated by nuclear and volcanic explosions, avalanches and landslides, tidal movements, traffic and trains, quarrying and building sites, to name but a few.

AUTOMATIC GREENHOUSE WATERING

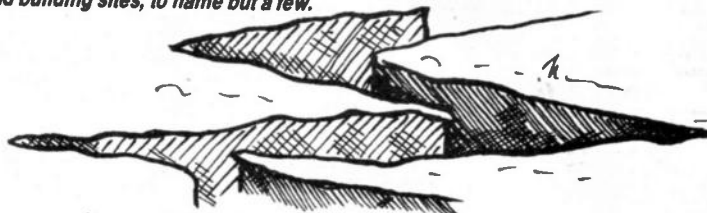
Maintains the best growing moisture for your plants.

This automatic watering system monitors the compost moisture content and when this falls to a user preset level opens a water solenoid valve for a preset time. The valve lets water pass to a mist irrigation system set up in the greenhouse over the seed trays and plants. Such a mist irrigation system is widely, and cheaply available.

To provide some protection for your plants certain safety features have been built in to prevent over watering if the spray head over the moisture detector were to block or fail.

THREE-CHANNEL LAMP CONTROLLER

This controller can drive up to three lamps, or sets of lamps, continuously varying their brilliance up and down between two



preset brightness levels. The speed of variation and the high and low brilliance levels are independently adjustable for each channel, allowing many different and interesting effects to be achieved.

Although originally intended to drive the lights on the author's Christmas tree, it can easily handle over 100W per channel, making it suitable for home discos, parties, advertising displays and a host of other applications where a colourful light display is required.

EVERYDAY WITH PRACTICAL ELECTRONICS

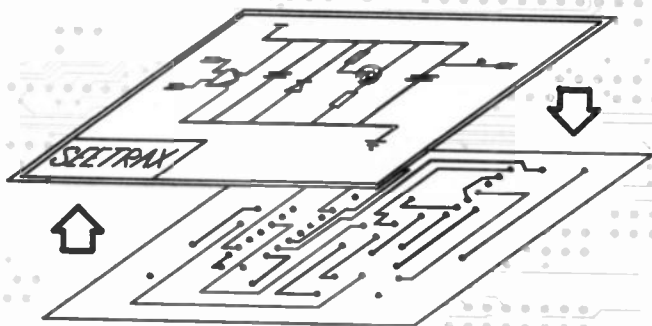
OUR SEPTEMBER ISSUE WILL BE ON SALE FRIDAY 5TH AUGUST

NEXT MONTH

SEETRAX CAE - RANGER - PCB DESIGN

Ranger1 £100

- * Schematic capture linked to PCB
- * Parts and wiring list entry
- * Outline (footprint) library editor
- * Manual board layout
- * Full design rule checker
- * Back annotation (linked to schematic)
- * Power, memory and signal autorouter - £50



Ranger2 £599

- All the features of Ranger1 plus
- * Gate & pin swapping (linked to schematic)
- * Track highlighting
- * Auto track necking
- * Copper flood fill
- * Power planes (heat-relief & anti-pads)
- * Rip-up & retry autorouter

Ranger3 £3500

- All the features of Ranger2 plus
- * UNIX or DOS versions
- * 1 Micron resolution and angles to 1/10th degree
- * Hierarchical or flat schematic
- * Unlimited design size
- * Any-shaped pad
- * Split power planes
- * Optional on-line DRC
- * 100% rip-up & retry, push & shove autorouter

Outputs to:

- * 8/9 and 24 pin dot-matrix printers
- * HP Desk/Laser Jet, Canon BJet, Postscript (R3 only)
- * HP-GL, Houston Instruments plotters
- * Gerber photoplotters
- * NC Drill Excellon, Sieb & Meyer
- * AutoCAD DXF

All systems upward compatible. Trade-in deals available.

Call **Seetrax CAE** for further information\demo packs.

Tel 0705 591037

Fax 0705 599036

Seetrax CAE, Hinton Daubnay House, Broadway Lane, Lovedean, Hampshire, PO8 0SG

All trademarks acknowledged.

SURVEILLANCE PROFESSIONAL QUALITY KITS

No. 1 for Kits

Whether your requirement for surveillance equipment is amateur, professional or you are just fascinated by this unique area of electronics SUMA DESIGNS has a kit to fit the bill. We have been designing electronic surveillance equipment for over 12 years and you can be sure that all our kits are very well tried, tested and proven and come complete with full instructions, circuit diagrams, assembly details and all high quality components including fibreglass PCB. Unless otherwise stated all transmitters are tuneable and can be received on an ordinary VHF FM radio.

Genuine SUMA kits available only direct from Suma Designs. Beware inferior imitations!

UTX Ultra-miniature Room Transmitter

Smallest room transmitter kit in the world! Incredible 10mm x 20mm including mic. 3-12V operation. 500m range.....£16.45

MTX Micro-miniature Room Transmitter

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

STX High-performance Room Transmitter

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

VT500 High-power Room Transmitter

Powerful 250mW output providing excellent range and performance. Size 20mm x 40mm. 9-12V operation. 3000m range.....£16.45

VXT Voice Activated Transmitter

Triggers only when sounds are detected. Very low standby current. Variable sensitivity and delay with LED indicator. Size 20mm x 67mm. 9V operation. 1000m range...£19.45

HVX400 Mains Powered Room Transmitter

Connects directly to 240V AC supply for long-term monitoring. Size 30mm x 35mm. 500m range.....£19.45

SCRX Subcarrier Scrambled Room Transmitter

Scrambled output from this transmitter cannot be monitored without the SCDM decoder connected to the receiver. Size 20mm x 67mm. 9V operation. 1000m range.....£22.95

SCLX Subcarrier Telephone Transmitter

Connects to telephone line anywhere, requires no batteries. Output scrambled so requires SCDM connected to receiver. Size 32mm x 37mm. 1000m range.....£23.95

SCDM Subcarrier Decoder Unit for SCRX

Connects to receiver earphone socket and provides decoded audio output to headphones. Size 32mm x 70mm. 9-12V operation.....£22.95

ATR2 Micro Size Telephone Recording Interface

Connects between telephone line (anywhere) and cassette recorder. Switches tape automatically as phone is used. All conversations recorded. Size 16mm x 32mm. Powered from line.....£13.45

UTLX Ultra-miniature Telephone Transmitter

Smallest telephone transmitter kit available. Incredible size of 10mm x 20mm! Connects to line (anywhere) and switches on and off with phone use. All conversation transmitted. Powered from line. 500m range.....£15.95

TLX700 Micro-miniature Telephone Transmitter

Best-selling telephone transmitter. Being 20mm x 20mm it is easier to assemble than UTLX. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. 1000m range.....£13.45

STLX High-performance Telephone Transmitter

High performance transmitter with buffered output stage providing excellent stability and performance. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. Size 22mm x 22mm. 1500m range.....£16.45

TKX900 Signalling/Tracking Transmitter

Transmits a continuous stream of audio pulses with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m. Size 25mm x 63mm. 9V operation.....£22.95

CD400 Pocket Bug Detector/Locator

LED and piezo bleeper pulse slowly, rate of pulse and pitch of tone increase as you approach signal. Gain control allows pinpointing of source. Size 45mm x 54mm. 9V operation.....£30.95

CD600 Professional Bug Detector/Locator

Multicolour readout of signal strength with variable rate bleeper and variable sensitivity used to detect and locate hidden transmitters. Switch to AUDIO CONFORM mode to distinguish between localised bug transmission and normal legitimate signals such as pagers, cellular, taxis etc. Size 70mm x 100mm. 9V operation.....£50.95

QTX180 Crystal Controlled Room Transmitter

Narrow band FM transmitter for the ultimate in privacy. Operates on 180 MHz and requires the use of a scanner receiver or our QRX180 kit (see catalogue). Size 20mm x 67mm. 9V operation. 1000m range.....£40.95

QLX180 Crystal Controlled Telephone Transmitter

As per QTX180 but connects to telephone line to monitor both sides of conversations. 20mm x 67mm. 9V operation. 1000m range.....£40.95

GSX180 Line Powered Crystal Controlled Phone Transmitter

As per QLX180 but draws power requirements from line. No batteries required. Size 32mm x 37mm. Range 500m.....£35.95

QRX180 Crystal Controlled FM Receiver

For monitoring any of the 'Q' range transmitters. High sensitivity unit. All RF section supplied as a pre-built and aligned module ready to connect on board so no difficulty setting up. Output to headphones. 60mm x 75mm. 9V operation.....£60.95

A build-up service is available on all our kits if required.

UK customers please send cheques, POs or registered cash. Please add £1.50 per order for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send sterling bank draft and add £5.00 per order for shipment. Credit card orders welcomed on 0827 714476.

OUR LATEST CATALOGUE CONTAINING MANY MORE NEW SURVEILLANCE KITS NOW AVAILABLE. SEND TWO FIRST CLASS STAMPS OR OVERSEAS SEND TWO IRCS.

★★★ Specials ★★★

DLTX/DLRX Radio Control Switch

Remote control anything around your home or garden, outside lights, alarms, paging system etc. System consists of a small VHF transmitter with digital encoder and receiver unit with decoder and relay output, momentary or alternate, 8-way dit switches on both boards set your own unique security code. TX size 45mm x 45mm. RX size 35mm x 90mm. Both 9V operation. Range up to 200m.

Complete System (2 kits).....£50.95

Individual Transmitter DLTX.....£19.95

Individual Receiver DLRX.....£37.95

MBX-1 Hi-Fi Micro Broadcaster

Not technically a surveillance device but a great ideal. Connects to the headphone output of your Hi-Fi, tape or CD and transmits Hi-Fi quality to a nearby radio. Listen to your favourite music anywhere around the house, garden, in the bath or in the garage and you don't have to put up with the DJ's choice and boring waffle. Size 27mm x 60mm. 9V operation. 250m range.....£20.95

**SUMA
DESIGNS**

DEPT. EE

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

VISITORS STRICTLY BY APPOINTMENT ONLY



Tel/Fax:
0827 714476

SUMMER SALE STILL ON

If you missed our 64 page Brochure in last months E&PE, ring, write or fax for your

FREE copy now!!

WORKSHOP PRACTICE SERIES

A Selection of books from our vast range!



WP1. Hardening, Tempering and Heat Treatment. Tubal Cain. Price: £6.95

A comprehensive exposition of the structure of steels and the effects of different heat treatments, particularly in respect of tools. Includes solid fuel, gas and electric furnaces, case hardening, tempering and other practical information. With accurate colour temperature charts.

WP2. Vertical Milling in the Home Workshop. Arnold Throp. Price: £6.50

Small workshops, including those of model engineers, are making increasing use of small vertical milling machines. This book explains how to use them (and lathe mill attachments) in clear and practical terms.

WP3. Screwcutting in the Lathe. Martin Cleeve. Price: £6.50

A fully comprehensive survey of the use of a lathe for all forms of screwcutting in all thread forms, imperial and metric. Calculations, gear trains, conversions etc., are all explained but also set out in tabular form.

WP4. Foundrywork for the Amateur. B. Terry Aspin. Price: £5.95

A new edition of a book which has already enjoyed twelve impressions in four editions and is regarded as the perfect introduction to casting work in most common metals.

WP5. Milling Operations in the Lathe. Tubal Cain. Price: £6.50

A thorough and totally practical discourse on how to use the lathe for all types of milling work. Tools, toolholding, work-holding, speeds and feeds, procedures and much more, with examples of different work profusely illustrated.

WP6. Measuring and Marking Metals. Ivan Law. Price: £6.50

Model engineers and many small workshops do not need, or have no access to, much of the sophisticated measuring equipment used in industry. Accurate marking out and measurement by more basic means at all stages of work are comprehensively described by an expert engineer.

WP7. Art of Welding. W.A.Vause. Price: £5.95

Welding, by oxy-acetylene or electric arc, is a skill in increasing demand. This book sets out the basic techniques for oxy-acetylene welding, brazing, flame cutting and electric arc welding with mild steel, cast iron, stainless steel copper, brass etc., in sheet, plate or cast form.

WP8. Sheet Metal Work. R. E. Wakeford. Price: £6.50

The author is an instructor in metalwork and allied crafts and describes clearly all the processes likely to be encountered by the hobbyist in a model or light engineering workshop.

WP9. Soldering and Brazing. Tubal Cain. Price: £6.50

Joining metals by one form or another of soft and hard soldering or brazing with various alloys, are run-of-the-mill jobs in model and light engineering workshops. Tubal Cain examines the processes, equipment, materials and explains what is happening in the joints as they are made.

WP10. Saws and Sawing. Ian Bradley. Price: £5.50

Used by carpenters and metalworkers every day, saws tend to be taken for granted. Examines all types of saw, hand and machine, their use, maintenance and useful tables relating to various applications.

WP11. Electroplating. J.Poyner. Price: £5.95

Replacing Electroplating for the Amateur, a popular title for many years. This new book will be of value to model engineers and small workshops, wishing to plate with any of the customary metals, using simple equipment.

WP12. Drills, Taps, and Dies. Tubal Cain. Price: £6.50

Discusses drills and drilled holes and threading with taps and dies, primarily by hand. Imperial and metric sizes and conversions, all standard thread gauges, sharpening etc., special cases.

WP13. Workshop Drawing. Tubal Cain Price: £6.95

Another essentially practical book from a writer with wide experience of teaching engineering draughting. Equally useful to those who wish to interpret drawings accurately or those setting out to prepare drawings. Includes the latest BSS and other recognised standards, with many illustrated examples.

WP14. Making Small Workshop Tools. Stan Bray. Price: £6.95

Making 14 simple but useful adjuncts to the tool kit for bench and lathe use, taking no more than 3-4 hours or involving special materials yet each able to save considerable time in use as well as aiding accuracy. With working drawings and photographs, sketches etc.

WP15. Workholding in the Lathe. Tubal Cain. Price: £6.95

A fundamental requirement of the lathe operation is the ability to hold any workpiece securely on the machine. Tubal Cain discusses all the practical aspects of the subject, with many photographs to illustrate specific points.

WP16. Electric Motors. V.J. Cox Price: £6.95

All types of electric motors for workshop use described. Principles, characteristics, operation, installation, speed control, braking etc., plus generators, safety, testing and a useful selection on identifying and applying 'scrap' motors.

WP17. Gears and Gear Cutting. Ivan Law. Price: £6.95

Gives comprehensive information on gear-cutting. Explanations and reasons for all conventional types of gears are clearly set out, with useful tables and machinery techniques, to form an invaluable reference work for anyone dealing with machinery.

WP18. Basic Benchwork. Les Oldridge. Price: £6.95

Model engineers and amateur metalworkers need to learn the tricks of accurate filing, sawing without breaking blades and dozens of other areas of handwork which experienced engineers take for granted. Details normal bench practice suitable for engineering apprentices and will save its cost, in avoiding tools and spoiled work, many times over.

WP19. Spring Design and Manufacture. Tubal Cain. Price: £6.95

Few mechanics are completely devoid of springs of one sort or another, and satisfactory operation frequently depends on details such as spring strength and degree of movement. Yet information on calculating and making springs is not easily available. Every type of spring and all necessary calculations are clearly explained as well as materials and methods.

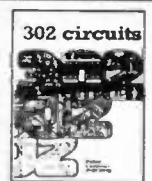
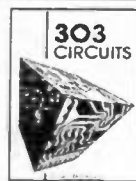
WP20. Metalwork and Machining Hints and Tips. Ian Bradley. Price: £6.50

A workshop information pot-pourri combining useful advice and instruction for beginners, with explanations of tools and techniques often familiar in name but not always found described in detail. Includes arbors and mandrels, belt joining and splicing, shaft collars, finishing metal surfaces, G-clamps, surface gauges, cutting holes, special nuts, hand turning tools, the wobbler, case-hardening and machine square material.

WP21. Adhesive and Sealants. David Lammas. Price: £6.95

Covers traditional adhesives, their advantages and shortcomings, as well as recent synthetic products. Discusses surface preparation, handling hazards, deterioration under adverse conditions, criteria employed during selection, and sealants for joints exposed to water, steam or oil. Illustrated with photographs and line drawings and will provide much practical help and guidance for all model engineers.

PROJECT & DATA BOOKS



301 CIRCUITS

The second in our 300 series of projects for construction at home, in a small workshop or at school or college. It contains 301 assorted circuits ranging from simple to fairly complex designs, described and explained in straightforward language. Order Code GAZ301 Price £9.95

302 CIRCUITS

In well over 300 pages, 302 circuits contains a variety of circuits for audio and video; car, cycle and motorcycle; home and garden; receivers and aerials; hobbies and games; measuring and testing; oscillators and generators; current sources and power supplies; microcomputers and electrophonics; and a miscellany of other interesting subjects. Order Code GAZ302 Price £9.95

303 CIRCUITS

Like its predecessors in the 300 series, 303 circuits offers a comprehensive collection of practical ideas, concepts and developments in the gamut of electronics. Unlike its predecessors, the book is arranged in 11 subject sections to make it easier for the reader to find that long-sought circuit. Order Code GAZ303 Price £10.95

304 CIRCUITS

The latest volume in the 300 series of practical circuit books offers a further selection of over 300 construction projects, design ideas and practical applications from all aspects of electronics. Order Code GAZ304 Price £12.00

MICROPROCESSOR DATA BOOK

Originally compiled to meet a need of Elektor Electronics engineers, technicians and editorial staff for a ready reference work on the most important microprocessors, this book contains information on not only the latest devices, such as the transputer, but also the older, well-established types, such as the Z80 and the 6800. Order Code GAZ311 Price £10.95

DATA SHEET BOOK 2

Data sheet book 2 offers concise, relevant and readily accessible information and data on integrated circuits as well as discrete devices. It contains an introduction to HCMOS devices and a review of symbolic logic proposed in British Standard BS3939: Section 21 (IEC 617-12). Order Code GAZ312 Price £9.95

DATA BOOK 3: PERIPHERAL CHIPS

Data book 3 offers complete data of the most often encountered peripheral ICs that logically belong to the microprocessor families described in Microprocessor Data Book. Order Code GAZ313 Price £10.95

DATA BOOK 4: PERIPHERAL CHIPS

This, the third and final part in the Microprocessor Data Book series, deals with general peripheral chips that, at least as far as their type coding is concerned, do not belong to a specific family of microprocessor. These chips have been chosen carefully on the basis of their practical application and frequency of use. Order Code GAZ314 Price £10.95

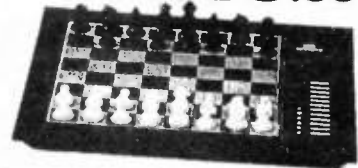
DATA BOOK 5: APPLICATION NOTES

Data book 5 contains a large number of collected 'Application Notes' published by well-known European, American and Japanese chip manufacturers. The notes cover both analogue and digital circuits and form a rich source of inspiration for all electronics designers. Order Code GAZ315 Price £10.95

COMPUTER CHESS BARGAIN

Z9238 Fully functional chess computer, complete with all pieces. Look at all these features!

£19.95



- 64 levels of difficulty
- Plays standard chess openings
- Takes back moves
- Set-up positions
- Verify position
- Warns user about threats
- Sound on/off
- Uses 4 x AA batts (not supplied)
- Up to 200 hrs batt life
- Memory save feature
- Allows player to change sides

Phone Nos: SALES 0703 236363; Technical 325999; Accounts 231003; Fax (All depts) 236307; FaxOnDemand 236315*

*To obtain latest lists, info etc, just dial 0703 236315 from any fax machine and follow instructions.

All 1 off and pack prices include VAT, qty prices do not. P&P £3 per order (£9.50 next day). Min Credit Card £12; Official Orders welcome from Education - min invoice charge £15. Payment accepted by cheque, PO, cash, book tokens, Access, Visa, Connect. Our stores (over 10,000 sq ft) have enormous stocks. We are open from 8-5.30 Mon-Sat. Come and see us!

GREENWELD
ELECTRONIC COMPONENTS



27D Park Road Southampton SO15 3UQ

£1 BARGAIN PACKS

In fact ... cheaper than £1 because if you buy 10 you can choose one other and receive it free!

- 1 x 12V Stepper Motor. 7.5 degree. Order Ref: 910.
- 1 x 10 pack Screwdrivers. Order Ref: 909.
- 2 x 5 amp Pull Cord Ceiling Switches. Brown. Order Ref: 921.
- 5 x reels Insulation Tape. Order Ref: 911.
- 4 x 14mm Bull-races. Order Ref: 912.
- 2 x Cord Grip Switch Lamp Holders. Order Ref: 913.
- 1 x DC Voltage Reducer. 12V-6V. Order Ref: 916.
- 1 x 10 amp 40V Bridge Rectifier. Order Ref: 889.
- Lightweight Stereo Headphones. Moving coil so superior sound. Order Ref: 896.
- 2 x 25W Crossovers. For 4ohm loudspeakers. Order Ref: 22.
- 2 x NiCad Constant Current Chargers. Easily adaptable to charge almost any NiCad battery. Order Ref: 30.
- 2 x White Plastic Boxes. With lids, approx. 3" cube. Lid has square hole through the centre so these are ideal for light operated switch. Order Ref: 132.
- 2 x Reed Relay Kits. You get 8 reed switches and 2 coil sets. Order Ref: 148.
- 1 x Big Pull Solenoid. Mains operated. Has 1/2" pull. Order Ref: 871.
- 1 x Big Push Solenoid. Mains operated. Has 1/2" push. Order Ref: 872.
- 1 x Mini Mono Amp. 3W into 4 ohm speaker or 1W into 8 ohm. Order Ref: 495.
- 1 x Mini Stereo 1W Amp. Order Ref: 870.
- 1 x In-Flight Stereo Unit is a stereo amp. Has two most useful mini moving coil speakers. Made for BOAC passengers. Order Ref: 29.
- 1 x 0-1mA Panel Meter. Full vision fact 70mm square. Scaled 0-100. Order Ref: 756.
- 2 x Lithium Batteries. 2.5V penlight size. Order Ref: 874.
- 2 x 3m Telephone Leads. With BT flat plug. Ideal for phone extensions, fax, etc. Order Ref: 552.
- 1 x 12V Solenoid. Has good 1/2" pull or could push if modified. Order Ref: 232.
- 4 x In-Flex Switches. With neon on/off lights, saves leaving things switched on. Order Ref: 7.
- 2 x 6V 1A Mains Transformers. Upright mounting with fixing clamps. Order Ref: 9.
- 2 x Humidity Switches. As the air becomes damper, the membrane stretches and operates a micro switch. Order Ref: 32.
- 5 x 13A Rocker Switch. Three tags so on/off, or changeover with centre off. Order Ref: 42.
- 1 x Suck or Blow-Operated Pressure Switch. Or it can be operated by any low pressure variation such as water level in tanks. Order Ref: 67.
- 1 x 6V 750mA Power Supply. Nicely cased with mains input and 6V output lead. Order Ref: 103A.
- 2 x Stripper Boards. Each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc. Order Ref: 120.
- 12 Very Fine Drills. For PCB boards etc. Normal cost about 80p each. Order Ref: 128.
- 5 x Motors for Model Aeroplanes. Spin to start so needs no switch. Order Ref: 134.
- 6 x Microphone Inserts. Magnetic 400 ohm, also act as speakers. Order Ref: 139.
- 6 x Neon Indicators. In panel mounting holders with lens. Order Ref: 180.
- 1 x In-Flex Solderstat. Keeps your soldering iron etc always at the ready. Order Ref: 196.
- 1 x Mains Solenoid. Very Powerful as 1/2" pull, or could push if modified. Order Ref: 199.
- 1 x Electric Clock. Mains operated. Put this in a box and you need never be late. Order Ref: 211.
- 4 x 12V Alarms. Makes a noise about as loud as a car horn. All brand new. Order Ref: 221.
- 2 x (8" x 4") Speakers. 16 ohm 5 watts, so can be joined in parallel to make a high wattage column. Order Ref: 243.
- 1 x Panostat. Controls output of boiling ring from simmer up to boil. Order Ref: 252.
- 2 x Oblong Push Switches. For bell or chimes, these can switch mains up to 5A so could be foot switch if fitted in pattern. Order Ref: 263.
- 50 x Mixed Silicon Diodes. Order Ref: 293.
- 1 x 6 Digit Mains Operated Counter. Standard size but counts in even numbers. Order Ref: 28.
- 2 x 6V Operated Reed Relays. One normally on, other normally closed. Order Ref: 48.
- 1 x Cabinet Lock. With two keys. Order Ref: 55.
- 1 x Shaded Pole Mains Motor. 1/4" stack, so quite powerful. Order Ref: 85.
- 2 x 5 Aluminium Fan Blades. Could be fitted to the above motor. Order Ref: 86.
- 1 x Case, 3 1/2 x 2 1/4 x 1 1/4 with 13A socket pins. Order Ref: 845.
- 2 x Cases, 2 1/2 x 2 1/4 x 1 1/4 with 13A pins. Order Ref: 565.
- 4 x Luminous Rocker Switches. 10A mains. Order Ref: 793.
- 4 x Different Standard V3 Micro Switches. Order Ref: 340.
- 4 x Different Sub Min Micro Switches. Order Ref: 313.
- 18V-0-18V 10VA mains transformer. Order Ref: 813.
- 12V-0-12V 8VA mains transformer, p.c.b. mounting. Order Ref: 938.
- 15V DC 150mA p.s.u., nicely cased. Order Ref: 942.
- Mini Cassette Motor, 9V. Order Ref: 944.
- 6 1/2 8Ω 5 Watt Speaker. Order Ref: 824.

BARGAINS GALORE

Speed Controller for 12V DC Motors. Suitable for C5 and similar motors up to 1/4 h.p. Gives very good control of speed. Uses mosfets and is based on a well tried circuit which appeared in the Model Engineer some time ago. The complete kit with case and on/off switch, price £18. Order Ref: 1878.

Ex-British Telecom Insulation Tester Offer. We have a quantity of these that are slightly faulty. There has been no attempt at repairing them and they are not missing any parts so should be repairable. The moving coil movement is in perfect working order so even if you cannot repair the instrument to perform all its original functions, you would be able to use it for another instrument that you need. We supply a circuit diagram of the instrument and chances are that you will find the fault and be able to repair it. Price of the instrument with circuit diagram is £3. Order Ref: 3P178.

Fig. 8 Flex. Fig. 8 flat white pvc, flexible with 4 sq.mm cores. Ideal for speaker extensions and bell circuits. Also adequately insulated for mains lighting. 50m coil, £2. Order Ref: 2P345. 12m coil, £1. Order Ref: 1014.

Friedland Undermode Bell. Their ref: 792, a loud ringer but very neat, 3" diameter, complete with wall fixing screws, £4. Order Ref: 4P75.

12V 10A Switch Mode Power Supply. For only £9.50 and a little bit of work because you have to convert our 135W PSU. Modifications are relatively simple - we supply instructions. Simply order PSU Ref: 9.5P2 and request modification details, price still £9.50.

Are You Making Mini Bugs? We can offer the ideal box. White plastic without any decoration or printing. This has an on/off switch in the top left-hand corner and a hole just above to take telescopic or wire aerial. The case is large enough to take a PP3 battery and a PCB and when finished it will have a really professional look. Box with switch £1. Order Ref: 1006, size approximately 4"x3"x1 1/2" thick and its cover is held by 4 screws.

Siren/Horn/Hooter/Klaxon. It isn't any of these - it does the same job but is quite nice to look at and could even be described as ornamental. It is Swiss made and in a grey plastic case, could be free standing or screwed down indoors or out. It is mains driven and when switched on it makes a shocking noise (its loudness is adjustable). You could switch it on to scare an intruder or arrange for your burglar alarm to do the same. Price £5, Order Ref: 5P226.

Medicine Cupboard Alarm. Or it could be used to warn when any cupboard door is opened. The light shining on the unit makes the bell ring. Completely built and neatly cased, requires only a battery, £3. Order Ref: 3P155.

Don't Let it Overflow! Be it bath, sink, cellar, sump or any other thing that could flood. This device will tell you when the water has risen to the pre-set level. Adjustable over quite a useful range. Neatly cased for wall mounting, ready to work when battery fitted, £3. Order Ref: 3P156.

Very Powerful Mains Motor. With extra long (2 1/2") shafts extending out each side. Makes it ideal for a reversing arrangement for, as you know, shaded pole motors are not reversible, £3. Order Ref: 3P157.

£1 Super Bargain

12V axial fan for only £1, ideal for equipment cooling, brand new, made by West German company. Brushless so virtually everlasting. Needs simple transistor drive circuit, we include diagram. Only £1. Order Ref: 919. When we supply this we will include a list of approximately 800 of our other £1 bargains.

Solar Panel Bargain. Gives 3V at 200mA. Order Ref: 2P324.

45A Double Pole Mains Switch. Mounted on a 6 x 3 1/2 aluminium plate, beautifully finished in gold, with pilot light. Top quality, made by MEM, £2. Order Ref: 2P316.

Amstrad 3" Disk Drive. Brand new and standard replacement for many Amstrad and other machines, £20. Order Ref: 20P28.

High Quality Key Switch. This is a single pole, 2 position switch, changeover or on/off. With 2 keys. Good British make, normally retails at £3, our price £1.50. Order Ref: 1.5P12.

AM-FM Radio Chassis. With separate LCD module to display date and time. This is complete with loudspeaker, £3.50. Order Ref: 3.5P5.

2, 3 and 4 Way Terminal Blocks. The usual grub screw types. Parcel containing a mixture of the 3 types, giving you 100 waves for £1. Order Ref: 875.

12/24 DC Solenoid. The construction of this is such that it will push or pull. With 24V this is terrifically powerful but is still quite good at 12V, £1. Order Ref: 877.

20 W 5" 4 Ohm Speaker. Mounted on baffle with front grille, £3. Order Ref: 3P145. Matching 4 ohm 20W tweeter on separate baffle, £1.50. Order Ref: 1.5P9.

Ultra Thin Drills, actually 0.3mm. To buy these regular costs a fortune. However, these are packed in half dozens and the price to you is £1 per pack. Order Ref: 797B.

You Can Stand On It! Made to house GPO telephone equipment, this box is extremely tough and would be ideal for keeping your small tools in. Internal size approx. 10 1/2" x 4 1/2" x 8" high. Complete with carrying strap, price £2. Order Ref: 2P283B.

Ultra Sonic Transducers. Two metal cased units, one transmits, one receives. Built to operate around 40kHz. Price £1.50 the pair. Order Ref: 1.5P74.

Power Supply with Extras. Mains input is fused and filtered and the 12V DC output is voltage regulated. Intended for high class equipment, this is mounted on a PCB and, also mounted on the board, but easily removed, are two 12V relays and Piezo sander, £3. Order Ref: 3P80B.

Philips 9" High Resolution Monitor. Black and white in metal frame for easy mounting. Brand new, still in maker's packing, offered at less than price of tube alone, only £15. Order Ref: 15P1.

LCD 3 1/2 Digit Panel Meter

This is a multi range voltmeter/ammeter using the A-D converter chip 7106 to provide 5 ranges each of volts and amps. Supplied with full data sheet. Special snip price of £12. Order Ref: 12P18.

Insulation Tester with Multimeter. Internally generates voltages which enable you to read insulation directly in megohms. The multimeter has four ranges. AC/DC volts, 3 ranges DC milliamms, 3 ranges resistance and 5 amp range. These instruments are ex-British Telecom but in very good condition, tested and guaranteed OK, probably cost at least £50, your for only £7.50 with leads, carrying case £2 extra. Order Ref: 7.5P14.

BARGAINS GALORE

Mains 230V Fan. Best make "PAPST", 4 1/2" square, metal blades, £8. Order Ref: 8P8.

2MW Laser. Helium neon by Philips, full spec. £30. Order Ref: 30P1. Power supply for this in kit form with case is £15. Order Ref: 15P16, or in larger case to house tube as well £18, Order Ref: 18P2. The larger unit, made up, tested and ready to use, complete with laser tube £69. Order Ref: 69P1.

4hp 12V Motor - The Famous Sinclair C5. Brand new, £18. Order Ref: 18P7.

Solar Charger. Holds 4AA NiCads and recharges these in 8 hours, in very neat plastic case £6. Order Ref: 6P3.

Mains Isolation Transformer. Stops you getting "to earth" shocks. 230V in and 230V out, 150 watt, £7.50. Order Ref: 7.5P5 and a 250W version is £10. Order Ref: 10P97.

Amstrad Power Unit. 13.5V at 1.9A or 12V at 2A encased and with leads and output plug, normal mains input, £8. Order Ref: 8P23.

80W Mains Transformer. Two available, good quality, both with normal primaries and upright mounting, one is 20V 4A. Order Ref: 3P106, the other 40V 2A. Order Ref: 3P107, only £3 each.

40W-250W Light Dimmers. On standard plate to put directly in place of flush switch. Available in colours, green, red, blue and yellow, £2.50. Order Ref: 2.5P9. Or on standard 3x3 cream metal switch plate, £3. Order Ref: 3P174.

Touch Dimmers. 40W-250W, no knob to turn, just finger on front plate, will give more, or less light, or off. Silver plate on white background, right size to replace normal switch, £5. Order Ref: 5P230.

Don't Stand Out In The Cold. Our 12m telephone extension lead has a flat BT socket one end and flat BT plug other end, so this would enable you to answer your telephone still sitting in a comfortable chair. This is a sturdy white pvc covered lead with white plug and socket, £2. Order Ref: 2P338.

High Current AC Mains Relay. This has a 230V coil and changeover switch rated at 15A with PCB mounting with clear plastic cover, £1. Order Ref: 965.

Project Box. Size approx. 8" x 4" x 4 1/2" metal, sprayed grey, louvred ends for ventilation otherwise undrilled. Made for GPO so best quality, only £3 each. Order Ref: 3P74.

Experimenting with Valves. Don't spend a fortune on a mains transformer, we can supply you with standard mains input and secs. of 250-0-250V at 75mA and 6.3V at 3A, £5. Order Ref: 5P167.

15W 8 Ohm 8" Speaker & 3" Tweeter. Made for a discontinued high quality music centre, gives real hi-fi and only £4 per pair. Order Ref: 4P57.

Water Pump. Very powerful, mains operated, £10. Order Ref: 10P74.

0-1mA Full Vision Panel Meter. 2 1/2" square, scaled 0-100 but scale easily removed for re-writing, £1 each. Order Ref: 756.

VU Meter. Illuminate this from behind becomes on/off indicator as well, 1 1/2" square, 75p each. Order Ref: 366.

1 RPM Motor. This is only 2W so will not cost much to run. Speed is ideal for revolving mirrors or lights, £2. Order Ref: 2P328.

Unusual Solenoid. Solenoids normally have to be energised to pull in and hold the core, this is a disadvantage where the appliance is left on for most of the time. We now have magnetic solenoids which hold the core until a voltage is applied to release it, £2. Order Ref: 2P327.

220VA Mains Transformer. Secondary voltages 8V-0-8V. So you could have 16V at 12A or 8V at 25A. Could be ideal for car starter charger, soil heating, spot welding, carbon rod welding or driving high powered amplifiers etc. £15. Order Ref: 15P51.

Fully Enclosed Mains Transformer. On a 2m 3 core lead terminating with a 13A plug. Secondary rated at 6V 4A. Brought out on a well insulated 2 core lead terminating with insulated push on tags, £3. Order Ref: 3P152.

Ditto but 8A, £4. Order Ref: 4P69.

Sintinel Component Board. Amongst hundreds of other parts, this has 15 ICs, all plug in so do not need desoldering. Cost well over £100, yours for £4. Order Ref: 4P67.

Sinclair 9V 2.1A Power Supply. Made to operate the 138K Spectrum Plus 2, cased with input and output leads. Originally listed at around £15, are brand new, our price is only £3. Order Ref: 3P151.

Amstrad Keyboard Model KB5. This is a most comprehensive keyboard, having over 100 keys including, of course, full numerical and qwerty. Brand new, still in maker's packing, £5. Order Ref: 5P202.

OPD Dual Motor Drive Unit. This is a twin unit, each with motor, record playback head and PCB with all electronics and the much coveted Ferranti IC8446. Can also be used with the Spectrum or the QL. Data supplied, £5. Order Ref: 5P194.

Prices include VAT. Send cheque/postal order or ring and quote credit card number.
Add £3 post and packing.
Orders over £25 post free.

M & B ELECTRICAL SUPPLIES LTD

Pilgrim Works (Dept. E.E.)
Stairbridge Lane,
Bolney,
Sussex RH17 5PA

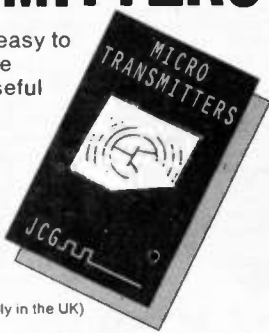
Telephone: 0444 881965
(Also fax but phone first)
Callers to 12 Boundary Road,
Hove, Sussex.

revised edition

TRANSMITTERS

AT LAST. A fully comprehensive, easy to follow guide to building short range micro transmitters. Packed with useful information and circuits.

- ★ How to build micro surveillance devices.
- ★ Radio mics.
- ★ Tracking and signaling transmitters.
- ★ Only **£3.93** inc p&p.



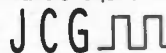
(Some of the circuits included can not be used legally in the UK)

KITS

- MICRO FM TRANSMITTER.** 1 mile range, very small including mic. Pick up on any FM radio. **£6.95**
- TRACKING FM.** Transmits a constant pulse tone that can be used for direction finding, tracking cars or animals etc. **£8.50**
- AM RADIO.** Tuner and power amp that make a tiny AM radio. Will drive a small pair of headphones. Easy to make and fun to use. **£8.50**
- INFRA RED REMOTE CONTROL.** Simple but effective remote control of relay switch up to 10 metres. Ideal for car alarms, light switches etc. Includes 240V relay. **£10.50**

MUSIC KITS PREAMPS POWER AMPS

Full range of on board units for guitars etc. — active tone controls/boosters, wah wah and other effects kits — send for list. Prices include P&P. **Mail order only.** Make cheques and postal orders payable to:



3 Bainbrigg Road, Headingley, Leeds LS6 3AD.

SUMMER 1994 CATALOGUE



NEW EDITION!

The new enlarged Catalogue is out now!

Included in this issue:

- A further 16 extra pages
- £200 worth discount vouchers
- 100's new products
- 256 pages, 26 sections, over 4000 products from some of the worlds finest manufactures and suppliers
- Expanded entertainment section with in-car amps, speakers, crossovers and low cost disco equipment
- Further additions from Europe's leading kit manufacture - Velleman
- Available from most large newsagents or direct from CirkIt
- **Send for your copy today!**

STILL ONLY
£1.90
+ 30p p&p

WE HAVE THE WIDEST CHOICE OF USED OSCILLOSCOPES IN THE COUNTRY

TEKTRONIX 7000 SERIES OSCILLOSCOPES
Available from £200 - PLUG-INS SOLD SEPARATELY

| | |
|--|-------|
| TEKTRONIX 2465 4 Channel 300MHz Delay Sweep Cursors | £2000 |
| TEKTRONIX 2245A 4 Channel 100MHz Delay Sweep Cursors | £950 |
| TEKTRONIX 2235 4 Dual Trace 100MHz Delay Sweep | £900 |
| PHILIPS 3285 2+1 Channels 100MHz Dual TB Delay Sweep | £700 |
| TEKTRONIX 485 Dual Trace 350MHz Delay Sweep | £750 |
| TEKTRONIX 475 Dual Trace 200MHz Delay Sweep | £700 |
| TEKTRONIX 465 Dual Trace 100MHz Delay Sweep | £400 |
| TEKTRONIX 2215 Dual Trace 60MHz Delay Sweep | £450 |
| TEKTRONIX 455 Dual Trace 50MHz Delay Sweep | £400 |
| TEKTRONIX SC504 Dual Trace 80MHz in TMS03B | £500 |
| HITACHI V650F Dual Trace 60MHz Delay Sweep | £350 |
| PHILIPS PM3217 Dual Trace 50MHz Delay Sweep | £300 |
| LEADER LB0524L Dual Trace 40MHz Delay Sweep | £160 |
| GOULD 051100 Dual Trace 50MHz | £260 |
| WATSU S95702 Dual Trace 20MHz | £160 |
| GOULD 052508 Dual Trace 15MHz | £125 |
| TELEQUIPMENT D32 Dual Trace 10MHz Mains Battery | £300 |
| TEKTRONIX 466 Dual Trace 100MHz Delay Sweep Analogue Storage | £350 |

THIS IS JUST A SAMPLE - MANY OTHERS AVAILABLE

HEWLETT PACKARD 1740A OSCILLOSCOPES
100MHz Dual Trace, delay Sweep. For Only... **£350**

| | |
|---|-------|
| MARCONI 2018 Synthesised AM/FM Sig Gen 80Hz-520MHz | £800 |
| SYSTRON DOWNER 702 Synth AM/FM Sig Gen 100Hz-10Hz | £800 |
| RACA 9081 Synthesised Sig Gen 1.5-20MHz | £600 |
| FARNELL S2520 Synthesised AM/FM Sig Gen 10MHz-520MHz | £400 |
| MARCONI TP2008 AM/FM Sig Gen 10kHz-510kHz Sweep | £200 |
| EP/DANA 3410 Microwave Frequency Counter 20Hz-18GHz | £950 |
| RACAL/DANA 1991 Nanosecond Universal Counter | £850 |
| RACAL 9302 RF Millivoltmeter True RMS 10kHz-1.5GHz | £900 |
| RACAL 9301A RF Millivoltmeter True RMS 10kHz-1.5GHz | £900 |
| RACAL 9009 Auto Mod Meter 10kHz-1.5GHz Wide Deviation | £250 |
| LYONS PG73N Pulse Gen. PRF: 1Hz-20MHz | £150 |
| KETHLEY 224 Programmable Current Source | £1000 |
| HP 5341A Frequency Counter 50MHz-45GHz | £900 |
| RACAL 1998 Frequency Counter 1.30kHz-CR6 & high Stabl | £900 |
| GAY MINDA Line Voltage Analyser | £500 |
| HP 7472A Pileter 2 pen HPB | £200 |

BRUEL & KJØER Vibration Exciter System
Consisting of Exciter Control 1047 Power Amp 2708 & Exciter Body 4802 Up to 1780N-4000Hz
OTHER B&K EQUIPMENT AVAILABLE

SPECTRUM ANALYSERS

| | |
|---|-------|
| HP 3580A LED 50Hz-500Hz | £1000 |
| ANRITSU MS628 With Tracking Gen 10MHz-170MHz | £1500 |
| POLARAD G41-1 10MHz-18GHz | £1500 |
| HP 1411 With BS55A & BS57B 10MHz-18GHz | £1700 |
| HP 1411 With BS54B & BS57B 500kHz-1250MHz | £1200 |
| HP 1411 With BS53B & BS52A 1kHz-110MHz | £800 |
| HP 1411 With BS53B & BS52A 1kHz-110MHz | £700 |
| MARCONI TP2370 30kHz-110MHz | £1000 |
| HP 8444 & 8443 Tracking Generators Available from | £300 |

| | |
|--|-----------|
| HP 8640B Sig Gen 20kHz-102MHz | £1500 |
| HP 8640C Sweep Osc with 86245A 5.9-12.4GHz | £750 |
| MARCONI Digital Frequency Meter 2GHz | £900 |
| BRADLEY 192 Oscilloscope Calibrator type 2435 | £600 |
| WILTRON 500 Scaler Network Analyser with Detectors | £1000 |
| FERROGRAPH Audio Test Set with ATU | £350 |
| LPDION LA1 Min 2B Audio Analyser | £500 |
| DATRON 1061A 6.5 digit True RMS AC Current | £1250 |
| DATRON 1065 Multimeter AC/DC ohms IEEE | £600 |
| HEWLETT PACKARD 3490A Bench Multimeter, 5 Digit AC/DC Ohms | £700 |
| PHILIPS PM2534 Multi Function DMM 3.5-6.5 digit with GPIB IEEE | Only £450 |
| MARCONI Digital Frequency Meter 2430A 10Hz-80MHz | £125 |
| MARCONI Digital Frequency Meter 2431A 10Hz-200MHz | £150 |
| MARCONI Universal Counter Timer 2437 DC - 100MHz | £178 |
| MARCONI Universal Counter Timer 2438 DC - 520MHz | £225 |
| SCHUMBERG Sweep Func. Gen 4415 0.1Hz - 7MHz Sine/Sq/Tri | £250 |
| FREEBACK F6000 100kHz Sine/Sq/Tri | £60 |

SOLAARTRON/SCHUMBERGER 1250 FREQUENCY Response Analyser

| | |
|--|-----------|
| HP 8690B Sweep Osc with 8697A Plug-in 26.5-40GHz | £900 |
| RACAL/DANA RF Power Meter 9104 | £400 |
| WAYNE KERR B905 Automatic Precision Bridge 0.05% | £900 |
| WAYNE KERR B424 Digital LCR Meter | £125 |
| COSSOR 108L Optical Cable Fault Locator | £1500 |
| BICOCOTEST T431M Cable Test Set | £1000 |
| FARNELL PSU 1V570M2C 0-70V 5A/0-30V 10A | £300 |
| FARNELL B3020 0-30V 20A | £250 |
| FARNELL B2010 0-30V 10A | £200 |
| BRANDENBURG 472R PSU +/- 2kV | £200 |
| MARCONI TP2700 Universal LCR Bridge, Battery | from £150 |
| FARNELL LAS20 RF Power Amp 15-520MHz 300mW | £175 |
| FARNELL PSU L30E 0-30V 0-5A | £125 |
| FARNELL PSU L30M 0-30V 0-500mA | £50 |
| RACAL 9100 Absorption Wattmeter 1MHz-1GHz 5W | £100 |
| KIKUSUI AVM23 AC Voltmeter Dual 10Hz-500MHz | £100 |
| AVO Valve Tester CT160 | £75 |

FARNELL ISOLATING TRANSFORMERS GU500, 240V 500VA Un-used £50

Isolating Transformers 500A Un-Cased **£30**

NEW EQUIPMENT

| | |
|---|------|
| HAMEG OSCILLOSCOPE HM1005 10MHz Trace 100MHz Daily Timebase | £847 |
| HAMEG OSCILLOSCOPE HM604 Dual Trace 60MHz Delay Sweep | £653 |
| HAMEG OSCILLOSCOPE HM203-7 Dual Trace 20MHz Component Tester | £362 |
| HAMEG OSCILLOSCOPE HM205-3 Dual Trace 20MHz Digital Storage | £653 |
| All other models available as oscilloscopes supplied with 2 or 4 probes | |
| BLACK STAR EQUIPMENT (P&P all units £5) | |
| APOLLO 10 100MHz Counter Timer Ratio Period/Time Int. etc. | £222 |
| APOLLO 100 100MHz (as above with more functions) | £275 |
| METOR 100 FREQUENCY COUNTER 100MHz | £119 |
| METOR 600 FREQUENCY COUNTER 600MHz | £146 |
| METOR 1000 FREQUENCY COUNTER 1GHz | £189 |
| JUPITOR 500 FUNCTION GEN 0.1Hz-500kHz Sine/Sq/Tri | £119 |
| ORION COLOUR BAR GENERATOR Pal/TV/Video | £229 |
| All other Black Star equipment available | |
| OSCILLOSCOPE PROBES 50cm/1m X1 X10 (P&P £5) | £12 |

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

STEWART OF READING
110 WYKEHAM ROAD, READING, BERKS RG6 1PL
Tel: 0734 268041 Fax: 0734 351696 Callers welcome 9am to 5.30pm MON-FRI (UNTIL 8pm THURS)

Everyday with Practical Electronics, August, 1994

CirkIt Access VISA

CIRKIT DISTRIBUTION LTD
Park Lane · Broxbourne · Hertfordshire · EN10 7NQ
Telephone (0992) 448899 · Fax (0992) 471314



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

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

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

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

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

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

AUDIO DESIGN 80 WATT POWER AMPLIFIER.



This fantastic John Linsley Hood designed amplifier is the flagship of our range, and the ideal powerhouse for your ultimate hi-fi system. This kit is your way to get £K performance for a few tenths of the cost! Featured on the front cover of 'Electronics Today International' this complete stereo power amplifier offers World Class performance allied to the famous HART quality and ease of construction. John Linsley Hood's comments on seeing a complete unit were enthusiastic: "The external view is that of a thoroughly professional piece of audio gear, neat elegant and functional. This impression is greatly reinforced by the internal appearance, which is redolent of quality, both in components and in layout." Options include a stereo LED power meter and a versatile passive front end giving switched inputs using ALPS precision, low-noise volume and balance controls. A new relay switched front end option also gives a tape input and output facility so that for use with tuners, tape and CD players, or indeed any other 'flat' inputs the power amplifier may be used on its own, without the need for any external signal handling stages. 'Slave' and 'monobloc' versions without the passive input stage and power meter are also available. All versions fit within our standard 420 x 260 x 75mm case to match our 400 Series Tuner range. ALL six power supply rails are fully stabilised, and the complete power supply, using a toroidal transformer, is contained within a heavy gauge aluminium chassis/heatsink fitted with IEC mains input and output sockets. All the circuitry is on professional grade printed circuit boards with roller tinned finish and green solder resist on the component ident side, the power amplifiers feature an advanced double sided layout for maximum performance. All wiring in this kit is pre-terminated, ready for instant use!

RLH11 Reprints of latest articles..... £1.80
K1100CM HART Construction Manual..... £5.50

LINSLEY HOOD 1400 SERIES ULTRA HIGH-QUALITY PREAMP

Joining our magnificent 80 Watt power amplifier now is the most advanced preamplifier ever offered on the kit, or indeed made-up marketplace. Facilities include separate tape signal selection to enable you to listen to one programme while recording another, up to 7 inputs, cross recording facilities, class A headphone amplifier, cancellable 3-level tone controls and many other useful functions, all selected by high quality relays. For full details see our list.

Send or 'phone for your copy of our FREE List of these and many other Kits & Components. Enquiries from Overseas customers are equally welcome, but PLEASE send 2 IRCs if you want a list sent surface post, or 5 for Airmail. Ordering is easy. Just write or telephone your requirements to sample the friendly and efficient HART service. Payment by cheque, cash or credit card. A telephoned order with your credit card number will get your order on its way to you THAT DAY.
Please add part cost of carriage and insurance as follows:—INLAND Orders up to £20 - £1.50,
Orders over £20 - £3.50. Express Courier, next working day £15.
OVERSEAS — Please see the ordering information with our lists.

LINSLEY HOOD 'SHUNT FEEDBACK' R.I.A.A. MOVING COIL & MOVING MAGNET PICKUP PREAMPLIFIERS



Modern, ultimate sound systems are evolving towards built-in preamplifiers within or near the turntable unit. This keeps noise pickup and treble loss to a minimum. We now offer two units, both having the sonically preferred shunt feedback configuration to give an accurate and musical sound, and both having the ability to use both moving magnet and moving coil cartridges.

Kit K1500 uses modern integrated circuits to achieve outstanding sound quality at minimal cost. The very low power requirements enable this unit to be operated from dry batteries and the kit comes with very detailed instructions making it ideal for the beginner. K1500 Complete kit with all components, printed circuit board, full instructions and fully finished case..... £67.99

Instructions only..... £2.80
Kit K1450 is a fully discrete component implementation of the shunt feedback concept and used with the right cartridge offers the discerning user the ultimate in sound quality from vinyl disks. Can be fitted inside our 1400 Preamp, used externally or as a standalone unit. It has a higher power requirement and needs to be powered from our 1400 Series preamplifier or its own dedicated power supply. K1450 Complete Discrete Component RIAA Phono Preamp..... £109.58
Factory Assembled and Tested..... £159.58
K1565 Matching Audio Grade Power Supply with potted toroidal transformer and limited shift earthing system..... £79.42
Factory Assembled and Tested..... £118.42
U1115 Power Interconnect Cable..... £7.29

SPECIAL OFFER PRECISION Triple Purpose TEST CASSETTE TC1DD.

Are you sure your tape recorder is set up to give its best? Our latest triple purpose test cassette checks the three most important tape parameters without test equipment. Ideal when fitting new heads. A professional quality, digitally mastered test tape at a price anyone can afford.
Test Cassette TC1DD..... Our price only £10.99

DISK-COUNT Classical CD's.

Top quality, Full Digital (DDD) Compact Disks of the great classical favourites. Like everyone else we didn't like the idea of paying silly prices for CD's. After a long search we have now located a source of top quality classical recordings at prices that make you suspect the quality – until you try them! Send for our list of titles.

TECHNICAL BOOKSHELF

The Following are a Small Selection of the Books we Offer. Full Details are in our Free List.

"THE ART OF LINEAR ELECTRONICS", John Linsley Hood.
Just Out! Hot Off the Press, the definitive electronics and audio book by the renowned John Linsley Hood. This 300+ page book will give you an unparalleled insight into the workings of all types of audio circuits. Learn how to read circuit diagrams and understand

amplifiers and how they are designed to give the best sound. The virtues and vices of passive and active components are examined and there are separate sections covering power supplies and the sources of noise and hum. As one would expect from this writer the history and derivation of audio amplifier circuitry have an entire chapter, as does test and measurement equipment.

Copiously illustrated this book is Incredible value for the amount of information it contains on the much neglected field of linear, as opposed to digital, electronics. Indeed it must be destined to become the standard reference for all who work, or are interested in, this field.

SPECIAL OFFER. With each book purchased you may request a FREE extended index, written by the Author, exclusively from HART.

0-7806-0868-4..... £16.95
Don't forget most of our kits have reprints of articles by John Linsley Hood that you can purchase separately.

"TOWERS' INTERNATIONAL TRANSISTOR SELECTOR". This will give you the specification, pin connections, case outline, manufacturer, equivalents and substitutes for over 27,000 European, American and Japanese transistors. Latest update 4 offers over 2,000 new entries plus surface mount cross index. 1990 432 Pages. 247 x 173.
0-572-01062-1..... £19.95

"DIGITAL AUDIO AND COMPACT DISC TECHNOLOGY" 2nd Edition. Baert, Theunissen and Vergult. (SONY Europe).

A thoroughly well written book covering the whole field of recording media starting with the Phonograph right through to modern professional PCM digital recording systems with particular and extensive coverage on the compact disc. All aspects of the recording and reproduction processes are explained with separate chapters on such things as compact disc encoding and the use of cross interleave Reed-Solomon error correction code (CIRC). This book is of course essential reading for engineers and students involved in the field but its very low prices makes it ideal for the enthusiast of recorded music who wants to know more about the hidden processes going on in his CD player.
1992/94 248 Pages. 247 x 190.
0-7506-0614-2..... £17.95

"THE ART OF SOLDERING", R. Brewster.
Absolutely essential reading for anyone who ever picks up a soldering iron. Written from knowledge gained in a lifetime in the field, this is the first book ever solely devoted to this essential and neglected skill for all electronic enthusiasts. Covers everything from the correct choice of soldering iron and solder to the correct procedures to follow with many illustrations and practical exercises.
0-85935-324-3..... £3.95

"HOW TO USE OSCILLOSCOPES & OTHER TEST EQUIPMENT", R.A. Penfold, 112 pages. 178 x 111. Publ. 1989.
BP267..... £3.50

Classics from the "Golden Age"

"THE WILLIAMSON AMPLIFIER", D.T.N. Williamson.
In April 1947, Williamson's power amplifier, using excellent-quality push/pull output valves, a special output transformer, and a highly filtered power supply, became an overnight success. The author takes the reader deep into his design considerations, offering practical advice on how to build the units plus concise instructions on setting up the new amp. A cult classic.
1947, Reprinted 1990. 40 Pages.
0-9624-1918-4..... £6.95

LOUDSPEAKERS; THE WHY AND HOW OF GOOD REPRODUCTION, G.A. Briggs.
This easy-to-read classic, last revised in 1949, introduces the reader to concepts such as impedance, phons and decibels, frequency response, response curves, volume and watts, resonance and vibration, cabinets and baffles, horns, room acoustics, transients, crossovers, negative feedback, Doppler and phase effects, and much more. A provocative survey of the right questions about sound reproduction.
1949, Reprinted 1990. 88 Pages. 215 x 140.
0-9624-1913-3..... £8.95

Postage on Single Books is £1.50 except for The Art of Linear Electronics, Digital Audio and Compact Disc Technology and The Towers International Transistor Selector which are £3.50. Two, or more, books are only £4.50, any size, any quantity.

QUALITY AUDIO KITS

24 hr. SALES LINE (0691) 652894

ALL PRICES INCLUDE UK/EC VAT



EXPRESS COMPONENTS

MAINS IONIZER KIT. Very useful kit that increases the flow of negative ions, helps clear cigarette smoke, dust, pollen etc. Helps reduce stress and respiratory problems. £15. kit, £20 built.

COMBINATION LOCK. Electronic 9 key combination lock suitable for alarms, cars, houses etc, easily programmable. Includes mains 2A relay o/p. 9v operation. £10 kit, £14 built.

VARIABLE POWER SUPPLY. Stabilized, short circuit protected. Gives 3-30v DC at 2.5A, ideal for workshop or laboratory. £14 kit, £18 built. 24V AC required.

LEAD ACID CHARGER. Two automatic charging rates (fast and slow), visual indication of battery state. Ideal for alarm systems, emergency lighting, battery projects etc. £12 kit, £16 built.

PHONE LINE RECORDER. Device that connects to the 'phone line and activates a cassette recorder when the handset is lifted. Ideal for recording 'phone conversations etc. £8 kit, £12 built.

ROBOT VOICE. Turns your voice into a robot voice! answer the phone with a different voice! £9 kit, £13 built.

PHONE BUG DETECTOR. This device will warn you if somebody is eavesdropping on your 'phone line. £6 kit £9 built.

PHONE BUG. Small bug powered by the telephone line. Only transmits when the phone is used. Popular surveillance product. £8 kit, £12 built.

STROBE LIGHT. Bright strobe light with an adjustable frequency of 1-60hz. (a lot faster than conventional strobes!) £16 kit, £20 built.

4W FM TRANSMITTER. 3RF stages, audio preamp. 12-18vDC. Medium powered bug £20 kit, £28 built.

3 CHANNEL LIGHT CHASER. 3x 800w output, speed and direction controls, can be used with 12 led's (supplied) or TRIACS for mains lights (also supplied). 9-15v DC. £17 kit, £23 built.

25W FM TRANSMITTER. 4 stage, a preamp will be required. (Our preamp below is suitable) £79 built. (no kits).

SOUND EFFECTS GENERATOR. Produces any thing from bird chips to sirens! add sounds to all sorts of things £9 kit £13 built.

FM/AM SCANNER. Well not quite, you have to turn the knob yourself but you will hear things on this radio (even TV) that you would not hear on an ordinary radio! A receiver that covers 50-160MHZ both AM and FM. Built in 5w amplifier. £15 kit, £20 built.

CAR ALARM SYSTEM. Works on vibration and/or voltage drop from door etc being opened. Entry and exit delays plus adjustable alarm duration. Low cost protection! £12 kit, £16 built.

15W FM TRANSMITTER. 4 stage, high power bug. You will need a preamp for this (see our preamp below which is ok) £69 built. (no kits).

1W FM TRANSMITTER. 2 stage including preamp and mic. Good general purpose bug. 8-30VDC. £12 kit, £16 built.

50 I/C's for £1.50
Nice mix of chips at a bargain price!

CERAMIC CAPACITOR PACK
Good mixed pack of 100 capacitors for just £1.00

ELECTROLYTIC PACK 1
100 small mixed electrolytic capacitors just £1.00

ELECTROLYTIC PACK 2
50 larger electrolytic mixed capacitors

RESISTOR PACK NO 1
250 low wattage resistors, ideal for most projects etc. Just £1.00

RESISTOR PACK NO 2
Hi wattage pack, good selection of mixed wattages and values 50 in all, bargain price just £1.00

PRESET PACK
Nice selection of 25 mixed preset pots for just another £1!

RELAY PACK NO 1
6 mixed relays for £1, that's just 17p each.

CONNECTOR PACK
10 different connectors, again for £1

FUSE PACK NO 1
40 mixed 20mm fuses, ideal for repairs etc, or just to stock up the spares box! Just £1.00

FUSE PACK NO 2
30 mixed 1.25" fuses again ideal for spares etc. Just £1.00

WIRE PACK
25 Metres of insulated wire for just £1.00, good for projects etc.

SLEEVING PACK
100 assorted pieces of sleeving for connectors etc. Yours for just £1.00

DIODE PACK
100 assorted diodes for just £1.00

LED PACK
20 light emitting diodes for £1.00

TRANSISTOR PACK
50 mixed transistors, another bargain at £1.00

BUZZER PACK
10 things that make a noise for just £1.00!

POT PACK
10 pots for £1, (5 different types) a snip at £1.00

DISPLAYS
10 seven segment displays for £1.00

ORDER 10 PACKS OR MORE AND CHOOSE ONE FREE PACK!!

FREE COMPONENT CATALOGUE WITH EVERY ORDER!!

BULK PACKS

99p
Post

KITS 'N MODULES

PREAMP MIXER. 3 channel input, independent level and tone controls. Ideal for use with the hi power FM transmitters. £15 kit, £19 built.

TREMBLER ALARM. Designed for bikes etc, adjustable sensitivity, preset alarm time, auto reset. Could be adapted for all sorts of "borrowable" things £12 kit, £16 built.

ULTRASONIC RADAR. A project that can be used as a movement detector in an enclosed space. Range about 10 metres, 12vDC. Good basis for car, shed, caravan alarm etc. £14 kit, £19 built.

PHONE CALL RELAY. Very useful kit that incorporates a relay that operates when the phone rings. Can be used to operate more bells, signalling lights etc. Good for noisy environments or if you have your headphones on! £10 kit, £14 built.

PORTABLE ALARM SYSTEM. Small 9v alarm system based on a mercury switch. The alarm continues to sound until disabled by the owner. Buzzer included. £11 kit £15 built.

800W MUSIC TO LIGHT EFFECT. Add rhythm to your music with this simplesound to light kit. £8 kit, £12 built.

MOSQUITO REPELLER. Modern way to keep the midges away! Runs for

about a month on one 1.5v battery. Frequency is set to drive away mosquitos etc. £7 kit, £11 built.

3 CHANNEL SOUND TO LIGHT. Can be used anywhere as no connection is made to hi fi. Separate sensitivity controls for each channel, 1,200W power handling. Microphone included. £14 kit, £19 built.

MINI METAL DETECTOR. Detects pipes, wires etc up to 20cm deep. Useful before you drill those holes! £8 kit, £12 built.

0-5 MINUTE TIMER. Simple time switch adjustable from 0-5 mins, will switch 2A mains load. 12v op. Ideal for laboratory, photographic projects etc. £7 kit, £11 built.

7 WATT HI FI AMPLIFIER. Useful, powerful amplifier 20hz-15hz, 12-18vdc. Good for intercoms, audio systems, car etc. £7 kit £11 built.

INCAR SOUND TO LIGHT. Put some atmosphere in your car with this kit. Each channel has 6 led's that create a beautiful lighting effect! £10 kit, £14 built.

VOX SWITCH. This is a sound activated switch, ideal for use on transmitters, CB's, tape recorders etc. Adjustable sensitivity, built in delay. Mic input. £7 kit, £11 built.

LIQUID LEVEL DETECTOR.

Useful item, can be used to detect fluid levels in water tanks, baths, ponds, fish tanks etc. Could also be used as rain alarm with an easily constructed sensor. £5 kit, £9 built.

FM TRANSMITTER. Mini FM transmitter 2 transistor, comes with FET miniature mic and is tuneable from 63 to 130MHZ. £7 kit, £11 built.

FUNCTION GENERATOR. Generates sinusoidal, saw tooth and square waveforms from 20hz upto 20khz. Separate level controls for each waveform. 24vac. £15 kit, £20 built.

5 WATT SIREN. Powerful siren kit with an impressive 5 watts output. Ideal for alarms etc. £6 kit £10 built.

TELEPHONE AMPLIFIER. Very sensitive amplifier which using a 'phone pickup coil (supplied) will let you fol-

low a telephone conversation without holding the handset to your ear! £11 kit £15 built.

SWITCH PACK
10 switches for just £1.00

12v FLOURESCENT. A useful kit that will enable you to light large fluorescent tubes from your car battery etc. 9v mains transformer required. £8 kit, £12 built.

KNOB PACK
10 knobs for just £1.00

REMEMBER! YOUR FREE COPY OF OUR CUT PRICE COMPONENTS CATALOGUE SENT WITH EVERY ORDER!!!

How to place your order.....

By phone.....0273 771156

By FAX.....0273 206875

By Post...PO box 517 Hove Sussex BN3 5QZ

Payment by ACCESS, VISA, CHEQUE OR POSTAL ORDER.

Cheques and postal orders should be payable to Express Components.

ALL PRICES ARE SUBJECT TO 99p POST AND VAT. Some of our products may be unlicensable for use in the UK (particularly the FM transmitters.)



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

NEW EPE MICROCONTROLLER P.I. TREASURE HUNTER

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

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



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

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

KIT 847.....£63.95

DIGITAL LCD THERMOSTAT

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

KIT 841.....£29.95

PORTABLE ULTRASONIC PEST SCARER

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

KIT 842.....£22.56

DIGITAL CAPACITANCE METER

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

KIT 493.....£39.95

ACOUSTIC PROBE

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

KIT 740.....£19.98

'COMSTEP' P.C. COMPUTER STEPPING MOTOR INTERFACE

An exciting project supplied with two 200 step motors, interface board, and easy to use P.C. software.

Allows independent control of both motors - speed, direction, number of steps, and half/full step mode. Connects to computer parallel port. Requires 12V 1A D.C. supply and printer lead.

KIT 846 (with 2 motors)£62.99 (Printer lead £5.00)

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

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



KIT 845.....£64.95

ULTRASONIC PEST SCARER

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



- KIT INCLUDES ALL COMPONENTS, PCB & CASE
- EFFICIENT 100V TRANSDUCER OUTPUT
- LOW CURRENT DRAIN

- COMPLETELY INAUDIBLE TO HUMANS
- UP TO 4 METRES RANGE

KIT Ref. 812.....£14.81

IONISER

A highly efficient mains powered Negative Ion Generator that clears the air by neutralising excess positive ions. Many claimed health benefits due to the ioniser removing dust and pollen from the air and clearing smoke particles. Costs virtually nothing to run and is completely safe in operation. Uses five point emitters.

KIT 707.....£17.75

BAT DETECTOR

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

KIT 814.....£21.44

12V EPROM ERASER

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

KIT 790.....£28.51

MOSFET 25V 2.5A POWER SUPPLY

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

KIT 769.....£56.82

INSULATION TESTER

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

KIT 444.....£22.37

3 BAND SHORT WAVE RADIO

Covers 1.6 to 30MHz in three bands using modern miniature plug-in coils. Audio output is via a built-in loudspeaker. Advanced stable design gives excellent stability, sensitivity and selectivity. Simple to build battery powered circuit. Receives a vast number of stations at all times of the day.

KIT 718.....£30.30

DIGITAL COMBINATION LOCK

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

KIT 840.....£19.86

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

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



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

- DETECTS FERROUS AND NON-FERROUS METAL - GOLD, SILVER, COPPER ETC.

- 190mm SEARCH COIL
- NO 'GROUND EFFECT'

KIT 815.....£45.95

HAMEG HM203-7 20 MHz DUAL TRACE OSCILLOSCOPE & COMPONENT TESTER

Western Europe's best selling oscilloscope - It is RELIABLE, HIGH PERFORMANCE, & EASY TO USE. Sharp bright display on 8 x 10cm screen with internal graticule. A special extra feature is the built-in component tester which allows capacitors, resistors, transistors, diodes and many other components to be checked. The quality of this instrument is outstanding, and is supported by a two year parts and labour warranty. If you are buying an oscilloscope - this is the one. - It costs a fraction more than some other 20 MHz 'scopes but it is far far superior. Supplied with test probes, mains lead, and manual.

£362.00 + £63.35 VAT Includes FREE Next-day delivery (Cheques must be cleared)

EDUCATIONAL BOOKS & PACKS

ADVENTURES WITH ELECTRONICS

The classic book by Tom Duncan used throughout schools. Very well illustrated, ideal first book for age 10 on. No soldering. Uses an S.DEC breadboard. **Book & Components £28.95, Book only £7.25**

FUN WITH ELECTRONICS

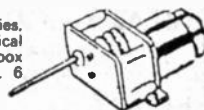
An Usborne book, wonderfully illustrated in colour. Component pack allows 6 projects to be built and kept. Soldering is necessary. Age 12 on, or younger with adult help. **Book & Components £20.88, Book only £2.95**

30 SOLDERLESS BREADBOARD PROJECTS

A more advanced book to follow the others. No soldering. Circuits cover a wide range of interests. **Book & Components £30.89, Book only £2.95**

DC MOTOR/GEARBOXES

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



Small type MGS....£4.77

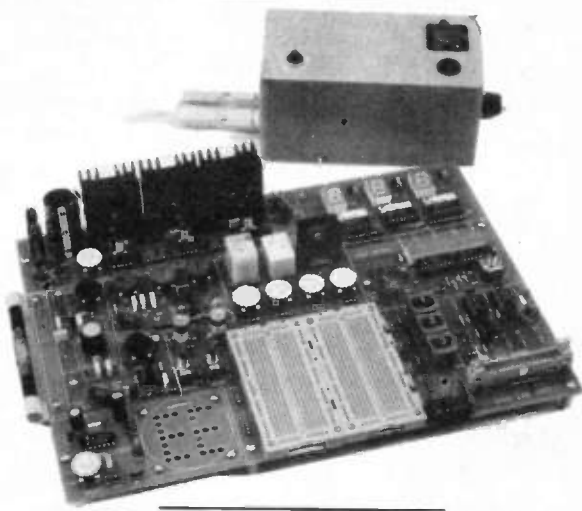
STEPPING MOTORS

For computer control via standard 4 pole unipolar drivers.

MD38 - miniature 48 steps per rev.....£9.15
MD35 1/4 - standard 48 steps per rev.....£12.99

MAGENTA

Teach-In '93



MINI LAB KITS

ALL COMPONENTS TO ASSEMBLE THE EPE MINI LAB.

Follow this exciting educational series as featured in EPE through 1993.

Full set of reprints£4.60

Components are supplied in packs to keep ordering simple.

A full MINI LAB consists of ML1, ML3, ML5, ML6. These are available at a special combined price of.....£114.99 or less the p.c.b.

ML2, ML3, ML5, ML6 at.....£104.99

The transformer unit ML4 is also needed....£21.45

KIT ML1 MINI-LAB P.C.B. + all components inclusive of breadboard for Part 1 (Nov. '92).....£49.95

KIT ML2 All Components for Part 1 less p.c.b.....£39.95

KIT ML3 Power Supply components.....£19.95

KIT ML4 Transformer unit.....£21.45

KIT ML5 L.E.D. Voltmeter, signal generator, audio amplifier and 555 timer.....£33.95

KIT ML6 Logic probe, display, radio tuner.....£17.95

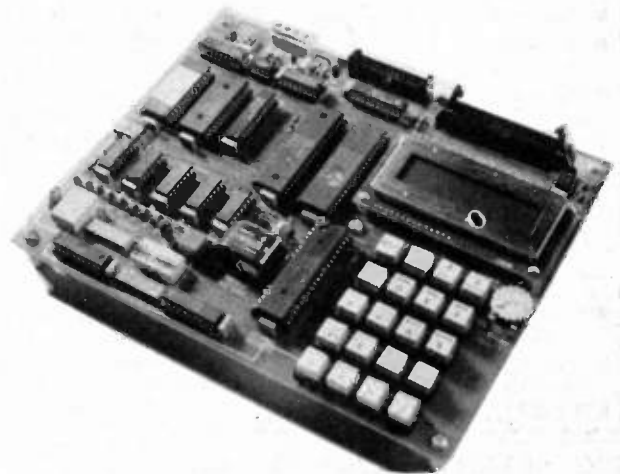
(Note: batteries not included)

All prices include V.A.T. Add £3.00 p&P.

Tel: 0283 65435 Fax: 0283 46932

MAGENTA

Teach-In '93



MICRO LAB KITS

ALL COMPONENTS TO ASSEMBLE THE EPE MICRO LAB.

A 6502 Microprocessor trainer with many features. Accompanied by an excellent set of tutorial articles and a manual.

Repair/fault-finding help assured when you buy your kit from us.

Full MICRO LAB kit including PC Board, EPROM, PAL, & Manual.

MIC 1£149.95

(Also available less PCB etc. if required).

Full set of reprints.....£3.00

BUILT & TESTED

Full MICRO LAB AS MIC1 (above) MIC1B.....£179.95

Professionally assembled, inspected, cleaned and tested. Full back-up service, spares, etc available.

All prices include V.A.T. Add £3.00 p&P.

Tel: 0283 65435 Fax: 0283 46932

EVERYDAY WITH PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

Editorial Offices:

EVERYDAY with PRACTICAL ELECTRONICS EDITORIAL,
6 CHURCH STREET, WIMBORNE,
DORSET BH21 1JH

Phone: Wimborne (0202) 881749

Fax: (0202) 841692. DX: Wimborne 45314.

See notes on Readers' Enquiries below - we regret that lengthy technical enquiries cannot be answered over the telephone. Due to the high cost we cannot reply to overseas readers queries by Fax.

Advertisement Offices:

EVERYDAY with PRACTICAL ELECTRONICS
ADVERTISEMENTS,

HOLLAND WOOD HOUSE, CHURCH LANE,
GREAT HOLLAND, ESSEX CO13 0JS.

Phone/Fax: (0255) 850596

VOL. 23 No. 8

AUGUST '94

MICROPROCESSORS

A number of readers have been intrigued by our recent microprocessor based projects and have asked for information on programming and using these devices. The *6802 Development Board* article in this issue provides an inexpensive way to get into this. The software necessary to use a PC to develop 6802 based projects is available very cheaply and the development board is relatively easy to build.

Of course it is impossible to carry a full tutorial on programming the 6802 but this information is available both from Motorola and in various books. We also hope to publish further material on programming and using other types of microprocessor in the future.

EXPERIMENTING

While many readers will be fascinated by working out and writing control software for projects there will also be many who are left cold by this growing aspect of our hobby. Such readers can, of course, simply treat programmed chips in the same way as they would any other dedicated chip, but there are also plenty of fascinating areas where hobbyists can still experiment with "basic circuitry".

One such area is covered by Robert Penfold's informative *Experimental Sound Cancelling Unit* article in this issue. As Robert points out, there is far more to this subject than meets the eye. With more and more interest being focused on pollution in various forms and with modern life generating increasing levels of noise pollution this is also a very worthwhile area of investigation, with plenty of avenues for experimentation open to the hobbyist.

WELCOME

Finally we would like to welcome John Becker to the EPE staff. John will be well known to many readers both as a contributor (this issue carries two articles written by him) and as the editor of *Practical Electronics* in the late 80's. With the continual development of our various technological publications the experience and expertise that John brings to our editorial team will benefit everyone.



SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £22. Overseas: £28 (£45.50 airmail). Cheques or bank drafts (in £ sterling only) payable to Everyday with Practical Electronics and sent to EPE Subscriptions Dept., 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: 0202 881749. Subscriptions start with the next available issue. We accept Access (MasterCard) or Visa payments, minimum credit card order £5.

BACK ISSUES

Certain back issues of EVERYDAY ELECTRONICS, PRACTICAL ELECTRONICS and EVERYDAY with PRACTICAL ELECTRONICS (from Nov '92 onwards) are available price £2.20 (£3 overseas surface mail) inclusive of postage and packing per copy - £ sterling only please, Visa and Access (MasterCard) accepted, minimum credit card order £5. Enquiries with remittance, made payable to Everyday with Practical Electronics, should be sent to Post Sales Department, Everyday with Practical Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH Tel: 0202 881749. In the event of non-availability one article can be photostated for the same price. Normally sent within seven days but please allow 28 days for delivery. We have sold out of Jan, Feb, Mar, Apr, May, June, Oct, & Dec 88, Mar, May & Nov 89, Mar 90, April, Aug & Sept 91 Everyday Electronics, and can only supply back issues from Jan 92 to Aug 92 (excluding Mar 92) of Practical Electronics. Dec 92, Jan, Feb and March 93 Everyday with Practical Electronics are also unavailable.

BINDERS

New style binders to hold one volume (12 issues) are now available from the above address for £5.95 plus £3.50 post and packing (for overseas readers the postage is £6.00 to everywhere except Australia and Papua New Guinea which cost £10.50). Normally sent within seven days but please allow 28 days for delivery.

Payment in £ sterling only please.

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

Editor: MIKE KENWARD

Secretary: PAM BROWN

Deputy Editor: DAVID BARRINGTON

Technical Editor: JOHN BECKER

Business Manager: DAVID J. LEAVER

Subscriptions: MARILYN GOLDBERG

Editorial: Wimborne (0202) 881749

Advertisement Manager:

PETER J. MEW, Frinton (0255) 850596

Advertisement Copy Controller:

DEREK NEW, Wimborne (0202) 882299

READERS' ENQUIRIES

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

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

COMPONENT SUPPLIES

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

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

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

ADVERTISEMENTS

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

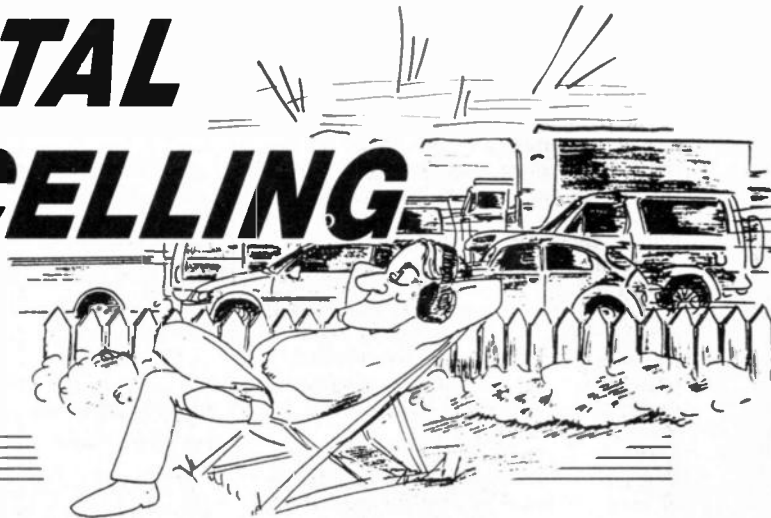
The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should first address them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

TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

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



EXPERIMENTAL NOISE CANCELLING UNIT



ROBERT PENFOLD

An experimental approach to controlling the ever increasing problem of "noise pollution", and how to combat it!

MODERN life undoubtedly has its advantages, but it is not without its drawbacks as well. One of these is the ever increasing amount of "noise pollution". As I sit writing this piece in tranquil suburbia, I can just about hear the odd "chirp" of spring birdsong above the drone of the hard disk in the computer, various noises from the central heating system, and the noise from air compressors, etc. as the gas board lay new pipes in the street outside!

It is not surprising that there has been a lot of interest recently in devices for combatting noise pollution. A number of readers have expressed an interest in electronic noise cancelling devices.

This is one of those things where it is easy to end up with a "sledgehammer to crack a nut" solution. If you simply need to cut out noise, mechanical solutions such as ear defenders, and ear plugs, are likely to be more effective than electronic solutions, and a lot cheaper.

The potential advantage of an electronic noise cancelling unit is that it enables unwanted sounds to be reduced while leaving other sounds intact. In particular, you could listen to your personal stereo, television set, etc. with the sound unaffected, while background noises could be greatly reduced. You could have music while you work via a personal stereo without having to put up with the whining sound of the laser printer in the background.

Noise cancelling systems are very simple in principle, and they use a basic phase cancelling technique. Although simple in principle, phase cancelling is something less than straightforward when applied to sounds. When systems are demonstrated on television programs it is all made to seem delightfully simple, but there are numerous factors which make life difficult when trying to produce a system that will work well in the real world.

The circuits provided in this article will certainly provide noise cancelling, but how

well (or otherwise) they function is dependent on a number of factors. These include such things as the type of sound that is to be combatted, how meticulously everything is set up, and the quality of the microphones used.

They provide a good basis for anyone wishing to experiment with noise cancelling techniques, and should be usable in practical noise cancelling systems. However, this article is primarily aimed at electronics experimenters who are prepared to spend some time getting to grips with the problems involved.

BIG NOISE

Phase cancelling is something that is used routinely in electronics circuits, and in a purely electronic context it normally works extremely well. The waveforms of Fig.1 show the effect of adding together in-phase and out-of-phase signals.

In the left hand set of waveforms two identical sinewave signals (a and b) are combined. This gives the end result that one would expect, with an output signal that is the same as the input signal, but that double the amplitude.

In the right hand waveforms two identical signals are again added together, but waveform (b) has been inverted. When waveform (a) is positive, waveform (b) is negative by an identical amount. When signal (a) is negative, signal (b) is positive by an identical amount.

Combining the two signals gives waveform (c), which is a steady 0 volts. Each signal precisely cancels out the other signal so that there is zero output.

It does not matter how simple or complex the two signals happen to be. Equal and opposite signals will always provide precise cancelling, resulting in no output signal.

PHASED OUT

In order to obtain a high degree of cancelling it is essential that the signals are accurately matched in amplitude, and that

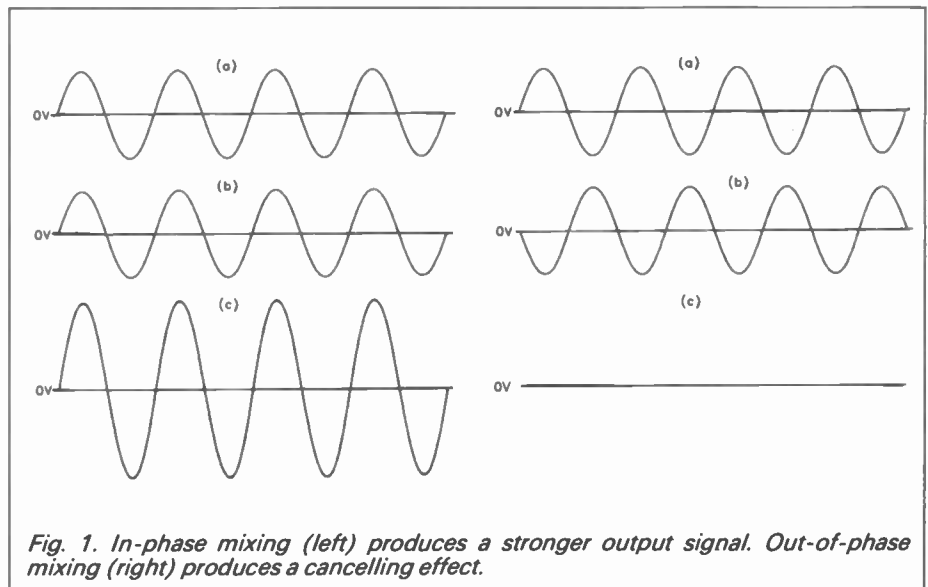


Fig. 1. In-phase mixing (left) produces a stronger output signal. Out-of-phase mixing (right) produces a cancelling effect.

they are precisely *180 degrees out-of-phase*. The waveforms of Fig. 2 show the effects of poor amplitude matching and incorrect phasing.

In the left hand waveforms two input signals are precisely out-of-phase, but signal (b) is at only half the amplitude of signal (a). As a result of this it only cancels signal (a) by 50 per cent, giving the output waveform of (c).

The right hand waveform shows the effect of inaccurate phasing. Signal (a) has precisely the same *amplitude* as waveform (b), but it is *phase* shifted by 90 degrees. In other words, it is exactly half way between being in-phase and out-of-phase.

One might expect that this would give a similar result to the mismatch in amplitude, with an output signal that is a somewhat reduced version of signal (a). In reality it produces an output waveform (c) that is phase shifted by about 45 degrees relative to signal (a), and which is also about 1.5 times greater in amplitude.

The implications of this are clear. Mixing a signal with an identical but inverted copy of itself will result in precise cancellation, and a high degree of attenuation. A mismatch in the amplitudes of the two signals will still give a certain amount of attenuation, but quite a small mismatch will severely limit the effectiveness of the system. Even a mismatch of just 10 per cent will limit the attenuation to 20dB.

Errors in the phasing of the two signals are more serious. Quite small errors will severely limit the attenuation obtained, and large errors will result in the signal being boosted. In a noise cancelling application a high degree of attenuation can be achieved if everything is just right, but with incorrect matching of the two signals you could end up with more noise rather than less!

SOUND ADVICE

Accurately phasing out an electrical signal does not usually present any major problems. A simple inverting amplifier is all that is needed in order to produce an out-of-phase copy of the input signal, and a variable attenuator enables the copy to be accurately matched to the amplitude of the original.

Very minor phase and amplitude variations may occur over the audio range, but it is generally only with wide bandwidth signals that it becomes difficult to obtain a high degree of attenuation over the full frequency range of the system. Over the audio range it is usually possible to achieve 60dB or even 80dB of attenuation without too much difficulty.

Phase cancelling can be applied to sounds, and many pieces of machinery use a balancing technique to keep noise and vibration down to acceptable levels. In theory, in order to remove a sound you simply have to generate an identical out-of-phase sound.

Any change in air pressure produced by the original sound is then balanced by an equal and opposite change in air pressure by the out-of-phase sound, producing silence. However, there are practical difficulties with real world noise cancelling systems.

My experiments with systems using a loudspeaker to generate the "anti-sound" were totally unsuccessful. Acoustic feedback and "howl-around" were constant problems, and changes in the position of the listener relative to the sound source and the loudspeaker seem to substantially affect results.

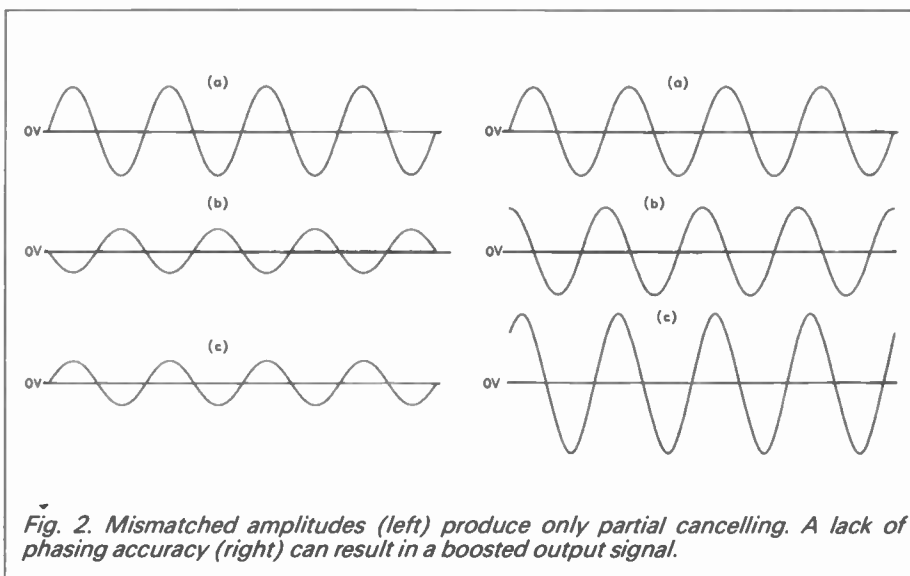


Fig. 2. Mismatched amplitudes (left) produce only partial cancelling. A lack of phasing accuracy (right) can result in a boosted output signal.

It is no doubt possible to obtain a worthwhile degree of noise cancelling using a loudspeaker based system, but it does not seem to represent a good starting point. Experiments with systems based on headphones were more simple, and provided much better results.

SOUND TRACK

An important point that must always be kept in mind when dealing with noise cancelling systems is that sound does not travel instantly from its source to your ears. Sound travels at about 0.3 metres (1ft.) per millisecond.

If you position a microphone close by one of your ears, what you hear and the microphone "hears" will be very much the same. If you move the microphone away from your ear, the sounds it picks up will be slightly different to those that you hear.

In particular, there will be a phase difference between the two sounds. At low frequencies the wavelengths are relatively long, and the positioning of the microphone is less critical. At high frequencies the wavelengths are much shorter, and even moving the microphone slightly away from your ear could produce an in-phase signal instead of an anti-phase type.

The most simple form of noise cancelling system that will work reasonably well is two microphones driving a pair of stereo headphones via a preamplifier. The microphones must be mounted one on each earphone, and as close to their respective earphones as possible. The earphones only produce very low sound levels, so acoustic feedback is not a major problem, although it is still necessary to have a small gap between each earphone and microphone.

With this method it is essential to use two microphones, since a single microphone would have to be well separated from one or both earphones. This would introduce phase shifts which would render the system ineffective.

MICROPHONE PREAMPLIFIER

A circuit diagram for a simple low noise Microphone Preamplifier which is suitable for use in a noise cancelling system is shown in Fig. 3. The circuit will work well with any normal type of low impedance microphone. A very low noise operational amplifier (op.amp) ICI is used here as an inverting amplifier having a voltage gain of about 47 times (34dB).

The circuit will work using a cheaper op.amp for ICI, but using a device such

The completed Experimental Noise Cancelling Unit showing front panel lettering, using the Phase Shifter board.



as the 741C or LF351N will degrade the signal-to-noise ratio by about 26dB or more. This could result in sounds being drowned by the system noise rather than being cancelled out!

The output of IC1 is coupled into a volume control style variable attenuator which is used to balance the output of the ear-phone with the direct sounds. IC2 provides further amplification, and it is used in a non-inverting amplifier having a voltage gain of 11 times (just over 20dB).

It is not necessary to use a very high quality operational amplifier in the IC2 position as this stage is operating at a much higher signal level than IC1. An LF351N or similar Bifet device (TL081CP, etc.) is perfectly adequate.

The output of IC2 is coupled to the input of a unity voltage gain inverting amplifier based on IC3. Switch S1 enables the headphone socket to be switched between the outputs of IC2 and IC3, giving the choice of *inverted* or *non-inverted* signals.

This may seem to be unnecessary, since it is only an inverted signal that is needed.

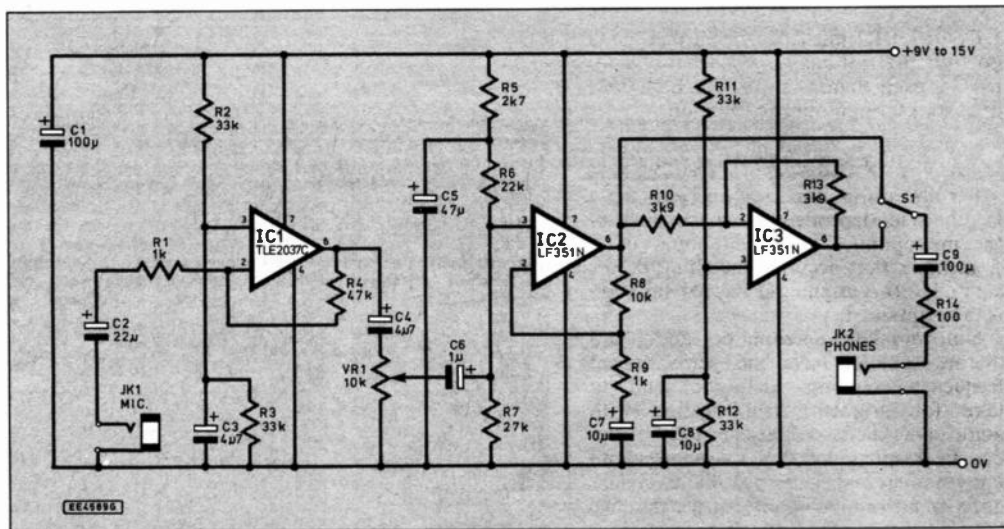


Fig. 3. Circuit diagram for the low noise Microphone Preamplifier.

However, the phasing of the microphones and the headphones is an unknown factor. The only way to determine the correct phasing for the output signal is to use the "suck it and see" method. Switch S1 and the inverter stage make it easy to alter the polarity of the output signal, and quickly determine which is the correct one.

CONSTRUCTION

The stripboard component layout for the microphone preamplifier and breaks required in the copper tracks are illustrated in Fig. 4. This layout is based on a board which has 50 holes by 22 copper strips. Of course, two boards are required, one for each channel.

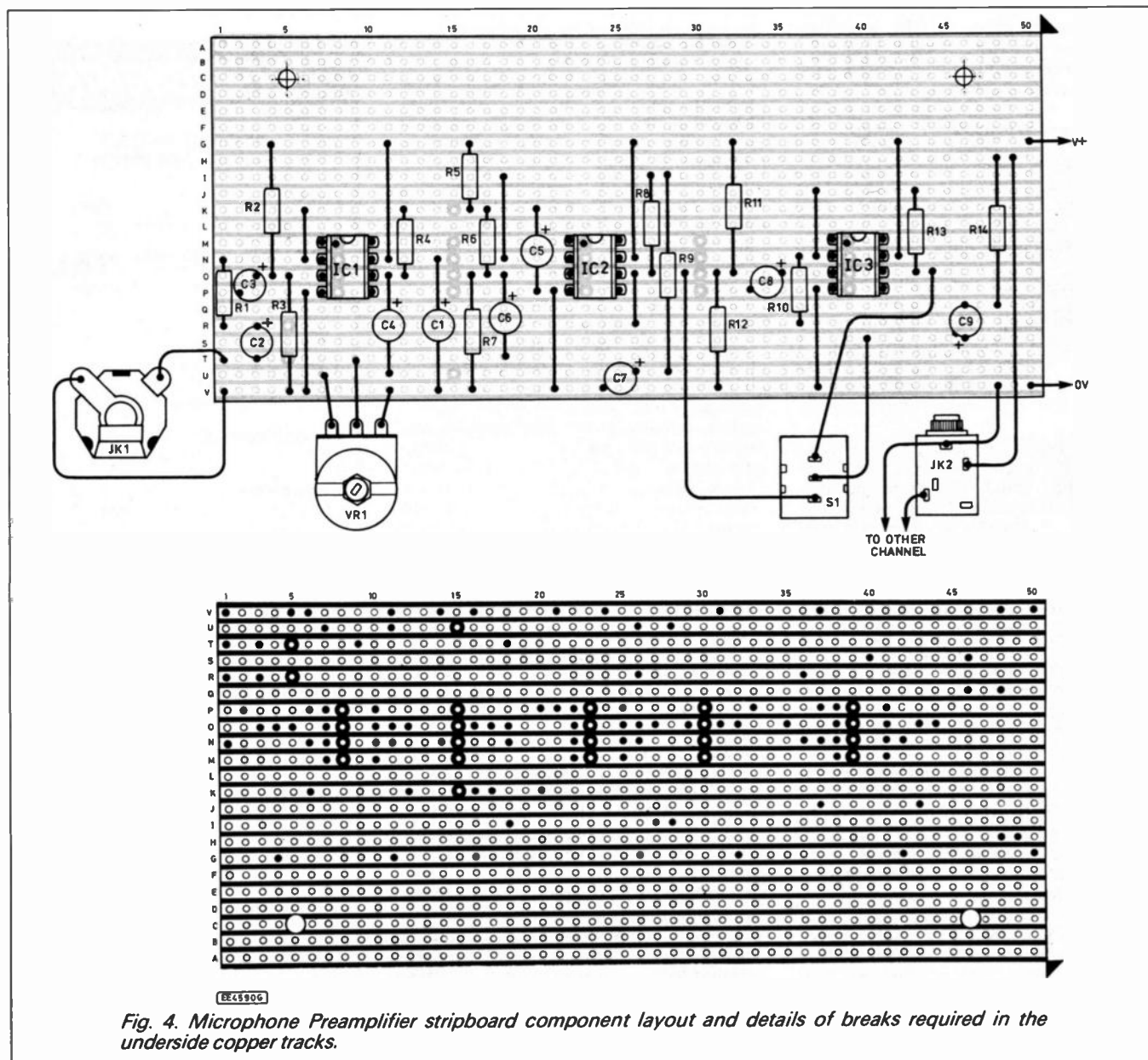


Fig. 4. Microphone Preamplifier stripboard component layout and details of breaks required in the underside copper tracks.

Control VR1 must *NOT* be a dual gang potentiometer; it has to be a separate control for each channel so that each channel can be set for optimum attenuation.

FLAT RESPONSE

Results using this system are to a large extent dependent on the quality of the microphones and headphones used. Remember that accurate matching of the sound levels is essential if high attenuation is to be obtained.

Unfortunately, microphones and headphones do not have the perfectly flat frequency responses that we tend to take for granted when dealing with audio amplifiers. Variations in the frequency response of the headphones and microphones make it impossible to obtain good matching at all frequencies. The flatter the responses of the microphones and headphones, the better the system should work.

Headphones have improved a great deal over recent years, and even quite inexpensive stereo headphones of the "inner-ear" variety were found to give quite good results. Higher quality types work that much better though.

For some reason results using anything other than "inner-ear" headphones were not particularly good. Possibly other types have a larger effect on the frequency response of the user's hearing, making it difficult to get good cancelling over a wide frequency range.

MICROPHONES

The microphones are likely to be the weakest link in the system, and various inexpensive dynamic microphones were found to give very poor results. In some cases no sound cancelling at all could be perceived.

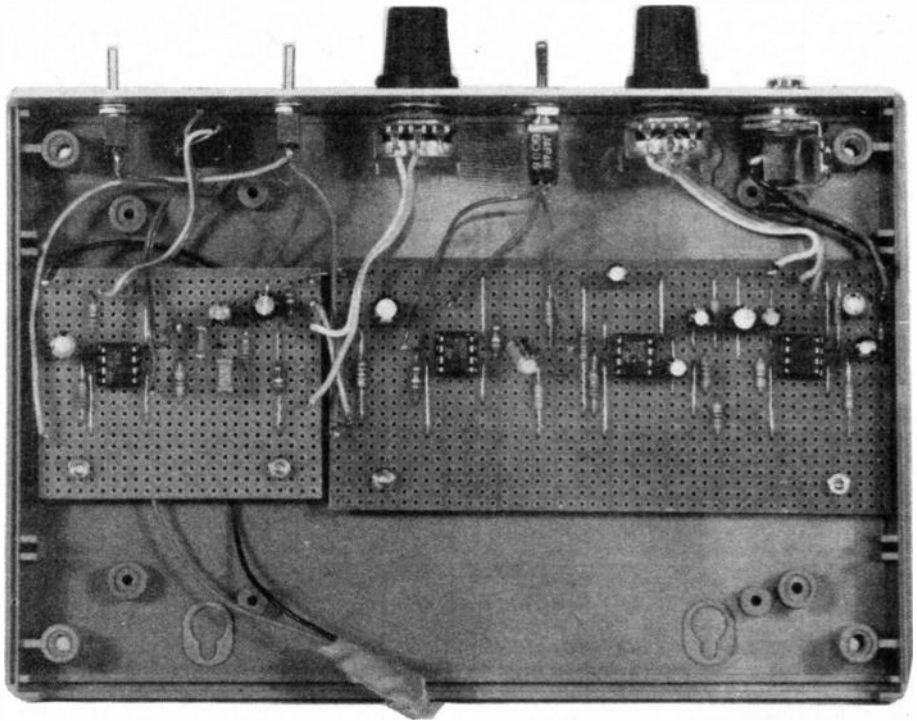
The large size of most dynamic microphones makes them a dubious choice anyway. Presumably few users would be prepared to look like something from an episode of *Doctor Who* with one of these perched on each ear! The fact that they are unidirectional also limits their overall effectiveness.

Human hearing is more or less equally sensitive in every direction, and the microphones should therefore be omnidirectional types that will match this response as closely as possible. The microphones therefore need to be reasonably small and light, and should also be an omnidirectional type.

Experiments using inexpensive electret microphone inserts were not very successful, but electret tie clip microphones were found to give quite good results. I used inexpensive microphones of this type, but if you have access to broadcast quality microphones they will presumably provide rather better results.

I would not recommend the use of any other type of microphone, but it would obviously be quite interesting to try other types if you have them to hand. Bear in mind though, that the microphone preamplifier featured here is only intended for use with low impedance microphones.

The microphones can simply be clipped onto the earphone leads, but ideally there should be some way of adjusting their position slightly. I tried mounting them in various positions on a headband removed from an old pair of headphones, and this proved quite successful.



The completed Experimental Noise Cancelling Unit showing the wiring to the preamplifier board and the small Phase Shifter board.

TUNING IN

When initially trying out the system it is a good idea to use an F.M. radio tuned between stations to provide a white noise source. With the gain controls well backed-off the noise will be heard to emanate from the radio set. If the gain controls are well advanced the apparent source of the noise will be the earphones. The correct settings are somewhere between these two extremes.

When a "null" is achieved there is a very obvious drop in the level of the noise signal, and its pitch will probably seem to change as well. The change in pitch is due to the fact that better cancelling is obtained over some frequency bands than is obtained over others.

If no attenuation can be obtained at any settings of the gain controls, try altering the settings of the phase switches. These switches will probably need the same settings, but it is possible that the microphones will not be connected with the same phase, and that these switches will need to be set for anti-phase outputs.

Do not expect to totally eliminate the noise. I found that it was possible to obtain a very useful degree of attenuation over the low and middle frequency range. It is not really possible to make accurate measurements with this type of thing, but I would estimate that there was a reduction of around 20dB to 30dB over this frequency range.

The higher frequencies proved to be more difficult. By adjusting the gain potentiometers it is possible to improve the high frequency attenuation, but at the expense of the low and middle frequency attenuation.

The high frequency performance seemed to be much better on some occasions than on others. It is likely that the precise positioning of the microphones is an important factor at higher frequencies where the wavelengths are short.

It is certainly worthwhile experimenting a little with the positioning of the microphones in an attempt to optimise the

COMPONENTS

MICROPHONE PREAMPLIFIER

Resistors

| | |
|----------|-------------|
| R1, R9 | 1k (2 off) |
| R2, R3, | |
| R11, R12 | 33k (4 off) |
| R4 | 47k |
| R5 | 2k7 |
| R6 | 22k |
| R7 | 27k |
| R8 | 10k |
| R10, R13 | 3k9 (2 off) |
| R14 | 100 |

All 0.25W 5% carbon film

Potentiometer

| | |
|-----|-------------------------|
| VR1 | 10k rotary carbon, log. |
|-----|-------------------------|

Capacitors

| | |
|--------|-----------------------------------|
| C1, C9 | 100µ radial elect. 16V (2 off) |
| C2 | 22µ radial elect. 16V |
| C3, C4 | 4µ7 radial elect. 63V (2 off) |
| C5 | 47µ radial elect. 16V |
| C6 | 1µ radial elect. 63V |
| C7, C8 | 10µ radial elect. 25V (2 off) |

Semiconductors

| | |
|----------|---------------------------------|
| IC1 | TLE2037C ultra low noise op.amp |
| IC2, IC3 | LF351N bifet op.amp (2 off) |

Miscellaneous

| | |
|---|-----------------------------|
| JK1 | standard 6.35mm jack socket |
| JK2 | 3.5mm stereo jack socket |
| S1 | s.p.d.t. min toggle switch |
| Stripboard 0.1in. matrix, size 50 holes by 22 strips; 8-pin d.i.l. i.c. holder (3 off); control knob; connecting wire, solder; etc. | |

Approx cost guidance only

£10

overall performance of the system. To obtain consistent results it would probably be necessary to mount the microphones in a way which would guarantee that their positioning remained constant relative to the earphones.

The obvious way of improving the performance over the full audio bandwidth is to use some tailoring of the frequency response. Experiments with simple tone controls were not very successful.

A point that should not be overlooked is that circuits which tamper with the frequency response are likely to produce phase shifts. Unfortunately, this means that corrections to the frequency response of the system could easily produce phase shifts that would leave the performance of the system worse rather than better.

It would probably be worthwhile experimenting with simple graphic equalisers, or a parametric equaliser perhaps, and I will certainly try both of these in due course. Even without any broadening of its frequency response, the system is quite effective if the unwanted sounds are predominantly in the lower and middle audio ranges.

PHASE COMPENSATION

Having a microphone close to each earphone is probably the only practical system if the user will be moving around. The microphones and the headphones move around with the user, ensuring that once

the system is set up correctly, it should work properly wherever the user goes.

If the user is going to remain more or less in the same place (sitting in the same chair for example), it is possible to separate the microphones from the headphones. In fact it is possible to use just a single microphone and still get quite good results. This saves the expense of a second high quality microphone, and it makes the mechanical side of construction much more straightforward.

The problem in moving the microphone away from the headphones is that, as explained previously, it introduces a phase shift that prevents the system from operating properly. This problem is not insurmountable, and all that is required is a circuit to correct the phase shift.

Basically all that is needed is a delay-line to compensate for the fact that the microphone is nearer to the sound than the user's ears. Sound travels at about 300 millimetres per millisecond, so a delay of a little over three milliseconds is needed if the microphone is one metre closer to noise source than the user.

Delays of a few milliseconds are easily produced using a small CCD (bucket brigade) delay-line. If the noise is at a single frequency, or predominantly over a narrow range of frequencies, a simple phase shifter circuit is all that is needed.

There is a potential drawback to any system which has the microphone well separated from the headphones. In most

COMPONENTS

PHASE SHIFTER

Resistors

| | |
|--------|-------------|
| R1, R2 | 3k9 (2 off) |
| R3, R5 | 10k (2 off) |
| R4 | 4k7 |
| R6 | 100 |

All 0.25W 5% carbon film

See
**SHOP
TALK**
Page

Potentiometer

| | |
|-----|--------------------------|
| VR1 | 100k rotary carbon, lin. |
|-----|--------------------------|

Capacitors

| | |
|--------|--|
| C1 | 10 μ radial elect. 25V |
| C2, C6 | 100 μ radial elect. 16V (2 off) |
| C3 | 2 μ 2 radial elect. 63V |
| C4 | 100n polyester |
| C5 | 10n polyester |

Semiconductors

| | |
|-----|---------------------|
| IC1 | LF351N bifet op.amp |
|-----|---------------------|

Miscellaneous

| | |
|--|----------------------------|
| JK1 | 3.5mm stereo jack socket |
| S1 | s.p.s.t. min toggle switch |
| Stripboard 0.1in. matrix, size 25 holes by 20 copper strips; 8-pin d.i.l. i.c. holder; control knob, connecting wire; solder, etc. | |

Approx cost
guidance only

£6

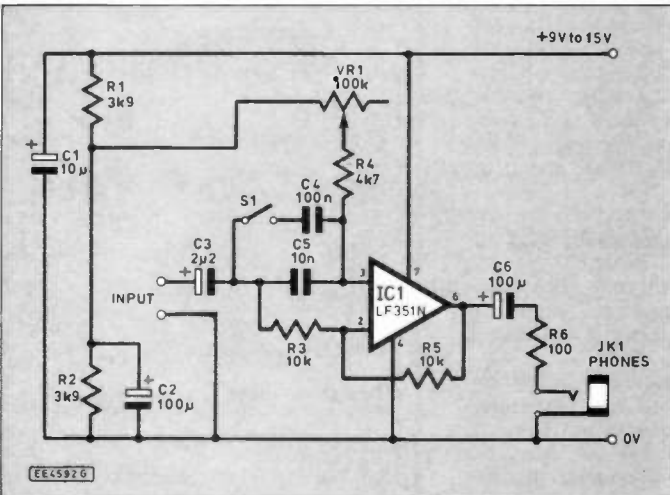
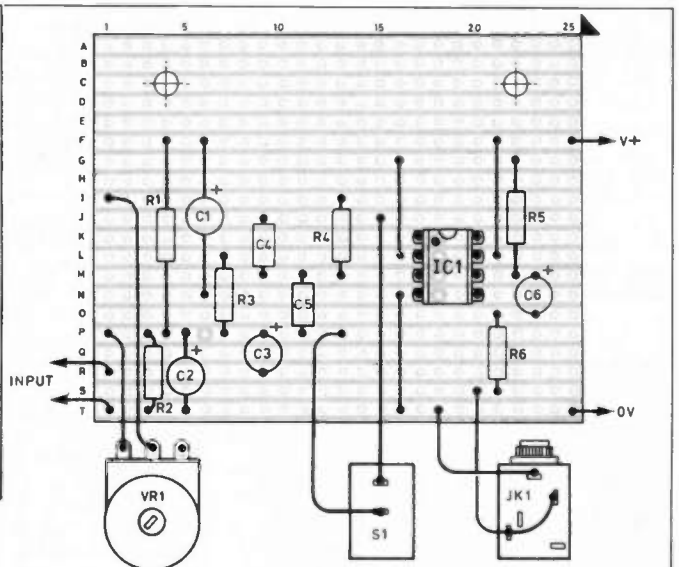
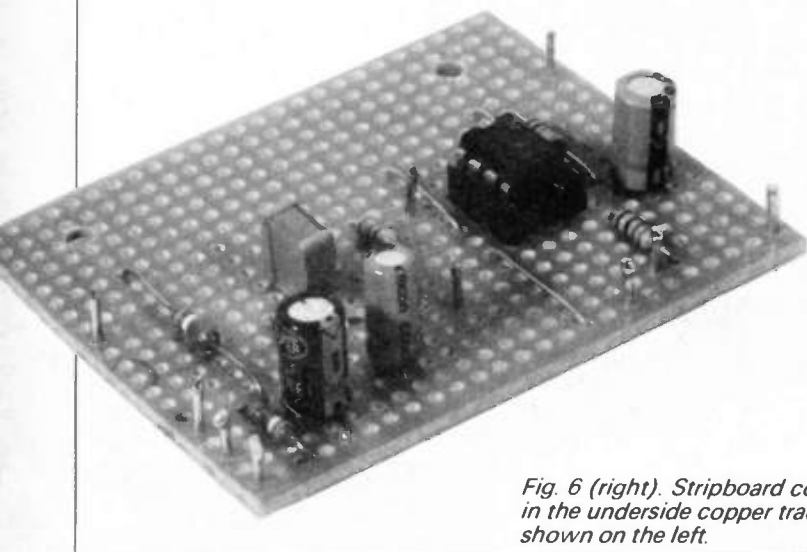


Fig. 5. Circuit diagram for the Phase Shifter.



EE4593G

Fig. 6 (right). Stripboard component layout, wiring and details of breaks required in the underside copper tracks of the Phase Shifter board. The completed board is shown on the left.



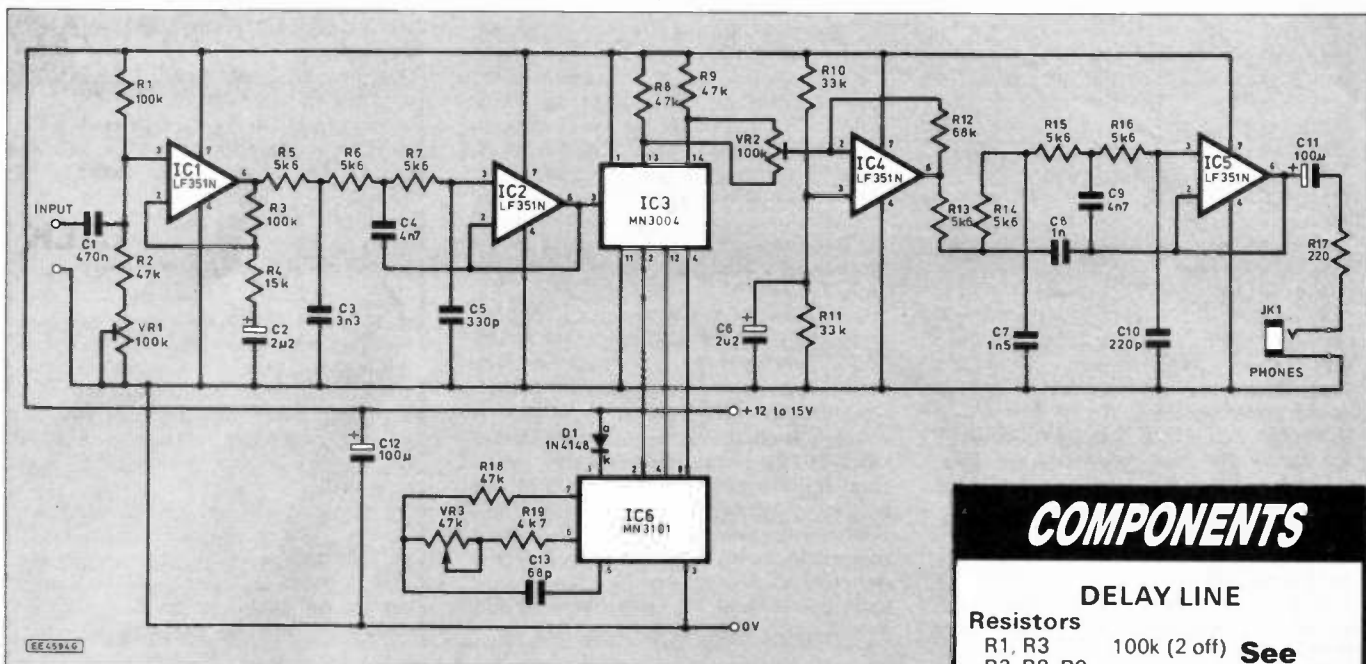


Fig. 7. Circuit diagram for the Delay-Line using MN3004 c.c.d. delay i.c.

cases the sound we hear is mainly received direct from the sound source. There is also a certain amount of sound which comes indirectly via reflections from the ceiling, etc., and it is this sound that is the source of the potential problem.

Because this "indirect" sound does not approach the user from the same direction as the main sound, it will often need a different delay or phase shift to the main sound. This is not practical, which means indirect sounds will not be properly cancelled out.

Just how much this factor compromises performance depends on the strengths of the reflected signals. In many cases they will not be strong enough to be of significance, particularly if the user is close to the sound source.

PHASE SHIFTER

The circuit diagram for a Phase Shifter is provided in Fig. 5. This is fed from the output of the microphone preamplifier. It can be used to drive both earphones, but for optimum attenuation a separate phase shifter should be used for each earphone.

The circuit is a conventional design which can be adjusted for a phase shift of between about 0 and 180 degrees over a large part of the audio range. With the phase inversion available from the preamplifier, this permits virtually a full 0 to 360 degree range to be covered. Switch S1 should be used to switch capacitor C4 into circuit when trying to null a low frequency sound.

Details of the stripboard and wiring for the Phase Shifter are provided in Fig. 6. The board measures 25 holes by 20 copper strips.

DELAY-LINE

The circuit diagram for a Delay-Line, based on an MN3004 512 stage c.c.d. chip (IC3), is shown in Fig. 7. IC1 acts as an input buffer stage, and it also provides a small amount of voltage amplification so that the circuit operates at a signal level which gives a good signal to noise ratio.

A three stage anti-aliasing filter ahead of the delay-line is provided by IC2. IC4

acts as a mixer which combines the outputs of the last two stages of the delay-line chip IC3. Output filtering is provided by a fourth order active filter based on IC5. IC6 is the matching clock and bias chip for IC3.

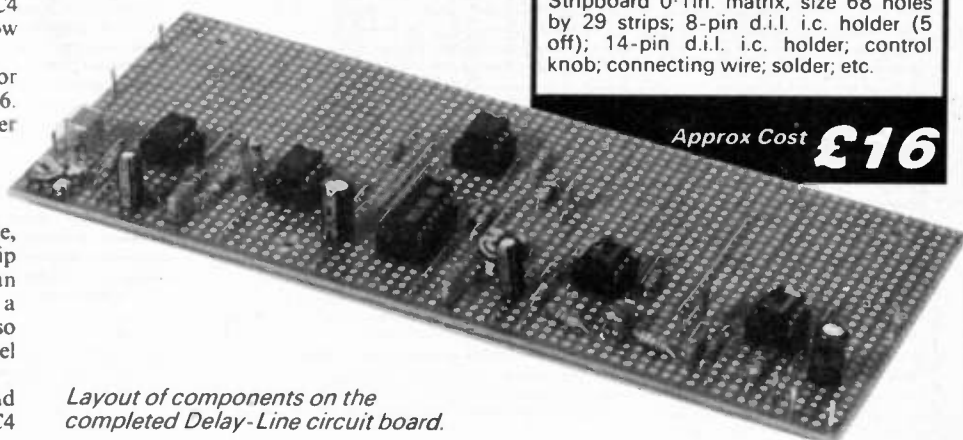
Potentiometer VR3 permits the clock frequency (and the delay time) to be varied. The clock frequency can be varied from about 50kHz to 200kHz. This provides a delay time that is variable from about 1.28 to 5.12 milliseconds, which represents a headphone to microphone distance of between about 384 millimetres and a little over 1.5 metres.

CIRCUIT BOARD

Details of the Delay-Line stripboard component layout and wiring are shown in Fig. 8. The board has 68 holes by 29 copper strips. IC3 and IC6 are MOS devices which therefore require the standard anti-static handling precautions.

Potentiometer VR1 is simply adjusted to give symmetrical clipping. If you do not have the appropriate test equipment, just use any setting that gives a low distortion output signal.

Preset VR2 must be adjusted to minimise the clock breakthrough at the output. If you do not have an oscilloscope to monitor the output of IC4, temporarily connect a capacitor of about 2n2 in parallel with C13. This will bring the clock frequency into the audio range so that it becomes



Layout of components on the completed Delay-Line circuit board.

COMPONENTS

DELAY LINE

Resistors

| | |
|--------------------------|--------------|
| R1, R3 | 100k (2 off) |
| R2, R8, R9, | |
| R18 | 47k (4 off) |
| R4 | 15k |
| R5, R6, R7, | |
| R13, R14, | |
| R15, R16 | 5k6 (7 off) |
| R10, R11 | 33k (2 off) |
| R12 | 68k |
| R17 | 220 |
| R19 | 4k7 |
| All 0.25W 5% carbon film | |

See
SHOP
TALK
Page

Potentiometers

| | |
|----------|---|
| VR1, VR2 | 100k min. carbon preset, horizontal (2 off) |
| VR3 | 47k rotary carbon, lin. |

Capacitors

| | |
|----------|--------------------------------|
| C1 | 470n polyester |
| C2, C6 | 2μ2 radial elect. 63V (2 off) |
| C3 | 3n3 polyester |
| C4, C9 | 4n7 polyester (2 off) |
| C5 | 330p ceramic plate |
| C7 | 1n5 polyester |
| C8 | 1n polyester |
| C10 | 220p ceramic plate |
| C11, C12 | 100μ radial elect. 16V (2 off) |
| C13 | 68p ceramic plate |

Semiconductors

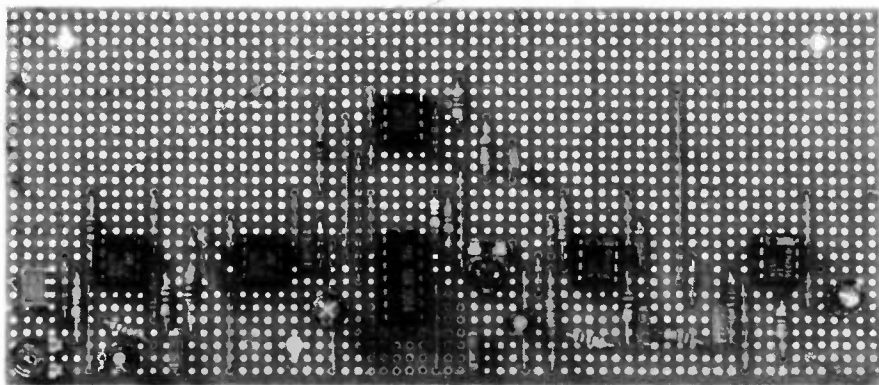
| | |
|-----------|-----------------------------|
| D1 | 1N4148 silicon signal diode |
| IC1, IC2, | |
| IC4, IC5 | LF351N bifet op.amp (4 off) |
| IC3 | MN3004 c.c.d. delay line |
| IC6 | MN3101 clock generator |

Miscellaneous

| | |
|-----|--------------------------|
| JK1 | 3.5mm stereo jack socket |
|-----|--------------------------|

Stripboard 0.1in. matrix, size 68 holes by 29 strips; 8-pin d.i.l. i.c. holder (5 off); 14-pin d.i.l. i.c. holder; control knob; connecting wire; solder; etc.

Approx Cost **£16**



audible. VR2 is then adjusted "by ear" for the lowest clock breakthrough. Like the phase shifter, the delay-line should be fed from the output of the microphone preamplifier.

IN USE

When using either the Phase Shifter or the Delay-Line it is advisable not to use

a headphone to microphone separation which is any greater than is really necessary. Results using the Phase Shifter on pure test tones were quite impressive.

Even using a single phase shifter to drive both earphones it was possible to obtain a degree of attenuation that I would estimate to be at least 30dB. However, the phase and gain controls must be adjusted very care-

fully if a high degree of attenuation is to be achieved.

Because the system is only operating over a narrow frequency range it is not essential to use high quality microphones. When tested on a real world sound the unit was quite effective at combatting the annoying whining sound from a laser printer, but it did little to reduce the quieter "whooshing" sound of the fan which contains a wide range of frequencies.

With the Delay-Line set for the correct delay time I found that quite good attenuation was obtained over the low to middle audio range. It is necessary to experiment a little with the delay time, since the wrong delay will provide good attenuation at certain frequencies where it just happens to provide the correct anti-phase signal.

In common with the system which has a microphone near each ear, this system, even using good quality microphones, failed to give a high degree of attenuation over the full audio range. Adjusting the controls to improve the high frequency

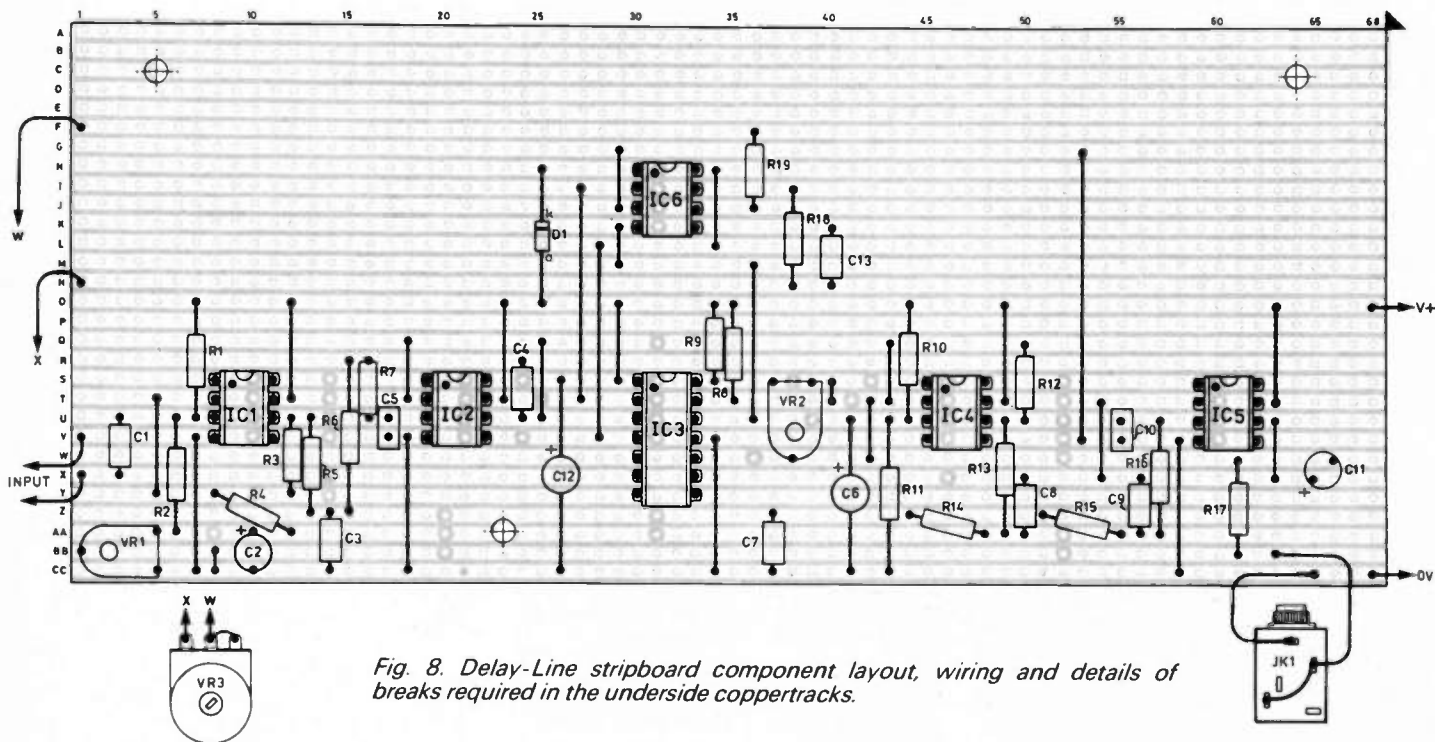
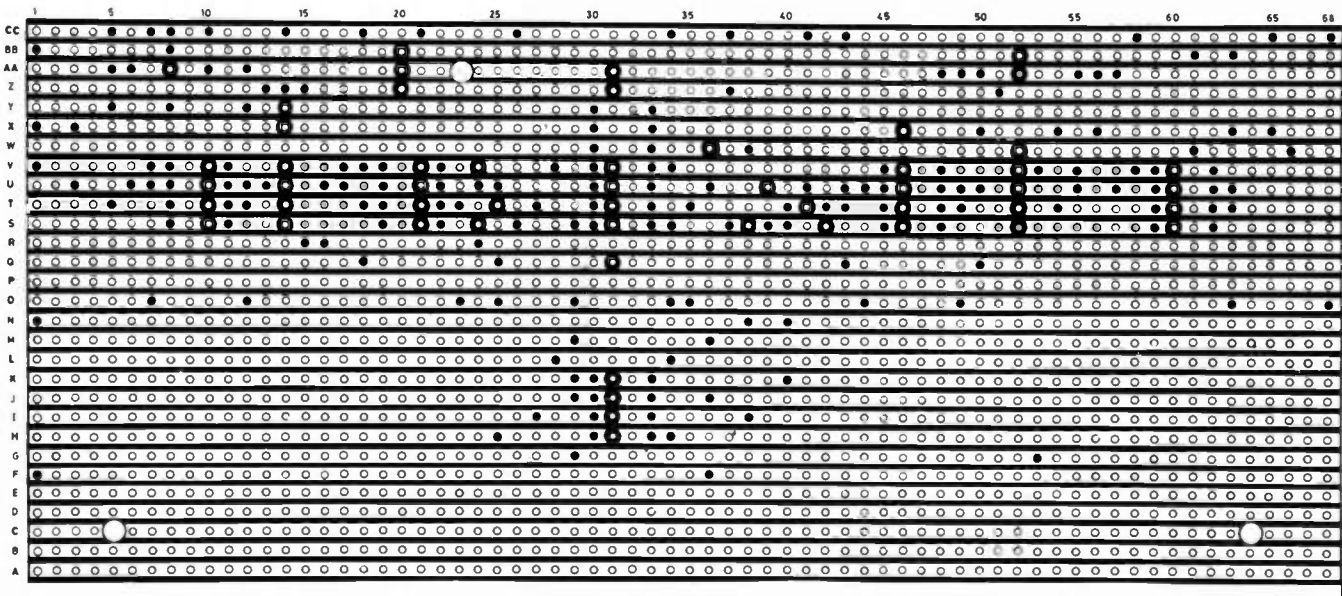


Fig. 8. Delay-Line stripboard component layout, wiring and details of breaks required in the underside coppertracks.

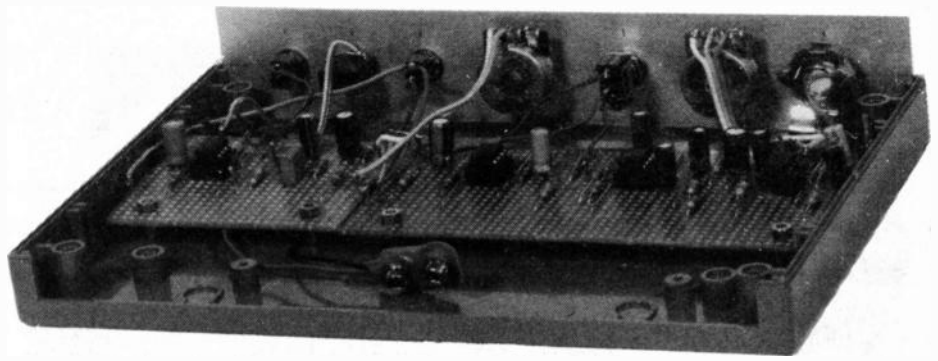


attenuation resulted in a loss of low and middle frequency performance.

FINALLY

If you wish to mix the output from a piece of audio equipment with the noise cancelling signals, the best method is to use a simple mixer circuit at the output of the noise cancelling circuit. Alternatively, the output from the audio device can be fed to pin 2 of IC1 in the Microphone Preamplifier via a one megohm resistor and a 22n capacitor. IC1 will then provide a simple summing mode mixer action. Of course, this will only work properly with a stereo signal if totally separate processing is used for each ear.

Noise cancelling certainly represents an interesting field for the experimenter. Obtaining reasonable performance over a narrow range of frequencies seems to be reasonably easy. Combatting noise that is predominantly at low and middle frequencies is more difficult but possible provided due care is taken to get everything just right.



The completed unit using the Phase Shifter board in combination with the microphone pre-amp. If the larger Delay-Line board is used, in place of the Phase-Shifter, an alternative method of mounting it in the case will need to be found; it could possibly be "stacked" above/below the pre-amp.

Obtaining a high degree of attenuation over the full audio range is a much more difficult prospect, and something I have yet to achieve. In order to accomplish this it is probably necessary to have a circuit that permits the amplitude and phase of high frequency signals to be trimmed, and

accurately matched with the sounds reaching the user's ears.

There may be a reasonably simple but effective way of achieving this, but if there is I have yet to discover it. It is a goal I will continue to pursue though.

SHOP TALK

with David Barrington

6802 Development Board

The most obvious item that stands out from the components list for the 6802 Development Board project, and one that readers will automatically ask "where do I get that?" is the pre-programmed 27C64 EPROM. A ready programmed EPROM, together with all relevant software is being made available by the author Richard Stone for the sum of £15 inclusive. This is by *Mail Order only* and orders should be sent to: **Mr. Richard Stone, Dept EPE, 19 Cheryfields, Poplars Farm, Bradford, BD2 1LB.**

Most of our components advertisers now stock fairly extensive ranges of computer-based i.c.s and should be able to supply the rest of the i.c.s "of-the-shelf". This comment also applies to the plugs and stockets.

The crystals should not prove too difficult to find and suitable types should be stocked by **Cirkit, Electromail, Cricklewood, Maplin** and many others. The small clip-on TO220 heatsink for the voltage regulator was obtained from **Maplin**, code KU50E.

The printed circuit board is available from the *EPE PCB Service*, code 894.

Stereo HiFi Controller

The "snap action" p.c.b. mounting connectors called for in the *Stereo HiFi Controller* should be widely available, but some readers may have problems sourcing them locally. The ones used in the model came from **Maplin**. These come in three parts consisting of the plug assembly, socket housing and terminal strip: 2-way assembly - **RK65V/HB59P/YW25C**; 3-way - **BX9E/BX97F/YW25C**; 4-way - **YW11NY/HB58N/YW25**; 5-way - **FY93B/BH66W/YW25C**; 17-way - **BH61R/RK69A/YW25C**. The 0.1 inch spacing socket strip also came from the same source, order code KP51F.

The semiconductor devices should be generally available. However, it is suggested you stick with the BC109C if you can, the other 109's tend to be of lower gain and will restrict overall performance. The double-digit, common cathode display came from **Maplin**, code BY68Y. Most component advertisers should be able to offer a similar device, but check the pinout arrangement before you purchase.

If you wish to use the same steel instrument case and the Paxolin based phono socket set, these were purchased from the above mentioned company, codes XJ27E (case) and BW74R (phono Skt.). You will need two socket panels and one will have to be trimmed down for the three-way version.

The printed circuit boards for the Controller are available from the *EPE PCB Service*, codes 887 (Main) and 888 (Exp/Display) boards. See page 639.

Dancing Fountains

The opto-isolators, used in the Pump Controller board of the *Dancing Fountains* project, are the only items that may be hard to track down. These appear to be RS devices and were purchased through **Electromail** (☎ **0536 204555**), codes 585-258 (transistor output) and 308-196 (triac output). The 4A 600V triac types BT134 or BT136 should be stock items or suitable alternatives may be offered.

The printed circuit boards for the Preamp, Pump Controller and Filter are obtainable from the *EPE PCB Service*, codes 889 (preamp), 890 (pump) and 891 (filter) - see Page 639. The choice of water pump is obviously left to the individual.

Experimental Noise Cancelling Unit

Most of the items needed to build the *Experimental Noise Cancelling Unit* project should be "over the counter" items and should not be too troublesome locating. But if readers do have problems with the i.c.s, particularly the TLE2037C low noise op.amp, MN3004 delay line and the MN3101 clock generator these were ordered from **Maplin**, codes CP87U, UM64U and UM66W respectively.

Circuit Surgery

The ICL7673 automatic battery change-over i.c. used in the Marine Battery Back-up circuit, described in this month's *Circuit Surgery*, is currently listed by **Electromail** (☎ **0536 204555**) part No. 632-966, **Maplin** Code No. UH36P and **Farnell** (☎ **0532 636311**) Part Ref ICL7673 CPA where the "P" stands for the 8-pin dual-in-line type. Also, shop around for nickel-cadmium cells suitable for your own specific needs.

PLEASE TAKE NOTE

EPE Miconcontroller P.I. Treasure Hunter (June '94)

Since publication of the *EPE Miconcontroller P.I. Treasure Hunter* project, a number of minor modifications and improvements have been made and a small number of errors in the parts list have been discovered. These are all listed below.

The table below clarifies the component references and values - these are the correct ones for the modified p.c.b. supplied not those shown in the magazine parts list.

| Circuit Ref. | Total Quantity | Description |
|--------------|----------------|--|
| C1, C13 | | 10µF 16V min. radial elect. capacitor |
| C14, C17 | 4 | |
| C4, C15 | 2 | 47µ 16V min. radial elect. capacitor |
| R26 | 1 | 220 ohm 0.6 Watt 5% metal film resistor |
| R27 | 1 | 470 ohm 0.6 Watt 5% metal film resistor |
| R28*A | 1 | 56 ohm 0.25 Watt resistor (between TR3 and TR4 on p.c.b.) |
| R28*B | 1 | 100 ohm 0.25 Watt resistor (next to R18 on p.c.b.). (R28 was used twice on p.c.b. component layout print). |

The magazine components list has a quantity of "5 off" listed against C7. There is only one.

Circuit changes: Resistor R28B and capacitor C17 have been added to give additional smoothing to the +16 volt supply.

The printed circuit board shown in the magazine has an error. (VR1 is connected to +9V and not +16V). This was corrected before any boards were made, and so all *PCB Service* boards and *Magenta* kits are correct.

Many circuits have been built and are working well.

250/600W Mains Inverter (Dec '93)

The voltage dependent resistors VDRs should be types: VDR1 = V18ZA1; VDR2, 3 = V275LA15. The mains transformer is RS part no. 210-780 (supersedes 207-835).

Note, VDR3 (next to VDR2) is incorrectly labelled as VDR1 on the p.c.b. layout (Fig. 10). PL1 on the same diagram is not required and should be omitted.

COMBATING ASTHMA AND ALLERGIES

Southampton promotes the electret as a medical aid – by Hazel Cavendish

ELECTROSTATIC technology is the basis of new methods to combat asthma and allergies in Southern England, where the Wessex area records the highest figures in Britain in these twin problems. Appropriately research is centering on Southampton University where over 70 researchers in its Medical School have been working to find out why people in this part of Britain are statistically more likely to develop these allergies than those in other areas.

The department of Electrical Engineering at the University is investigating ways of controlling the mites and parasites that are responsible for these afflictions. Electrets are the name of the game.

The value of their research is immense, with a quarter of the adult population of Great Britain known to suffer from asthma, eczema, rhinitis or the allergy known to be caused by dust mites. In the Wessex area one third of children in the 7/9 age group develop "episodic wheezing" which may be early asthma. Professor Stephen Holgate, who returned from Harvard University in the States to Southampton University, was one of the instigators of the charity known as AIR set up by the Allergy and Inflammation Research Trust to raise £100,000 to carry out research in homes in the area, where he claimed the South's high standard of living contributed largely to its allergy record.

"It is a mixture of the South's warm climate and humidity, together with the fact that so many homes down here are centrally heated with double glazing and wall-to-wall carpets, that provide an ideal breeding-ground for the house mite, one of the principal causes of allergy," he said.

Meanwhile Professor John Hughes was busy working with his team in the Electrical Engineering faculty, utilising electrets as a valuable weapon against the dust mite. Although electrets had been around for 15 to 20 years he realised they had many more applications than had been investigated in the past two decades.

An electret is the electrical analogue of a permanent magnet. Where a magnet is magnetically polarised north and south, an electret is electrically polarised plus and minus, and can be summarised as a piece of plastic with its positive and negative charges permanently

separated. They are manufactured in a number of ways, but the most common method is to bring the plastic up to a temperature where it becomes liquid and then subject it to an electric field, so the positive and negative are correctly set. While still under the electric field the temperature is brought down to room temperature so that it solidifies again, ensuring the separated charge is "frozen in."

In developing the electret it was found necessary to manufacture the plastic material in very fine fibre form – finer than a human hair – to form a filter which looked like felt or a sheet of material. It was this which proved to have the property of being able to trap very small particles efficiently, including minute insects and pests so small as to be invisible to the human eye – as for example, the dust mite. The electret filter first saw the light of day in domestic vacuum cleaners, and its success was the green light for future research.

Possibilities

Professor Hughes is more excited by some of the possibilities now emerging from the latest research into the potential of the electret. "Our interest has been directed towards the control of all particles from car emissions, as well as the air pollution connected with occupations such as painting and photo-copying. We try and ensure that those particles do not become airborne, for if you can do that the problem is solved because you won't inhale them. We need to anchor those particles in some way."

Because carpets are known to be the most popular habitat for dust mites after bedding, electrets have been considered for an interweave to be incorporated in carpet manufacture which would prevent dust being kicked up into the air. "This is where our discovery is im-

portant to child care", says Hughes, "Young children crawl on carpets, and put their faces into the pile." Cleaning with wet shampoos and the possibility of liquid spillage on a carpet does not affect the electret adversely as he describes it as "quite a rugged element."

A more recent development in the carpet field, which has aroused considerable interest in the trade, is an invisible film containing the electret which is both permeable and flexible, and able to be attached to the underside of a carpet like an adhesive coating, or to a mattress.

With the co-operation of entomologist Dr Howe with his expertise in insect-trapping, a new range of Pet Care products is presently envisaged. The Professor believes a disposable collar with electrets would be more environmentally friendly than the insecticide-treated collars which have been around for some time. Some animals are known to have had adverse reactions to the latter, and insecticides are increasingly unpopular in public concern for a healthy environment. The new collar would trap all the parasites in it ensuring the animal is kept completely clear of pests.

Electret Gel

The latest extension of the technology is to produce it in a non-solid property such as a cream or gel. "This opens up a whole new area of application," says Hughes, adding that such gels could be used as an instant treatment for carpets which had not been treated in the manufacturing process, for the grooming of pets, and also as a cosmetic application. The Professor is well aware of public concern at the level of pollution in the atmosphere, and envisages an invisible cream or gel which could be smeared inside the human nose, coating the nasal hairs so that these assumed electret properties themselves – "improving on Nature's filter, in fact."

"This may sound like science fiction, but we already know that there are some naturally occurring products which actually display electret properties, so we believe a significant product might be developed in the next five years."

SINCLAIR ZETA

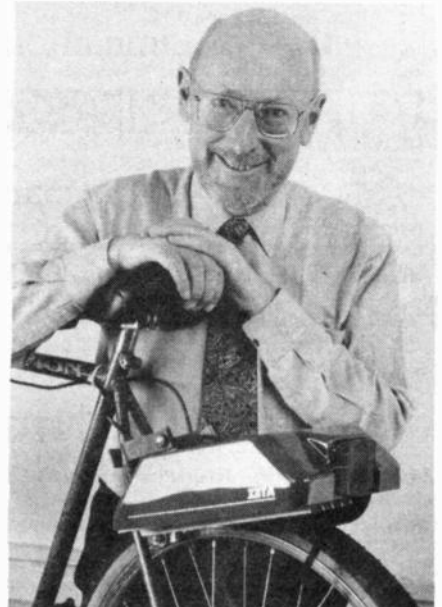
Following "hard on the wheels" of their Zike electric cycle, Sinclair Research launched what is claimed to be the "next major breakthrough in the growing electric bicycle market" in the form of ZETA – the ZeroEmission Transport Accessory. This bolt-on accessory for bicycles provides electric motor drive to the rear wheel at the press of a button. The power-assistance means less effort for cyclists, enabling them to tackle steeper gradients or head winds by switching in the motor boost when required. It can be used on any tyre or wheel size including MTB's. The complete unit weighs just under 5 kilos and sits over the rear wheel, explained Sir Clive.

ZETA transmits power using a novel toothed belt arrangement which provides a friction drive directly onto the tyre tread, and is operated with a handlebar switch. Designed more for supplementing the cyclists' own efforts rather than providing full-time propulsion, ZETA utilises a standard sealed

12V 7Ah lead acid Yuasa battery coupled to a 174W maximum power (0.25 horsepower) compact d.c. motor of Japanese manufacture. Top speed is 15 m.p.h., being the maximum permissible by law for this class of transport. Range is anywhere between 10 and 30 miles depending on usage and the drive can be adjusted for wet weather to provide extra traction. The UK designed ZETA includes a mains recharger which enables a completely discharged battery to be replenished in approximately 14 hours at a cost of under one penny, claims Sinclair. The battery can also be trickle charged on the move, to a limited extent.

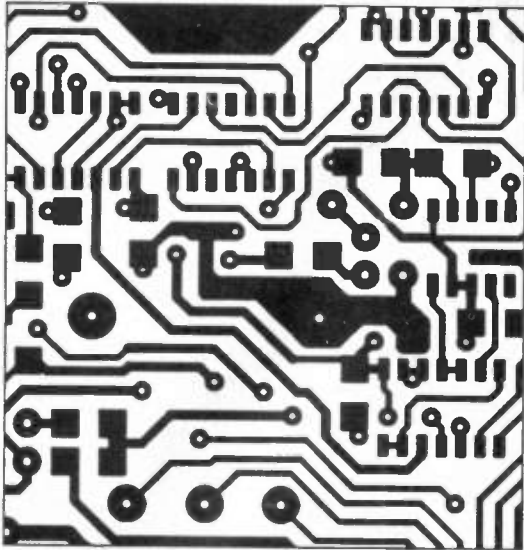
Retail price is £144.95 with spare batteries available for £29.95. ZETA is currently being distributed by mail order; expect it to be in the shops in the autumn.

Contact Sinclair Research Ltd., 15-16 Margaret Street, London, W1N 7LE. – Alan Winstanley.



EASY-PC, Schematic and PCB CAD

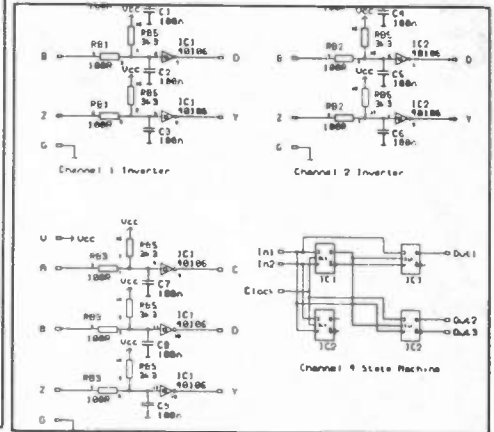
Over 18,000 Installations
in 80 Countries World-wide!



- Runs on:- PC/XT/AT/ 286/ 386/ 486 with Hercules, CGA, EGA or VGA display and many DOS emulations.
- Design:- Single sided, Double sided and Multi-layer (8) boards.
- Provides full Surface Mount support.
- Standard output includes Dot Matrix / Laser / Ink-jet Printer, Pen Plotter, Photo-plotter and N.C. Drill.
- Tech Support - free.
- Superbly easy to use.

**Still
Only
£98.00!**
Plus P&P+VAT

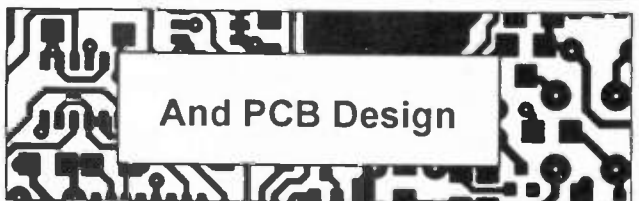
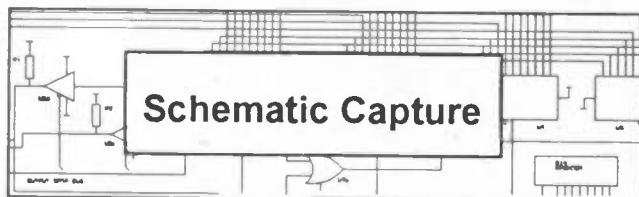
**BRITISH
DESIGN
AWARD
1989**



Options:-500 piece Surface Mount Symbol Library £48,
1000 piece Symbol Library £38, Gerber Import facility £98.

Electronic Designs Right First Time?

Integrated Electronics CAD



Affordable Electronics CAD

| | | |
|---|----------|---|
| EASY-PC: Entry level PCB and Schematic CAD. | \$195.00 | £98.00 |
| EASY-PC Professional: Schematic Capture and PCB CAD. Links directly to ANALYSER III and PULSAR. | \$375.00 | £195.00 |
| EASY-PC Pro' XM: Extended Memory Version - Greatly increased capacity | \$475.00 | £245.00 |
| PULSAR: Digital Circuit Simulator ~ 1500 gate capacity. | \$195.00 | £98.00 |
| PULSAR Professional: Digital Circuit Simulator ~ 50,000 gate capacity. | \$375.00 | £195.00 |
| ANALYSER III: Linear Analogue Circuit Simulator ~ 130 node capability | \$195.00 | £98.00 |
| ANALYSER III Professional: Linear Analogue Circuit Simulator ~ 750 node capability. | \$375.00 | £195.00 |
| Z-MATCH for Windows: NEW Windows based Smith-Chart program for RF Engineers . | \$475.00 | £245.00 |
| FILTECH: Active and Passive Filter Design program | \$275.00 | £145.00 |
| <i>We operate a no penalty upgrade policy. You can upgrade at any time to the professional version of a program just for the difference in price.</i> | | <i>US\$ prices include Post and Packing</i> |
| | | <i>UK£ prices exclude P&P and VAT</i> |

Prices from UK£195 / US\$375

For full information, please write, phone or fax:-

Number One Systems

UK/EEC: Ref. EVD, HARDING WAY, ST.IVES, CAMBS., ENGLAND, PE17 4WR.

Telephone UK: 0480 461778 (7 lines) Fax: 0480 494042 International +44 480 461778

USA: Ref. EVD, 1795 Granger Avenue, Los Altos, CA 94024

Telephone/Fax: (415) 968 9306

- TECHNICAL SUPPORT FREE FOR LIFE
- PROGRAMS NOT COPY PROTECTED.
- SPECIAL PRICES FOR EDUCATION.

MASTERCARD, VISA Welcome.

New Technology Update

Ian Poole investigates the latest research developments in digital picture correction for c.r.t.s and 50V CMOS semiconductors.

CATHODE ray tubes are still the most widely used form of display in the electronics industry today. They find uses in a variety of applications from television sets to computer monitors, and are manufactured in their millions each year.

Despite the fact that many other forms of display have been tipped to overtake the c.r.t., no other type has yet been able to displace them from their number one position. The reason for this is that c.r.t.s offer better performance for cost when compared to any other type. Having been in use for many years now, they have undergone a vast amount of development and improvement, and this has resulted in a high level of performance for a relatively low price.

C.R.T. Drawbacks

Despite this c.r.t.s still have some drawbacks. Some, like their size, weight, and the voltages and power required are almost fundamental limitations about which little can be done. However there are problems which can be addressed. One of these is that the picture quality deteriorates towards the edge of the screen. This arises because the electron beam has to undergo much larger degrees of deflection for these areas.

It is found that the images become distorted as a result of non-linearities which occur as the beam angles change. This results in the convergence for the colours as well as the focus not being as good as it is at the centre of the screen. A number of methods have been devised to help overcome this, and many of these are in current tubes in use today. However a new and rather interesting scheme to solve the problem involves digital techniques and is being developed by Philips Consumer Electronics at Knoxville, Tennessee.

Automatic Compensation

The new system uses some additional circuitry over that normally employed to drive a c.r.t. In conjunction with a magnetic sensor to detect the levels of external fields, the new circuitry automatically compensates for any non-linearities and changes which would cause the image to become distorted. Using this circuitry the system is able to cater for any non-linearities within the tube, as well as any external ones; these often occur when a monitor is moved from one place to another.

The new circuitry is designed to be included in the monitor itself. The system has been designed so that any adjustments

which need to be made can be effected quickly and accurately. Then they are stored within the monitor in a digital format. These adjustments are implemented at the final stage in the production of the monitor. In this way it is possible to remove the effects of any tolerances in the electronic components as well as those introduced by the distortion of fields from any mechanical components.

The system has been shown to be very successful. The brightness level can be maintained to within 90 per cent over the whole area of the screen against 75 per cent for a traditional monitor. In addition to this the colour information can be controlled more accurately.

Apart from maintaining the uniformity of brightness and colour, the circuitry also enables other functions to be controlled more easily. One specific example is that it enables the colour temperature to be set to a user defined level. Normally this is preset in monitors, but in some specialised applications it is very useful to be able to control it.

Although today's monitors perform very well by comparison with those produced even a few years ago, new software which is reaching the market is pushing the requirements for monitors to the limits. These new developments should enable monitor technology to keep a few steps ahead of the software.

50V CMOS Structure

In most areas of electronics it seems as if there is a growing trend for lower voltage i.c.s (3.3V looks set to become the new standard quite soon) to fill the expanding requirement for battery operated equipment. However there are many other areas where high voltage chips are needed. In fact there is increased use of electronics in a wide variety of machines which previously used purely electrical or electro-mechanical devices. This has brought about a need for high voltage chips which can be used as controllers.

With this demand comes a great challenge for i.c. designers because conventional i.c. technology running from standard five or 3.3 volt rails needs to be contained on the same chip as much higher voltage and current control devices.

To meet this demand a company called Austria Mikro Systeme has produced a new CMOS structure which is capable of running at 50V and switching relatively large currents. Being CMOS it allows standard microprocessor logic to be contained on the same chip. This enables less chips to be used in any given circuit, thereby reducing the cost and size whilst

increasing the reliability. This last factor is particularly important because many of these circuits have to operate in environments which are not ideal for electronic circuits.

New Structure

The new structure uses a new "2 μ m CBK" process. This has a *p*-type substrate and uses two levels of metallisation together with one of polysilicon (a layer of silicon deposited onto the substrate during manufacture). This gives the basic CMOS structure. *N* channel FETs are also used as well as a number of bipolar transistors, some of which are totally isolated from the rest of the chip by using an insulating oxide layer.

The new chip will handle much higher voltages than standard CMOS because of small but crucial changes to the structure. Normally the gate is placed on an insulating oxide layer between the drain and source. When a high voltage is placed across the channel, breakdown can occur across the channel electrodes via the gate, destroying the device.

In the new structure (Fig. 1) a thick oxide layer is used to enlarge the gap between channel electrodes and the gate. Furthermore the drain is placed into a well of *n*-type material which extends into the substrate.

This has two effects. Firstly it increases the distance between the gate and the drain, and secondly it enables the depth of the channel to be increased, allowing the "on" resistance to be reduced. This is very important when considering the higher currents which are also used in control applications.

The new process is particularly good because it makes only small modifications to an existing and well established one. As a result it will be relatively cheap and easy to introduce into full scale production.

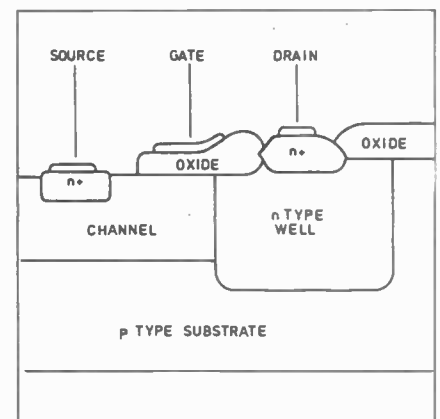


Fig. 1. The new 50V CMOS semiconductor structure.

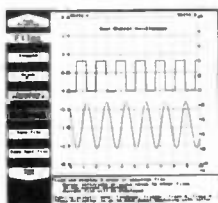
Low cost data acquisition for IBM PCs & compatibles

A unique range of easy to use data acquisition products designed for use with IBM compatible computers. Combined with the software they allow your PC to be used as a host of useful test and measurement instruments, or as an advanced data logger.

Installed in seconds they simply plug into the parallel port (except the ADC-16 which connects to the serial port). They are self-contained, require no power supply and take up no expansion slots.

Each device comes with a comprehensive manual. Software drivers are included for users who wish to write their own software. Software supplied on 3.5" disk.

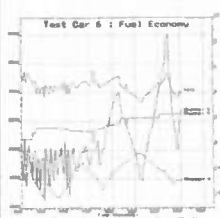
PicoScope



Storage oscilloscope with trigger, timebase, rulers and offset functions. Real time spectrum analysis with min/max frequency and signal averaging. Multiple meters on screen (digital and bargraph). Printer and file handling support.

'Virtual instrument' software package.

PicoLog



Collect, store, display and print data from 1 sample per ms to 1 per day. Record average, min/max values or scaled values (linear, equation, table look-up). Report types: monitor (with min/max alarms), y-t graphs, x-y graphs, tabulation.

Advanced data logging software package

NEW ADC100 Virtual Instrument Dual Channel 12-bit resolution

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



NEW
from
PICO

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

ADC100 with PicoScope £199
PicoScope & PicoLog £209

ADC 10 1 Channel 8-bit

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

The ADC 10 gives your computer a single channel of analogue input. Simply plug into the parallel port and you're ready to go.

ADC 10 with
PicoScope £49
PicoScope and
PicoLog £59

ADC 11 11 Channel 10-bit

- Digital output
- Up to 18kHz sampling
- 0-2.5V input range

The ADC 11 provides 11 channels of analogue input in a case slightly larger than a matchbox. It is ideal for portable data logging using a 'notebook' computer.

ADC 11 with
PicoScope £85
PicoScope and
PicoLog £95

ADC 12 1 Channel 12-bit

- High resolution
- Up to 18kHz sampling
- 0-5V input range

The ADC 12 is similar to the ADC 10 but offers an improved 12-bit (1 part in 4096) resolution compared to the ADC 10's 8-bit (1 part in 256).

ADC 12 with
PicoScope £85
PicoScope and
PicoLog £95

ADC 16

8 Channel 16-bit + sign

- Highest resolution
- 2Hz sampling - 16-bit
- $\pm 2.5\text{V}$ input range

The ADC 16 has the highest resolution of the range, it is capable of detecting signal changes as small as $40\mu\text{V}$. Pairs of input channels can be used differentially to reject noise. Connects to the serial port.

ADC 16 with
PicoLog £115

PicoLog for ADC 10/11/12 £25. Oscilloscope Probes (x1, x10) £10. Carriage UK free. Overseas £6



Pico Technology Ltd. Broadway House, 149-151 St Neots Road, Hardwick, Cambridge CB3 7QJ, UK

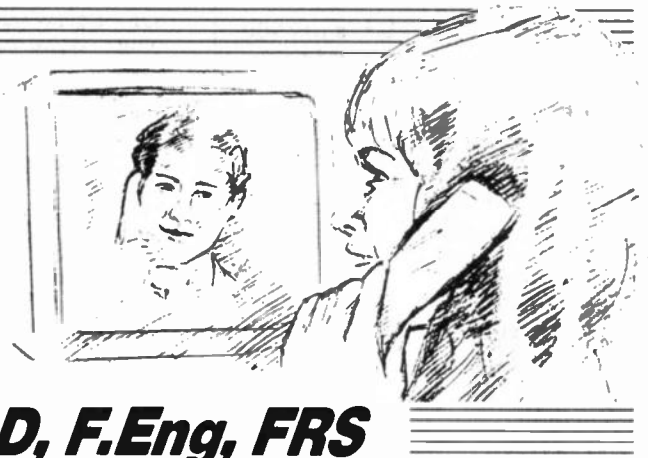
TEL: 0954-211716 FAX: 0954-211880



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

PICO TECHNOLOGY

I'LL BE SEEING YOU



ALAN W. RUDGE OBE, PhD, F.Eng, FRS

The face of telecoms services for the future is taking shape now. What can we tell about the future world of infinite bandwidth?

THE world's telecoms network is the largest human construction of all time. It is also the most complex, handling in excess of 1000 billion calls every year plus an immense amount of data. It allows communications to be sent and received almost anywhere, virtually without censorship or control. Its very existence is an important element of our personal freedom.

Although the concept of telephonic communication existed at least 300 years ago, the practical realisation is not yet 120 years old. The progressive penetration of telephony into everyday life has continued steadily ever since.

While telephony flourished in the USA, development was much slower in Europe, where telecoms were provided by government agencies, which failed to appreciate the scale of the opportunity and its potential impact on commerce and society. This lack of vision contributed to a critical early lead by the USA, which continues to retain an edge.

SATELLITE COMMUNICATIONS

In the 1960s, a major step forward occurred with the onset of satellite communications. The *Intelsat* programme, which commenced in 1965 provided at first for 240 telephone circuits or one TV channel per satellite. Succeeding generations have grown in size, complexity and capability; the latest *Intelsat VI* satellite offers simultaneous capacity for 24,000 telephone circuits and three TV channels.

Cable technology was far from dormant during this period. In 1965, Kao and Hockam at STC Laboratories in the UK published their paper on optical fibre and laid the theoretical basis for a revolution in cable technology. Photons of light rather than electrons were to be the transmission medium, and if technological challenges could be overcome, each hair-like fibre strand could convey virtually limitless bandwidths.

The GPO, later BT, in conjunction with UK industry and academia, played a major role in establishing the UK as a world leader in this new technology. The BT network now contains more than two

million kilometres of optical fibre. BT also played a major role in the development of the first fibre-optic cables, linking the UK and Europe in 1985 and the UK and USA in 1988.

With optical fibre providing significantly higher transmission quality than satellite, optical technology is progressively replacing satellite communications on high-capacity international routes (Fig.1). The combined effect of these technological advances has been a logarithmic improvement in capacity and corresponding decrease in cost. For instance, a three-minute direct-dialled call from Britain to the USA costs less than £1.50 today. A call of similar duration, but inferior quality, in 1946 would have required the assistance of an operator, a three-hour wait, and cost the equivalent of £440 in today's money.

TECHNOLOGY ADVANCES

In parallel with advances in transmission technology, equally momentous advances were occurring in electronics, computing and radio technology. The advent of integrated-circuit electronics, software engineering and new digital technologies has initiated a transformation of telecoms services. Since privatisation in 1985, BT has invested over £19

billion to modernise its networks with digital switches, computerised network management, new billing and customer service systems and optical-fibre transmission. Over this period, a new competitive regime has been established in the UK: Mercury has built a second national long-distance network, while Cellnet and Vodafone have established major cellular-radio telephony networks.

The first "intelligent" network services have also appeared, using the software controlled potential of exchange switches and network-based computers to provide advanced services such as 0800, 0345, voice-bank, voice-messaging and "star services" including call forwarding, call waiting and three-way calling. Intelligent-network technology will make available a plethora of new services, capable of being tailored to suit individual needs.

DATA TRANSMISSION

It is not only in telephony that these technological advances have been felt. The rapid growth of computing has led to a growing need for data transmission. Driven by the exponential growth of computing, the growth rate of data transmission over the past decade has exceeded that of telephony by a substantial margin.

Today there are more than 800 million telephones in use in some 230 countries around the world, most of which can be dialled direct for voice or fax transmission. Data networks wrap around the globe, and electronic mail and electronic data interchange are becoming common-place.

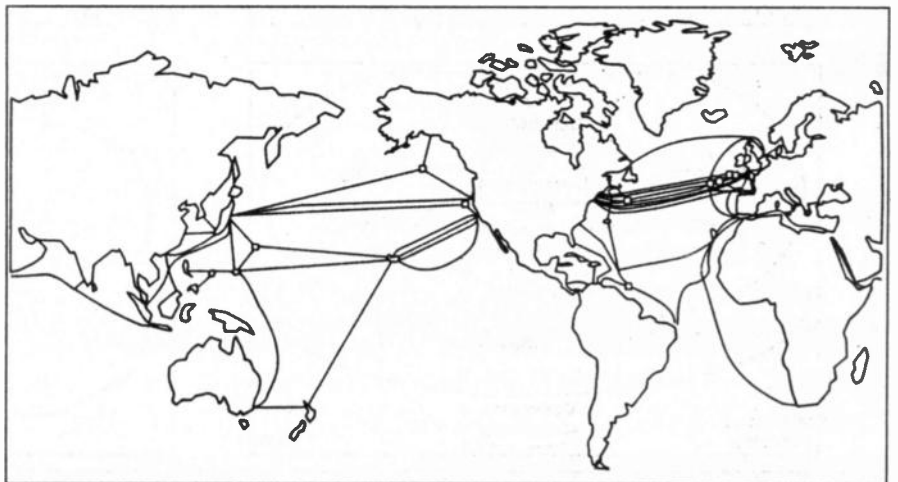


Fig. 1. Undersea fibre-optic lines now span most of the busiest international circuits.

| Country | Lines per 100 population |
|----------------|--------------------------|
| Sweden | 68.8 |
| Canada | 58.6 |
| Denmark | 57.7 |
| United States | 51.6 |
| France | 51.0 |
| Australia | 46.4 |
| Hong Kong | 45.2 |
| Japan | 45.1 |
| United Kingdom | 44.6 |
| Germany | 40.4 |
| Latvia | 24.1 |
| Slovenia | 23.5 |
| Lithuania | 21.8 |
| Armenia | 17.7 |
| Ukraine | 15.6 |
| Russia | 15.0 |
| Rumania | 10.5 |
| Georgia | 10.3 |
| South Africa | 9.5 |
| China | 0.7 |

Fig. 2. Telephony penetration in world markets.

The impact on the world of this capability to communicate at the personal level cannot be over-estimated. There is little doubt that telecoms is a fundamental requirement for sustaining and developing modern civilisation. Every nation's defence, trade, commerce, industry and social practices are all inextricably dependent on the reach and quality of their communications.

The recent collapse of the totalitarian regimes in the USSR and Eastern Europe cannot be attributed to a single cause,

but the growing ability of their people to communicate was certainly a factor. It is interesting to note that at the time of their collapse, most of the Eastern Bloc states had achieved a telephone penetration of between 10 and 20 lines per 100 population, whereas China, which has resisted such change, has a penetration rate of less than 1 per 100 (Fig. 2).

RATE OF CHANGE

It would be easy to dismiss the progress of telecoms as merely following a natural course of evolution. However, this would show a lack of vision even greater than that which held back many European nations in the early days of telephony. Let us consider some of the key points.

The rate of technological change is accelerating rather than declining. Computer memory and signal-processing power are doubling every two years, while costs are halving in the same timescale. Digital signal-processing techniques and video compression are transforming the prospects for widespread use of image and video over cable or radio systems.

Transmission and switching capabilities are being transformed. New digital transmission techniques, such as synchronous digital hierarchy and asynchronous transfer mode, will offer higher transmission rates, lower unit costs and improved network quality. Optical networks offer the potential for gigabit switched bandwidths, while optical amplifiers, now becoming available, will provide another enormous step forward in transmission and processing, lowering the cost of both terrestrial and submarine transmission.

The appearance of intelligent-network architectures will in essence, convert the networks into giant distributed computing

platforms to run a wide range of software-controllable applications. The high degree of software control will allow both the rapid deployment of new services and an increasing degree of control to be placed with the end user.

Driven by the highly competitive consumer-electronics market, dramatically lower costs for complex equipment are already becoming apparent, a trend that will certainly continue under the twin pressures of technological progress and competition. Systems and software engineering are emerging as critical skills in managing complex equipment and networks, and in implementing the services of the future, although much remains to be done to establish software engineering on a finer scientific base.

In summary, as far as technology is concerned, the issue is not "can it be done?" but rather, "what needs to be done?". It is noteworthy that these key technologies underpin not only the telecoms industry, but also computing, broadcasting, consumer electronics, and a diverse range of activities broadly defined as the information-technology sector.

CONVERGENCE

Major companies, which formerly operated in relatively independent sectors, increasingly find themselves in direct competition with organisations from adjacent sectors (Fig.3). The net effect of this dual convergence - of technology on the one hand and markets on the other - will be both a dramatic increase in competition on a global scale and a further acceleration in the rate of technological change.

In the past, the separate identity and licensing of telephony and data and broadcast services reflected basic dif-

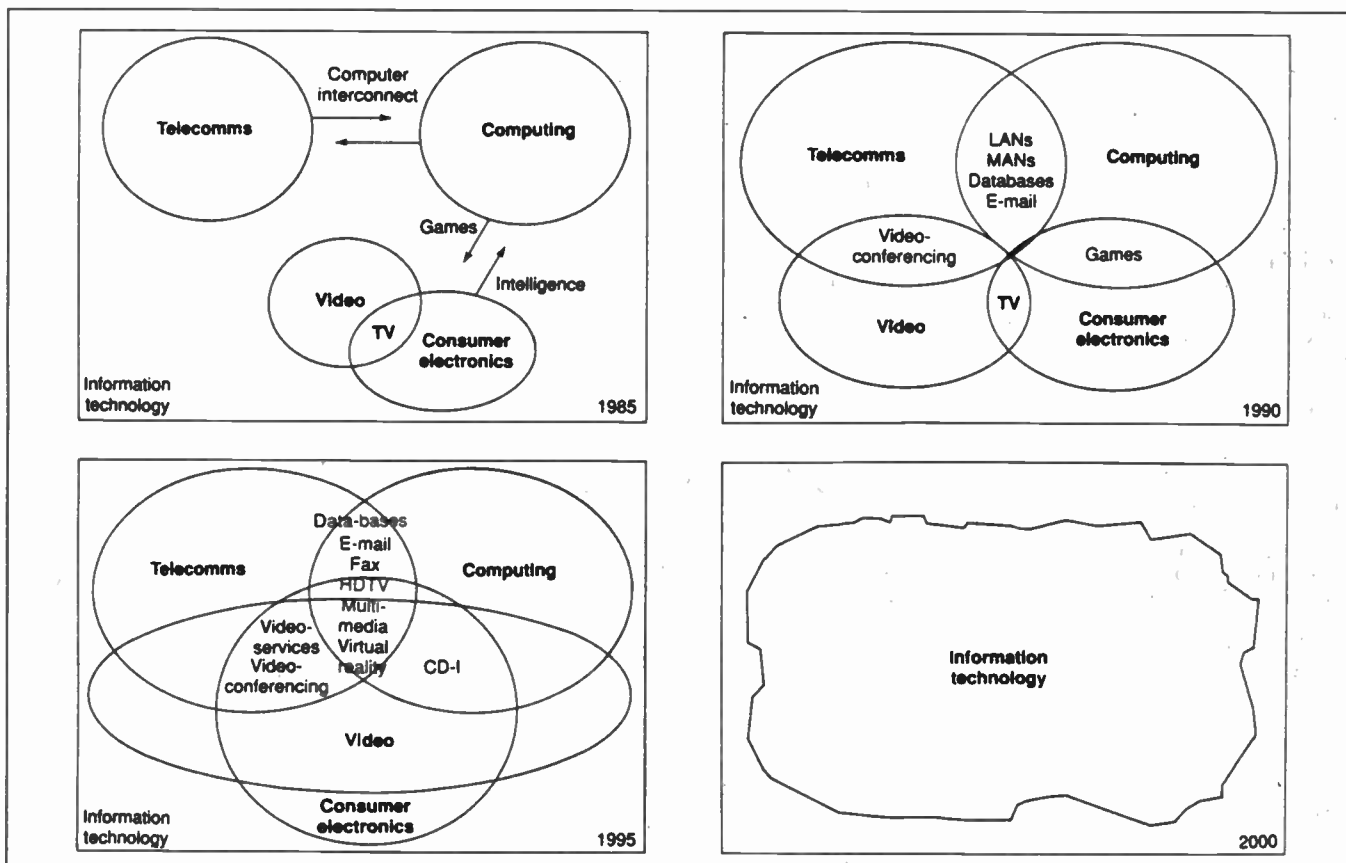
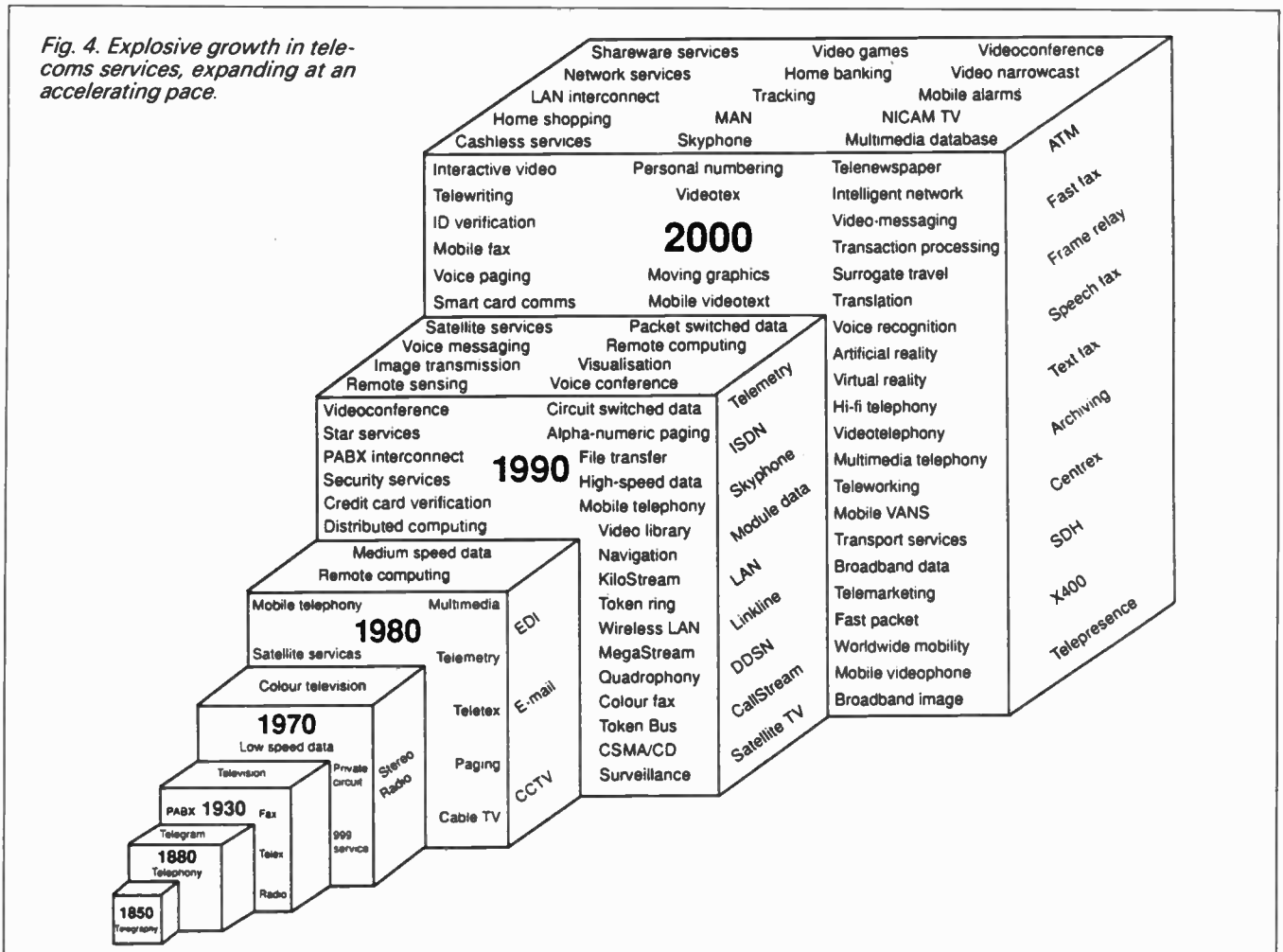


Fig. 3. Previously quite distinct markets are moving together; companies now find themselves competing with others from sectors that were once completely separate.

Fig. 4. Explosive growth in telecoms services, expanding at an accelerating pace.



ferences in the transmission. With the advent of digital technology, distinctions between the processing and convenience of these services have become arbitrary. More importantly, advances in digital technology have given a glimpse of the enormous potential of integrating and processing information flows to provide a very broad range of multimedia applications.

Multimedia applications in which the terminal equipment takes the form of either a personal computer or a workstation can represent a very powerful business tool, particularly for interpretative work, where large amounts of data are required to solve complex multi-parameter problems. With combined telecoms and computing capabilities, such an application could provide for the simultaneous sharing of information with other users, as well as integrated voice and video communications or electronic-mail facilities.

MULTIMEDIA APPLICATIONS

The current capabilities of multimedia applications are limited mainly by the bandwidth constraints imposed by the network. The advent of switched broadband networks will lead to a dramatic increase in the quantities of data transmitted and displayed, and hence in the quality and scale of the video component. For example, during the past year, BT has carried out a very successful experiment with home-based directory enquiry operators in Inverness. The relief in travel congestion that could arise from widespread adoption of these

teleworking practices would be a major national benefit.

Some potential multimedia applications are shown in Fig. 4, which illustrates the exponential growth in telecoms services. These include home shopping and home banking, estate agency, travel agency, market research, education and training, healthcare, security and consultancy.

On the entertainment front, the potential is equally promising. Many of these applications require large computing resources, which could be located with a service provider and connected via

a broadband network. Examples are interactive games, video on demand, telepresence, video books and library facilities, video meetings and holograph.

The potential for applications of wide-bandwidth multimedia technology is almost unbounded and is constrained only by the limits of imagination. Some of the applications may seem frivolous, but the impact on many aspects of business and social life will be enormous.

With the use of digital compression, the current narrowband networks can support early multimedia applications over the existing copper network. However, a

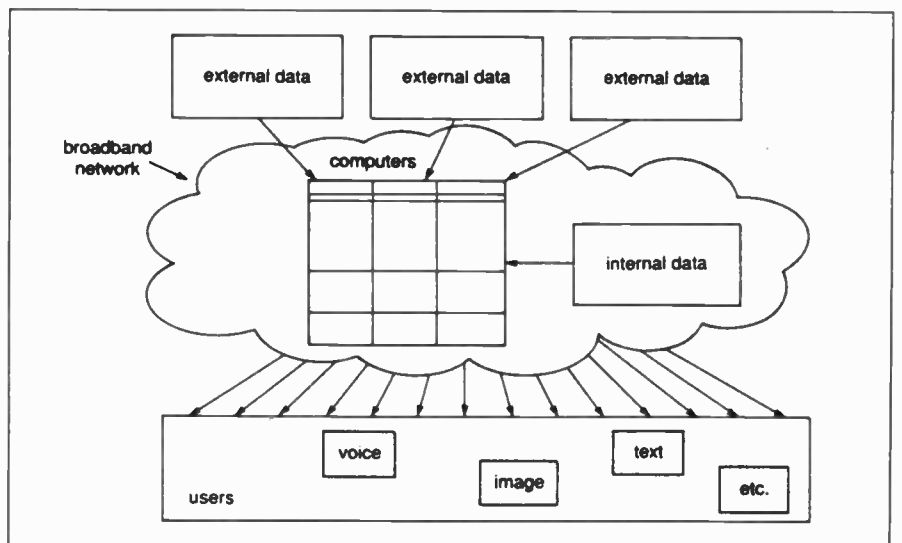
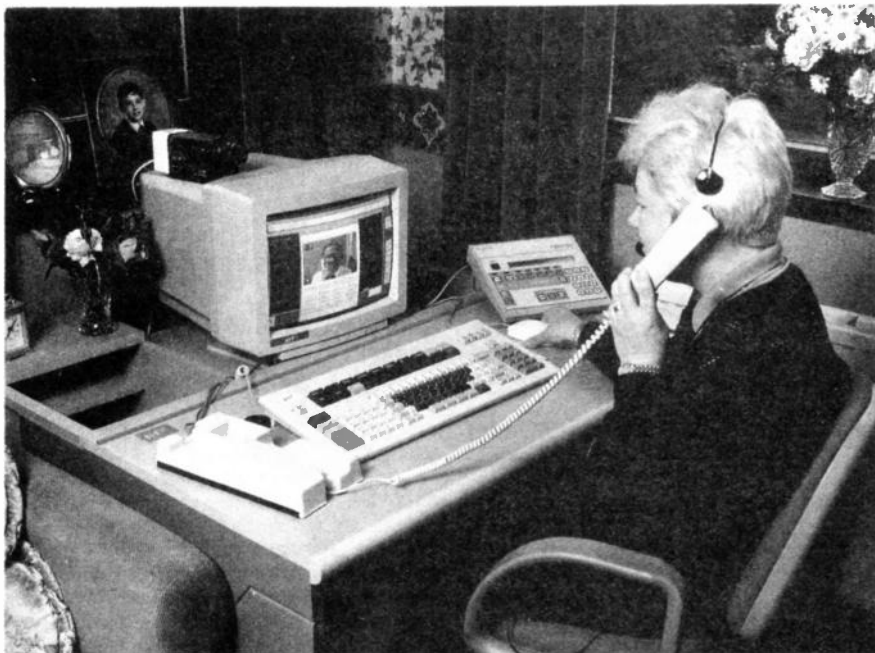


Fig. 5. The integrated broadband network will give users access to data in many forms, from many sources.



A BT directory enquiry operator working at home as part of the Inverness telework-
ing experiment (BT Pictures).

ubiquitous, intelligent, switched broad-
band network will be an essential re-
quirement for any nation with ambitions
to establish a strong position in the
"information age". In economic terms,
this will be the 21st-century equivalent of
today's motorway network (Fig.5).

The intelligent broadband network will
allow service providers to offer myriad
new services and applications. It will not

only simulate the telecoms industry, but
also encourage the growth of a whole
new sector of the IT industry engaged in
the provision and development of such
services.

Early implementation of a national
broadband network will provide a sig-
nificant strategic advantage. However, in
the UK regulatory constraints on the
major network operators are discourag-

ing this development. This warrants
urgent review by the Department of Trade
& Industry.

REVOLUTION

Although the development of tele-
coms has not been slow, the rapid
advance of key technologies, along with
increasing competition, will produce
conditions in future years closer to
revolution than evolution. Market op-
portunities will be huge and the im-
pact all-pervasive. Besides the obvious
benefits for the IT industry, an intelligent
broadband network could bring major
benefits to all aspects of the UK
economy.

There is no shortage of critics to argue
that there is little market demand and no
commercial justification for multimedia
services. But history is littered with the
opinions of experts who underestimated
either the latent demand for information
or the ability of technology to deliver it
economically.

It is not clear quite when the UK will
have an intelligent broadband network,
or how many of the new services touched
on above will be available. However, I
can predict that many of the video and
multimedia services in their infancy today
will be the norm within the next decade,
along with many others not mentioned or
yet conceived. Providing that my health
holds out, I feel sure that "I'll be seeing
you" courtesy of multimedia technology
and the UK broadband network. □

*Dr. Rudge is the 111th President of the
IEE. This article is based on his Inaugural
Address.*

LÔÖKING FOR...

**ICs ★
TRANSISTORS ★ SEMIS?**
especially those hard to find?
Why not give us a buzz?

WE STOCK A MASSIVE RANGE

We specialise in devices with the following prefix
(to name but a few):

2N 2SA 2SB 2SC 2SD 2SJ 2SK AN BA BC BD BDT BF
BFR BFY BFX BU BUK BUT BUY BUW BUZ CA DTA
HA IRF LA LB LC LF LM M MC MJ MJE MM MPS
MPSA MPSU NE RC SAA SAB SDA SI SL SN STA
STK STR TA TBA TC TDA TIP TEA TL UAA ULN UPC
XR ZN ZTX... plus daily arrival of new numbers.

ALSO

RESISTORS ★ CAPACITORS ★ CHOKES ★ CABLES
LEADS ★ CONNECTORS ★ VIDEO HEADS ★ DRIVE BELTS
SWITCHES ★ TTL ★ CMOS ★ OP AMPS ★ VOLTAGE REGS
SPECIAL FUNCTION ★ TRANSFORMERS ETC ETC ETC

WE SPECIALISE IN PHONE & FAX MAIL ORDERS
BY CREDIT CARD



Callers & Mail orders welcome



CRICKLEWOOD ELECTRONICS

40 CRICKLEWOOD BROADWAY, LONDON NW2 3ET
TEL: 081 452 0161 & 081 450 0995 FAX: 081 208 1441

!!! CATALOGUE DUE OUT AUTUMN 1994 !!!

SYSTEM 200 DEVICE PROGRAMMER

SYSTEM: Programs 24, 28, 32 pin EPROMS,
EE-PROMS, FLASH and Emulators as
standard, quickly, reliably and at low cost.

Expandable to cover virtually any
programmable part including serial E²,
PALS, GALS, EPLD's and microcontrollers
from all manufacturers.

DESIGN: Not a plug in card but connects to the PC
serial or parallel port; it comes complete
with powerful yet easy to control software,
cable and manual.

SUPPORT: UK design, manufacture and support.
Same day dispatch, 12 month warranty,
10 day money back guarantee.



ASK FOR FREE
INFORMATION
PACK

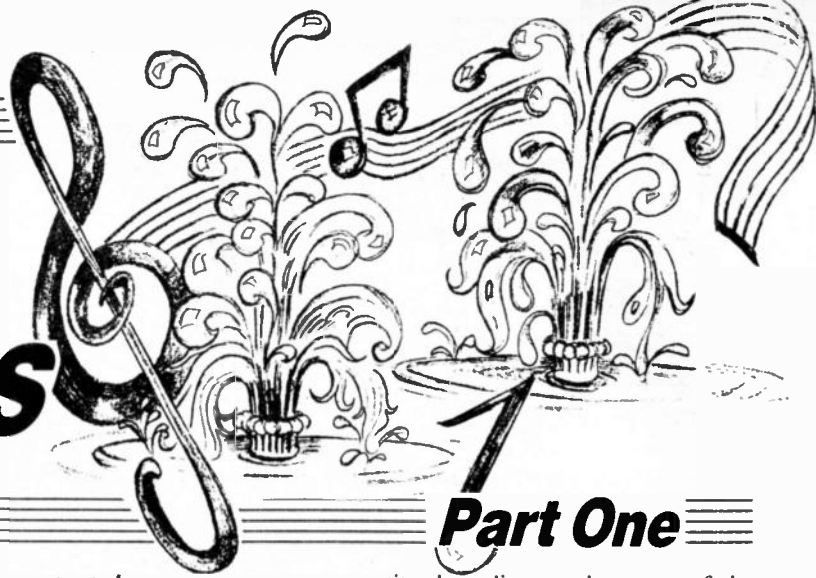


MQP ELECTRONICS Ltd.
Unit 2, Park Road Centre,
Malmesbury, Wiltshire, SN16 0BX UK
TEL. 0666 825146 FAX. 0666 825141

GERMANY 089/4602071
NORWAY 0702-17890
ITALY 02 92 10 3554
FRANCE (1)69.41.28.01
IRELAND 1-2800395
SWEDEN 08-590-32185
Also from ELECTROSPEED UK

Constructional Project

DANCING FOUNTAINS



JOHN BECKER

Part One

Join the musical jet set at the pool and let the fountains dance the day away.

Plus optional PC-Compatible Interface (next month) to let your computer call the tune.

WHILST in Jersey a couple of years ago, my wife and I became fascinated by the dancing musical fountains display at Fort Regent. By the time we had returned home, the fascination had become an obsession. I had to design a miniature version for the garden pond.

The Jersey display consisted of numerous fountain jets of varying sizes configured in regimented groups whose columns and sprays of water had been choreographed to the beat and mood of the music. The effect was enthralling.

Inquisitive examination of the outer workings revealed a vast complexity of plumbing pipes but did not show how the water was controlled. It seemed likely that it had been pre-programmed to the music, using a computer to open and close powerful pumps or solenoid valves. Though, of course, it might have been Bergerac or Charlie Hungerford pulling levers behind the scenes.

During that winter, I experimented with various design ideas for a fountain display which would respond to any music

from any source, indoors or out, live or recorded. Once the winter ice had melted, electronically controlled pumps and fountains were installed amongst the back-garden fish, frogs and water plants.

They now enjoy the freshness of rhythmically cascading waters while we watch and listen as the display dances to our favourite music tracks.

MODULAR CONSTRUCTION

The system described here is in modular form and there are several ways in which the modules can be combined. There are three modules: audio preamplifier and compressor, audio filter, and garden-pump controller.

Three combinational methods of controlling garden pond fountains from the modules are shown in Fig. 1. The simplest combination requires one Preamp and one Pump Controller in the same box, controlling a single garden pump.

With this combination several fountain jets can be attached to the pump, the

quantity depending on the power of the pump, all responding to the music in unison. This setup requires the music source, such as a cassette player, to be placed alongside the control box.

The second combination is similar to the first, except that the Preamp and the Controller are in separate boxes. This allows the Preamp to be treated as a "roving" unit which can be placed near an indoor audio source at the end of a lengthy cable connected to the pump controller.

The third combination allows several pumps to be controlled independently by different aspects of the same music signal. For this option one Preamp and one Filter are needed, and then one Slave Pump Controller for each pump used. The Preamp can be in the controller box, or connected as a roving unit, as above.

The systems can be used for applications other than garden fountain control, for example, control of lighting effects or the speeds of various types of a.c. motor.

PUMPS AND POWER SUPPLIES

The electronic circuits have been designed to run from a 12V d.c. supply regulated down to 9V. This may be provided from either a 12V car battery, or from an integral mains power supply, depending on the system option chosen.

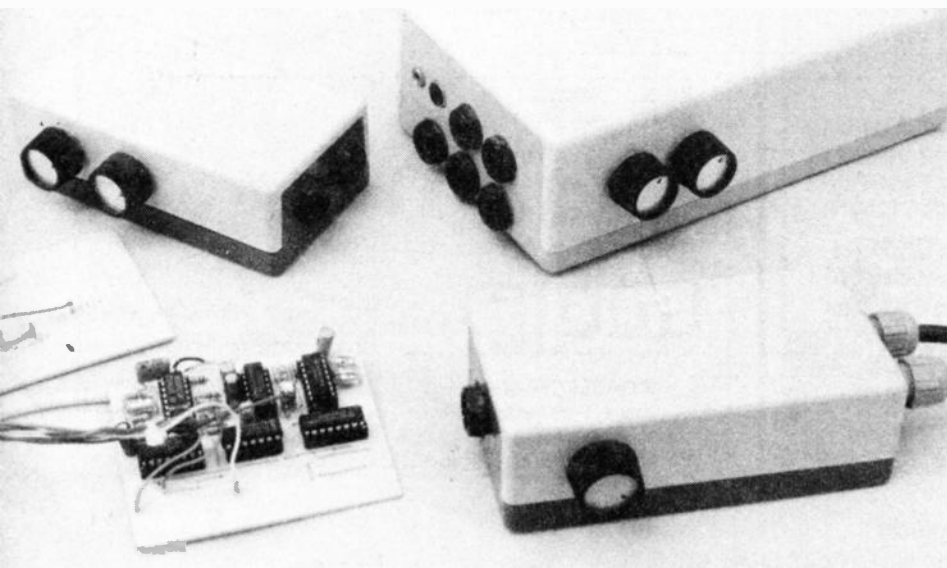
The Pump Controllers are for use with mains powered garden pond pumps. They have been used with the small Lotus Mermaid 120 pump, a medium sized Beresford Otter and the much more powerful Lotus Mermaid 1200.

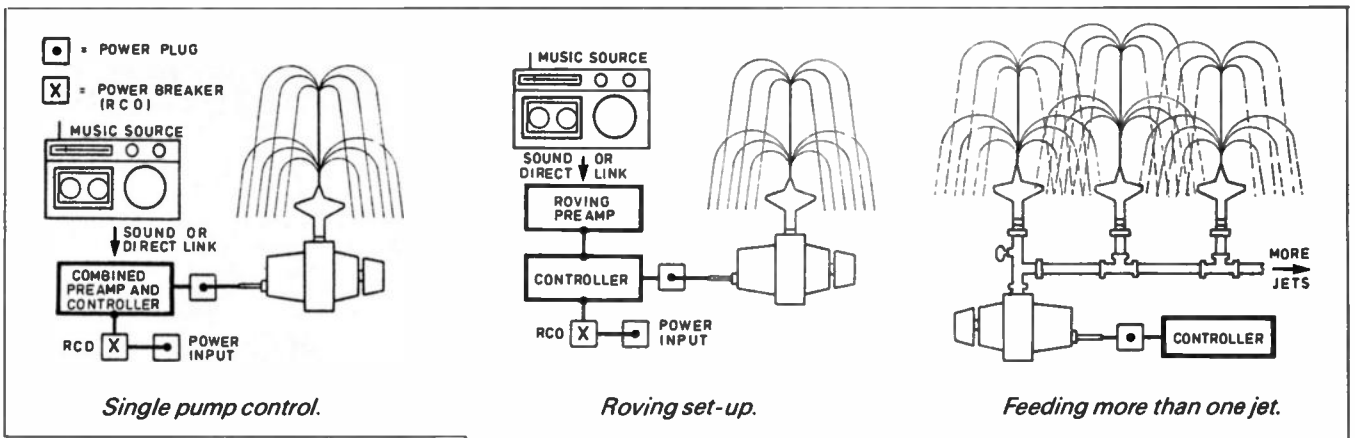
AUDIO INPUT CIRCUIT

The circuit diagram for the audio Preamp module is shown in Fig. 2. Music or other audio signals can be input to the circuit via its integral microphone, MIC1, or via a cable connected to the line output of a hifi, CD player, cassette, or similar source. A computer controlled audio signal generator Interface board will be described next month.

A sub-miniature microphone insert MIC1, having an impedance of about one kilohm, is used with my own fountain systems. Its output is amplified by the fixed gain stage consisting of IC1a and IC1b, both of which represent one half of a dual operational transconductance amplifier (TCA).

The gain is set by current flowing into the control node via resistor R1, which in turn sets the current through R2. IC1b buffers the output of IC1a.



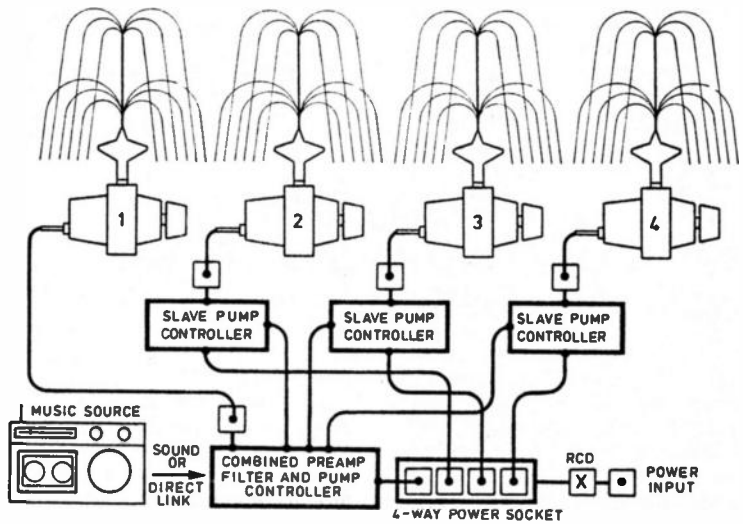


The impedances at the TCA's input pins 3 and 4 have to be balanced in order to maintain a midway d.c. level at pin 5. Preset potentiometer VR1 provides this control. If a microphone having an impedance greater than the 10k range provided by VR1 is used, the value of the preset will need increasing accordingly.

Socket SK1 is a switched input type through which either the amplified microphone signal, or an external signal source, is routed to the compressor stage via amplitude control VR2. The signal is further amplified by TCA IC1c, buffered by IC1d, and fed to the buffered output stage IC2c.

From IC1d, the signal is also fed to the compressor control circuit consisting of the network around IC2a and IC2b. Resistor R12 and diode D1 control the rate at which capacitor C3 charges up (attack rate) to match positive-going signal peaks. Resistor R13 and D2 control C3's discharge rate (decay rate) when the signal amplitude falls.

Using IC2a as a buffer, changes in the amplitude envelope level are amplified by IC2b and adjust the current flowing into



PUMP ALLOCATIONS :- 1. FULL AUDIO SIGNAL 2. LOWER RANGE FREQUENCIES
3. MIDDLE RANGE FREQUENCIES 4. UPPER RANGE FREQUENCIES

Frequency selective set-up.

Fig. 1. Some of the fountain control options.

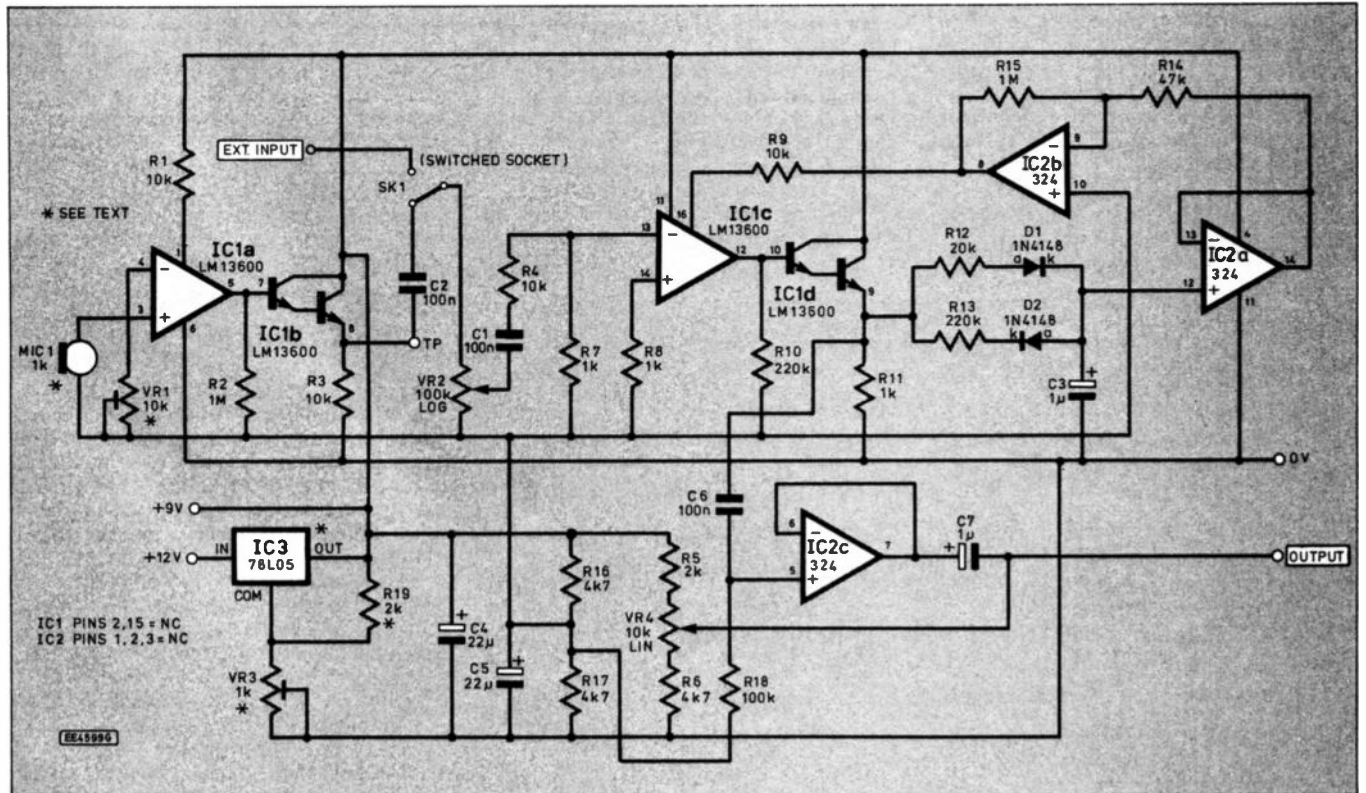


Fig. 2. Circuit diagram for the fountain Pre-amplifier module.

the control node of IC1c, so determining its gain value. The net result is that high amplitude signals are compressed, while low level signals are increased, so standardising the average output level.

From IC2c and via capacitor C7, the processed signal can be routed to the Pump controller circuit in Fig. 3, or to the Filter stage in Fig. 4. A d.c. bias level, which sets the range of the Pump Controller, is applied to the output side of C7 via the network consisting of VR4, R5 and R6. Resistors R16 and R17 set the midway d.c. reference level for the Preamp circuit.

When the Preamplifier is used separately in its own box, the 12V power supply is regulated down to 9V by IC3 under control of the feedback through resistor R19 as set by preset potentiometer VR3. These components are omitted when the Preamp is in the same box as a Pump Controller, the latter supplying 9V directly to the preamp.

PUMP CONTROLLER

The circuit diagram for the Pump Controller is shown in Fig. 3. It is basically a triac controller circuit of the type often used to control any a.c. motor or lamp.

The triac CSR1 controls the power flowing through the pond pump motor M1. The triac is repeatedly switched on and off by pulses applied to its gate (g) via optoisolator IC9. The power flowing through the motor is determined by the width of the controlling trigger pulses and their synchronisation with the phases of the a.c. mains cycles.

Synchronisation pulses are generated from the 50Hz mains a.c. supply and frequency-doubled to 100Hz. The positive mains a.c. line is taken via resistor R42, preset VR6, diodes D3 and D4 to optoisolator IC7.

Since the two l.e.d.s within IC7 are not necessarily current-matched, VR6 is used to equalise the effective balance between the two halves of the mains a.c. cycle, which are half-wave rectified through

COMPONENTS

Approx. cost from

£25
excluding pumps

PREAMP BOARD

Resistors

| | | | |
|----------------|---------------------------------|----------|--------------|
| R1, R3, R4, R9 | 10k (4 off) | R10, R13 | 220k (2 off) |
| R2, R15 | 1M (2 off) | R12 | 20k |
| R5, R19 | 2k (2 off) (see text about R19) | R14 | 47k |
| R6, R16, R17 | 4k7 (3 off) | R18 | 100k |
| R7, R8, R11 | 1k (3 off) | | |

All 0.25W 5% carbon film or better.

Potentiometers

| | |
|-----|--------------------------------------|
| VR1 | 10k sub-min. round preset (see text) |
| VR2 | 100k log. rotary panel mounting |
| VR3 | 1k sub-min. round preset (see text) |
| VR4 | 10k lin. rotary panel mounting |

Capacitors

| | |
|------------|-------------------------------|
| C1, C2, C6 | 100n polyester (3 off) |
| C3, C7 | 1µ radial elect. 63V (2 off) |
| C4, C5 | 22µ radial elect. 16V (2 off) |

Semiconductors

| | |
|--------|--|
| D1, D2 | 1N4148 signal diode (2 off) |
| IC1 | LM13600 dual transconductance op.amp |
| IC2 | 324 quad op.amp |
| IC3 | 78L05 + 100mA voltage regulator (see text) |

Miscellaneous

| | |
|----------|--|
| SK1 | 3.5mm mono switched jack socket |
| SK2, SK3 | 0.25 inch plastic stereo jack socket (2 off) |
| MIC1 | Microphone insert, one kilohm (see text) |

Printed circuit board available from the *EPE PCB Service*, code 889 (Preamp); 14-pin d.i.l. socket; 16-pin d.i.l. socket; knob (2 off); terminal pins; connecting wire; solder, etc.

FILTER

Resistors

| | | | |
|------------------|---------------|-----------------------|-------------|
| R20 | 2k (see text) | R25 to R27, R30, R31, | |
| R21 | 20k | R34, R38 to R41 | 1k (10 off) |
| R22 to R24, R28, | | R32 | 220k |
| R29, R33, R35 | 100k (7 off) | R36, R37 | 4k7 (2 off) |

All 0.25W 5% carbon film or better.

Potentiometer

| | |
|-----|-------------------------------------|
| VR5 | 1k sub-min. round preset (see text) |
|-----|-------------------------------------|

Capacitors

| | |
|-----------------------|-------------------------------|
| C8, C9, C11, C14, C15 | 1µ radial elect. 63V (5 off) |
| C10, C13 | 470p polystyrene (2 off) |
| C12, C16 | 22µ radial elect. 16V (2 off) |

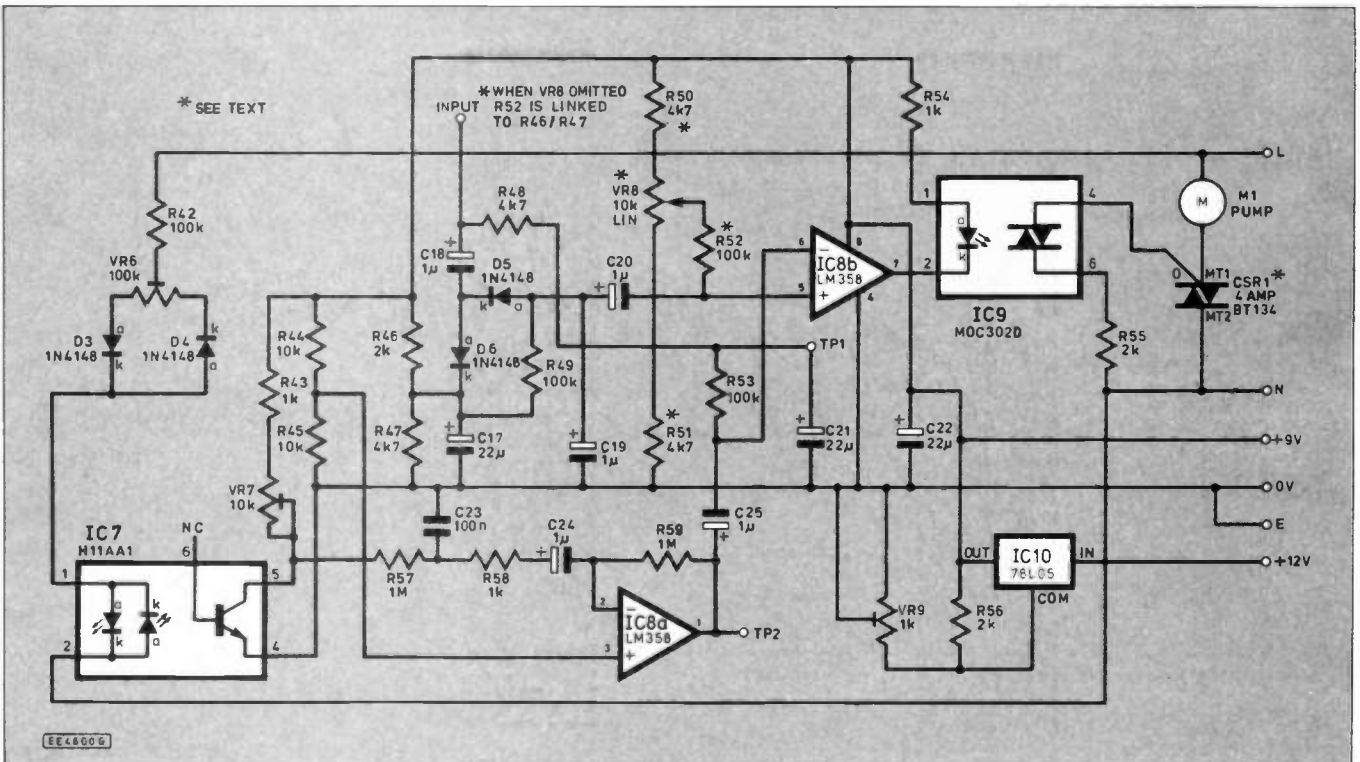


Fig. 3. Circuit diagram for the A.C. Pump Controller module.

Semiconductors

IC4 78L05 +5V 100mA voltage regulator (see text)
 IC5 LM358 dual op.amp
 IC6 LM13600 dual transconductance op.amp

Miscellaneous

SK5 to SK7 0.25inch plastic stereo jack socket (3 off)
 Printed circuit board available from the *EPE PCB Service*, code 891; 8 pin d.i.l. socket; 16 pin d.i.l. socket; terminal pins; connecting wire; solder, wire, etc.

PUMP CONTROLLER

Resistors

R42, R49, R52, R53 100k (4 off) R46, R55, R56 2k (3 off)
 R43, R54 1k (2 off) R47, R48 4k7 (2 off)
 R44, R45 10k (2 off) R50, R51 4k7 (2 off) (see text)
 All 0.25W 5% carbon film or better.

Potentiometers

VR6 100k sub-min. round preset
 VR7 10k sub-min. round preset
 VR8 10k rotary panel mounting (see text)
 VR9 1k sub-min round preset

Capacitors

C17, C21, C22 22µ radial elect. 16V (3 off)
 C18 to C20, C24, C25 1µ radial elect. 63V (5 off)
 C23 100n polyester

Semiconductors

D3 to D6 1N4148 signal diode (4 off)
 IC7 H11AA1 a.c. controlled opto-isolator, transistor output
 IC8 LM356 dual op.amp
 IC9 MOC3020 d.c. controlled opto-isolator, triac output
 IC10 78L05 +5V 100mA voltage regulator
 CSR1 4A 600V triac, e.g. BT134, BT136 etc.

Miscellaneous

Printed circuit board available from *EPE PCB Service*, code 890; 6-pin d.i.l. socket (2 off); 8-pin d.i.l. socket, TB1 8-way (or 2 x 4-way) p.c.b. mounting mains rated terminal socket, 0.2 inch pitch; knob for VR8; terminal pins; connecting wire; solder, etc.

diodes D3 and D4 respectively. Both rectified signals trigger the output of IC7, resulting in a somewhat spiky 100Hz waveform whose basic amplitude is set by preset VR7. The signal is reshaped more closely to that of a sinewave by the action of R57 and C23, and is then amplified by IC8a.

From IC8a the 100Hz signal is coupled to one input of comparator IC8b via C25. The output of IC8b controls IC9 by switching its isolating i.e.d. on and off. The point

in the mains a.c. cycle at which IC9 triggers the triac is determined by the relative levels on both inputs of IC8b.

The output signal from either the Preamp or the Filter is brought into the pump controller at the junction of resistor R48 and capacitor C18. The signal contains the audio waveform and a controlling d.c. bias level.

An additional bias control is provided by potentiometer VR8. When the Preamp is housed in the same box as the Pump

Controller, VR8, R50 and R51 are omitted, and resistor R52 is connected to the reference line (R46/R47).

The d.c. bias level from the Preamp is added to the 100Hz signal at IC8b pin 6, via R48 and R53. Capacitor C21 removes the a.c. audio signal from the bias level.

Capacitor C18 passes the audio signal to the diode-pump circuit consisting of D5, D6, R49 and C19. This circuit removes the higher signal frequencies whilst retaining the low frequency amplitude envelope waveform. The envelope waveform at C19 is then coupled to the second input of IC8b.

It is the relationship of the three signal levels, d.c. bias, 100Hz and envelope amplitude which determines the trigger thresholds of the comparator, and thus the point at which the pump-controlling triac CSR1 is triggered. The result is that varying music levels cause water to be pumped through the fountain nozzles at correspondingly different pressures, so changing their jet spray heights.

The d.c. power for the Pump Controller is regulated down from the 12V power supply level to 9V by IC10, R56 and VR9.

FILTER

So far, the active pump controlling signal has been derived from the full frequency range of the audio signal, as set by the tone controls of the *original* audio source. The purpose of the Filter is to split that signal into three frequency ranges, *High, Middle and Low*, each of which can control its own pump.

The Filter circuit diagram is shown in Fig. 4. The audio signal is brought into op.amp IC5 via capacitor C8 and is processed by the complex feedback circuit around the dual TCA IC6.

The frequency range which appears at the circuit's three outputs is determined by the current flowing into the control nodes at IC6a pin 16 and IC6c pin 1, and by the value of capacitors C10 and C13. For this fountain control design, the filter's central frequency has been fixed by the value of resistor R32. An external control signal, however, could be applied via R33 (Scan

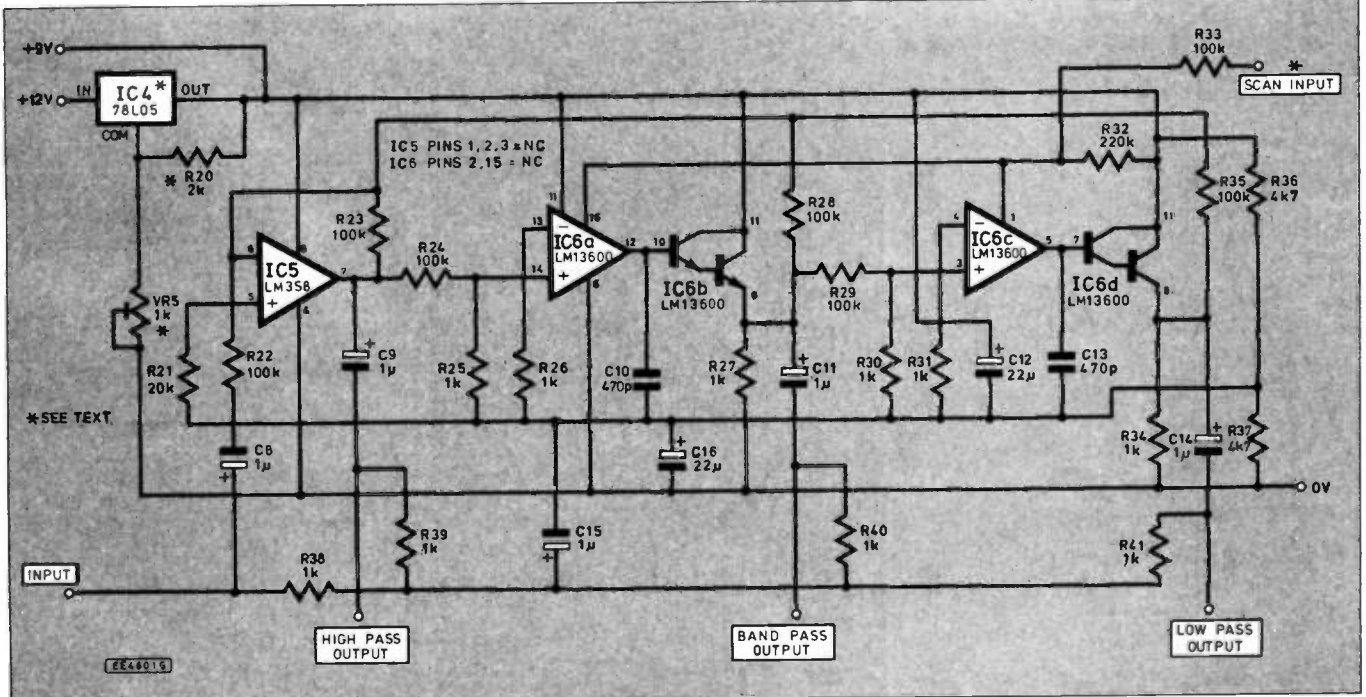


Fig. 4. Circuit diagram for the Filter module.

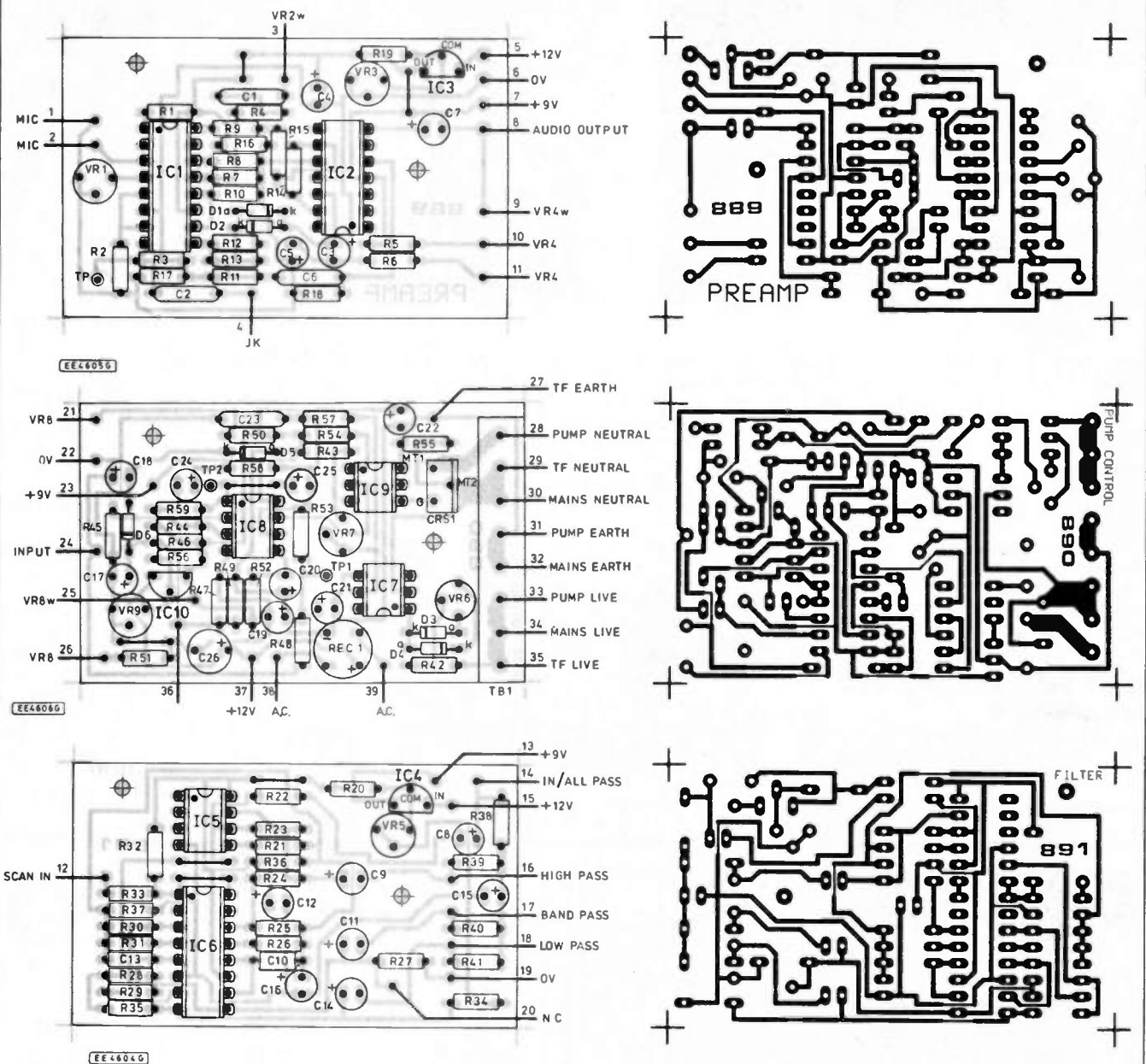
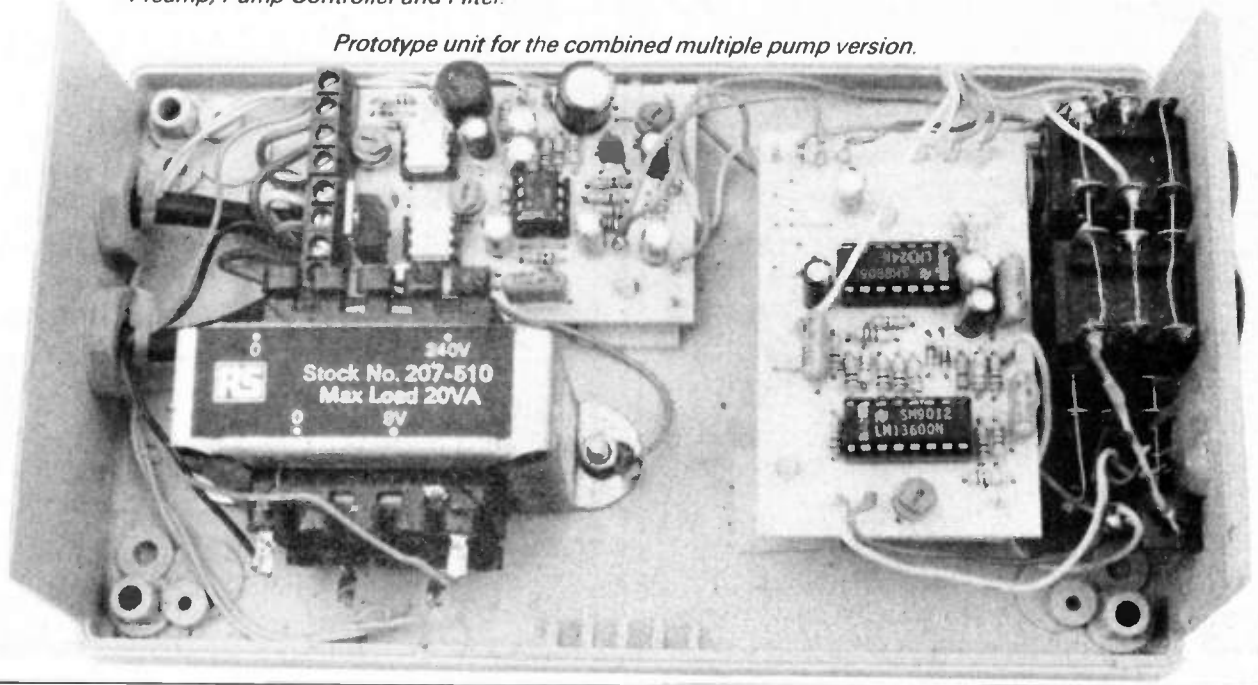
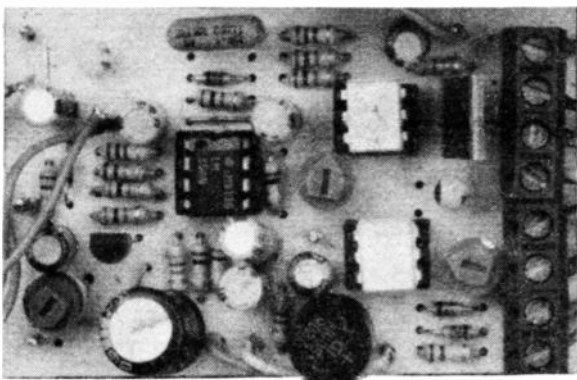


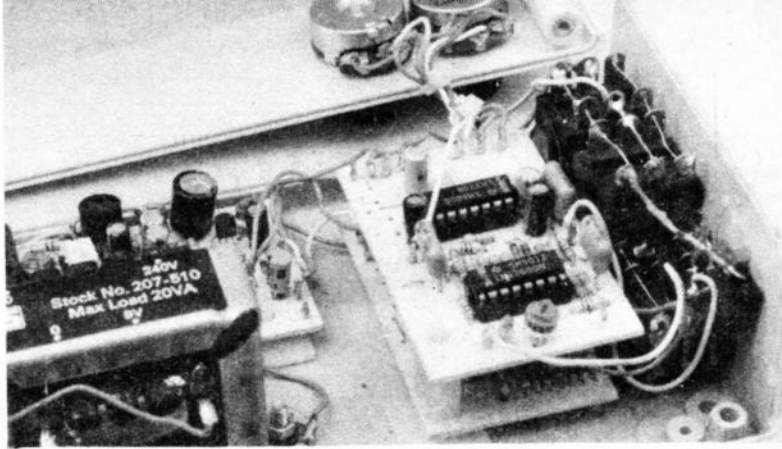
Fig. 6. Printed circuit board component layouts and full size copper foil master patterns for the Preamp, Pump Controller and Filter.

Prototype unit for the combined multiple pump version.





Complete prototype Pump Control board.



Stacking the Preamp and Filter boards so they will fit in the case.

Input), from a signal generator for example, although I shall not discuss that here.

As with the previous two circuits, the filter's power line can be regulated down from 12V to 9V, by IC4, R20 and VR5. These components are omitted when the Filter is housed in the same box as a Pump Controller, the latter supplying 9V directly to the Filter.

It is intended that the input signal to the Filter should originate from the Preamp circuit. However, if a capacitor of, say, 22µF were to be included in the input line, the Filter could be driven directly from the high level output of an ordinary audio system.

MAINS POWER SUPPLY

A suitable simple mains driven power supply which produces an output of about 12V d.c. is shown in Fig. 5. The 9V a.c. output of the transformer is full-wave bridge-rectified by REC1 and smoothed by capacitor C26.

The rectifier and capacitor are mounted on the Pump Controller board.

If more than one controller board is used, only the one in the main controlling box needs the power supply components. The d.c. output from that board supplies power to all other function boards, except for the optional PC-compatible Interface board described next month.

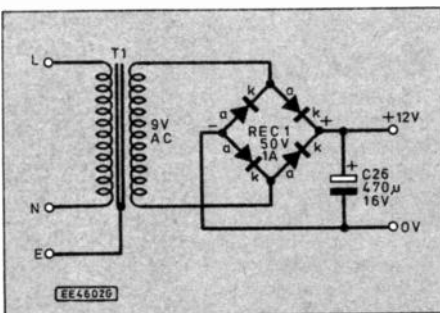


Fig. 5. Mains power supply circuit.

ASSEMBLY

The printed circuit board (p.c.b.) provides component layouts and full size copper foil master patterns for the Preamp, Filter and Pump Controller are shown in Fig. 6. These boards are available from the EPE PCB Service, code 889 (Preamp), 890 (Pump Con.) and 891 (Filter).

The boards have been designed for compactness and for stacked mounting inside the boxes where required. Components may be assembled in any order you find most convenient.

The on-board links can be made using resistor off-cut wires. It is recommended that terminal pins are used for all inter-wiring points, except for the mains power points 28 to 35 for which a screw-terminal block TB1 is used.

Next Month: Final wiring and a PC-Compatible Interface.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 220/240V AC 50/60
OUTPUT 0-280V

| | Price | P&P |
|--------------------|-------------------|-------|
| 0.5KVA 2.5 amp max | £31.90 | £6.00 |
| | (£44.53 inc VAT) | |
| 1KVA 5 amp max | £41.15 | £7.00 |
| | (£56.58 inc VAT) | |
| 2KVA 10 amp max | £59.40 | £8.50 |
| | (£79.78 inc VAT) | |
| 3KVA 15 amp max | £78.65 | £8.50 |
| | (£102.40 inc VAT) | |
| 5KVA 25 amp max | £139.15 | |

(Plus Carriage)

Buy direct from the Importers. Keenest prices in the country
CDMPREHENSIVE RANGE OF
TRANSFORMERS-LT-ISLATION & AUTO

110-240V Auto transfer either cased with American socket and main lead or open frame type. Available for immediate delivery

WIDE RANGE OF XENON FLASH TUBES

Write/Phone your enquiries

ULTRA VIOLET BLACK LIGHT
FLUORESCENT TUBES

| | | |
|-------------|-----------------------|------------------|
| 4ft 4 watt | £12.00 (callers only) | (£14.10 inc VAT) |
| 2ft 20 watt | £7.44 + £1.25 p&p | (£10.21 inc VAT) |
| 12in 8 watt | £4.80 + 75p p&p | (£6.52 inc VAT) |
| 9in 6 watt | £3.98 + 50p p&p | (£5.24 inc VAT) |
| 6in 4 watt | £3.98 + 50p p&p | (£5.24 inc VAT) |

230V AC BALLAST KIT
For either 6in, 9in or 12in tubes £8.06 + £1.40 p&p (£9.75 inc VAT)

400 WATT UV LAMP
Only £38.00 + £4.00 p&p (£49.35 inc VAT)
160 WATT SELF BALLASTED BLACK
LIGHT MERCURY BULB
Available with B.C. or E.S. fitting
Price inc VAT & p&p £25.95

12V D.C. BILGE PUMPS

500 GPH 15ft head 3 amp £19.98
1750 GPH 15ft head 9 amp £34.55
Also now available:
24V D.C. 1750 GPH 15ft head
5 amp £36.55
All designed to be used submerged.
PRICES INCLUDE P&P & VAT

EPDM ERASURE KIT

Build your own EPDM ERASURE for a fraction of the price of a made-up unit kit of parts less case includes 12in 8 watt 2537 Argon Tube Ballast unit, pair of bi-pin leads, neon indicator, on/off switch, safety microswitch and circuit £15.00 + £2.00 p&p (£19.98 inc VAT)

SUPER HY-LIGHT STROBE KIT

Designed for Disco, Theatrical use etc.
Approx 16 joules. Adjustable speed £50.00 + £3.00 p&p (£62.28 inc VAT)
Case and reflector £24.00 + £3.00 p&p (£31.73 inc VAT)
SAE for further details including Hy-Light and industrial Strobe Kits

"BOFFINS SPECIAL" - UNIQUE OFFER

Surplus Precision Medical Unit, internally in excellent condition. Designed primarily to eject a precise controllable amount of fluid from a medical syringe (letter not supplied). Contains the following removable components: Dual Micro Processor Boards and EPROMS. Escap Precision 12V DC Motor with 300:1 Gear Box and optical encoder coupled to a precision threaded drive mechanism. Mains supply with 6 x 1.5V Ni-Cad A.A. cells back-up. L.C.D. Digital read-out 17mm high with legends. Audible warning

These are sold for the dismantling of the exceptional quality components. Regret no Circuits available. Ridiculously low price: £20.00 + £4.00 p&p (£28.20 inc VAT)

12V D.C. GEARED MOTOR

12V D.C. Reversible precision-built Motor. Output speeds no load approx. 12V-28 rpm; 9V-20 rpm; 6V-12 rpm. Will work at lower voltages and still retain a reasonable torque. Ideal for robotics etc. Size: L 40mm, W 29 mm, H 39mm, Shaft: 3mm dia x 10mm long. Price: £8.00 + 50p p&p (£10.00 inc VAT)

240V AC CENTRIFUGAL BLOWER

New Manuf. Surplus Skeleton Blower suitable for mounting inside an enclosure to cool equipment. Overall size 130 x 110 x 85mm. Outlet 80 x 35mm. Impeller 60mm dia. x 60mm long. Price £14.10 inc p&p & VAT.

SEWING MACHINE MOTOR

Brand new 220/240V AC/DC SEW-TRIC 2 lead Brush Motor. Size L 100mm x H 70mm x W 56mm. Spindle 1/8 in. dia. x 1 in. long. Price £14.10 inc p&p & VAT.

GEARED MOTORS

71 RPM 20lb inch torque reversible 115V AC input including capacitor and transformer for 240V AC operation. Price inc VAT & p&p £27.73.

SOLID STATE EHT UNIT

Input 230/240V AC. Output approx 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec, 30 sec to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, eg supplying neon or argon tubes etc. Price less case £8.50 + £2.40 p&p (£12.11 inc VAT) NMS

SAVE POUNDS!!!

Build your own forged bank note detector. Can detect counterfeiters amongst a quantity of notes. Complete kit of parts less case, 240V a.c., including 6 µV black light tube, starter and holder, a pair, bi-pin tube holders. Total price including p&p & VAT only £13.99.

MICROSWITCH

Pye 15 amp changeover lever microswitch, type S171 Brand new, price 5 for £7.05 inc VAT & p&p

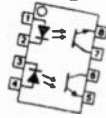
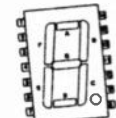
WASHING MACHINE WATER PUMP

Brand new 240V AC fan cooled. Can be used for a variety of purposes. Inlet 1 1/8 in., outlet 1 in. dia. Price includes p&p & VAT £11.20 each or 2 for £20.50 inclusive.

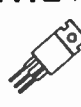
OMNI ELECTRONICS

174 Dalkeith Road, Edinburgh EH16 5DX ★ 031 667 2611

The supplier to use if you're looking for:-



A WIDE RANGE OF
★ COMPONENTS AIMED AT THE ★
HOBBYIST



★ COMPETITIVE VAT INCLUSIVE ★
PRICES

★ MAIL ORDER - generally by ★
RETURN OF POST



★ FRIENDLY SERVICE ★



OPEN:

Monday-Thursday 9.15 - 6.00

Friday 9.15-5.00

Saturday 9.30-5.00



SERVICE TRADING CO
57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB
TEL: 081-995 1580 FAX: 081-995 0549
ACCOUNT CUSTOMERS MIN. ORDER £10

CHARGED UP

KEN LEE

Don't get overcharged when you need to replace the clock back up battery in your computer.

I AM not an avid computer user so during the summer months when I prefer the great outdoors the monster only gets switched on when it is absolutely necessary. On the occasion when this did happen recently I saw that the time was way out, more than usual that is, as this computer has always run slow since it was new, the time always appears on boot up as I have added this instruction to the prompt line.

I set this time right and thought I had better check the date and to my horror this was weeks out, this could only mean one thing, the internal battery was running out of energy. After the short session I switched off and removed the mighty cover and with my trusty digital voltmeter checked the battery voltage. It was 3.64V, about half of what it should be. The next day with £5 in my pocket, I cycled the four miles into town to the local computer shop to purchase a new battery.

SERIOUS BUSINESS

"We have the very thing you want" said the shop keeper. "And what is more it is your lucky day, we have just reduced the price from £32 to £23, plus VAT of course". I felt sick and weak at the knees at the same time, because being out of work for a couple of years, £27.03 is a lot of money for a six volt battery, and raises the serious question can I afford to go on running a computer.

"That's ludicrous" I said. "Think yourself lucky you do not require a battery for a Cannon printer, that's £59 plus VAT", he said pointing to what looked like a black plastic drain pipe hanging in a plastic bag on the wall. Funny I thought, I don't remember seeing that in the test reports. On my way home I thought the affordable way out was to replace the "High Energy

Lithium Battery" as it was called with standard alkaline cells.

The next day I cycled back into town and purchased a battery holder for four AA cells for 69 pence and four AA cells for £1.99, making a total of £2.68, saving £24.35!

CELL TALK

Let me put reader's minds at rest before they reach for their pens by looking at the lithium cell. This cell has two points in its favour, they are: (a) The power/size/weight ratio, which is fine for wrist watches but there is enough space inside my box for a dozen D cells, (b) six to 10 year shelf life because of their low internal leakage, which is fine for manufacturers and shop keepers as they should turn over their stock in six years even in a recession! Do not confuse shelf life with battery life in use. The big disadvantage is cost, which some manufacturers have enhanced with their "specials" making it even more costly.

Now lets look at useable battery life, cell manufacturers call this Voltage Capacity and it is measured in milliamp hours, so if a battery is quoted as 1000mAh and your apparatus draws 1mA then it will run for 1000 hours continuously on average. Remember batteries are a chemical device and as such each cell will vary.

If we now look at the manufacturers' published data for C cells we find the following:

| CELL TYPE | VC mAh |
|-----------|--------|
| Alkaline | 5,000 |
| NiCad | 2,000 |
| Lithium | 1,000 |

It can now be seen that as far as usable battery life is concerned, lithium is at the bottom so why fit lithium in the first place? Unless you have got a space/weight/size problem there is no need at all.

REPLACEMENT

The original battery supplied was a white plastic box that measured 60 x 40 x 20mm, a black and red twisted pair of wires and a 4-way p.c.b. socket. I decided to open it up and see just what I would have got for my £27.03. Inside there were two AA size lithium batteries and a 47kΩ resistor in series with the positive lead, which I did not expect. The resistor is a safety component which restrict's the discharge rate if a short circuit develops, due to the small current taken by the computer, the computer does not notice it.



It took very little time to solder the original lead and resistor to the new battery box and install it, replace cover, run set up and I was computing again at a price I could afford.

BENEFITS

It is possible to buy computer type lithium batteries by mail order which only cost around £12 but this is still more than four times my total cost. Also check that the battery in your computer is not fitted with an internal anticharge diode, to prevent the supply trying to charge the battery when the computer is on and the battery voltage is low. If it is fit a similar diode in the supply lead to your battery - a 1N4148 will unfortunately add another 5p or so to the total price!

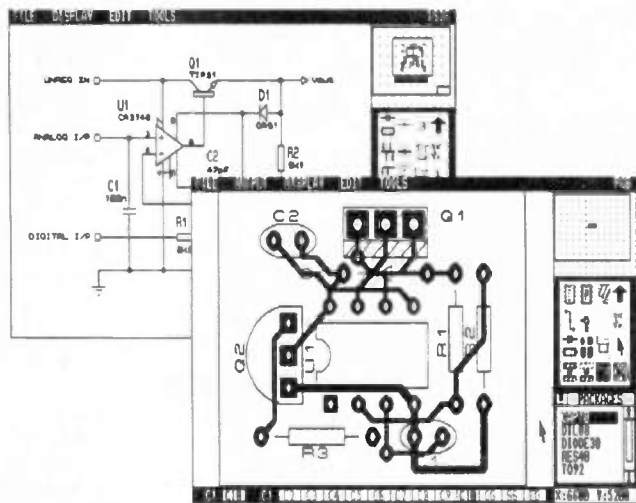
Battery replacement next time will be easy, AA alkaline cells are sold in lots of places, even on weekends, no special journey to the specialist shop. They will probably not last any longer, even though they have a greater capacity, as the internal leakage of alkaline is slightly greater than lithium.

You may ask why do computer manufacturers not fit alkaline in the first place? I cannot answer that, but what I do know is that if your profit or mark up is 33 per cent then on £3 you make a £1, on £33 you make £11 and it all adds to the great high priest mystique of computing which the computing industry loves to cultivate. Or could it be the VAT man looking for a bigger return? (Our rather old Apricot computers used for our Subscription Service are fitted with PP3s in the keyboards - nice and cheap and easy! - Ed.) □

| | |
|---|---|
| EVERYDAY WITH PRACTICAL ELECTRONICS SUBSCRIPTION ORDER FORM Annual subscription rates (1993/4): UK £22.00. Overseas £28 (surface mail) £45.50 (airmail) To: Everyday with Practical Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH | I enclose payment of £ (cheque/PO in £ sterling only), payable to Everyday with Practical Electronics Access or Visa No. |
| |  |
| | Signature..... Card Ex. Date Please supply name and address of card-holder if different from the subscription address shown below. Subscriptions can only start with the next available issue. For back numbers see the Editorial page. |
| Name Address Post code |  |

POWERFUL SCHEMATIC CAPTURE, PCB DESIGN AND AUTOROUTING ALL FOR JUST £395...

PROPAK AR for DOS provides all the features you need to create complex PCB designs quickly and easily. Draw the circuit diagram using the powerful facilities of ISIS DESIGNER+ and then netlist into ARES AUTOROUTE for placement, autorouting and tidy up. Advanced real time design rule checks guarantee that the final PCB will correspond exactly with the schematic thus saving you from costly layout errors and time consuming debugging.



- Attractive, easy to use graphical interface.
- Object oriented schematic editor with automatic wire routing, dot placement and mouse driven place/edit/move/delete.
- Netlist generation for most popular CAD software.
- Bill of Materials and Electrical Rules Check reports.
- Two schemes for hierarchical design.
- Automatic component annotation and packaging.
- Comprehensive device libraries and package libraries including both through hole and SMT parts.
- User definable snap grids (imperial and metric) and Real Time Snap to deal with tricky SMT spacings.
- Manual route editing features include Auto Track Necking, Topological editing and Curved tracks.
- Autorouting for single, double and multi-layer boards.
- Non autorouting PROPAK is available for just £250 if you do not need or want the router.
- Full connectivity and design rule checking.
- Power plane generator with thermal relief necking.
- Graphics support to 800x600 Super VGA.
- Output to dot matrix and laser printers, HP and Houston plotters, Postscript devices, Gerber and Excellon NC machines plus DXF and other DTP file formats.

CADPAK

Two Programs for the Price of One

ISIS SUPERSKETCH

A superb schematic drawing program for DOS offering Wire Autorouting, Auto Dot Placement, full component libraries, export to DTP and much more.

**Only
£79**

Exceptionally easy and quick to use. For example, you can place a wire with just two mouse clicks - the wire autorouter does the rest.

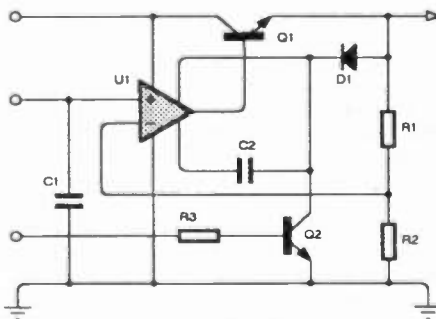
PCB II

High performance yet easy to use manual PCB layout package. Many advanced features including curved tracks, auto track necking, DXF export, Gerber and NC file generation, Gerber viewing and more.

Alan Chadwick writing in ETI (January 94) concluded...
"At £79 I thought this was an excellent buy."

ISIS ILLUSTRATOR

Schematic Drawing for Windows

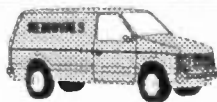


**From
£99**

Running under Windows 3.1, ISIS ILLUSTRATOR lets you create presentation quality schematic drawings like you see in the magazines. Furthermore, when the drawing is done, transferring it to another document is just a matter of pasting it through the Clipboard.

Now used by a number of prominent technical authors to illustrate their latest books and magazine articles.

Labcenter
Electronics



WE HAVE MOVED - NOTE NEW ADDRESS

Call us today on 0756 753440 or fax 0756 752857 for a demo pack - state DOS or Windows. Multi-copy and educational discounts available.

Prices exclude p&p (£5 for U.K.) and VAT. All manufacturers' trademarks acknowledged.

53-55 Main St, Grassington, North Yorks. BD23 5AA.

CALCULATION CORNER

Kirchhoff's Laws

STEVE KNIGHT

Part Eight



This series is designed to help you make your way, at your own pace, through the often imagined fears of mathematics, as this is applied to electronic and electrical engineering matters.

FOR many of you, the mention of Kirchhoff's laws may arouse some foreboding, but as we will discover these laws are simply generalisations of the ideas developed from the previous parts of this series which greatly assist in the calculation of currents in circuit networks which are rather more complicated than those we have encountered so far.

Kirchhoff's laws are essentially an extension of Ohm's law, which by this stage you should have mastered reasonably well and, as you will see, require only the mathematical ability to solve simple simultaneous equations. Here are the two laws.

THE CURRENT LAW

The current law tells us that at any junction (or node) of conductors in a network, the sum of the currents flowing towards the junction is equal to the sum of the currents flowing away from it.

From the junction shown in Fig. 8.1 we see that three currents, *a*, *b* and *c* are entering and two currents, *d* and *e*, are leaving. Then, because there can be no accumulation of charge at any junction, we can write

$$a + b + c = d + e$$

or $a + b + c - d - e = 0$

This last expression is known as the *algebraic sum* of the currents since account is taken of the signs given to the currents – those entering are taken to be positive and those leaving as negative. So what Kirchhoff's current law is really telling us is that the algebraic sum of the currents meeting at a junction is always zero.

THE VOLTAGE LAW

The voltage law tells us that in any closed loop (or mesh) of a network, the algebraic sum of the IR voltage drops around the loop is equal to the algebraic sum of the e.m.f.s acting in the loop.

Interpreting this law is not so grim as it sounds to the newcomer. Look at Fig. 8.2; there is a single source of e.m.f. here, the battery, and the conventional direction in which this e.m.f. is acting is

shown by the arrow drawn alongside. There are also three p.d.s or voltage drops present in the circuit, these being the three voltages developed by the passage of current *I* through resistors *R*₁, *R*₂ and *R*₃, that is *IR*₁, *IR*₂ and *IR*₃ respectively.

Then Kirchhoff simply tells us (going clockwise around the loop) that

$$IR_1 + IR_2 + IR_3 = E$$

or $IR_1 + IR_2 + IR_3 - E = 0$

The application of Kirchhoff's law is best illustrated by worked example and this we will now do, adding the necessary precautions as we proceed.

WORKED EXAMPLES

1. Use Kirchhoff's current law to find the currents *x*, *y* and *z*, and their directions, in the network branches of Fig. 8.3a.

We have been given three current values and their directions and we have to find the other three. First of all, mark the junction points A, B and C as in Fig. 8.3b. Then starting at junction A we see that a current of 8A is *entering* the junction and that a current of 3A is *leaving* the junction. Hence their difference of 5A must be *leaving* the junction at A and going towards C; hence *x* = 5A.

Now going to junction C, two currents, *x* and *y* are *entering* and 7A is *leaving*; but *x* = 5A, hence *y* must be 2A flowing from B towards C.

To complete the story, junction B has 3A *entering* from A and *y* = 2A *leaving* towards C. Current *z* must therefore have a value of 1A *leaving* the network from B. Fig 8.3b is now completed.

It is always useful as a working check to ensure that the total current entering the network (8A here at junction A) is equal to the total current leaving the network, (1 + 7) = 8A at points B and C.

Notice, incidentally, that the triangle of conductors ABC, forms a loop or mesh which is what we look for when applying Kirchhoff's voltage law.

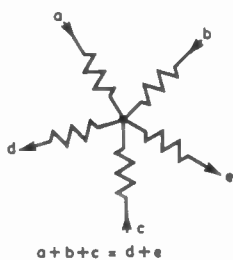


Fig. 8.1. Illustrating Kirchhoff's current law.

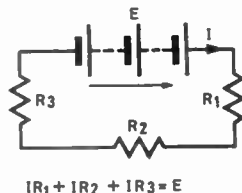


Fig. 8.2. Illustrating Kirchhoff's voltage law.

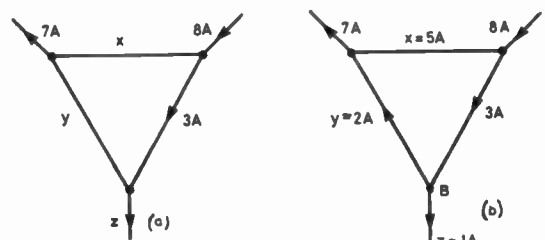


Fig. 8.3. An exercise in the use of the current law.

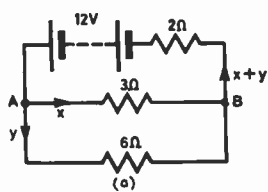


Fig. 8.4. Using Kirchhoff's laws to solve an elementary network problem.

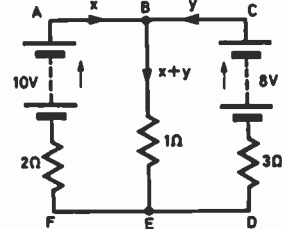
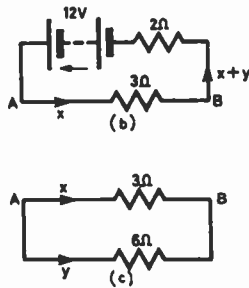


Fig. 8.5. A more difficult network to solve.

2. In Fig. 8.4a find the currents in each branch of the circuit using Kirchhoff's laws.

Now this is a very simple circuit which could be quickly solved by the elementary Ohm's law procedures covered in earlier parts of this series. However, we are here illustrating the application of Kirchhoff; we therefore label up the junction points as A and B in Fig 8.4a and then assign currents (using the current law) to the various branches.

So, for junction A, we let the current flowing in the 3Ω branch be x amperes and the current flowing in the 6Ω branch be y amperes. Then, by Kirchhoff's first law, the current flowing in the battery branch will be $(x + y)$ amperes.

We now have the *three* parallel branches labelled for the currents, but only *two* unknown currents are involved. It is always an advantage to keep the number of unknown currents to a minimum by combination as we have done here, as this reduces the number of final equations which have to be solved.

We now apply the voltage law. There are three possible loops available in this circuit: the upper loop, the lower loop and the "outside" loop. We have to use as many different loops as there are unknown currents, hence two loops must be selected for our purpose. *The solution is totally unaffected by whichever loops we choose.*

Using the upper loop first, then, we derive an equation in the manner shown in Fig. 8.4b, equating the voltage drops to the e.m.f. (if any) in the loop. Going anticlockwise we get

$$3x + 2(x + y) = 12$$

$$\text{or } 5x + 2y = 12 \dots\dots (i)$$

This gives us one equation relating currents x and y ; we need another to solve for both x and y

Using the lower loop this time, as shown in Fig. 8.4c, we start at A and go clockwise, noting that when we do this, the current y in the 6Ω branch is acting in *opposition* to our chosen direction and must therefore be given a negative sign. We then get an equation for the loop

$$3x - 6y = 0 \dots\dots (ii)$$

there being no source of e.m.f. within this loop.

Using these two equations, we can find the two unknown currents:

$$5x + 2y = 12 \dots\dots (i)$$

$$3x - 6y = 0 \dots\dots (ii)$$

Multiplying (i) by 3 to equalize the y terms

$$15x + 6y = 36$$

$$3x - 6y = 0$$

and *adding* these, we have

$$18x = 36 \text{ or } x = 2 \text{ amperes}$$

Substituting this value back into either of the first equations we find

$$y = 1 \text{ ampere}$$

Summarizing: current in the 3Ω branch = $x = 2A$
 current in the 6Ω branch = $y = 1A$
 current in the 2Ω branch = $x + y = 3A$

PRECAUTIONS

When applying Kirchhoff's law, the following precautions must be carefully observed at all times: when applying the current law, the choice of current direction is purely arbitrary; if you have chosen the "wrong" direction for your arrowheads, the answer to the current value will turn out to be negative. This simply indicates

that the current actually flows in a direction *opposite to your choice*; the actual value obtained is correct.

When applying the voltage law around a loop, whenever your choice of direction round the loop takes you in opposition *either* to a current direction in a resistor path or against the direction of action of an e.m.f. you *must* assign a negative sign to that voltage drop or e.m.f.

The next worked example will illustrate these points. Follow each step carefully and, with a bit of practice, you should be able to apply Kirchhoff's laws with confidence.

3. In the circuit network of Fig. 8.5, find the currents flowing in each branch.

Here we have a more complicated circuit that is not so easily solved using only an Ohm's law approach.

First of all we mark in the directions in which the battery e.m.f.s are acting by arrows drawn alongside; we then use capital letters to mark out the various loops into which the network can be divided. Having done this as the figure shows (and try always to copy this approach), we apply the current law.

We *suppose* that current x flows from point A, current y to flow from point C, and the sum of these, $(x + y)$ to flow along the centre branch from point B. Remember; these allocated directions are arbitrary; do *not* try to work out from an inspection of the circuit which way the currents might *actually* flow, just keep in mind that Kirchhoff's current law *must* be obeyed at any junction. This is of absolute importance.

Now we have two unknown currents to find so we need two independent equations. We get these from any two of the three possible loops available in the circuit.

In loop ABEF the 10V e.m.f. is acting in a clockwise direction, so equating the sum of the IR products to this gives us

$$1(x + y) + 2x = 10$$

$$\text{or, collecting up: } 3x + y = 10 \dots\dots (i)$$

In loop BEDC the 8V e.m.f. is acting in an anticlockwise direction, so going round the loop in this direction gives us

$$1(x + y) + 3y = 8$$

$$\text{or, collecting up: } x + 4y = 8 \dots\dots (ii)$$

This gives us the two independent equations we need to find currents x and y , and then, of course, the third current $(x + y)$. Multiplying equation (ii) by 3 and subtracting equation (i) gives us $11y = 14$ so that

$$y = \frac{14}{11} \text{ or } 1.28 \text{ amperes}$$

Substituting this value back into equation (ii) gives us

$$x + 4\left[\frac{14}{11}\right] = 8$$

from which we find $x = \frac{32}{11}$ or 2.91 amperes

The current in the centre branch = $(x + y) = 4.19$ amperes.

As all these results have a positive sign, our choice of current directions was correct.

We could of course have used the outer loop ACDF for one of our equations; check for yourself that the equation for this outer loop will be $2x - 3y = 2$ and that this, used with either of the other loop equations, still provides us with the same solutions.

6. Suppose, as an experimenter, you want to supply a current of 1A to a 2Ω load resistor. You have a potentiometer of total track resistance 16Ω and a heavy duty d.c. supply of 12V.

You accordingly hook up the circuit of Fig. 8.6a so that you can adjust the sliding contact of the potentiometer to provide the 1A

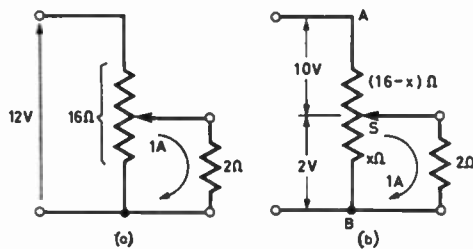


Fig. 8.6. A problem with the adjustment of a potentiometer to provide a given output.

current in the 2Ω load. Unhappily, you have no ammeter to hand to measure this current; whereabouts along the track would you set the slider so that you could feel certain that your required condition was satisfied? (Take it that the scale of the potentiometer is marked off in 1Ω steps).

Well, here's another nice mess we've got ourselves into, as Mr Hardy might say. Let us draw a circuit diagram of the situation, and this has been done in Fig. 8.6b.

A current of 1A will be flowing through the 2Ω load resistor, so the voltage drop across this resistor will be 2V . This voltage must also be present across the points SB of the potentiometer, hence the voltage across AS must be $(12 - 2) = 10\text{V}$.

If now we call the lower portion of the potentiometer $x\Omega$, the upper portion must be $(16 - x)\Omega$. All this information has been marked in on Fig. 8.6b. We now need to find the value of x so that we can determine the position of the sliding contact along the potentiometer track.

Kirchhoff's current law will come to our assistance. Applying the law to point S, then:

Current entering the junction = current flowing in AS

$$= \frac{10}{16-x} \text{A}$$

Current leaving the junction = current in SB + current in the load

$$= \frac{2}{x} + 1 = \frac{2+x}{x} \text{A}$$

These currents must be equal and so we have

$$\frac{10}{16-x} = \frac{2+x}{x}$$

Cross multiplying $10x = (16 - x)(2 + x)$

or $10x = 32 + 14x - x^2$

Rearranging the terms we get a quadratic

$$x^2 - 4x - 32 = 0$$

which factorizes into $(x - 8)(x + 4) = 0$

Hence $x = 8\Omega$ or -4Ω . We can ignore the negative result here, consequently the sliding contact must be set half-way along the track.

This example is a good illustration of how the output of a potentiometer is *not* proportional to the position of the slider when the load resistance is small in relation to the total track resistance. Here, setting the slider to the mid-way position on the track does not give us half the input voltage, but something considerably less i.e. the 2V that we actually desired. You will find a reference to this effect on your first wallchart (given free with the March '94 issue).

Throughout this month's work I have emphasised the necessity to draw a carefully labelled diagram for each problem. In many examinations, problems are presented in word form, no diagram being given. So it is vital, if you are entering for any examinations (and if you are not as well!) to be able correctly to interpret the wording into a neat diagram.

It is difficult to put over the applications of Kirchhoff's laws in a short article such as this, but I hope it contains enough information to enable any of you who have never tackled the laws before to get a working insight into them, and for those who have already met them, to consolidate and possibly clarify what you already know.

Now attempt the following self-assessment problems.

1. Two currents, x and y , in a certain network, lead to the following equations when Kirchhoff is applied. Find x and y .

$$2x + y = 2.5$$

$$x + 2y = 3.5$$

2. In the circuit of Fig. 8.7 find the currents in each branch and the current supplied by the battery. What is the p.d. between the points A and B? (Use Kirchhoff).

3. Find the current in each of the resistors shown in Fig. 8.8.

4. Find the current in the 2Ω resistor for the circuit of Fig. 8.9. What current does the 8V battery supply?

5. When resistance R in the circuit of Fig. 8.10 equals 8Ω , the ammeter reads 0.8A . What will it read when $R = 2\Omega$? (Hint: find the ammeter resistance first).

6. Find the currents in each of the branches of the circuit of Fig. 8.5 if the 8V battery is reversed in polarity.

Last month's answers

1. (a) 4dB , (b) 10.8dB , (c) 20dB , (d) 27.8dB . 2. -23.5dB . 3. (a) 100W , (b) 1mV . 4. 8.16dB . 5. 0.2V , 9.54dB . 6. 26dB , 104dB . 7. Approx 50Hz to 10kHz . 8. True.

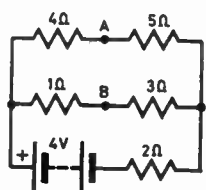


Fig. 8.7. Circuit for Problem 2.

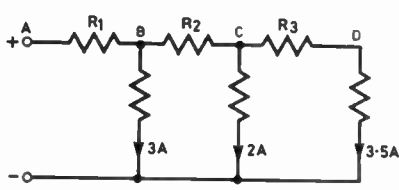


Fig. 8.8. Circuit for Problem 3.

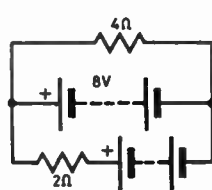


Fig. 8.9. Circuit for Problem 4.

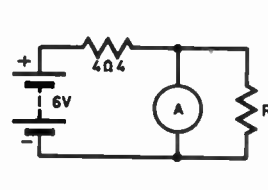


Fig. 8.10. Circuit for Problem 5.

EVERYDAY WITH PRACTICAL ELECTRONICS

NEWSAGENTS ORDER FORM

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

Everyday with Practical Electronics is published on the first Friday of each month and distributed by Seymour. Make sure of your copy of EPE each month - cut out this form, fill it in and hand it to your newsagent.

Signed

Name and Address
(BLOCK CAPITALS PLEASE)

.....

.....

.....

ELECTROMAIL

At last, a power drill system scaled down to the jobs you do!

The perfect, precision power tool range for electronics, model making and all kinds of delicate work.

Forget about the heavy, cumbersome, tiring power tools of the past. RS now offer a comprehensive range of light and precise drills and accessories, ideal for all types of electronic construction and repair (electrical parts, circuit boards, computers, videos, office equipment). And all those awkward corners conventional drills can never get to!

They're an essential for every well-equipped electronic or engineering workshop - and because they all work from 12V, they're quieter and safer to use too! Look through the range below and see how useful they could be to you!

Mini Precision Drill

12V d.c. drill with precision keyed chuck for greater accuracy. Twin bearing drive shaft for smooth running. Fan cooled motor. Complete with chuck key.

| stock no. | price each | |
|-----------|------------|--------|
| | 1-2 | 3-9 |
| X182-578 | £35.74 | £33.00 |

Variable Speed Transformer

230-240V a.c., suitable for use with RS mini-tools. Features variable speed control and re-settable cut-off safety facility. Provides sufficient power for continuous work at varying speeds.

| stock no. | price each | |
|-----------|------------|--------|
| | 1-2 | 3-9 |
| X182-691 | £35.74 | £33.00 |

High Speed Drill Kit



Includes RS high speed mini-drill X182-584, a plug-in 230-240V a.c. mains transformer and 20 accessories for drilling, grinding, routing and shaping.

| stock no. | price each | |
|-----------|------------|--------|
| | 1-2 | 3-9 |
| X182-663 | £31.26 | £28.50 |

Drilling/Cutting Kit

Consists of 7 cutting wheels, 4 grinding wheels, 2 mandrels, 6 PCB drills and 6 routing tools.

| stock no. | price each | |
|-----------|------------|--------|
| | 1-2 | 3-9 |
| X182-736 | £13.40 | £12.30 |

Polishing/Cleaning Brushes

Steel or brass brushes in either pencil, wheel or cup profiles. Supplied in bags of 3.

| Drive Shaft Diameter 2.4mm Nominal | | price each | |
|------------------------------------|----------|------------|-------|
| stock no. | | 1-2 | 3-9 |
| steel brushes pencil (3) | X182-770 | £3.30 | £3.02 |
| steel brushes wheel (3) | X182-786 | £3.30 | £3.02 |
| steel brushes cup (3) | X182-792 | £3.30 | £3.02 |
| brass brushes pencil (3) | X182-809 | £3.30 | £3.02 |
| brass brushes wheel (3) | X182-815 | £3.30 | £3.02 |
| brass brushes cup (3) | X182-821 | £3.30 | £3.02 |

Cutting Wheels

Six carborundum 22mm diameter cutting wheels for use with RS mandrels X182-865.

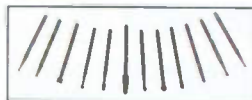
| stock no. | price each | |
|-----------|------------|-------|
| | 1-2 | 3-9 |
| X182-871 | £2.86 | £2.60 |

Buffing Kit

Consists of a 22mm felt wheel and a 22mm wool wheel with fixed mandrels, and a pot of buffing/polishing paste.

| Drive Shaft Diameter 2.4mm Nominal. | | price each | |
|-------------------------------------|--|------------|-------|
| stock no. | | 1-2 | 3-9 |
| X182-837 | | £4.02 | £3.65 |

Cutting Kit



12-piece set of fine and medium cutting tools for use on plastics, wood, etc.

| stock no. | price each | |
|-----------|------------|--------|
| | 1-2 | 3-9 |
| X182-758 | £13.40 | £12.30 |

Drill Accessories

RS p.c.b. drill accessories for cutting, cleaning and finishing many workshop materials. The kit consists of a 1.6mm dia. saw and mandrel, a felt polisher (hard), and a reamer (arrowhead). Shank dia. 2.4mm.

| stock no. | price each | |
|-----------|------------|-------|
| | 1-4 | 5-24 |
| X543-967 | £7.85 | £7.10 |

Engraving Kit

Simple to use, complete with a lightweight pen-style engraver, plug-in 230-240V a.c. transformer, 1 diamond engraving bit and 2 grinding stones. Plastic stencil for security marking on plastics and metals. Handy carrying case. Engraving pen is also available separately with a diamond bit for use with RS tool transformers X182-691 and X182-708. Spare round head 1.8mm diameter. Diamond bits are also available separately.



| stock no. | | price each | |
|---------------|----------|------------|--------|
| | | 1-2 | 3-9 |
| engraving kit | X182-679 | £24.12 | £22.00 |
| engraving pen | X182-685 | £14.28 | £13.00 |
| diamond bit | X182-859 | £4.46 | £4.10 |



FAST DELIVERY

- all orders will be despatched next working day.

24 HOUR ORDERING

- we accept orders 24 hours a day.

PRICE GUARANTEE

- fixed until 31st October 1994.

Prices do not include VAT. Please multiply total order value by 1.175 to add VAT at current rate.

NB: Please add £3.46 to cover postage and packing.

To Order: Phone: 0536 204555 OR Fax:

0536 405555 quoting your Access/Visa card

number and expiry date. OR Write: Send written orders, accompanied by cheque, postal order or include your Access/Visa card number and expiry date, ensuring that your order is signed. Cheques and postal orders must be crossed and made payable to ELECTROMAIL.

DO NOT SEND CASH OR CREDIT CARD.

Electromail PO Box 33, Corby, Northants. NN17 9EL

- Prices are valid until 31st October 1994, and they exclude VAT which will be charged at the relevant rate.

- Offer applies in the U.K. only.

- The products featured are subject to the

conditions of sale and

servicing as stated in the current

Electromail catalogue. These are

available on request.

- RS, RS and Electromail are

registered trademarks of RS

Components Ltd.



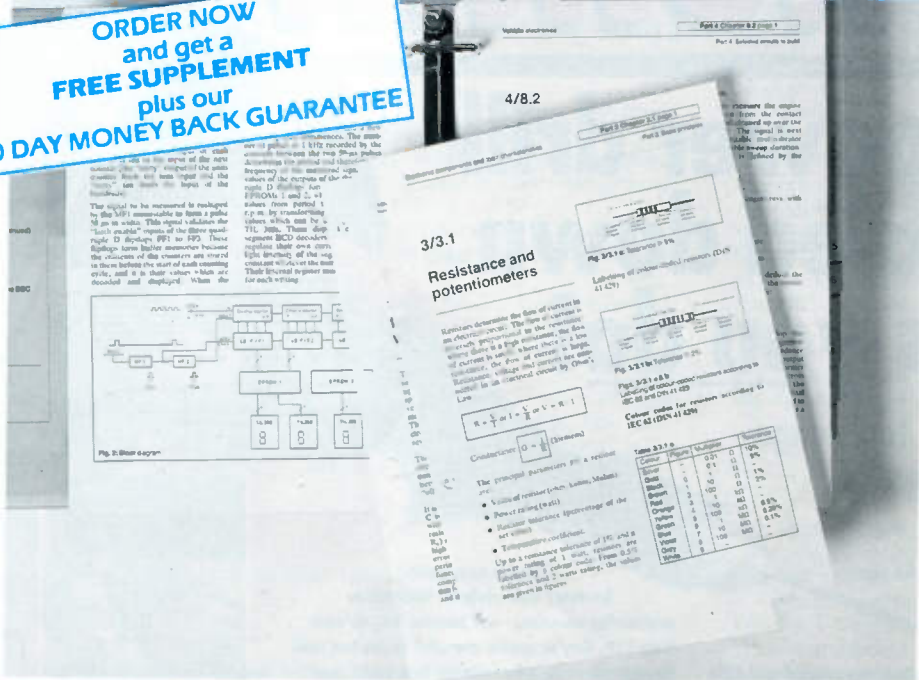
Full technical details of these products and 41,000 others in the 3-part Electromail Catalogue - phone for your copy now!

*Special offer price. Special offer ends 31st October 1994. Normal Price £6.50.

Order by phone - pay by Access or Visa - it couldn't be easier
PHONE: 0536 204555 FAX: 0536 405555

WHETHER ELECTRONICS IS YOUR HOBBY OR YOUR LIVELIHOOD . . . YOU NEED THE MODERN ELECTRONICS MANUAL

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



The essential reference Work

- Easy-to-use format
- Clear and simple layout
- Regular Supplements
- Sturdy ring-binder
- News of latest developments
- Full components checklist
- Extensive data tables
- Detailed supply information
- Ready-to-transfer PCBs
- Comprehensive subject range
- Detailed assembly instructions
- Professionally written

EVERYTHING YOU NEED TO KNOW ABOUT ELECTRONICS!

If the fascinating and fast-changing world of electronics is your livelihood, your study subject or simply your passion, the revised edition of **THE MODERN ELECTRONICS MANUAL** is the reference work for you to have at your side.

The Base Manual contains information on the following subjects:

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

CIRCUITS TO BUILD: Construction techniques, radio, telephony, microcomputing, measuring instruments, vehicle electronics, security, audio, power supplies, electronic music (over 25 different projects).

REPAIRS AND MAINTENANCE: Basic circuit operation for radio, television, audio/hi-fi, telephones.

DATA: Diodes, transistors, thyristors and triacs, digital and linear i.c.s, microprocessors.

The Manual also covers **Safety, Specialist Vocabulary with Abbreviations and Suppliers.**

OVER 1,000 pages, with over 900 diagrams and photographs, A4 looseleaf format weighing over 3.5kg.

ALL-IN-ONE AND EASY-TO-USE: A sturdy ring-binder allows you to use the Manual on your workbench. The looseleaf format also means you can slot in the regular supplements as they arrive – so all your information is there at a glance.

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.

GUARANTEE

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

Now – at last – the most comprehensive reference work ever produced at a price you can afford, the revised edition of **THE MODERN ELECTRONICS MANUAL** provides you with all the essential information you need.

Over 1,000 pages of well-organised and clearly explained information is brought to you by an expert editorial team whose combined experience ensures the widest coverage.

Regular supplements to this unique publication, each around 160 pages, mean that you will always be kept abreast of the latest developments from around the world as they occur

REGULAR SUPPLEMENTS

Unlike a book or encyclopedia, the Manual is a living work – continuously extended with new material. Recent or upcoming supplements include radio, superconductors, electric motors, basic electronic building blocks for beginners which can be joined together to construct elaborate circuits, filters, IBM PC and compatibles (including updating/expanding PCs). Supplements are sent to you approximately every two months. Each supplement contains approximately 160 pages – all for only £23.50 + £2.50 p&p. You can of course return any supplement (within 10 days) which you feel is superfluous to your needs.

RESPONDING TO YOUR NEEDS

We are able to provide you with the most important and popular, up to the minute, articles in our supplements. Our unique system is based on readers

requests for new information. Through this service you are able to let us know exactly what information you require in your Manual. You can also contact the editor directly in writing if you have a specific technical request or query relating to the Manual.

baby alarms – plus – many more popular devices.

**Wimborne Publishing Ltd.,
6 Church St, Wimborne,
Dorset BH21 1JH
Tel: 0202 881749 Fax: 0202 841692**

ASSEMBLING ...

There's nothing to beat the satisfaction of creating your own project. From basic principles to circuit-building, the Manual describes clearly, with appropriate diagrams, how to assemble radios, loudspeakers, amplifiers, car projects, measuring instruments etc. The revised edition of The Modern Electronics Manual contains practical, easy-to-follow instructions for building a wide range of projects. It shows you how to make fun gadgets such as a remote control door opener and a digital rev. counter for your car. It also tells you how to construct useful devices like test gear, security and



THE MODERN ELECTRONICS MANUAL

Revised Edition of Basic Work: Now contains over 1,000 pages of information.

Regular Updates: Approximately 160-page supplements of additional information which are forwarded to you immediately on publication. These are billed separately and can be discontinued at any time.

Presentation: Durable looseleaf system in large A4 format (297mm × 210mm)

Price of the Basic Work: £39.95 + £5.50 p&p (to include a recent supplement free).

PLEASE send me **THE MODERN ELECTRONICS MANUAL** plus a **FREE SUPPLEMENT**. I enclose payment of **£45.45** (£39.95 plus £5.50 postage and packing). Should I decide **not** to keep the Manual I will return it to you in good condition within 30 days for a full refund of this payment. I shall also receive the appropriate supplements several times a year. These are billed separately and can be discontinued at any time.

FULL NAME
(PLEASE PRINT)

ADDRESS.....

.....

..... **POSTCODE**

SIGNATURE.....

I enclose cheque/PO payable to Wimborne Publishing Ltd.

Please charge my Visa/Mastercard/Access

Card No. **Card Ex. Date**

ORDER FORM

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

**Wimborne Publishing Ltd, 6 Church Street
Wimborne Dorset BH21 1JH**

**We offer a 30 day MONEY BACK
GUARANTEE – if you are not happy with
the 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.

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

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

Note surface mail can take over 10 weeks to some parts of the world. Each manual weighs about 4.5kg including the free supplement when packed.

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

VIDEOS ON ELECTRONICS

A range of videos designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They should prove particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc.

VT201 to VT206 is a basic electronics course and is designed to be used as a complete series, if required.

VT201 54 minutes. Part one; D.C. Circuits. This video is an absolute must for the beginner. Series circuits, parallel circuits, Ohms law, how to use the digital multimeter and much more. **Order Code VT201**

VT202 62 minutes. Part two; A.C. Circuits. This is your next step in understanding the basics of electronics. You will learn about how coils, transformers, capacitors, etc are used in common circuits. **Order Code VT202**

VT203 57 minutes. Part three; Semiconductors. Gives you an exciting look into the world of semiconductors. With basic semiconductor theory. Plus 15 different semiconductor devices explained. **Order Code VT203**

VT204 56 minutes. Part four; Power Supplies. Guides you step by step through different sections of a power supply. **Order Code VT204**

VT205 57 minutes. Part five; Amplifiers. Shows you how amplifiers work as you have never seen them before. Class A, class B, class C, op.amps. etc. **Order Code VT205**

VT206 56 minutes. Part six; Oscillators. Oscillators are found in both linear and digital circuits. Gives a good basic background in oscillator circuits. **Order Code VT206**

By the time you have completed VT206 you have completed the basic electronics course and should have a good understanding of the operation of basic circuit elements.

Now for the digital series of six videos. This series is designed to provide a good grounding in computer technology.

VT301 56 minutes. Digital One 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 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 56 minutes. Digital Three is your next step in obtaining a solid understanding of the basic circuits found in today's digital design. Gets into multiplexers, registers, display devices, etc. **Order Code VT303**

VT304 57 minutes. Digital Four 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 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 gives you a thorough understanding in the basics of the central processing unit and the input/output circuits used to make the system work. **Order Code VT306**

By now you should have a good understanding of computer technology and what makes computers work. This series is also invaluable to the computer technician to understand the basics and thus aid troubleshooting.

NEW 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**

Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier.
(All videos are to the UK PAL standard on VHS tapes)

VCR MAINTENANCE

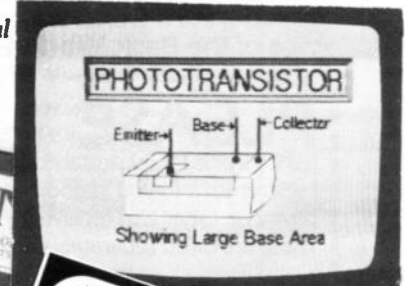
VT102 84 minutes: Introduction to VCR Repair. Warning, not for the beginner. Through the use of block diagrams this video will take you through the various circuits found in the VHS system. You will follow the signal from the input to the audio/video heads then from the heads back to the output. **Order 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**

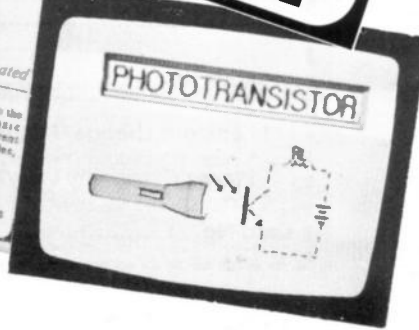
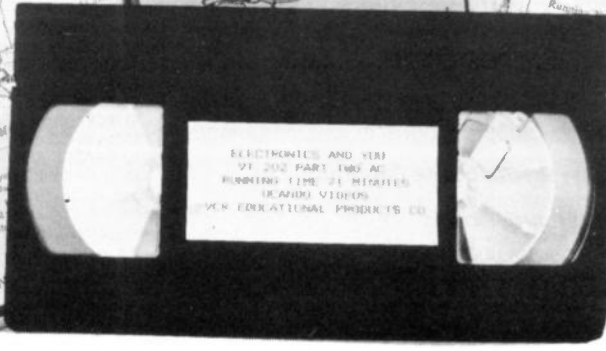
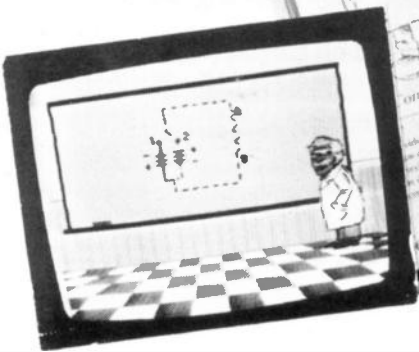
ORDERING: Add £1 p&p per order for UK orders. **OVERSEAS ORDERS:** Add £2 postage for countries in the EEC. Overseas orders outside the EEC countries send £24.44 per tape (price less VAT) plus £3 per tape airmail postage (or £3 per order surface mail postage). All payments in £ sterling only (send cheque or money order drawn on a UK bank. Visa and Mastercard orders accepted - please give card number, card expiry date and cardholders address if different to the delivery address. Send your order to: Direct Book Service, 33 Gravel Hill, Merley, Wimborne, Dorset BH21 1RW (Mail Order Only)

Direct Book Service is a division of Wimborne Publishing Ltd., publishers of *Everyday with Practical Electronics*. Tel: 0202 881749. Fax: 0202 841692

£29.95
each inc. VAT

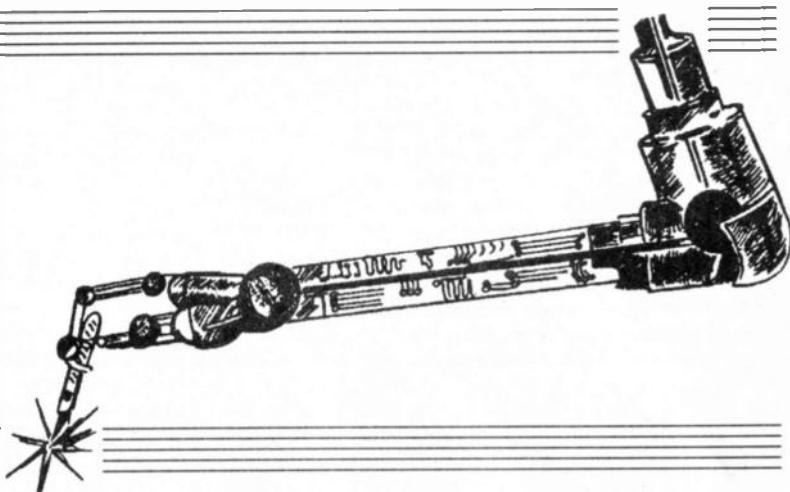


ORDER EIGHT OR MORE TOGETHER - GET ONE FREE



CIRCUIT SURGERY

ALAN WINSTANLEY



Our monthly round-up of constructors' questions and suggestions this month includes a small selection of readers' own circuit ideas, also more information on capacitor identification and a battery back-up for boat owners.

Marine Battery Back-up

We covered the topic of power back-up systems in some depth in earlier *Circuit Surgery* articles, illustrating various ways of using custom-made chips such as the MAX 8211 and the 7673. A boat-owner himself, Mr. G.M.C. Taylor from Worcestershire asks a question relating to one of these specialised integrated circuits.

My requirement is to provide a back-up for the Decca and GPS navigators which require 10V to 15V d.c. at about one amp. At present they are operated from the 12V services battery with manual change-over to the starting battery, but I'd prefer a system of automatic changeover to a "dedicated" Ni-Cad battery.

Mr. Taylor pointed the way in his letter by referring to the 7673 device (see *Circuit Surgery*, April 1994). This 8-pin d.i.l. device monitors two power supply input voltages (V_{PI} and V_{SEC}) and automatically switches its output pin (V_O) to the highest supply, behaving as a superfast (50 μ S) break-before-make change-over switch. It will cope with up to 15V d.c. supplies (18V absolute maximum) and will drive loads in the low tens of milliamps directly. It's possible to make the secondary battery a rechargeable nickel-cadmium (Ni-Cad) and have this constantly trickle-charging, as shown in April's issue. By adding a pair of external *npn* pass transistors, the chip can be made to drive higher loads.

A suggested circuit for a battery back-up system is shown in Fig. 1. This circuit is intended as a starting point for readers to experiment with "in the field". As always, any readers' feedback or experiences are welcome. R1 and D1 provide a trickle charge current for the back-up battery. Without a doubt, it is worth shopping on the surplus market for a source of cheap Ni-Cads. Eight cells are required in series to obtain a 10V d.c. back up (the minimum level specified), and buy the largest capacity cells you can afford. They must not be paralleled in an attempt to increase capacity.

Resistor R1 is selected for a trickle current of say C/10 to C/50, where C

is the total battery capacity in Amperes-Hours. If the primary supply is a nominal 12V, assume a voltage drop of 2V across the resistor and calculate the trickle current flowing through it. For example, a series connection of eight 2AH cells would provide 10V which assuming a trickle of C/50 suggests a series resistor of 50 ohms (2V/40mA).

The two transistors could be Darlingtons types such as the BDX34B, rated at a very conservative 10A with an hFE of 750. They shouldn't need a heatsink. Once again, I emphasise that this is a suggested circuit only but it is very simple and will hopefully operate a complex load without any problems.

Capacitor Markings

In May's *Circuit Surgery* we looked at capacitor nomenclature and the unusual markings which appear on some types of capacitor. Mr. W. Carter of Holmfirth, Yorkshire followed up on that "unidentifiable capacitor" shown in May's issue (Fig. 1d). He advises that it's actually a 300pF \pm 5% 100V working voltage type - so I was wrong on that one! Mr. Carter also kindly sent me an example of a 5-6pF ceramic "NP0" type. I am especially indebted to Mr. B.J. Taylor of Rickmansworth who supplied exhaustive data on these capacitor types and fully identified that cap. Mr. Taylor says:

Regarding Mr. Key's mysterious capacitor, I would expect this to be a 300pF \pm 5%, 100V maximum working voltage, with a negative temperature co-efficient of minus 750 parts per million per degree Celsius, which is what "N750" indicates. At one time it was jolly useful to specify a capacitor's tempco. to cancel out tuning drift in home-made FM tuners without AFC circuits - these tended to drift when the cabinet became warm! Sometimes a coloured band on the body of a ceramic is used to indicate the temperature co-efficient as follows:

| | | | |
|--------|-------------------------|--------|------|
| Black | NP0 (i.e. zero tempco.) | | |
| Brown | N030 | | |
| Red | N080 | Blue | N470 |
| Orange | N150 | Violet | N750 |
| Yellow | N220 | Grey | P030 |
| Green | N330 | White | P100 |

The figures equate to p.p.m. per degree Celsius and "N" represents a negative and "P" a positive co-efficient. Note the "NP0" mark which equates to a zero temperature co-efficient.

Apart from the NP0 group, there are other variants, too - such as the X7R and Z5U classes which trade off stability against the size of the capacitor body, and although these aren't often listed in a retailer's catalogues, the right type is important if you're involved with miniature surface-mount boards where you

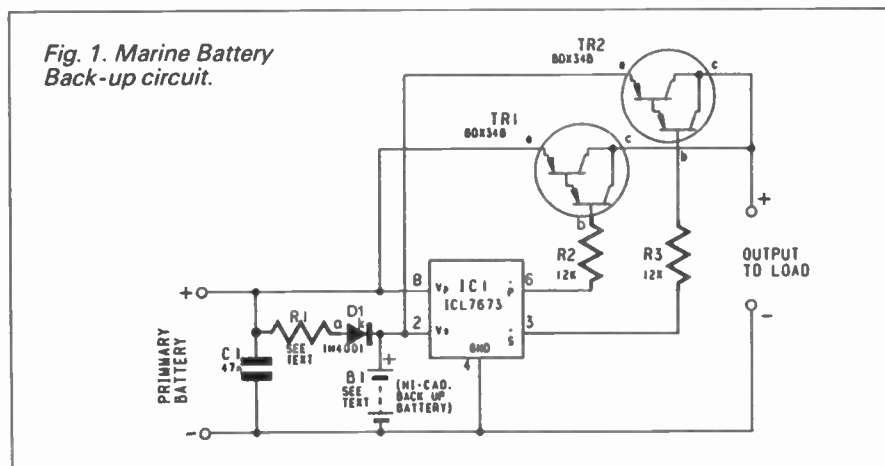


Fig. 1. Marine Battery Back-up circuit.

might be forced to compromise between temperature stability and physical size.

Spoilt for choice

It can be quite a job to decide what sort of capacitor to pick for a particular application, but unless you have a particularly demanding requirement, generally the choice boils down to a small number of varieties which are readily available from all the usual sources. Capacitors are classified by their dielectric material, i.e. the material which is used to separate and insulate the two capacitor plates. Different dielectrics give rise to particular characteristics which can affect the performance of the circuit. Mr. Kenneth Yeo of Glasgow asked for help in this respect:

I started my practical interest in electronics by buying some mixed capacitor packs, but even with the help of catalogues, I find the various types confusing with respect to their specific applications. Could you help me to sort them out?

Table 1 below summarises the readily available types we see so often in our projects.

Table 1. Capacitor Selector.

| Dielectric Material | Typical Range | Typical Tolerance | Leakage | Typical Applications |
|---------------------|-----------------------------|-----------------------|-----------|--|
| Ceramic | 1pF - 0.47 μ F | -20% to +80% | Average | RF, decoupling |
| Electrolytic | 100nF - 470,000 μ F (!) | -20% to +50% or worse | Very poor | PSU smoothing, decoupling, timers. |
| Polycarbonate | 100pF - 10nF | 10% | Good | High stability decoupling, filters and timers. |
| Polyester | 1nF - 1 μ F | 5 to 20% | Good | General purpose |
| Polypropylene | 100pF - 47nF | 1 to 20% | Very good | High stability, high voltage, filters, tuned circuits etc. |
| Polystyrene | 10pF - 33nF | 1 to 5% | Excellent | Low loss, high stability, filters, tuned circuits. |
| Silver Mica | 3.3pF - 4.7nF | 1% typical | Very good | High stability, RF, filters. |
| Tantalum 85ad | 100nF - 100 μ F | \pm 20% | Poor | Timers, PSU decoupling. Compact. |

You will find that an EPE project designer will specify any critical factors concerning any particular capacitors, in the constructional article itself. Also, we always include any extra buying information in our monthly *Shop Talk* column. This will indicate any part numbers, sources and other essential data where any unusual components may be called for. You should check the Components List closely in addition, just to be certain.

Ahoy Landlubbers!

Some interesting correspondence ensued following my simple Bilge Pump Controller project (June issue). Mr. David Dewey of Bovingdon, Herts, had a similar sort of problem with a "water still" pump controller some year ago. He suggests:

My solution used a pressure switch from an old washing machine. These are used to control the water fill level and are available from junk yards. I used an upturned

funnel connected by a length of rubber tube to the pressure switch. As the water level gradually rises, the air in the funnel is compressed into the level switch, until the switch turns off the still - or it could operate a bilge pump directly. The solution was so simple that I recommend it to anyone wishing to control virtually any liquid.

A brilliant example of lateral thinking, if I may say so! Mr. R. Chatfield of Reading went further, suggesting a variety of home-spun improvisations which incorporated a cistern ball-cock and float, a brake light switch, alternatively a mercury switch or a car petrol tank float sender unit would have sufficed. Mr. Chatfield suggested that my controller was "needlessly expensive and unnecessarily complex" and also indicated that something like a washing machine level switch was adequate for the job.

Well, Mr. Chatfield, our original enquiry did ask for an electronic solution and no matter how elaborate or complex the original circuit may seem, the design is in electronics terms an extremely simple one. The LM1830N integrated

circuit performs a complex function very easily and neatly, and solves many potential troublesome problems at a stroke.

There are often other ways in which constructors can improvise - an essential quality of hobbyists - but an electronic module such as my own Bilge Pump Controller provides a completely reliable, maintenance-free solution with no moving parts (except for a relay). You can also readily tweak the circuit to make it perform exactly as you require - it's the way to go!

Meanwhile, reader *Alwyn Beck* over in Rochdale is using the Bilge Pump Controller to help pump drinking water! Well not quite - like many modern caravans, his tourer has a fully submerged 12V electric pump for hot and cold water which can be damaged if the water tank has emptied. The water's necessary to circulate through and cool the pump - so Mr. Beck has used the controller circuit to disconnect the sup-

ply before the water level had dropped too far. As an extra refinement, the relay's changeover contacts are used to sound an alarm buzzer: it warns that the 12V supply must be switched off and the tank refilled.

"Illegal" logic

My item on logic bistables (*Circuit Surgery*, May issue) prompted an interesting query from *Andrew Judge* of Tadworth, Surrey.

I found your article very clear but have one query - what does it mean when you say that "pressing both switches produces a forbidden or indeterminate state"? If both switches are pressed, pins 1 and 5 are grounded (LOW logic). Assume pin 2 is high, pin 3 output will be a logic HIGH, so would output pin 6. Is this only "forbidden" in the sense that it may not be a change from a previous state?

The reason for the "illegality", Andrew, is that in the context of bistables, it is technically impossible to have both outputs at the same logic levels - they must always be mutual opposites.

You're right to point out that this particular circuit, which is constructed from logic gates, will still hang together and the truth tables of the individual gates themselves will still be obeyed if both switches are closed. However, bistables have two outputs, actually designated Q and \bar{Q} . Being complementary or the opposite of each other, it's impossible for both outputs to have the same level and the logic laws of a bistable to be obeyed. Hence, pressing both switches will produce an "illegal" state in the general context of a logic bistable circuit.

And finally

A small number of readers' ideas are shown below this month. These may help or stimulate thinking but have not been proven by ourselves. Last month we invited your opinions about re-introducing the *Practical Electronics* "Ingenuity Unlimited" feature. Please tell us what you think. We will pay between £10 to £50 for your electronic circuit designs, which must be the readers' own work and not have been published elsewhere. If there is sufficient interest we will be glad to re-instate this popular feature. We look forward to hearing your views.

Readers' Bright Ideas

This month we reproduce a small number of readers' hints and tips. These have not been proven by ourselves but they may stimulate further thought.

Regulator Protection

A dual \pm 15V power supply is shown in Fig. 2. By adding two rectifiers across each regulator as indicated, extra protection is afforded to them which might save the cost in due course of replacement capacitors or regulators. D1 and D2 protect the i.c.s from C3 and C4 discharge. This is also useful with bench power supplies to avoid the possibility of any capacitors in the load circuit trying to discharge backwards into the regulators when the main power is switched off, when the i.c.s would possibly become reverse biased.

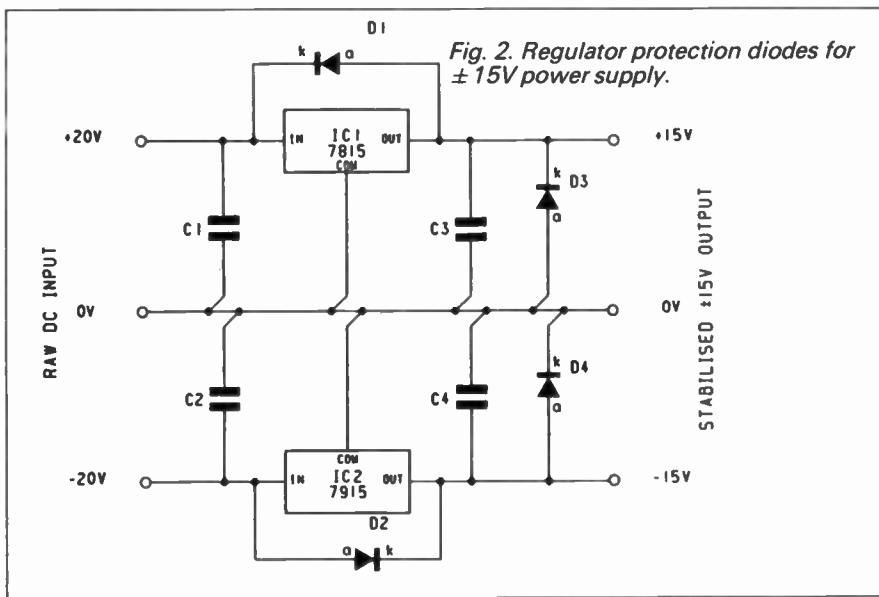


Fig. 2. Regulator protection diodes for $\pm 15V$ power supply.

I found that sometimes, the regulators don't "start up" properly, for example the +15V rail may measure correctly but the negative rail is only -1V or so. On one occasion a full +28V appeared on the positive rail and -2V on the negative rail! The cause might be partly due to unequal current demand on the two rails at switch-on. The two diodes D3 and D4 seemed to cure this, and are well worth the extra 10p. or so. *Barry Taylor, Rickmansworth, Herts.*

Car Battery Monitor

A "cheap and cheerful" voltmeter which measures the condition of a 12V car battery, is shown in Fig. 3. A 2V

f.s.d. voltmeter monitors the potential between points "A" and "B", starting at zero with a 12V battery, and rising to 2V at 14V d.c., thus the 2V meter scale expands the region of 12V to 14V battery voltage and gives a direct indication of the car battery's condition.

The Zener diodes D1 and D4 form a bridge network. At 12V supply, point "A" is 6.2V and "B" is 6.4V. At 14V input, "B" becomes 8.4V instead, the meter displays roughly 2V. The 2V7 Zener (D2) protects the meter against over-voltage whilst D3 protects against reverse voltages, which will occur below 12V d.c. input. The circuit could be used for boat or caravan batteries too. *J.P. Brady, Calstock, Cornwall.*

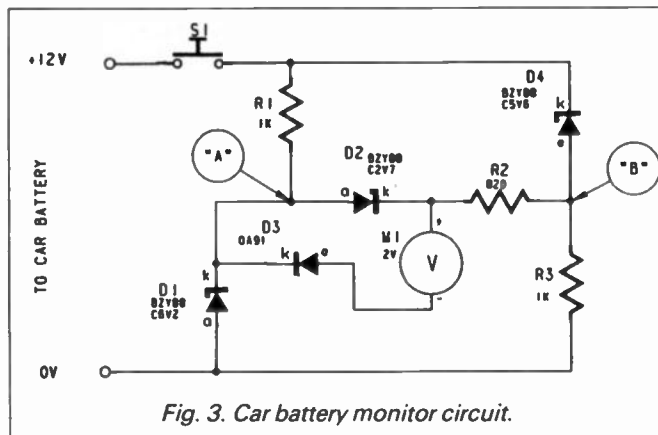


Fig. 3. Car battery monitor circuit.

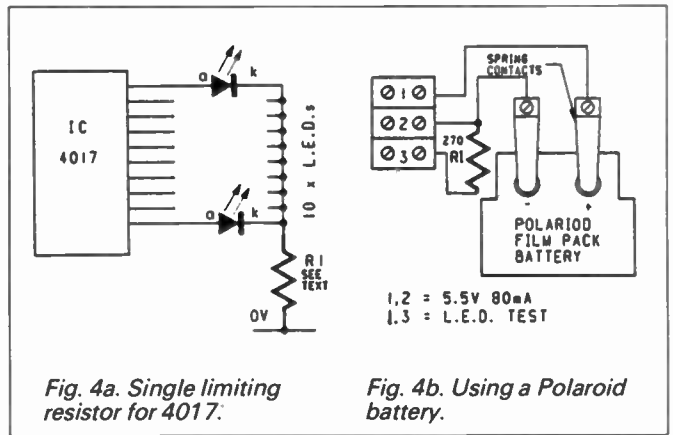


Fig. 4a. Single limiting resistor for 4017.

Fig. 4b. Using a Polaroid battery.

RING BINDERS FOR EPE

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

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

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

Send your payment in £'s sterling cheque or PO (Overseas readers send £'s sterling bank draft, or cheque drawn on a UK bank or pay by credit card), to Everyday with Practical Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: 0202 881749. Fax: 0202 841692 (We cannot reply to overseas queries by fax due to the high costs).

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

Everyday with Practical Electronics, August, 1994



4017 limit resistors; Polaroid batteries

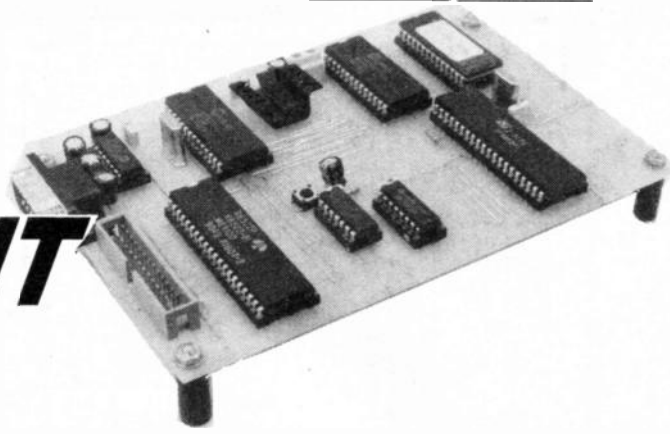
When using a CMOS 4017 Decade Counter to drive a series of light-emitting diodes, only one series resistor is needed for all ten l.e.d.s because only one output is active at any time, see Fig. 4a. This does not apply to certain circuits such as traffic light sequencers or circuits with "delay off" capacitors for each l.e.d.

A source of "free" power can be derived from the Polaroid Image System film pack which contains a battery, this has some power remaining even when the films have been used, refer to the illustration in Fig. 4b. The battery can be used with a 270 ohm series resistor for testing l.e.d.s and also can be used to power other projects.

The spring metal contacts were cut off the Polaroid pressure device of the film pack and screwed to an insulating base, the battery itself can then be slid under the springs to make electrical contact with the battery terminals. A "flat" battery in shape only! *R.L.A. Latham, Weeping Cross, Stafford.*

Circuit Surgery tries to help readers and students who may have encountered problems in electronics. If you have any suggestions for topics to include in this column, or ideas for potential projects – or advice which you think might benefit others – then write to me: Alan Winstanley at *Circuit Surgery*, 6 Church Street, Wimborne, Dorset, BH21 1JH. Please note, I cannot advise on the repair of commercial equipment and whilst I cannot guarantee an individual reply, we do read every letter. Your views count, so write in. See you next month!

6802 DEVELOPMENT BOARD



RICHARD STONE

A microprocessor development system that employs "Public Domain" and "Shareware" software to provide an inexpensive but practical and versatile unit.

THIS article describes the design and construction of a small microprocessor development board based around the Motorola 6802 eight-bit microprocessor. The article came about as it was perceived that there were a large number of electronics enthusiasts who would like to be able to develop applications using microprocessors who were unable to due to the comparatively high cost of "professional" microprocessor development tools.

This high cost generally precludes the use of such tools to commercial concerns. However, suitable software exists as Public Domain Shareware for the IBM PC and compatibles and the required hardware is fairly simple and hence relatively cheap as well. The development system that is

described here is illustrated in Fig. 1, this also shows typical costs of this system compared to a professional system.

SYSTEM FEATURES

The 6802 Development Board has the following hardware and software features:

- (1) 6802 microprocessor running at 4MHz.
- (2) 6522 Versatile Interface Adaptor (VIA) featuring 20 I/O (input/output) lines and two 16-bit interval timers.
- (3) 6551 Asynchronous Interface Adaptor (ACIA) to provide serial communications with the host computer via an RS 232 compatible serial link.
- (4) 8K bytes of system ROM containing a monitor program.

- (5) 8K bytes of system RAM to contain user program.
- (6) The monitor program provides the following functions:
 - Inspect/change user memory
 - Inspect microprocessor registers
 - Download user program from host PC
 - Execute user program
 - Set/Clear breakpoint in user program

A block diagram of the development board hardware is shown in Fig. 2.

6802 MICROPROCESSOR

The Motorola 6802 is an 8-bit microprocessor which is software compatible with the earlier 6800 microprocessor. It does however feature some enhancements on the hardware side, namely on chip clock generation circuitry and 128 bytes of on chip RAM. These enhancements generally serve to reduce the chip count compared to a 6800 based system which is one of the reasons why the 6802 was chosen.

Although the 6802 is now considered rather "long in the tooth", being first introduced in the late 1970's, it has several features that make it particularly suitable for beginners to learn about microprocessor hardware and software. These include an easy to understand interface to peripheral chips and memory and a simple and flexible machine language. However, readers should note that the 6802 has sufficient processing power to undertake quite complex tasks and is certainly not obsolete.

Any microprocessor of whatever complexity can be described in terms of a hardware timing diagram and a software programmers model. The timing diagram (in conjunction with the data sheet) enables the hardware designer to interface the necessary memory and peripherals in order to realise a working system. The software programmers model is essentially a symbolic representation of the internal microprocessor registers which the programmer must manipulate (using the microprocessor machine language) in order to perform the given task.

The hardware timing diagram for the 6802 microprocessor is shown in Fig. 3 and Fig. 4 is the software programmers model.

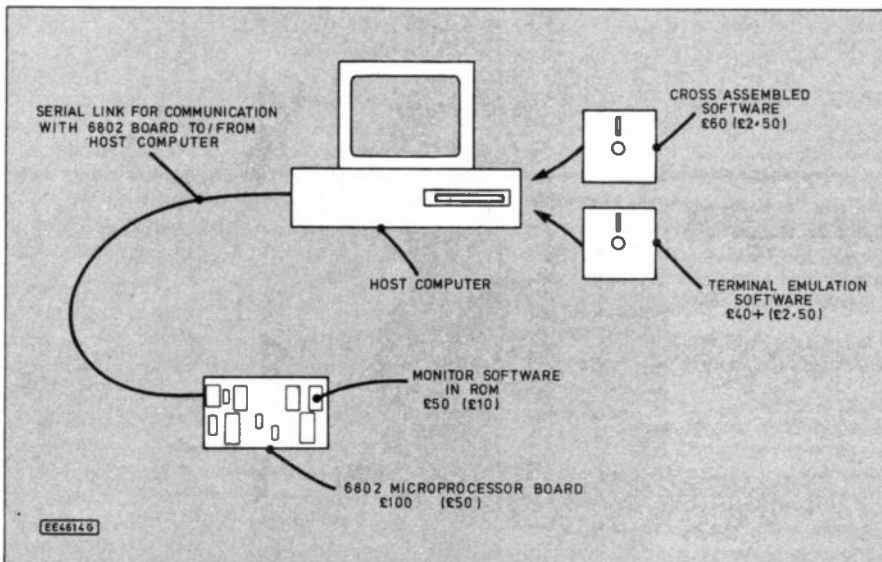


Fig. 1. Comparison of the 6802 Development Board with a professional system.

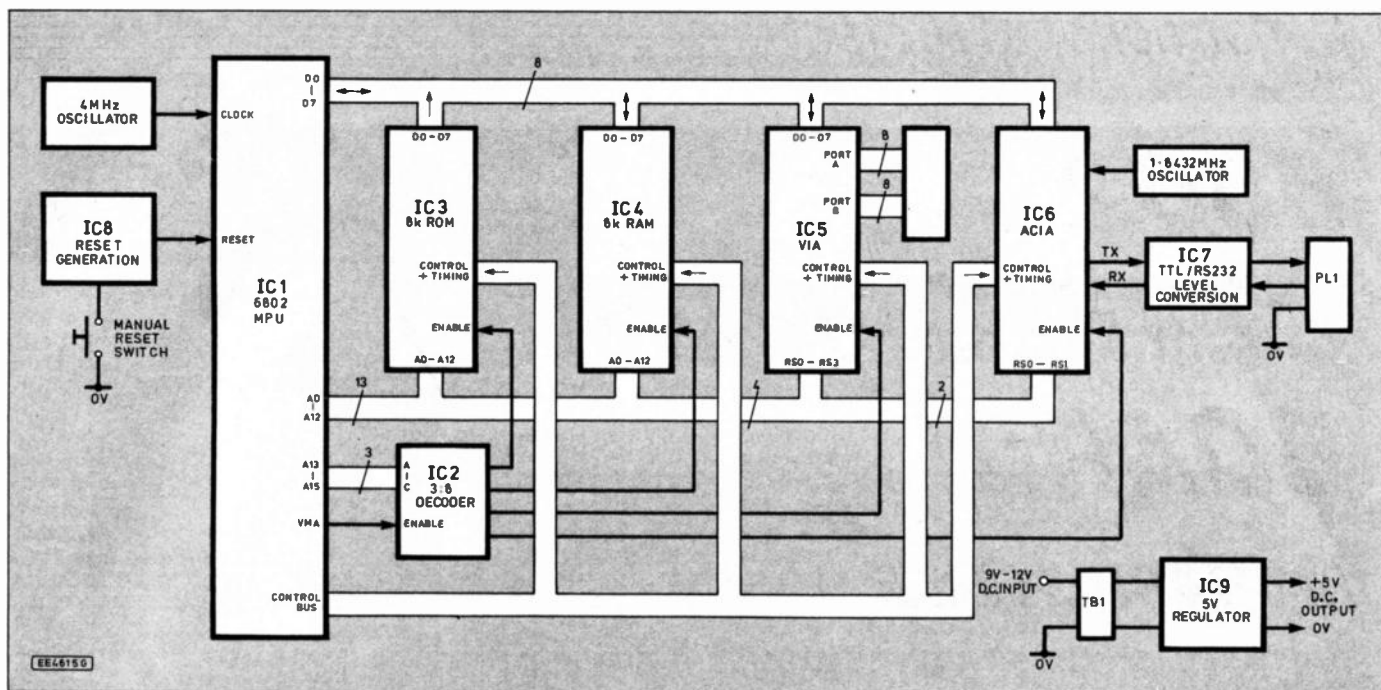


Fig. 2. Block diagram of the 6802 Development Board hardware.

These two diagrams will be referred to in more detail later.

6802 HARDWARE

The hardware design for the 6802 Development system is fairly simple as is most microprocessor based design at this level. The main point of note is that the peripheral chips used in this design (6522 and 6551) were originally intended for use with the Rockwell 6502 series of microprocessors.

This is not a problem as the 6502 and 6802 are termed "bus compatible" which means that the hardware timing diagrams are virtually identical. To have used the Motorola 6800 family peripheral chips would have quite significantly increased the chip count of the design with little or no extra benefit.

The complete circuit diagram for the 6802 Microprocessor Development Board is shown in Fig. 5 and should be referred to whilst reading the following paragraphs.

Address Decoding

The 6802 (IC1) has a 16-bit address bus which means that it can uniquely address any one of 2^{16} (65536 or 64K) byte wide memory locations. However, most memory chips and all peripheral devices intended for use with 8-bit microprocessors have considerably less addressable locations than this and hence it is necessary to divide (or decode) the 64K addressing range of the 6802 into smaller more convenient segments.

This is a very common problem in microprocessor systems design and specific chips are available to perform this task in both the TTL and CMOS logic families. The chip used in this design is a 74LS138 3-line to 8-line decoder (IC2).

The 74LS138 decodes the binary code present at the inputs (A, B and C) and drives one of the outputs (Y_0 to Y_7) logic low, with the non decoded outputs remaining logic high (providing the chip is cor-

rectly enabled at the time). In this implementation the select inputs (A, B and C) of IC2 are connected to address lines A13 to A15 of IC1 (pins 23, 24, 25) respectively. This effectively decodes the 64K addressing range of the 6802 into eight 8K segments.

The outputs (Y_0 to Y_7) of IC2 pins 13, 12, 10 and 7 are used to enable or "select" the appropriate memory or peripheral chip when the microprocessor outputs the appropriate address on the address bus. This can be illustrated by means of a "memory map" for the system which is shown in Fig. 6. This shows that the 27C64 EPROM (IC3) occupies the address range E000 to FFFF (hex) and is enabled by the Y_7 output (pin 7) of IC2.

The 6264 RAM (IC4) occupies the address range A000 to BFFF (hex) and is enabled by the Y_5 output (pin 10) of IC2. In a similar fashion the 6522 and 6551 peripheral chips (IC5 and IC6) occupy the address ranges 6000 to 7FFF (hex) and 4000 to 5FFF (hex) and are enabled by the

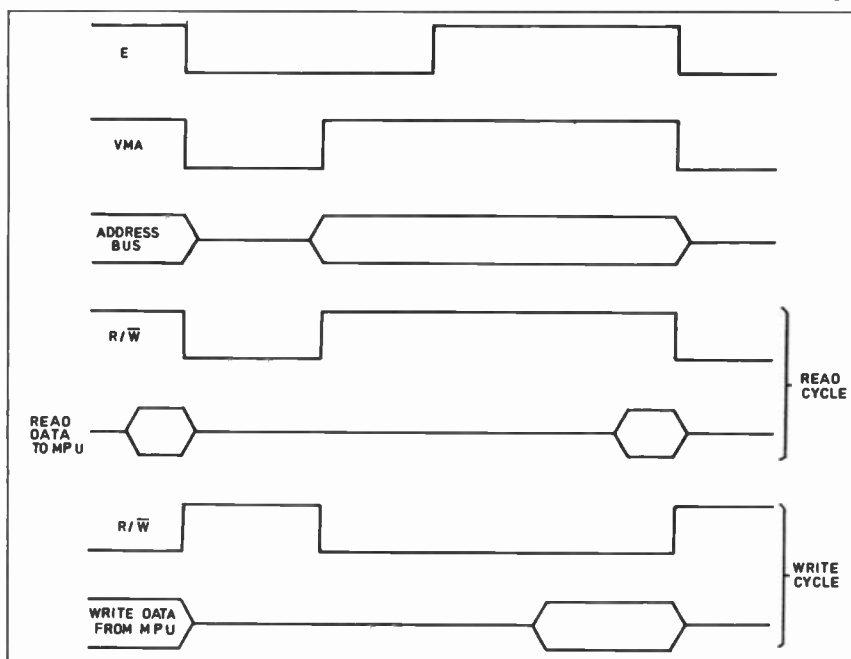


Fig. 3. The hardware timing diagram.

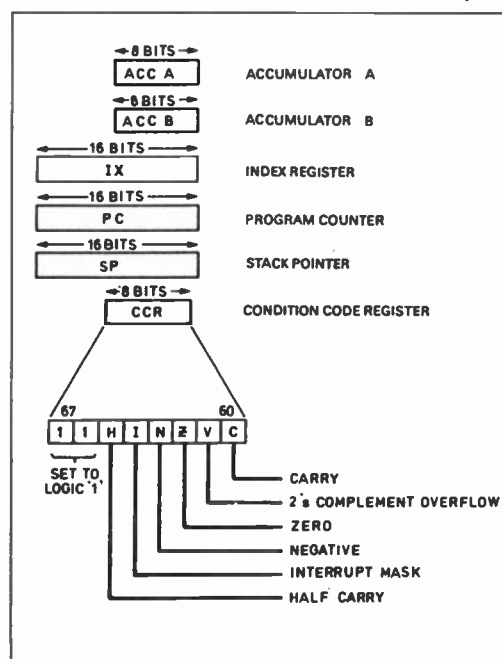


Fig. 4. Software programmers model.

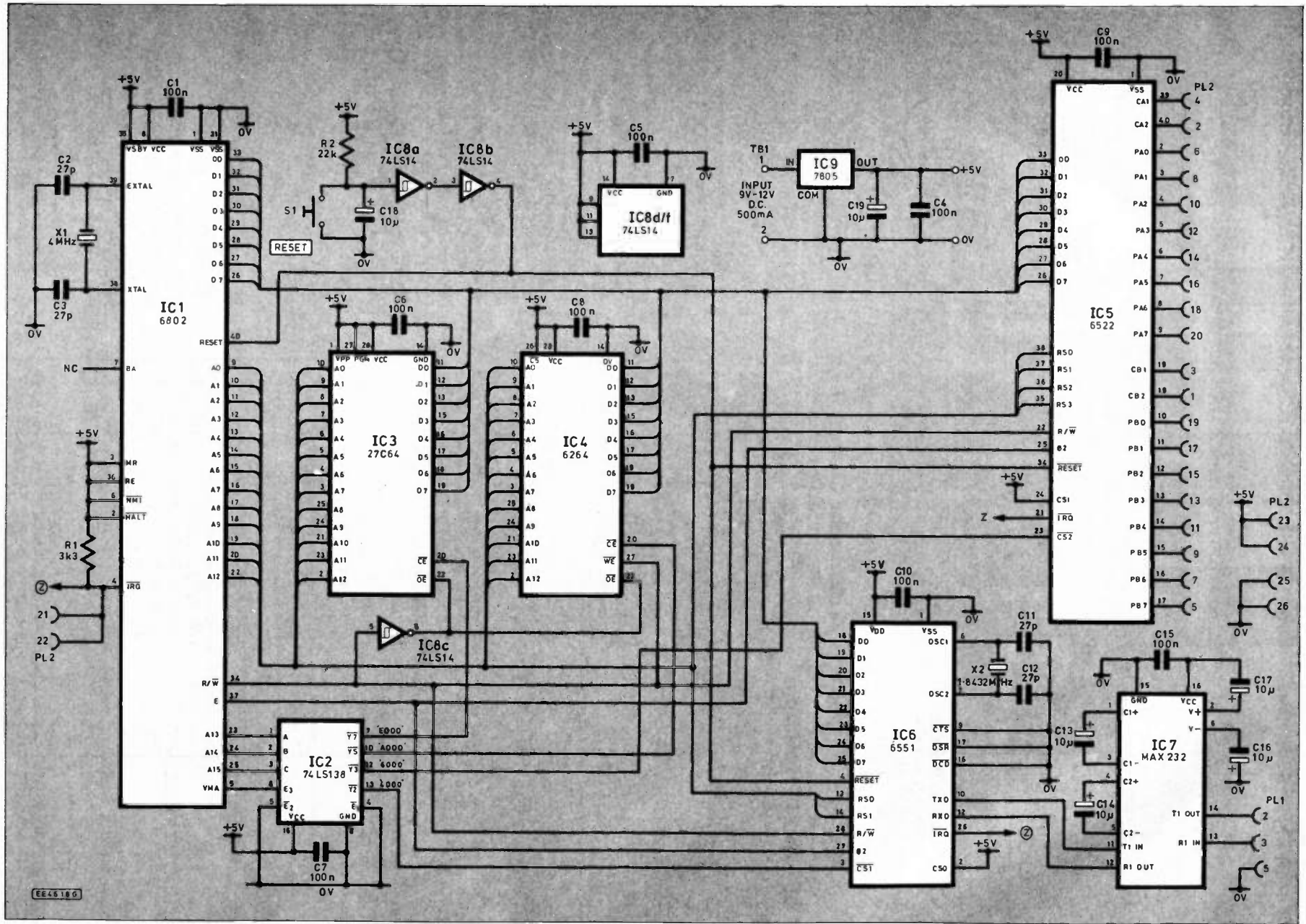


Fig. 5. Complete circuit diagram of the 6802 Development Board.

$\overline{Y3}$ (pin 12) and $\overline{Y2}$ (pin 13) outputs of IC2 respectively.

The 74LS138 IC2 has three enable ($\overline{E1}$, $\overline{E2}$ and $\overline{E3}$) inputs which must all be correctly asserted otherwise all the outputs ($\overline{Y0}$ to $\overline{Y7}$) remain at a logic high level regardless of the input state. Two of these inputs are active low ($\overline{E1}$ and $\overline{E2}$) and these are permanently asserted by connecting them to 0V.

The third input ($\overline{E3}$) of IC2 is active high and this is connected to the VMA (Valid Memory Address) output of the 6802. As the name suggests this signal is only active (logic high) when the 6802 (IC1) outputs an address during a memory read or write cycle.

This can be seen by referring to the hardware timing diagram Fig. 3. By enabling the 74LS138 (IC2) in this way it ensures that there is no possibility of memory being corrupted by being enabled if spurious signals appear on the address bus at any time.

Memory Interface

The 6802 Development Board features two memory chips, both of 8K capacity. These are a 27C64 EPROM (IC3), which contains the monitor software, and a 6264 RAM (IC4) which is used to store data used by the monitor software and also to store user generated programs whilst they are being debugged. These two chips interface to the 6802 microprocessor in a very similar fashion; only the differences between the two chips will be highlighted.

Each chip has thirteen address lines (A0 to A12), which correspond to 2^{13} (8192) memory locations within each chip. These address inputs are connected directly to the appropriate address outputs of the

6802 (IC1). Each chip also has an 8-bit data bus (D0 to D7) which again are connected directly to the appropriate pins of the 6802.

The 6264 RAM IC4 has two chip enable inputs (\overline{CE} and \overline{CS}) while the 27C64 EPROM IC3 has a single \overline{CE} input. The \overline{CS} input of IC4 is permanently asserted by connecting it to the +5V line so that both IC3 and IC4 chips are enabled by the single \overline{CE} input. These inputs are connected to the appropriate outputs of the address decoder (IC2) as explained earlier.

If IC1 needs to read data from either IC3 or IC4 then the R/W output is logic "high" during the memory access cycle (see Fig. 3). Both memory chips will only output data onto the data bus (D0 to D7) when their \overline{OE} inputs are at a logic "low" level and the respective chip enable inputs are asserted.

Consequently, the R/W output of IC1 is inverted by a section of a 74LS14 Hex inverter IC8 before being connected to the \overline{OE} input of IC3 and IC4. The 6264 RAM IC4 also has a write enable (\overline{WE}) input which is used when IC1 needs to write data to the device.

In this case the R/W output of IC1 is logic low during the memory access cycle. As the \overline{WE} input of IC4 (pin 27) is an active low input, R/W is connected directly to it. The 27C64 EPROM IC3 has two other inputs, V_{pp} and PGM, which are used during programming of the chip and need to be connected to +5V for normal operation.

Versatile Interface Adaptor

The 6522 Versatile Interface Adaptor IC5 (VIA) is a very powerful and flexible device which provides all of the system I/O (input/output) necessary in a simple system like this one. The data sheet for this chip alone runs to nearly twenty pages so it is only possible to summarise the features of the chip within this article.

The 6522 VIA communicates with the "outside" world via two 8-bit bi-directional ports. Each one of these sixteen lines can be individually programmed as either an input or an output. The 6522 also contains two 16-bit interval timers which can be used for generating pulse waveforms or counting externally applied pulses.

In addition to this it contains a serial-to-parallel/parallel-to-serial shift register and has the capability to generate an external interrupt signal if certain internal conditions are satisfied. The 6522 modes of operation are programmed by means of sixteen internal registers which appear to the 6802 (IC1) as normal RAM.

Interfacing the 6522 (IC5) to the 6802 (IC1) is extremely simple for the reasons mentioned earlier. The signals D0 to D7, R/W, \overline{IRQ} and RESET from IC5 connect directly to the appropriate pins of IC1. The 6522 signals register select inputs (RS0 to RS3) of IC5 are, as the name implies, used to address internal registers within the 6522 and hence these are connected to the A0 to A3 outputs of IC1. The $\phi 2$ input is used for synchronisation between the 6802 and the 6522 and is connected to the E output of the 6802. The $\phi 2$ nomenclature (which represents "phase 2") is a legacy from the days of the 6800 and 6502 microprocessors which used two phase clock circuits. The E output of the 6802 (IC1) is generated internally but carries the same timing information as the 6800/6502 $\phi 2$ signal.

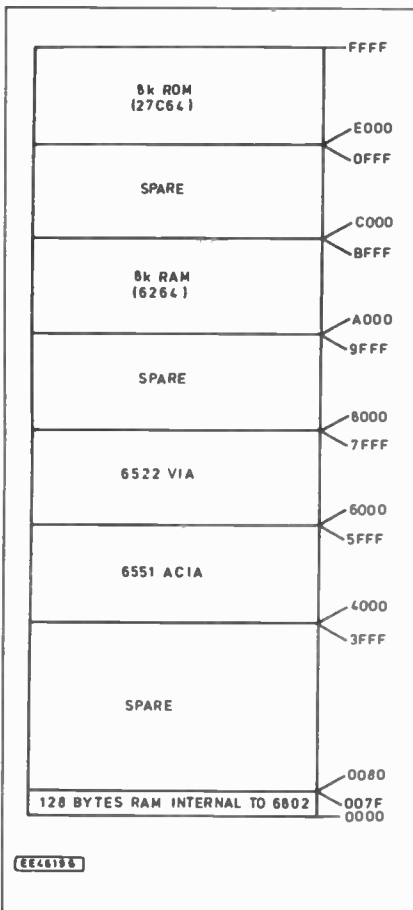


Fig. 6. System memory map.

COMPONENTS

Resistors

| | |
|---------------------|-----|
| R1 | 3k3 |
| R2 | 22k |
| 0.6W 1% carbon film | |

See
**SHOP
TALK**
Page

Capacitors

| | |
|----------------------|------------------------------------|
| C1, C4 to C10, C15 | 100n ceramic (9 off) |
| C2, C3, C11, C12 | 27p ceramic (4 off) |
| C13, C14, C16 to C19 | 10 μ radial elect. 50V (6 off) |

Integrated Circuits

| | |
|-----|---|
| IC1 | 6802 microprocessor |
| IC2 | 74LS138 3-line to 8-line decoder |
| IC3 | 27C64 ready-programmed EPROM (see Shop Talk page) |
| IC4 | 6264 RAM |
| IC5 | 6522 VIA (versatile interface adaptor) |
| IC6 | 6551 ACIA (asynchronous communications interface adaptor) |
| IC7 | MAX232 RS232 transceiver |
| IC8 | 74LS14 Hex Schmitt inverter |
| IC9 | 7805 +5V 1A voltage regulator |

Miscellaneous

| | |
|---------|---|
| X1 | 4MHz crystal (can HC-49/U) |
| X2 | 1.8432MHz crystal (can HC-49/U) |
| TB1 | 2-way p.c.b. mounting terminal block (5mm) |
| PL1/SK1 | 9-way right-angled D-plug, with straight pin socket |
| PL2/SK2 | 26-way IDC non-latching header plug, with straight pin socket |
| S1 | Miniature p.c.b. mounting push-switch |

Printed circuit board available from EPE PCB Service, code 894; clip-on TO220 heatsink; insulated 15mm p.c.b. spacers (4 off); single-core link wire; multistrand connecting wire; solder etc.

Software

Text Editor, 6802 Cross Assembler and Terminal Emulation programs - see Shop Talk page.

Approx cost
guidance only

£65

The 6522 (IC5) has two chip enable inputs, CS1 (pin 24) and CS2 (pin 23) for address decoding purposes. CS1 is permanently asserted by connecting to +5V line and CS2 is connected to the relevant ($\overline{Y3}$) output of IC2, the 74LS138 3-line to 8-line decoder i.e. discussed above.

Asynchronous Communications Interface Adaptor

The 6551 Asynchronous Communications Interface Adaptor, or ACIA for short, is used in the Development System to communicate with the host computer by means of a serial link. The 6551 (IC6) accepts data from IC1 in an 8-bit parallel format and converts this to a serial format. It then transmits this serialised data to the host computer serial port. Conversely, serialised data received by IC6 from the host computer is converted to a parallel

format which can be read by IC1 via the data bus.

One of the advantages of using the 6551 ACIA (compared to the 6800 family 6850 ACIA) is that it incorporates on-chip baud rate generation circuitry which only requires the addition of a 1.8432MHz crystal X2 and a couple of capacitors (C11, C12) if the CMOS version of the 6551 is used. The 6850 would require additional circuitry to perform the baud rate generation function.

The 6551 IC6 interfaces to the 6802 IC1 in exactly the same way as described above for the 6522 IC5. IC6 has two chip enable inputs, CS0 pin 2 and CS1 pin 3 for address decoding purposes. CS0 is permanently asserted by connecting pin 2 to +5V line and CS1 is connected to the relevant output (Y2) of IC2.

Serialised data is transmitted by IC6 via the TXD output (pin 10) and serial data is input to the RXD (pin 12). There are also three inputs, CTS, DSR and DCD, which are for use when IC6 is used to control a Modem. In this application they are required to be connected to the 0V line.

RS-232 Level Conversion Circuitry

The serial data output from the TXD (pin 10) of IC6 is at TTL voltage levels and it requires serial data input to RXD also to be at TTL voltage levels. However, the host computer requires that serial data transmission and reception is at bipolar RS232 voltage levels. Hence there is a requirement for interface circuitry between the 6551 IC6 and the host computer to perform the necessary voltage level conversion.

This is a common problem for the microprocessor systems designer and consequently several semiconductor manufacturers have come up with chips to solve this problem. One of the most popular solutions is the Maxim MAX232 RS232 transceiver chip (IC7).

This chip will both generate the necessary RS232 voltage levels for transmission and convert received RS232 format data to TTL levels whilst only requiring a single +5V supply. It generates the +10V and -10V voltages by means of internal "charge pump" circuitry which only requires the addition of four external capacitors to function. Some RS232 interface chips from other manufacturers require external dual supplies which would be a nuisance on a system that otherwise operates on a single +5V supply.

Power Supply

The 6802 Development Board requires the addition of a smoothed external 9V to 12V d.c. supply capable of supplying 500mA. The simplest way to supply this is to use one of the "plug top" transformer type power supplies. This is regulated down to the +5V required by the integrated circuits by means of a 7805 three terminal voltage regulator (IC9).

The +5V output from the voltage regulator IC9 is smoothed and ripple reduced by means of capacitors C19 and C4 connected in parallel across the output. All other chips used on the board are "decoupled" by means of individual 100nF capacitors (C1, C5 to C10, C15) mounted physically near the i.c.s and connected across the supplies.

Microprocessor Support Circuitry

In order to ensure that the 6802 IC1 functions correctly on power-up it is necessary to provide a logic low level pulse at the 6802 RESET input (pin 40) which remains low for a certain amount of time after the supply voltage has reached the correct level.

The simplest way to obtain this delayed pulse is to use an RC delay. This is implemented by resistor R2 and capacitor C18.

At power-up the slow rising edge at the output of this RC combination is "squared up" by inverter IC8a and then further inverted by IC8b. The output of IC8b provides the RESET pulse for the system. It should be noted that the peripheral chips (IC5 and IC6) are also required to be reset at power-up so the RESET pulse is fed to these as well.

The 6802 microprocessor IC1 requires a clock of some form to be present in order to operate. The 6802 has its own internal clock generation circuitry and only requires the addition of a crystal X1 and a couple of capacitors C2, C3. This feature also helps to reduce the amount of external circuitry necessary in order to design a 6802 based system compared to a 6800 based system.

The external clock frequency (4MHz in this case) is divided by four internally to give an E output clock frequency of 1MHz. 4MHz is the highest frequency that a standard 6802 should be clocked at though the 68A02 and 68B02 versions have maximum clock frequencies of 6MHz and 8MHz respectively.

The 6802 IC1 has several inputs MR, RE, NMI, HALT, and V_{sby} which are not required in a simple system so these are connected or tied to +5V. IC1 also has an interrupt request input (IRQ) which when at a logic low level can be used to interrupt an executing program.

This input, pin 4, is "pulled up" to +5V by resistor R1 and hence several interrupting sources can be connected to it, providing their interrupt output is of the "open drain" or "open collector" type. The 6522 IC5 and 6551 IC6 interrupt outputs are both of the "open drain" type and hence are connected directly to IC1 IRQ input pin 4.

It should be noted that when multiple interrupt sources are connected to the IRQ input in this way, the 6802 has no inherent

way of knowing which source caused the IRQ input to go low and the programmer has to use a software technique known as "polling" in order to determine this.

SOFTWARE MONITOR

One of the major problems of producing software for a microprocessor based design is that of "debugging" successive versions of the program until a version that functions correctly is obtained. It is an accepted fact amongst programmers that only the simplest and most trivial programs have any chance of working correctly first time.

Due to the inherent nature of microprocessors it is very difficult to find out why a program is not working correctly as the most important clues are hidden away in the internal registers of the chip. The cheapest way to develop software for a microprocessor is termed "burn and crash".

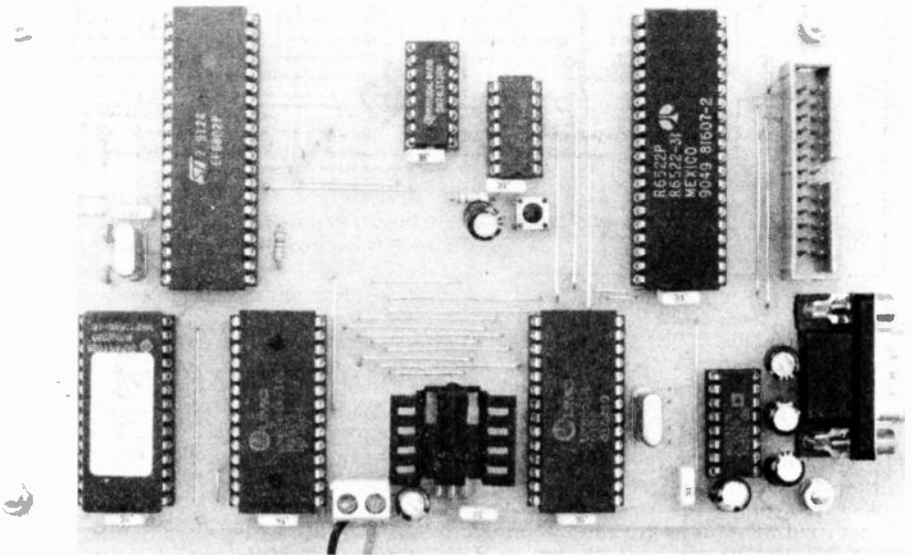
This involves burning an EPROM with the program and then trying it on the target system. The programmer must then try and infer from the external results why the program is not functioning correctly. Needless to say this is a very time consuming process although the author has developed programs successfully using only this technique.

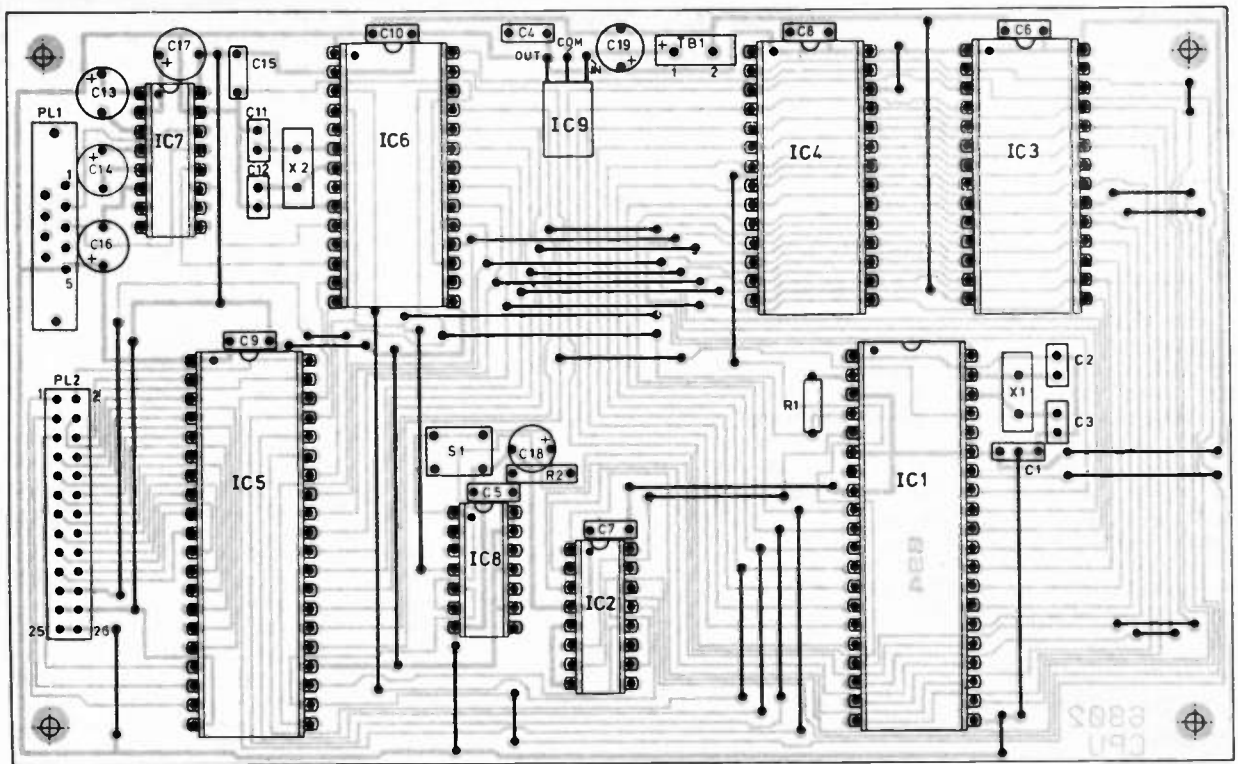
Developing software with the aid of a monitor program is a huge improvement on the "burn and crash" technique. A typical monitor program, running in ROM on the target system, will allow the program to be downloaded into the target system RAM from the host computer via a serial link. The program in RAM can then be tested, modified and retested under control of the ROM based monitor program.

The monitor program for the 6802 Development System is designed to interact with the user via a terminal. This will require the running of a "terminal emulation" program on the host computer if a dedicated terminal is not available.

The monitor program provides the following functions:-

- Inspect/change user memory (M)
- Inspect microprocessor registers (R)
- Download user program from host PC (L)
- Execute user program (J)
- Set breakpoint in user program (+)
- Clear breakpoint in user program (-)





EE46216

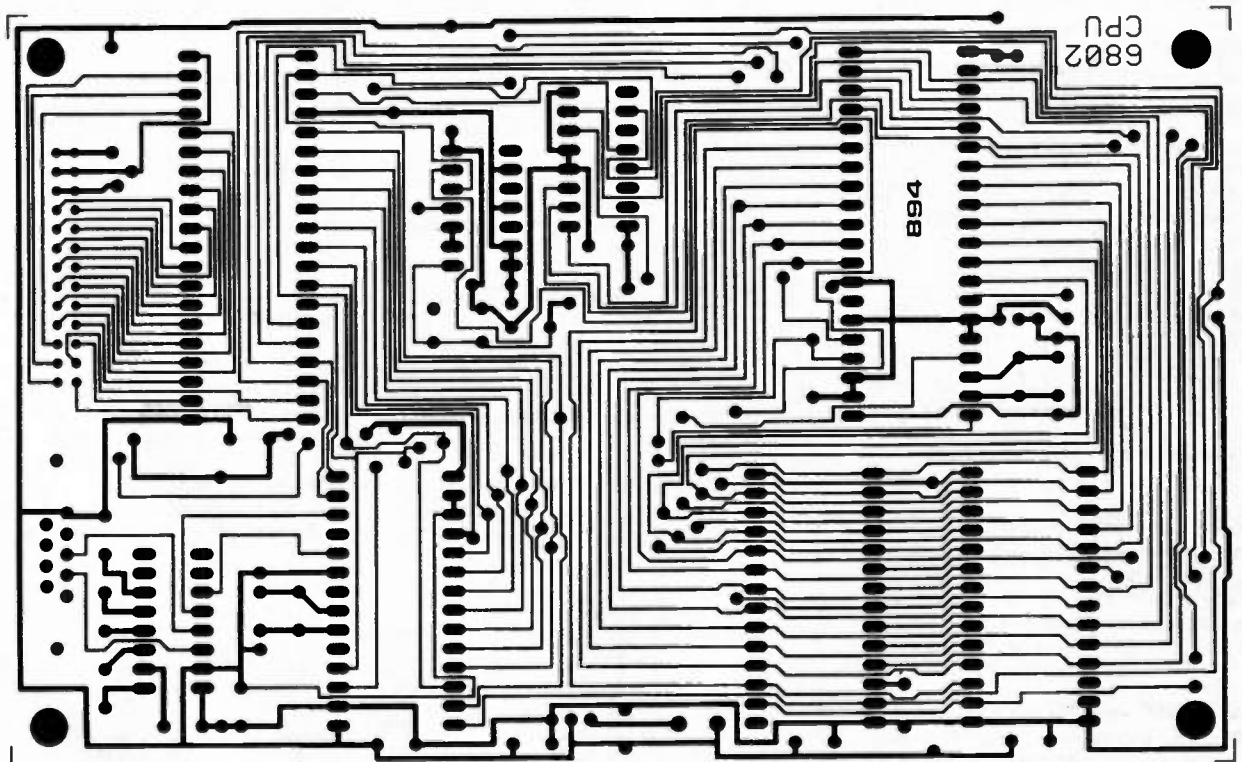


Fig. 7. P.C.B. layout and wiring for the 6802 Development Board. Note that a small clip-on heatsink is required for the regulator IC9, as can be seen in the photograph.

Each function is invoked by typing a single character on the terminal as shown above. Depending on the particular action required supplementary input may also need to be input.

When the monitor is ready to accept a new command, the ">" prompt will be displayed on the terminal. Each monitor command will now be explained in greater detail in the following text.

Inspect/Change User Memory

To invoke Inspect/Change User Memory command: 'M' must be typed at the terminal followed by the four-digit hexadecimal address of the location to be examined. The monitor will respond by printing the address followed by the memory contents.

The user can then view the contents of the next memory location by typing any character other than 'carriage return', 'space', '.', 'B' or 'N'. Typing any of these characters will cause the following alternative actions to occur:

'B' will cause the preceding memory address and contents to be displayed.

'N' will allow the user to enter a new four-digit hexadecimal address and the

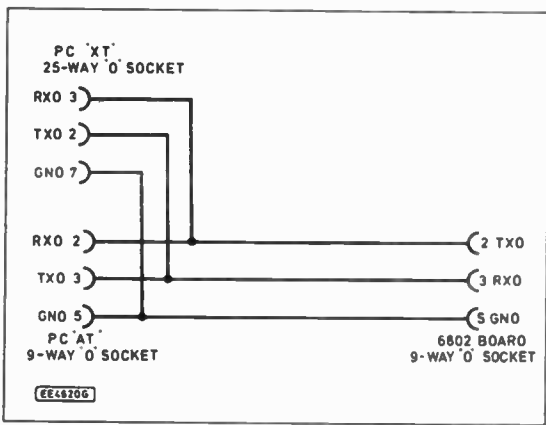


Fig. 8. Wiring diagram for the serial connector cable.

monitor will display the contents of this address.

'.' will display the memory data in the form of one machine code instruction per line.

'space' followed by two hexadecimal characters of data will attempt to replace the current data of the address by the new data. If the monitor is unable to store this data correctly (e.g. if the address is that of ROM or faulty memory) then a '?' will be displayed followed by the data actually read at that address location.

'carriage return' will cause the inspect/change memory function to be terminated and the '>' to be displayed.

Inspect Microprocessor Registers

To invoke the Inspect Microprocessor Registers command: 'R' must be typed at the terminal. This will result in the 6802 registers (see Fig. 4.) being displayed on the terminal in the following order:-

- Condition code register
- Accumulator B
- Accumulator A
- Index register X
- Program counter
- Stack pointer

It should be noted that this command will only display valid register contents if invoked immediately after an interrupt has occurred.

Download user program from host computer

To invoke this command: 'L' must be typed at the terminal. The monitor will then expect a file to be transmitted to it from the host computer.

The file will be read by the monitor program and stored in the 6802 Development system RAM. The file must be in the form of Motorola S1-S9 records which is the default format produced by most assemblers for Motorola 8-bit microprocessors.

The monitor program continually checks the received file for transmission errors and will flag these at the terminal after the file transmission has ended. This will ensure that the user does not attempt to execute an incorrectly loaded program.

Execute User Program

To invoke this command: 'J' must be typed at the terminal. This should

be followed by a four-digit hexadecimal address which would normally be the start address of the user program.

The monitor will then "jump" to this address and begin execution of the user program.

Set breakpoint in user program

To invoke this command: '+' must be typed at the terminal. This should be followed by a four-digit hexadecimal number which should be the instruction address where the user wishes to halt execution of the user program. The monitor will replace the byte stored at this address by the 'SWI' (software interrupt) op-code.

When the user program reaches this point a software interrupt will be executed. The monitor program handles this by displaying the microprocessor registers on the terminal, in the same format as for the 'R' command, before awaiting further input.

It should be noted that if a 'SWI' instruction is encountered in the user program without a breakpoint being active then a user supplied interrupt service routine will be executed instead.

Clear breakpoint in user program

To invoke this command: '-' must be typed at the terminal. The effect of this command is to clear a previously set breakpoint. The 'SWI' op-code is replaced by the original contents of the memory location.

CONSTRUCTION

The 6802 Microprocessor Development Board is intended to be used as the basis for investigation and experimentation and consequently is not enclosed in a case. As mentioned earlier a "plug top" transformer - better known as a 3-pin Mains Adaptor - is the only external component required.

All other components are mounted on a single printed circuit board (p.c.b.) which is supported on four plastic "stand-offs". External d.c. power is applied to the board via a 2-way terminal block.

All of the components for the 6802 Development board are mounted on a single-sided p.c.b. of standard single Eurocard size, 160mm x 100mm. This board is available from the *EPE PCB Service*, code 894.

The printed circuit board topside component layout and full size copper foil master pattern is shown in Fig. 7. Assembly of the components onto the p.c.b. is relatively straight forward but it is recommended that the following sequence is adhered to:

Before beginning assembly, the p.c.b. should be inspected to ensure that all holes are drilled and clear and no tracks are "shorted" together. If these prove to be all correct then the next stage is to begin mounting the p.c.b. with the components.

The initial task is to fit all the wire links using tinned copper wire of an ap-

propriate gauge (e.g. 22 s.w.g.). There are a total of 40 of these so care should be taken not to omit any. Some of the wire links are close to each other so it is important to ensure that none of these links are shorting to adjacent links.

The resistors, R1 and R2, can be fitted next followed by the i.c. sockets, if these are to be used. Although the use of i.c. sockets is not strictly essential, it is strongly recommended that they are used. The sockets will be marked in some way to indicate orientation and this should be checked against the p.c.b. component layout.

The capacitors (C1 to C18) and the crystals (XT1 and XT2) can be fitted next. Capacitors C13, C14, C16, C17, and C18 are polarised types and care should be taken that these are orientated correctly. Also, note that capacitor C1 actually straddles the end of one of the wire links.

Extra attention needs to be taken to ensure that no inadvertent short circuits occur. It should be noted that capacitors C11 and C12 are only required if a CMOS version of the 6551 (IC6) is used.

The Reset switch (S1) and the three connectors should be fitted next. The pins of S1 may need a little bending in order to fit correctly into the p.c.b.

It is also important that the 26-way IDC header is fitted with pin one positioned towards the middle of the p.c.b. edge. Care should be taken when mounting the 9-way D-plug to ensure that the sprung retaining clips locate correctly within the p.c.b.

The final component to be fitted is the 7805 voltage regulator (IC9). This component dissipates a certain amount of heat and is therefore fitted with a clip-on heatsink. This should be fitted and then the leads of IC9 should be gently bent to a right angle to the component body. IC9 can now be soldered in place.

It may be necessary to gently bend the regulator/heatsink combination backwards in order to avoid it fouling nearby components or to avoid the heatsink touching the regulator leads. The orientation of this component is important and Fig. 7. should be referred to if there is any doubt.

As the voltage regulator and heatsink combination stands proud of the rest of the p.c.b. it is important that no stress is imparted to this component during handling of the p.c.b. or fracture of the component leads is likely to result. The final operation in the construction is to fit the four stand-offs to the corners of the p.c.b.

TESTING

The first test of the assembled p.c.b. should be a visual one, to check for any soldering defects and the correct orientation of the polarised components. If this is satisfactory then an external voltage (7.5V to 9V d.c.) should be applied to the terminal block TB1, taking the utmost care to ensure correct polarity.

Check that +5V d.c. ($\pm 5\%$) is present at all the relevant points on the p.c.b. If this voltage is only present at certain points then the p.c.b. should be checked using a continuity checker for dry joints or track breaks. If the measured voltage is outside the stipulated range, the fault is almost certainly with the voltage regulator IC9.

Once the power supply has been verified then the integrated circuits can be inserted into their appropriate sockets. This should be done with *power off* and care should be

taken to ensure that the chips are both orientated correctly and mate correctly with their respective sockets.

At this stage the 6802 Development Board can be powered up and connected to the host computer. The wiring diagram for the serial cable is given in Fig. 8. The actual connector required at the computer end will depend on the host computer used.

The serial cable should be connected between the host computer and the 6802 Development Board and then the host computer should be switched on and the "Terminal Emulation" program run. The important parameters for the "Terminal Emulation" program are:

- Transmit and receive baud rates set to 1200.
- 8 data bits, 1 stop bit, no parity.
- Local echo at host computer.

The 6802 Development Board should then be powered up. If the system is functioning correctly then the '>' prompt should be displayed on the host computer screen.

If this is not the case then power should be removed immediately from the Development Board while further investigations are carried out.

The first check that should be made, and also the easiest, is that the "Terminal Emulation" program is configured correctly as described above. The documentation supplied with this program should be studied if there is any doubt. It is probably worthwhile to check the integrity of the serial cable wiring using a continuity checker or similar.

Once satisfied that the above aspects are OK then the system can then be tried again

using the procedure described above. If the system still fails to work then it is likely that the fault lies with the 6802 Development Board itself.

Microprocessor based systems are difficult to test without specialised equipment and it should be noted that unless incorrect operation is due to faulty soldering or some other easily remedied problem, then replacement of integrated circuits or other components may be necessary. In the author's experience, it is extremely unlikely that integrated circuits, which have been handled correctly, are faulty from new.

They are, however, very likely to be damaged by incorrect handling, insertion or faulty external circuitry. Therefore the importance of performing all the preliminary checks to the assembled board before power is applied cannot be overstressed.

USING THE 6802 SYSTEM

The software run by the host computer to support the 6802 Development Board comprises three distinct programs:-

- Text Editor Program.
- 6802 Cross Assembler Program.
- Terminal Emulation Program.

These programs are a mixture of "Public Domain" and "Shareware" programs. It is the responsibility of the user that any conditions of use imposed by the original authors of these programs are adhered to.

All of the programs contain sufficient documentation for the user to be able to operate them. However, a couple of tips are included here which

may help the user avoid some common pitfalls:

- Ensure that the source code file produced using the Text Editor Program is saved as an ASCII file (if this is not obligatory) and with the correct file extension required by the Cross Assembler Program.
- The Monitor Program uses the RAM from A000 to A200 (Hex) so this area should be avoided by user programs.
- Ensure that the Terminal Emulation Program is configured correctly for the 6802 Development Board each time it is run by saving the settings as "defaults".
- Ensure that all files reside in the correct directories for them to be found by the program requiring them.

Obviously it is beyond the scope of this article to fully describe 6802 assembly language programming but a suitable textbook is:

Using Microprocessors and Microcomputers: The Motorola Family. (2nd Edition 1988). Authors: Greenfield and Wray. Publisher: Simon and Schuster.

This book describes the basic theory behind microprocessors, before going on to describe the hardware and software aspects of the 6800/6802 in greater detail. It contains several useful examples of assembly language programming. □

Footnote:

1. The software monitor for this project was based on one originally written by Dr. Alan Clements of the University of Teeside. The author would like to extend his appreciation to Dr. Clements for his permission to use his original monitor design.

| | |
|---|----------------------------------|
| Inverter toroidal transformers 225VA 10 5-0-10 5V primary 0-260-285V secondary | £29.96 |
| LEDs 3mm or 5mm red or green 6p each, yellow 11p each. High intensity red, green or yellow, 5mm 30p each. | |
| Cable Ties 1p each, £5.96 per 1000, £49.50 per 10,000. | |
| High quality photo resist copper clad epoxy glass boards | |
| Dimensions single-sided double-sided | |
| 3/4 inches £1.09 £1.23 | |
| 4x8 inches £2.75 £2.99 | |
| 6x12 inches £8.20 | |
| 12x12 inches £12.25 | |
| RECHARGEABLE BATTERIES | |
| AA (HP7) 500MAH | £0.99 |
| AA 700MAH | £1.75 |
| C 2AH with solder tags | £3.60 |
| D 4AH with solder tags | £4.95 |
| 1/2AA with solder tags | £1.66 |
| AAA (HP16) 160MAH | £1.76 |
| AA 500MAH with solder tags | £1.66 |
| C (HP11) 1.8AH | £2.20 |
| D (HP21) 2AH | £2.60 |
| PP3 8-4V 110MAH | £4.95 |
| Sub C with solder tags | £2.50 |
| 1/3 AA with tags (Philips CTV) | £1.95 |
| Standard charger, charges 4 AA cells in 5 hours or 4Cs or Ds in 12 to 14 hours + 1xPP3 (1, 2, 3 or 4 cells may be charged at a time) | £6.96 |
| High power charger, as above but charges the Cs and Ds in 5 hours, AAs, Cs and Ds must be charged in twos or fours | £10.96 |
| Nickel Metal Hydride AA cells, high capacity with no memory, 1000mAh £3.85, 1200mAh | £8.40 |
| SPECIAL OFFERS - PLEASE CHECK FOR AVAILABILITY | |
| 42mm x 16mm dia. 1.2V | £1.46 |
| Stick of 4 171mm x 16mm dia., with red and black leads 4-9V | £5.95 |
| Computer grade capacitors with screw terminals, 33000pF 20V £2.60, 87000pF 10V £1.95, 68000pF 15V £2.96, 10000pF 16V £1.50, 58000pF 60V £4.96 | |
| 7-segment common anode i.e.d display, 12mm | £0.46 |
| LM2931 AT 5.0 low drop out 5V regulator TO220 package | £0.85 |
| 7812 and 7912 1.2V 1A regulators | £26.00 per 100 |
| LM337K TD3 case variable regulator 100 + £1.44 each | £1.96 |
| GaAs F.E.T. low leakage current 58873 | £12.96 each, £9.95 10 + |
| BC250 p-channel MOSFET | 45p |
| BC559 transistor | £3.96 per 100 |
| 74LS06 Hex inverter | £10.00 per 100 |
| Used 8748 microcontroller | £3.50 |
| SL1952 UHF limiting amplifier, LC 16 surface mounting package with data sheet | £1.95 |
| AM27502 | £1.25 each, 90p 100 + |
| CD4007UB | 10p 100 +, 6p 1000 + |
| Sinclair light gun terminated with a jack plug and PP3 chip gives a signal when pointed at 50Hz flickering light, with output waveform chart | £3.96 |
| DC-DC converter, Reliability model, V12P5, 12V in 5V 200mA out, 300V input to output isolation, with data | £4.96 each or pack of 10 £39.50 |
| Hour counter used 7 digit 240V a.c. 50Hz | £1.46 |
| QWERTY keyboard, 58 key good quality switches, new | £6.00 |
| Airpac A82903-C large stepping motor 14V 7.5 step, 27 ohm, 68mm dia. body, 6.3mm shaft | £8.95 or £200.00 for a box of 30 |
| Polyester capacitors, box type, 22.5mm lead pitch 0.9uF 250V d.c. 18p each, 14p 100 +, 9p 1000 + 1uF 250V d.c. 20p each, 15p 100 +, 10p 1000 + 2.2uF 250V d.c. 30p each, 20p 100 +, 15p 1000 + 3.3uF 100V d.c. 30p each, 20p 100 +, 15p 1000 + 1uF 50V bipolar electrolytic axial leads, 15p each, 7.5p 1000 + | |
| 0.22uF 250V polyester axial leads, 15p each, 100 + 7.5p each | |
| Polypropylene 1uF 400V d.c. (Wima MKP10) 27.5mm pitch, 32 x 29 x 17mm case, 75p each, 60p 100 + | |
| Philips 123 series solid aluminium axial leads, 33pF 10V & 2.2uF 40V 40p each, 25p 100 + Philips 108 series 22uF 63V axial | |
| 30p each, 15p 1000 + | |
| Multilayer AVX ceramic capacitors, all 5mm pitch, 100V 100pF, 150pF, 220pF, 10,000pF (10n) 10p each, 6p 100 +, 3.5p 1000 + 500pF compression trimmer | 60p |
| 40uF 370V a.c. motor start capacitor (dialectrol type containing no p.c.b.s) | £12.96 |
| Welwyn W23 9W 120 ohm 35p each, 20p 100 + 680 ohm 2W metal film resistor | 4p 100 +, 2p 1000 + |
| Solid carbon resistors, very low inductance, ideal for r.f. circuits, 27ohm 2W, 68ohm 2W 25p each, 15p each 100 + | |
| We have a range of 0-25W, 0-5W, 1W and 2W solid carbon resistors - please send SAE for list P.C. 400W PSU (Intel part 201035-001) with standard motherboard and 5 disk drive connectors, fan and mains inlet/output connectors on back and switch on the side (top for tower case) dims. 212 x 149 x 149mm excluding switch, £26.00 each, £138.00 for 6 | |
| MX180 Digital multimeter 17 ranges, 1000V d.c. 750V a.c. 2Mohm 200mA transistor Hfe 9V and 1.5V battery test | £12.96 |
| AMD 27256-3 EPROMS £2.00 each, £1.25 100 + | |
| DIL switch 3PCD 12 pin (ERG SDC-3-023) 60p each, 40p 100 + | |
| Disk Drive Boxes for a 5.25 disk drive, with room for a power supply, light-grey plastic 67mm x 265mm x 247mm | £7.96 or £48.50 for 10 |
| Handheld Ultrasonic remote control | £3.96 |
| CV2486 gas relay 30mm x 10mm die with 3 wire terminals, will also work as a neon light | 20p each, £7.50 per 100 |
| A23 12V battery for car alarms or lighters | 75p each, £50 100 + |
| All products advertised are new and unused unless otherwise stated. | |
| Wide range of CMOS TTL 74HC 74F Linear Transistors kits, rechargeable batteries, capacitors, tools etc. always in stock | |
| Please add £1.96 towards P&P VAT included in all prices | |

PCB Designer

For Windows 3.1
Runs on any PC running Windows in standard or enhanced mode with 2MB RAM

Only £49 All Inclusive

- ✓ Produce Single or Double sided PCBs.
- ✓ Print out to any Windows supported printer.
- ✓ Toolbar for rapid access to commonly used components.
- ✓ Helpful prompts on screen as you work.
- ✓ Pads sizes fully customisable.
- ✓ No charges for technical support.
- ✓ Snap-to grid sizes 0.1", 0.05" 0.025" and unrestricted.
- ✓ SMT pads and other pad shapes.
- ✓ Positive reviews by Robert Penfold and Paul Stenning, copies available on request.

Phone (0432) 355 414 (Access and Visa welcome)

Niche Software

22 Tavistock Drive, Belmont, Hereford, HR2 7XN.

Please Note: Since PCB designer is so easy to use, and to keep costs down, PCB Designer has an On-Line manual, in Windows Help format. A FREE tutorial is also supplied.

INTERFACE



Robert Penfold

IN THE world of computing there are various developments which are perpetually just around the proverbial corner. I think that it is fair to say that speech recognition systems have fallen into this category. Speech recognition systems have actually been in existence for many years, and I described a simple system for the BBC computers in an article in the April 1987 issue of *Everyday Electronics*.

Despite tremendous advances in computer hardware, plus a few significant developments on the software front, we have only just arrived at a PC that can genuinely take dictation. There is now one IBM system that can take dictation once the user has read a fairly long text to it to "teach" it his or her pronunciation etc.

There are also lower cost systems that can recognise a limited vocabulary of learned words, and these are designed to be used as a means of controlling programs. For example, if you were using a drawing program you could call up the circle drawing command simply by saying the word "circle". I believe that some of the Apple Macintosh computers are supplied as standard with a speech recognition system of this type.

Possibly the new generation of RISC chip computers will be the basis for low cost systems that can turn any plain speech into 99.9 percent accurate text files – or maybe this will still be something that awaits the next generation of computers!

DIY Speech Recognition

Although it is difficult to produce a speech recognition system that works to a worthwhile degree, it is not impossible to produce a do-it-yourself system. You have to settle for a fairly small vocabulary, and the finished system is likely to be of limited practical value due to problems in integrating it into applications programs. It is an interesting field for experimentation though, and it does not require any particularly expensive hardware.

The success of speech recognition systems (or lack of it) is to a large extent dependent on the efficiency of the software. It is a line of research which should therefore appeal to the software enthusiast who would like to tackle something that is both challenging and a little different. Some basic speech recognition software will be provided, but there is plenty of scope for users to refine it, or to try out their own ideas.

The obvious approach to speech recognition is to first digitise the audio input signal. This operates in the manner shown in Fig.1, where the signal voltage is sampled

at regular intervals, and the series of voltage readings obtained is stored in memory. These voltage readings provide the computer with an accurate mathematical representation of the speech waveform, and a pattern recognition routine should be able to match the waveform to the appropriate word.

Problems

In practice there are a few problems with this approach. In order to obtain an accurate mathematical representation of the input waveform the signal must be sampled at a fairly high rate. In our example of Fig.1 the sample rate is barely high enough, and on the higher frequency parts of the waveform the sampled voltages provide only a rather rough model of the waveform.

In order to obtain reasonable results the sample frequency must be at least double the maximum input frequency, and should ideally be three or more times the maximum input frequency. Speech contains a wide range of frequencies, but frequencies above about 3kHz are not essential to intelligible speech. The minimum acceptable sample frequency is therefore about 6kHz.

Words vary in duration from about 0.5 to two seconds, which represents between about 3k and 12k of data per word. Modern computers have plenty of memory, so there is no difficulty in storing a number of digitised words for comparison purposes. The problem with a straightforward digitising system is a lack of speed. Large amounts of data require large amounts of processing, which can easily render the system too slow to be of any practical value.

Also, the more detailed the digital representation of the word, the harder it is to produce an effective pattern matching system. It is easy to end up with a system that "can't see the wood for the trees". Bear in mind that the same word never sounds the same twice, even if spoken by the same person. If a speech recognition system is made too picky, it will hardly ever produce an accurate enough match. Rather than producing a high degree of reliability, the system will fail to recognise more than the occasional word.

A system that keeps things as simple as possible has definite advantages. Digitising each word into (say) 100 bytes makes it much easier to identify each word, and greatly speeds things up. The drawback of simplifying the system is that it reduces its ability to distinguish between two similar words.

A simplified speech recognition system is therefore only able to support a limited vocabulary, but in most cases this is all that is needed. Also, it is necessary to avoid using "key" words that have very similar sounds, but in practice there should be no problem in doing this.

Shaping Up

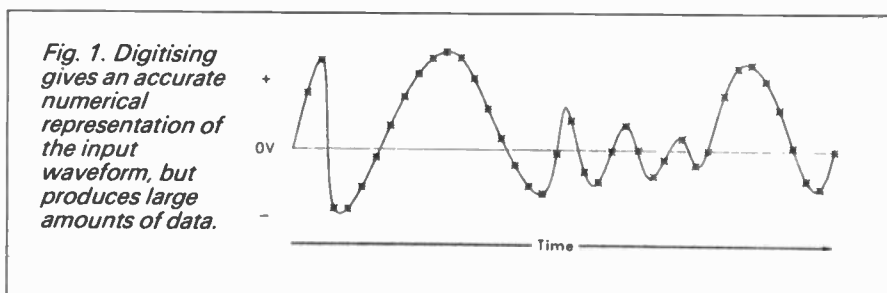
One way of simplifying the numerical representation of each word is to digitise the envelope shape. Fig. 2 helps to explain the way in which this process works. First input waveform (a) is half-wave rectified to produce waveform (b). This signal is then smoothed to produce the envelope waveform of (c).

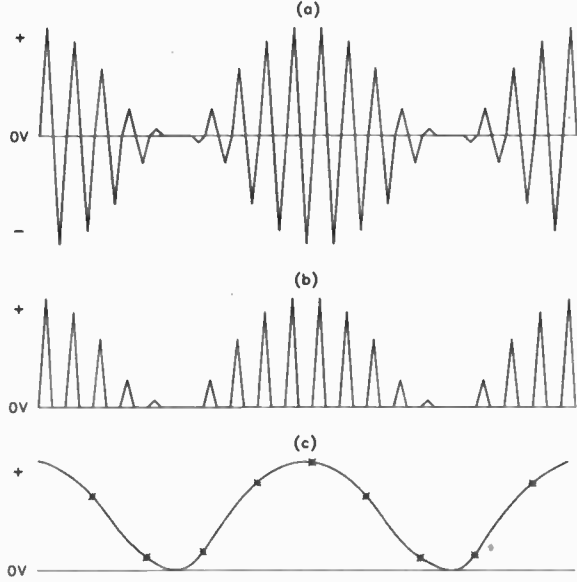
The envelope waveform follows the changes in the average amplitude of the input signal. It varies at a much slower rate than the input signal, and a low sampling rate will provide an accurate numerical representation of the envelope shape. In fact a sampling rate as low as about 25Hz seems to be satisfactory. This enables words to be digitised into about 25 bytes of data.

Unfortunately, in practice this method simplifies things too far. A lot of words which sound quite different have very similar envelope shapes. The basic envelope sampling method will work, but only if the system is limited to very few words which have significantly different envelope shapes. In "real world" applications this is likely to be too limiting for such a system to be of any practical value.

Much improved results can be obtained using a system of the type outlined in the block diagram of Fig. 3. This probably represents the most simple system that will be of any real use.

The signal from the microphone is at a very low level, so it is amplified by a high gain preamplifier in order to produce a more





usable signal level. The output from the preamplifier is split two ways. One signal path is through a highpass filter, a rectifier and smoothing circuit, and then to one output via a buffer amplifier. This produces an envelope waveform that can be digitised by the computer, but it is the envelope of the high frequency part of the input signal.

The other signal path is through a lowpass filter, a rectifier and smoothing circuit, and then to a separate output via a buffer stage. This again produces an envelope waveform, but this time it is the envelope of the input signal's low frequency content.

Advantages

This splitting of the high and low frequencies increases the amount of data per sampled word, but it still only uses about 50 bytes per word. Although there may seem to be little advantage in this separate sampling of the high and low frequency bands, it enables the unit to differentiate between different types of sound that have similar overall envelope shapes.

For example, "shhhh" and "arrrr" sounds might have very similar overall envelope shapes. However, their frequency content is very different. There is a strong high frequency content in a "shhhh" sound, but only weak signals at low and middle frequencies. Conversely, an "arrrr" sound has a strong low frequency content, but only relatively weak components at high and middle frequencies.

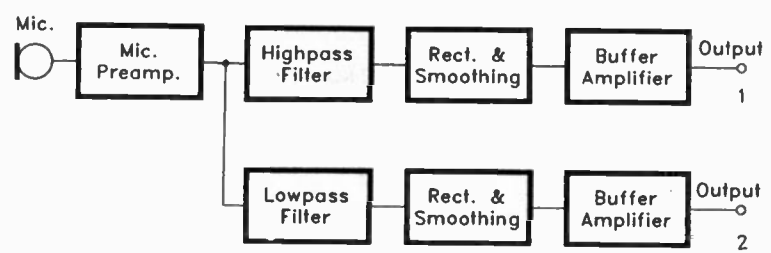


Fig. 3. Block diagram for a minimal speech recognition system.

Fig. 2. (left) Input signal (a) is half-wave rectified (b) and smoothed to produce the waveform of (c). This is then digitised using a low sample rate.

When processed by this system the two sounds will therefore produce very different pairs of envelope shapes. A "shhhh" sound will produce a strong signal from output 1, but only a weak signal from output 2. An "arrrr" sound will produce a strong signal from output 2, but only a relatively weak signal at output 1. This makes it easy for the pattern recognition system to differentiate between most words that have similar overall envelope shapes, but which sound quite different.

This method is not perfect, and it is still possible for two words to sound different, but produce similar output signals from a voice recognition system of this type. In practice the system will only have to handle a few words, and you would be unlucky to choose two words that proved to be indistinguishable. However, if necessary the system can be refined somewhat, with the signal being split into several bands.

The system for the BBC micro that I mentioned previously operated on the basis of a four way split, with approximate centre frequencies of 300Hz, 600Hz, 1.2kHz, and 2.4kHz. This system was usually capable of distinguishing between similar sounding words, but with any simple speech recognition system it is probably best to avoid using very similar words. The less similar the words you use, the more reliable the system will be, especially when your diction is something less than perfect.

A drawback of having two or more outputs is that the computer needs to have more than one analogue input port. As the sampling rate can be as low as 25Hz, a single port plus some electronic switching should be an adequate solution. Even with four outputs, sampling them all via a single analogue input only represents a total sampling rate of 100Hz. Many analogue ports can sample at rates over a thousand times faster than this.

One Voice

Anyone who uses a speech recognition system needs to be aware of a potential flaw. Virtually all practical systems operate on the basis of the user "teaching" the system various "key" words than must be recognised. In most cases each word is spoken into the system several times, and the software works out a sort of average response from the all the samples.

This method usually provides quite good reliability, but only when used by the person who "taught" the system the "key" words. This is sometimes put forward as an advantage, and I suppose that in some circumstances it could be. It would presumably prevent unauthorised use of the system.

On the other hand it can also be a disadvantage. If two or three people are to use the system, they will each need their own version of the control program, set up with their versions of the "key" words. This is not necessarily a major problem, but it is not very convenient either. There would seem to be no easy way around this problem, and it is something that users of simple speech recognition systems simply have to accept.

Next Month: Some practical circuits for speech recognition systems will be provided.

CAMBRIDGE COMPUTER SCIENCE LIMITED

LCD modules: 16 char by 1: £4.00, 20 char by 2: £6.00, 40 char by 1: £8.00

5.25" Disk Drives, 80 Tk, DSDD £18.00 each
 5.25" Disk Drives, 80 Tk, DSDD Used, No Wty £7.00 (The £7.00 drives are sold on a strictly "as is" basis)
 5.25" Disks, DSDD, 480pi, boxes of 10 £2.00/box
 Apricot Disk drive PSU 5V @ 2.5A, 12V @ 2A £10.00 each
 5V @ 6A PSU £4.00 each 5V @ 10A PSU £5.00 each
 Disk Drive Data lead BBC Micro to Disk Drives(S) Single 2.00 Dual £4.00 each
 Disk Drive Power lead BBC Micro to Disk Drives(S) Single 2.00 Dual £4.00 each
 68000 CPUs 8MHz £2.50 each
 Z80A CPU, CTC, PIO £1.20each; DMA £2.00; £4.50 all 4
 74LS TTL pick and mix, buy 10 or more for £0.12 each

Types available: 00 02 04 08 10 11 12 13 14 15 20 21 26 27 30 32 33 37 38 42 74 83 85 86 96
 107 109 122 125 132 136 138 139 145 151 153 157 158 160 162 163 164 165 174 191 193 240
 253 257 260 298 353 365 366 373 385 390 399 670 682

27128 EPROMS £2.50 each 16, 18 & 20 pin dill low profile IC sockets 0.3" wide £0.40/10; £3.00/100
 27C256 EPROMS (Ex Equipment) £1.40 each 22 & 24 pin dill low profile IC sockets 0.4" wide £0.40/10; £3.00/100
 27256 EPROMS £2.00 each
 27C256-25 EPROMS £3.50 each
 256K DRAM (Ex Equipment) £0.40 each 24, 28, 32, 40 & 48 pin dill low profile IC sockets 0.5" wide £0.40/10; £3.00/100
 6116 2K Byte SRAM £1.10 each
 6264 4K Byte SRAM £3.80 each Metal project boxes drilled & painted but unused £4.00 each
 62256 10 32K Byte SRAM £3.00 each 28 x 32.5 x 5cm £4.00 each
 65256 32K Byte SRAM £4.00 each Eurocard Racks £10.00 each
 8K Byte NV ram chips £3.00 each or £10.00 Four Keyboards, full Qwerty, no pad and LCD £8.00 each

Prices include postage. Add £1 (plus VAT) to orders below £5.00.
 All items new unless stated. Add 17.5% VAT to all prices. Send an SAE for our latest list or for more info.
 Dept EE, 374 Milton Road, Cambridge CB4 1SU
 Tel: 0223 424602, 0831 430496 or 0831 430352 (Mail order only)

**WE ARE STOCKISTS OF
 REPLACEMENT JAPANESE ICs
 AND TRANSISTORS**

**WE WOULD LIKE TO BUY OR SELL
 ALSO ELECTRONIC KITS.**

YUGA ENTERPRISE

705 Sims Drive, Shun Li Industrial Complex,
 #03-09 Singapore 1438.
 Tel: 65-741-0300 Fax: 65-749-1048.

CCD TV CAMERA UPDATE

JOHN BECKER

Viewing moons, stars and other matters.

SINCE the *CCD TV Camera* was published in the March and April 1994 issues of *EPE*, a number of questions have been raised by readers, particularly regarding the camera's use in astronomy. This article answers some of the queries.

First, I must comment that although I take an interest in the sky at night, I am not an astronomer and do not have a telescope. Consequently, I cannot answer the astronomical questions in detail. However, I have run a variety of tests and produced some very interesting results which seem to confirm the TV camera's potential usefulness for astronomical viewing.

noise data barely distinguishable from the tiny stellar images. I am sure, though, that readers who have telescopes, or camera lenses having focal lengths much greater than 50mm, will be able to obtain better images than my lens has allowed.

Theoretically, it is possible to use a Peltier-effect device to cool the sensor and reduce its noise-generation levels. It is also possible, of course, to write the software so that images are built up on the computer screen over several sample periods, using an averaging routine to suppress random noise data bits.

It should be noted that during lengthy

exposures the Earth's rotation will cause images to shift across the screen unless the camera and telescope are attached to a synchronous tracking mount.

A monochrome computer-printout of one of my views of Neptune and Spica can be seen in Fig. 1. Part of the window frame centre, on the right is a data value graph and colour reference bar.

The screen image was more dramatic in colour and ideally it should have been photographed in colour for a permanent record of the viewing. I wonder if colour printers are useful for computer processed stellar images?

SAMPLE RATE REDUCER

To suit normal TV receivers, in the published circuit the TV camera's frame-sampling rate is fixed at 50Hz, resulting in an equivalent image exposure time of one-fiftieth of a second. As implied above, star light is too feeble to be adequately registered by the image sensor at such a short exposure, even when using a wide aperture lens.

Fortunately, though, the exposure time can be increased easily by the insertion of a Simple Delay timer into the camera control circuit. The Delay circuit is shown in Fig. 2. It is inserted between IC10a and IC18 of the *TV Camera* (see Fig. 5 on page 211 of *EPE* March 1994).

The circuit consists of 12-stage binary divider IC31, and switch S2 which selects the required binary output. Switch position 1 selects the normal 50Hz rate, then each subsequent switch position succes-

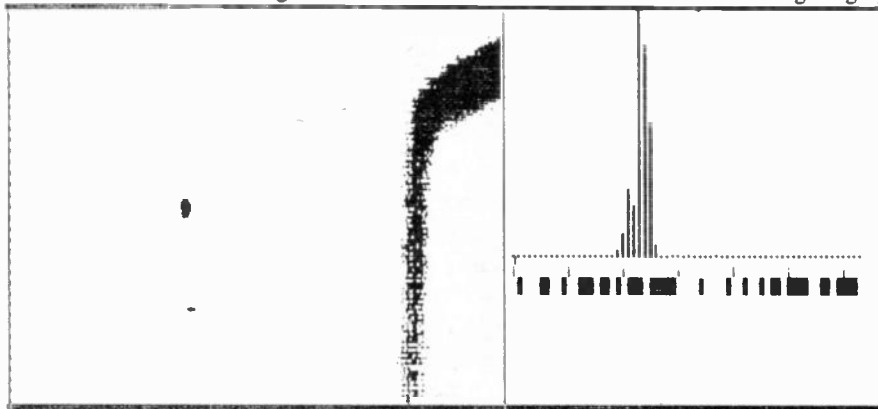


Fig. 1. Neptune and Spica (left) with the window frame centre. Data reference graph is on the right. Exposure time 20 secs, f2, 50mm lens.

STARGAZING

Using a 50mm focal length lens from a 35mm film camera, set at aperture *f16*, and without any circuit modification, I have used the TV camera to view the Moon, in daylight and at night, on a TV receiver and on a computer screen. With the same lens and with the addition of a simple sample-rate reducing (delay) circuit, I have also viewed, via the computer only, the planet Neptune and a bright star visually near to it, believed to be Spica (as deduced from one of Patrick Moore's books). For the latter view, the exposure time was best at about 20 seconds with an aperture of *f2*. Interestingly, I could still discern Neptune on the computer screen with an exposure time of only 0.2 seconds.

Looking at other regions of the sky, from the rather limited view through my workroom window, faint images of some other less bright stars have been just discernable. However, when increasing the exposure time beyond about 80 seconds, the inherent thermal noise from the sensor circuit, operating in an ambient room temperature of about 20°C, just began to result in the introduction of low level random

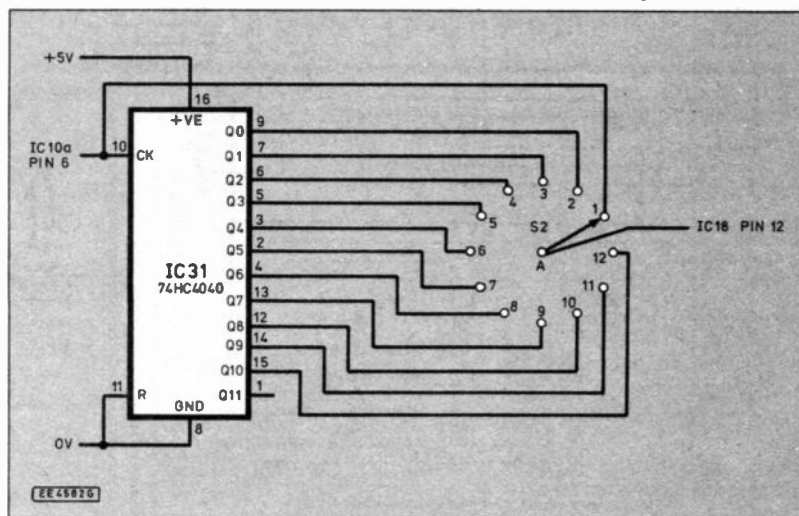


Fig. 2. TV Camera sample rate reducer.

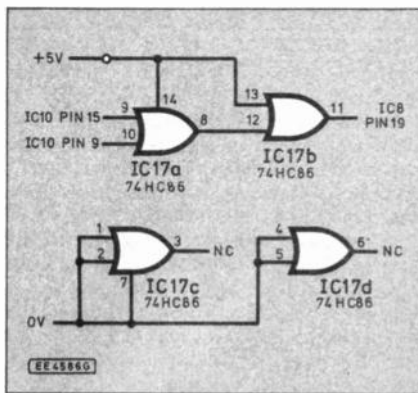


Fig. 3. Modification for Frame Grab use with sample rate reducer.

sively divides the rate by two, so progressively doubling the exposure times.

With position 12 selected, an exposure time of 40 seconds is obtainable. Longer exposure times can be produced by feeding the pole of switch S2 into a second identical circuit.

It is not possible to display the extended-exposure image directly on the TV receiver as the latter requires the fixed 50Hz rate for correct frame synchronisation. The modified image has to be input via the *Frame Grab Interface* to the computer, where it can be displayed or output back to the TV receiver as a processed image. The *Frame Grab* needs a simple modification to its circuit for use with the Delay circuit.

FRAME GRAB MODIFICATION

In the *Frame Grab* circuit, when reading the contents of memory chip IC7 (Fig. 19 page 305 *EPE* April 1994), the memory address counters IC4 and IC5 are stepped on by one place each time the computer makes a Read call to interface bus address decimal 768 (&H300). When the TV

Camera's sampling rate is reduced below 50Hz, the Read calls made to this address while the computer is waiting for sync data line D7 to go high, can cause the total count on IC4 and IC5 to prematurely switch the circuit into Record mode before the correct synchronisation signal from the TV Camera is received. Consequently, I have had to change the address via which the computer looks for its sync data.

In the revised addressing, software calls to address 768 still step on the IC4 and IC5 counters as before, but examination of the status of line D7 is now made via Read calls to address 774 (&H306). The logical circuit implementation of this change requires that octal bus buffer IC8 must be enabled by either of the Read calls.

This is achieved by the addition of the circuit in Fig. 3, which consists of the two interconnected Exclusive-OR gates IC17a and IC17b. Read calls to addresses 768 or 774 respectively take low either pin 15 or pin 9 of IC10 in the original Fig. 19. In either instance, the output of IC17b in Fig. 3 is caused to go low, thus enabling IC8 and allowing its data output lines to be read.

To match this circuit change, Test Program Listing 1 on page 310 must be amended as follows:

```
360 F=INP(774) AND 128:IF F>0 THEN 360
```

```
370 F=INP(774) AND 128:IF F=0 THEN 370
```

CONSTRUCTION

The circuit additions for the *TV Camera* and *Frame Grab* can be mounted on two small pieces of stripboard, constructional details for which are shown in Fig. 4 and Fig. 5. Also shown in these figures are the amendments to the respective original printed circuit boards (p.c.b.s).

As shown in Fig. 4, the track on the component side of the TV Camera's main Control p.c.b. connecting from IC10a pin 6 to IC18 pin 12 is cut near to the latter pin. Connecting wires to the new sub-circuit are

COMPONENTS

FOR MODIFICATIONS

Semiconductors

| | |
|------|----------------------------------|
| IC17 | 74HC86 quad exclusive-OR gate |
| IC31 | 74HC4040 12-stage binary counter |

Miscellaneous

| | |
|---|-----------------------------|
| C28 | 100n polyester capacitor |
| S2 | 1-pole 12-way rotary switch |
| S3 | min s.p.d.t. toggle switch |
| 14-pin d.i.l. socket; 16-pin d.i.l. socket; knob for switch S2; self-adhesive p.c.b. supports (2 off); two small pieces of stripboard to suit; connecting wire; solder etc. | |

Approx. cost guidance only

£4

soldered directly to the respective sections of the cut p.c.b. track. The power lines for the sub-circuit are soldered on the normal trackside to the same p.c.b. pads to which resistor R15 and capacitor C10 are also soldered.

With my camera, the sub-assembly board and the new switch were mounted on the lid of the camera's box, on the side nearest to the modified part of the main p.c.b. A hole should be drilled for the switch, and two self-adhesive p.c.b. supports used to fix the sub-assembly board.

In Fig. 5, the track on the component side of the *Frame Grab* p.c.b. connecting between IC10 pin 15 and IC8 pin 19 is cut at the most convenient point near to the latter pin. Connecting wires to the sub-circuit are soldered directly to the respective sides of the cut track.

Power lines for the sub-circuit are soldered on the component side of the p.c.b. to the nearest two conveniently placed

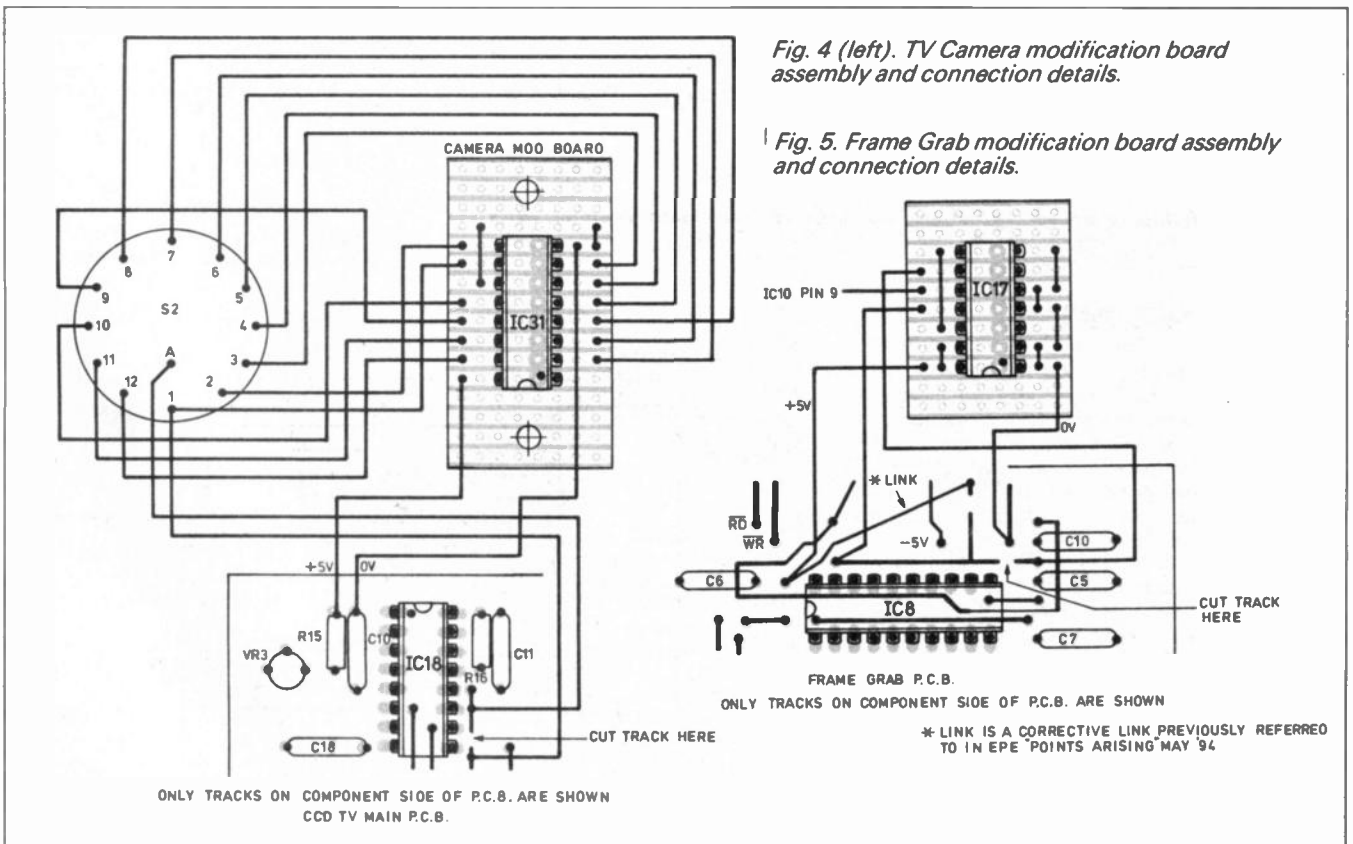


Fig. 4 (left). TV Camera modification board assembly and connection details.

Fig. 5. Frame Grab modification board assembly and connection details.

solder pads as shown. I used about 25mm of 18s.w.g. tinned annealed copper wire for each of the power lines, so rigidly attaching the sub-assembly to the main board.

PELTIER-EFFECT DEVICES

I have had no experience of using Peltier-effect devices (heat-pumps), and as I shall not be putting my TV Camera to serious astronomical use I do not feel justified in buying one for examination. However, I know that when supplied with an electric current, these devices can either be heated or cooled, depending on the direction of the current.

They can be attached to other electronic components in order to similarly change their temperature. In the cooling mode, the use of the devices helps to minimise the generation of unrequired thermal-electric noise.

Three sources of Peltier-effect devices are RS Components, Electromail and Farnell. Several Peltier-effect devices are stocked by these companies at prices ranging between about £12 and £100. Data sheets giving theoretical and practical use details are available from them.

The first two companies are part of the Electrocomponents Group and have identical catalogue numbers for components. Electromail and Farnell are the companies to which non-trade readers are referred, telephone 0536 204555 and 0532 636311, respectively.

You may be interested to know that the magazine *Astronomy Now* has recently been running a series of articles on CCD cameras as used in astronomy, written by Maurice Gavin. Further information can be obtained from the editor of *Astronomy Now*, Steven Young, 081-743 8888.

OTHER QUERIES

In Fig. 2 on page 210 of *EPE March 1994*, the image section of the FT800P sensor is shown as having 580 lines, yet the storage section has only 301 lines. What happens to the remaining lines?

The pixels in the sensor's image section are arranged as two interleaved blocks each consisting of 290 lines. Selection of which 290-line block is transferred into the storage section is determined by the phase relationship of the four waveforms of the AX clock signals. The additional 11 lines of the block transfer do not contain pixel data, but only blank data bits.

In a broadcast-quality camera, the control circuit would be designed to alternate the required AX clock phases to swap between the two blocks and build up the normal interleaved frame-pair image on the TV screen. The timing circuit would also effectively add additional blank lines so that the total number would match that required by the relevant broadcast standard. In Britain, that total would normally be 625 lines.

As stated in the opening paragraph on page 210 of *EPE March 1994*, the camera was originally designed for use with a PC-compatible computer. Since the standard EGA screen of a PC-compatible computer can only display a maximum of 350 lines in Screen Mode 9, the TV Camera and Frame Grab circuits were designed to process data from only one of the interleaved frame-pair blocks. Data from the second block is ignored.

The Frame Grab samples horizontal data at half the rate at which it is output to the TV receiver. All 131072 bytes of

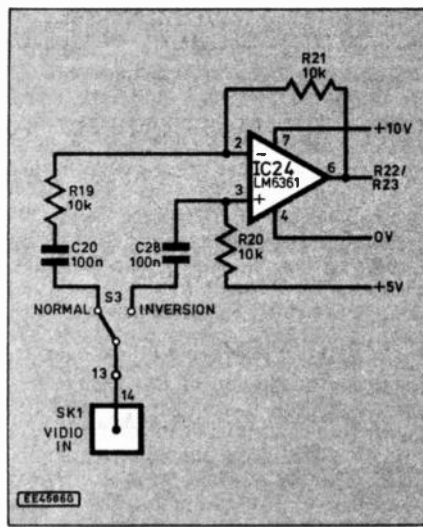


Fig. 6. Modification for image polarity inversion.

memory chip IC7 are filled during the image transfer/recording process, though some of these bytes contain synchronisation data, plus some irrelevant data beyond the end of the 290th line.

Software can input fewer than the maximum number of lines if preferred, to suit the screen mode selected. With my own software, in Screen Mode 9, I input and display all 290 lines but limit their length to 360 pixels, making a total display count of 104400 pixels. The remainder of the screen area is used for menu prompts, graph displays and so forth.

My camera produces a good image on the TV screen but this is marred by vertical interference bars and no amount of screening seems to help. How can I cure the problem?

Only one reader has asked this question and until then I was not aware of the condition. Now looking for the condition, on a cheap monochrome TV receiver (with which the camera is intended to be used) I can just make out tightly packed vertical grey bars of differing densities when the camera looks at a blank sheet of white paper. They are more apparent at higher amplifier gains as set by the control pots. They are likely to be more noticeable if the image is displayed on a colour TV receiver.

Tests show that the bars appear to be generated within the Image Sensor and are not caused by the amplifier circuit picking up stray digital signals. The bars appear to be an inherent result of the sensor's sampling and transfer clocking procedures, consequently, screening of interconnecting leads and of the amplifier has no effect on them. Nor does increasing the values of the electrolytic capacitors of the sensor circuit.

I have examined various simple ways of filtering out the bars but find that these techniques also reduce the sharpness of the normal image. Although more sophisticated filtering techniques are possible, their complexity and need for precision inductors and other components make their use unrealistic in this comparatively simple camera. The bars can be made less apparent by reducing the bias voltage set by VR1 of the image sensor circuit (Fig.4 page 211 March 1994), and by keeping low the gain settings of the amplifiers IC25 and IC26, as controlled by pots VR4 and VR5 (Fig.9, page 214 March 1994).

Normally, the bars are not evident when the image is displayed on a computer screen. Although I can program the software to make them visible, I can also similarly cause them to be suppressed.

INVERTED IMAGE

Is it possible to invert the video so that photographic negatives can be scanned and displayed as positives on the TV screen?

One way in which this can be done simply is shown in Fig. 6. The diagram shows the first stage of the TV camera's amplifier circuit as originally detailed in Fig. 9 page 214 of *EPE March 1994*.

By using S3 to switch the signal via the new capacitor C28, instead of via C20, the TV receiver and the computer will be fed with an inverted (negative-reversal, not upside-down!) image. One end of C28 should be soldered directly to the junction of R20 and IC24 pin 3.

Is the FT800P image sensor responsive to infra-red radiation?

The answer is both yes and no. In tests, I have produced very good images of a hot soldering iron in a blacked-out room, but I have not been able to similarly detect a cup of hot coffee.

It appears that the sensor will not respond to infrared of the wavelengths associated purely with heat radiation, such as that registered by the movement detectors of security systems, in the 10nm to 20nm (nanometre) ranges for example. The sensor does respond, though, to the wavelengths generated by infrared diodes, typically 800nm to 1000nm. It is assumed, therefore, that the soldering iron radiates in this longer wavelength range.

What defects are there likely to be in the sub-spec versions of the FT800P sensor?

A better term for me to have used instead of sub-spec would have been test sample grade. The sensor manufacturer advises that no major defects exist in this grade of sensor, although it is possible that occasionally adjacent pixels might be connected, or that a pixel or two might be inoperative.

I use two sensors of test sample grade, one in the main body of the TV camera, the other mounted on a quarter-plate camera as a roving extension having a wide angle lens; I cannot see any difference between them. It is believed that the vertical bars referred to above are not a defect found only in the test sample grade sensors.

Can the TV camera control circuit be used with other types of sensor instead of the FT800P?

No, it cannot without major redesign work since the FT800P has unique pinning and control requirements.

I cannot find a supplier for the 74AC164 chip, who supplied yours?

Farnell Electronic Components Ltd, telephone 0532 636311. They stock a wide range of the 74AC chips.

FINALLY

Since publication, I have considerably rewritten and extended my lengthy software program referred to in *EPE April 1994*. The entire program, including all machine-code routines, can now be run from QuickBasic as well as from GW-Basic. New routines allow images to be more versatily recorded onto disk and re-input for further processing, including easier data-byte modification and colour allocation, plus a new zoom facility.

Readers who have bought my original program can have a FREE copy of the new one if they send me a blank formatted 5.25 inch SSD disk plus four 25p stamps to cover incidental postage costs. Other readers can purchase the program on disk for £15 inclusive of post etc. Write to: John Becker, 8 Finucane Drive, Orpington, Kent BR5 4ED. □

BTEC
Certificated



N A T I O N A L
C O L L E G E O F
T E C H N O L O G Y

TUTOR
Supported

DISTANCE LEARNING COURSES

Update and reskill at home or in your workplace training centre with these highly practical industrially approved short courses. There is no travelling so commence at any time on

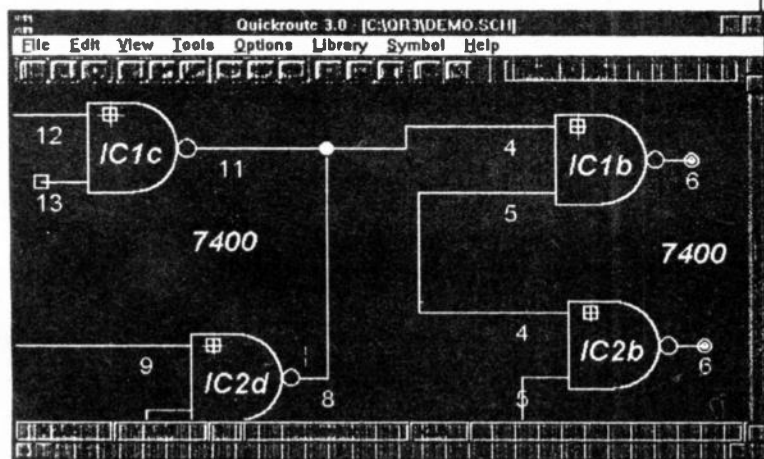
Electronic Testing & Fault Diagnosis
Analogue Electronics
Digital Electronics
Fibre/Optoelectronics
Programmable Logic Controllers

Courses are supplied with NCT training workbooks, audio cassette lecturettes, PCB's, instruments, tools, components and leads as necessary for each course. Continuous tutor support and **BTEC** certification is available as an option from NCT. Individual course certificates can be credited towards a **BTEC** Continuing Education Certificate which is at **NVQ level 4**. For the latest information on courses and your options write or telephone:

National College of Technology, NCT Ltd., PO Box 11
Wendover, Bucks. Tel: (0296) 624270

Quickroute 3.0

PCB & Schematic Design System for Windows 3.1



Announcing a new range of affordable, powerful Windows based PCB and schematic design packages from **POWERware**.

DESIGNER £99*

PCB and schematic design with all the new 'Easy-Edit' features and an Auto router!

DESIGNER+ £149*

For larger PCB and schematic designs, adds Gerber and NC-Drill support.

PRO £199*

Schematic capture, with integrated rats-nest generation and auto-router. Export net-lists for design rule checking.

PRO+ £299*

Advanced schematic capture for management of larger schematics. Gerber import facility for file exchanging.

For more details, contact
POWERware, 14 Ley Lane,
Marple Bridge, Stockport,
SK6 5DD, UK.

* Prices exclude post & packing, etc.

Tel/Fax 061 449 7101

from
£99*
excluding P+P

THE BEST OF BRITISH

TERRY de VAUX-BALBIRNIE



Where is Britain's place in the world scene?

Last month was the "final" article in a "four-part" short series about the British electronics industry. However, since the time of writing some further information has come to light – so this one becomes the fifth!

IT is obviously not possible to cover all areas and types of company in the electronics field in this series and no attempt has been made to do this. However it is felt that the extra information contained in this part warrants a place in *The Best of British*.

Power to the People

Quickroute, the p.c.b. and schematic design package from *POWERware*, was reviewed in Robert Penfold's *Interface* (EPE December 1993). It is mentioned here because this product, in its various forms, has been completely revised and given many new features. In fact, by the time this article appears in print, the first three versions – *Quickroute 3.0 Designer*, *Quickroute 3.0 Designer+* and *Quickroute Pro* – will be on general release. All are designed to run on the IBM PC and compatibles under Windows 3.1 and using a mouse.

In the latest versions, the user interface has been completely re-designed to make it more user-friendly. New editing features are called "EASY-EDIT" – these include "auto alignment", powerful "pick-up-and-place" and a group capability. This latter point means that groups of objects spread around the design area (not simply in blocks which is the usual case) can be edited in the familiar ways – moved, copied, multi-copied, deleted, etc.

Groups can be copied on to the clipboard and the

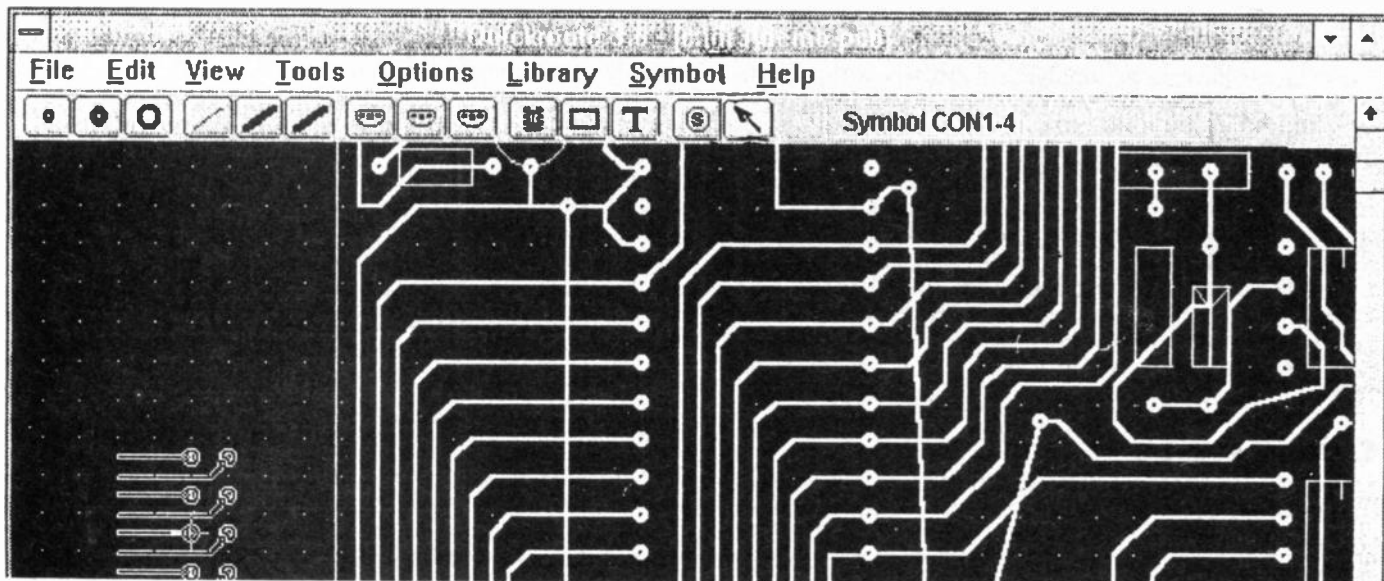
contents rotated, reflected and otherwise manipulated. This group facility sets *Quickroute* apart by its ability to handle objects which are not adjacent to one another on the screen.

All objects in the design have editable attributes – double click on any to change its size, width, etc. Note also that any Windows 3.1 text font may be used to produce professional-looking artwork. A set of symbol libraries for both schematics (circuit diagrams) and p.c.b. layouts are included in the package.

One very useful feature is that buttons on a button bar can be customised by the user and may be used to call up much-used pads, tracks, symbols, etc. according to his or her preferences. This can save a lot of time.

Designer is the entry-level package and it comes with all the features mentioned above. There is also an auto-router capable of routing two-layer boards – this is a limited version of the full auto-router available on the more advanced packages. *Designer+* includes the *full* auto-router and the ability to export GERBER and NC-DRILL files (important for the professional user). It can also handle more complex designs.

In addition to all this the professional package, *Quickroute 3.0 Pro*, has a powerful schematic capture facility. Thus, once the circuit diagram has been drawn, symbols and the wiring made between them are "captured" and converted into an equivalent set of p.c.b. symbols and "rats



nest" interconnections. This may be subsequently auto-routed or manually-routed as required.

All versions come with a comprehensive manual. Designer is priced at £99, Designer + £149 and Pro, £199. Prices are based on the single-user rate and exclude VAT and carriage. Information and costs of site licences are available from the company.

Ease of use has been "built-in" by using a logical and consistent approach to design. In terms of the facilities offered, Quickroute represents very good value and readers contemplating using this type of software should certainly look at it. Anyone making a serious enquiry can obtain a free demonstration disc with limited facilities. This will give them a feel for the product before making a commitment to buy. The address of POWERware is given at the end of this article.

A lifeline

Amplicon Lifeline is an entirely British organisation based in Brighton. They began business as the distribution company Amplicon 21 years ago but soon began manufacturing digital panel meters and computer instrumentation products.

As Amplicon Lifeline, the company in its present form began about six years ago. The product range now includes data acquisition control boards and software for PC's, l.e.d. and l.c.d. panel instruments and displays. Also, communications boards printers and fibre optic links.

The company currently employs 40 people with all stages from design and development to actual manufacture taking place on site. Work is supported by a team of technical authors with access to full desk top publishing and typesetting facilities.

The company's export policy involves the development and expansion of overseas distributors combined with extensive international advertising. Distributors now exist throughout Europe and in such diverse places as Egypt, New Zealand, Pakistan, Singapore, South Africa and the U.S.A. Their aggressive philosophy is paying off with a doubling of export sales in only two years.

Purchasing is usually made via the local distributor but may be made direct if one does not exist. Write to the company for the address of the local distributor - details are given at the end.

Green discs

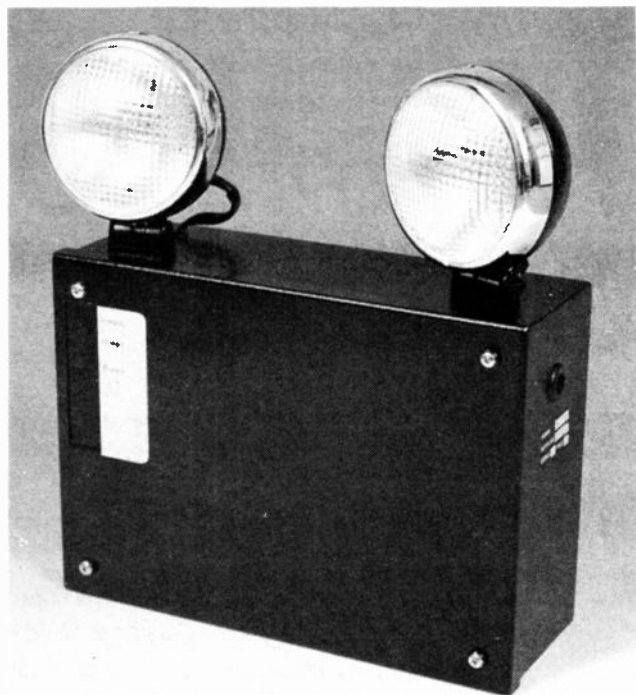
Greenweld Electronics Ltd have recently ventured into budget CD's and tapes and have made a free catalogue available listing hundreds of titles which should appeal to just about every taste (the titles were also listed in their Summer Sale Catalogue given away with last months *EPE*). When various arguments about the price of CDs are raging Greenweld have put out around 700 titles for just £2.99 each. They are all "pressed" by Tring International PLC, thus ensuring good quality.

Greenweld have been supplying hobbyists with a wide range of components for the past twenty years and have specialised in surplus items. Peter Green, who started the company by selling surplus bits to colleagues when he worked for BT, tells us they now have a turnover of nearly £1 million with 35,000 listed customers who are mailed several times a year. They issue a major catalogue every year and subscribers receive a monthly newsletter plus their latest list of bargains for an annual subscription of £6.

Most orders are turned around the same day and, with an average of around 2,000 orders a week (including shop sales), the staff are kept fairly busy. They operate from 12,000 sq. ft. premises near the docks in Southampton.

Crafty lot

The *Lab-Craft* brand name will be familiar to readers who use 12V lighting, low-voltage power supplies, battery charging equipment, shaver inverters, control panels, etc. in boats and caravans. Lab-Craft is a small British manufacturing company founded in 1956 and still owned by the



The Lab-Craft twinspace emergency lighting system.

original three families. The factory is based in Harold Wood, near Havering, Essex, with warehouse sales offices in Chelmsford not far away. The company employs a workforce of approximately 120.

In the early days, the sales line was electronic instrumentation products. However, Lab-Craft soon found a niche market using their pioneering work on transistorised fluorescent lighting in 1961. It is still for this type of equipment that Lab-Craft is often remembered. However, for commercial rather than leisure purposes, the company supplies low-voltage lighting to various vehicle manufacturers such as Ford, Vauxhall, Renault and Volvo.

Less well known, but highly successful is the company's design, manufacture and marketing of emergency equipment. This includes a range of lighting, sounders, alarm panels, smoke detectors and heat detectors (for use in smoky environments where a smoke detector would give false alarms). Lab-Craft products are found in such diverse places as the British Museum, Guys Hospital, the Royal Naval Dockyards - even in motorway tunnels in Bahrain!

Keeping up with demand and staying one step ahead of the opposition is the philosophy boasted by this company. An example is the development of lighting powered by batteries and charged by solar panels. Of new leisure products, the *Tri-Lite* is a low-voltage fluorescent light with the option of operating one, two or three 8W tubes to enable the user to match the lighting to the need.

At the commercial end, the *Twinspace* emergency lighting system may be seen in factories and supermarkets all over the country. This is a maintenance-free system based on twin halogen spotlights powered by lead-acid batteries. Recently, lighting has been developed for use in the harsh environment of refrigerated vehicles which, traditionally, suffer from a poor level of illumination. □

ADDRESSES

POWERware, 14 Ley Lane, Marple Bridge, Stockport, SK6 5DD. Tel: 061 449 7101.

Amplicon Lifeline Ltd., Centenary Industrial Estate, Hollingsdean Road, Brighton, East Sussex, BN2 4AW.

Lab-Craft Ltd., Bilton Road, Waterhouse Lane, Chelmsford, Essex, CM1 2UP. Tel: 0245 359888.

Greenweld Electronics Ltd., 27 Park Road, Southampton SO15 3UQ. Tel: 0703 236363.

Techniques

ACTUALLY DOING IT!

by Robert Penfold

WHAT is the difference between a rectifier and a diode? This is one of those perennial questions which I seem to have been answering for more years than I care to remember. I suppose that there is actually very little difference between the two.

A diode allows a current to flow in one direction but blocks a current flow in the opposite direction, and so does a rectifier. I think that the diode name actually goes back to the valve era, when a diode was a valve that had two electrodes, and a triode was a valve with three electrodes.

JUST PLAIN DIODES

These days the word diode is generally used to describe a semiconductor diode that can only handle low currents. These are sometimes referred to as "small signal" diodes, but are more commonly known as just plain diodes. A rectifier is generally taken to be something that can handle higher currents, and is primarily intended for use in power supply circuits.

The 1N4148 is an example of a diode. This has a respectable reverse voltage rating of 50 volts, but it can only handle forward currents of up to 75 milliamps. The popular 1N4002 rectifier can withstand reverse voltages of up to 100 volts, and it can handle forward currents of up to 1 amp (1000 milliamps). This is quite modest by rectifier standards, and reverse voltage ratings of 1000 volts or more and current ratings of several amps are quite common.

Physically, diodes and the smaller rectifiers are very similar. Surprisingly perhaps, they are not necessarily much different in size either. The most obvious differences are that the bodies of diodes have rounded ends, whereas rectifiers are flat-ended. Also, the leadout wires of rectifiers are normally much thicker than those of diodes, resistors, etc. This is partially due to the fact that the leadout wires of rectifiers have to handle relatively high currents, but it is mainly to aid the removal of heat from a rectifier. In effect, the leadout wires act as small heatsinks.

POLARITY

It is essential to fit diodes and rectifiers with the correct polarity. Even in low power circuits, connecting a diode round the wrong way can result in a large current flowing through the diode, plus (possibly) a driver transistor or other component in the circuit.

Getting the polarity of rectifiers wrong tends to produce an output of the wrong polarity from the power supply circuit, which in turn tends to produce exploding electrolytic capacitors and integrated circuits! Always double-check that diodes and rectifiers are connected properly before trying out a newly constructed project.

The polarity of most diodes and small rectifiers is indicated by a band marked around the cathode ("k" or "+") end of the body. With some diodes this band completely covers one end of the component, but either way there should be no difficulty in identifying the cathode lead.

In most cases you will probably be following printed circuit or stripboard overlays which clearly show the band, and it is then just a matter of making sure that your circuit board matches up with the component layout diagram. The only likely exception is where a diode is mounted vertically. On the diagram one lead of the diode should then be marked with a "+" or "k". You simply have to remember that this lead is the one which is designated by the band.

SYMBOL

A little more care is needed if you are working from a circuit diagram. At one time a few diodes were marked with little diode circuit symbols, which made life much easier for beginners. Unfortunately, this seems to have totally gone out of fashion, and is something you are unlikely to see on anything other than a few high current rectifiers. It is still quite easy to get the polarity right, since the cathode end of the diode symbol, like the real thing, has a bar across.

Incidentally, the arrow part of the symbol indicates the direction in which the diode will pass a current (i.e. from anode to cathode). We are dealing with conventional current flow here (from positive to negative), not electron flow. To a current flowing in the opposite direction the diode acts as a barrier, which is represented by the bar part of the symbol.

Some diodes are marked with a number of coloured bands around their bodies, rather like resistors. Apparently this is a form of colour coding, and 1N4148 diodes sometimes have the "4148" part of the type number marked in the same manner that is used for the first two digits of a resistor colour code. The bands would therefore be yellow, brown, yellow, and grey. These

multiple bands obviously make it slightly more difficult to work out which way round the diode should be connected. If you look carefully at a diode of this type you should find that one band is much thicker than the others. This band is at the cathode end of the component.

In practice the thicker band is often not that much thicker than the others, but you should be able to sort things out if you look closely enough. The broad band is the first one in the colour code (the first yellow band for a 1N4148). This method of marking seems to be falling from favour, which is perhaps not surprising.

Rectifiers which can handle currents of up to a few amps often lack the band which designates the cathode lead. These larger rectifiers usually have a sort of bullet shaped casing, with the cathode lead coming from the "pointed" end of the case. Fig. 1 explains the methods of polarity marking used for a variety of common rectifiers and diodes.

SMASHING TIME

Rectifiers normally have plastic encapsulations which make them physically very tough. Diodes mostly have glass encapsulations, and this makes them very vulnerable to physical damage. If you should accidentally tread on a diode, drop a pair of pliers on one which is on the workbench, or something similar, the diode will almost certainly be smashed.

Less obviously, bending a leadout wire close to the body of the component can result in the case cracking. This will often result in small pieces of the case actually breaking off. This does not necessarily result in the diode being damaged badly enough to prevent it from working properly, but this can happen, and at best the component will be seriously weakened.

It is not really a major problem with modern diodes such as the 1N4148, which are very small and relatively tough. It is the larger glass cased diodes such as the OA90, OA91, and many Zener types which seem to be the most vulnerable to this type of damage. If a component layout dictates that the

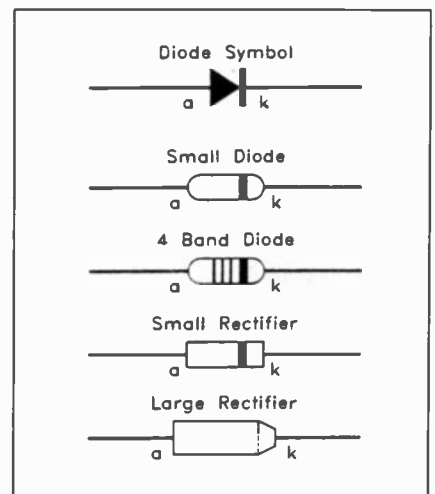


Fig. 1. Methods of polarity indication for most popular diodes and rectifiers.

leadout wires must be bent close to the body of the diode, proceed very carefully. Ideally each leadout wire should be gripped next to the body of the diode using tweezers or a small pair of long-nosed pliers, so that the lead can be bent without putting the glass encapsulation under stress.

Glass cased diodes are more easily damaged by excessive heat than most other semiconductors. Also, germanium based semiconductors are relatively easily damaged by heat. Although germanium transistors have been obsolete for many years, germanium diodes are still used a great deal. This is due to the lower voltage drops that germanium diodes provide, which makes them superior to silicon diodes in some applications.

In the past it was normal to use a heatshunt on each lead of a diode before soldering it in place. A heatshunt is a simple metal clip which is fitted on the leadout wire close to the body of the diode. Modern heatshunts are mostly in the form of tweezer-like implements which have jaws that lock together. The basic idea is that a lot of the heat flowing up the lead from the soldered joint is diverted into the heatshunt, and is kept away from body of the diode.

I have not found it necessary to use a heatshunt when fitting modern glass bodied diodes, even the germanium variety. Modern diodes seem to be that bit more hardy than those of 20 or so years ago. However, each soldered joint should be completed reasonably quickly. Also, once the first joint has been completed it is a good idea to let everything cool down a little before proceeding to the second joint.

ACID TEST

If the polarity marking of a diode is ambiguous, or the markings have simply rubbed off, a check with a multimeter will soon show which lead is the cathode. When using an analogue multimeter to test a diode, set it to a middle resistance range and connect it across the diode. If a low

resistance reading is obtained, the diode's cathode lead is the one connected to the positive test lead. If a very high reading is obtained, the cathode is connected to the negative test lead.

The same basic procedure can be used with a digital multimeter, but the test works the other way round. If the resistance reading is high, it is the cathode that is connected to the positive test prod. If the reading is low it is the cathode lead that is connected to the negative test prod.

Most digital multimeters have a diode checking range, and when available this range should obviously be used. On the normal resistance ranges the test voltage might be too small to give a low forward resistance from a silicon diode or rectifier.

SEEING THE LIGHT

The diodes that give the most trouble are undoubtedly the light emitting variety. A l.e.d. is a true diode, and will only conduct (and light up) if it is connected the right way round. One reason for the difficulty in determining the polarity of l.e.d.s is that they are now supplied in a vast range of sizes, colours, and shapes. However, most l.e.d.s, including the more exotic varieties, have a cathode lead that is slightly shorter than the anode lead.

At one time ordinary (round) l.e.d.s also had cases which were flattened

slightly next to the cathode lead. Most l.e.d.s still have the shorter cathode lead, but the "flat" is now often absent, or so slight as to be barely detectable.

Various instant methods of telling l.e.d. polarity have been put forward from time-to-time. Unfortunately, for every method that is suggested there seem to be a few l.e.d.s which disprove the rule. The only 100 per cent certain method is to actually try each l.e.d. in a test circuit. I always check every l.e.d. before connecting it into circuit, even if it does have all the usual polarity indicators.

The multimeter check described above will work with most meters, although a few might not provide a high enough test voltage. The simple test arrangement shown in Fig. 2 will work with any l.e.d. that produces visible light. There is no need for any soldering as it is quite easy to hold the l.e.d. and series resistor in place.

Never connect a l.e.d. directly across a battery or other power source. Without the series resistor a high current will flow, and the l.e.d. is likely to be almost instantly "zapped". Fortunately, connecting a l.e.d. the wrong way round will not result in it being damaged. Therefore, if you should get a l.e.d. connected with the wrong polarity, simply reversing the connections to it should cure the problem.

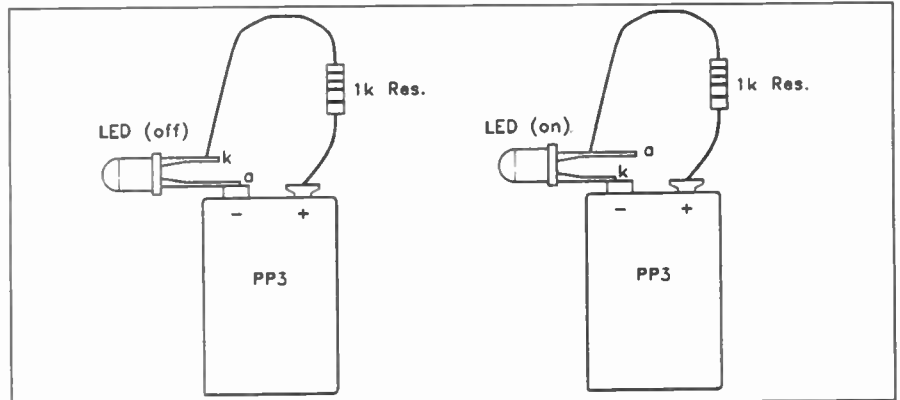


Fig. 2. Checking the polarity of an l.e.d.

Home Base

Jottings of an electronics hobbyist—Terry Pinnell

Poor ceiling

When a section of downstairs ceiling fell onto my carpet, it didn't take long to establish that faulty sealing around the bath upstairs was the cause. I was a bit ashamed not to have noticed the gradually increasing stain in the plaster, but in mitigation you just don't make a point of looking up there very often, do you?

It was a simple matter of water seeping through the sealing at the edge of the bath and into the plaster below. Repairs

completed, my mind turned to future avoidance. Ideally I wanted a more helpful warning of trouble than the appearance of yet another ominous stain. Clearly a plausible excuse to design an electronic damp detector.

The first step was a bit of research. Browsing through countless old magazines and books, which I keep for just such an occasion, I found many circuits which might be relevant. These fell into two main categories, the most common being the rain or water alarm

type, which typically detected water in large volumes. Applications included a bath reaching a certain level, an overflowing washing machine, a flooded bilge in a boat, and so on.

Putting a damper on it

But it was the second type of circuit that I was interested in, the moisture detectors. What was needed was to be alerted to insidious dampness, not an outright flood. However none of the examples I dug up seemed at first sight to do what I had in mind.

For a start it had to be battery operated—no question of using a mains supply in the bathroom. Secondly it had to have negligible quiescent current consumption, so that I could forget about changing the battery for a year or two. Thirdly, it should be possible to just leave it switched on, with no intervention. Obviously, when the

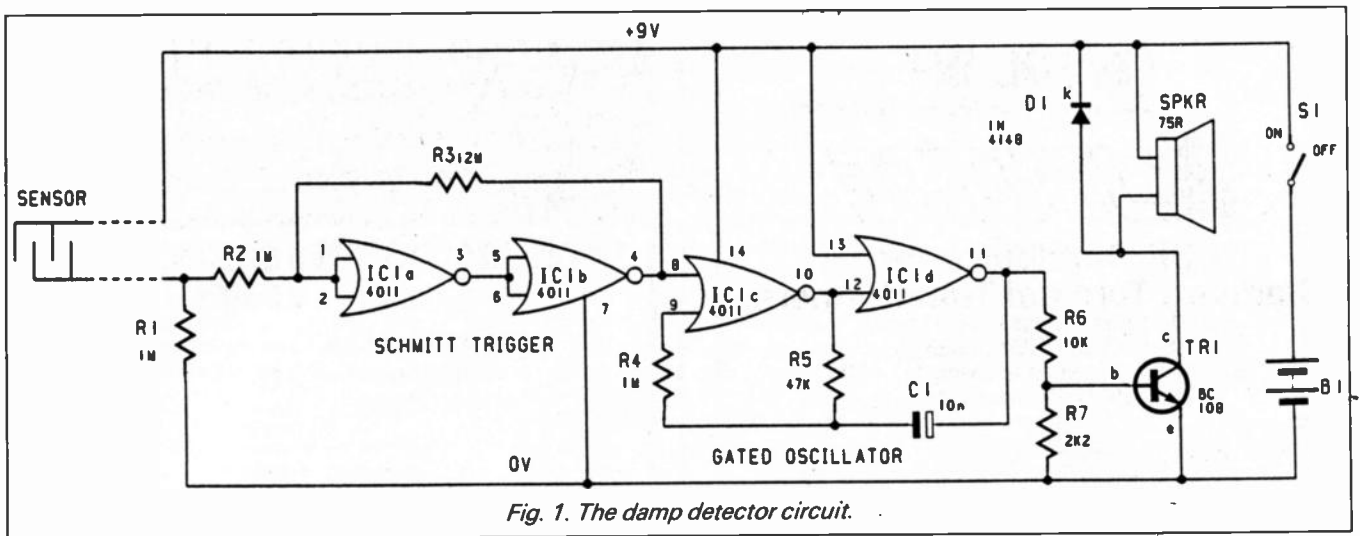


Fig. 1. The damp detector circuit.

alarm was triggered I would then want to be able to turn it off, so it did still need an on/off switch.

Despite being restricted to a battery, I decided that the alarm should also be loud enough to be heard downstairs in normal conditions. To cover the situation when I wouldn't have heard it, I did fleetingly consider the trouble of adding a visual indicator downstairs, but that was overkill. (Where to draw the line – a lamp in every room?) Anyway, I reckoned that the battery would cheerfully keep the alarm going at virtually full blast for several hours, so unless I was engrossed in a war epic on TV or something, I would undoubtedly hear it at some point in that period.

Positively alarming

A fifth objective was reliable and clean-cut switching. One characteristic of most of the circuits I looked at was their difficulty in dealing with the sort of "intermediate" state I anticipated, when the floor underneath the bath was neither flooded nor bone-dry.

Completing the sextet of requirements, I also wanted it to be simple and cheap. These tend to go hand in hand of course, but I've come across circuits which achieve their simplicity of construction by using complex, specialist i.c.s, which are often also pricey.

For those of you thinking of rigging up something similar, the circuit that evolved to meet these specifications is shown in Fig. 1. It is straightforward enough, with the resistance of the sensors forming the upper half of a voltage divider, which turns the resistance into a voltage. This is fed to IC1a and IC1b, which form the two gates of a Schmitt trigger to give it clean switching. The output from that stage then enables a conventional CMOS oscillator made from IC1c and IC1d. In turn, the oscillations from that are fed to the final stage, the speaker driver.

You could substitute whatever miniature speaker you had available, adding a protective series resistor if your transistor was low powered like the one I used. Of course, some of your battery power would then be going into warming that resistor rather than being turned into alarm sound.

The basic sensor is a piece of copper stripboard with adjacent tracks wired to two separate points. These therefore

present a resistance which falls dramatically when there is moisture across any one or more of the gaps. I also used a sensor made out of blotting paper folded around lengths of stripped solid core wire. When it absorbs moisture, the resistance between the wires embedded inside it dropped from many megohms to perhaps a few hundred kilohms.

Another sensor was even more basic: just lengths of bare wire laid about a centimetre apart on top of the dusty plasterboard, kept flat by anything handy, like a few strips of wood or plastic. In all I used five sensors, of several types, placed strategically, such as along the wall where the previous trouble had arisen, below the taps, and close to the U-bend. All were wired in parallel, so that if the resistance across any of them dropped below a pre-set level, then the alarm would be triggered.

ESP

In addition to those five sensors under the bath I also fixed a pair of springy wires to the unit itself. Its case was made, appropriately enough, from a length of plastic, rectangular-section rain guttering, of the type I described in earlier ramblings. When fitted with the neat end-caps, this is raised a few millimetres from the surface, so the wires in the bottom could be arranged to slant down to make firm contact with the bathroom floor, where the unit was resting beside the bath. So that when I got too enthusiastic while having a shower and sprayed the floor, this would immediately alert me. This proved to be a useful afterthought, although it scared the wits out of me the first time it was activated a few weeks after installation, in those few seconds before I remembered what the heck it was.

Another reason for choosing that guttering for the case was that it was a perfect fit for the PP9 battery I chose. This gave a very long life; around four years for that first one I think.

The first time the alarm went off apart from that was a good six months later. After the boring bit of removing some ten screws from the panel on the side of the bath I was surprised to find nothing obviously wet. Although this was good news, it did highlight a shortcoming in the way I'd wired up the sensors, connecting all five together inaccessibly underneath the

bath, with just two wires going out to the unit. Even those two were not accessible for easily measuring the resistance across them. I subsequently changed the wiring so that I could take a resistance reading not only across all six (including the in-built prongs) but also across the five inaccessible sensors.

In practice this proved worthwhile, because I never actually found one of the sensors sitting in a puddle – even my pathetic skill with a tube of that gooey bath sealant stuff was sufficient to keep most of the water inside the bath. No, in practice, I always wanted to find out just which sensor was responsible for the overall low resistance, so that I could isolate the cause of the trouble.

AC/DC?

After a year or two I started to get false alarms, which turned out to be due to corrosion of the sensors rather than any significant leaks. No doubt there are materials which would operate properly forever, but copper strips and wire in particular do suffer from both tarnishing and corrosion.

Chemistry graduates please don't write in, but I presume the former is due to oxidation, and the latter to reaction with water and other trace elements. The result is to coat the copper with compounds of various kinds, which wreak havoc with the basic operating principle, because they cause a low resistance to be measured across the input of the detector, thus giving false alarms.

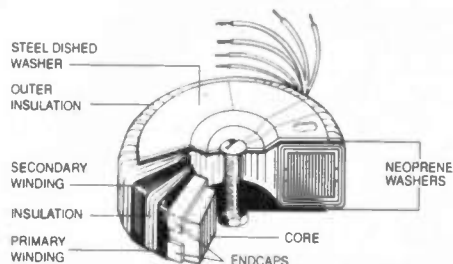
One of the circuits found during my earlier magazine-browsing proposed a novel approach to the corrosion problem. Its author claimed that a.c. current through the sensors would drastically minimise the effect, and his circuit therefore generated low-level a.c. with a CMOS oscillator, which was then fed to the sensor. If its resistance was low enough, the signal would be transmitted with sufficient strength to the next stage. This rectified the a.c. back into d.c. and then passed it to Schmitt trigger and alarm stages, as in my circuit. I understand this type of circuit is now available in a dedicated chip.

I wonder if this additional complexity is worth the effort? Meanwhile I'll continue with my simple version, changing the battery every Leap Year and giving the sensors their annual MOT. □



UK Distributor for Standard Toroidal Transformers

- 107 types available from stock
- Sizes from 15VA to 625VA
- Dual 120v primaries allowing 110/120v or 220/240v operation



| TYPE | SERIES NO. | SEC VOLTS | RMS CURRENT | TYPE | SERIES NO. | SEC VOLTS | RMS CURRENT |
|-----------------|----------------|-----------|-------------|-----------------|------------|-----------|-------------|
| 15VA £10.68 | 03010 | 6-6 | 1.25 | 225VA £21.04 | 63012 | 12+12 | 7.50 |
| | 03011 | 9-9 | 0.83 | | 63013 | 15+15 | 6.25 |
| | 03012 | 12+12 | 0.63 | | 63014 | 18+18 | 5.11 |
| | 03013 | 15+15 | 0.50 | | 63015 | 22+22 | 4.75 |
| | 03014 | 18+18 | 0.42 | | 63016 | 25+25 | 3.75 |
| | 03015 | 22+22 | 0.34 | | 63017 | 30+30 | 3.21 |
| | 03016 | 25+25 | 0.30 | | 63018 | 35+35 | 2.81 |
| | 03017 | 30+30 | 0.25 | | 63026 | 40+40 | 2.50 |
| 30VA £12.21 | 13010 | 6-6 | 2.50 | 63025 | 45+45 | 2.25 | |
| | 13011 | 9-9 | 1.66 | 63033 | 50+50 | 2.04 | |
| | 13012 | 12+12 | 1.25 | 63028 | 110 | 1.02 | |
| | 13013 | 15+15 | 1.00 | 63029 | 220 | 0.93 | |
| | 13014 | 18+18 | 0.83 | 63030 | 240 | 10.00 | |
| | 13015 | 22+22 | 0.68 | 73013 | 15+15 | 8.33 | |
| | 13016 | 25+25 | 0.60 | 73014 | 18+18 | 6.82 | |
| | 13017 | 30+30 | 0.50 | 73015 | 22+22 | 6.00 | |
| 50VA £13.84 | 23010 | 6-6 | 4.16 | 73016 | 25+25 | 5.00 | |
| | 23011 | 9-9 | 2.77 | 73017 | 30+30 | 4.28 | |
| | 23012 | 12+12 | 2.08 | 73018 | 35+35 | 3.75 | |
| | 23013 | 15+15 | 1.66 | 73026 | 40+40 | 3.33 | |
| | 23014 | 18+18 | 1.38 | 73025 | 45+45 | 3.00 | |
| | 23015 | 22+22 | 1.13 | 73033 | 50+50 | 2.72 | |
| | 23016 | 25+25 | 1.00 | 73028 | 110 | 1.36 | |
| | 23017 | 30+30 | 0.83 | 73029 | 220 | 1.25 | |
| | 23028 | 110 | 0.45 | 73030 | 240 | 10.00 | |
| | 23029 | 220 | 0.22 | 83016 | 25+25 | 8.33 | |
| | 23030 | 240 | 0.20 | 83017 | 30+30 | 7.14 | |
| | 80VA £15.43 | 33010 | 6-6 | 6.66 | 83018 | 35+35 | 6.25 |
| 33011 | | 9-9 | 4.44 | 83026 | 40+40 | 5.55 | |
| 33012 | | 12+12 | 3.33 | 83025 | 45+45 | 5.00 | |
| 33013 | | 15+15 | 2.66 | 83033 | 50+50 | 4.54 | |
| 33014 | | 18+18 | 2.22 | 83042 | 55+55 | 4.54 | |
| 33015 | | 22+22 | 1.81 | 83028 | 110 | 2.27 | |
| 33016 | | 25+25 | 1.60 | 83029 | 220 | 2.08 | |
| 33017 | | 30+30 | 1.33 | 83030 | 240 | 10.41 | |
| 33028 | | 110 | 0.72 | 93017 | 30+30 | 8.92 | |
| 33029 | | 220 | 0.36 | 93026 | 35+35 | 7.81 | |
| 33030 | | 240 | 0.33 | 93025 | 40+40 | 6.94 | |
| 120VA £16.45 | | 43010 | 6-6 | 10.00 | 93025 | 45+45 | 6.25 |
| | 43011 | 9-9 | 6.66 | 93042 | 55+55 | 5.68 | |
| | 43012 | 12+12 | 5.00 | 93028 | 110 | 2.84 | |
| | 43013 | 15+15 | 4.00 | 93029 | 220 | 2.60 | |
| | 43014 | 18+18 | 3.33 | 93030 | 240 | 10.41 | |
| | 43015 | 22+22 | 2.72 | | | | |
| | 43016 | 25+25 | 2.40 | | | | |
| | 43017 | 30+30 | 2.00 | | | | |
| | 43018 | 35+35 | 1.71 | | | | |
| | 43027 | 20+20 | 3.00 | | | | |
| | 43028 | 110 | 1.09 | | | | |
| | 43029 | 220 | 0.54 | | | | |
| 43030 | 240 | 0.50 | | | | | |
| 160VA £19.21 | 53011 | 9-9 | 8.89 | | | | |
| | 53012 | 12+12 | 6.66 | | | | |
| | 53013 | 15+15 | 5.33 | | | | |
| | 53014 | 18+18 | 4.44 | | | | |
| | 53015 | 22+22 | 3.63 | | | | |
| | 53016 | 25+25 | 3.20 | | | | |
| | 53017 | 30+30 | 2.66 | | | | |
| | 53018 | 35+35 | 2.28 | | | | |
| | 53026 | 40+40 | 2.00 | | | | |
| | 53028 | 110 | 1.45 | | | | |
| | 53029 | 220 | 0.72 | | | | |
| | 53030 | 240 | 0.66 | | | | |

13.8V DC POWER SUPPLY TRANSFORMERS

| | | | |
|-------|-------|--------|--------|
| 8C267 | 500VA | 18+18V | £32.64 |
| 9T845 | 675VA | 16.1V | £38.06 |



Prices include VAT and carriage

Quantity prices available on request

Write, phone or fax for free Data Pack

Jaytee Electronic Services

Unit 171/172, John Wilson Business Park,
Whitstable, Kent CT5 3RB. U.K.

Tel: (0227) 265333 Fax: (0227) 265331

SAVE SECURITY EQUIPMENT SAVE

DIRECT FROM THE MANUFACTURER

Join the 1000's who protect their property with Autona equipment.

LATEST 2000 SERIES CONTROL UNITS



2250

- ★ Auto reset
- ★ Self Testing
- ★ Intelligent exit delay
- ★ Simple operation
- ★ Choice of Models

2050 Budget version, suitable for all sizes of installations.

£39.95
VAT

2150 Key-operated full feature unit with zone switching and very simple operation.

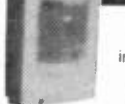
£49.95
VAT

2250 Digital keypad version offering a user-set code of 2-12 digits plus full specifications.

£54.95
VAT

Colour brochures available on these exciting new units. CALL TODAY!

MINIATURE PASSIVE INFRA-RED SENSOR-RP33



£16.95
VAT

Quantity discounts start at 3 units

Switchable Dual range, detects intruders up to 6 or 12 metres. This advanced sensor operates by detecting the body heat of an intruder moving within the detection field. Slow ambient changes such as radiators, etc. are ignored. Easily installed in a room or hallway. Providing reliable operation from a 12V supply, it is ideal for use with the CA 1382 or equivalent high quality control unit. Supplied with full instructions.

Size 80x60x40mm

COMPLETE SECURITY SYSTEM ONLY £63.95 + VAT

DIRECT FROM THE MANUFACTURER

INCLUDES LATEST MICRO CONTROL UNIT, PASSIVE INFRA-RED SENSOR, SIREN & BELL BOX, CONTACTS, CABLE, ETC.

EASY TO INSTALL - SIMPLE TO USE
CALL FOR FULL DETAILS TO-DAY!!

Plus complete range of systems and accessories.

★ AUDIO MODULES ★

AL 12580-125W AMPLIFIER

A rugged high powered module that is ideal for use in discos & P.A. Systems where powers of up to 125W, 4 ohms are required. The heavy duty output transistors ensure stable and reliable performance. It is currently supplied to a large number of equipment manufacturers where reliability and performance are the main considerations, whilst for others its low price is the major factor. Operating from a supply voltage of 40-80V into loads from 4-16 ohms.



£18.95
VAT

AL 2550-COMPACT LOW-COST 25W AMPLIFIER

A popular module with tens of thousands installed. Ideal for domestic applications. Supply rail 20-50V with loads of 8-16 ohms.



£6.55
VAT

MM 100-BUDGET 3-INPUT MIXER

With a host of features including 3 individual level controls, a master volume and separate bass and treble control, it provides for inputs for microphone, magnetic pick-up and tape, or second pick-up (selectable), and yet costs considerably less than competitive units. This module is ideal for discos and public address units and operates from 45V-70V.



£17.49
VAT

MM 100G GUITAR MIXER

As MM100 with two guitar + 1 microphone input intended for guitar amplifier applications.



£17.49
VAT

COMPLETE AUDIO RANGE FROM 10-125W.
SEND FOR DETAILS TODAY

AUTONA LTD

DEPT EPE 84
51 POPPY ROAD
PRINCES RISBOROUGH
BUCKS HP27 9DB
FAX: (0844) 347102

Carriage add £2.00
Export 10% - minimum £2.00.
Credit Card orders immediate dispatch.
UK orders add V.A.T.

Tel: (0844) 346326

STEREO HI-FI CONTROLLER

DAVID GEARY



Part Two

Provides a smooth professional "fade-in" to your chosen background music/speech once the CD, disc or tape etc. has finished playing.

LAST month we outlined the facilities of the Controller and described the System Power Supply. This month we conclude with Main board construction and add an optional Expansion/Display board.

CONSTRUCTION

Construction of the Main Control Board is also straightforward, follow the usual rules mentioned last month, and watch out for the links! The p.c.b. component layout and full size underside copper foil master is shown in Fig. 10. This board is also available from the *EPE PCB Service*, code 887.

Again, the specified p.c.b. connectors are well worthwhile. Note the mounting holes in the p.c.b. are just right for M3 bolts.

If you intend to use the Expansion Board, as no doubt most will, resistors R17 and R18 should be omitted and capacitors C7 and C8 replaced with wire links. If this is not done, these components combine with others on the Expansion p.c.b. to form a reasonably effective high pass filter to priority inputs!

TESTING AND SETTING UP

Having checked for solder bridges, etc. apply power to the Main Control board via connector PB5. Set preset VR1 to maximum resistance and VR4 to two-thirds maximum. Connect an oscilloscope, or failing that, an amplifier to PB10.

Apply a signal from a signal generator or music source (a robust one) to PB6. Allow ten seconds or so and the signal should fade up. Now move the signal input to PB9, and after four seconds or less it should fade up again. Gain should be adjustable using preset VR2 (Background) and VR3 (Priority).

If all does not seem well, check the outputs of IC5 at the links across the "ground" connection to IC6. Pin 2 of IC5 should be high with no signal at connection point PB9. Also check for approximately 1Hz at the long link from IC4 to IC6. With the signal connected to PB9, check there are pulses on the short link from IC4 to IC6 over the ground connection to IC5.

If the fault still does not come to light, recheck all component values, placements, etc.

If your board is not going to be used with the Expansion Module, you can set the gain controls VR2 and VR3 to give a gain of unity or any other gain up to about 2.5 that you require. Presets VR1 and VR4 can be adjusted to provide the necessary sensitivity for your application, but should not be set so the board is over-sensitive and triggers when the fridge compressor comes on! (I'm serious...)



| COMPONENTS | | Approx cost guidance only | £32 |
|--|--|---|--|
| MAIN BOARD | See SHOP TALK Page | | |
| Resistors | | | |
| R4, R5, R7, R8, R25, R26 | 12k (6 off) | C22, C24 | 10µ radial elect. 16V or greater (2 off) |
| R6, R27, R43, R47, R48, R50 | 1k (6 off) | | |
| R9, R13, R21, R22, R28, R29, R34, R38, R42, R46, R49, R51, R55 | 10k (13 off) | Semiconductors | |
| R10, R11, R14, R15, R35, R36, R39, R40 | 470 (8 off) | D6 | 1N4148 signal diode |
| R12, R16, R37, R41 | 39k (4 off) | D7, D8 | 1N4001 1A 50V rect. diode (2 off) |
| R17, R18 | 180k (2 off) | TR3, TR4 | BC109C npn silicon transistor (2 off) |
| R19, R20, R30, R31, R44, R45 | 4k7 (6 off) | IC1, IC2 | LM13700 dual transconductance op.amp (2 off) |
| R23, R24, R32, R33 | 5k6 (4 off) | IC3 | LF347N quad j-f.e.t. op.amp |
| R52, R53 | 1M (2 off) | IC4 | 4093BE quad 2-input NAND Schmitt trigger |
| R54, R56 | 100k (2 off) | IC5 | 4013BE dual D-type flip-flop |
| All 0.6W 1% metal film | | IC6 | 4017BE decade counter |
| | | IC7 | TL082 dual bi-f.e.t. op.amp |
| Potentiometers | | Miscellaneous | |
| VR1, VR4 | 100k enclosed horizontal carbon preset, lin. | Printed circuit board available from the <i>EPE PCB Service</i> , code 887 (Main); steel metal case, size 175mm x 155mm x 58mm; 8-pin d.i.l. socket; 14-pin d.i.l. socket (4 off); 16-pin d.i.l. socket (2 off); chassis mounting phono sockets, mounted on Paxolin panel; 3-way p.c.b. connector, with latch housing and terminals (5 off); 4-way p.c.b. connector, with latch housing and terminals; connecting wire; solder; M3 14mm threaded spacer (4 off); M3 nylon spacer (or 6BA drilled out) (4 off); M3 10mm bolt (4 off); M3 20mm bolt (4 off); M3 full nuts (12 off); nuts and bolts, required for front and back panels. | |
| VR2, VR3 | 22k enclosed horizontal carbon preset, lin. | | |
| Capacitors | | | |
| C5 to C13, C18 to C20, C23, C25 | 150n metallised polyester film (14 off) | | |
| C14, C15 | 100µ radial elect. 16V or greater (2 off) | | |
| C16, C17 | 1µ radial elect. 16V or greater (2 off) | | |
| C21 | 4µ7 radial elect. 16V or greater | | |

PB5 SUPPLY INPUT
OV, -, +.

PB6 BACKGROUND
L, R, GND.

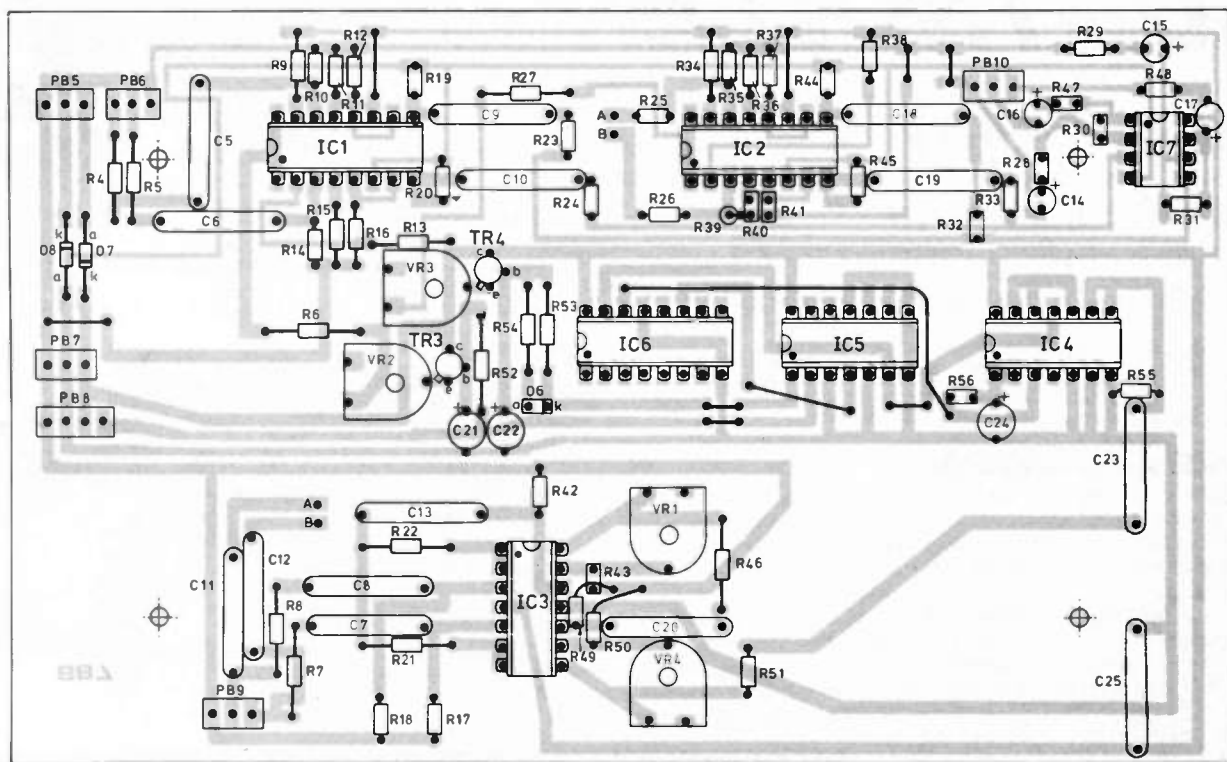
PB7 SPARE POWER
OV, -, +.

PB8 EXP. BOARD
OV, -, +, TRIG.

PB9 PRIORITY IN
GND., L, R

PB10 OUTPUT
GND., R, L.

CONNECT POINTS
A TO A AND B TO B



EE45769

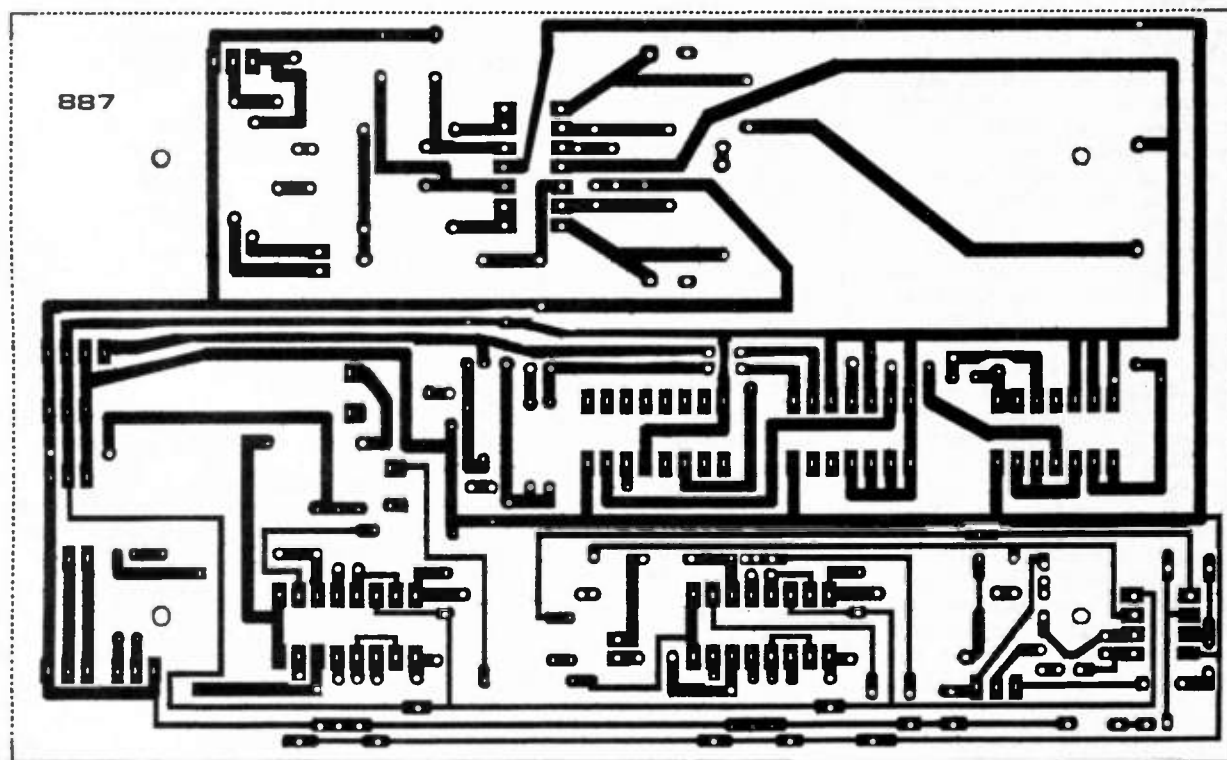


Fig. 10. Printed circuit board component layout and full size copper foil master pattern for the Main Control Board. The p.c.b. connector pin details are shown at the top.

EXPANSION AND DISPLAY BOARDS

The Expansion board increases the number of Priority Inputs to four. In addition, a Tape Output facility is provided and a dual seven-segment display to indicate status of main and tape outputs. The tape output is also provided with a fixed gain output amplifier with a gain of 1.47.

This board is fairly straightforward as can be seen from the block diagram Fig. 11. The only special connection to the Main board is the trigger signal, so the Expansion Module could be added later if desired, subject to the component changes mentioned earlier.

The Expansion/Display circuit diagram is shown in Fig. 12. It is almost as simple as the block diagram. Once again, a 4093 (IC8) provides the clock frequencies. Two counters are required, a 4520 dual counter (IC9) provides these efficiently. Note that as only the first two data lines are required (LSB, LSB + 1), either a BCD or Binary counter can be used. The data lines drive IC13 and IC14, 4511 7-segment decoders, and IC10, IC11, 4052 bilateral switches.

The available technical data for these "switches" (4052) suggest making pin 7 negative with respect to ground (pin 8) for the best a.c. performance. Having evaluated this mode of operation against making pins 7 and 8 the same potential, no

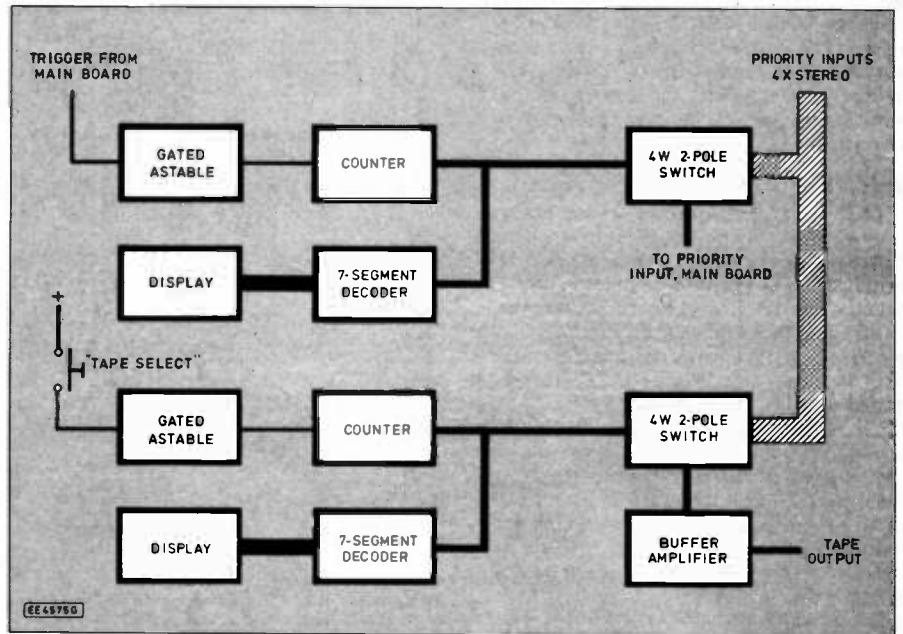


Fig. 11. Block diagram for the Expansion/Display boards.

noticeable degradation in performance was found to justify the extra complication (the rest of the CMOS would be running on a different ground potential). Although it would be possible to separate pins 7 and 8,

no practical advantage was evident and I have therefore ignored this suggestion.

The required gain for the tape output is provided by the dual op.amp IC12. Capacitors C29 to C36 in conjunction with

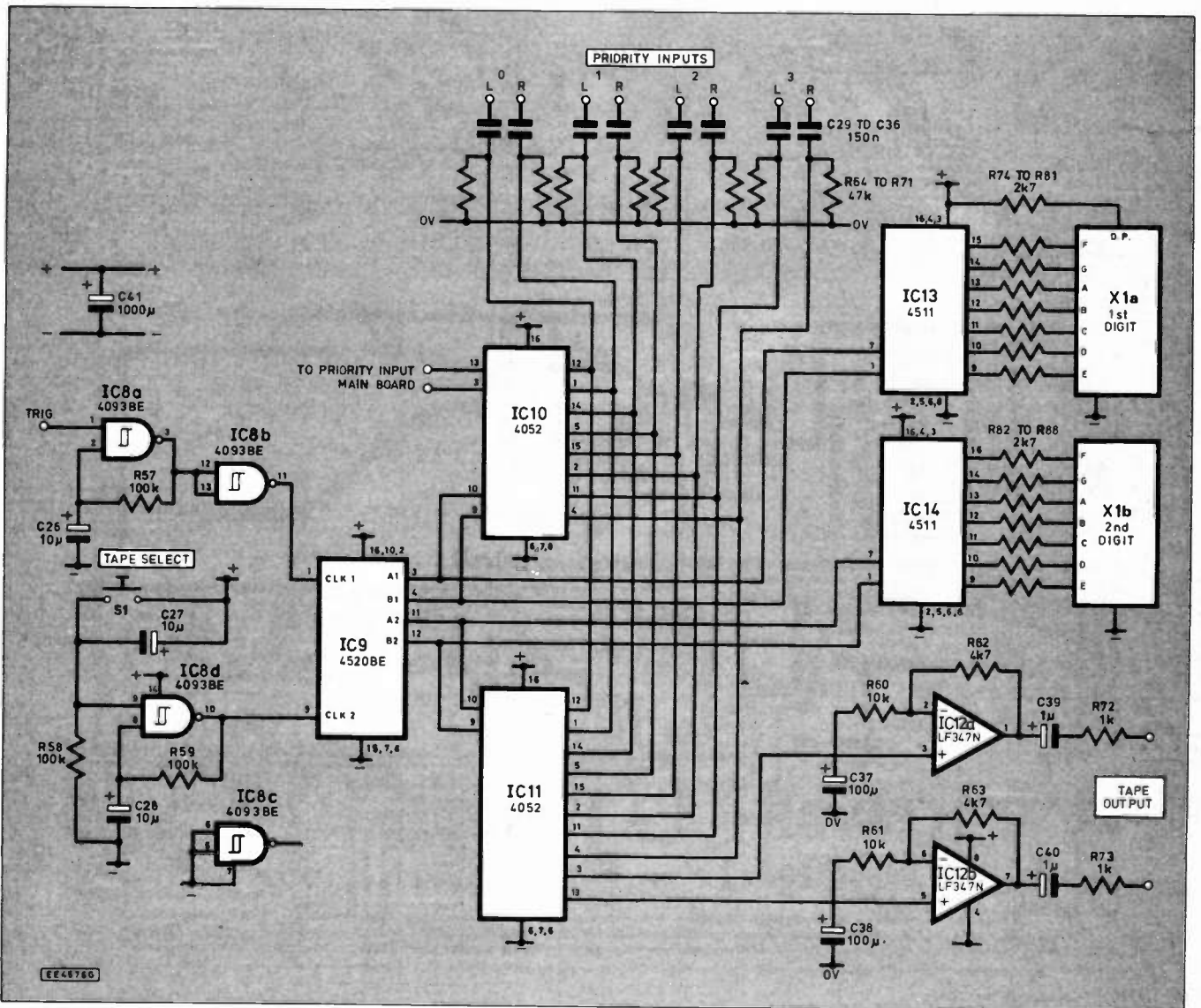


Fig. 12. Complete circuit diagram for the Expansion and Display boards for the Stereo Hi-Fi Controller.

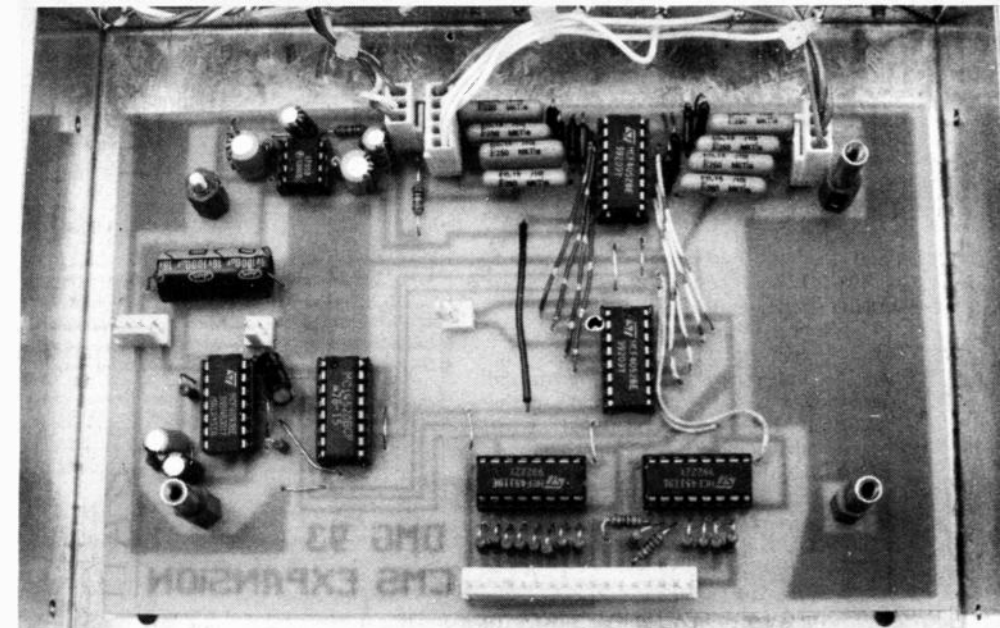
resistors R64 to R71 decouple the inputs. (Hence C7/R17 and C8/R18 are not required). This configuration removes the danger that a slight d.c. offset at the input could prevent the system operating correctly.

HOW IT WORKS

The trigger input from the Main board is high when the clock is required to stop, i.e. a signal has been found. This is used to stop IC8a from oscillating by gating off the Schmitt NAND gate. IC8b inverts the output from IC8a to prevent the counter triggering on the rising edge that could result, and therefore stopping at the count required + 1.

The same gated astable configuration is used on IC8d, but the inversion is not required as the pushbutton switch S1 will be released quickly when the correct count is reached. These clock pulses, when present, clock dual up-counter IC9. The LSB and LSB+1 outputs from each half of IC9 drive the seven-segment displays (X1, X2) via decoder/drivers (IC13, IC14), and 4-way double-pole bilateral switches (IC10, IC11).

The inputs of the bilateral switches IC10 and IC11 are paralleled so as to make the four inputs accessible for both tape and main outputs. The tape output selector IC11 is connected to a conventional negative feedback op.amp IC12 to provide a gain of 1.47 (an arbitrary figure)



and buffering, so that any noise on this output cannot feed back to the rest of the circuit.

Unused inputs are tied to ground. Capacitor C41 blocks any supply-borne pulses causing spurious triggering on the main board.

CONSTRUCTION

Both the Expansion board and Display board are quite easy to build, but bear in

mind there are a number of links to be made. In addition, there is the 17-way connector to the Display board, which can be a little tedious. However, a little care here will pay dividends in the shape of a project which should work first time.

The p.c.b. component layouts and full size underside copper track masters for the Expansion and Display boards are shown in Fig. 13 and Fig. 14. These boards are available from the *EPE PCB Service*, code

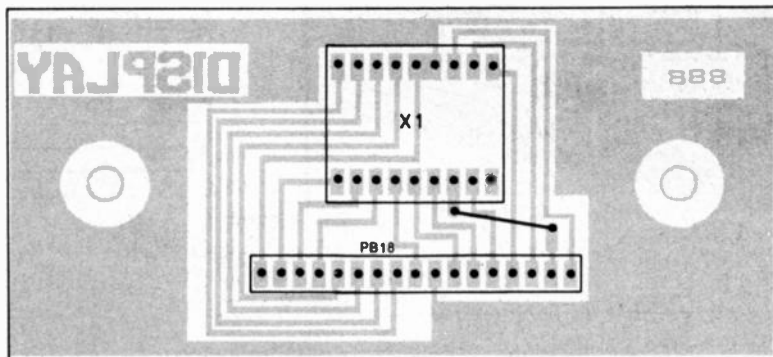
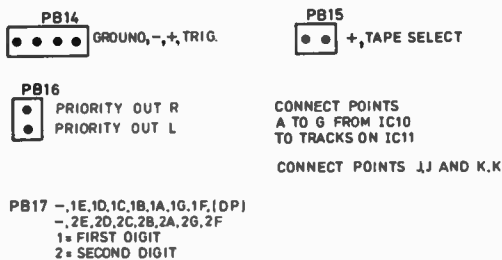
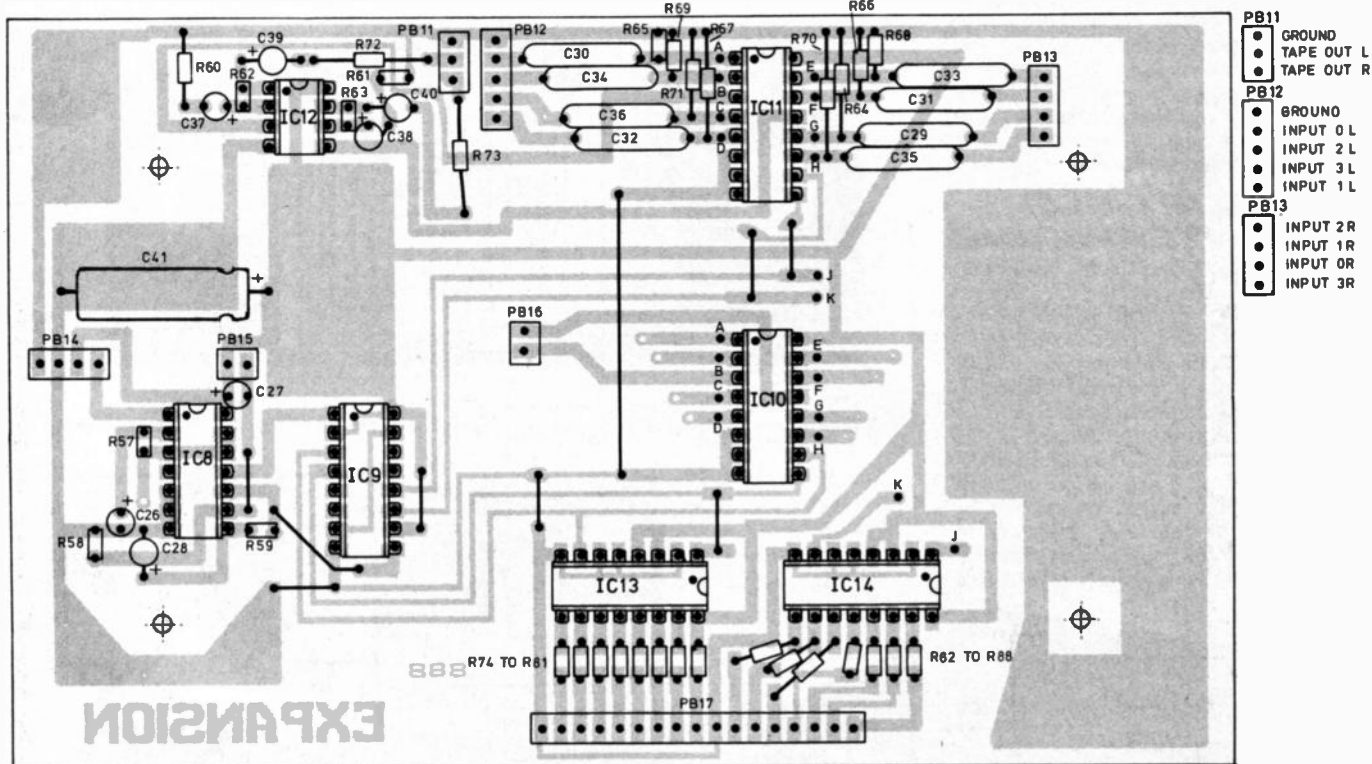


Fig. 13. Printed circuit board component layouts for the Expansion and Display p.c.b.s.

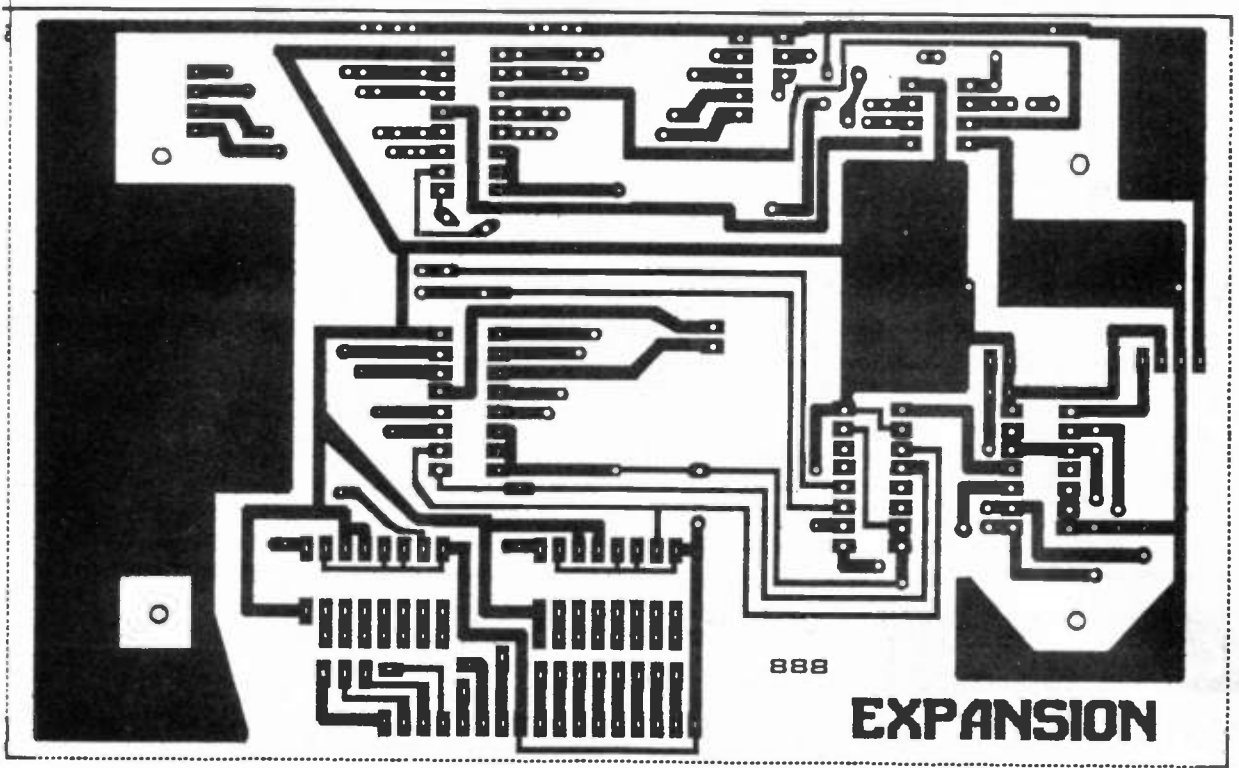


Fig. 14. Full size copper foil printed circuit board master patterns for the Expansion board and the Display board.

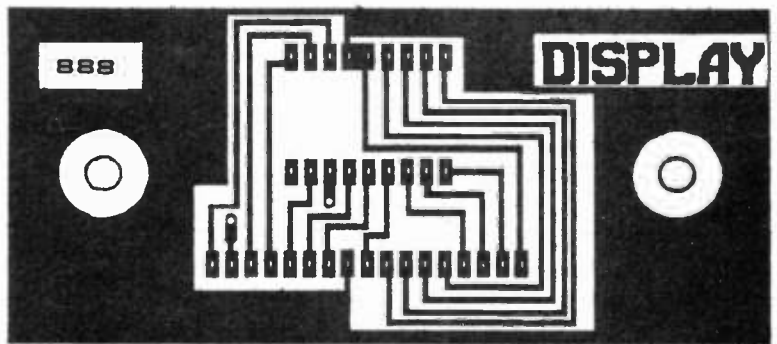
888 (Expan/Dis). Note that the pads on the Display board exactly match those on the Expansion board, both for spacing and order of connection.

Be careful of component orientation, bridged tracks, etc. None of the boards in this project are very difficult to complete given some attention.

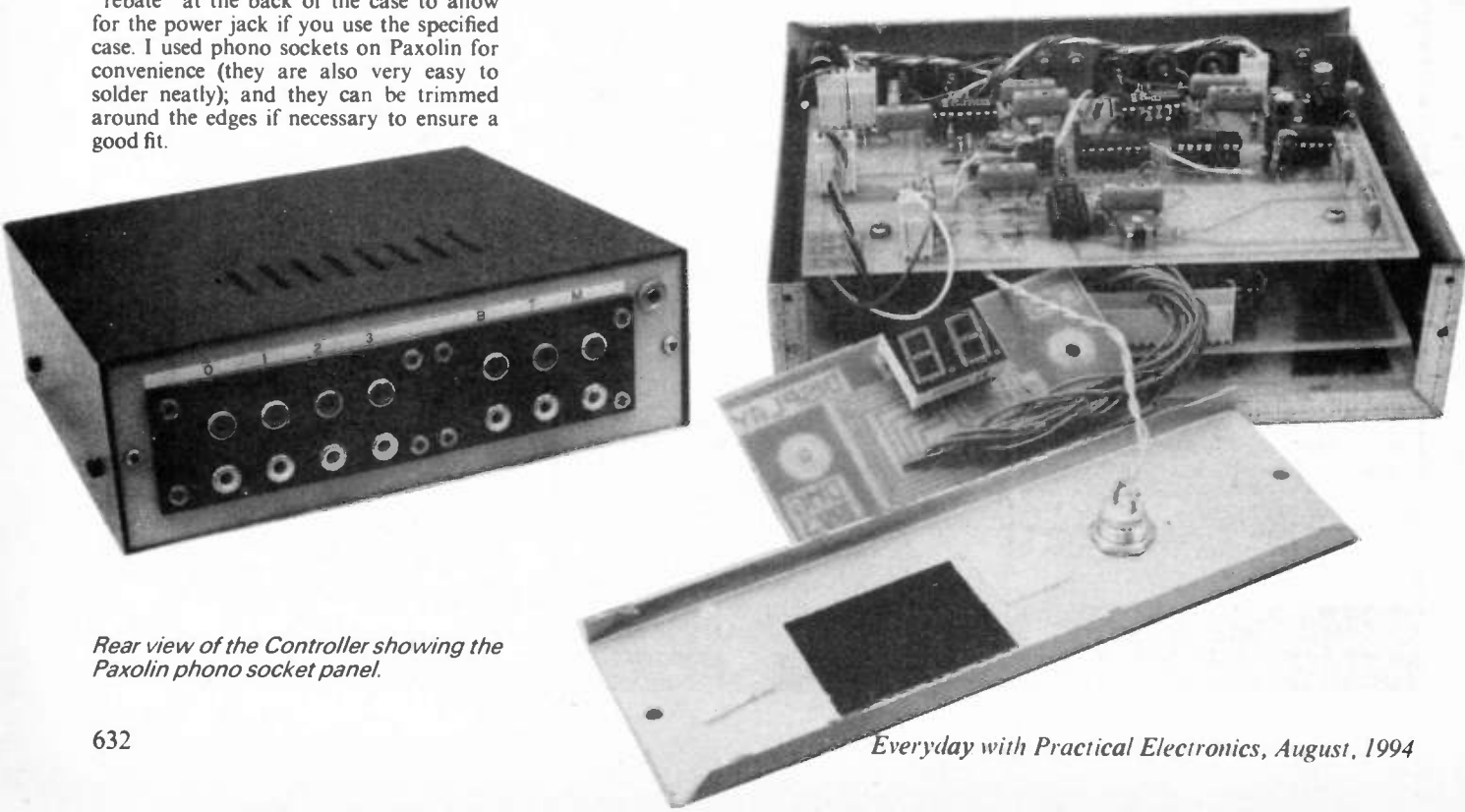
CASE DETAILS AND INTERWIRING

Once construction of the p.c.b.s is complete, you should have three boards to install in a box; Main Board, Expansion Board, Display Board. The specified metal case has removable front and rear panels. It is suggested that the rear panel is made up first. It is a bit of a squeeze but it does fit!

You will need to cut away part of the "rebate" at the back of the case to allow for the power jack if you use the specified case. I used phono sockets on Paxolin for convenience (they are also very easy to solder neatly); and they can be trimmed around the edges if necessary to ensure a good fit.



The front panel removed from the unit showing the p.c.b. "stacking" arrangement.



Rear view of the Controller showing the Paxolin phono socket panel.

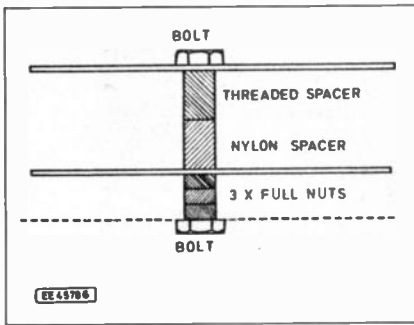


Fig. 15. Suggested method of mounting the two larger boards using spacers and nuts.

The two larger p.c.b.'s are mounted inside the case using an unusual arrangement using threaded spacers. Having drilled four 3mm holes in the right places, pass an M3 bolt through each, and put three nuts on the inside. This will locknut

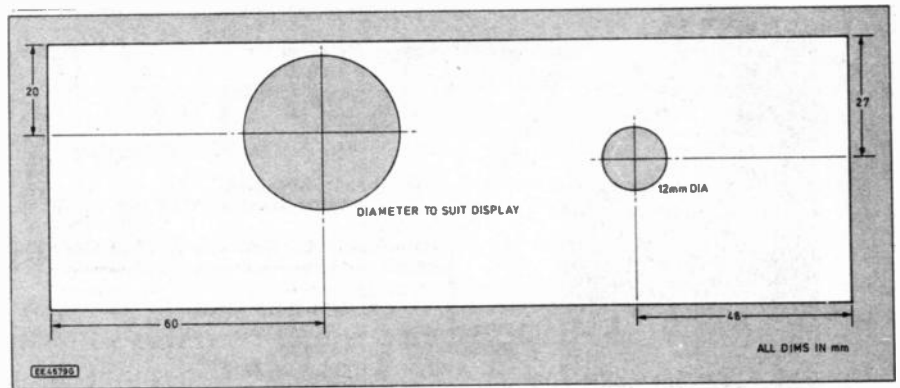


Fig. 16. Front panel drilling and cutting details.

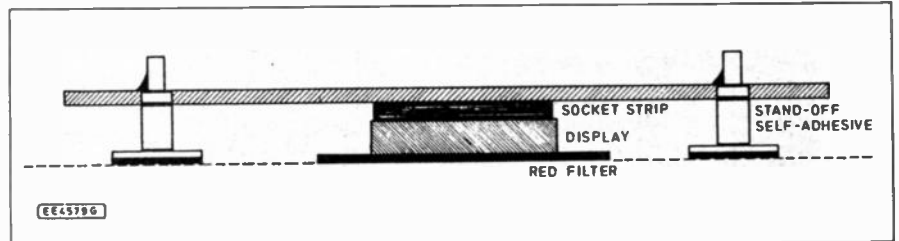


Fig. 17. Using self-adhesive p.c.b. stand-offs to mount and position the Display board behind the front panel.

COMPONENTS

EXPANSION AND DISPLAY

Resistors

| | |
|------------------------|--------------|
| R57 to R59 | 100k (3 off) |
| R60, R61 | 10k (2 off) |
| R62, R63 | 4k7 (2 off) |
| R64 to R71 | 47k (8 off) |
| R72, R73 | 1k (2 off) |
| R74 to R88 | 2k7 (15 off) |
| All 0.6W 1% metal film | |

See
**SHOP
TALK**
Page

Capacitors

| | |
|------------|--|
| C26 to C28 | 10 μ radial elect. 16V or greater (3 off) |
| C29 to C36 | 150n metallised polyester film (8 off) |
| C37, C38 | 100 μ radial elect. 16V or greater (2 off) |
| C39, C40 | 1 μ radial elect. 16V or greater (2 off) |
| C41 | 1000 μ axial elect. 16V or greater |

Semiconductors

| | |
|------------|--|
| IC8 | 4093BE quad 2-input NAND Schmitt trigger |
| IC9 | 4520BE dual binary counter |
| IC10, IC11 | 4052BE 2-pole 4-way bi-directional analogue switch (2 off) |
| IC12 | LF347N quad j-f.e.t. op.amp |
| IC13, IC14 | 4511BE BCD to 7-segment decoder driver (2 off) |
| X1 | Double digit 0.56in. common cathode display |

Miscellaneous

Printed circuit boards available from EPE PCB Service code 888 (Expan/Dis); pushbutton switch, push-to-make; 8-pin d.i.l. socket; 14-pin d.i.l. socket; 16-pin d.i.l. socket (5 off); 20-way socket strip; 2-way p.c.b. connector, with latch housing and terminals (2 off); 3-way p.c.b. connector, with latch housing and terminals; 4-way p.c.b. connector, with housing and terminals (2 off); 5-way p.c.b. connector, with housing and terminals; 17-way p.c.b. connector, with housing and terminals; connecting wire; solder.

Approx cost
guidance only

£21

the boards very securely and provide the right spacing.

Pass the Expansion Board over the bolts, followed by a nylon spacer and a threaded steel spacer. Then put the Main board on top to check it all fits. It should be possible to screw into the threaded spacers with short M3 bolts to secure the Main board - Fig. 15.

Do not tighten down the Main board yet. If using the specified p.c.b. connectors, make up jumper leads to run from PB8 (Main board) to PB14 (Expansion board), and from PB9 (Main board) to PB16 (Expansion board). Plug the Expansion board ends of the leads in position, leaving the Main board ends free for now.

Wire from the pair of Tape Output jacks to PB11 and plug in. Do the same for the left and right sets of inputs to PB12 and PB13 respectively.

Solder a pair of wires to the front panel pushbutton switch and put a two-way socket on the other end of the wires to suit PB15. The specified pushbutton and p.c.b. connector allows the connector to pass through the front panel cutout on final assembly and connect to PB15. Finally, connect seventeen leads to PB17, soldering them to the Display p.c.b.

Install the Main board. Connect the flying leads from the Expansion board to PB8 and PB9. Connect PB5 to the power jack, and PB6 and PB10 to the Background input and main output respectively. Connect PB17 to the Expansion board.

TESTING

If the Main board worked correctly, then there is little to go wrong. The displays should never show a number other than 0, 1, 2 or 3. The middle decimal point should illuminate permanently.

If the left-hand digit is counting, the "background" input should pass through to the Main Output. Try each priority input in turn, left and right channels separately, checking that the count stops at the correct number. If not, check your wiring.

Using the Tape Select pushbutton S1, advance the tape selection counter (right digit). Try each priority input in turn, checking that the corresponding channel is passed to the Tape Output. If it doesn't, and the priority input worked OK, your links are incorrectly made on the Expansion board.

You may need to adjust presets VR1 and VR4 to get best results.

If all is well, switch off and make up the front panel as shown in Fig. 16, mounting the display board as indicated in Fig. 17. The display cutout diameter is 27mm.

You will need to remove the Main board in order to finally assemble the unit, because of the pushbutton connection to PB15. Once assembled for the last time, connect a signal generator to the Background Input and set the required gain on VR2. (This is why the Main board goes on top).

Disconnect the "sig-gen" and reconnect it to one of the Priority Inputs. Repeat adjustment, this time with preset VR3. A feature of this design is that you can set the background to be slightly quieter than the priority inputs if you wish, by reducing the gain of IC1 (turn VR3 anti-clockwise).

USING THE CONTROLLER

Interconnect the unit with your hi-fi system as shown in Fig. 1 (last month), with the top cover off. Try using different sources to ensure the unit triggers reliably. You may need to adjust preset VR1 and VR4 for best results. Once set, you can finally adjust VR2 and VR3 to set the gains required and refit the top cover.

An idea: Connect a stereo video. Set it on Camera input, so that unless a tape is playing, both video and audio outputs are nil. Start a commercial tape, watch the film/titles start, and the background source fade out in favour of stereo video. □

Acknowledgments/References

Op.Amp Circuits Manual, Ray Marston, Heinemann Newnes, ISBN 0-434-91207-7.

**NEW
VERSION II**

ELECTRONICS PRINCIPLES II SOFTWARE

from E.P.T. Educational Software (Tel: 0376 514008)

If you are looking for a means of improving your knowledge of the basics of electronics then this software is for you.

Electronics Principles II covers:

- ★ Insulators, Conductors, Resistance
- ★ D.C. Circuits
- ★ Capacitance and Inductance
- ★ A.C. Series Circuits
- ★ A.C. Parallel Circuits
- ★ Reactance and Impedance
- ★ A.C. and D.C. Power
- ★ Frequency and Tuned Circuits
- ★ Using Numbers
- ★ Complex Numbers, Phase Angles
- ★ P.N. Junction Diode
- ★ Transistors
- ★ Operational Amplifiers
- ★ Logic Gates
- ★ Digital Number Systems
- ★ Combinational Logic
- ★ Flip Flops
- ★ Counters and Shift Registers
- ★ Memory
- ★ Microcomputer operation

Electronics Principles II is a major revision of the successful original version currently used by electronics hobbyists, schools, colleges, and for training within industry throughout the U.K. and overseas. Some of the modifications are as a result of feedback from teachers, but mostly the changes are due to making greater use of the available improvements in software development technology. Text has been removed from the screen and is now selected by the F1 key. This provides a larger screen area on which to develop the circuit diagrams and calculations, greatly improving the graphics presentation.

The individual sub-menus are changed to selection buttons, this makes all those topics available within a module, clearly visible to the user. The layout of the calculations is considerably enhanced, firstly by providing the formulae used and secondly by showing the calculation steps, exactly as in a textbook; the advantage here being that you can input your own values.

Mouse selection is improved by increasing the screen range over which the button may be clicked. There are several additional screens, developing further previous topics and a new program illustrating microprocessor registers and the operation of a micro-computer.

Having reviewed a dozen, or more, educational software packages designed to "teach" electronics, I was more than a little sceptical when I first heard about Electronics Principles: there seemed to be little that could be done that has not been done elsewhere. When I started to use the package my views changed. Indeed, I was so impressed with it that I quickly came to the conclusion that Everyday with Practical Electronics readers should have an opportunity to try the package out for themselves! – MIKE TOOLEY B.A. Dean of Faculty of Technology, Brooklands Technical College

Over 200 menu driven screens with interactive graphics enabling a learning by doing approach to encourage experimentation.

Complete package **Only £49.95** inc. VAT.

NEW VERSION 2.0

ELECTRONICS P.C. TOOLBOX VERSION 2.0

New extended and improved version of the popular Toolbox software. Presents commonly used formulae in a way that makes calculations easier thus encouraging experimentation in circuit design.

Covers D.C. Calculations from Ohm's Law to Loading a Potential Divider; Further D.C. Calculations from Power Ratio Decibels to Kirchhoff's Laws; A.C. Calculations from Average Peak Current to Filters and Admittance; Capacitance Calculations from values to RC Time Constants; Inductance Calculations from value to Selectivity; Binary Calculations from Addition to 2's Complement; Numbers and Phase Angles from addition to Polar to Rectangular; Operational Amplifiers from Inverting Op-Amp to Op-Amp Differentiator.

Only £19.95 inc. VAT

FREE While stocks last each Toolbox Version 2.0 ordered will be supplied with two different EPE "Calculation Corner" wall charts covering D.C. and A.C. Electricity.

Demonstration disk available
Electronic Principles II or GCSE Maths
(state which)
send £2 (Overseas orders send £3)
– includes P&P

GCSE MATHS

A series of programs covering all the major topics required by the school syllabus. Designed to be user friendly enabling you to study or revise in what we believe is an interesting and enjoyable way. There are nearly one hundred and fifty menu driven screens with interactive graphics, enabling a 'learning through doing' approach to encourage experimentation. Now being used in many schools throughout the U.K.

Only £49.95 inc. VAT

These programs require a PC (or fully compatible system) running DOS with an 80286 or better processor and VGA (ideally colour) graphics. In addition you must have 4Mb of hard disk space, a high density (1.44Mb) floppy drive and at least 640K of RAM. We also recommend the use of a mouse. Site licences are available – please enquire.

Distributed by Direct Book Service, 33 Gravel Hill, Merley, Wimborne, Dorset, BH21 1RW. (Mail Order Only).

Add £1 per order for UK post and packing. Make cheques payable to Direct Book Service.

Direct Book Service is a division of Wimborne Publishing Ltd. publishers of *Everyday with Practical Electronics*.

Tel: 0202 881749. Fax: 0202 841692.

Visa and Mastercard orders accepted (minimum credit card order £5) – please give card number, card expiry date and cardholders address if different to the delivery address. Orders are normally sent within seven days but please allow a maximum of 28 days – longer for overseas orders.

OVERSEAS ORDERS: Add £2 postage for countries in the E.E.C. Overseas readers, outside the E.E.C. countries add £3 for airmail postage.

DIRECT BOOK SERVICE

The books listed have been selected by *Everyday with Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page. For another selection of books see next month's issue.

ELECTRONIC PROJECTS - BOOK 1

Published by *Everyday Electronics* in association with *Magenta Electronics*.

Contains twenty of the best projects from previous issues of EE each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mains Tester and Fuse Finder, Light Rider - (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator. 128 pages (A4 size) **Order code EPT1** £2.45

ELECTRONICS TEACH-IN 88/89 - INTRODUCING MICROPROCESSORS

A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc. Starting with basic terminology, integrated circuits, logic families and numbering systems the text builds in stages, with revision and assessments built in, up to programming, languages, flow charts, etc. The course is ideal for the newcomer to the subject. 80 pages (A4 size) **Order code TI-88/89** £2.45

Special Everyday Electronics Books

ELECTRONICS TEACH-IN No. 3 - EXPLORING ELECTRONICS

LAST FEW - ORDER NOW

(published by *Everyday Electronics*)
Owen Bishop
Another EE value for money publication aimed at students of electronics. The course is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. The book does not contain masses of theory or formulae but straightforward explanations and circuits to build and experiment with. Exploring Electronics contains more than 25 useful projects, assumes no previous knowledge of electronics and is split into 28 easily digestible sections. 88 pages (A4 size) **Order code 113** £2.45

ELECTRONICS TEACH-IN No. 4 INTRODUCING DIGITAL ELECTRONICS

(published by *Everyday Electronics*)
Michael J. Cockcroft
Although this book is primarily a City & Guilds Introductory level course (726/301), approximately 90% of the information forms a very basic introductory course in electronics in general, it therefore provides an excellent introductory text for beginners and a course of revision for GCSE students. Full details of the assessment, details of assessment requirements required and information on the course are given. The City & Guilds introduction to module 726/301 reads: "A candidate who satisfactorily completes this module will have a competence to identify basic components and digital integrated circuits and connect them together to form simple working circuits and logic units." This provides an excellent introduction to the book.

ELECTRONICS TEACH-IN No. 5 GUIDE TO BUILDING ELECTRONIC PROJECTS

Published by *EVERYDAY ELECTRONICS*
Due to the demand from students, teachers and hobbyists we have put together a range of articles from past issues of *Everyday Electronics* that will assist those involved with the construction of electronic projects. The book contains the complete *Project Development for GCSE* series. Contents: Features - First Steps in Project Building;

Building with Vero; Project Development for GCSE; Getting your Project Working; Guide to Printed Circuit Boards; Choosing and Using Test Equipment - The Multimeter, The Oscilloscope, P.S.U.s, Logic Probes, Digital Frequency Meters, Signal Generators, etc; Data - Circuit Symbols; Component Codes; Resistors; Identifying Components; Capacitors; Actually Doing It - Understanding the Circuit Diagram, Component Codes, Mounting circuit boards and controls, Understanding Capacitors; Projects - Lie Detector; Personal Stereo Amplifier; Digital Experimenter's Unit; Quizmaster; Siren Effects Unit; UV Exposure Unit; Low-cost Capacitance Meter; Personal Radio. 88 pages (A4 size) **Order code 115** £2.95

ELECTRONICS TEACH-IN No. 6 DESIGN YOUR OWN CIRCUITS

(Published by *Everyday with Practical Electronics*)
Mike Tooley B.A.
This book is designed for the beginner and experienced reader alike, and aims to dispell some of the mystique associated with the design of electronic circuits. It shows how even the relative newcomer to electronics can, with the right approach, design and realise quite complex circuits. Fourteen individual p.c.b. modules are described which, with various detailed modifications, should allow anyone to design and construct a very wide range of different projects. Nine "hands-on" complete DIY projects have also been included so readers can follow the thinking behind design, assembly, construction, testing and evaluation, together with suggested "mods" to meet individual needs. The practical projects have each been designed to stand on their own as complete items of equipment. P.C.B.s for all the modules and projects are available by mail order.

The subjects covered in each chapter of the book are: Introduction and Power Supplies; Small Signal Amplifiers; Power Amplifiers; Oscillators; Logic Circuits; Timers; Radio; Power Control; Optoelectronics.

The nine complete constructional projects are: Versatile Bench Power Supply; Simple Intercom; Bench Amplifier/Signal Tracer; Waveform Generator; Electronic Die; Pulse Generator; Radio Receiver; Disco Lights Controller; Optical Communications Link. 136 pages **Order code 116** £3.45



Computers and Computing

HOW TO CHOOSE A SMALL BUSINESS COMPUTER SYSTEM

D. Weale
This book is for anyone intending to buy an IBM compatible computer system, whether it is their first system or a replacement. There are sections on hardware, application and systems programs and how to actually make your choice as well as sections on the law, ergonomics and a glossary of common terms. The text contains many useful tips and some warnings (which could save much effort and expense). 114 pages **Order code BP323** £4.95

UNDERSTANDING PC SPECIFICATIONS

R. A. Penfold
If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGAI. 104 pages **Order code BP282** £4.95

AN INTRODUCTION TO 68000 ASSEMBLY LANGUAGE

R. A. & J. W. Penfold
Obtain a vast increase in running speed by writing programs for 6800 based micros such as the Commodore Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals. 112 pages **Order code BP184** £2.95

THE ART OF PROGRAMMING THE ZX SPECTRUM

M. James, B.Sc., M.B.C.S.
It is one thing to have learnt how to use all of the Spectrum's commands and functions, but a very different one to be able to combine them into programs that do exactly what you want them to. This is just what this book is all about - teaching you the art of effective programming with your Spectrum. 144 pages **Order code BP119** £2.50

A CONCISE INTRODUCTION TO MS-DOS

N. Kantaris
This guide is written with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section. The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems. 64 pages **Order code BP232** £2.95

MAKING MS-DOS WORK FOR YOU

N. Kantaris & P. R. M. Oliver
This book was written with the busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the

book has also been designed to be circular, which means that you don't have to start at the beginning and go to the end.

The book explains: How to write customised batch files which allow you to display what you want on your screen, and in the form and order you want it, instead of being forced to use the DOS prompt on a blank screen. How to design and set up a fast interactive and professional looking menu system, so that you or anyone else can run utility applications or commercial software packages easily. How the ANSISYS display and keyboard commands can be used to position the cursor on any part of the screen, change the intensity of the displayed characters or change their colour. How the Edit screen editor or the Edlin line editor can be used to enter ESCape (ANSI.SYS) commands into simple ASCII files to allow control of both your screen display and your printer. How to control the operation of the two main types of printers in use today, Epson compatible dot matrix and HP compatible laser printers. How to use several useful routines, such as moving and finding files, protecting files from accidental erasure, a simplified backup process, a screen saver, and a disc cataloguing system.

The Debug program and how it can be used to create, see and change the contents of any file, including those of programs written in assembler code. This includes how to find your way around the names and tasks of the CPU registers and the meaning of some simple assembler mnemonics. 182 pages **Order code BP319** £4.95

AN INTRODUCTION TO CP/M

R. A. Penfold
In order to run and use programs operating under CP/M it is not essential to have an understanding of the system, but a reasonable knowledge of the subject can certainly be of immense help when minor problems occur, and also in fully exploiting the possible potential of the system. This book tells the story! 84 pages **Order code BP183** £2.95

Audio and Music

ACOUSTIC FEEDBACK - HOW TO AVOID IT

Feedback is the bane of all public address systems. While feedback cannot be completely eliminated, many things can be done to reduce it to a level at which it is no longer a problem.

Much of the trouble is often the hall itself, not the equipment, but there is a simple and practical way of greatly improving acoustics. Some microphones are prone to feedback while others are not. Certain loudspeaker systems are much better than others, and the way the units are positioned can produce or reduce feedback. All these matters are fully explored as well as electronic aids such as equalizers, frequency-shifters and notch filters.

The special requirements of live group concerts are considered, and also the related problem of instability that is sometimes encountered with large set-ups. We even take a look at some unsuccessful attempts to cure feedback so as to save readers wasted time and effort duplicating them.

Also included is the circuit and layout of an inexpensive but highly successful twin-notch filter, and how to operate it. **92 pages**

Order code BP310 £3.95

PRACTICAL MIDI HANDBOOK

R. A. Penfold

The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.

The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those manuals. **128 pages**

Order code PC101 £6.95

PREAMPLIFIER AND FILTER CIRCUITS

R. A. Penfold

This book provides circuits and background information for a range of preamplifiers, plus tone controls, filters, mixers, etc. The use of modern low noise operational amplifiers and a specialist high performance audio preamplifier i.c. results in circuits that have excellent performance, but which are still quite simple. All the circuits featured can be built at quite low cost (just a few pounds in most cases).

The preamplifier circuits featured include:- Microphone preamplifiers (low impedance, high impedance, and crystal). Magnetic cartridge pick-up preamplifiers with R.I.A.A. equalisation. Crystal/ceramic pick-up preamplifier. Guitar pick-up preamplifier. Tape head preamplifier (for use with compact cassette systems).

Other circuits include:- Audio limiter to prevent overloading of power amplifiers. Passive tone controls. Active tone controls. PA filters (highpass and lowpass). Scratch and rumble filters. Loudness filter. Audio mixers. Volume and balance controls **92 pages**

Order code BP309 £3.95

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 why and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure. **148 pages**

Order code BP256 £2.95

COMPUTERS AND MUSIC - AN INTRODUCTION

R. A. Penfold

Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone.

If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.

This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully. **174 pages**

Order code PC107 £8.95

ELECTRONIC PROJECTS FOR GUITAR

R. A. Penfold

This book contains a collection of guitar effects and some general purpose effects units, many of which are suitable for beginners to project building. An introductory chapter gives guidance on construction.

Each project has an introduction, an explanation of how it works, a circuit diagram, complete instructions on strip-board layout and assembly, as well as notes on setting up and using the units. Contents include: Guitar tuner; Guitar preamplifier; Guitar headphone amplifier; Soft distortion unit; Compressor; Envelope wasa; Phaser; Dual tracking effects unit; Noise gate/expander; Treble booster; Dynamic treble booster; Envelope modifier; Tremolo unit; DI box. **110 pages**

Order code PC110 £8.95

HIGH POWER AUDIO AMPLIFIER CONSTRUCTION

R. A. Penfold

Practical constructional details of how to build a number of audio power amplifiers ranging from about 50 to 300/400 watts r.m.s. Includes MOSFET and bipolar transistor designs. **96 pages**

Order code BP277 £3.95

Theory and Reference

ELECTRONIC HOBBYISTS HANDBOOK

R. A. Penfold

Provides an inexpensive single source of easily located information that the amateur electronics enthusiast is likely to need for the day-to-day pursuit of this fascinating hobby. Covers common component colour codes. Details the characteristics and pinouts of many popular semiconductor devices, including various types of logic ICs, operational amplifiers, transistors, FETs, unijunctions, diodes, rectifiers, SCRs, diacs, triacs, regulators and SMDs, etc. Illustrates many useful types of circuits, such as timers and oscillators, audio amplifiers and filters, as well as including a separate section on power supplies. Also contains a multitude of other useful data. **88 pages**

Order code BP233 £4.95

FROM ATOMS TO AMPERES

F. A. Wilson

Explains in crystal clear terms the absolute fundamentals behind electricity and electronics. Really helps you to discover and understand the subject, perhaps for the first time ever.

Have you ever: Wondered about the true link between electricity and magnetism? Felt you could never understand the work of Einstein, Newton, Boltzmann, Planck and other early scientists? Just accepted that an electron is like a little black ball? Got mixed up with e.m.f. and p.d.? Thought the idea of holes in semiconductors is a bit much?

Then help is at hand with this inexpensive book, in as simple a way as possible and without too much complex mathematics and formulae. **244 pages**

Order code BP254 £3.50

ELECTRONICS - A 'MADE SIMPLE' BOOK

G. H. Olsen

This book provides excellent background reading for our *Introducing Digital Electronics Teach-In* Book and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity. **330 pages**

Order code NE10 £6.95

A REFERENCE GUIDE TO PRACTICAL ELECTRONICS TERMS

F. A. Wilson

Electronic devices surround us on all sides and their numbers are increasing without mercy. Ours is the problem therefore in keeping up with this relentless expansion. Unfortunately we cannot know it all and most

of us do not wish to afford the cost of large reference books which explain many concepts in fair detail. Here is an answer, an inexpensive reference guide which explains briefly (but we hope, well) many of the underlying electronics features of practical devices, most of which, to a certain extent, control our lives.

This book is in effect more than just a dictionary of practical electronics terms, it goes a stage further in also getting down to fundamentals. Accordingly the number of terms may be limited but the explanations of the many which are included are designed to leave the reader more competent and satisfied - and this is without the use of complicated mathematics which often on first reading can even be confusing.

For those who also wish to get right down to the root of the matter, there is a second volume entitled *A Reference Guide to Basic Electronics Terms* (BP286), each of the books referring to its companion as necessary.

A reference guide for practically everybody concerned with electronics. **432 pages**

Order code BP287 £5.95

NEWNES ELECTRONICS POCKET BOOK

E. A. Parr

Newnes Electronics Pocket Book has been in print for over twenty years and has covered the development of electronics from valve to semiconductor technology and from transistors to LSI integrated circuits and microprocessors. To keep up to date with the rapidly changing world of electronics, continuous revision has been necessary. This new Fifth Edition takes account of recent changes and includes material suggested by readers of previous editions. New descriptions of op. amp. applications and the design of digital circuits have been added, along with a totally new chapter on computing, plus other revisions throughout. **315 pages (hard cover)**

Order code NE02 £12.95

ELECTRONIC MODULES AND SYSTEMS FOR BEGINNERS

Owen Bishop

This book describes over 60 modular electronic circuits - how they work, how to build them, and how to use them. The modules may be wired together to make hundreds of different electronic systems, both analogue and digital. To show the reader how to begin building systems from modules, a selection of over 25 electronic systems are described in detail, covering such widely differing applications as timing, home security, measurement, audio (including a simple radio receiver), games and remote control. **200 pages**

Order code BP266 £3.95

Project Building

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING

R. A. Penfold

We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects. **96 pages**

Order code BP110 £2.95

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s

R. A. Penfold

Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s. **80 pages**

Order code BP121 £2.50



A BEGINNERS GUIDE TO MODERN ELECTRONIC COMPONENTS

R. A. Penfold

The purpose of this book is to provide practical information to help the reader sort out the bewildering array of components currently on offer. An advanced knowledge of the theory of electronics is not needed, and this book is not intended to be a course in electronic theory. The main aim is to explain the differences between components of the same basic type (e.g. carbon, carbon film, metal film, and wire-wound resistors) so that the right component for a given application can be selected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor. **166 pages**

Order code BP285 £3.95

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS

R. A. Penfold

Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also include examples in the form of simple projects. **112 pages**

Order code 227 £1.95

ELECTRONICS SIMPLIFIED - CRYSTAL SET CONSTRUCTION

F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

Especially written for those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day one can read intelligently and handle simple tools. **80 pages**

Order code BP92 £1.75

GUIDE TO BUILDING ELECTRONIC PROJECTS

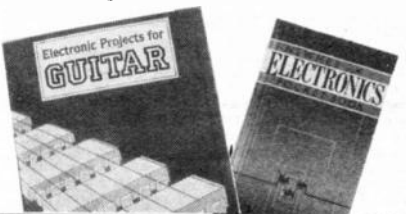
Published by *Everyday Electronics*

See the first page of books - ELECTRONICS TEACH-IN No.5 - for full details.

ELECTRONICS PROJECT BOOK

Published by *Everyday Electronics* in association with *Magenta Electronics*.

See the first page of books for full details.



Testing and Test Gear

HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT

R. A. Penfold

This book explains the basic function of an oscilloscope, gives a detailed explanation of all the standard controls, and provides advice on buying. A separate chapter deals with using an oscilloscope for fault finding on linear and logic circuits, plenty of example waveforms help to illustrate the control functions and the effects of various fault conditions. The function and use of various other pieces of test equipment are also covered, including signal generators, logic probes, logic pulsers, and crystal calibrators. **104 pages**

Order code BP267 £3.50

Circuits and Design

PRACTICAL ELECTRONIC FILTERS

Owen Bishop

This book deals with the subject in a non-mathematical way. It reviews the main types of filter, explaining in simple terms how each type works and how it is used.

The book also presents a dozen filter-based projects with applications in and around the home or in the constructor's workshop. These include a number of audio projects such as a rhythm sequencer and a multi-voiced electronic organ.

Concluding the book is a practical step-by-step guide to designing simple filters for a wide range of purposes, with circuit diagrams and worked examples.

88 pages **Order code BP229** £4.95

ELECTRONIC ALARM CIRCUITS MANUAL

R. M. Marston

One hundred and forty useful alarm circuits, of a variety of types, are shown in this volume. The operating principle of each one is explained in concise but comprehensive terms, and brief construction notes are given where necessary.

Aimed at the practical design engineer, technician and experimenter, as well as the electronics student and amateur.

124 pages **Order code NE11** £13.95

DIGITAL LOGIC GATES AND FLIP-FLOPS

Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages **Order code PC106** £8.95

ELECTRONIC CIRCUITS FOR THE COMPUTER

CONTROL OF ROBOTS

Robert Penfold

Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kit and a wide range of mechanical components available. The micro controller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.

The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the

robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.

92 pages **Order code BP179** £2.95

ELECTRONIC POWER SUPPLY HANDBOOK

Ian R. Sinclair

This book covers the often neglected topic of electronic power supplies. All types of supplies that are used for electronics purposes are covered in detail, starting with cells and batteries and extending by way of rectified supplies and linear stabilisers to modern switch-mode systems. IC switch-mode regulators, DC-DC converters and inverters.

The devices, their operating principles and typical circuits are all dealt with in detail. The action of rectifiers and the reservoir capacitor is emphasised, and the subject of stabilisation is covered. The book includes some useful formulae for assessing the likely hum level of a conventional rectifier reservoir supply.

136 pages **Order code PC108** £7.95

50 SIMPLE LED CIRCUITS

R. N. Soar

Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components - the light-emitting diode (LED). Also includes circuits for the 707 common anode display.

64 pages **Order code BP42** £1.95

BOOK 2 50 more l.e.d. circuits

Order code BP87 £1.95

CIRCUIT SOURCE BOOK 1

A. Penfold

Written to help you create and experiment with your own electronic designs by combining and using the various standard "building block" circuits provided. Where applicable, advice on how to alter the circuit parameters is given.

The circuits covered in this book are mainly concerned with analogue signal processing and include: Audio amplifiers (op.amp and bipolar transistors); audio power amplifiers; d.c. amplifiers; highpass, lowpass, bandpass and notch filters; tone controls; voltage controlled amplifiers and filters; triggers and voltage comparators; gates and electronic switching; bargraphs; mixers; phase shifters, current mirrors, hold circuits, etc.

Over 150 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.

182 pages **Order code BP321** £4.95

CIRCUIT SOURCE BOOK 2

R. A. Penfold

This book will help you to create and experiment with your own electronic designs by combining and using the various standard "building blocks" circuits provided. Where applicable, advice on how to alter the circuit parameters is provided.

The circuits covered are mainly concerned with signal generation, power supplies, and digital electronics.

The topics covered in this book include: 555 oscillators; sine wave oscillators; function generators; CMOS oscillators; voltage controlled oscillators; radio frequency oscillators; 555 monostables; CMOS monostables; TTL monostables; precision long timers; power supply and regulator circuits; negative supply generators and voltage boosters; digital dividers, decoders, etc.; counters and display drivers; D/A and A/D converters; opto-isolators, flip/flops, noise generators, tone decoders, etc.

Over 170 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.

192 pages **Order code BP322** £4.95

HOW TO USE OP-AMPS

E. A. Parr

This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

160 pages **Order code BP88** £2.95

MICRO INTERFACING CIRCUITS - BOOK 1

MICRO INTERFACING CIRCUITS - BOOK 2

R. A. Penfold

Both books include practical circuits together with details of the circuit operation and useful background information. Any special constructional points are covered but p.c.b. layouts and other detailed constructional information are not included.

Book 1 is mainly concerned with getting signals in and out of the computer; Book 2 deals primarily with circuits for practical applications.

BOOK 1 112 pages **Order code BP130** £2.75

BOOK 2 112 pages **Order code BP131** £2.75

DIRECT BOOK SERVICE

ORDERING DETAILS

Please state the title and order code clearly, print your name and address and add the required postage to the total order.

Add £1 to your total order for postage and packing (overseas readers add £2 for countries in Europe, or add £5 for all countries outside Europe, surface mail postage) and send a PO, cheque, international money order, (£ sterling only) made payable to **Direct Book Service** or credit card details (including the card expiry date), Visa or Mastercard (Access) - minimum credit card order is £5 - quoting your name and address, the order code and quantities required to **DIRECT BOOK SERVICE, 33 GRAVEL HILL, WIMBORNE, DORSET BH21 1RW** (mail order only).

Although books, videos and software are normally sent within seven days of receipt of your order, please allow a maximum of 28 days for delivery. Overseas readers allow extra time for surface mail post.

Please check price and availability (see latest issue of *Everyday with Practical Electronics*) before ordering from old lists.

Note - our postage charge is the same for one book or one hundred books!

MORE BOOKS NEXT MONTH
Direct Book Service is a division of Wimborne Publishing Ltd

Tel: 0202 881749
Fax: 0202 841692

Radio, TV, Satellite

PROJECTS FOR RADIO AMATEURS AND S.W.L.S.

R. A. Penfold

This book describes a number of electronic circuits, most of which are quite simple, which can be used to enhance the performance of most short wave radio systems.

The circuits covered include:- An aerial tuning unit; A simple active aerial; An add-on b.f.o. for portable sets; A wavetrapp for combat signals on spurious responses; An audio notch filter; A parametric equaliser; C.W. and S.S.B. audio filters; Simple noise limiters; A speech processor; A volume expander.

Other useful circuits include a crystal oscillator, and RTTY/C.W. tone decoder, and a RTTY serial to parallel converter. A full range of interesting and useful circuits for short wave enthusiasts.

92 pages **Order code BP304** £3.95

AN INTRODUCTION TO AMATEUR RADIO

I. D. Poole

Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century.

This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.

150 pages **Order code BP257** £3.50

SIMPLE SHORT WAVE RECEIVER CONSTRUCTION

R. A. Penfold

Short wave radio is a fascinating hobby, but one that seems to be regarded by many as an expensive pastime these days. In fact it is possible to pursue this hobby for a minimal monetary outlay if you are prepared to undertake a bit of d.i.y., and the receivers described in this book can all be built at low cost. All the sets are easy to construct, full wiring diagrams etc. are provided, and they are suitable for complete beginners. The receivers only require simple aerials, and do not need any complex alignment or other difficult setting up procedures.

The topics covered in this book include: The broadcast bands and their characteristics; The amateur bands and their characteristics; The propagation of radio signals; Simple aerials; Making an earth connection; Short wave crystal set; Simple t.r.f. receivers; Single sideband reception; Direct conversion receiver.

Contains everything you need to know in order to get started in this absorbing hobby.

88 pages **Order code BP275** £3.95

AN INTRODUCTION TO AMATEUR COMMUNICATIONS SATELLITES

A. Pickford

Communications and broadcast satellites are normally inaccessible to individuals unless they are actively involved in their technicalities by working for organisations such as British Telecom, the various space agencies or military bodies, even those who possess a satellite television receiver system do not participate in the technical aspects of these highly technological systems.

There are a large number of amateur communications satellites in orbit around the world, traversing the globe continuously and they can be tracked and their signals received with relatively inexpensive equipment. This equipment can be connected to a home computer such as the BBC Micro or IBM compatible PCs, for the decoding of received signals.

This book describes several currently available systems, their connection to an appropriate computer and how they can be operated with suitable software.

102 pages **Order code BP290** £3.95

AERIAL PROJECTS

R. A. Penfold

The subject of aerials is vast but in this book the author has considered practical aerial designs, including active, loop and ferrite aerials which give good performances and are relatively simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.

Also included are constructional details of a number of aerial accessories including a pre-selector, attenuator, filters and tuning unit.

96 pages **Order code BP105** £2.50

INTERNATIONAL RADIO STATIONS GUIDE

P. Shore

Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed to guide him or her around the ever more complex radio bands. This new edition has been completely revised and rewritten and incorporates much more information which is divided into the following sections:

Listening to Short Wave Radio; Choosing a Short Wave Radio Receiver; How to Use the IRSG; Abbreviations; Country Codes; Worldwide Short Wave Radio Stations; European, Middle Eastern and African Long Wave Radio Stations; European, Near and Middle Eastern and African Medium Wave Radio Stations; Canadian Medium Wave Radio Stations; USA Medium Wave Radio Stations; Broadcasts in English; Programmes for DXers and Short Wave Listeners; UK FM Radio Stations; Time Differences From GMT; Wavelength/Frequency Conversion.

226 pages **Order code BP255** £5.95

BABANI BOOKS

We now supply *all* the books published by Bernard Babani (Publishing) Ltd. We have always supplied a selected list of Babani books and you will find many of them described on the previous pages or in next months issue of *Everyday with Practical Electronics* (the books with a BP prefix to the order code are Babani books).

Many readers have asked us to also supply various other Babani books, which have a reputation for value for money. Our customers tell us they appreciate our speedy service and low postage charge and they

would like to be able to purchase all the books from us and thus keep the postage charge to an absolute minimum (£1 for UK p&p no matter how many books you buy). We are pleased to be able to respond; with the aid of Michael Babani (M.D.) we are now able to meet all your requirements for their books. *If it's Babani and in print we can supply it.* Babani presently list over 180 different technical titles those *not* described in detail on the previous *Direct Book Service* pages or in next months issue are listed below:

| Code | Title | Price | Code | Title | Price | Code | Title | Price |
|-------|---|-------|-------|---|--------|-------|---|--------|
| BP28 | Resistor Selection Handbook | £0.60 | BP193 | LOGO for Beginners | £2.95 | BP283 | A Concise Introduction to SmartWare II | £4.95 |
| BP37 | 50 Projects using Relays, SCRs and TRIACs | £2.95 | BP196 | BASIC & LOGO in Parallel | £2.95 | BP284 | Programming in QuickBASIC | £4.95 |
| BP39 | 50 (FET) Field Effect Transistor Projects | £2.95 | BP197 | An Introduction to the Amstrad PC's | £5.95 | BP287 | A Reference Guide to Practical Electronics Terms | £5.95 |
| BP44 | IC 555 Projects | £2.95 | BP198 | An Introduction to Antenna Theory | £2.95 | BP288 | A Concise Introduction to Windows 3.0 | £3.95 |
| BP48 | Electronic Projects for Beginners | £1.95 | BP230 | A Concise Introduction to GEM | £2.95 | BP291 | A Concise Introduction to Ventura | £3.95 |
| BP49 | Popular Electronic Projects | £2.50 | BP243 | BBC BASIC86 on the Amstrad PC's and IBM Compatibles - Book 1: Language | £3.95 | BP292 | Public Address Loudspeaker Systems | £3.95 |
| BP56 | Electronic Security Devices | £2.50 | BP244 | BBC BASIC86 on the Amstrad PC's and IBM Compatibles - Book 2: Graphics and Disk Files | £3.95 | BP293 | An Introduction to Radio Wave Propagation | £3.95 |
| BP74 | Electronic Music Projects | £2.50 | BP245 | Digital Audio Projects | £2.95 | BP294 | A Concise Introduction to Microsoft Works | O.O.P. |
| BP76 | Power Supply Projects | £2.50 | BP246 | Musical Applications of the Atari ST's | £5.95 | BP298 | A Concise Introduction to the Mac System & Finder | £3.95 |
| BP78 | Practical Computer Experiments | £1.75 | BP247 | More Advanced MIDI Projects | O.O.P. | BP302 | A Concise Users Guide to Lotus 1-2-3 Release 3.1 | £3.95 |
| BP84 | Digital IC Projects | £1.95 | BP249 | More Advanced Test Equipment Construction | £3.50 | BP303 | Understanding PC Software | £4.95 |
| BP90 | Audio Projects | £2.50 | BP250 | Programming in FORTRAN 77 | £4.95 | BP306 | A Concise Introduction to AmiPro 3 | £4.95 |
| BP94 | Electronic Projects for Cars and Boats | £1.95 | BP251 | Computer Hobbyists Handbook | £5.95 | BP307 | A Concise Introduction to QuarkXPress | £4.95 |
| BP95 | Model Railway Projects | £2.95 | BP258 | Learning to Program in C | £4.95 | BP311 | An Introduction to Scanners and Scanning | £4.95 |
| BP97 | IC Projects for Beginners | £1.95 | BP259 | A Concise Introduction to UNIX | £2.95 | BP312 | An Introduction to Microwaves | £3.95 |
| BP122 | Audio Amplifier Construction | £2.95 | BP260 | A Concise Introduction to OS/2 | £2.95 | BP313 | A Concise Introduction to Sage | £3.95 |
| BP125 | 25 Simple Amateur Band Aerials | £1.95 | BP261 | A Concise Introduction to Lotus 1-2-3 (Revised Edition) | £3.95 | BP314 | A Concise Introduction to Quattro Pro | £4.95 |
| BP126 | BASIC & PASCAL in Parallel | £1.60 | BP262 | A Concise Introduction to Wordperfect (Revised Edition) | £3.95 | BP315 | An Introduction to the Electromagnetic Wave | £4.95 |
| BP132 | 25 Simple SW Broadcast Band Aerials | £1.95 | BP264 | A Concise Advanced User's Guide to MS-DOS | £3.95 | BP322 | Circuits Source Book 2 | £4.95 |
| BP136 | 25 Simple Indoor and Window Aerials | £1.75 | BP269 | An Introduction to Desktop Publishing | O.O.P. | BP324 | The Art of Soldering | £3.95 |
| BP137 | BASIC & FORTRAN in Parallel | £1.95 | BP270 | A Concise Introduction to Symphony | £3.95 | BP328 | Sage Explained | £5.95 |
| BP138 | BASIC & FORTH in Parallel | £1.95 | BP272 | Interfacing PC's & Compatibles | £3.95 | BP329 | Electronic Music Learning Project | £5.95 |
| BP144 | Further Practical Electronics Calculations & Formulae | £4.95 | BP273 | Practical Electronic Sensors | £4.95 | BP330 | A Concise user's Guide to Lotus 1-2-3 Release 2.4 | £4.95 |
| BP145 | 25 Simple Tropical and MW Band Aerials | £1.75 | BP274 | A Concise Introduction to SuperCal5 | O.O.P. | BP331 | A Beginners Guide to MIDI | £4.95 |
| BP148 | Computer Terminology Explained | £1.95 | BP276 | Short Wave Superhet Receiver Construction | £2.95 | BP334 | Magic Electronics Projects | £4.95 |
| BP171 | Easy Add-on Projects for Amstrad CPC 464, 664, 6128 and MSX Computers | £2.95 | BP279 | A Concise Introduction to Excel | £3.95 | BP336 | A Concise Users Guide to Lotus 1-2-3 Release 3.4 | £5.95 |
| BP182 | MIDI Projects | £2.95 | BP280 | Getting the Most From Your PC's Hard Disc | £3.95 | BP339 | A Concise Introduction to WordPerfect 5.2 for Windows | £5.95 |
| BP187 | A Practical Reference Guide to Word Processing on the Amstrad PCW8256 and PCW8512 | £5.95 | | | | | | |
| BP190 | More Advanced Electronic Security Projects | £2.95 | | | | | | |
| BP192 | More Advanced Power Supply Projects | £2.95 | | | | | | |

IF NO PRICE IS SHOWN THE BOOK IS OUT OF PRINT (O.O.P.)
SEE PREVIOUS PAGE FOR FULL ORDERING DETAILS

PCB SERVICE

Printed circuit boards for certain EPE constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to The PCB Service, *Everyday with Practical Electronics*, 6 Church Street, Wimborne, Dorset BH21 1JH. Cheques should be crossed and made payable to *Everyday with Practical Electronics* (Payment in £ sterling only).

NOTE: While 95% of our boards are now 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 Editorial page for details.

Please check price and availability in the latest issue.

Boards can only be supplied on a payment with order basis.

SALE! All p.c.b.s on THIS page reduced to **1/2 PRICE**

(Just send half the price shown, while stocks last.)
PCBS ON OPPOSITE PAGE PRICES AS SHOWN

| PROJECT TITLE | Order Code | Cost |
|--------------------------------|------------|-------|
| Suntan Timer | 610 | £3.07 |
| Car Alarm | 615 | £3.12 |
| Eprom Eraser | 620 | £4.07 |
| Doorbell Delay | 616 | £3.56 |
| Sound-to-Light Interface | 637 | £6.24 |
| Midi Pedal | 639 | £7.00 |
| Midi Merge | 640 | £3.00 |
| Audio Lead Tester | 641 | £5.77 |
| Light Sentinel: Main Board | 632 | £9.20 |
| 4-Channel Auto-Fader Interface | 642 | £6.80 |
| Electronic Spirit Level | 649 | £3.85 |
| Distance Recorder | 651 | £5.23 |
| Music on Hold | 646 | £3.85 |
| Power Supplies - 25V 700mA | 656 | £4.35 |

| PROJECT TITLE | Order Code | Cost |
|---|------------|--------|
| Wash Pro | 643 | £3.83 |
| Logo/lego & Spectrum Interface | 664 | £5.60 |
| Biofeedback Signal Generator | 666 | £4.08 |
| Quick Cap Tester | 668 | £3.92 |
| Superhet Receiver/Tuner/Amp | 679/680 | £4.22 |
| Stereo Noise Generator | 681 | £4.24 |
| Amstrad Speech Synthesiser | 689 | £4.68 |
| The Tester | 696 | £4.15 |
| Mains Appliance Remote Control Mains ON/OFF Decoder | 697 | £4.55 |
| Hand Tally: Main Bd and Display Bd | 699, 700 | £10.95 |
| Ghost Waker | 703 | £4.32 |
| Frequency Meter | 704 | £5.25 |
| Freq. Meter/Tachometer | 705 | £3.98 |
| Microcontroller Light Sequencer | 708/709 | £10.90 |
| Spatial Power Display | 714 | £5.33 |
| Amstrad PCW Sound Generator | 715 | £5.03 |
| Pocket Tone Dialler | 729 | £4.36 |
| Simple Basic Alarm | 731 | £4.50 |
| Humidity Tester | 716 | £4.97 |
| Model Train Controller (double-sided) | 736 | £9.75 |
| Digital LCD Thermostat | | |
| - Control Board | 740 | £4.05 |
| - Power Relay Board | 741 | £3.76 |
| Control and Power Relay Boards together | | £5.00 |
| Digilogue Car Tachometer | 744 | £5.63 |
| Modular Disco Lights - Simple Chaser | 745 | £5.00 |
| Sweeper Module | 746 | £5.17 |
| Automatic Light Control - PSU Board | 747 | £4.88 |
| Logic Board | 748 | £5.17 |
| Mod. Disco Lights | | |
| Superchaser (Double-sided) | 771 | £6.91 |
| Supersweep (Double-sided) | 772 | £8.26 |
| Bicycle Alarm | 773 | £5.01 |
| Knockerbox | 775 | £5.35 |
| Signal Generator - Main Board | 776 | £7.46 |
| Mind Machine - Main Board | 778 | £7.00 |
| Auto Nightlight | 779 | £5.03 |

| PROJECT TITLE | Order Code | Cost |
|---|------------|-----------------|
| Mind Machine - Programmer Board | JAN '92 | 780 £7.39 |
| Transistor Checker | 781 | £4.63 |
| Stepping Motor Driver/Interface | 782 | £10.39 |
| Micro-Sense Alarm | 783 | £5.42 |
| Telesound | FEB '92 | 784 £4.66 |
| Programmable Timer | 785 | £4.63 |
| Auto Garage Light | MAR '92 | 786 £6.10 |
| Versatile BBC Computer Interface | 787 | £11.59 |
| Economy Seven Timer | 788 | £5.20 |
| Sonic Continuity Tester | APR '92 | 789 £4.79 |
| Telephone Ringer | 790 | £5.46 |
| Experimental Weighing Scale | MAY '92 | 792 £5.17 |
| 12V Drill Charger/PSU (both boards) | 793 | £5.31 |
| Digital Servo Interface | JUNE '92 | 791 £4.73 |
| Tie Pulsar | 794 | £5.19 |
| CCD Reverb Unit | 795 | £6.39 |
| Switch-Mode Power Supply | 796 | £7.01 |
| UV Exposure Timer | JULY '92 | 797 £5.33 |
| Cricket Game | 798 | £6.77 |
| Quick Prom | 799 | £5.61 |
| Gas Alarm | AUG '92 | 800 £5.47 |
| Dual Metronome | 801 | £6.74 |
| Ultrasonic Tape Measure | SEP '92 | 802 £6.06 |
| Quicktest | 803 | £4.82 |
| Extended Range Capacitance Meter | OCT '92 | 804 £5.63 |
| Traffic Lights System | 806 | £5.04 |
| Mini Lab | NOV '92 | MINI LAB £14.95 |
| EPE Altimeter (Altimeter) | 807 | £6.30 |
| Personal Stereo Amplifier | 808 | £6.47 |
| Universal Infra-Red Remote Control | DEC '92 | 811T/811R £6.56 |
| Combination Switch | 812 | £5.68 |
| Christmas Lights Colour Spectrum | 813 | £5.97 |
| TV/UHF Aerial Amp (double-sided) | JAN '93 | 814 £7.23 |
| Continuously Variable Balanced Power Supply | 815 | £5.65 |
| Emergency Lighting Unit | 816 | £6.77 |
| Biomet Pulse Monitor | FEB '93 | 817 £6.30 |
| Sensor | 818 | £6.30 |
| Display | | |
| Biomet Pulse Monitor | MAR '93 | 819 £7.11 |
| -ADC Interface (double-sided) | | |
| Car Electric Window Enhancer | 821 | £5.00 |
| Simplify Atari STFM Interface | 822 | £5.55 |
| Personal Stereo Amp. Add-On | 823 | £3.90 |
| Electronic Fire | APR '93 | 820 £4.84 |
| Mind Machine MkII - Signal Generator | 824 | £5.57 |
| Ventilation Fan Timer | 825 | £4.70 |
| Universal Data Logger | 826 | £5.88 |
| Mind Machine MkII - Magic Lights | MAY '93 | 827 £6.58 |
| Superhet Radio Control Receiver | 828 | £5.93 |
| Guitar Preamp and Distortion Unit | 829 | £5.46 |
| Linear Clock - Timing Board | 830 | £8.00 |
| Display Board | 831 | £7.00 |
| Universal Alarm Module | 9070 | £3.00 |
| Electronic Snooker Scoreboard | JUNE '93 | 832 £9.17 |
| Mind Machine MkII | JULY '93 | 833 £6.39 |
| - Computer Interface | 834 | £5.84 |
| Xenon Strobe | 835 | £7.50 |
| Electronic Gong | MICRO | £35.00 |
| Micro Lab - p.c.b., EPROM, PAL and booklet | | |
| Bike Odometer (pair of boards) | AUG '93 | 836/7 £7.00 |
| Amstrad PCW A to D Converter (double sided) | 838 | £9.85 |
| Experimental Electronic Pipe Descaler | 839 | £5.50 |
| Sound Activated Camera Trigger | SEP '93 | 840 £5.34 |
| L.E.D. Sandglass | OCT '93 | 841/2 £7.30 |
| Main and Display boards | 843 | £5.19 |
| Kettle Alert | 844 | £9.77 |
| Linear Power Supply (double-sided) | | |
| Multi-Purpose Audio System | | |
| Six Channel Stereo Mixer | 845 | £11.98 |
| Multi-Purpose Audio System | NOV '93 | 846 £4.88 |
| Microphone Pre-Amp module | 847 | £5.11 |
| RIAA Pre-Amp module | 848 | £6.63 |
| 20 Metre Receiver | | |
| Multi-Purpose Audio System | DEC '93 | 849 £6.09 |
| Tone Control and 1W Stereo Amplifier | 850 | £5.12 |
| Tone Control | 851 | £4.88 |
| 1W Stereo Amplifier | 853 | £5.65 |
| Three-Way Christmas Tree Lights Flasher | 854 | £5.49 |
| Auto Alarm | 855 | £13.92 |
| 250W/600W Battery to Mains Inverter | | |
| Multi-Purpose Audio System | JAN '94 | 852a £5.65 |
| 10W + 10W Stereo Power Amplifier | | |
| Amplifier | 852b | £5.49 |
| Power Supply | 856 | £5.77 |
| Pond Heater Thermostat | 857 | £6.30 |
| Timer/NiCad Capacity Checker | | |

| PROJECT TITLE | Order Code | Cost |
|--|------------|------------|
| Multi-Purpose Audio System | FEB '94 | 858 £5.30 |
| Balanced Microphone Preamplifier | 859 | £5.14 |
| Balanced Microphone Power Supply | 860 | £5.19 |
| Whistle Controlled Light Switch | 862 | £7.38 |
| Battery To Mains Inverter - U.P.S. charger board | | |
| Three Phase Generator | MAR '94 | 861 £5.95 |
| Visual Doorbell | 863 | £5.80 |
| CCD TV Camera - Control Board | | |
| (double-sided, plated-through-hole) | 865 | £15.00 |
| Telephone Ring Detector | APR '94 | 864 £4.72 |
| CCD TV Camera | | |
| Combined Video, Test & Ext Plug Boards | 866a/e | £11.00 |
| Frame Grab Control | 867 | £15.00 |
| (double-sided plated-through-hole) | | |
| EPE Sound DAC PC Sound Board | 868 | £4.77 |
| MOSFET Variable Bench Power Supply | 869 | £5.80 |
| L.E.D. Matrix Message Display Unit | MAY '94 | 870 £18.00 |
| Display Board | 871 | £7.20 |
| CPU Board | 873 | £6.14 |
| Stereo Noise Gate | 875 | £5.84 |
| Simple TENS Unit | 876 | £6.44 |
| Capacitance/Inductance Meter | | |
| Advanced TENS Unit | JUN '94 | 877 £6.56 |
| Digital Water Meter -Scaler | 878 | £11.19 |
| Counter/Display | 879 | pair |
| L.E.D. Matrix Message Display Unit | | |
| Keypad | 872 | £5.19 |
| PC Interface | 880 | £5.82 |
| Microprocessor Smartswitch | 881 | £5.61 |
| Microcontroller P.I. Treasure Hunter | 882 | £6.60 |
| Print Timer | JULY '94 | 874 £5.82 |
| Watering Wizard | 883 | £6.60 |
| Simple NiCad Charger | 884 | £4.98 |
| Voxbox | 885 | £6.90 |
| Stereo HiFi Controller - 1 Power Supply | 886 | £5.66 |
| Stereo HiFi Controller - 2 | AUG '94 | 887 £7.39 |
| Main Board | 888 | £9.80 |
| Expansion/Display Boards (pair) | | |
| Dancing Fountains - 1 | | |
| Pre.Amp | 889 | £5.28 |
| Pump Controller | 890 | £5.41 |
| Filter | 891 | £5.23 |
| 6802 Microprocessor Development Board | 894 | £9.15 |

EPE PRINTED CIRCUIT BOARD SERVICE

Order Code Project Quantity Price

Name.....

Address.....

I enclose payment of £..... (cheque/PO in £ sterling only) to



Everyday with
Practical Electronics
Access (MasterCard) or
Visa No. Minimum order
for credit cards £5



| | | | | | | | | | | | | | | | | | | | | |
|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| | | | | | | | | | | | | | | | | | | | | |
|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|

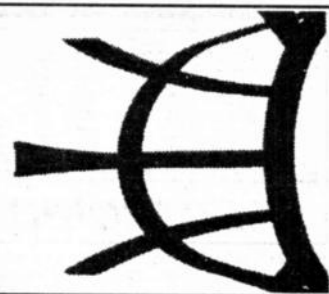
Signature..... Card Ex. Date.....

Please supply name and address of card-holder if different from the address shown

BLOCK CAPITALS PLEASE

REPORTING AMATEUR RADIO

Tony Smith G4FAI



IARU TO CONSIDER MORSE ISSUES

The president of the International Amateur Radio Union, Richard L. Baldwin, W1RU, recently announced his intention to appoint a special ad-hoc committee to examine the issues relating to the amateur Morse test and to propose the position the IARU should take on this controversial matter.

In a statement in the June issue of *Morsum Magnificat*, the Morse magazine, Mr Baldwin explains the reasons for this decision:

"In Article 32 of the Radio Regulations of the International Telecommunication Union appears Regulation 2735 which has a mandatory requirement for competency in Morse code operating to be shown before a radio amateur is permitted to operate on the HF bands – the 'DX' bands below 30MHz.

"There are some groups of radio amateurs who from time to time query the necessity for this mandatory Morse code requirement. On the other hand, many radio amateurs – indeed possibly complete societies and even whole regions – continue to support the continuance of this provision.

"As part of an on-going review of the Amateur Service, the Administrative Council of the International Amateur Radio Union (IARU AC) has established a 'CW Ad-Hoc Committee' to produce a report for consideration by the IARU AC at its meeting in Singapore in September 1994.

"The Committee comprises: Fred Johnson, ZL2AMJ, a Director of IARU Region 3 as Chairman; Dr John Allaway, G3FKM, Secretary IARU Region 1; and David Sumner, K1ZZ, from the IARU International Secretariat and the American Radio Relay League, as members. The Committee is thus drawn from the three IARU Regions.

"It is expected that after consideration by the IARU AC, the Report of the Committee may be made available to the IARU Regional organizations for further study and comment."

CALL BOOK ON DISK

Obtainable for many years only in printed form, the UK amateur radio callbook is now available on disk for use with IBM compatible computers. The first edition, published by GOLOV & G4LUE, covers all current UK calls issued up to 10th April 1994, namely G0UQZ (Class A), G7SGS (Class B), 2E0AHR (Novice A) and 2E1CUL (Novice B).

The basic data was purchased from the Radiocommunications Agency (RA) and supplied by Subscription Services Ltd (SSL) on their behalf. Other information was supplied by user groups and other sources "to the best of their knowledge."

Menu driven, the callbook comes on three 3.5 inch HD disks, requires DOS 3.1 or above and about 15Mb of hard disk. It is easy to install and provides some useful facilities not readily available from the printed version.

It covers individual UK call signs, repeaters, beacons, mailboxes and nodes. The name and address of a particular licensee can be found by simply typing in the callsign. Entries on either side of the selected call can be run on or back by using the F1 or F2 keys.

A search facility enables information to be obtained when only the address (town) or postcode is known. This lists all the amateurs in that town or postal district and each in turn can be individually displayed if required.

Some years ago, some amateurs I know ploughed through the whole call book to find the addresses of all those within reasonable distance who might be interested in joining a newly re-started local radio club. It must have taken days. With this new program, the job could have been done in minutes.

If you have only part of the call sign, e.g., G4F** or G4FA*, a wild card facility will display all calls in those series enabling the wanted one to be tracked down.

Information on repeaters, beacons, mailboxes and nodes can be called up by typing in the callsign or address (town) to obtain details of the type of station, its frequency, location, keeper, town and county. Lists of all stations can be displayed and the desired calls selected as required.

SMALL PROBLEMS

Inevitably, in a first edition, there are one or two small difficulties that need to be put right. I didn't find anything too dramatic myself but there were a couple of problems when searching by address (town name).

If a name is normally hyphenated, and it is used in the call book without the hyphens then two separate lists are thrown up by searches. For example, "Leigh-on-Sea" has eleven amateurs listed and "Leigh on Sea" (the same place) has 40 more listed.

Also, if the name of another town is part of an address, e.g., Glen Holt Park, Plymouth, then this address comes up when searching for amateurs in Holt, Norfolk. However, if you key in "Plymouth" Glen Holt Park comes up again, this time with all the other Plymouth callsigns.

The first problem is probably a result of inconsistent entries in the original data provided by SSL Ltd., on behalf of the RA. The second is clearly an error in the program. Both can easily be rectified for future editions and do not necessarily detract from the value of the callbook as

currently offered, so long as users are aware of them.

If you want details of a particular call sign you can still get it fast – unless it is one of those listed as "Particulars Withheld"! For security reasons, I suspect there may be more of those in the future now that all the amateurs in a given area can be so easily identified.

It was inevitable that the call book should eventually be produced on disk, and it is surprising that no one seems to have thought of it before. The initial problems seem minimal. The publishers have asked for feedback on any difficulties encountered and they will probably have sorted them out long before this review appears in print.

The *GOLOV & G4LUE Spring 1994 UK Callbook on disk* is available from J. Bailey, 8 Hild Avenue, Cudworth, Barnsley, South Yorks S72 8RN, price £10.00 plus £1.50 post and packing. Overseas, £10.00 plus £5.00 post & packing, payable in sterling only. If you order a copy, please mention that you read about it in this column.

SUMMER BROADCAST GUIDE

Short wave listeners will welcome the publication of the International Short Wave League's *Guide to English Language Short Wave Broadcasts to Europe – Summer Schedules 1994*. This bi-annual guide provides an invaluable, and inexpensive, means of keeping up with schedule changes across the whole short wave spectrum.

Changes take place as a result of cutbacks by some stations and seasonal variations by all. Some of the data presented originates from direct monitoring by ISWL members and some from the published schedules of individual stations; and every possible care is taken to ensure that the information presented is accurate and current.

As usual, broadcasts are listed in time order round the clock (GMT/UTC), and include station names, country of origin, frequencies, and brief details of the type of programme to be heard. Also included are details of transmissions not beamed at, but receivable at an acceptable quality in Europe.

I have always found this publication to be extremely useful and never hesitate to recommend it, especially to those just taking up short wave listening. It has 33 A4 pages and costs just £1.30 or two IRCs (stamps to the value of £1.30 also acceptable).

It can be obtained from ISWL HQ, 10 Clyde Crescent, Wharton, Winsford, Cheshire, CW7 3LA, or from the ISWL stand at various amateur rallies during the coming season. If you do send off for it, be sure to mention that you read about the guide in EPE!

MAILTECH

ELECTRONIC COMPONENTS

PROJECT BOXES A range of high quality boxes moulded in black high impact ABS, easily drilled or punched to produce a professional looking end product

| TYPE | W | L | H | PRICE |
|------|-----|-----|----|-------|
| T2 | 75 | 56 | 25 | £0.77 |
| T4 | 111 | 57 | 22 | £0.92 |
| MB1 | 79 | 61 | 40 | £1.35 |
| MB2 | 100 | 76 | 41 | £1.47 |
| MB3 | 118 | 98 | 45 | £1.71 |
| MB4 | 216 | 130 | 85 | £5.19 |
| MB5 | 150 | 100 | 60 | £2.35 |
| MB6 | 220 | 150 | 64 | £3.95 |
| MB7 | 177 | 120 | 83 | £3.42 |
| MB8 | 150 | 80 | 50 | £2.22 |

All sizes are in millimetres

MICRO SWITCH roller arm operation spdt 40p each

| MINIATURE TOGGLE SWITCHES | | | |
|---------------------------|----------|--|----------|
| spdt | 60p each | spdt 3 position c/off | 70p each |
| dpdt | 70p each | spdt 3 position c/off | 80p each |
| spdt biased | 60p each | spdt 3 position c/off biased both ways | 70p each |
| | | dpdt 3 position c/off biased one way | 80p each |

MINIATURE PUSH TO MAKE SWITCH

| | | | |
|------------|-----------------------|--|------------------|
| DIL RELAYS | 5 volt dp/changeover | | 50p each |
| | 12 volt dp/changeover | | 60p 10 for £5.00 |
| | | | 80p 10 for £6.00 |
| | | | £1.20 each |

RELAY 10 amp contacts sp/changeover 12 volt coil

CAR HORN RELAY in metal can with fixing lug, 2/pole on 10 amp contacts £1.00 each 6 for £5.00
20 AMP RELAY dp on 12 volt coil £1.50 each 4 for £5.00

| 'D' CONNECTORS | | | |
|----------------|------|--------|-------|
| | plug | socket | cover |
| 9 pin | 30p | 30p | 35p |
| 15 pin | 40p | 40p | 35p |
| 25 pin | 50p | 50p | 40p |

REED RELAY 12 volt 50p each 10 for £4.00

240 VOLT AC RELAY 3-pole c/o 10 amp contacts £1.50 each 4 for £5.00

SEMICONDUCTORS - TRANSISTORS - ICs - DIODES - REGULATORS - ETC

VOLTAGE REGULATORS
 1 amp 7805/7812/7815 all 33p each, 7905/7912/7915 all 39p each
 2 amp 7805/7812/7815 all 54p each
 100mA 78L05/78L12/78L15 all 26p each, 79L05/79L12/79L15 all 29p each
 Adjustable LM317T 70p each, LM723 29p each, L200 £1.28 each
 Transistors TIP2955 70p each, TIP 3055 70p each
 2N3053 29p each, 2N3055 70p each, 2N4403 28p each, 2N3819 40p each
MICRO IC'S - 280A CPU £1.20; 280A PIO £1.50; 280B SIO-1 £4.00

OPTO DEVICES - LEDs - ETC

| | |
|---|-------------------------------------|
| 5mm rnd red/yellow/green/amber | 10p each 12 for £1.00 any mix |
| 5mm rnd high brightness red/green | 20p each 6 for £1.00 any mix |
| 5mm rnd flashing | red 60p each, yellow/green 70p each |
| 5mm rnd bi-colour | 35p each, tri-colour 45p each |
| LED mounted in chrome bezel red, yellow or green | 30p each, 4 for £1 |
| LED mounted in a black bezel red only | 25p each, 5 for £1.00 |
| PLASTIC BEZEL for 5mm rnd leds | 10 for 40p |
| High brightness bi-colour i.e.d., rectangular, red/green, two leads | 40p each |

TEMPERATURE PROBE
 High quality probe made for the medical profession. Consists of a resistive sensor mounted in a plastic covered probe with a 1 meter curled lead. Temp. range -40 to 150°C. Resistance at 150°C 188.3 ohms; -40°C 336.5 kohm; 25°C 10.0 kohm ± 70 ohms. The original price of these probes was over £24.00. Full data supplied. **OUR PRICE £3.76**

RESET TIMER PCB
 Gives a timed relay closure following a momentary input. Requires 12V d.c. supply SP c/o relay output LED indication. 19 different time intervals from 25sec to 35min 20sec. £5.98 each

UNIVERSAL BELL TIMER
 10 or 20 minute bell cut off + ve or - ve trigger* timed relay contacts. £4.96

ALARM CONTROL UNIT
 Single zone alarm control unit built into a domestic light switch box. Ideal for home, caravan, boat, garage, shed etc.

Facilities: - Normally closed loop for pir sensors, door/window contacts etc. Normally open loop for pressure mats. 24-hour loop for personal attack button Visual indication that the system is operational. Automatic entry/exit delay. Automatic system reset.
SIREN
 12 volt dc for external use 115db £8.95

PRICE COMPLETE WITH FULL INSTRUCTIONS £8.95
SUB-MINIATURE PASSIVE INFRA-RED SENSOR ONLY £7.95
 Brand new passive infra-red sensor, measures only 33mmW x 24mmH x 29mmD. Logic level output. Full data and application notes supplied.

EX INSTALLATION SENSORS tested working. **1 NEW LOWER PRICES!**
 Type 1. Measures 130 x 70 x 50mm with walk test led, relay output and tamper protection. 12 volt dc supply required £6.50 each
 Type 2. As above but a smaller unit 90 x 75 x 50mm £8.50 each
 Type 3. Ceiling mounting passive, infra red sensor 360° detection, 12V d.c. supply relay output, tamper circuit and pulse count option. Data supplied. £15.70 each

Please note: There may be variations in the size of the above passive infra red sensors depending on stock at the time of ordering. But the unit will certainly be within the stated sizes.

DUAL TECH SENSOR Microwave and passive infra-red combined. Separate led indication for each function. Measures 120 x 75 x 50mm. 12 volt d.c. supply. Relay output. Tamper protection. £21.15 each

ALARM CONTROL PANEL ST3000

"Wire free alarm control panel, detectors communicate with the panel by means of radio transmitters". Speech synthesis for programming and general operating guidance". Built in user programmable telephone dialler". Up to 32 transmitters can be used". Programmable exit/entry and bell timers". Programmable user codes". Full installation data supplied, the only thing that has to be handwired is the output to the siren/bell unit (not supplied)". These control panels cost over £300.00. Yours for only £59.95.
Suitable PASSIVE INFRA SENSOR/TX £25.85
 Battery operated, available in 8m range, 10m range or 25m range.

UNIVERSAL TX
 For connection of normally open or closed contacts e.g. door/window switches, pressure mats etc. £17.63

METAL CLAD HIGH WATTAGE WIREWOUND RESISTORS
 0-12 Ohm 5W 30p each
 0-10 Ohm 25W 80p each
 1-00 Ohm 50W £1.00 each
 2-20 Ohm 50W £1.00 each
 3-9 Ohm 50W £1.00 each
 10-00 Ohm 100W £2.00 each
 2-2 kohm 50W £1.00 each

MOSFET RFM70N60
 70A 50V 250W
 £4.11 each

SPECIAL OFFER PROJECT BOX
 In white
 high impact ABS
 50 x 70 x 25mm
 60p each 10 for £5.00

BREADBOARDS - CAPACITORS - SOLAR CELLS - HEATSHRINK - ETC

SOLAR CELL 2 volt 150mA max, size 60 x 100mm £1.35 each 5 for £6
BNC SOCKETS 50 ohm single hole fixing 50p each 10 for £4.00

MERCURY TILT SWITCH
 Standard on/off £1.00 each
 4 Contact (Directional) £1.50 each
PIEZO VIBRATION SENSOR
 with data sheet £1.00 each

BREADBOARD
 173 X 65mm 840TP £5.25 each
TEXT TOOL ZIF SOCKET
 28 pin zero insertion socket £5.95 each

CAPACITOR 10,000 mfd 25 volt with fixing clip 60p each
EPROMS 27C256 - 30 27C512 - 25. Once programmed but never used eprom. Mounted on a plastic carrier, can easily be removed from the carrier or used with a low insertion force socket.
27C256 £1.00 each 6 for £5.00
27C512 £1.20 each 5 for £5.00
 Suitable low insertion force socket 28 pin 40p each 3 for £1.00
MULTITURN PRESETS 20mm rect. 1K, 5K, 10K, 20K, 50K, 100K 1M0.
 40p each, 3 for £1.00

100db PIEZO SOUNDER
 2KHz note, 3-12V d.c. 40Ma, 45mm dia. x 26mm £1.76 each
SOUND BOMB Two tone alarm sounder incorporating four piezo elements in white plastic box. 100db 12V D.C. £5.99
MINIATURE HORN SIREN 100db two-tone Piezo siren 12V D.C. £5.17
VIBRATION SENSITIVE ALARM BOARD WITH PIEZO SOUNDER
 Originally a bike alarm. There is a short delay after activation then the piezo sounder operates for a preset period. £3.76 each
 or the above alarm board with custom designed case, fixing clip and keyswitch £9.95

INFRA-RED BREAK BEAM Transmitter and receiver p.c.b. with 2 lens assemblies. 12V d.c. supply. These are ex-installation units and are not guaranteed to be working. £4.96 pair
RECHARGEABLE BATTERIES
 AA (HP7) 600 mA H £1.02 each C (HP11) 1200 mA H £2.29 each
 D (HP2) 1200 mA H £2.40 each PP3 8.4V 100 mA H £4.77 each

FLOURESCENT LIGHT INVERTOR. Drives an 8 watt tube directly from 6V d.c. Data supplied £4.50 each

£1.00 BARGAIN PACKS

SUB-MINIATURE TOGGLE SWITCHES

P.C.B. Mounting

- BO1 S.P. on 4 for £1.00
- BO2 D.P. on 3 for £1.00
- BO3 3 x D.P. 3 pos. centre off
- BO04 DIL SWITCHES 4-way S.P. on 3 for £1.00
- BO05 DIL SWITCHES 8-way S.P. on 2 for £1.00
- BO06 DIL SWITCHES 12-way 90° sp on 2 for £1.00
- BO07 12 x PP3 BATTERY SNAPS
- BO08 1 x CAPACITOR 1 FARAD 5.5 VOLT 20mm dia. x 7mm high
- BO09 INSTRUMENT KNOBS (0.25" SHAFT) High quality grey plastic knob, collet fixing 15mm dia. 5 for £1.00
- BO10 as above but 29mm dia. 3 for £1.00
- BO11 4 x MAGNETIC EARPIECE 8 ohm with 3.5mm plug
- BO12 4 x 28-WAY TURNED PIN DIL SOCKET
- BO13 15 x 12 VOLT WIRE-ENDED LAMPS
- BO14 8 x 2 PIN DIN PLUGS screw terminal connection
- BO15 2 x LIGHT DEPENDENT RESISTOR Less than 200 ohms in daylight, greater than 10 megohms in darkness
- BO16 1 x KEYPAD 20-key in 5 x 4 matrix bubble type switch contacts
- BO17 2 x PIEZO BUZZERS approx 3 to 20 volt d.c.
- BO18 5 x 78M12 VOLTAGE REGULATORS positive 12V 500mA
- BO19 4 x TLO82CP bi-let op-amps
- BO20 20 x ASSORTED LEADS full spec. various shapes and sizes
- BO21 3 x INFRA-RED DIODE TX/RX PAIRS made by Honeywell (no Info)
- BO22 4 x CONSTANT CURRENT LED 5mm round, red 2-18V d.c. or a.c. nominal 1mA
- BO23 50 x IN4148 diode
- BO24 2 x INFRA-RED TRANSISTOR FPTS1533
- BO25 5 x DIACS
- BO26 3 BDX33C 10 amp 100V npn transistor
- BO27 12 x 2N3702 Transistor
- BO28 12 x 2N3904 Transistor
- BO29 12 x BC337 Transistor
- BO30 4 x LM317T Variable regulator mounted on a small heatsink
- BO31 2 x MAM6610 2 digit 0.6" 7 segment display Com anode, amber
- BO32 3 x PHONO TO PHONO LEAD 63cm long
- BO33 15 x RECTANGULAR RED LEDs 5 x 6 x 2mm stackable
- BO34 1 x PHOTO SENSITIVE SCR mounted on a PCB, data sheet supplied
- BO35 4 x IEC Panel Mounting Mains Plug Snap fix
- BO36 5 x ASSORTED PIEZO TRANSDUCERS
- BO37 5 LENGTHS OF HEATSHRINK SLEEVING 8mm dia. 400mm long
- BO38 25 x CERAMIC DISC CAPACITORS 0.1 mfd 63V
- BO39 15 x MONOLITHIC CERAMIC CAPACITORS 0.1 mfd 63V, in a dil package
- BO40 25 x ASSORTED ELECTROLYTIC CAPACITORS PCB mounting useful values
- BO41 25 ASSORTED PRE-SET RESISTORS
- BO42 6 x 3-5mm LINE JACK SOCKETS (mono)
- BO43 6 x 3-5mm JACK PLUG (mono)
- BO44 8 x 3-5mm CHASSIS SOCKET (mono)
- BO45 2 x TRIACS 800 volt 8 amp
- BO46 12 x BC213L Transistor
- BO47 12 x MIN SLIDE SWITCH dpdt
- BO48 15 x MIN CERMET TRIMMER POTS (good range of values)
- BO49 1 x PCB WITH TWO LARGE LEADS 15mm square, one red and one green
- BO50 1 x 12V DC RELAY 4-pole c/o with plug in base
- BO51 4 x LM324 quad op-amps
- BO52 4 x 555 Timer
- BO53 5 x 741 op-amp
- BO54 25 x IN4001 diode
- BO55 20 x IN4007 diode
- BO56 1 x SLOTTED OPTO
- BO57 1 x DAC08 Digital to analogue convertor with data
- BO58 4 x OPTO ISOLATOR
- BO60 3 x C106D Thyristor
- BO61 5 x 78M05 VOLTAGE REGULATORS positive 5 volt 500mA
- BO62 10 x TACTILE SWITCHES

Please make cheques and postal orders payable to Mailtech.

All prices include VAT.

Please add £1.00 postage to all orders.

At the moment it is not possible to have a full telephone answering service. But we will have the phone definitely manned on Tuesdays, Wednesdays and Thursdays between 10am and 4pm.

Dept EE, Mailtech
PO Box 16 Ludlow
Shropshire SY8 4NA
Tel/Fax: 058 474475

EVERYDAY WITH PRACTICAL ELECTRONICS

CLASSIFIED

Everyday with Practical Electronics reaches twice as many UK readers as any other independent monthly hobby electronics magazine, our audited sales figures prove it. We have been the leading independent monthly magazine in this market for the last nine years

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £8 (+ VAT) per single column centimetre (minimum 2.5cm). The prepaid rate for classified adverts is 30p (+ VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday with Practical Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to Advertisements, Everyday with Practical Electronics, Holland Wood House, Church Lane, Great Holland, Essex CO13 0JS. Phone/Fax (0255) 850596.

For rates and information on display and classified advertising please contact our Advertisement Manager, Peter Mew as above.

NEWMARKET TRANSFORMERS LTD

Mail Order Transformer Specialists.
Toroidal and Laminated Transformers,
3VA to 1kVA.
Fast delivery. Competitive prices.
Quality guaranteed.

Phone: Michael Dorman
on 0638 662989 for Immediate Quote

RCS VARIABLE VOLTAGE D.C. BENCH POWER SUPPLY

1 to 24 volts up to 1/2 amp. 1 to 20 volts up to 1 amp. 1 to 16 volts up to 1 1/2 amps d.c. Fully stabilised. Twin panel meters for instant voltage and current readings. Overload protection.
Fully variable.
Operates from 240V a.c.
Compact unit.
Size 9 x 5 1/2 x 3in.
NEW MODEL. Up to 30volts d.c. at 6amps 10amps peak. Fully variable. Twin panel meters. Size 14 1/2 x 11 x 4 1/2in. £98 inc VAT. Carr £6.



£45 inc. VAT
+ Post and insurance £4

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON
SURREY, U.K. Tel: 081-684 1665

List. Large SAE. Delivery 7 days. Callers welcome. Closed Wednesday

BTEC ELECTRONICS TECHNICIAN FULL-TIME TRAINING

THOSE ELIGIBLE CAN APPLY FOR E.T. GRANT SUPPORT AN EQUAL OPPORTUNITIES PROGRAMME

O.N.C., O.N.D. and H.N.C.

Next course commences
Monday 19th September 1994
FULL PROSPECTUS FROM

LONDON ELECTRONICS COLLEGE
(Dept EPE) 20 PENYVERN ROAD
EARLS COURT, LONDON SW5 9SU
TEL: 071-373 8721

LED BULB/FUSE TESTER KIT

★ Ideal beginners kit ★ Full instructions ★
Quality components, including 2 LEDs,
2 Transistors, toggle switch, and case
★ Money back guarantee.

Send £5.00 plus £1.99 p&p to:
P. CLARK, 4 Comroston Court,
Brocket Road, Hoddesdon, Herts EN11 8PQ.

PP ELECTRONICS

PCB Population & de-population.
One off's or multiples.
PCB Artworking & schematics.
Technical or Electronic enquiries welcome.
PP Electronics, PO Box 38, Aberdeen AB9 8DP
Phone/Fax 0224 735456 Mobile 0374 452876

SURVEILLANCE KITS

MICRO TRANSMITTER, tuneable 70-115MHz, 500M range, 40mm x 20mm including microphone, 3-12V. Kit £5.95, Assembled £9.95, Order Code KT1.
TELEPHONE TRANSMITTER, 30mm x 10mm, powered from line, transmits both sides of conversation, 500M range, 88-130MHz. Kit £7.95, Assembled £12.95, Order Code KT3.
3 WATT TRANSMITTER, 80-110MHz, 12-15V, adjustable input sensitivity, varicap controlled, several miles range, Kit £15.95, Assembled £25.95, Order Code KT4.

All prices include p&p.
Credit card orders telephone 021 486 3092.
Send 2x1st class stamps for Catalogue. Cheques/P.O.s payable to:
C.E.C.
(Dept. EPE), 515A Bristol Road,
Birmingham B29 6AU

UNIVERSITY DEGREES

Convert your existing Life Experience into a Degree from Earlscroft University:

- Liberal Arts & Sciences
- Tailor-Made Programmes
- Low-Cost
- Bachelors, Masters, Doctorates
- Entry at any time

Details Dr. J. East, E.U.I.,
Redgrove House, 393 Lordship Lane,
Dulwich, London SE22 8JN.



MSX Link is the UK's MSX user group

Ring us on 0733 242952,
or write to: MSX Link,
6 Main Street, Farcot,
Peterborough PE7 3AN

★★★ SURVEILLANCE KITS ★★★

MRT1 MICRO TRANSMITTER, 26mm x 20mm including sensitive electret microphone, tuneable 80-115MHz, 500M range. Kit £4.95, Assembled £8.95.

MTT1 TELEPHONE TRANSMITTER, 35mm x 10mm, powered from line, transmits all conversations, 500M range, 80-120MHz. Kit £5.95, Assembled £10.95.

All prices include p&p. Send 2x2nd class stamps for Catalogue. Cheques/P.O.s payable to:

EXCEL PRODUCTS (Dept. EPE)
Unit 14, Sunningdale, Bishop's Stortford, Herts CM23 2PA

THE BRITISH AMATEUR ELECTRONICS CLUB

exists to help electronics enthusiasts by personal contact and through a quarterly Newsletter.

For membership details, write to the Secretary:

Mr. J. F. Davies, 70 Ash Road, Cuddington,
Northwich, Cheshire CW8 2PB.

Space donated by Everyday with Practical Electronics

RESISTOR CLEARANCE

2-MILLION 1/2W AND 1/4W CARBON FILM RESISTORS MUST GO. LOTS OF VALUES.

Mixed bag of 1,000 £4.00 + 75p P&P.

Mixed bag of 5,000 £15.00 + £2.00 P&P.

Mixed bag of 10,000 £25.00 + £3.00 P&P.

D.J. Hooker, Unit 7, Romney Enterprise Centre,
North Street, New Romney, Kent, TN28 8DW.
Tel/Fax: (0797) 367225 24hr.

Miscellaneous

PROTOTYPE PRINTED CIRCUIT BOARDS
one off's and quantities, for details send s.a.e. to B. M. Ansbro, 38 Poynings Drive, Sussex BN3 8GR, or phone Brighton 883871.

G.C.S.E. ELECTRONICS KITS, at pocket money prices. S.A.E. for FREE catalogue. SIR-KIT Electronics, 70 Oxford Road, Clacton, CO15 3TE.

PLDs AND EPROMS copied or programmed. We supply logic devices/convert discrete logic to PLDs. Also PCBs designed. Send for details to PO Box 1561 Bath (0225 444467).

ELECTRONIC AND RADIO component bargains. Secure Assignments Ltd, 2 Cedar Lodge Drive, Wolverton, Milton Keynes, MK12 5ES. Tel: 0908 319245.

VALVE ENTHUSIASTS: Capacitors for valve circuits - ring for list. Free advice from experienced engineer, if required. Geoff Davies (Radio). Tel: 0788 574774.

PLANS, BOOKS AND MANUALS. Windgenerators, petrol generators, inverters, portable welding generators, engine crane, electric bike, solar projects, electronic circuit and project books, and many more. Two first class stamps for descriptive catalogue. Jemmett Engineering, 8 Hallam Gardens, Pinner, Middlesex HA5 4 PR.

OSCILLOSCOPE. Hameg 20MHz, dual trace, component tester, TV separator. Purchased Oct. 1993. Guarantee. Cost over £400. Accept £195. 0483 762645.

AUDIOPHILES. Can now build the "Musician", a high quality Class A Valve power amp, for set of Blueprints send large S.A.E. with £2.50 cheque/P.O. to S. Perry (Audio Engineering Ltd), 57a Lyndhurst Drive, Leyton, London E10 6JB.

This 2 1/2cm space in
**Everyday with
Practical Electronics**
Would ONLY cost you
£20 + VAT

EVERYDAY WITH PRACTICAL ELECTRONICS

SUBSCRIPTION ORDER FORM

Annual subscription rates
(1994):
UK £22.00. Overseas £28
(surface mail). £45.50 (airmail)

To:
Everyday with Practical Electronics,
6 Church Street, Wimborne,
Dorset BH21 1JH
Tel: 0202 881 749 Fax: 0202 841 692

Name

Address

I enclose payment of £.....

(cheque/PO in £ sterling only, payable to Everyday with Practical Electronics). Alternatively send Access or Visa number and card expiry date.

Signature

Please supply name and address of card-holder if different from the subscription address shown above. Subscriptions can only start with the next available issue. For back numbers see the Editorial page.

M8/94

MAKE YOUR INTERESTS PAY!

Over the past 100 years more than 10 million students throughout the world have found it worth their while! An ICS home-study course can help you get a better job, make more money and have more fun out of life! ICS has over 100 years experience in home-study courses, and is the largest correspondence school in the world. You learn at your own pace, when and where you want under the guidance of expert personal tutors. Find out how we can help YOU. Post or phone today for FREE INFORMATION on the course of your choice. (Tick one box only!)

GCSE/A' LEVEL over 40 examination subjects to choose from. Ask for details.

| | |
|--|---|
| Electronics <input type="checkbox"/> | TV, Video & Hi-Fi Servicing <input type="checkbox"/> |
| C & G Basic Electronic Engineering <input type="checkbox"/> | Refrigeration & Air Conditioning <input type="checkbox"/> |
| Electrical Engineering <input type="checkbox"/> | PC Repair <input type="checkbox"/> |
| Electrical Contracting/Installation <input type="checkbox"/> | Computer Programming <input type="checkbox"/> |

Mr/Mrs/Miss/Ms

Address _____

P.Code _____

ICS International Correspondence Schools, Dept. ECS 84, 312/314 High Street, Sutton, Surrey SM1 1PR. Tel: 041-221 7373 (24 hours). Fax: 041-221 8151.

VISA



Cooke International

SUPPLIER OF QUALITY USED TEST INSTRUMENTS

ANALYSERS, BRIDGES, CALIBRATORS, VOLTMETERS, GENERATORS, OSCILLOSCOPES, POWER METERS, ETC. ALWAYS AVAILABLE

ORIGINAL SERVICE MANUALS FOR SALE
COPY SERVICE ALSO AVAILABLE

EXPORT, TRADE AND U.K. ENQUIRIES WELCOME

SEND LARGES, A.E. (50p POSTAGE) FOR LISTS OF EQUIPMENT & MANUALS

ALL PRICES EXCLUDE VAT AND CARRIAGE

DISCOUNT FOR BULK ORDERS SHIPPING ARRANGED

OPEN MONDAY TO FRIDAY 9AM-5PM

Unit Four, Fordingbridge Site, Main Road, Barnham, Bognor Regis,
West Sussex, PO22 0EB

Tel (+ 44) 0243 545111/2 Fax (+ 44) 0243 542457

HIGH END EQUIPMENT PURCHASED

MARAPET ELECTRONIC COMPONENTS

Tel: 0452 526883

Spares for TV ★ Video ★ Audio ★ Computer Equipment

VIDEO SPARES

We can supply Pinch Rollers, Idlers, Belt Kits, Heads + many other Service & Specific parts for over 160 makes

TV - SATELLITE

AUDIO SPARES

Switches, Transformers, Semiconductors, etc., etc. Large range available

EQUIPMENT MANUALS

Large selection of Manufacturers Service & User information available. Original manuals supplied if possible.

SEMICONDUCTORS

We can supply thousands of different Custom & Industry Standard devices
BLU484 £4.99 25K301R £1.85
STK4122II £7.19 27C256-200 £2.98

PHONE for a 'PRICE & AVAILABILITY' on your requirements, or send S.A.E. for more information on our service.

COMPUTER SPARES

PHILIPS MONITORS

BM7513 Serv. Manual £3.49
CM8833 Serv. Manual £7.84
CM8833 Line O/P Tx £24.94
CM8833 to Amiga Lead £3.28
CM9073 O/O Switch £8.63
CM11342 Line O/P Tx £28.51

AMSTRAO

CP464 User Manual £10.95
CP464 Keyboard £29.99
PCW 9512 Serv. Manual £14.99
AY3812 £7.06
SE9420CAC £14.93
Most Amstrad parts available

FLYBACK TRANSFORMERS

OIGITAL VT320 £29.05
IBM 8512 (State type) £49.93

We can supply many other types. We only show a small sample of our range. Batteries, Leads, ribbons also stocked.

SPECIAL OFFER

Sinclair, Atari Commodore CHIPS

COMMODORE

40054 ROM (+2) £11.69
TMS4532NL 4 DRAM £0.99
ZX8302 ULA (QL) £6.44
ZX8401 ULA (Spec.) £5.44
CO25913 DMA (ST) £32.99
Keyboard CPU (ST) £23.50
PC713V (STE-PSU) £2.89
PC900V/H1L3 (ST) £2.78
6569 VIC (C64) £19.95
8555 VIC (C64C) £18.85
MB81416-12 DRAM (C18) £4.49
Further savings for (+) quantities. Please enquire

COMMODORE

C64/64C Serv. Manual £14.99
C64C User Manual £4.49
905114-01 PLA (C64) £3.99
83728 (A3000) £34.19

Order by Post or Phone VISA, ACCESS, DELTA & SWITCH accepted with pleasure. Minimum P&P charge is £1.25 - Please then add extra 50p if ordering a Manual or LOPT. All items subject to availability. Prices can change without notice.

Mail Order to:- MEC
1 HORNBEAM MEWS
GLOUCESTER GL2 0UE

INFOTECH & STREE

76 Church St, Larkhall, Lanarks, ML9 1HE
Phone (0698) 883334/888343 or Fax (0698) 884825

Remember: Not only do we have every sheet ever produced, but we also have

The World's Largest Collection of SERVICE MANUALS & CIRCUITS

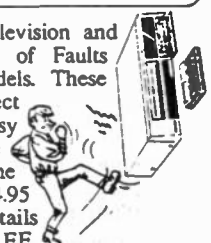
We are now successfully running a Library Service which allows you to borrow any manual you want for as long as you want, and when you need another manual, just return the one you have, plus a £4.95 exchange fee and tell us what you want next.

Borrow any Service Manual for £4.95
regardless of its size or normal cost

The cost of this service is a yearly subscription fee of only £59.95. Join now & get a free 'Data Ref Guide'.

FAULT LISTS FOR TV AND VIDEO

Our latest range of FAULT LISTS for Television and Video Recorders cover a VAST selection of Faults for Dozens of different Makes and Models. These Guides which are ONLY available direct from us will prove invaluable to the busy Service Department. The 3 books are normally £5.95 each but if you order the full set at once they are just £14.95 inclusive of postage and packing. Full details of the contents are shown in our FREE catalogue.



Just £14.95 for the full set. Order MP-277.

The above are just three from hundreds of Technical and Repair books we publish. From Valve Data to Video Recorders with everything else in between. We also have what is probably the largest range of Service Manuals available anywhere, for practically any Make, Model, Type or Age of equipment.



For your FREE catalogue detailing our full range of Technical Books and Repair Guides complete the coupon below.



MAURITRON TECHNICAL SERVICES (EPE277),

47A High Street, Chinnor, Oxon, OX9 4DJ.

Tel:- 0844-351694. Fax:- 0844 352554.

Please forward your latest catalogue for which I enclose 2 x 1st Class Stamps.

NAME _____

ADDRESS _____

POSTCODE _____

| | |
|---|------------------------------------|
| 80 Column printer stand.....£4.50 | 25 off buzzers & sounders..£3.50* |
| 132 Column printer stand....£4.95 | 25 off mixed relays.....£4.95* |
| 80286-1 Microprocessor...£9.95* | 50 off mixed switches.....£7.50* |
| Electret condenser mics | 250 off i.c. sockets.....£3.95 |
|£1 ea 10 for £5* | 1000 off Ceramic caps.....£7.50* |
| 5 1/4" to 3 1/2" floppy converter | 5 off 3V Lithium memory |
| leads.....£1.50 ea* | back-up batteries.....£2.00* |
| 360K 5 1/4" customer returned | 100 off 2200µF 25V caps...£6.00* |
| disk drives.....2 for £5 | 100 off 4.7µF 25V caps...£2.50* |
| 9-pin High Density VGA | 3lb mixed component |
| leads.....£2.50* | pack.....£4.95 |
| 10A 250V IEC leads.....£1.50* | Jumbo component pack.....£10 |
| Spectrum 128K + 2 p.s.u. | Crystal oscillators |
| 9V 2-1A.....£4.95 | 10/12Mhz.....£1 ea |
| STC p.s.u. 240V Input; 5V 6A | 5V DPCO D.I.L. relay.....60p ea* |
| Output, (converts to 12V 3A, | 5V SPCO S.I.L. reed relay. 40p ea* |
| details supplied).....£5.95 | 12V Piezoelectric Sounders.50p ea |
| Temperature probes, with | DIL Switches 3/4/6 and |
| data.....£3.95* | 12-way.....35p ea* |
| Universal Timer (10 min. | Sounder and video modulator |
| delay and 20 min. cut-off |£3.50 ea, 10 for £20* |
| functions).....£3.95* | UM1233 video modulators....£2* |
| Dictaphone cassette mech.£2.00* | 3-5mm jack plugs.....10 for £1* |
| 35mm Camera returns, with | 16A BT surge arrestors..10 for £5* |
| auto flash, wind on, etc. | 100 off Zener diodes, mixed....£2* |
|£6 ea, 2 for £10* | 21-piece mini screwdriver |
| 60mm ² 12V D.C. brushless fans | set.....£3.95* |
|£3.50 ea, 10 for £30* | Universal test lead kit.....£3.95* |
| 40 Character x 1-line dot | 10 crocodile clip leads.....£3.50* |
| matrix display.....£4.95 ea* | 20 off mixed R.F. Filters, |
| Car Dashboard Display (shows | Crystals, etc.....£4.95* |
| lights, indicators, doors, | 100m P.V.C. sleeving.....£4.50* |
| on picture of car).....£4.95* | |
| 4-digit clock display.....£2.50* | |
| 4-digit l.c.d. with 7211 | |
| driver.....£3.50* | |
| 17-digit v.f. display.....£2.95* | |
| Giant 2 digit v.f. display....£2.95* | |
| 12V stepper motors, 48 steps | |
| per rev., 7-3° step angle...£3.95* | |
| 250 off mixed electrolytic | |
| caps.....£4.95* | |
| 250 off polyester caps.....£4.95* | |
| 1000 off mixed resistors | |
| 1/4W.....£4.95* | |
| 100 off phono plugs.....£2.95* | |
| 50 off mixed terminal | |
| blocks.....£2.50* | |

QUANTITY DISCOUNTS AVAILABLE PLEASE RING

We also buy all forms of electronic components, p.s.u.'s, disk drives etc. Lists to below address.

ALL PRICES INCLUDE V.A.T. PLEASE ADD £2.00 p&p EXCEPT ITEMS MARKED* WHICH ARE 50P. SAE FOR BULK BUYING LIST PAYMENT WITH ORDER TO:

Dept EE, COMPELEC,
14 Constable Road,
St. Ives, Huntingdon,
Cambs PE17 6EQ
Tel/Fax: 0480 300819

N. R. BARDWELL LTD (EPE)

| | | | | | |
|-----|--|-------|-----|--|-------|
| 200 | Signal diodes 1N4148 | £1.00 | 200 | Assd. disc ceramic capacitors | £1.00 |
| 75 | Rectifier Diodes 1N4001 | £1.00 | 80 | Assd capacitors 1nf to 1uf | £1.00 |
| 50 | Rectifier Diodes 1N4007 | £1.00 | 80 | Assd electrolytic capacitors | £1.00 |
| 25 | Rectifier Diodes 1N5401 | £1.00 | 80 | 1UF 16V Radial electrolytics | £1.00 |
| 100 | Assd. Zeners | £1.00 | 80 | 4.7UF 16V Radial electrolytics | £1.00 |
| 10 | NE555 Timer ICs | £1.00 | 75 | 4.7UF 50V Radial electrolytics | £1.00 |
| 30 | BC478 Transistors | £1.00 | 80 | 10UF 16V Radial electrolytics | £1.00 |
| 30 | BC547 Transistors | £1.00 | 50 | 10UF 50V Radial electrolytics | £1.00 |
| 30 | BC558 Transistors | £1.00 | 40 | 22UF 25V Radial electrolytics | £1.00 |
| 30 | MPSA42 Transistors | £1.00 | 60 | 33UF 16V Radial electrolytics | £1.00 |
| 30 | 5mm red l.e.d.s | £1.00 | 80 | 100UF 10V Radial electrolytics | £1.00 |
| 25 | Assd. high brightness l.e.d.s | £1.00 | 50 | 220UF 16V Radial electrolytics | £1.00 |
| 24 | Miniature red l.e.d.s 3mm dia | £1.00 | 60 | 470UF 10V Radial electrolytics | £1.00 |
| 50 | Axial l.e.d.s (Diode package) wide angle l.e.d.s | £1.00 | 20 | 1000UF 10V Axial electrolytics | £1.00 |
| 12 | Assd. seven segment displays | £1.00 | 12 | 1000UF 25V Axial electrolytics | £1.00 |
| 30 | Assd. IF transformers | £1.00 | 1 | 1 Farad 5.5V memory back up capacitor | £1.00 |
| 48 | Assd. coil formers | £1.00 | 100 | 4N7 Mini Axial capacitors | 80p |
| 100 | Assd. RF chokes (inductors) | £1.00 | 100 | 5mm plastic l.e.d. holders (for tapered l.e.d.s) | £2.00 |
| 30 | Assd. connectors edge-dil-sil etc. | £1.00 | 1 | 10 watt Stereo amplifier, 4 controls plus data | £2.95 |
| 10 | 4P 3W MBB min rotary switches | £1.00 | | | |
| 20 | 1 inch Glass reed switches | £1.00 | | | |
| 20 | Magnetic ear pins plus lead & plug | £1.00 | | | |
| 20 | Min SP/CO slide switches | £1.00 | | | |
| 30 | Assd. d.i.l. sockets up to 40 pin | £1.00 | | | |
| 20 | 24-way turned pin IC sockets | £1.00 | | | |
| 24 | 24 pin d.i.l. wire wrap IC sockets | £1.00 | | | |
| 2 | GRP12 light dependant resistors | £1.00 | | | |

Prices include VAT, postage £1.25. Stamp for Lists
288 Abbeydale Road, Sheffield S7 1FL
Phone (0742) 552886 Fax (0742) 500689

Millions of quality components at lowest ever prices!

Plus Tools, Watches, Fancy Goods, Toys.
Mail order UK only.

All inclusive prices –
NO VAT to add on.

Send 43p stamped self addressed label or envelope for catalogue/clearance list.

At least 2,100 offers to amaze you.

Brian J Reed

**6 Queensmead Avenue, East Ewell
Epsom, Surrey KT17 3EQ
Tel: 081-393 9055**

| | |
|---|----------------|
| Carbon Film resistors ¼W 5% E24 series 0.51 R to 10MΩ | 1p |
| 100 off per value – 75p. even hundreds per value totalling 1000 | £6.00p |
| Metal Film resistors ¼W 10R to 1 MΩ 5% E12 series – 2p. 1% E24 series | 3p |
| Mixed metal/carbon film resistors ¼W E24 series 1 RΩ to 10MΩ | 1½p |
| 1 watt mixed metal/Carbon Film 5% E12 series 4R7 to 10 Megohms | 5p |
| Linear Carbon pre-sets 100mW and ¼W 100R to 4M7 E6 series | 7p |
| Miniature polyester capacitors 250V working for vertical mounting | |
| 015, 022, 033, 047, 068, 4p 0.1 - 5p, 0.12, 0.15, 0.22 - 6p, 0.47 - 8p, 0.68 - 8p, 1.0 - 12p | |
| Mylar (polyester) capacitors 100V working E12 series vertical mounting | |
| 1000p to 8200p - 3p, 0.1 to 0.68 - 4p, 0.1 - 5p, 0.12, 0.15, 0.22 - 6p, 0.47/50V - 8p | |
| Submin ceramic plate capacitors 100V wkg vertical mountings. E12 series | |
| 2½ 1.8pf to 47pf - 3p, 2% 56pf to 330pf - 4p, 10% 390p-4700p | 4p |
| Disc/plate ceramics 50V E12 series 1 PΩ to 1000P, E6 Series 1500P to 47000P | 2p |
| Polystyrene capacitors 63V working E12 series long axial wires | |
| 10pf to 820pf - 5p, 1000pf to 10,000pf - 6p, 12,000pf | 7p |
| 741 Op Amp - 20p, 555 Timer - 20p, LM3900 | 80p |
| CMOS 4001 - 20p, 4011 - 22p, 4017 - 40p, 4069SUB unbuffered | 20p |
| DIL holders, 8-pin 9p, 14-, 16-, 18-pin 12p; 24-pin 18p; 28-pin 20p; 40-pin 25p. | |
| ALUMINIUM ELECTROLYTICS (Mfds/Volts) | |
| 1/50, 2.2/50, 4.7/50, 10/25, 10/50 | 5p |
| 22/16, 22/25, 22/50, 33/16, 47/16, 47/25, 47/50 | 6p |
| 100/16, 100/25 7p; 100/50 | 12p |
| 220/16 8p; 220/25, 220/50 10p; 470/16, 470/25 | 11p |
| 1000/25 25p; 1000/35, 2200/25 35p; 4700/25 | 14p |
| Submin. tantalum bead electrolytics (Mfds/Volts) | |
| 0.1/35, 0.22/35, 0.47/35, 1.0/35, 3.3/16, 4.7/16 | 7p |
| 2.2/35, 4.7/25, 4.7/35, 6.8/16 15p; 10/16, 22/6 | 20p |
| 33/10, 47/6, 22/16 30p; 47/10 35p; 47/16 60p; 47/35 | 80p |
| VOLTAGE REGULATORS | |
| 1A + or - 5V, 8V, 12V, 15V, 18V & 24V - 55p, 100mA, 5.8, 12, 15, V + | 30p |
| DIODES (piv/amps) | |
| 75/25mA 1N4148 2p, 800/1A 1N4006 4½p, 400/3A 1N5404 14p, 115/15mA OA91 | 8p |
| 100/1A 1N4002 3½p, 1000/1A 1N4007 5p, 60/1.5A S1M1 5p, 100/1A bridge | 25p |
| 400/1A 1N4004 4p, 1250/1A BY 127 10p, 30/150mA OA47 gold bonded | 18p |
| Zener diodes E24 series 3V3 to 33V 400mW - 8p, 1 watt | 12p |
| Battery snaps for PP3 - 7p for PP9 | 12p |
| L.E.D.'s 3mm & 5mm, Red, Green, Yellow - 10p, Grommets 3mm - 2p, 5mm | 2p |
| Red flashing L.E.D.'s require 9-12V supply only | 50p |
| Mains indicator neons with 220k resistor | 10p |
| 20mm fuses 100mA to 5A, 0 blow 6p, A/surge 10p, Holders, chassis, mounting | 6p |
| High speed pc drill 0.8, 1.0, 1.3, 1.5, 2.0mm - 40p, Machines 12v dc | £15.00 |
| HELPING HANDS 6 ball joints and 2 croc clips to hold awkward jobs | £4.50 |
| AA/HP7 Nicad rechargeable cells 90p each, Universal charger unit | £6.50 |
| AA/HP7 zinc/carbon batteries in packs of 4 | £1.10 per pack |
| Glass reed switches with single pole make contacts - 8p, Magnets | 20p |
| 0.1" Stripboard 2½" x 1" 9 rows 25 holes - 25p, 3½" x 2½" 24 rows 37 holes | 70p |
| Jack plugs 2.5 & 3.5mm - 14p, Sockets Panel Mtg, 2.5 & 3.5mm | 10p |
| Ear pieces 2.5 & 3.5mm, dynamic - 20p; 3.5mm crystal | £1.50 |
| Multi cored solder, 22G - 8p yard, 18G - 14p yard. | |
| TRANSISTORS | |
| BC107/8/9 - 12p, BC547/8/9 - 8p, BC557/8/9 - 8p, BC182, 182L, BC183, 183L | |
| BC184, 184L, BC212, 212L - 10p | |
| BC327, 337, 337L - 12p, BC727, 737 - 12p, BD135/6/7/8/9 - 25p, BCY70 - 18p, | |
| BFY50/51/52 - 20p | |
| 8FX88 - 15p, 2N3055 - 55p, TIP31, 32 - 30p, TIP41, 42 - 40p, BU208A - £1.50, 8F195, 197 - 12p | |
| Ionisers with seven year guarantee, 240V AC, list price £16.95 or more | £12.50 |

All prices are inclusive of VAT. Postage 30p (free over £5). Stamp for list.

THE CR SUPPLY CO

127 Chesterfield Rd., Sheffield S8 0RN Tel: 0742 557771 Return posting

SHERWOOD ELECTRONICS

7 Williamson Street, Mansfield, Notts. NG19 6TD

SPECIAL OFFER - choose 2 x £1 packs FREE with every 12 purchased

| | | | |
|------|------------------------|-------|----------------------------------|
| SP1 | 15 x 5mm Red Leds | SP36 | 25 x 10/25V radial elect caps |
| SP2 | 15 x 5mm Green Leds | SP42 | 200 x Mixed 0.25W C.F. resistors |
| SP3 | 12 x 5mm Yellow Leds | SP47 | 5 x Min. push button switches |
| SP6 | 15 x 3mm Red Leds | SP102 | 20 x 8 pin DIL sockets |
| SP7 | 12 x 3mm Green Leds | SP103 | 15 x 14 pin DIL sockets |
| SP8 | 10 x 3mm Yellow Leds | SP104 | 15 x 16 pin DIL sockets |
| SP10 | 100 x 1N4148 diodes | SP115 | 3 x 10mm Red Leds |
| SP11 | 30 x 1N4001 diodes | SP116 | 3 x 10mm Green Leds |
| SP12 | 30 x 1N4002 diodes | SP130 | 100 x Mixed 0.5W C.F. resistors |
| SP18 | 20 x BC182 transistors | SP133 | 20 x 1N4004 diodes |
| SP20 | 20 x BC184 transistors | SP134 | 15 x 1N4007 diodes |
| SP23 | 20 x BC549 transistors | SP137 | 4 x W005 rectifiers |
| SP24 | 5 x Cmos 4001 | SP140 | 3 x W04 rectifiers |
| SP25 | 5 x 555 timers | SP142 | 2 x Cmos 4017 |
| SP26 | 5 x 741 Op-amps | SP151 | 4 x 8mm Red Leds |
| SP28 | 5 x Cmos 4011 | SP157 | 5 x BCY70 transistors |

| | | | |
|-------------------------------|---------------------------|--------------------------------|--------------------------------|
| RESISTOR PACKS - 0.25W C Film | | Catalogue available £1 or FREE | |
| RP3 | 5 each value - total 365 | £2.50 | with first order over £5 |
| RP7 | 10 each value - total 730 | £3.75 | |
| RP10 | 1000 popular values | £4.95 | Please note new address |

Cheques or P.O. to **SHERWOOD ELECTRONICS** NO VAT
Please add £1.25 P&P to all orders

ADVERTISERS INDEX

| | |
|--------------------------------|-------------|
| AUTONA | 627 |
| N. R. BARDWELL | 644 |
| B.K. ELECTRONICS | Cover (iii) |
| BRIAN J. REED | 644 |
| BULL ELECTRICAL | Cover (ii) |
| CAMBRIDGE COMPUTER SCIENCE | 617 |
| CHATWIN GUITARS (JCG) | 567 |
| CIRKIT DISTRIBUTION | 567 |
| COMPELEC | 643 |
| COOKE INTERNATIONAL | 643 |
| CRICKLEWOOD ELECTRONICS | 589 |
| CR SUPPLY COMPANY | 644 |
| DISPLAY ELECTRONICS | 562 |
| ELECTROMAIL (RS COMPONENTS) | 601 |
| ESR ELECTRONIC COMPONENTS | 572 |
| EXPRESS COMPONENTS | 569 |
| GREENWELD ELECTRONICS | 565 |
| HART ELECTRONIC KITS | 568 |
| ICS | 643 |
| INFOTECH & STREE | 643 |
| JAYTEE ELECTRONIC SERVICES | 627 |
| JPG ELECTRONICS | 615 |
| LABCENTER | 597 |
| MAGENTA ELECTRONICS | 570/571 |
| MAILTECH | 641 |
| MAPLIN ELECTRONICS | Cover (iv) |
| MARAPET | 643 |
| MAURITRON | 643 |
| M&B ELECTRICAL SUPPLIES | 566 |
| MQP ELECTRONICS | 589 |
| NATIONAL COLLEGE OF TECHNOLOGY | 621 |
| NICHE SOFTWARE | 615 |
| NUMBER ONE SYSTEMS | 583 |
| OMNI ELECTRONICS | 595 |
| PICO TECHNOLOGY | 585 |
| POWERWARE | 621 |
| SEETRAX CAE | 563 |
| SERVICE TRADING | 595 |
| SHERWOOD ELECTRONICS | 644 |
| STEWART OF READING | 567 |
| SUMA DESIGNS | 564 |
| YUGA ENTERPRISE | 617 |

ADVERTISEMENT MANAGER:

PETER J. MEW

ADVERTISEMENT OFFICES:

EVERYDAY with PRACTICAL ELECTRONICS,
ADVERTISEMENTS,

HOLLAND WOOD HOUSE, CHURCH LANE,
GREAT HOLLAND, ESSEX CO13 0JS.

Phone/Fax: (0255) 850596

For Editorial address and phone numbers see page 573.

OMP MOS-FET POWER AMPLIFIERS
HIGH POWER, TWO CHANNEL 19 INCH RACK

THOUSANDS PURCHASED BY PROFESSIONAL USERS



THE RENOWNED MXF SERIES OF POWER AMPLIFIERS
FOUR MODELS:- MXF200 (100W + 100W) MXF400 (200W + 200W)
MXF600 (300W + 300W) MXF900 (450W + 450W)
ALL POWER RATINGS R.M.S. INTO 4 OHMS, BOTH CHANNELS DRIVEN

FEATURES: ★ Independent power supplies with two toroidal transformers ★ Twin L.E.D. Vu meters ★ Level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 & MXF900 fan cooled with D.C. loudspeaker and thermal protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.

SIZES:- MXF200 W19" x H3 1/2" (2U) x D11"
MXF400 W19" x H5 1/4" (3U) x D12"
MXF600 W19" x H5 1/4" (3U) x D13"
MXF900 W19" x H5 1/4" (3U) x D14 1/2"

PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15
SPECIALIST CARRIER DEL. £12.50 EACH



OMP X03 STEREO 3-WAY ACTIVE CROSS-OVER



Advanced 3-Way Stereo Active Cross-Over, housed in a 19" x 1U case. Each channel has three level controls: bass, mid & top. The removable front fascia allows access to the programmable DIL switches to adjust the cross-over frequency: Bass-Mid 250/500/800Hz, Mid-Top 1.8/3/5KHz, all at 24dB per octave. Bass Invert switches on each bass channel. Nominal 775mV Input/output. Fully compatible with OMP rack amplifier and modules.

Price £117.44 + £5.00 P&P

STEREO DISCO MIXER SDJ3400S

*** ECHO & SOUND EFFECTS ***

STEREO DISCO MIXER with 2 x 7 band L & R graphic equalisers with bar graph LED Vu meters. MANY OUTSTANDING FEATURES:- including Echo with repeat & speed control, DJ Mic with talk-over switch, 6 Channels with individual faders plus sound fade, Cue Headphone Monitor, B Sound Effects. Useful combination of the following inputs:- 3 turntables (mag), 3 mics, 5 Line for CD, Tape, Video etc.



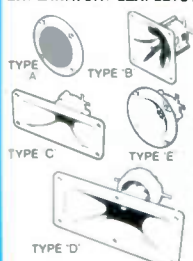
Price £144.99 + £5.00 P&P

SIZE: 482 x 240 x 120mm

PIEZO ELECTRIC TWEETERS - MOTOROLA

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

TYPE 'A' (KSN1036A) 3" round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi speakers. Price £4.90 + 50p P&P.
TYPE 'B' (KSN1005A) 3 1/2" super horn for general purpose speakers, disco and P.A. systems etc. Price £5.99 + 50p P&P.
TYPE 'C' (KSN1016A) 2" x 5" wide dispersion horn for quality Hi-Fi systems and quality discos etc. Price £6.99 + 50p P&P.
TYPE 'D' (KSN1025A) 2" x 6" wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. Price £9.99 + 50p P&P.
TYPE 'E' (KSN1038A) 3 1/2" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £5.99 + 50p P&P.
LEVEL CONTROL Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. Price £4.10 + 50p P&P.



IBI FLIGHT CASED LOUDSPEAKERS

A new range of quality loudspeakers, designed to take advantage of the latest speaker technology and enclosure designs. Both models utilize studio quality 12" cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands.

POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET
FREQUENCY RESPONSE FULL RANGE 45Hz - 20KHz

ibi FC 12-100WATTS (100dB) PRICE £159.00 PER PAIR
ibi FC 12-200WATTS (100dB) PRICE £175.00 PER PAIR

SPECIALIST CARRIER DEL. £12.50 PER PAIR

OPTIONAL STANDS PRICE PER PAIR £49.00
Delivery £6.00 per pair



IN-CAR STEREO BOOSTER AMPS



PRICES: 150W £49.99 250W £99.99
400W £109.95 P&P £2.00 EACH

THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS
150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono

ALL POWERS INTO 4 OHMS
Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

OMP MOS-FET POWER AMPLIFIER MODULES

SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, **NOTE** that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS



OMP/MF 100 Mos-Fet Output power 110 watts
R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P



OMP/MF 200 Mos-Fet Output power 200 watts
R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P



OMP/MF 300 Mos-Fet Output power 300 watts
R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 + £5.00 P&P



OMP/MF 450 Mos-Fet Output power 450 watts
R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P



OMP/MF 1000 Mos-Fet Output power 1000 watts
R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.
PRICE £259.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 800mV, BAND WIDTH 100KHz, PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.

LOUDSPEAKERS

LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (60p STAMPED) FOR COMPLETE LIST.



McKenzie and Fane Loudspeakers are also available.

EMINENCE:- INSTRUMENTS, P.A., DISCO, ETC

ALL EMINENCE UNITS 8 OHMS IMPEDANCE
8" 100 WATT R.M.S. ME8-100 GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID. DISCO. RES. FREQ. 72Hz, FREQ. RESP. TO 4KHz, SENS 97dB. PRICE £32.71 + £2.00 P&P
10" 100 WATT R.M.S. ME10-100 GUITAR, VOCAL, KEYBOARD, DISCO, EXCELLENT MID. RES. FREQ. 71Hz, FREQ. RESP. TO 7KHz, SENS 97dB. PRICE £33.74 + £2.50 P&P
10" 200 WATT R.M.S. ME10-200 GUITAR, KEYB'D, DISCO, VOCAL, EXCELLENT HIGH POWER MID. RES. FREQ. 65Hz, FREQ. RESP. TO 3.5KHz, SENS 99dB. PRICE £43.47 + £2.50 P&P
12" 100 WATT R.M.S. ME12-100LE GEN. PURPOSE, LEAD GUITAR, DISCO, STAGE MONITOR. RES. FREQ. 49Hz, FREQ. RESP. TO 6KHz, SENS 100dB. PRICE £35.64 + £3.50 P&P
12" 100 WATT R.M.S. ME12-100LT (TWIN CONE) WIDE RESPONSE, P.A., VOCAL, STAGE MONITOR. RES. FREQ. 42Hz, FREQ. RESP. TO 10KHz, SENS 98dB. PRICE £36.67 + £3.50 P&P
12" 200 WATT R.M.S. ME12-200 GEN. PURPOSE, GUITAR, DISCO, VOCAL, EXCELLENT MID. RES. FREQ. 58Hz, FREQ. RESP. TO 6KHz, SENS 98dB. PRICE £46.71 + £3.50 P&P
12" 300 WATT R.M.S. ME12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARD, DISCO ETC. RES. FREQ. 47Hz, FREQ. RESP. TO 5KHz, SENS 103dB. PRICE £70.19 + £3.50 P&P
15" 200 WATT R.M.S. ME15-200 GEN. PURPOSE BASS, INCLUDING BASS GUITAR. RES. FREQ. 46Hz, FREQ. RESP. TO 5KHz, SENS 99dB. PRICE £50.72 + £4.00 P&P
15" 300 WATT R.M.S. ME15-300 HIGH POWER BASS, INCLUDING BASS GUITAR. RES. FREQ. 39Hz, FREQ. RESP. TO 3KHz, SENS 103dB. PRICE £73.34 + £4.00 P&P

EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohm)
BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND
8" 50WATT EB8-50 DUAL IMPEDANCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. PRICE £8.90 + £2.00 P&P
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz, SENS 97dB.
10" 50WATT EB10-50 DUAL IMPEDANCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. PRICE £13.65 + £2.50 P&P
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS 99dB.
10" 100WATT EB10-100 BASS, HI-FI, STUDIO. PRICE £30.39 + £3.50 P&P
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB.
12" 100WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO. PRICE £42.12 + £3.50 P&P
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB.
FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND
5 1/2" 60WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. PRICE £9.99 + £1.50 P&P
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB.
6 1/2" 60WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. PRICE £10.99 + 1.50 P&P
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB.
8" 60WATT EB8-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. PRICE £12.99 + £1.50 P&P
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 99dB.
10" 60WATT EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC. PRICE £16.49 + £2.00 P&P
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB.

TRANSMITTER HOBBY KITS

PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP.
PRICE £14.85 + £1.00 P&P

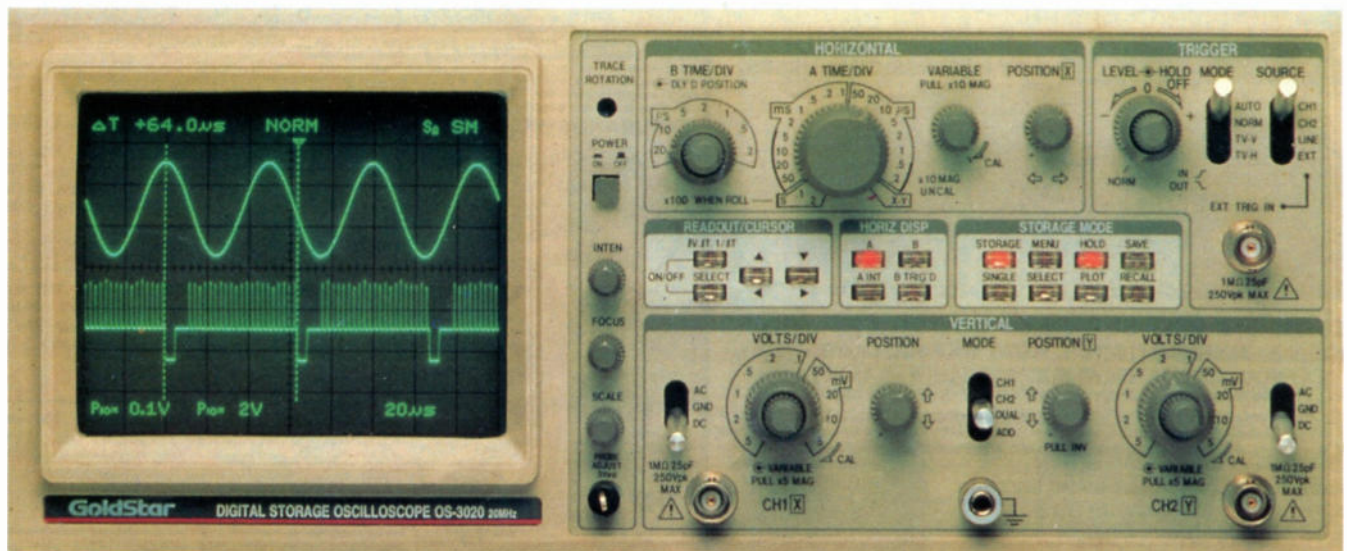
FM MICRO TRANSMITTER 100-108MHz, VARICAP TUNED, COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATTERY.
PRICE £8.80 + £1.00 P&P



PHOTO: 3W FM TRANSMITTER

B.K. ELECTRONICS

UNITS 1 & 5 COMET WAY, SOUTHERN-O-N-SEA, ESSEX, SS2 6TR.
Tel.: 0702 - 527572 Fax.: 0702 - 420243



Model OS-3020 illustrated above

Star Quality, Reliability, and World Class Performance

from only **£269.95**

NEW Maplin Electronics are pleased to announce their superb new range of precision, laboratory grade Oscilloscopes from Goldstar.

NEW The range starts with the super value-for-money, 20MHz Dual-trace Oscilloscope, OS-9020A. Features include a large 6in., high luminance CRT with internal 8 x 10cm graticule, TV field or line triggering and X-Y mode producing Lissajous patterns for phase shift measurements.

NEW For higher frequency applications, the 40MHz Dual-trace Oscilloscope, OS-9040D, is ideal for TV and video signals and a trigger delay facility allows observation of fast leading edges.

NEW For RF signals and high-speed logic applications, the highly specified 100MHz triple-trace Oscilloscope, OS-9100D, has 3 independent input channels and is ideal for simultaneous display of 3 logic pulse trains for timing comparison.

NEW The dual-trace, 40MHz Oscilloscope, OS-904RD, is similar in specification to OS-9040D, but with the additional facility of a digital readout on the CRT. The readout displays information such as timebase and attenuator settings, and on-screen measurements can be performed using movable cursors, the value appearing on the CRT screen.

NEW Top-of-the-range is the excellent 20MHz Digital Storage Oscilloscope, OS-3020, with on-screen digital readout and measurement facilities. The digital storage function enables one-off events to be captured and stored for detailed analysis. Stored waveforms can be printed out on a suitable X-Y plotter via the built-in RS232 interface. Repetitive high-speed waveforms up to 20MHz can be digitised using equivalent sampling techniques and pre-trigger mode allows events occurring before the triggering point to be captured.

All models are supplied complete with probes, mains lead, spare fuses and detailed operating manual. Full details and specifications can be found in the 1994 Maplin Full Colour Catalogue, available from WHSMITH and selected branches of RSMcColl in Scotland for £2.95 (£3.45 by post direct from Maplin). To order, Phone the Credit Card Hotline, 0702 554161, or send your Mail Order to P.O Box 3, Rayleigh, SS6 2BR, or visit your local Maplin store. Please note latest models all now cream in colour as Model OS-3020.

Maplin ELECTRONICS. UK AGENTS FOR **GoldStar**

Visit our stores in: Birmingham, Brighton, Bristol, Cardiff, Chatham, Coventry, Edinburgh, Glasgow, Ilford, Leeds, Leicester, London (Edgware, Forest Hill and Hammersmith), Manchester (Oxford Road and Cheetham Hill), Middlesbrough, Newcastle-upon-Tyne (The Metro Centre, Gateshead), Nottingham, Portsmouth, Reading, Sheffield, Slough, Southampton, Southend-on-Sea, Stockport, plus a NEW store opening soon in Milton Keynes. Phone 0702 552911 for further details.

All items subject to availability, prices include VAT and may change after Feb. 28 1994. Carriage charge per order £5.70. Handling charge £1.40 per order. Overseas customers please phone 0702 552911.



OS-9020A GW03D £269.95



OS-9040D GW04E £399.95



OS-904RD GW06G £499.95



OS-9100D GW05F £699.95



OS-3020 GW07H £749.95

GoldStar
Technology with the human touch